EGI-InSPIRE

Final Report

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Abstract

The final report describes the activities undertaken during the span of the EGI-InSPIRE project (May 2010 – December 2014). The report focuses on the project's achievements and outcomes, reports on the use and dissemination of the foreground of the project and on the project performance and impact.

I. COPYRIGHT NOTICE

II. DELIVERY SLIP

	Name	Partner/Activity	Date
From	Tiziana Ferrari	EGI.eu/NA1	05 February 2015
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III. DOCUMENT LOG

Issue	Date	Comment	Author/Partner
1	12/12/2014	TOC/First draft	Tiziana Ferrari
2	27/12/2014	Second draft	Samuel Keuchkerian / AMB
3	17/01/2015	Third draft	Tiziana Ferrari / Activity Managers
4	28/01/2015	Fourth draft	Tiziana Ferrari / Activity Managers
5	12/02/2014	Final Report	Tiziana Ferrari

IV. APPLICATION AREA

This document is a formal deliverable for the European Commission, applicable to all members of the EGI-InSPIRE project, beneficiaries and Joint Research Unit members, as well as its collaborating projects.

V. DOCUMENT AMENDMENT PROCEDURE

Amendments, comments and suggestions should be sent to the authors. The procedures documented in the EGI-InSPIRE "Document Management Procedure" will be followed:

https://wiki.egi.eu/wiki/Procedures

VI. TERMINOLOGY

A complete project glossary is provided at the following page: http://www.egi.eu/about/glossary/

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FINAL PUBLISHABLE SUMMARY

1.1 Executive summary

EGI-InSPIRE is the EC project created to support the establishment and evolution of EGI - a federation of e-Infrastructure providers of distributed High Throughput Computing (HTC) in Europe. Through the project, EGI has established a vision, mission and core values that go beyond the original objectives and expand them into a long-term strategy to support the European Research Area.

During EGI-InSPIRE, the provisioning and operations of HTC services evolved from a set of activities delivered through projects entirely supported by the EC, to a new self-sustainable landscape of National Grid Initiatives (NGIs) responsible for national HTC services, under the coordination by EGI.eu. Since then, EGI became a stable federation spanning 57 countries and relying on 37 Operations Centres, with increasingly strong partnerships with other e-Infrastructures, user communities and technology providers in Europe and worldwide.

The governance of EGI, grounded on the principles of openness and cooperation, is based on the EGI.eu Executive Board and the EGI Council at a policy and strategic level, and technically on several managerial and advisory boards. From an infrastructure driven by the needs of a few well-established user communities, EGI is now evolving towards the Open Science Commons, to allow researchers from all disciplines to have easy and open access to the digital services, data, knowledge and expertise they need to collaborate and perform excellent research.

Throughout EGI-InSPIRE, a portfolio of services and solutions was defined, as well as an engagement programme with European Research Infrastructures, and the establishment of pay-per-use services. The new EGI Cloud Platform addresses new customer segments and is attracting the interest of SMEs and industries thanks to its open standards and the level of trust that can be ensured by publicly-funded cloud operators.

In the last four years the infrastructure has increased its technical stability for continued and improved support to user communities in all sectors from the long tail of science to the heavy user communities. To expand on this work, EGI developed an Engagement Strategy to help EGI.eu, the NGIs and EIROs and the user communities in targeting technical support activities towards new large research infrastructures. These research infrastructures demonstrate how existing solutions can be successfully adopted as a foundation layer and used to extended support to pan-European research infrastructures. Reflecting this, in four years 57 new Virtual Organisations were created, of which five are to support testing activities by ESFRI projects. EGI policies, procedures and operational tools are now technology agnostic and the operations architecture is easily extendible to any type of platform, including cloud, HPC and desktop grids, as demonstrated with the launch in May 2014 of the Federated Cloud solution.

From a monolithic infrastructure based on a single internally sourced HTC technology, EGI changed into a landscape of integrated platforms delivering different and complementary services to the end-user. The current architecture – comprising a core infrastructure, the cloud, high-throughput data analysis and the collaboration and community Platforms – is now easily extensible.

1.2 Summary description of EGI-InSPIRE context and objectives

The project ended in December 2014 after 56 months of activities aimed at leading to a transition from a project-based collaboration to a sustainable pan-European e-Infrastructure, federating services across Europe and worldwide in North and South America, the Asia Pacific region and the Africa-Arabia region, open to the adoption and distribution of open source software, promoting the sharing of compute and data through transnational access, leveraging the distributed expertise available at local level and federating it at European level and, through its engagement strategy, offering its solutions to research communities, including the long tail of science, international collaborations, Research Infrastructures, and Industry and SMEs.

Activities were led by six objectives:

1. **The continued operation and expansion of today's production infrastructure by transitioning to a governance model and operational infrastructure that can be increasingly sustained outside of specific project funding.**
   Activities: SA1, NA2, NA5

EGI-InSPIRE aimed at consolidating **national, regional, and international initiatives into an integrated European production e-Infrastructure** coordinated by EGI.eu, which in turn is sustained by its stakeholders. Through this objective EGI has supported the e-IRG recommendation: *major e-Infrastructure initiatives investigate the integration of commercial and non-commercial infrastructure services and of Grid and cloud-like technologies especially for achieving the provision of on-demand virtual computing and storage resources into existing e-Infrastructures*.

Both the HTC and Federated Cloud solutions that are now in production federate services contributed by the NGIs and EIROs for access by the research partners in their communities, where the services are sustained by their own funding. Therefore the sustainability of NGIs was and is critical to the sustainability of EGI as they are the providers of the vast majority of the resources within the infrastructure. The project co-founded the **establishment of NGI international tasks as national services regulated by an OLA**, i.e. the services and activities required to allow the federation of service providers. With the start of the production activities of the EGI Federated Cloud the integration of **commercial providers** is being experimented.

Sustainability required the analysis of different **organisational and governance models** for EGI and the other e-Infrastructure of European relevance, the establishment of a **service portfolio**, the definition of **EGI solutions and the related business models** with target groups and delivery channels and more recently in PY5 the definition of a **business engagement plan** grounded on the success of various SME engagement activities facilitated by the possibility of hosting custom applications through the EGI Federated Cloud. For services facing research communities, free at point of use has been complemented by the experimentation of pay-for-use, while for the support services that enable the European federation, project funding was replaced by membership feeds and in-kind contributions of the EGI technical partners.

The expansion of the infrastructure has developed through different actions: **capacity building, the differentiation of the capabilities offered through the launch of a federated IaaS cloud infrastructure, the integration of desktop grids, and the extension of the tools needed to operate heterogeneous service technologies**.

2. **The continued support of researchers within Europe and their international collaborators that are using the current production infrastructure.**

   Activities: NA2, NA3, SA1, NA4

Through the coordination of user and operational support provided within SA1, the use of the infrastructure by a diverse end-user community was required and supported. Domain specific support was provided through Virtual Research Communities designed to bring together and structure research communities to provide mutual support, networking, dissemination, training and resources, while e-Infrastructure support was provided by federating expertise from the EGI Community and the EGI Technology Providers through the Distributed Competence Centre (DCC). The DCC provides continued support to help international research communities facing data handling and processing challenges. The DCC pools the technical knowhow from the NGIs and Resource Centres which are part of EGI and offers expertise on:

1) core e-Infrastructure services that provide the foundations for community-specific services, such as authentication, authorisation, accounting and information discovery; 2) the HTC and Federated Cloud solution and 3) community-specific platforms, such as compute-intensive parallel applications, visualisation, science gateways and workflows.

EGI-InSPIRE helped with the establishment of a DCC to provide end-users with a unified support structure. By recognising community-driven structures within the VRC for governance and representation, EGI is in a better position to understand and prioritise their requirements, and to ensure user-driven innovation of the services.

3. **The support for current heavy users of the infrastructure in earth science, astronomy and astrophysics, fusion, computational chemistry and materials science technology, life sciences and high energy physics as they move to sustainable support models for their own communities.**

   Activities: SA3

This objective acknowledges the importance of the availability of Virtual Research Environments that provide community-specific capabilities enabled by generic components like the EGI Core Infrastructure Platform and the HTC and Cloud platforms. Community software provides combined features such as, for example, easy authentication, brokering of computation and data transfer, data discovery, data composition, workflow execution.

As part of the EGI-InSPIRE project, the Heavy User Community activity (SA3) provided dedicated support to the applications, services and tools currently being used by the heavy users in integrating their domain-specific use of the generic production infrastructure. This included software services and support to ensure that the infrastructure delivers the capability they need. This activity built on synergies between these communities where it exists, to transition these capabilities either into the production infrastructure for the benefit of new heavy user communities and the general national or local user, or to sustainably support the work within the domain community.

4. **Interfaces that expand access to new user communities including new potential heavy users of the infrastructure from the ESFRI projects.**

   Activities: SA1, NA2, NA3, NA5

The European Research Area (ERA) needs to support researchers from diverse scientific disciplines taking approaches to data analysis. These will need to work seamlessly together in a distributed multi-disciplinary research collaborations that cross national and intellectual borders to tackle society's

grand challenges. For the ERA to successfully increase the ability of Europe to produce 'excellent science', which delivers exploitable innovations and new growth, Europe's researchers will need easy to use integrated services that provide access to high capacity and high quality computing and storage resources, wherever the resources and the researcher are located.

The benefits of a generic infrastructure that enables collaboration within and between science communities and their related virtual organisations have been shown repeatedly. As the ESFRI projects move from the planning to the commissioning phases the need for a generic research infrastructure to support their data-analysis needs becomes clearer. As many of these projects will have a life-span (operation and data-analysis phases) measured in decades, the use of a sustainable DCI to support this work is essential.

The definition of the EGI engagement strategy, including RIs on the ESFRI roadmap, but also Industry and SMEs and the long tail of science answers the need of exploiting the existing solutions an devolve them according to new use cases. The outreach to user communities new to EGI took place at a strategic level within NA2 (PY1-PY4) and NA4 (PY5).

5. **Mechanisms to integrate existing infrastructure providers in Europe and around the world into the production infrastructure, so as to provide transparent access to all authorised users.**
   Activities: SA1, SA4, SA5

Already in 2010 the project collaboration recognized the importance of a borderless and integrated offer of services for science.

Several actions for the ERA implementation have been undertaken by many actors with the aim of increasing the performance of European research through mobility and cross-border cooperation. The 2013 White Paper[1] released by the European e-Infrastructure Reflection Group (e-IRG) stated that "*...Europe needs a single 'e-Infrastructure Commons' for knowledge, innovation and science, as a living ecosystem, which is open and accessible and continuously adapts to the changing requirements of research*", to support the ERA and the emerging ESFRI communities.

While the vision of the e-Infrastructure commons has been embraced by many groups, the sector is fragmented and includes too many narrowly focussed services based on closed platforms that limit the portability of data, applications and knowledge. Also, we are still missing a common body of knowledge and a coordinated broad programme for knowledge transfer, including the private sector and the long tail of science, providing a barrier to entry for the emerging research infrastructures, skills and professions.

Services are often provided by a broad range of sector-based, national and pan-European providers, which grew in different ways. This objective of the project acknowledges that as digital science services such as e-Infrastructures, move toward sustainable operating models, the need for coordination and coherence is rapidly increasing.

EGI-InSPIRE supported the development a single portfolio of services increasingly integrated (AAI, data staging, desktop grids, HTC, parallel computing and cloud capabilities) to provide a 'backbone' of European ICT capabilities.

6. **Establish processes and procedures to allow the integration of new DCI technologies (e.g. clouds, volunteer desktop grids) and heterogeneous resources (e.g. HTC and HPC) into a**

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[1] e-Infrastructure Reflection Group, White Paper 2013 (http://www.e-Irg.eu/images/stories/dissemination/white-paper_2013.pdf)

seamless production infrastructure as they mature and demonstrate value to the EGI community.
Activities: SA1, SA2

The objective addresses issues e-Infrastructure landscape like fragmented solutions and policies for access to data and computing, and the not integrated provisioning of services and knowledge. Access to research data and existing bodies of knowledge has moved towards openness, but is a long process that also requires cultural shifts. The objective aimed at significantly advance integration of technical solutions, application and allocation, provisioning, and business models.

This required evolving the infrastructure **from distributed HTC to an open federation of common platforms and community-specific services**, offering seamless authentication and authorization, being discoverable and accountable. This allows EGI to constantly evolve its portfolio of solutions according to the user needs while being open to the adoption of any technology that suits the user needed and ensures compliance to a basic set of security and functional requirements, which are subject to the EGI verification and validation procedures. From a single internally source technology, EGI developed the capability of federating any technical capability, including data management services, cloud IaaS, desktop grids, community-specific services.

The following table provides an overview of the Work Packages, and their duration and the respective effort allocation, and how after PY4 activities in the area of Operations and software provisioning and Software development and maintenance became self-sustained services in the form of "Core Services" being supported by EGI Council membership fees and partners' in-kind contributions.

Table 1. Overview of activities and work packages during PY-PY5

Area		PY1	PY2	PY3	PY4	PY5
Project Management	Cloud Platform	NA1				
Policy, strategy and business development		NA2				➔NA5
Community Engagement and Technical Support through the DCC	Heavy User Communities	SA3				
	Technical support and community engagement	NA2, NA3 (PM01-PM18), SA1				➔NA4.1 (coord.), NA4.3, SA5.2
Communications and events		NA2				➔NA4.2
Operations and software provisioning		SA1, SA2				➔ SA4.1 (coord.) ➔ **Core Services**
Software development and maintenance	Core Infrastructure Platform	JRA1				➔ JRA2 (Dev.) ➔ **Core Services** (Maintenance)
	Collaboration Platform	JRA1				➔ **Core Services** (Maintenance)
	Cloud Platform			SA2		➔ SA5

1.3 Results

This section provides an overview of the project achievements grouped by objective.

1.3.1 Continued operations and infrastructure expansion

> *Objective 1: The continued operation and expansion of today's production infrastructure by transitioning to a governance model and operational infrastructure that can be increasingly sustained outside of specific project funding.*

1.3.1.1 European Grid Infrastructure

EGI federates generic e-Infrastructure services and user community-specific services. EGI comprises **3600 service end-points** that are operated locally with central coordination at EGI.eu. Operational responsibility are completely delegated to data and computing centres locally, EIROs and to NGIs for national coordination.

Starting at PY1 the operations activities (SA1) drove the radical transition from the pre-existing 14 regional federated Operations Centres to 40 NGI operated by 27 Operations Centres (PY1), which became **38 Operations Centres** at the end of PY5, including service providers in **Europe, the Asia Pacific region, the Africa Arabia region, North America and Latin America**. From May 2014 the High Throughput Computing infrastructure, providing a platform for data analysis, was completed with the offer of a Federated Cloud infrastructure, providing IaaS services (compute and storage) and progressing towards the provisioning of PaaS and SaaS.

During the project lifetime, the number of production Resource Centres (RCs) increased from 326 to **358 (+10%)**, while the **installed capacity** in the RCs grew considerably from 270,800 logical cores (PY1) to **520,000 (PY5) (+92%)** providing 4.19 million HEP-SPEC 06 (PY5) compared to the 3 million HEP-SPEC 06 of PY2. Disk space increased from 40 PB at the beginning of PY1 to **306.7 PB (PY5) (+666%)**.

EGI Operations teams with EGI.eu coordination run several campaigns to upgrade the deployed middleware in order to keep the infrastructure secure and reliable by using software supported by the external technology providers. The main campaigns have been: upgrade from UMD-1 to UMD-2, from UMD-2 to UMD-3 and the upgrade to middleware supporting SHA-2 signed certificates for users and hosts authentication. For each campaign this has required the tracking and proactive upgrade of more than 3000 service end-points.

Small-scale campaigns have been planned to remove critical security vulnerabilities from the infrastructure, coordinated by the EGI security experts, who also organized security trainings and challenges to improve and monitor the security processes of EGI. As part of the continuous improvement of the security processes EGI CSIRT underwent the TI CSIRT certification process, which was completed in PY4.

EGI signed six MoUs with additional infrastructure providers throughout EGI-InSPIRE: ASGC (Asia-Pacific), BCC-UNG (Ukraine), CSIR - SAGrid (South Africa), OSG (United States of America), IHEP (China) and C-DAC (India). The successful integration of new infrastructures was the first step towards for the support of international user communities and to foster collaboration between scientists across the world.

Figure 1. Status and trends of the EGI infrastructure from PY1 to PY5: (a) number of certified resource centres, (b) CPU wall time usage (normalized), (c) and (d) computing and storage capacity.

(a)

(b)

(c)

(d)
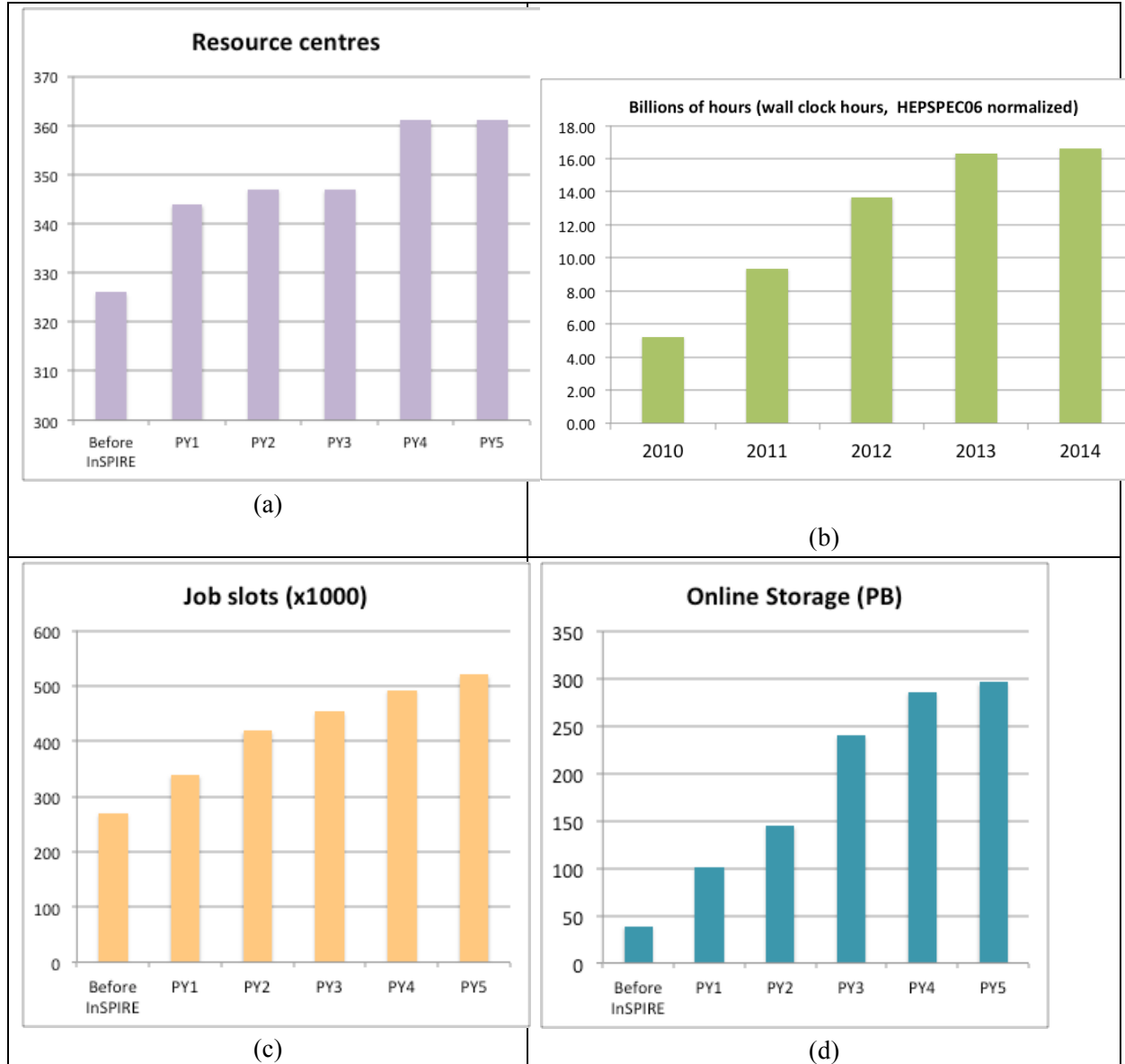
After PY1 the variations in number of sites has been of few sites per year until PY4, when the integration of new operations centres (Ukraine and Africa Arabia) brought new sites to widen the geographical distribution of the EGI production resources.

As shown in Figure 1 (b), the monthly amount of wall clock time hours, normalized in HEPSPEC06, consumed during the project has been regularly increasing year after year from the 500 million hepspec06 hours at the beginning of the project to the 2,500 million hepspec06 hours at the end of PY4. During the five years there have been some months with negative trend of usage, for example for the second part of 2014. The overall trend has been mainly driven by the computational needs of the biggest user communities (again high energy physics) that are based on the data availability or the deadlines of their communities.

1.3.1.2 Establishment of EGI.eu

> *EGI.eu mission: provide services and coordination to our participants enabling them to create value, as a federation, for researchers performing digital collaborative science, research and innovation*

EGI.eu was established and consolidated its coordination role and mission during EGI-InSPIRE. EGI.eu is now charged with defining, in consultation with its stakeholders represented through the EGI Council, the policies and procedures necessary to deliver an integrated set of grid services to the European Research Area.

From May 2014 EGI.eu is responsible of sustaining the services that enable the federation, i.e. the European "glue" that allows NGIs and EIROs to work as members of a international federated infrastructure. These tasks (formerly delivered through SA1 and SA2) are the so-called **EGI Core Activities** that will still be delivered by partners of the EGI collaboration, but will no longer rely on EC project funding according to the EGI services sustainability plan.

A new set of partners responsible of providing these activities and services from May 2014 was appointed. Operational Level Agreements were established with the technical partners. The cost of the Core Activities – currently amounting to 1.5 million Euro, is fully supported by the EGI members through fees and in-kind contributions.

In preparation to this, the technical profile and costs of the EGI-InSPIRE operations and technical Global Tasks of EGI-InSPIRE were reviewed in preparation to the change in funding structure.

1.3.1.3 EGI Governance

> EGI Mission: to provide solutions for open science, research and innovation by federating IT capabilities, people and knowledge

Participatory governance[2] complementing the EGI Council and Executive Board and involving all stakeholders – technology providers, user communities, the NGI operations teams and the NGI security teams – was established in PY1 by defining, creating and sustainably running a number of policy boards that in different areas of EGI provide advice and guidance:

- the **Technology Coordination Board** contributing to the technical EGI roadmap,
- the **User Community Board** and the NGI International Liaisons responsible for the Community Engagement Roadmap,
- the **Operations Management Board** managing the running of the production infrastructure (HTC and Cloud) and the operations of the "EGI Core Services",
- the **Security Policy Board** and the **Security Coordination Board** responsible for developing the policy needed to provide NGIs with a secure, trustworthy distributed computing infrastructure and for bringing together representatives of the various security functions within the EGI to ensure that there is coordination between the operational security, the security policy governing the use of the production infrastructure and the technology providers whose software is used within the production infrastructure.
- the **Computer Security and Incident Response Team** aiming at coordinating the operational security activities in the infrastructure, in particular the response to security incidents.

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[2] http://www.egi.eu/about/policy/groups/index.html

- the **Strategy and Innovation Board** with representative from outside the EGI Community to provide external advice to EGI in strategy making. Terms were defined and the board will be created in 2015.
- a new board – the **Services and Solutions Board** – is being discussed to ensure a managed process for the periodic review of the EGI services and solution, to ensure services keep abreast of user requirements and that new requirements, technology and pilot activities generate a continuous feeding of innovation into the solutions and services.

1.3.1.4 ERIC

An important contribution of the EGI-InSPIRE project was a study on the opportunity to adopt the ERIC legal framework for EGI.eu. An initial study was performed to understand benefits and limitations[3]. Later, the vision moved towards the idea of setting up an ERIC for an overarching organisation acting as umbrella organisation for the main e-Infrastructures. This was tentatively called the **Digital Research Infrastructure ERIC** to focus on the delivery of ICT services needed for the transnational coordination of e-Science resources for different research communities within ERA. A potential **transition plan** outlining the necessary implementation steps and draft statutes, was also developed[4]. The proposal was presented at the e-IRG meeting in December 2012, but at that time consensus was not sufficient among the stakeholders to be ready for concrete implementation steps.

1.3.1.5 Sustainability and business models

EGI-InSPIRE activities quickly evolved into professional service management. The main milestones in this process where:

1. The definition of a **service catalogue** for EGI.eu services according to best practices from IT service management,
2. A **solutions portfolio** improve the promotion and communication of how EGI can solve specific problems from user communities,
3. The development of **business models** and preparatory work for the introduction of pay-for-use,
4. The definition of a **business engagement programme**.

A cost model for the EGI global services has been defined leading to clarity on the cost of each service and supporting the plans for sustainability. By May 2014, a cost recovery model has been established so that **EGI core activities**[5] are now fully paid by EGI.eu membership feeds and in-kind contributions from NGIs, does not depending on EC funding.

IT service management has been considerably improved by both introducing the FitSM standard (co-creation within the EC-funded FedSM project[6]) and by training EGI.eu and NGI staff with associated certification.

New **revenue models and service access policies** were explored, in particular the option of offering services with direct charge to users. This needed a change in culture from the free-at-point-of-delivery model. Several resource providers have defined prices and operational tools have been extended to

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[3] Alignment of EGI.eu with the ERIC organisational model, EGI-InSPIRE Milestone MS212 (https://documents.egi.eu/document/244)

[4] EGI.eu Transition Plan to ERIC, EGI-InSPIRE Deliverable D2.11 (https://documents.egi.eu/document/1339)

[5] https://wiki.egi.eu/wiki/Core_EGI_Activities

[6] http://www.fedsm.eu/

support price setting, accounting and billing. In the context of this work, EGI participated to the EC initiative on "European Charter for Access to Research Infrastructures"[7] aiming at defining RI access models for adoption by the European Council. EGI.eu contributed its experience and input. The current elements of the charter are already being discussed in EGI, while waiting for the European Council to adopt the policy in late 2015.

The **business engagement programme**[8] has been introduced to define how private organisations, with a focus on SMEs, can engage with EGI for joint collaborations. The programme outlines the opportunities and benefits for organisations to work with EGI, and defines varying levels of collaboration. An implementation plan has also been provided so to put the program in place.

1.3.1.6 Open Science Commons Vision

In PY5 a new vision around the concept of the **Open Science Commons**[9] was defined. The vision is the foundation of the EGI strategy, and has been promoted in key policy events and through a dedicated website[10]. The Open Science Commons is an overarching policy designed to overcome the barriers preventing the implementation of the ERA. It seeks to encompass all the elements required for a functioning ERA: research data, scientific instrumentation (such as the Large Hadron Collider or Square Kilometre Array), ICT services (connectivity, computing, platforms and research-specific services such as portals), and knowledge. This concept builds on the principles of Open Science (or Science 2.0) supported by the European Commission and others and also the commons principle for management of shared resources. EGI is seeking other e-Infrastructures, research infrastructures and stakeholders from the digital research community to collaborate in constructing the Open Science Commons.

1.3.1.7 Strategy development

Strategy making activities increased and widened their scope during the lifetime of the project. These produced four main outputs.

Milestone 1 (2012) The Strategic Plan – Seeing New Horizons: EGI's Role in 2020[11]. The first strategy document published in 2012 focuses on technology and architecture of the EGI solutions and outlines a 24 months roadmap to evolve EGI into an open federation of ICT capabilities. The plan describes how EGI will evolve into a universal federated platform for supporting compute and data intensive Research and Education communities. The document required EGI to evolve to provide a framework capable of hosting a range of high throughput solutions, including both grid and cloud approaches. The intention was to separate the higher level software solutions (the virtual research environments) from the operational infrastructure so that a complete range of approaches could be hosted depending on the needs of each Research and Education community.

- **Outcome**. The roadmap was full accomplished by the end of EGI-InSPIRE by extending EGI to a managed environment capable of providing appropriate services to a wide variety of software stacks. EGI is now a global e-Infrastructure capable of hosting the complete range of distributed computing approaches required by European Research and Education.

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[7] http://e-irg.eu/documents/10920/260645/charter_access_ri_workshop_-_vandenbroucke.pdf

[8] https://documents.egi.eu/document/2339

[9] http://go.egi.eu/osc

[10] www.opensciencecommons.org

[11] https://documents.egi.eu/document/1098

Milestone 2 (2013) Secure Federated Data-Analysis Capability for the European Research Area[12]. The "Grand Vision" approved by the Council in 2013 acknowledges the need of user focused approach to innovation and of expanding the EGI platforms to provide customer-specific services. This implies shifting the focus of the service portfolio from the generic "core infrastructure platform" to "community platforms". Co-development is introduced to address the European Research Area (ERA) need of supporting researchers from diverse scientific disciplines taking integrated and seamless approaches to data analysis.

- **Outcome**. After 15 months from the approval all of the objectives set in the strategy document were addressed in PY5 of EGI-InSPIRE. "Provide Enabling Services to Researchers" was addressed through the implementation of the Distributed Competence Centre, which aggregates expertise from NGIs, technology providers and user communities for advancing the EGI solutions. The EGI Federated Cloud started its production activities in 2014 and increased the capabilities offered to the end-users to "Operate an unprecedented European capability for High Throughput Data Analysis", and a network of Competence Centres was created to develop, test and "Provide Flexible Virtual Environments" following the principle of user co-development.

Milestone 4 (2014-2015) EGI Strategy 2015-2020: "Building an Open Science Commons" (in progress) Strategy development processes, tools and methodologies were developed in PY5 providing the capabilities needed to develop a **complete participatory leadership** involving all EGI stakeholders in the whole spectrum of EGI areas: policy, engagement, innovation, business.

A strategy development process and methodology were adopted that led to the definition of an EGI strategy – in development at the time of writing – involving EGI.eu staff, the Executive Board, the EGI Council and key users communities.

The process that was followed is based on the use of the strategy map and balanced scorecard tools, and supported by an external consultant to better develop the skills of EGI.eu staff and consolidate a process that would increase the maturity of EGI strategic planning.

An initial high-level view of the **EGI strategy map and analysis of the main strategic shifts** was developed, together with **strategy tablets**. This was followed by **interviews** to capture the stakeholders' viewpoints on strengths and weaknesses of the current situation, the future challenges and their perceived needs. This input contributed to the definition of the main shifts that should be captured by the EGI strategy. Consultations were also run in the form of interviews involving the Council. **Milestones** for the years 2015-2017 were defined to implement the defined strategy. At the time of writing, the outcome of the strategy making activities is under evaluation by the EGI Council**.**

1.3.1.8 Collaborations

A large number of **strategic collaborations** have been established with many projects and organisation in various areas like: technology providers, virtual research communities, resource providers, dissemination and support initiatives.

Besides MoUs with e-Infrastructure provider, new agreements were also signed with external partners.

Since the beginning of EGI-InSPIRE, a total of 27 MoUs were signed, of which seven have been completed with all agreed milestones.

As part of its strategic activities in PY5, EGI significantly advanced in the establishment of new collaborations or in strengthening on-going ones with a large number of European and international projects and partners. The list of involved parties includes: the European Commission, the European e-

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Infrastructure Reflection Group, RDA, the GÉANT Association, EUDAT, PRACE, the Security for Collaborating Infrastructures initiative, Big Data Value Association, FAO, ESA, CANFAR, Open Science Grid, and GARUDA.

- In the context of a MoU between EGI.eu and DANTE signed in 2011[13], collaboration meetings with the **GÉANT Association** were held to plan a long-term collaboration in the area of security, cloud, communications, events and policy including service procurement, were organized in PY5. The definition of a joint cloud technology and strategy roadmap was agreed by both organisations. A joint symposium on cloud and big data technologies was co-located with the EGI conference "EGI Conference on Challenges and Solutions for Big Data Processing on Cloud" and boosted the collaboration activities between the two communities.

- A collaboration was established with the **APARSEN** project to bring in competences within the EGI community in the area of data curation and preservation. The signed MoU was meant to expand the EGI service portfolio in the area of services needed to manage the full life cycle of data in the medium term[14].

- A technical collaboration plan was defined with the **EUDAT** project to harmonize data management services of the EGI High Throughput Computing solution and EUDAT. The plan will be driven by the use cases of 4 research infrastructures: BBMRI, ELIXIR, EPOS and ICOS. Open calls for additional use cases will be also organized to further evolve the plan. In addition, both e-Infrastructures expressed the interest in joining efforts in user community engagement and support. The first user workshop for Environmental Science was held in Amsterdam in January 2015. Similar coordination meetings were organized with **PRACE**. EGI also engaged with a subset of PRACE partners to expand its network of competence centres to offer integrated HPC, HTC and cloud knowledge and service.

- The security coordination team of EGI coordinates the "**Security for Collaborating Infrastructures**" initiative. The team organized a joint meeting with EUDAT and PRACE to discuss synergies, collaborations and communication channels for a better cooperation of the e-Infrastructures in the area of security operations[15].

- Through the **Helix Nebula project**, EGI.eu has engaged in the work for an interoperable and integrated European federated cloud with the commercial cloud providers and also supported the development of a connector to enable to connect EGI cloud providers within the **Helix Nebula Marketplace (HNX)**. In 2014, a MoU was signed with HNX to regulate the participation of EGI cloud providers to the market place to ensure that the public sector data centre resources from within EGI required by customers are accessible.

- EGI is evaluating the opportunity of becoming member of the **Big Data Value** association to promote its Open Science Commons vision and boost its engagement with the private sector leveraging on the capability of providing a distributed open standards based cloud infrastructure and on the possibility to provide a scalable access to distributed datasets of public or commercial relevance.

- Collaborations were established with **FAO** and **ESA** for the provisioning of open data for the agriculture and food sector and to support the ESA big data challenge activities on space observation. European Space Agency (ESA) will collaborate with EGI to port and run e-Collaboration for Earth Observation (e-CEO), a platform developed by ESA to help researchers to

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[13] https://documents.egi.eu/document/501

[14] https://documents.egi.eu/document/2063

[15] https://indico.egi.eu/indico/conferenceDisplay.py?confId=2163

compare and evaluate different problem-solving approaches. The NGIs that participate to the EGI Federated Cloud will provide capacity to the e-CEO platform.

- A collaboration with **EMBL** was established for the analysis of medical metabolic phenotype data. The aim of the collaboration is to provide distributed access to open metabolomics datasets through a federated cloud infrastructure integrated with the EGI cloud solution.

1.3.1.9 Policy

Two EGI Compendium editions were published[16], covering 2011 and 2012. The data collected through the Compendium contributes to our understanding of EGI and its supporting national ecosystem and many of these figures are reflected in the strategic metrics captured through the EGI balanced scorecard.

A number of policy papers have been created and approved by the EGI Council in the area of federated resource allocation and demonstrating excellent science on EGI resources, pay-for-use models, a scientific publications repository that has led to a strategic collaboration with the OpenAIRE project, a new proposed classification for scientific disciplines to be adopted by EGI's tools. These were developed in collaboration with representatives from both the operational and non-operational representatives within the NGIs, and external collaborators as required.

1.3.2 Technical User Support

Objective 2: The continued support of researchers within Europe and their international collaborators that are using the current production infrastructure.

1.3.2.1 76 New Projects, 38,000 Users and 6 RIs

EGI has supported **302 projects**, of which **220 are currently active** either nationally or internationally.

Nowadays, Virtual Organisations (VO) access the High Throughput Computing infrastructure and the Federated Cloud via science gateways and user portals, which automate tasks on behalf of the end-user through robot certificates, which do not carry information about the corresponding user. The purpose of a robot certificate is to allow the VO performing the automated tasks to authenticate without needing individual user certificates. The robot certificate is used in a completely automated environment, without human interventions. At the time of writing robot certificates are used to support various projects and disciplines: High Energy Physics, Radio Astronomy, Art and Humanities, Structural Biology, Neuroscience, Material Engineering, Computational Chemistry, Medical and Health Sciences, Bioinformatics, and Hydrology. The number of users currently using robot certificates can only be estimated, and it is in the order of **15,000** (1,600 only for structural biology), with users from all regions of the world. In January 2015 the number of users who own a personal account is **23,000** (13,319 in March 2011). In total EGI enables approximately **38,000** users.

During EGI-InSPIRE, EGI established **76 new Virtual Organisations**, of which six are related to Research Infrastructures on the ESFRI roadmap: BBMRI, CTA, EISCAT-3D, ELI-NP, LIFEWATCH and KM3Net.

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[16] http://www.egi.eu/newsJandJmedia/publications/

1.3.2.2 Sharing of Scientific Applications and Virtual Appliances

EGI-InSPIRE promoted the discoverability and reuse of scientific codes ported to EGI (both HTC and Cloud). This activity contributes to the achievement of the Knowledge Commons, facilitating the creation of communities of code bridging developers of scientific applications, tools, DCI middleware, workflows, and users, and facilitating sharing. The **EGI Applications Database (AppDB)**[17] is a central service that EGI provides and open to all to store and provide information about software products, and for the EGI Federated Cloud virtual appliances and software appliances. AppDB provides access to the software, information about the programmers and scientists involved, and publications derived from the registered solutions

Reusing software products, registered in the AppDB, means that scientists and developers may find a solution that can be directly used in EGI avoiding duplication of development and porting efforts, and allowing to reuse a solution already packaged for running on the Distributed Computing Infrastructures (DCIs). AppDB, thus, aims to avoid duplication of effort across the DCI communities, and to inspire scientists less familiar with DCI programming and usage.

The EGI Applications Database is **open to every scientist**, interested on publishing and therefore sharing, his/her software solution.

Currently, three types of software solutions are offered through the EGI Applications Database:

- Software items, including **applications** (program or a group of programs that aims to address a specific scientific problem and in most of the cases is associated with one scientific field/discipline), **tools** (multipurpose, multidisciplinary program or a group of programs), **science gateways** (community-specific set of tools, applications, and data collections that are integrated together via a web portal or a desktop application, providing access to resources and services from EGI), **workflows** (sequences of computational and data manipulation steps required to perform a specific analysis, using resources from the e-Infrastructure) and **middleware products**.
- **Virtual Appliances:** ready-to-run virtual machines packaged with an operating system and software application(s) for Cloud deployment.
- **Software Appliances:** a Virtual Appliance and a Contextualization Script pair for Cloud deployment.

AppDB provides to date 280 software products that have been added or updated in the last 3 years (2011-2014) – 506 is the total number of items registered. The new items registered from PY1 to PY5 is **257**. These are primarily contributed (in decreasing order) by Italy, United Kingdom, Spain, Germany, Netherlands and France. **In addition, 31 virtual appliances are registered since the beginning of PY5 when the AppDB Cloud Marketplace is considered as in full production mode.** Last but not least and under the Cloud context, the AppDB is the tool responsible for securely distributing the registered virtual appliances to the resource providers/sites. This is realized by supporting all the necessary functionality for the VO managers in order to be able to select the virtual appliances needed by their VO and from the other hand all the necessary mechanisms (client & server) to the resource providers/sites in order to subscribe to the Independent list of virtual appliances (one per VO) and fetch the respective virtual machine images. AppDB and the Federated Cloud can become together a good solution for repeatability of science, through the capability of running pre-packaged virtual appliances on specific open data sets and by making these discoverable and open for sharing.

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[17] https://appdb.egi.eu/

Increase in usage has been constant through the years for all disciplines. Sizeable increases in usage in most of the disciplines, with big relative increases in all of the non-physical disciplines. Biological sciences and medical sciences are those that experienced the higher relative increase, stimulated by the outreaching activities in these areas also facilitated by the participation to the BioMedBridges and ENVRI ESFRI cluster projects, and the presence of a well internally organized Virtual Research Community: the "Life Science Grid Community"[18]. More information is provided in 0

1.3.2.3 Distributed Competence Centre

EGI-InSPIRE established the network of NGI International Liaisons (NILs) and a 'Virtual Team framework' in 2012 to improve communication with the NGIs for non-operational activities and support for new technologies for existing and new communities. NILs are delegated by the NGIs to act as single point of contact between the NGIs and EGI.eu. NILs played a key role in mobilising suitable experts and resources from the NGIs for multi-national communities, including VRCs.

In PY4 a new organisational structure was given to community engagement activities, the Distributed Competence Centre (DCC)[19], the technical arm for the implementation of the engagement strategy to user communities. The DCC is not only responsible of engagement and exploration of requirements of new use cases, but also of development, testing and insertion of new technology. In the past years of the project user engagement was mainly delivered by NGI user support teams; as of January 2014, the DCC is also participated by external experts from research communities and technology providers, who are supported with human effort and/or travel budget centrally distributed by EGI.eu according to the support and training needs.

1.3.2.4 Virtual Teams

Through the NILs the community initiated 21 Virtual Team projects between 2012-2014, with many of these focusing on improving services and support for multi-national communities. Such Virtual Team projects were: Organise a high impact presence for EGI at EGU General Assembly 2012; Assessing the adoption of Federated Identity Providers within the EGI Community; MPI within EGI; DCH-EGI Integration; Science gateway primer; GPGPU requirements (General-Purpose computation on Graphics Processing Units); Environmental & Biodiversity; Fire and Smoke simulation; SPEEch on the grid (SPEED); Towards a Chemistry, Molecular & Materials Science and Technology (CMMST) