WORK PROGRAMME 2016 – 2017

European research infrastructures (including e-Infrastructures)

(note this draft only covers the e-Infrastructure part)

(European Commission C(2015)XXX of XX … 2015)

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Call "E" - e-Infrastructures

H2020-EINFRA-2016/2017

The e-infrastructures[1] work programme for 2016/2017[2] will support the European policies on open research data, data and computing intensive science, research and education networking, high-performance computing and big data innovation[3]. It is structured along the following themes:

1 - Integration and consolidation of e-infrastructure platforms supporting European policies and research and education communities

Integration and consolidation and of e-infrastructure platforms cover the following aspects: (a) coordination of regional, national and European operations and funding (b) synergies between operational e-infrastructures (c) testing, deployment of new technologies, services and resources to ensure the continuous small upgrade of the infrastructure without service disruption.

2 - Prototyping innovative e-infrastructure platforms and services for research and education communities, industry and the citizens at large

The support to e-infrastructure innovation is done by means of two types of activities: (a) Platform-centric e-Infrastructure innovation (technology push, driven by the supply-side) and (b) User-centric e-Infrastructure innovation (user pull, driven by the demand-side).

3 – Support to policies and international cooperation

The e-infrastructures work programme for 2016/2017 foresees support to the implementation of the Open Research Data Pilot[4]. It will provide support for coordination of European, national and/or regional policies and programmes. International co-operation will promote the development of new e-infrastructure capacity on research data, high performance computing and networking, ensuring interoperation at global level. It will enable European communities to be linked with third countries, have access to unique research infrastructures and contribute to standardisation activities in international *fora*, aligning strategic developments and sharing best practices.

The implementation of the e-infrastructures work programme for 2016/2017 is informed by the following framework conditions:

Open Research Data in Horizon 2020:

The projects funded under this programme will participate in the Horizon 2020 Pilot on Open Research Data in line with the Commission's policy on Open Access to research data for facilitating access, re-use and preservation of research data. Projects have the possibility to

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[1] a.k.a Information and Communication Technologies infrastructure

[2] Is based on the "Scoping Paper" for Research Infrastructures (including e-infrastructures) and other extensive consultations

[3] COM Data value chain

[4] Further information on the Open Research Data Pilot is made available on the Participant Portal.

opt out of the Pilot. A related new element in Horizon 2020 is the use of Data Management Plans (DMPs) detailing what data the project will generate, whether and how it will be exploited or made accessible for verification and re-use, and how it will be curated and preserved. The use of DMPs is required for projects participating in the Open Research Data Pilot. Other projects are invited to submit a DMP if relevant for their planned research. The projects funded under the other calls of this Work Programme may participate in the Open Research Data Pilot in Horizon 2020 on a voluntary basis.

Maximizing and assessing the impact of the e-infrastructures Workprogramme 2016-17:

Proposals shall define, collect and make available key performance indicators (KPIs) in support of operational, technical and socio-economic impact assessment.

Proposals shall plan for active participation in international *fora* and community-led consensus building initiatives to promote data and computing infrastructure interoperability such as the Research Data Alliance.

H2020 as a catalyst of the European plan for growth and jobs:

Horizon 2020 encourages synergies with other European Union Funds, with appropriate provisions not to cover the same cost items[5]. The e-infrastructures work programme for 2016-2017 will promote when feasible the combined and/or the cumulative use other funding sources as instrument to support initiatives of European interest to foster growth and jobs[6].

Costs associated with e-Infrastructures:

The operation of e-infrastructure services will be funded by supporting the trans-national and virtual access activities provided to researchers.

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[5] Article 17a of the Horizon 2020 Regulation and Article 31 of the rules of participation.

[6] Proposed "game-changer" on *European high-performance data networks*

1 - Integration and consolidation of e-infrastructure platforms supporting European policies and research and education communities

Providing the best services to research and education communities across Europe is the key challenge of all supported e-infrastructures initiatives. Reaching a high level of dependability requires the integration and consolidation of e-infrastructure platforms through stable, secure and sustainable operations. It is not only a question of offering advanced research capacity; reliability and 24/7 availability are essential attributes of e-infrastructure services responding to user communities' short and medium-term requirements. Technology integration, training and interoperation, testing, certification, etc. are essential so that research and education users and the citizen at large can fully benefit. Sound mechanisms to monitor and evaluate the usefulness of services and underlying infrastructures are necessary to support informed decisions on infrastructure upgrades or phasing out of obsolete services.

The objective is to enable the integration and opening of national research infrastructures by means of remote access to the research resources (research instruments and facilities, global high-speed networks, high-performance computing and research data) offering more than the sum of individual components by sharing resources. It entails the development of efficient and participatory governance structures at European level and to establish a solid foundation to manage investment with the objective of scientific excellence while widening access to the key research and education resources.

Areas covered under this theme are:

Support to the next implementation phase of Pan-European High Performance Computing infrastructure and services: to help creating a world-class pan-European High Performance Computing (HPC) infrastructure and to provide state-of-the-art services with access by users, independently of their location.

Data Management and Distributed Computing e-infrastructures: to foster the integration of a, secure, permanent, on-demand service-driven, privacy-compliant and sustainable e-infrastructures incorporating distributed databases, computing resources and software.

E-Infrastructure for Open Science: to integrate and consolidate further an e-infrastructure supporting reliable and permanent open access to digital scientific records, based on existing initiatives across Europe (institutional and thematic repositories, aggregators, etc.).

The support to integration and consolidation of e-infrastructure platforms is done by topics described under the "other actions" sections. These are related with the running Framework Partnership Agreements (FPAs), in particular:

Research and Education Networking – GÉANT; FPA action described in detail under "other actions": addressing the persistent and dependable availability of a high-performing network is a key challenge to ensure Europe remains a central hub for research and innovation. Based on successful experiences GÉANT infrastructure supports the whole European research and education communities being connected at high-speed across the continent and at World scale. It provides seamless networking services to all scientists and other contributors, independently of location or discipline, to progress the frontiers of knowledge and innovation.

Trans-Atlantic submarine cable - FPA action described in detail under "other actions": addressing investments in digital infrastructure are needed to ensure Europe remains a central hub for research and innovation, offering the best infrastructure to the brightest minds in the

world. Based on successful experiences in providing reliable connectivity services and access to knowledge resources, the initiative will help facing the challenges of the next decade with connectivity at world scale and providing a seamless services to all scientists and other contributors to knowledge and innovation creation in Europe.

EINFRA-1.1-2016/17 - Support to the next implementation phase of Pan-European High Performance Computing infrastructure and services

Specific Challenge: In order to create a world-class pan-European High Performance Computing (HPC) infrastructure and to provide state-of-the-art services with access by users, independently of their location, the HPC resources need to be further pooled, integrated and rationalised. Horizon 2020 is a key element to support the European strategy on High Performance Computing which sets the way forward, in particular regarding the access to the best supercomputing facilities and services for both industry and academia. This topic complements the activities of the Public-Private Partnership (PPP) in HPC in order to fully implement the European HPC strategy.

Scope: proposals should address all points below:

(1) Provide a seamless and efficient Europe-wide Tier-0[7] service to users, based on promoting research excellence and innovation; this includes peer-review procedures for the allocation of computing time; transparent billing; and specific services adapted to the needs of users, including ESFRI projects, Horizon 2020 projects/programmes, large institutional users or industry.

(2) Carry out activities (training, service prototyping, software development etc.) that build on national HPC capabilities (Tier-1) and are necessary to support Tier-0 services or a functional European HPC ecosystem;

(3) Ensure openness to new user communities and new applications; promote industrial take-up of HPC services in particular by SMEs;

(4) Implement inclusive and equitable governance and a flexible business model to ensure long term financial sustainability; the business model should allow financial or in-kind contributions by research projects/programmes, institutions, industry and regions or countries; based on an auditable cost model for the operation of HPC Centres providing European services with different financing sources;

(5) Develop and maintain the strategy for the deployment of a rich HPC environment of world-class systems with different machine architectures - evolving towards exascale - including the implementation roadmap at EU and national level, taking into account financial aspects, best practices for reduction of operating and energy costs, and the specifications and technical requirements for a varied set of Tier-0 systems ensuring a broad coverage of user needs;

(6) Working in synergy with the European Technology Platform for HPC (ETP4HPC) and the Centres of Excellence in HPC applications in support of the European HPC strategy towards the next generation of computing systems, technologies and applications. In particular, for the provision of technical specifications to guide research activities for future exascale prototypes

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[7] Tier-0 are those services provided at pan-European level with machines devoted to the pan-European infrastructure for a significant fraction of cycles (to be agreed with the Commission) and having a minimum performance level to be periodically defined by the consortium

and systems, for the testing and demonstration of such exascale solutions, for the identification of new user needs in the use of next generation computing systems evolving towards exascale, and for the reaching out to scientific and industrial communities and the transfer of know-how for the use of HPC.

(7) Design and execute training and skills development programmes tailored to the needs of research in academia and industry and relevant public services in order to stay at the forefront of scientific breakthroughs, as well as introduction of scientific computing and HPC in academic curricula;

(8) Develop an international cooperation policy and associated activities in the area of HPC aiming at systems interoperation.

The infrastructure should provide core and basic services in coordination with other e-infrastructure providers to promote interoperability and a seamless user experience. Interworking with other computing infrastructures such as clouds and grids should be ensured.

Expected impact: The successful response to this area will improve services and procedures for user access to HPC infrastructure resources and services. Allocation schemes fostering openness to new user communities and applications will increased the amount of computing cycles available to researchers at European level through user-friendly and efficient procedures. This will help Europe staying at the forefront of scientific breakthroughs and innovation. This initiative will increase the number of industrial organisations (in particular SMEs), EU projects and institutional users benefiting from access to services including training in HPC. Benefits will also translate in increased investment in HPC infrastructure in Europe (national, regional and EU), long term financial sustainability through flexible business models and inclusive governance, better coordination between demand and supply in the European HPC ecosystem, with improved collaboration of the users and procurers with technology developers and suppliers to foster innovation.

EINFRA-1.2-2016/17 - Data Management and Distributed Computing e-infrastructures

Specific Challenge: The European data and computing e-infrastructure landscape remains very fragmented which is a huge obstacle for research collaboration at European and global levels and introduces additional complexity for achieving sustainable governance and financing. Dealing with research data, including big data, is a challenge to all scientific disciplines performing data-intensive science. Data and distributed computing infrastructures need to provide services cutting across a wide-range of scientific communities, addressing a diversity of computational requirements, legal and organisational constraints for access and long term preservation. Europe needs to integrate, secure, permanent, on-demand service-driven, privacy-compliant and sustainable e-infrastructures incorporating distributed databases, computing resources and software.

Scope: proposals should address all points below:

(1) integrate computing, software and storage resources to offer services to the European research and education communities. This integration should be done by means of open and flexible architectures and include institutional, regional, national and European capabilities, packaging them in the optics of end-user needs.

(2) secure the continuity of distributed computing services at different levels while empowering users to customise and optimize the response to their requirements which will differ across disciplines, applications etc.

(3) offer and adoption of a standards-based open source middleware that supplies common interfaces to access and analyse underlying data collected/stored in different platforms and formats. It should engage users (researchers, educators and students) to contribute to the improvement of the data and software quality and computing infrastructure by tailoring of services and applications that remain available for re-use.

(4) foster interoperability of pan-European community-driven e-infrastructures providing cost-effective and interoperable solutions for data management and long term preservation. The e-infrastructure should accommodate the needs for data access, storage, replication, annotation, search, compute, analysis and reuse of information.

(5) work closely with user communities (from hard sciences to social sciences and humanities) to foster the use of digital infrastructures, promote the values of open science and support their data management plans. Operate computing and software infrastructures and services used for generating, processing and correlating data so that the reproducibility and accuracy of the data can be verified. Reach out to new user communities through effective training and dissemination of the available resources. Services shall enable user communities to more easily access computing and software infrastructure resources by maintaining customisable catalogues.

(6) enable seamless transition and upgrades, exploiting economies of scale and promoting interoperability with similar infrastructures across and beyond Europe and operate user-friendly and comprehensive repositories of software components for research and education.

The data and computing infrastructure should be able to interoperate with resources based on different technologies which are operated/owned by public and or private organisations. The above objectives will support coherent, scalable, integrated, secure and reliable services offers; incentivise an open eco-system of innovative usages of e-infrastructures services ensuring a smooth collaboration among e-infrastructures as well as with the targeted science case.

Expected impact: the operation of a federated European data and distributed computing infrastructure for research and education communities will optimise the access to IT equipment and services and will put all European researchers and educators in equal footing to access essential resources to express their talent and creativity. While establishing partnerships with industrial and private partners the e-infrastructure will train people in research and academic organisations preventing lack of skilled and specialised infrastructure operators. It will avoid the locking-in to particular hardware or software platforms that would jeopardise the long-term planning for capacity upgrades. With such an operational infrastructure more scientific communities will use storage and computing infrastructures with state-of-the-art services for their research and education activities. The open nature of the infrastructure will allow scientists, educators and students to improve the service quality by interacting with data, software and computing resources. It will increase the incentives for scientific discovery and collaboration across disciplinary and geographical boundaries, putting Europe in the driving seat at global level. It will further develop the European economic innovation capacity and provide stability to the e-Infrastructure.

EINFRA-1.3-2016/17 - e-Infrastructure for Open Science

Specific Challenge: With digital technologies research data and scientific publications are gradually becoming a continuum. The seamless access to publications and research data and its long term preservation is an important requirement for Open Science as enabler of trust in

the scientific enterprise. Europe needs a robust and sustainable e-infrastructure supporting Open Access policies for research data and publications. An infrastructure based on existing initiatives across Europe (institutional and thematic repositories, aggregators, etc.), should support reliable and permanent access to digital scientific records. A key challenge is the capacity building to link all kinds of research objects in order to enable a more transparent evaluation of research and reproducibility of results.

Scope: proposals should address all points below:

(1) Deployment and maintenance development of service-driven data e-infrastructure responding to general and specific requirements of researchers and research organisations for open access to and deposit of research digital objects. This e-infrastructure will further develop the research capacity through a coordinated and participatory architecture linking institutional and thematic repositories across Europe with scientific information to be used by humans and machines. An essential part of this service-driven approach will be helpdesks, training and guidance designed to support the producers and users of scientific information, human networks to support research data sharing and management, as well as implementation of Open Access policies in Europe. Relevant indicators on the take-up of open access in Europe including for both publications and data should be elaborated and reported upon regularly. The project will promote a limited set of biblio- and webometrics that reflect open access policies. It will collect bibliometric data on publications, citations, data citations, etc. on all Horizon 2020 scientific output (including on the Open Research Data Pilot) and produce both standard and on-demand statistics.

(2) Supporting global interoperability of open access data e-infrastructures and linking with similar initiatives across the globe to complement the physical access to research facilities with data access and to ensure that Europe plays a leading role in international collaborations.

Expected impact: The intellectual capital of Europe is available to researchers, business and citizens to generate economic and scientific advances now, and that capital is safely preserved for further exploitation by future generations. Open Access publications resulting from Horizon 2020 funded research are available and easily findable online. Data needed to validate published results is linked to the publications and publicly shared whenever possible. Accurate science metrics for Horizon 2020 can be produced with almost no effort. Most of the European institutional repositories (at least 95%) as well as the principal thematic repositories are part of the same interoperable repository network.

Type of action: Research and innovation actions

Indicative budget for the three topics above: 55M€ (15M€, 30M€ and 10M€)

2 - Prototyping innovative e-infrastructure platforms and services for research and education communities, industry and the citizens at large

The support to e-infrastructure innovation is done by means of two topics described below: (a) Platform-centric innovation (technology push, driven by the supply-side) and (b) User-centric innovation (user pull, driven by the demand-side). The topics unfold in the following activities:

Areas covered in platform-centric e-Infrastructure innovation

Support to Public Procurement of innovative HPC systems, PPI: Mastering high-performance computing (HPC) technologies and accessing the best HPC infrastructures and services are key factors for competitiveness and social, scientific and industrial innovation[8]. Industry and academia need access to leading-edge supercomputing infrastructures and services in order to stay competitive. The most advanced state-of-the-art systems (evolving from current dozens of peta-scale to future exa-scale performance) require ever-increasing investments hardly affordable by a single EU Member State. A Public Procurement of Innovation (PPI) action addressing HPC can mobilise the national and EU resources needed to help renew the current set of HPC top systems in Europe dedicated to excellent research that is being progressively outdated. The PPI can contribute to a dynamic supply and demand HPC ecosystem in the EU, where the most advanced solutions produced by R&I in Europe can find a way to the HPC infrastructure. This action contributes to the implementation of the EU strategy on High Performance Computing (HPC), in particular regarding the access to the best supercomputing facilities and services for both industry and academia. This topic complements the activities of the Public-Private Partnership (PPP) in HPC in order to implement the European HPC strategy.

Universal discoverability of data objects and provenance: A digital science ecosystem requires that research data, software and computational resources are discoverable, accessible and usable. These are conditions for researchers and educators to collaborate and, through adequate incentives such as data citation, share data and assess its quality. Encouraging openness while respecting constraints such as privacy and community legacy best practices requires managing discoverability and provenance, quality review, citation and certification. There are technological and organisational challenges to offer a sustainable, robust, pan-European e-infrastructure service for universal discoverability of data objects and their provenance (by means of Universal Digital Identifiers). Such a service will open new prospects for data and computing-intensive science and education, encouraging openness and building trust.

Computing e-infrastructure with extreme large datasets: Long-term capacity upgrade of data and computing e-infrastructure is constantly tested by research communities that push the envelope in terms of volume, velocity and variety of research data. Scientific communities are increasingly aware of the rising tide of data which requires new approaches to data discoverability, management, quality assurance and trust, preservation, access and sharing. E-infrastructures incorporating advanced computing resources and software based on up-to-date mathematical methods are essential in order to increase the capacity to manage and store

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[8] Communication "High Performance Computing (HPC): Europe's place in a global race"

extremely large, heterogeneous and complex datasets and to enable intelligent and timely analyses, to extract accurate knowledge and information from huge datasets.

Networking infrastructure: platform innovation – FPA action described in detail under "other actions": The GÉANT research and education network has reached an outstanding level of performance, global reach and maturity serving millions of users, in Europe and worldwide. It is a success in terms of partnership with industry to build and operate the barer high-speed network. Several long-term objectives in terms of future capacity have to be pursued such as servicing extreme-scale research infrastructures located in remote areas and develop further the local and campuses networks as drivers of new science and new service and applications.

EINFRA-2.1-2016/17: Platform-Centric e-Infrastructure innovation

Specific Challenge: Prepare the capacity required to future generations of e-infrastructure is the key challenge. E-infrastructure platforms and services need to evolve through innovation actions to respond to the long-term needs of research and education communities (e.g. in case of large RIs entering in functions in a 5 to 10 years' timeframe). Platforms and services are first designed, prototyped and piloted with "supply and demand-side" approaches triggered by to the most demanding cases. The innovative developments bringing state-of the-art technology need to evolve and mature to be integrated and offered as dependable e-infrastructures.

Scope: proposals are expected to address the following areas:

(a) Support to Public Procurement of innovative HPC systems, PPI *(proposals should address all points below)*:

(1) procurement of innovative HPC solutions supporting the deployment in Europe of world-leading HPC capability infrastructure

(2) ensuring and reinforcing European access to European leading-edge supercomputing Tier-0 infrastructures and services, by making available a substantial percentage of the new systems to European researchers in the frame of the Pan-European High Performance Computing infrastructure and services (see EINFRA-1.1-2016/17)

(3) diversify the available leading-class HPC capabilities through a rich set of HPC architectures featuring the most advanced technology made available by R&I in Europe, in order to satisfy the needs of a wider range of users in very different key application areas

(4) contribute to the coordination of plans and procurements for the provision of leading-class HPC capabilities at European and national level in view of the implementation the European supercomputing strategy , encompassing funding and technical specifications

(b) e-Infrastructure prototypes *(proposals should address one of the two activities below)*

(b1) Universal discoverability of data objects and provenance *(proposals should address all points below)*:

Prototyping an e-infrastructure service for the uptake of a Digital Identifier e-infrastructure for digital objects (articles, datasets, collections, software, nomenclature, etc.), contributors and authors which cuts across geographical, temporal, disciplinary, cultural, organisational and technological boundaries, without relying on a single centralised system but rather federating locally operated systems to ensure interoperability. The requirements of all relevant stakeholder groups (researchers, libraries, data centres, publishers, etc.) will be addressed.

(b2) Computing e-infrastructure with extreme large datasets *(proposals should address all points below):*

Develop data and software infrastructure proof of concept and service prototypes for modelling, simulation, pattern recognition, visualisation, etc. using robust mathematical methods and tools (e.g. for databases and data mining). Prototypes should adopt standards-based open source platform that supplies a common interface to access and analyse underlying data collected/stored in different platforms, formats, locations and e-infrastructures and be tested against requirements of extremely large or highly heterogeneous research data sets scaling to zetabytes and trillion of objects. Clean slate approaches to high-performance computing and data management (HPC-through-the cloud) targeting 2020+ 'data factory' requirements of research communities and large scale facilities (e.g. ESFRI projects) are encouraged.

Expected impact

(a) Support to Public Procurement of innovative HPC systems, PPI: This action will contribution to the European HPC strategy through the creation of a European procurement market for the benefit of the HPC actors in Europe (in particular technology suppliers) and catalysing the efforts to vitalise the European HPC ecosystem. It position Europe as a world-class HPC hub with more leading-class HPC computing resources and services available at European level for European academia and industry, independently of the location of users or HPC systems. It will foster adoption and use of innovative world-class HPC solutions featuring the most advanced results of the R&I in Europe, widening the access to more users, in particular for and industry (including SMEs). It will improve effectiveness of public procurement in leading-class HPC systems through joint procurement and pooling of European and national resources, contributing to sustainability. Benefits will also translate in better coordination between demand and supply in the European HPC ecosystem, with improved collaboration of the users and procurers with technology suppliers.

(b): **e-Infrastructure prototypes**

(b1) Universal discoverability of data objects and provenance: The successful set up of such service will support interoperability of e-infrastructure services. The use of Digital Identifiers opens new prospects for advanced services for science and education and for encouraging openness and building trust. Data and other resources become discoverable and easy to use which will facilitate access to resources and collaboration between scientists. It has the potential to be used as a core service across Europe and globally. Duplication of efforts for developing services common to many e-infrastructures is reduced.

(b2) Computing e-infrastructure with extreme large datasets: The successful prototyping of this action services will support the evolution of e-infrastructure services based on exascale data. It will prepare data and computing infrastructure to absorb needs of communities that

push the envelope in terms of data and computing intensive science while softening the learning curve for scientific communities that will be using new services.

Type of action:

    a. Public Procurement for Innovative solutions Co-fund actions (PPI)

    b. Research and innovation actions

Indicative budget:

    a. 26M€

    b. 20M€

Areas covered in user-centric e-infrastructure innovation

Exploitation of e-Infrastructures for user-centric innovation and pilots responding to community specific challenges: There is an increasing demand on research e-Infrastructures to contribute to the further development of a modern European *data economy*. Increasingly EU policy related initiatives (e.g. the Copernicus programme, environmental initiatives on marine, agricultural and biodiversity, covered by the Inspire Directive[9] etc.) share common requirements for reliable high-speed connectivity, access to data management and computing resources to address the exponential growth of data produced and make them available to the European researchers and citizens at large.

EC-funded scientific e-infrastructures have been focusing on serving academic and research communities and institutions. Facilitating access to computing power and data analytics for industry and in particular SMEs that cannot afford building their own infrastructures remains a challenge. Opening up research equipment and facilities would increase their utilisation, make them less dependent on public funding and improve their long term sustainability. Furthermore, establishing a close cooperation between existing e-infrastructures and industry (particularly SMEs), the latter playing more active role both at supply and demand side, is necessary to ensure faster transfer of research results to the market, thus contributing to implementation of EU strategy aiming to boost growth and jobs. Open e-infrastructures to communities of users to prototype user-centric services enhancing the service offer, its reliability and usability remain a big challenge.

Innovation for Open Science e-infrastructures and services: Open Science is a pre-requisite for building trust in research discovery processes, not only between peers but also to engage citizens to become better informed and more engaged. Europe needs that the e-infrastructure supporting Open Science is enriched with innovative services to exploit open scientific content (literature and data), make use of open e-infrastructures for connectivity and high-performance computing and promote a culture of transparent scientific culture. The key challenge is to promote user-driven innovation services to empower a participatory pan-European e-infrastructure linking institutional and thematic repositories, scientific content aggregators etc. Innovative services will support reliable and permanent access to digital scientific records and link all kinds of research objects in order to enable a more transparent evaluation of research and reproducibility of results.

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[9] INSPIRE Directive

EINFRA-2.2-2016/17: User-centric e-infrastructure innovation[10]

Specific Challenge: Prepare the capacity required to future generations of e-infrastructure is the key challenge. The objective is to support user-driven design and prototyping of innovative e-infrastructure services and applications to meet the scientific needs of those communities that push the envelope in scientific and technological domains requiring top-of-the range capacity in the long term. Promoting multi-domain approaches to fully exploit e-infrastructure scientific and economic innovation potential. Opening e-infrastructures to develop and test innovative functionalities and advanced technology entails the support of Open Science and stairways for excellence to increase citizen's trust in science, bridging the gap between the leading research and education communities and the wider population. The activities support opening e-infrastructures to innovative stakeholders (researchers, citizens and SMEs) to exploit a wide range of technology developments, research results and data.

Scope: proposals are expected to address only one of the following areas:

(a1) Exploitation of e-Infrastructures for user-centric innovation and pilots responding to community specific challenges *(proposals should address only one of the points below):*

(1) Proposals are expected to support, through open e-infrastructure resources, specific requirements of EU policy related initiatives (e.g. the Copernicus programme, environmental initiatives on marine, agricultural and biodiversity, covered by the Inspire Directive etc.). E-infrastructures should enable fast prototyping and development of innovative networking, data and computing intensive application and services promoting adaptation, extension and repurposing of basic services. Special attention should be devoted to standardisation to make data and software reusable by across the board. The barer network, data and computing services should lead to economies of scale and facilitate access to resources by innovators.

(2) Foster the development of innovative prototype services and products by innovative actors in particular SMEs. These prototypes should either extend the current service offering of European e-Infrastructures or exploit existing European e-Infrastructures services and resources for development of new products/services e.g. in exploiting networked sensors, mobility, virtualisation or educational resources for users-centric innovation.

The action will involve initiatives led by innovative actors (notably SMEs) for which financial support will be granted (minimum 85% of the EU funding requested by the proposal, in the order of EUR 100.000 – 150.000 per innovative actor) in line with the conditions set out in Part K of the General Annexes.

(3) Stimulate AAI services supporting communities involved in the emerging data-rich science era to manage and share their resources. It should respond to user requirements towards integrated identity management across-disciplines and interoperable at global level.

(a2) Innovation for Open Science e-infrastructures and services *(proposals should address all points below):*

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[10] As part of innovation activity linking the Arts into the innovation practices of H2020, projects are encouraged to dedicate, whenever appropriate, resources to creative and artistic practices for requirements definition, exploration of technological limits via art installations, developing novel and unexpected uses of technology, testing of unexpected technical solutions, and for working on social acceptance.

(1) Reuse and improve (performance, quality, reputation, etc) the open access repository infrastructure by prototyping new infrastructure services in support of open science through new forms of publishing, machine-assisted knowledge extraction from heterogeneous data resources and strengthening of machine readability. Development of open review services engaging researchers, educators and students.

(2) Develop further and widening the scope of the Open Science e-infrastructure. It should focus more generally on an open scientific knowledge management infrastructure the dimension of scientific and educational information repositories forming a visible part of inter-connectedness and global knowledge structure. This should include all relevant parts of the scientific information ecosystem to enhance the interlinks between literature, data, software, models and other digital objects in an interoperable framework in order to enable more efficient digital science as well as transparent evaluation of research and reproducibility of results.

Proposals should consider barriers (including legal) to data sharing in the context of these new services and assess the possibility of using pan-European authentication and authorization infrastructures.

Expected impact:

Exploitation of e-Infrastructures for user-centric innovation and pilots responding to community specific challenges:

(a1.1) This actions will accelerate the development of innovative data and computing intensive services in areas of policy relevance for Europe such as Health, Environment monitoring and management. It will foster the use of open e-infrastructures eco-systems to innovative use promoting smooth collaboration among and between the large European Policy data intensive initiatives. It will bridge the gap between adjacent but not connected scientific communities and promote wide dissemination of data including to the citizens engaged in science. It will support collaboration in data provision and exchange across regional and national related infrastructures allowing the integration of data from a myriad of resources and research communities.

(a1.2 and a1.3) Successful proposals will have an impact in making European and global intellectual capital available to researchers, business and citizens. This will support scientific advances now and generate innovation with economic impact leveraging e-infrastructures such as GÉANT. The knowledge capital will be better preserved for further exploitation by future digital-born generations. This action will support the objectives of Open Science, contribute to the modernization of the underlying infrastructures and improve access to content and resources through federated management.

(a2) Innovation for Open Science e-infrastructures and services: Successful proposals will increase the number of SMEs that are aware of available e-infrastructures resources and services and become active innovators as users and or suppliers of e-infrastructures. Stronger links between e-Infrastructure operators and other actors in the innovation chain will be put in place.

Type of action: Research and innovation actions

Indicative budget: 20M€

3 - Support to policies and international cooperation

The support to innovation, human resources, e-infrastructure related policies and international cooperation is done by the following activities:

International Co-operation on e-Infrastructure[11]: European research and education communities need to be supported to link with counterparts in third countries to align strategic developments, share best practices and promote interoperation of e-infrastructures at global level. Putting in place effective and targeted international co-operation mechanisms remains a challenge to address number of scientific and societal challenges, which helps to share and pool resources and brings in the best expertise from wherever it exists. International co-operation activities are a way to support the Commission policies on neighbourhood countries, developing countries, emerging economies (BRICS) and developed countries.

Policy support to e-infrastructure programme: The success of the actions supported by the workprogramme depend on the identification and exploitation of synergies between the funded initiatives in order to ensure common aims are being pursued and supported by sustainable investments. It is important to monitor the impacts to optimise efforts and resources and it is necessary to progress towards common transparent monitoring of the e-infrastructure services and associated costs. The definition of qualitative and quantitative performance indicators (Key Performance Indicators, KPI) remains a challenge for operators, users and funders of e-Infrastructures. Future e-infrastructure needs and requirements need to be analysed supported by a reliable time series of KPI.

European support to the Research Data Alliance, RDA: Research/Science funders have a common problem when tackling the area of research data infrastructures. The landscape is geographically fragmented and different disciplines have very different practices. It is very difficult to build critical mass and provide common services to different scientific disciplines and take advantage from economies of scale. Some scientific communities are pushing the envelope and adopting new technologies and others are lagging behind. Scientists are, at the end of the day, the generators and users of research data in their experiments, simulations, visualization of complex data arrays, etc. The Research Data Alliance is a useful initiative bringing together competences from different scientific fields and also the competences of technology and services providers in order to make use of the opportunities offered by new information and communication technologies. Interoperable data infrastructures will allow researchers and practitioners from different disciplines to find access and process the data they need in a timely manner. They can collaborate across different domains of science and engineering. The innovative power of industry and enterprise will be leveraged by clear and efficient arrangements for exchange of data between private and public sectors.

EINFRA-3-2016/17: Support to policies and international cooperation

Specific Challenge: Fostering targeted international co-operation is essential promote e-infrastructure interoperation at global level allowing European communities to link with third countries, contribute to standardisation activities in international *fora*, to align strategic developments and share best practices.

To optimise e-infrastructures investments in Europe it is essential to coordinate European, national and/or regional policies and programmes for e-infrastructures in order to develop

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[11] According to the conditions set in H2020 for International cooperation.

complementarities and promote cooperation between e-infrastructures and related EU policies.

Scope: proposals are expected to address the following areas:

(a) **International Co-operation on extreme scale e-infrastructure requirements** *(proposals should address all points below):*

International cooperation involving different third countries, to facilitate the development of globally interoperable e-infrastructures ensuring their global reach, innovation, skill development and sharing of lessons learned.

Europe is a leading partner together with other countries in the world in the construction of the forthcoming Square Kilometre Array (SKA) radio telescope. SKA will generate more data per day than the entire internet when it comes online. Efficient processing and computation of the large volume of data are significant challenges and global co-operation is essential. SKA has the potential to drive innovation in query and knowledge creation on large databases, energy efficient computing (as very large computers like the SKA massive energy demands), and improved communications and networking technologies.

Proposals bringing together key international partners presently involved in SKA and others who can contribute to the challenges should address the following aspects:

- Define and test the high-speed networking e-infrastructure architecture, components and services to respond to the extreme bandwidth requirements for SKA while ensuring adequate channels of dissemination of data.

- Define and test SKA's computational requirements and architectures in terms of High-Performance Computing, distributed computing, storage e-infrastructures and services.

- Foster global co-operation on management e-infrastructure and services for the huge volumes of data that will be generated from SKA through joint efforts on global interoperability in the context of the Research Data Alliance (RDA).

(b) **Support Actions for International Co-operation and Policy Development**

(b1) **International Co-operation on e-Infrastructure supporting major societal challenges** *(proposals should address all points below):*

International cooperation involving different third countries, to facilitate the development of globally interoperable e-infrastructures ensuring their global reach, innovation, skill development and sharing of lessons learned.

Co-operation with third countries on interoperability of e-infrastructures for networking, computing and data in order to support joint-efforts on one or more major societal challenges (e.g.: health, agriculture, education/skills, etc.). Innovation and spin-off of technology for developing and developed countries and emerging economies to establish a platform for sharing information and best practices on e-infrastructure development, deployment and operation.

Proposals should address the following aspects:

- Define one or more key societal challenge that has significant potential of maximising benefit of e-infrastructure across developing, developed and emerging economies,

- Organise a platform for sharing information and best practices,

- Identify and explore spin-off and innovation, in particular with the co-operation of developing and developed countries.

(b2) Policy support to e-infrastructure programme *(proposals should address only one of the points below):*

(1) Support the e-IRG[12] secretariat in assisting the e-IRG operation in particular of providing strategic advice on the development of European e-Infrastructures. Special support should be given to the collection and aggregation of relevant policy information to the development of EC-funded e-Infrastructures, in particular of Key Performance Indicators (KPIs) and associated costs. The collection of KPIs shall be done in coordination with the funded e-infrastructure initiatives and made available in open formats for reuse.

(2) Develop and maintain dissemination and *concertation* activities for information sharing among projects and stakeholders. They should include a web-portal to convey updated information related to the evolution of e-infrastructures at regional, national and European levels. The portal should be a vehicle to present Key Performance Indicators (see point above) to experts and the wider public. It should support monitoring activities on take-up of open science and e-infrastructures policies (e.g. Horizon 2020 Open Research Data Pilot and Horizon 2020 Open Access to publications mandate), monitoring how many publications are published in green and gold OA, and how much the EC spends on article processing charges for gold OA by research communities and citizens, per country, region and research domain.

(3) Support small-size foresight roadmaps for research and education communities and e-infrastructure operators to define long-term requirements and identify potential collaboration from users across different scientific domains.

(b3) European support to the Research Data Alliance, RDA *(proposals should address all points below):*

Proposals are expected to support the development of global interoperable research data infrastructures that will greatly benefit the coordination at European level. The objective is (a) support to the RDA secretariat for logistics, open access to RDA reference documents and dissemination activities (b) support the emergence of building blocks of an open, interoperable data infrastructure fostering interoperability across regions, organisations and scientific disciplines (c) support new communities to engage in Open Science and data sharing principles. In particular, the proposal activities should cover the organisation and coordination of European stakeholders' participation and contribution to the Research Data Alliance.

Expected impact

(a) International Co-operation on extreme scale e-infrastructure requirements: The impact of successful proposals will lead to the improvement of co-operation on e-

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[12] e-Infrastructure Reflection Group

Infrastructures with European partners that are joining efforts in major research infrastructure undertakings. It will help the identification of benefits of joint technology development, standardisation and sharing risks.

(b) Support Actions for International Co-operation and Policy Development:

(b1) International Co-operation on e-Infrastructure supporting major societal challenges: will exploit the potential for further economic and educational co-operation between Europe and third countries. It will also improve the identification of areas for further co-operation on scientific development and innovation. The actions will provide mechanisms to assess measurable benefits of co-operation on major societal challenges in the developing countries.

(b2) Policy support to e-infrastructure programme: Support actions provide solid ground for future choices for a comprehensive European Research Infrastructure and especially e-Infrastructure policy and enable decision making and deployment of e-infrastructures. Successful collaboration between all projects under the H2020 e-infrastructure funding brings together all key stakeholders, and enables finding further synergies towards a harmonised European e-infrastructure approach.

(b3) European support to the Research Data Alliance, RDA: Europe will be in a leading position in enabling the use of the world's store of research data in multi-disciplinary, data intensive global scientific collaborations. It will help the development and adoption of relevant international open standards based on the best practices of a large spectrum of research communities. It will engage research communities at early stages of standards development and address common data requirements for new services bringing together users and technology providers. It will promote sustainable models for research data sharing and install trust in the adopted solutions.

Type of action:

    a. Research and innovation actions
    b. Coordination and Support Action (CSA)

Indicative budget:

    c. 3M€
    d. 7M€

The conditions related to different topics are provided at the end of this call and in the General Annexes.

(empty)

Other actions with different types of instruments:

(a) - GÉANT Partnership projects[13]

The GÉANT consortium will be invited to submit three proposals addressing objectives defined in the Framework Partnership Agreement (FPA) and action plan. The proposals will be evaluated according to the criteria established in the invitation from the Commission, complying with the Horizon 2020 general requirements of evaluation and selection procedures[14].

Scope: proposals are expected to address only one of the following activities:

(a1) Research and Education Networking – GÉANT

Effectively support data and computing-intensive collaborative research and education anywhere in Europe and beyond, through reliable networking services and operational excellence. Supply dependable, secure around the clock, high-speed internet access to research and education communities, enhancing the quality of service improving geographical coverage and support cooperation of emergency response teams at European level. Deploy short and medium-term investments to extend geographic network coverage and prepare capacity to integrate new services to be included in the mainstream service bouquet of future generations of the infrastructure. Deploying the 100 Gbits/s technology across Europe and improving peering; decisions for investing in new networking services should be based on a clear business case and commitment by National Research and Education Networks.

(a2) Networking infrastructure: platform innovation

Enhance future generations of GÉANT platform by prototyping network components, modules, services and applications accessing wired/wireless infrastructures and networked resources. In particular these should to respond to the needs of extreme-scale systems (e.g. requiring massive data transfer capacity). They should develop further and test network resilience, trust and security in scenarios pushing network performance to the limits. Prototype and customise network services to manage the movement of large data files (i.e., PetaByte, ExaByte) between data sources and computing sites. Develop operator and user interfaces for easy deployment, customisation and test of new networking services. Analyse legal, economic, policy evolution scenarios related with use of open network architectures.

(a3) Trans-Atlantic submarine cable

Improve the global footprint of the European research and education high-speed network (e.g. through the investment in submarine cables or other trans-national backbone infrastructure) to connect Europe with other continents that offer collaboration opportunities to European research and innovation communities.

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[13] Awarding of specific grants in a FPA will follow the rules and procedures established in the Financial Regulation

[14] This action allows for the provision of financial support to third parties in line with the conditions set out in the part K of the General Annexes

Expected impact:

(a1) Research and Education Networking – GÉANT N: The investment at the European level in GÉANT is expected to: maximise the value of innovation in a cooperative, open and multi-domain eco-system; the cooperation at European and global levels will minimise the risk of divergent, redundant, overlapping and incompatible investments on the whole REN chain; it will stimulate advancement of the combined REN infrastructures to tackle cross-border links. The GÉANT network is an essential resource to address the digital divide in Europe through a common cost sharing model effectively enabling equal access to IT resources in Europe. It will create economies of scale in procuring/brokering access to cross-border resources at European level and to optimise costs of cross-border links. GÉANT will continue to contribute to the effective European research enterprise making Europe the best connected region in the world.

(a2) Networking infrastructure: platform innovation: The above objectives ensure GÉANT's excellent barer infrastructure in support of coherent, scalable, integrated, secure and reliable networking service; keeping it based on open and flexible architecture that made the Internet such a powerful societal game changer. It is the basis of an open eco-system of innovative usages of e-infrastructures services ensuring a smooth collaboration among e-infrastructures as well as with global scientific communities.

(a3) Trans-Atlantic submarine cable: This action will directly support inter-continental research and education collaborations with long term low cost view, and will have extended socio-economic impacts for Europe notably in improving the connectivity of the major European internet exchanges and European data-based services, helping addressing emerging markets in Latin America, Africa and East Asia.

Type of action: Research and innovation actions

Indicative budget: 64M€

(b) – Computing/storage e-infrastructure for the Human Brain Project FET Flagship (FPA)[15] [16]

Within the Human Brain Project (HBP) Framework Partnership Agreement (FPA) awarded under topic FETFLAG 1 - 2014 of the Call FET Flagships, the selected consortium will be invited to submit a proposal for a Specific Grant Agreement (SGA) that will define and deliver the main computing and storage e-infrastructure that the Flagship needs in the context of its brain simulation activities, as indicated in the HBP FPA[17].

Specific challenges: Availability of the main computing and storage capacities that the HBP Flagship needs in the context of its brain simulation and data analysis activities is an important part to its success.

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[15] This action is related with the objective to address e-Infrastructure pilots responding to community specific challenges, bringing a user-centric e-infrastructure innovation perspective.

[16] Awarding of specific grants in a FPA will follow the rules and procedures established in the Financial Regulation

[17] This action allows for the provision of financial support to third parties in line with the conditions set out in the part K of the General Annex

Scope: The proposal should adhere to the programme of activities as envisioned in the FPA. It should describe how the approach proposed will build on related activities carried out during the HBP FP7 ramp-up phase and during the first SGA of the HBP core project. In particular, it will have to take into account the results of the Pre-Commercial Procurement (PCP) phase launched in the ramp-up phase of the Flagship regarding the specifications for a (pre-exascale) computing system with (i) very high memory footprint and (ii) interactivity and visualisation. It should also take into account, whenever relevant, progress made by technology providers and evolution of related requirements by other scientific communities.

The proposal should explain how the partners involved will finalise the requirements, consult with suitable providers, procure the e-infrastructure, validate the delivered computing and storage capacity and make it available to the HBP core project and other relevant scientific communities. The proposal should also include clear contingency and mitigation plans to address relevant high risk aspects related to the provisioning of such an e-infrastructure. The sources of any complementary funding required should be sufficiently explained.

The proposal should describe the coordination with the other HBP computing and data storage facilities and the transition from the current main HBP system used for running brain simulations to this new e-infrastructure and also the foreseen later move to exascale performances (for an operational exploitation of the brain simulators after the end of the HBP FPA). The proposal should detail the scheme foreseen for ensuring that the necessary capacity of the e-infrastructure is available for the HBP research activities, and how its specific features can be shared with other user communities. The proposal should also explain how resources will be made available to the Pan-European High Performance Computing Tier-0 infrastructure and services (see EINFRA-1.1-2016/17), by making available a percentage of the new e-infrastructure to European researchers at large.

Expected impact: This action will contribute to the targeted impacts defined in the action plan of the Human Brain Project FPA. It will also contribute to diversify the available leading-class HPC capabilities in the Tier-0 Pan-European HPC infrastructure, and to the adoption and use in Europe of the most advanced HPC technology.

Type of action: Research and innovation actions

Indicative budget: 25M€

(c) – Inducement Prize for e-infrastructure service innovation

Specific challenges: e-Infrastructures in Europe are primarily used by research institutions. Innovative SMEs could increase use of modern research networking, computing, data management and other e-infrastructure services. Obstacles are found both in the adequacy of the services for SMEs as well as skills to use them by SMEs.

Scope: Prize for the most innovative and effective way to provide e-infrastructure services to SMEs.

Expected Impact: the initiative will increase the user base of e-infrastructure services and help building a catalogue of success stories related to the use of e-infrastructures for innovation.

Type of action: Inducement prize

Indicative budget: 1 M€

Annex: Summary of actions and budgets

Topic	Budget (M€)	Type of action	Annex K?
1 - Integration and consolidation of e-infrastructure platforms supporting European policies and research and education communities	(55)		
EINFRA-1.1-2016/17 - Support to the next implementation phase of Pan-European High Performance Computing infrastructure and services	15	RIA	
EINFRA-1.2-2016/17 - Data Management and Distributed Computing e-infrastructures	30	RIA	
EINFRA-1.3-2016/17 - e-Infrastructure for Open Science	10	RIA	
2 - Prototyping innovative e-infrastructure platforms and services for research and education communities, industry and the citizens at large	(66)		
EINFRA-2.1-2016/17 – platform-centric e-infrastructure innovation	46		
(a) Support to Public Procurement of innovative HPC systems, PPI		PPI	
(b1) Universal discoverability of data objects and provenance		RIA	
(b2) Computing e-infrastructure with extreme large datasets		RIA	
EINFRA-2.2-2016/17 – user-centric e-infrastructure innovation	20		
(a1) Exploitation of e-Infrastructures for user-centric innovation and pilots responding to community specific challenges		RIA	
(a2) Innovation for Open Science e-infrastructures and services		RIA + K	X
3 - Support to policies and international cooperation	(10)		
EINFRA-3.1-2016/17 - Support to policies and international cooperation			
(a) International Co-operation on extreme scale e-infrastructure requirements		RIA	
(b1) International Co-operation on e-Infrastructure supporting major societal challenges		CSA	
(b2) Policy support to e-infrastructure programme		CSA	
(b3) European support to the Research Data Alliance (RDA)		CSA	
Other actions including different type of instruments:			
(a) FPA - GÉANT Partnership Projects	(64)		
(a1) Research and Education Networking – GÉANT N	50	RIA/SGA	X
(a2) Networking infrastructure: platform innovation	9	RIA/SGA	
(a3) Trans-Atlantic submarine cable	5	RIA/SGA	
(b) FPA - Computing and storage e-infrastructure for the Human Brain Project FET Flagship (FPA)	(25)	RIA/SGA	X
INDUCEMENT PRIZE – Prize for e-infrastructure service innovation	(1)	Ind.Prize	
Total	**221**		