Fachbeitrag

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Architectures of Knowledge: The European Open Science Cloud

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Abstract: In November 2018, the European Commission launched the European Open Science Cloud (EOSC) in Vienna. The EOSC envisions establishing a European data infrastructure, integrating high-capacity cloud solutions, eventually widening the scope of these services to include the public sector and the industry. Understanding the EOSC structure is a first step in recognizing the opportunities offered by the newly launched EOSC. This article offers some reflections for a better understanding of the realization of the EOSC at the present stage, including currently ongoing developments.[1]

Keywords: European Open Science Cloud, EOSC, Digital Single Market

Architektur des Wissens: Die European Open Science Cloud

Zusammenfassung: Im November 2018 wurde die European Open Science Cloud (EOSC) von der Europäischen Kommission in Wien gelauncht. Mit der EOSC wird eine europäische Dateninfrastruktur für Wissenschaft und Forschung aufgebaut, die leistungsstarke Cloud-Lösungen für Forschende integriert und in Zukunft diese Dienste auf den öffentlichen Sektor und die Industrie ausweiten wird. Das Verständnis der EOSC-Struktur ist ein erster Schritt, um die Möglichkeiten von interoperablen und standardisierten Services zu erkennen. Dieser Artikel bietet einige Überlegungen zum besseren Verständnis der Realisierung des EOSC im gegenwärtigen Stadium und gibt Auskunft über die fortlaufenden Entwicklungen bis Ende 2020.

Schlüsselwörter: European Open Science Cloud, EOSC, Digital Single Market

1 European Open Science Cloud (EOSC): a process, not a project

In November 2018, under the Austrian Presidency, the European Commission launched the European Open Science Cloud at the University of Vienna.[2]

The EOSC is not a new infrastructure or software package, it is a process of making research data in Europe accessible to all researchers under the same terms of use and distribution. The initiative aims to push Europe towards a culture of open research data that are detectable, accessible, interoperable and reusable (FAIR), hence allowing all European researchers to embark on a journey towards data-driven science.

The EOSC envisions to interlink existing European data infrastructures, integrating high-capacity cloud solutions, and in due course, widening the scope of these services to include users from the public sector and industry. Efforts focussing on the development of sustainable collaborative ecosystems, as foreseen by the EOSC, are particularly made in the fields of *Data Culture, Research Data Services, Federated Architecture and co-Funding*.

To undertand the EOSC process, the following five characteristics must be taken into consideration:

1. *The EOSC results from two complementary movements: community-driven and multi-governmental.* Therefore all kinds of domestic/national initiatives were and still are invited to link up with existing pan-European initiatives, infrastructures and bodies, for example ESFRI, RDA, GO FAIR, EGI, EUDAT, e-IRG, EOSC-Pilot, EOSC-Hub, OpenAIRE[3], as well as expert groups

1 Burgelman and Schouppe published under their own names and their text does not necessarily represent the view of the EC.

2 The EOSC Portal: https://www.eosc-portal.eu/ (16.05.2019).

3 ESFRI: The European Strategy Forum on Research Infrastructures (ESFRI) plays a key role in policy-making on Research Infrastructures in Europe. https://ec.europa.eu/info/research-and-innovation/strategy/european-research-infrastructures/esfri_en (this and all following websites checked: 16.05.2019).
RDA: In 2013, the Research Data Alliance (RDA) was launched as a community-driven initiative by the European Commission, the United States Government's National Science Foundation and National Institute of Standards and Technology, and the Australian Govern-

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and advisory groups to the European Commission like the High Level Expert Group on the European Open Science Cloud or the Standing Working Group on Open Science and Innovation of the European Research Area and Innovation Committee (ERAC OSI). The overall aim is to make everybody contribute to an Internet of FAIR Data and Services governed by European public interests.[4]

2. *The EOSC faces complex governance issues*: The EOSC is launched in the complex reality of a multi-national and regional Europe. A long-term, sustainable service infrastructure for the European researchers, such as the EOSC, requires a strong and flexible ''federal'' governance model based on trust and increasing mutuality. Given the EOSC's objective to enable cross- and inter-disciplinarity by offering data in compatible formats, this model must be based on representativity, proportionality, accountability, inclusiveness and transparency.[5]
3. *The EOSC follows two years of intense consultations culminating in the EOSC launch event and the related Vienna Declaration*. Several important EOSC milestones were achieved in 2018 during the Bulgarian and the Austrian presidencies of the European Union (EU). One of this is the proclamation at Member State level of the "Vienna Declaration on the EOSC". This Declaration, paved by the Bulgarian presidency of the EU, is composed of eleven statements meant to start the process of implementation while capturing Europe's main stakeholders' common understanding of the required governance to make the EOSC a reality by 2020. This declaration builds upon former agreed conclusions (EU Council Conclusions on the EOSC, Brussels 29 May 2018, 9291/18)[6] and the roadmap on the EOSC (Commission Staff Working Document, Implementation Roadmap for the European Open Science Cloud, Brussels, 14 March 2018, SWD (2018) 83 final).[7] The implementation of these processes does not mean that everything is already written in stone. Together, the member states and the European Commission will work towards the implementation of the Science Cloud as part of an evolutive pan-European process.
4. *The EOSC raises many questions from the scientific communities because it concerns them all*. What are the EOSC implications at national or institutional levels? What does it mean that "the EOSC has been launched"? How can the research communities engage with the EOSC? How can interested stakeholders contribute to the design and co-creation of the EOSC? How can future user communities help to prepare the transition to an operational capacity after 2020? In other words, how and when will all efforts converge into seamless data services for the 1.7 million publicly funded researchers in Europe?
5. *A common understanding of the EOSC vision and governance is a pre-requisite for convergence*. This article offers some reflections for a better understanding of the realization of the EOSC at the present stage, as well as updated information on the three-layer struc-

ment's Department of Innovation with the goal of building a social and technical infrastructure that enables open sharing and re-use of data. https://rd-alliance.org/about-rda.

