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## Deliverable 2.2

### eInfraCentral in the context of the European Open Science Cloud



eInfraCentral

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<b>Authors:</b>	Alasdair Reid, Jelena Angelis, Orsolya Gulyas (EFIS), Jorge Sanchez, Theodore Ntezes (JNP), George Papastefanatos (UoA)
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**Abstract:** The European Open Science Cloud (EOSC) is an evolving agenda that is important not only from the European perspective, but also from the point of view of the developments in the global landscape. This document positions the eInfraCentral catalogue of services and the defined monitoring requirements within the EOSC vision. This is a policy oriented document that highlights and elaborates on the strategic fit between the work done in eInfraCentral and the emerging EOSC.



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## Executive Summary

The mission eInfraCentral is to “ensure that by 2020 a broader and more varied set of users discovers and accesses the existing and emerging e-Infrastructure capacity and e-Infrastructure Services”. To fulfil this mission, eInfraCentral is building a common catalogue of European data, compute and networked services. Since its launch in January 2017, the target ecosystem for eInfraCentral has changed with various exits and new entrants. This complex ecosystem is the starting point for the journey towards the European Open Science Cloud (EOSC).

Launched in 2016 with a €6.7 billion long-term funding plan, the EOSC initiative promotes the EU’s agenda in the transition to Open Science and helps advance the Digital Single Market. More specifically, the EOSC aims to tackle the current widespread fragmentation of European cloud infrastructures. Through solving such fragmentation, the EOSC should also become a trusted environment to share, host, and process research data where researchers can store, manage, and access resources in a secure and seamless manner. eInfraCentral – with its service catalogue – is a main building block of the Implementation Roadmap for the EOSC in terms of improving access for users to pan-European services.

eInfraCentral’s role in the EOSC is multi-faceted:

- **Role 1:** In light of the EOSC Implementation Roadmap adoption, eInfraCentral is now strongly positioned as the service catalogue for the future EOSC portal.
- **Role 2:** eInfraCentral’s Service Description Template should be adopted as a standard for describing e-services in the future EOSC portal.
- **Role 3:** eInfraCentral automates the aggregation of service information from partners’ service catalogues.
- **Role 4:** The eInfraCentral Portal – acting as an aggregator and a single-entry point to access data, applications, software, pipelines, data-as-a-service, knowledge-as-a-service and other resources than e-Infrastructure services – is an underpinning element of the EOSC Portal.
- **Role 5:** eInfraCentral Portal will take a lead in ensuring collection and comparability of an agreed set of performance indicators of e-services.

To deliver on the Open Science, Open Innovation and Open to the World vision for Europe, eInfraCentral will play a crucial role in the implementation of the EOSC.

**The eInfraCentral’s future vision is to become the central EOSC gateway, an aggregator of services, an access portal to pan-European Open Science resources, supporting multiple marketplaces to promote their services to end users.**

eInfraCentral is well positioned to achieve this because of ten core principles which guide the design, set-up, development of the eInfraCentral service catalogue and portal as well as the attraction, retention and constant increase of the eInfraCentral Gateway’s customers. eInfraCentral is neutral, objective, transparent, inclusive, scalable, reliable, accessible, intuitive, efficient and trustworthy.

eInfraCentral has already contributed to the development of the EOSC with its common approach to service description and standard methods for exchanging service-related information among service providers and aggregators in the ecosystem. Further developments of the EOSC should take advantage of the neutrality and expertise which eInfraCentral brings to a fragmented and underdeveloped service landscape of e-infrastructures.

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## Glossary

Table 1: Glossary

Abbreviation	Meaning
<b>API</b>	Application Programming Interface
<b>CSA</b>	Coordination and Support Action
<b>CoS</b>	Catalogue of Services
<b>EC</b>	European Commission
<b>e-IRG</b>	e-Infrastructure Reflection Group
<b>EOSC</b>	European Open Science Cloud
<b>ERA</b>	European Research Area
<b>ESFRI</b>	European Strategic Framework for Research Infrastructure
<b>IT</b>	Information Technology
<b>KPI</b>	Key Performance Indicator
<b>SDT</b>	Service Description Template
<b>SLA</b>	Service Level Agreement
<b>TRL</b>	Technology Readiness Level

## Short Names of Partner Organisations

Table 2: Partner organisation and their short names

Short name	Name of Organisation
<b>EFIS</b>	European Future Innovation System Centre
<b>JNP</b>	JNP CO
<b>UoA</b>	National and Kapodistrian University of Athens
<b>LUH</b>	Gottfried Wilhelm Leibniz Universität Hannover
<b>GEANT</b>	GÉANT Limited
<b>PRACE</b>	Partnership for Advanced Computing in Europe AISBL
<b>EGI</b>	Stichting EGI
<b>UEDIN</b>	The University of Edinburgh
<b>CNR</b>	Consiglio Nazionale delle Ricerche

## 1. Introduction

The mission eInfraCentral is to “ensure that by 2020 a broader and more varied set of users discovers and accesses the existing and emerging e-Infrastructure capacity and e-Infrastructure Services”. To fulfil this mission, eInfraCentral is building a common catalogue of European data, compute and networked services. Since its launch in January 2017, the target ecosystem for eInfraCentral has changed with various exits and new entrants.

Initially built around the five most prominent e-Infrastructures (EGI, EUDAT, GEANT, OpenAIRE and PRACE), which are partners in the project, eInfraCentral’s ecosystem is now richer and its horizons broader. The services offered by EGI, EUDAT and Indigo DataCloud have been aggregated under the EOSC-hub umbrella, OpenAIRE has evolved into OpenAIRE-Advance and EOSC-hub and OpenAIRE-Advance have embarked upon a joint workplan. New projects and research infrastructures have started while others have ceased operating. This complex ecosystem is the starting point for the journey towards the European Open Science Cloud (EOSC) for which the eInfraCentral service catalogue is a main building block in terms of improving access for users to pan-European services.

### 1.1 Policy landscape

The European Commission invests in the development of e-infrastructures and e-services through several funding streams. The main vehicle is Horizon 2020, the EU’s Research and Innovation framework programme with an overall budget of nearly €80 billion in the period 2014-2020. From this amount, €890 million are dedicated to e-Infrastructure activities over the 7-year funding period, under the 'European Research Infrastructures, including e-infrastructures' programme.<sup>1</sup>

With the proliferation of digital research data and the development of electronic research infrastructures it has been recognised that such e-services for research should be federated in order to better serve users, to strengthen data-driven science, and to increase cost effectiveness. As such, the 2016-2017 Horizon 2020 work programme (WP) contained some initial provisions with regard to the implementation of the EOSC. Developing the EOSC, as a secure, permanent, on-demand, service-driven, privacy-compliant and sustainable environment integrating or federating e-Infrastructure platforms, distributed databases, computing resources and software was a focus under EINFRA-12-2017. EINFRA-21-2017 focused on prototyping innovative e-Infrastructure platforms and services for universal discoverability of data objects and provenance, and computing with extreme large datasets.

In WP 2018-2020 the INFRAEOSC call was launched with a budget of ca. €60 million aimed at providing support to the implementation and governance of the EOSC. This dedicated call will support “the integration of services and the federation mechanism; the setting/operationalisation of the principles of FAIR data (findable, accessible, interoperable and reusable); the development of a FAIR-compliant certification scheme for data infrastructure and the connectivity of the pan-European Research Infrastructures such as the ESFRI projects and landmarks.”<sup>2</sup> Furthermore, the EuroHPC Joint Undertaking was launched in order to enhance Europe’s High-Performance Computing infrastructure. In order to finalise the last EOSC-related topic of WP 2018-2020 – INFRAEOSC-03-2020 – a public consultation was launched to identify additional activities which Horizon 2020 should fund during the period 2020-2023 to consolidate and further develop the results achieved through previous topics.

The importance and benefits of the EOSC are also being actively discussed at the national level. Dur-

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<sup>1</sup> <https://ec.europa.eu/programmes/horizon2020/en/h2020-section/e-infrastructures>

<sup>2</sup> [http://ec.europa.eu/research/openscience/pdf/swd\\_2018\\_83\\_f1\\_staff\\_working\\_paper\\_en.pdf](http://ec.europa.eu/research/openscience/pdf/swd_2018_83_f1_staff_working_paper_en.pdf) pp 4-6

ing the Open Science Cloud workshop in June 2016, representatives of Member States<sup>3</sup> expressed support for the EOSC initiative, stressing the need to think beyond single project lifecycles in Horizon 2020 and the upcoming FP9, and to integrate and federate existing and future initiatives for the sake of sustainability. On this note, Member States also emphasised the possibility of utilising European Structural and Investment Funds (ESIF) to invest in building and sustaining the EOSC infrastructure. Currently €875 million is earmarked for ICT infrastructures (large-scale computer resources or equipment) and €1.5 billion to very high-speed broadband connectivity in the ESIF programmes<sup>4</sup>. It is often said that the bulk of funding and resources is invested at the level of national electronic research infrastructures. However, it is difficult to estimate the amount of funds spent on research (data) infrastructures on the national levels as almost no information has been published by Member States on this<sup>5</sup>.

## 1.2 The European Open Science Cloud

The availability of growing amounts of data, the development of powerful digital technologies, and the rise of new societal challenges call for recognising the need for Open Science, which will transform the way research is done and science is organised. Potentially, scientists will be less location-dependent for their resources and, together with increased rates of global scientific collaboration, can become more efficient in finding solutions for pressing societal challenges, and deliver more reliable and accurate research results. The Open Science principle helps spread these benefits by making research data widely available and encouraging its reuse, promoting open access to knowledge, strengthening research integrity, supporting citizen science, and thus bringing science closer to society.

Launched in 2016 with a €6.7 billion long-term funding plan, the EOSC initiative promotes the EU's agenda in the transition to Open Science and helps advance the Digital Single Market (DSM). The initiative is foreseen to start in 2020 and aims to answer the scientific community's need to "boost data access and re-use and to reduce the cost of data storage and high-performance analysis by pooling existing capacity and by aggregating demand (initially by researchers in the public sector)."<sup>6</sup>

More specifically, the EOSC initiative aims to tackle the current widespread fragmentation of European cloud infrastructures and to ensure that through accessing and re-using data via the EOSC, European researchers perform science in an open way. A fragmented landscape poses several risks: the building of silos where service availability and research needs become misaligned; cost inefficiencies in service implementation and operation; issues with sustainability. The EOSC should also become a trusted environment to share, host, and process research data where researchers can store, manage, and access resources in a secure and seamless manner. In this way, the EOSC will contribute to limiting data wastage and speeding up research processes.

There are a range of different types of e-services for science that are planned for inclusion in the EOSC. These can be "technical services such as analytics and computational services, cloud services, thematic services tuned to particular research disciplines, e-infrastructure and middleware services such as access identity management; but also knowledge resources such as datasets, storage, digital library and archives; access services such as a service catalogue and portals; scientific instruments and facilities; and facilitation activities such as training, software development support and consul-

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<sup>3</sup> Representatives from SK, DE, NL, FR, AT, DK, SE, IT, ES, EE, BE, RO, UK, TR, NO and CH attended; <http://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud-workshop>

<sup>4</sup> [http://ec.europa.eu/research/openscience/pdf/swd\\_2018\\_83\\_f1\\_staff\\_working\\_paper\\_en.pdf](http://ec.europa.eu/research/openscience/pdf/swd_2018_83_f1_staff_working_paper_en.pdf) p5

<sup>5</sup> Ibid. p20

<sup>6</sup> <https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud>



tancy.”<sup>7</sup>

On 15 March 2018, the European Commission published a Staff Working Document Implementation Roadmap for the European Open Science Cloud<sup>8</sup>. The document identifies eInfraCentral as one of the main contributors to the future EOSC Portal.

## 2. eInfraCentral’s role in EOSC

### 2.1 A Service Catalogue for EOSC

At the end of 2016, there was no unified online service catalogue that potential users could explore. Some e-Infrastructure organisations had existing, incompatible IT Service Management systems. Additionally, many e-infrastructures were at an early or evolving stage with service catalogue work; for example, some had no link to services on their landing page and differing descriptions of services with varying level of detail and complexity.

The goal of eInfraCentral was to address this, working in partnership with five key e-infrastructures to promote and extend best practice and to begin the process of harmonising service descriptions in a single, common catalogue. Along the way, a number of key results – standardised service descriptions, dynamic aggregation of service data and common presentation in a rich, user-facing portal – have laid the foundations for a broader role.

The target ecosystem for eInfraCentral is shown in **Error! Reference source not found.** illustrating the main e-infrastructures alongside the rich diversity of other research infrastructures and projects. eInfraCentral has already engaged with these various EU-funded e-infrastructures; the next step is to go further and engage with a wider community, including clusters and thematic services offered by research infrastructures. In parallel, integration/convergence of different types of services (e-services, data-related services, etc.) will start.

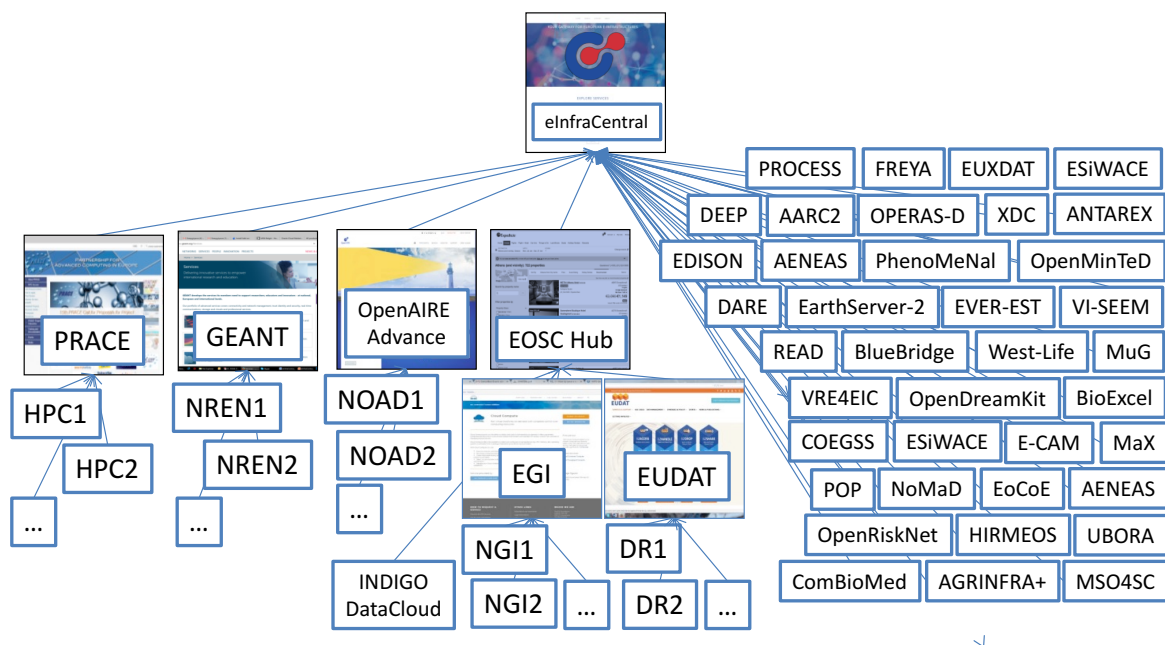


Figure 1: Primary and secondary eInfraCentral ecosystem

<sup>7</sup> <https://eoscpilot.eu/sites/default/files/eoscpilot-d2.2.pdf>

<sup>8</sup> [http://ec.europa.eu/research/openscience/pdf/swd\\_2018\\_83\\_f1\\_staff\\_working\\_paper\\_en.pdf](http://ec.europa.eu/research/openscience/pdf/swd_2018_83_f1_staff_working_paper_en.pdf)

To deliver on the eInfraCentral's mission, efforts have been made in structuring an open and guided discussion between e-Infrastructures to consensually define a **common catalogue for their services**. eInfraCentral stressed to its key stakeholders a need for a shared understanding of the conditions of service delivery, the need to harmonise the services provided by European e-Infrastructures, to increase the user base by making services discoverable and easier to relate to user needs, to expand the pool of users, to facilitate service providers with a shared language and path to users, to become user-oriented and professional in-service provisioning.

These are all concrete steps in building a bigger catalogue of services, offer a wider choice and include very specialised services outside the original audience.

**Role 1: In light of the EOSC Implementation Roadmap adoption, eInfraCentral is now strongly positioned as the service catalogue for the future EOSC portal.**

## 2.2 Common Service Descriptions

eInfraCentral has driven the agenda on harmonising service descriptions across the e-Infrastructures. The fact that the discussion was guided by the eInfraCentral core project team, and not by one of the existing e-Infrastructures, helps underpin the objectivity and neutrality of the service catalogue.

The e-Infrastructure community now recognises that a **common approach to both describing and exchanging service-related information is the way forward** to enhance discoverability and thus potential uptake. One of eInfraCentral's first contributions has been to coordinate this common approach to service description across the core partners, and disseminate the results into the EOSC ecosystem. Because of this, the Service Description Template now enjoys wide recognition in the e-infrastructure community.

Requests have also started coming from individual countries on using eInfraCentral's Standard Service Description Template for describing services available on the national level. This presents a unique opportunity for a structured dialogue with national organisations in helping them standardise the way they describe services and maybe change their thinking about how they manage their own services. The main outcome of such dialogues would be a more harmonised service classification methodology and a greater understanding at a national level of what is available on a European scale (and also potentially at a local level). This in turn could help national organisations with funding decisions thus supporting harmonisation of services provision on an European level.

**Role 2: eInfraCentral's Service Description Template should be adopted as a standard for describing e-services in the future EOSC portal.**

## 2.3 An EOSC Aggregator of Service Information

Any EOSC service catalogue – which as described in Role 1 is the eInfraCentral service catalogue – must be up to date. As the ecosystem expands beyond the core e-Infrastructures, services will come and go and manual updates for multiple catalogues will quickly become unsustainable. Building on the standardised service definitions, eInfraCentral has defined a **common API and automated mechanism to keep individual service catalogues in sync** with the central one.

Figure 2 illustrates this for the research/scientific resources market. For this open market model to

work, both standardised descriptions of research resources and standard APIs for the exchange of service/resources-related information among service providers and aggregators of this ecosystem are essential.

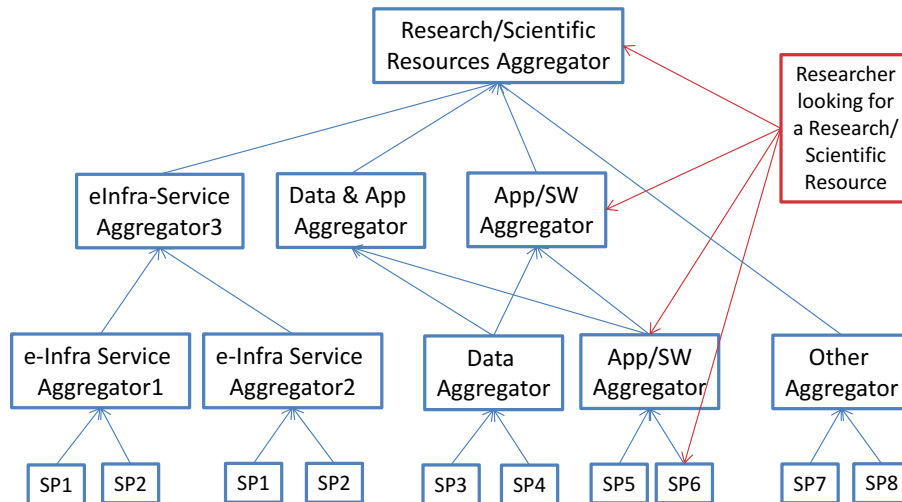


Figure 2: Model for the development of the Catalogue for the Research/Scientific Resources

eInfraCentral has shared its outputs with all key stakeholders in the wider ecosystem to help accelerate convergence towards a framework that allows the automatic exchange of service-related information among stakeholders. eInfraCentral is investigating two ways of the automatic update of a service: via a PUSH method (where the service manager is responsible for publishing information in the eInfraCentral Gateway) or a PULL method (where the eInfraCentral Gateway harvests new updates from a remote endpoint offered by the service manager). In either way, the main objective is to help drive interoperability and enable service providers to leverage additional distribution channels and end-users to select their preferred aggregation point.

**Role 3: eInfraCentral automates the aggregation of service information from partners' service catalogues.**

## 2.4 A Common EOSC Portal

The eInfraCentral portal has been developed to serve as a single entry-point to Europe's e-Infrastructure services. This aligns with the future development of the EOSC Portal, which is expected to become the universal entry point to access EOSC services, as described in the European Commission's Implementation Roadmap for the European Open Science Cloud.

**Role 4: The eInfraCentral Portal – acting as an aggregator and an entry point to access e-Infrastructure services, data, applications, software, pipelines, data-as-a-service, knowledge-as-a-service and other resources – is an underpinning element of the EOSC Portal.**

Based on a bottom-up consultation process, eInfraCentral designed, developed and deployed a **service gateway for end-users to the harmonised catalogue of services of European e-Infrastructures and solve the "last mile" problem**. The eInfraCentral portal offers end-users a gateway to an aggregated service catalogue, and provides an additional distribution channel to e-Infrastructure service providers. The portal provides different views of the catalogue for different

user perspectives and acts as a “matchmaker” between e-Infrastructure services and service requests by end-users.

The eInfraCentral portal collects and aggregates content from registered services, including service KPIs. Through standardised guidelines, its Service Description Template and an Application Programming Interface (APIs), it creates a uniform service catalogue of continuously up-to-date information. In this respect, it accommodates a wide range of stakeholders, including users of e-services, from research and industry, as well as e-infrastructure providers and other stakeholder groups like policy makers and funding bodies.

As a neutral portal (i.e. not run by any of the e-service providers) eInfraCentral will play a central role to ensure that service providers supply reliable, relevant and up to date information.

## 2.5 Towards Service Comparison

As the number of e-Infrastructures has grown significantly there is a clear need for all stakeholders to understand how to assess the use, operation, innovation and impact of e-Infrastructures in Europe. As a result, the topic of metrics and indicators has moved up the agenda of policy-makers and funders of all types of research infrastructures (not only e-), and their associated services as a way to look at the operational, technical and economic impacts of investments already made. This supports the accountability of e-Infrastructures towards both their users and funders.

The e-Infrastructures Reflection Group (e-IRG), recognising the need of various stakeholders “to understand how to assess the use, operation and innovation of e-Infrastructures in Europe”<sup>9</sup>, has defined an initial framework for a) evaluating and assessing e-Infrastructures at the regional, national and European level, and b) categorising key performance indicators.

Adoption of an appropriate and measurable set of performance indicators can only take place with the active participation of the various stakeholders, including the e-Infrastructures themselves. eInfraCentral is taking a lead in fostering this discussion with the e-infrastructure community, focusing on metrics for service level performance.

**Role 5: eInfraCentral Portal will take a lead in ensuring collection and comparability of an agreed set of performance indicators of e-services.**

Addressing this question takes into account the needs and expectations of various involved and interested stakeholders:

- e-Infrastructure providers’ interests about the uptake of their offered services;
- users’ expectations around the availability of all possible resources needed for their research and scientific expectations vis-à-vis an optimal use of financial and other resources towards accomplishing their needs;
- policy-makers and funders of infrastructures’ expectations around financial accountability and operational capability towards the tax payers;
- funders of infrastructures’ expectations around certain “research impact” indicators such as, for example, research articles datasets or software produced thanks to the services;
- expectations of the general public around the overall outcome of this financial spending, and how this fits into the broader agenda of societal challenges.

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<sup>9</sup> e-IRG, 2017. Evaluation of e-Infrastructures and the development of related Key Performance Indicators, e-Infrastructure Reflection Group, <http://e-irg.eu/catalogue/eirg-1005>, see p. 5.

### 3. Future Vision

During the last two decades, Europe has invested significantly in the development of e-Infrastructures that support scientific research and the commercialisation of resulting services. E-Infrastructures empower scientific communities with ubiquitous, trusted and seamless access to facilities, resources and collaboration tools, bringing to them the power of technology for communication, computation, storage and instrumentation. To date, these services primarily address small groups – and mainly researchers. This needs to change in the ‘Open Science, Open Innovation and Open to the World’ era to allow a broader group of actors to enter the picture: industry, governments, educators, citizens. Concerns have been raised about the uptake of e-Infrastructure benefits by a wider set of stakeholders due to issues of service accessibility, interoperability and fragmentation, comprehensibility and clarity.

To deliver on this open innovation, open science, open to the world vision for Europe, eInfraCentral will play a crucial role in the implementation of the EOSC. Taking the key roles and input of eInfraCentral discussed earlier in this paper:

**The eInfraCentral’s future vision:**

**To become the central EOSC gateway, an aggregator of services, an access portal to pan-European Open Science resources, supporting multiple marketplaces to promote their services to end users.**

Taking up the six action lines from the EOSC Implementation Roadmap – architecture, data, services, access & interface, rules and governance – eInfraCentral has a clear and important contribution to the two action lines (Figure 3).

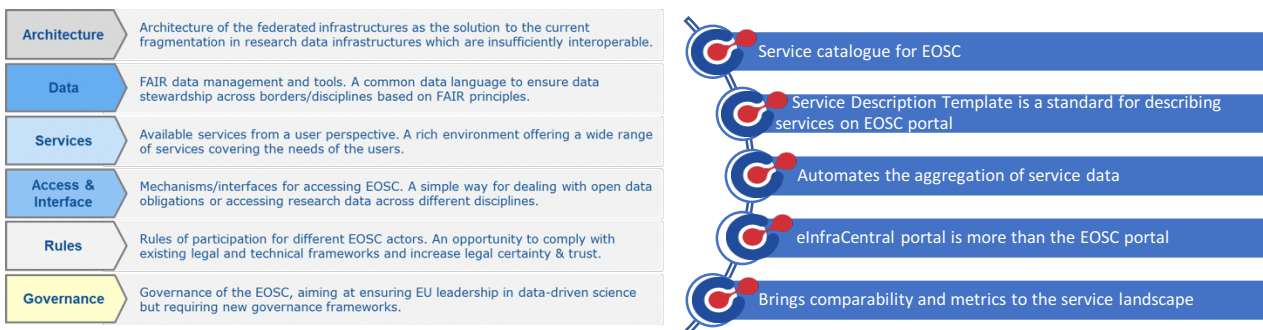


Figure 3: eInfraCentral in the context of the EOSC

eInfraCentral is well positioned to achieve this because of ten core principles which guide the design, set-up and development of the eInfraCentral service catalogue and portal (

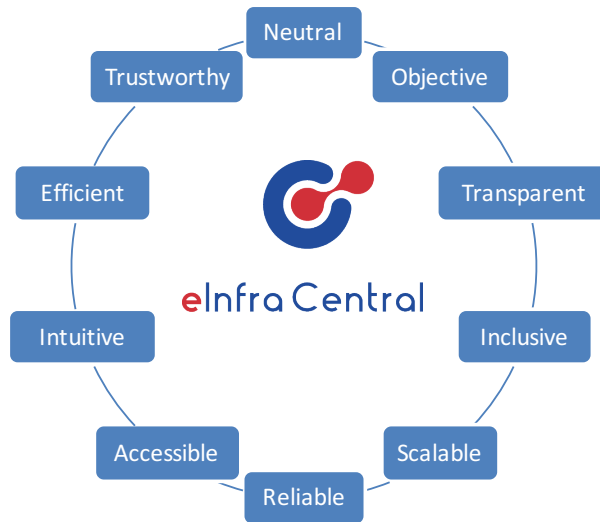


Figure 4).



Figure 4: Unique Selling Points of eInfraCentral

These principles not only guide development but also work towards the attraction, retention and constant increase of the eInfraCentral Gateway's customers:

1. eInfraCentral, being led by a group of key partners which are not providers of e-services, is **neutral** in producing and managing a homogenised service catalogue description for all major e-Science infrastructures in Europe.
2. eInfraCentral is **objective**: as the choice of services on the portal will be based exclusively on pre-defined fields and attributes of a homogenised service catalogue.
3. eInfraCentral is **transparent**, ensuring transparency of all income and spending of users as an integral part of the eInfraCentral Gateway.
4. eInfraCentral is **inclusive**, seeking to include as many European (and in the future also global) e-Science service providers as possible.
5. eInfraCentral is **scalable**, allowing for an expansion to new service offerings, the increase of its user base and the incorporation of additional service providers.
6. eInfraCentral is **reliable**, operating 24x7x365 with full redundancy, disaster recovery and

back up plans, in order for its service to be uninterrupted and seamlessly provided to its customers and to the European public at large.

7. eInfraCentral is **accessible**, providing easy access via any digital interface, including mobile devices, smartphones and tablets as well as various computer browsers.
8. eInfraCentral is **intuitive**, being designed based on the latest trends and UI technologies as well as best design practices deployed in internationally-acclaimed aggregators.
9. eInfraCentral is **efficient** in the operation of the Portal and particularly in the maintenance (via dedicated API and tools) and updating (via automated harvesting techniques) of the represented service offerings, including their descriptions, tags and fields
10. eInfraCentral is **trustworthy**, bringing the track record of prior effort and results of the main eInfraCentral partners.

eInfraCentral has already contributed to the development of the EOSC with its common approach to service description and standard methods for exchanging service-related information among service providers and aggregators in the ecosystem. Further developments of the EOSC should take advantage of the neutrality and expertise which eInfraCentral brings to a fragmented and underdeveloped service landscape of e-infrastructures.