GO FAIR: GO (Global Open) FAIR is a 'bottom up' initiative that aims at making fragmented and unlinked (research) data *Findable*, *Accessible*, *Interoperable* and thus *Reusable (FAIR)*. https://www.go-fair.org/go-fair-initiative/.

EGI: EGI is a federation of 21 cloud providers and hundreds of data centres, spread across Europe and worldwide. EGI delivers advanced computing services to support scientists, multinational projects and research infrastructures. https://www.egi.eu/.

EUDAT: EUDAT's vision is *Data is shared and preserved across borders and disciplines (ist das ein Zitat? Dann "hhh")*. Achieving this vision means enabling data stewardship within and between European research communities through a Collaborative Data Infrastructure (CDI), a common model and service infrastructure for managing data spanning all European research data centres and community data repositories https://eudat.eu/what-eudat.

E-IRG: e-IRG is a strategic body to facilitate integration in the area of European e-Infrastructures and connected services, within and between member states, at the European level and globally.

The mission of e-IRG is to support both coherent, innovative and strategic European e-Infrastructure policymaking and the development of convergent and sustainable e-Infrastructure services. http://e-irg.eu/.

EOSC-Pilot: The EOSCpilot project will support the first phase in the development of the European Open Science Cloud (EOSC). https://eoscpilot.eu/about-eoscpilot.

EOSC-Hub: The EOSC-hub brings together multiple service providers to create the Hub: a single contact point for European researchers and innovators to discover, access, use and reuse a broad spectrum of resources for advanced data-driven research. https://www.eosc-hub.eu/about-us.

OpenAIRE: The mission of OpenAIRE is to encourage more openness and transparency in scholarly communication and to facilitate innovative ways to communicate and monitor research. https://www.openaire.eu/.

4 For more information on these topics, see also: High Level Expert GrouponthEOSChttps://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud-hleg (16.05.2019).

5 Public available information periodically published at the Open Science portal of the EC: https://ec.europa.eu/research/openscience/index.cfm (16.05.2019).

6 Council conclusions on the European Open Science Cloud (EOSC) https://www.era.gv.at/object/document/4013/attach/CC_EOSC_final.PDF (16.05.2019).

7 Implementation Roadmap for the European Open Science Cloud. https://ec.europa.eu/transparency/regdoc/rep/10102/2018/EN/SWD-2018-83-F1-EN-MAIN-PART-1.PDF (16.05.2019).

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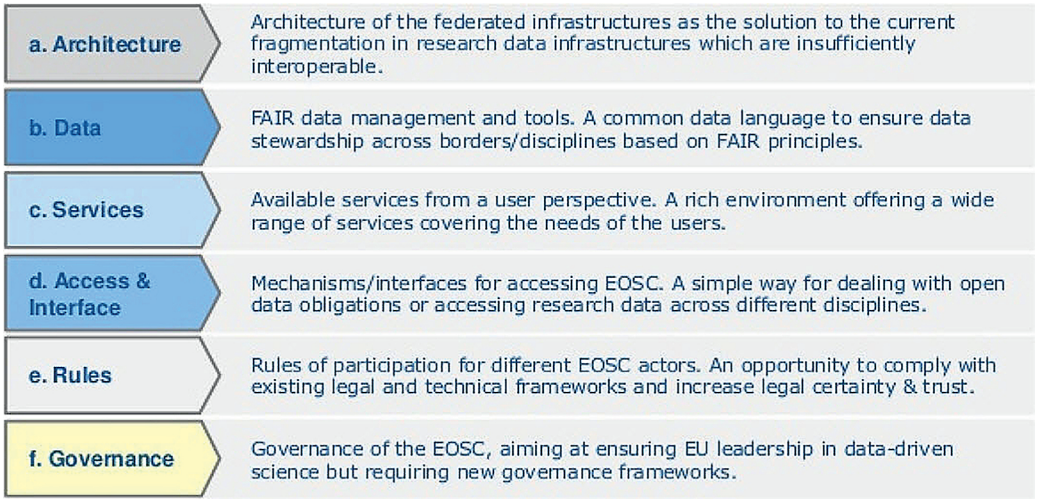

Fig. 1: EOSC Model: 6 lines of action (Source: Implementation Roadmap for the European Science Cloud (*Staff Working Document SWD* (2018): 83), 14 March 2018: http://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud, 16.05.2019)

ture of its governance and the newly established EOSC Secretariat.

2 Why the EOSC is NOT a cloud "made in Brussels"

The EOSC will provide 1.7 million European researchers with an environment that brings access to open services for data storage, management, analysis and re-use across disciplines that shall be free at the point of use. A further objective is the alignment of different aspects of the European landscape of research infrastructures: the EOSC model is to federate existing and emerging cyber- (horizontal) and thematic (vertical) data infrastructures, bridging existing silos and ad-hoc solutions. Through the EOSC, public research projects will have lower expenses for their platforms and the cost for the cloud service is marginal. In that sense, the EOSC will optimize the return of the public investments in science and research. The EOSC will add value and influence past and future infrastructure investments (10 billion euros per year by the EU Member States over the last two decades).

As stated at the EOSC Summit in June 2017, "the EOSC is not a physical space but a diverse ecosystem of connected services and infrastructures. Emphasis should shift from project-based development to sustainable collaborative ecosystems."[8] As a result, some Member States might be tempted to review their national infrastructure strategies or initiate them in the first place. The expectation is that systems and networks must increasingly be inclusive across disciplines and countries. The focus is increasingly put on user-friendly systems that enable easy data re-use. This includes addressing legal issues related to data protection and re-use, common definitions and assessment methods for FAIR data as well asdesign of trusted and scalable user environments. These types of issues are now being addressed by the new Governance Framework inaugurated in Vienna for a period of two years. This framework includes two boards sharing the steering and executive functions for the implementation of the EOSC. The *EOSC Governing Board* (GB) gathers representatives from the EU Member States, the associated countries and the European Commission. Its role is to ensure the strategic steering of the EOSC implementation. The other Board is the *EOSC Executive Board* (EB), which is composed of representatives of Pan-European research organizations and a few independent experts supported by the *EOSC Secretariat*. The Executive Board is in charge of monitoring of and reporting on the current implementation and should support the transition to an operational EOSC post-2020.

During the EOSC Summit in June 2017, it was also stated that future governance and funding models must consider the cost implications of effective research data stewardship. A common strategy for research funders across Europe, based on a shared understanding of the minimum requirements for Data Management Plans (DMPs), would also be required.

The Implementation Roadmap for the European Science Cloud comprises six lines of implementation

8 https://ec.europa.eu/research/index.cfm?pg=events&eventcode=44D86060-FBA1-1BD1-9355822B162BB0EE (16.05.2019).

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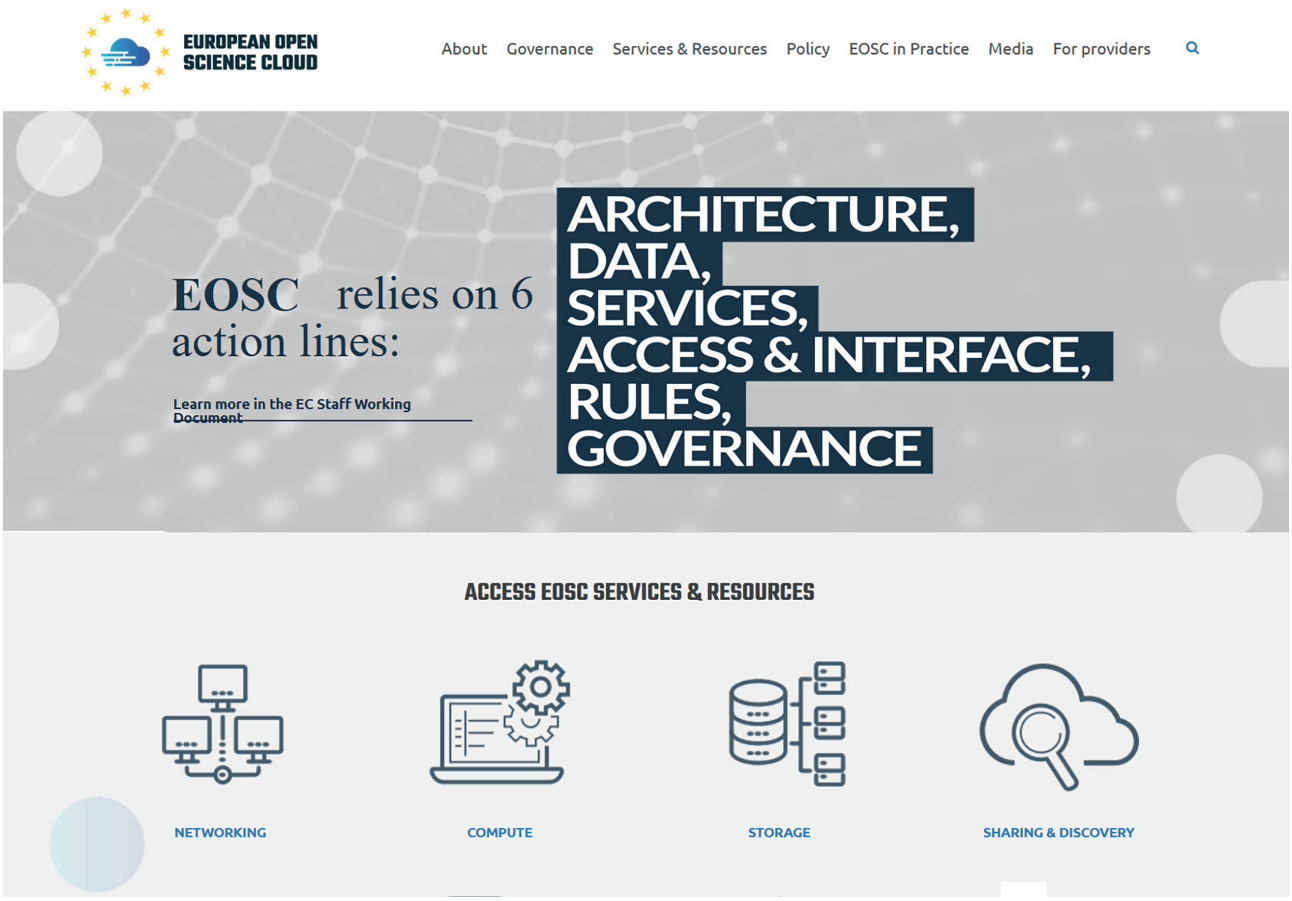

Fig. 2: The EOSC Portal

actions:[9] a) architecture, b) data, c) services, d) access & interfaces, e) rules and f) governance.

These lines of action influence the development of the EOSC Portal.[10] While still in the early days of its development, the intention is to go for a gradual expansion of its range of services (currently presenting a joint catalogue of more than 150 services and with more than 50 providers in its market place). This prototype portal acts as a "non-exclusive" entry point to the EOSC.

In 2018, two reports were produced following a wide and open consultation of the scientific communities.

The report "Prompting an EOSC in Practice" covers on a number of crucial elements of the EOSC, from defining the Minimum Viable Research Data Ecosystem to establishing the main Rules of Participation; The report also pays attention to issues as such as governance and possible business models. It analyses various aspects of how the EOSC can effectively interlink people, data, services and training, publications, projects and organisations and presents a set of detailed practical recommendations – for implementation, engagement and steering – which will serve as a valuable input for the EOSC governance.

The report "Turning FAIR into reality" describes the broad range of changes required for the implementation of the FAIR data principles. It offers a survey and analysis of what is needed to implement FAIR and it provides a set of concrete recommendations and actions for stakeholders in Europe and beyond. By following a holistic approach, the FAIR Data EG provides a template for key changes in the practice and culture of research as well as the implementation and normalisation of certain technologies and practices.

9 Implementation Roadmap for the European Science Cloud (*Staff Working Document SWD* (2018): 83), 14 March 2018: https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud (16.05.2019).
See also the full text concerning the six lines of action in: http://ec.europa.eu/research/openscience/pdf/swd_2018_83_f1_staff_working_paper_en.pdf#view=fit&pagemode=none (16.05.2019).
10 https://www.eosc-portal.eu (16.05.2019).

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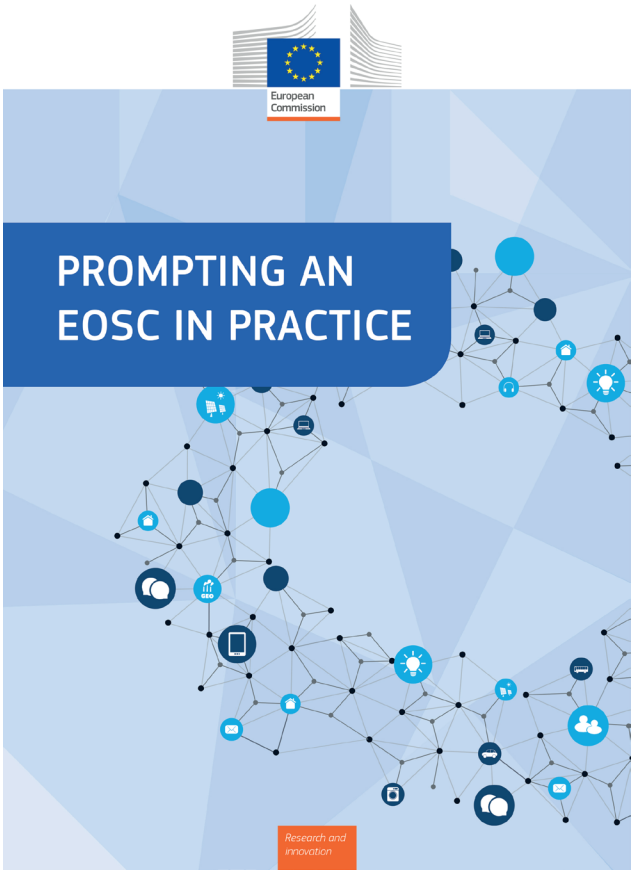

Fig. 3: Prompting an EOSC in practice (https://ec.europa.eu/info/events/2nd-eosc-summit-2018-jun-11_en, 16.05.2019)

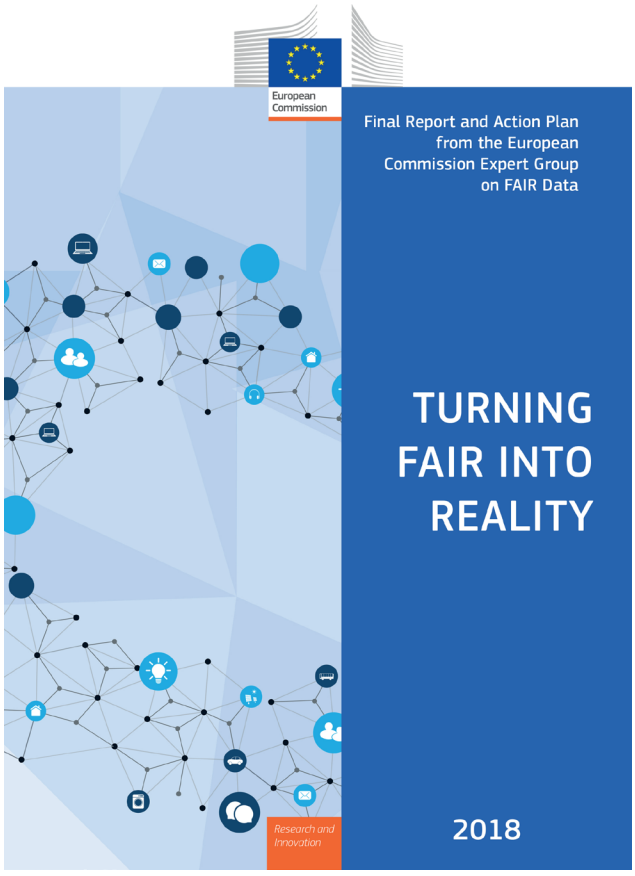

Fig. 4: Turning FAIR into Reality: Report and Action Plan (doi.org/10.2777/1524)

3 Launch of the EOSC and the Vienna Declaration on the European Open Science Cloud, a landmark and a starting point

3.1 The formal launch of the initial implementation phase 2018–2020 of the EOSC

The launch of the European Open Science Cloud was held on 23 November 2018 at the main reading room at Vienna University Library. The setting was selected deliberately, an academic library, a traditional place for sharing knowledge, to launch the 21st century virtual place for sharing data (the EOSC). The half-day event served as an occasion to reveal the brand-new EOSC Governance Framework as well as the public release of the initial prototype version of the EOSC Portal. The event culminated in the acclamation by all member states of the "Vienna Declaration".

3.2 The political dimension of the launch event

The EOSC Declaration[11] was officially proclaimed by the Austrian Presidency of the Council of the EU, then reiterated by the Bulgarian (former Presidency) and Rumanian (following Presidency) representatives, and finally endorsed through the acclamation of all the participants. The Declaration marks the starting point of the implementation of the EOSC. It provides a relevant landmark for all institutions in Europe willing to advance Open Science and implement an internet of FAIR research data.

11 https://eosc-launch.eu/declaration/ (16.05.2019).

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The Vienna Declaration on the European Open Science Cloud

We, ministers, delegates and other participants attending the launch event of the European Open Science Cloud (EOSC):

1. **Recall** the challenges of data driven research in pursuing excellent science as stated in the "EOSC Declaration" signed in Brussels on 10 July 2017.
2. **Reaffirm** the potential of the European Open Science Cloud to transform the research landscape in Europe. Confirm that the vision of the European Open Science Cloud is that of a research data commons, inclusive of all disciplines and Member States, sustainable in the long-term.
3. **Recognise** that the implementation of the European Open Science Cloud is a process, not a project, by its nature iterative and based on constant learning and mutual alignment. Highlight the need for continuous dialogue to build trust and consensus among scientists, researchers, funders, users and service providers.
4. **Highlight** that Europe is well placed to take a global leadership position in the development and application of cloud services for Science. Reaffirm that the European Open Science Cloud will be both European and open to the world, reaching out over time to relevant global research partners.
5. **Recall** that the Council – in its conclusions of 29 May 2018 – welcomed the implementation roadmap and the federated model for the European Open Science Cloud. It invited the Commission and all Member States to set up a common governance framework that ensures participation of stakeholders from the research community based on the principles of transparency, openness and inclusiveness as well as an effective involvement of all Member States.
6. **Note** that the 2018 EOSC Summit (held on 11 June 2018) called for an acceleration towards making the European Open Science Cloud a reality, hinting at the need to further strengthen the ongoing dialogue across institutions and with stakeholders, for a new governance framework to be launched in Vienna, on 23 November 2018.

We therefore:

7. **Resolve** to harness the many ongoing and planned activities at EU and Member States level to cooperate in establishing an inclusive partnership with a view to developing the European Open Science Cloud as a federated infrastructure that can enhance value-based, open, trusted, user-centric digital services across borders within the Digital Single Market (DSM).
8. **Invite** all Member States, as well as public and private stakeholders in Europe, to actively support this joint effort and the new European Open Science Cloud governance structure for a successful implementation of the initiative.
9. **Call** for the European Open Science Cloud to provide all researchers in Europe with seamless access to an open-by-default, efficient and cross-disciplinary environment for storing, accessing, reusing and processing research data supported by FAIR data principles.
10. **Commit** to support service provision for the European Open Science Cloud by helping connecting relevant national and disciplinary nodes to the pan-European level.
11. **Reaffirm** the potential of the European Open Science Cloud to enable first-class data-driven science and to stimulate new business models benefittting our society and the economy. Recognise that such services will create opportunities for both public and private sectors, notably by intensifying the reuse of public sector information while preserving data integrity, and ensuring access and transparency within and across borders.

We therefore declare to work together towards realising the potential of the European Open Science Cloud for the benefit of citizens, society and the economy.

The Vienna EOSC Declaration was developed by Paolo Budroni, University of Vienna, and Stefan Hanslik, Austrian Federal Ministry for Education, Science and Research in close cooperation with the European Commission

3.3 The tangible value of the Vienna Declaration

The tangible value of the Vienna Declaration can be summarized as follows:

a) The Declaration underpins the fact, that the EOSC is not a project, but a process aiming at the convergence of research data policies across Europe. As such it is dynamic and subject to constant evolution:

> We, Ministers, delegates and other participants attending the launch event of the European Open Science Cloud (EOSC): [...] 3. Recognise that the implementation of the European Open Science Cloud is a *process, not a project*, by its nature iterative and based on *constant learning* and *mutual alignment*.

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b) The Declaration underlines the involvement of the European Commission, the Member States and the EU Council in the elaboration process of the EOSC:

> We, Ministers, delegates and other participants attending the launch event of the European Open Science Cloud (EOSC): [...] 5. **Recall** *that the Council* – in its conclusions of 29 May 2018 – welcomed the implementation roadmap and the federated model for the European Open Science Cloud. It *invited the Commission and all Member States to set up a common governance framework*.

c) The Declaration explicitly comments on the supporting role of the EOSC to realise a Digital Single Market (DSM) in Europe. This reference to the DSM offers a link to the Sustainable Development Goals of the United Nations, especially the goals "Quality Education", "Gender Equality" and "Industry, Innovation and Infrastructure":[12]

> We, Ministers, delegates and other participants attending the launch event of the European Open Science Cloud (EOSC): [...] 7. **enhance** value-based, open, trusted, user-centric digital services across borders within the Digital Single Market (DSM).

d) The Declaration is explicit on the inclusive character of the EOSC process, which shall influence future rules of engagement in the EOSC.

> We, Ministers, delegates and other participants attending the launch event of the European Open Science Cloud (EOSC): [...] 8. **Invite** all Member States, as well as public and private stakeholders in Europe [...]

e) The Declaration recalls the focus of the EOSC on the needs of the researchers, contributing in a concrete way to an internet of FAIR data and services:

> We, Ministers, delegates and other participants attending the launch event of the European Open Science Cloud (EOSC): [...] 9. **Call** for the European Open Science Cloud to provide all researchers in Europe with seamless access to an open-by-default, efficient and cross-disciplinary environment for storing, accessing, reusing and processing research data supported by FAIR data principles.

12 https://www.un.org/sustainabledevelopment/sustainable-development-goals/ (16.05.2019).

3.4 The launch event perspective on the EOSC stakeholders

The event provided an occasion to clarify that the priority target users of the EOSC are the European researchers themselves. However, the EOSC follows a multistakeholders approach and will gradually expand its user base. The fact, that the launch event took place in a research library underlines the key role of research supporting entities and units like ICT-services or libraries, as holders of qualified and structured data. The list of concerned stakeholders also extends to all kinds of research data producers, small to big research infrastructures, academic institutions, research funders, enterprises, NGOs or the public sector.

The clock has started ticking in Vienna: The timeline is set to 25 months in order to set up the EOSC to be operational by December 2020. It has started in Vienna and should have an operational capacity after 2020. In other words, the EOSC implementation phase has started, albeit with an interim *Governance Framework* mandated to steer the implementation until the end of 2020 and to help with the transition post-2020. In the aftermath of the launch event, all members of the *Governance and Executive Boards* were nominated and appointed. A *Secretariat* was granted. Supporting EOSC working groups are being set up. The Stakeholder Forum is being re-designed for effective annual assemblies in autumn 2019 and 2020.

4 Governance structure – a short introduction to the EOSC Governance 2019–2020

The Governance Framework is in charge of steering and overseeing the initial development of the EOSC (until the end of 2020) towards the EOSC federated model described in the EOSC Implementation Roadmap.[13]

The Governance Model relies on the interplay between three components:

- the EOSC *Governance Board* (GB)[14]
- the EOSC *Executive Board* (EB)[15]
- the *Stakeholders Forum* (SF)[16]

13 https://ec.europa.eu/research/openscience/pdf/swd_2018_83_f1_staff_working_paper_en.pdf (16.05.2019).
14 https://eosc-portal.eu/governance/eosc-board (16.05.2019).
15 https://eosc-portal.eu/governance/executive-board (16.05.2019).
16 https://eosc-portal.eu/governance/stakeholders-forum (16.05.2019).

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Tab. 1: Image: Roles within the EOSC Governance

	Role
EOSC Board	To **oversee & steer** the EOSC strategy and implementation → *Review and decide*
EOSC Executive Board	To **help & support** the EOSC strategy, implementation, monitoring and reporting on progress of implementation → *Elaborate and propose*
Stakeholders Forum	To **advise** the Executive Board and reach-out to the scientific community → *Provide input and feedback*
EOSC Secretariat	To **support** to the EOSC Executive Board and the Governance Board to work openly and inclusively together with communities to co-create an all-encompassing EOSC → *Support and co-create*

In addition, the EOSC *Secretariat*[17] supports the whole Governance Framework with a particular focus on the *Executive Board* and the *Stakeholders Forum*.

The EOSC Governance Board is chaired by the European Commission and composed of representatives of the EU Member States and associated countries. The GB ensures strategic direction and oversight of the EOSC implementation based on the EOSC roadmap, in synergy with relevant national initiatives. The four core operating principles of the GB are openness, inclusiveness, balance and foresight.

The EOSC Executive Board is composed of representatives of Pan-European research organizations and few independent experts supported by the *EOSC Secretariat*. The Executive Board is in charge of monitoring and reporting on the current implementation and helping in the transition to an operational EOSC post-2020. It will create working groups to take stock of best practices helping to shape future EOSC policies and processes. This could be a good means for the stakeholders to help shaping future EOSC implementation measures.

The *Stakeholders Forum* aims to bring together scientific and user communities, research institutions, research infrastructures and e-Infrastructures, funders and specialized EU agencies. The *Forum* will consist of open assemblies playing a consultative role and allowing for wide feedback on future implementation plans.

The *EOSC Secretariat* is granted through the Horizon 2020 framework programme in the form of Coordination and Support Action (CSA). The EOSC *Secretariat* aims to be neutral towards the community it is serving. It provides a flexible service offering support to the EOSC *Governance Framework* for the duration of the initial implementation phase in 2019–2020. The consortium involved in the secretariat comprises 11 beneficiaries[18] with complementary expertise and strong connections to the scientific community, also in an international context. Typical tasks for the *Secretariat* consist notably in:

- Helping to engage with relevant communities to ensure that their needs, requirements, advice and commitments are reflected and passed on to the EOSC and Executive Boards and its Working Groups;
- Supporting coordination and consultation with strategic, thematic, EU or global initiatives and projects;
- Supporting and structuring the *Stakeholders Forum*.

Addressed stakeholders of the *Secretariat*, according to the settings of the EOSCSecretariat.eu grant:
Policy makers & funding bodies (incl. EC)
National & EU e-/digital/infrastructures
National & EU funded projects & initiatives
Research & academia organisations
Researchers & research support
Industry and third sector
Support services for the *Stakeholder Forum*

4.1 The proposed Working Groups of the Executive Board

The *Executive* and *Governance Boards* jointly consider how to set up a series of Working Groups, studies and open consultations on future EOSC implementation orientations.

17 https://www.eoscsecretariat.eu (16.05.2019).

18 https://www.eoscsecretariat.eu (16.05.2019).

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An initial proposal is to focus on a first batch of working groups in 2019 on the following topics:

- Sustainability
- Landscape
- FAIR
- Rules of Participation
- Architecture
- National initiatives[19]

5 Key issues for the 2-year period 2019–2020

5.1 Brokerage of different interests

The present development is marked by a first phase of two years of interim governance. A challenge for the governing body is to provide an added value through identifying the common interests between multiple stakeholders, including the Member States, the European Commission, the various communities of researchers, infrastructure and service providers, libraries, universities and other research performing organisations, research funding organisations, industrial partners, citizens and other open science communities. When considering research infrastructures supporting open science in Europe, the challenge is even bigger given the different maturity levels observed from one discispline to another and from one country to another.

5.2 Coordination of ongoing EOSC-related initiatives and projects

There are many ongoing pan-European network activities and EU-funded projects that are already prototyping different parts of the EOSC during its initial implementation phase. Another challenge for the interim leadership is to ensure a coherent feedback loop with these groups of implementers.

5.3 Timely delivery by the end of 2020

The interim *Governance Framework* of the EOSC is inspired from models already tried and testd in Europe during the last 60 years. This three-layer structure has already proved to be successful in the European context. This might be a reason why it was possible to set it up for the EOSC in a relative brief period of time (8 months after the release of the EOSC roadmap in March 2018). Still, the delivery timeline for this structure is very tight (by the end of 2020) and will require trust, commitment and flexibility. The main expected deliverables inherited from the EOSC roadmap of March 2018 and the EU Council conclusions of May 2018 include:

- A new governance model and best-fit legal vehicle for the period after 2020;
- Rules of participation that will govern future EOSC transactions;
- The further alignment between EOSC-relevant national initiatives;
- The evolution of the EOSC Portal and its interfaces;
- An action plan to turn the FAIR principles into practice;
- A widening strategy for the EOSC user base;
- A strategy to internationalise the EOSC in the global context;
- The definition of financing model(s) to sustain EOSC services in the long run.

5.4 Moving from the initial implementation phase 1 of to the operational phase 2 post-2020

The EOSC roadmap welcomed by the EU Council foresees two implementation phases for the roll-out of the EOSC. During the first phase 2018–2020, the European Commission will invest up to 250 million euros to support directly the prototyping of the core functions of the EOSC. This is mainly done through Horizon 2020 competitive calls for proposals funded by EU grants. An updated list of ongoing Horizon 2020 projects is available from the EOSC Portal.[20]

The Council has underlined that the start of the second EOSC phase depends on an evaluation by the Commission and the Member States of the first phase. Without prejudging future decisions by the interim *Governance Framework* on the settings of the EOSC post-2020, it is expected that this second phase will be marked by hybrid funding sources and instruments. Amongst others, one

19 According to Cathrin Stover, EOSC Executive Board Vice Chair https://www.eoscsecretariat.eu/node/224 (published in March, 2019) (16.05.2019).

20 https://eosc-portal.eu/about/eosc-projects (16.05.2019).

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Tab. 2: Top Ten Languages used in the Web – 31 December 2017

TOP TEN LANGUAGES IN THE INTERNET	World Population for this Language (2018 Estimate)	Internet Users by Language	Internet Penetration (% Population)
English	1,462,008,909	**1,055,272,930**	72.2 %
Chinese	1,452,593,223	**804,634,814**	55.4 %
Spanish	515,759,912	**337,892,295**	65.5 %
Arabic	435,636,462	**219,041,264**	50.3 %
Portuguese	286,455,543	**169,157,589**	59.1 %
Indonesian / Malaysian	299,271,514	**168,755,091**	56.4 %
French	412,394,497	**134,088,952**	32.5 %
Japanese	127,185,332	**118,626,672**	93.3 %
Russian	143,964,709	**109,552,842**	76.1 %
German	96,820,909	**92,099,951**	95.1 %
TOP 10 LANGUAGES	5,135,270,101	**3,209,122,400**	62.5 %

option under investigation consists of eventual deposit fees from national funders based on a full cost estimate for the running of the EOSC, conducted by the EOSC Governance Framework in phase 1.

6 More critical issues to be solved

6.1 Positioning the EOSC in a global and evolutive context

Open Science knows neither borders nor limits. For sure, it is not limited to *Europe*. Furthermore, as explained in chapter A), the EOSC is a process, not a project. The envisaged science cloud is evolutive. Given the nature of science and the permanent evolution of ICT technologies, the science cloud will have to continuously adapt its federation to changing entities, services and needs.

6.2 "Cloud" as an ambiguous term

The term "cloud" would be misleading if it were to be seen as a centralised server. Ninety nine percent of the data exchanged worldwide are running through about one million kilometer of optical fiber cables – many of them underwater, and deposited in X thousands of servers, and not "somewhere up in the sky". In fact, the EOSC is a thin interoperability layer in Europe which connects some of these servers.[21] Of course these connections are foreseen for all kinds of data; nevertheless, the EOSC has to be considered also in a context where billions of citizens – worldwide – expose their data and information to the internet. Around 80 % of these data are then collected and stored in the U.S., mainly on servers in the Silicon Valley or near Seattle.

6.3 Web intelligence of research trends in Europe

Let us consider three sets of figures concerning European Internet users and then comment on the implications on the European research ecosystem.

6.3.1 Big data and the end of users' languages

According to Eric Schmidt, CEO at Alphabet, "there was 5 Exabytes of information created between the dawn of

21 For example: „In 2019, Google is planning to build three underwater cables to help expand its cloud business to new regions as it battles rivals Amazon and Microsoft" (https://www.cnbc.com/2018/01/16/google-plans-to-build-3-new-underwater-cables-to-expand-cloud-business.html, 16.05.2019). The new cables will have an extension of 100,000 km and will connect Chile with California, Denmark with Ireland, Guam with Hong-Kong (https://www.blog.google/products/google-cloud/expanding-our-global-infrastructure-new-regions-and-subsea-cables/, 16.05.2019).

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civilization through 2003, but that much information is now created every 2 days, and the pace is increasing“[22]. Another revealing figure relates to the numbers of internet users by language.[23]

6.3.2 Data is important, Information too

Social media have an immense number of users: 98.54 % of Internet users worldwide are registered on social media networks whose servers are based in the U.S. (Facebook, Pinterest, Twitter, YouTube, Reddit, Instagram).[24]

6.3.3 Search engines and discovery strategies

U.S.-based discovery services (search engines) collect the information related to 97.09 % of all queries[25]. This figure refers to: Google, Yahoo! and Bing. The share of the Chinese search engine Baidu is equivalent to 1.03 %. In February 2019 Google's share was 93.65 %. In selected „EOSC Countries“ Google's market share in February 2019 amounted to: Italy 96.12 %, France 93.92 %, Germany 94.8 %, UK 92.51 %, Spain 96.64 %.[26]

With the above-mentioned services and the related data *and* information, the analysts working outside Europe are potentially (and virtually) able to track and understand habits, trends, learnings of communities in EOSC participating countries (including research/scientific communities) *better* than the European governing bodies of the Member States or the European Commission.

7 Conclusions

7.1 The European added value of the EOSC

By providing improved access to world-class European data infrastructures and cloud-based services, the EOSC represents a key contribution to crating a European Digital Single Market. In principle, Europe keeps monitoring the complex nebula of the world wide web notably to preserve its public investments in research data and related digital infrastrucutres, to ensure fair competition on international digital markets or to preserve data privacy. The „European way“ has often consisted in readjusting regulative settings, trying to forge legislative architectures. Examples from 2018 include the General Data Protection Regulation (GDPR) which came into effect, the data-related amendment of the Public Sector Information (PSI) Directive, the succesful fining of Google (2.4 bn USD), Apple (13 bn USD) and Amazon (250 million USD). Further fields of activities are related to the regulation of copyright issues and the so called “digital tax“, which according to plans – if approved – would introduce a 3 % tax on revenues. These developments, however, are relatively slow, due to the fact, that fiscal policy is subject of each single Member State. The spirit of the mentioned European initiatives shows that European decision makers are becoming aware of these complex issues, but that a proactive strategy is lacking. Still too often, new Pan-European initiatives have to overtake the common threat of being perceived as a field of brokerage of single Member States interests, rather than a converging point of interest. This assertion seems to fit also to the EOSC. The succesful implementation of the EOSC will depend on how its value proposition will attract a critical mass of participating countries in Europe. From a research data point of view, the EOSC could help Europe to build a “Schengen Area for digital Data“, contributing to the upcoming Internet of Everything and paving the course to a potential European sovereignty on public-funded research data (within the borders foreseen by the Digital Single Market).[27]

22 Upbin, Bruce. “The Web is Much Bigger (And Smaller) Than You Think.” Forbes 24/4/2012, https://www.forbes.com/sites/ciocentral/2012/04/24/the-web-is-much-bigger-and-smaller-than-you-think/#768f54b97619 (16.05.2019). Compare also: AUTHOR “L'impero informatico americano alla prova cinese” *Limes, rivista italiana di geopolitica, La rete a stelle e strisce*, 10 (2018): PAGE.

23 Top Ten Languages Internet Stats were updated on 31 December 2017: https://www.internetworldstats.com/stats7.htm (16.05.2019). See also: Collot, Giovanni. “Il mercato unico serve, ma non basta.” *Limes, rivista italiana di geopolitica, La rete a stelle e strisce* 10 (2018): PAGE.

24 Social Media Stats Worldwide – February 2019. http://gs.statcounter.com/social-media-stats (16.05.2019). Facebook's share in February 2019 was 68.95 %.

25 Search Engine Market Share Worldwide – February 2019: http://gs.statcounter.com/search-engine-market-share (16.05.2019). Google's share in February 2019 was 92.92 %.

26 View search engine market share by region: http://gs.statcounter.com/search-engine-market-share/all/Europe (16.05.2019).

27 A possible limitation in this context could come from a projection of the U.S. jurisdiction, which might affect the European Digital Single Market and also the EOSC in the future. According to the Cloud Act (The Cloud Act, or: Clarifying Lawful Overseas Use of Data Act 23/3/2018 (H.R. 4943) is a United States federal law enacted in 2018 by the passing of the Consolidated Appropriations Act, 2018, PL 115–141, section 105 executive agreements on access to data by foreign governments: https://en.wikipedia.org/wiki/CLOUD_Act, 16.05.2019) each monetary transaction effected in US-Dollar underlies U.S. jurisdiction. In this case, U.S. laws might be relevant worldwide. This situation might diminish the wiggle room of other countries or entities

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7.2 A simple but much needed mission

Overall, the focus of the EOSC should always be to provide access to relevant data services for the researchers. Scientists do not care so much where their data is stored as long as they can access them. In order to be attractive for end users, the EOSC has to be more than the aggregation of national research data interests. It has to offer a secure environment where the research data of the scientists are managed in a FAIR way. This can only be achieved if all stakeholders nurture the EOSC as a key policy for creating a European research data commons.

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Disclaimer: The views expressed in this paper are those of the authors. They do not necessarily represent the opinions of the European Commission which cannot be hold responsible for what is written here. (Brussels/Vienna, in March 2019)

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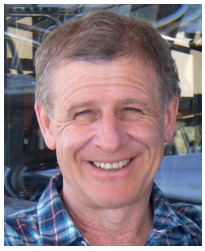

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including those in Europe. Future services offered within the EOSC in the frame of industrial research cooperations, where transactions would be effected in US-Dollar might underly to the Cloud Act. In those case, any transfer of documents deposited in U.S. servers (e. g. documents related to cooperation between industry and universities) would need to be approved by U.S. courts.

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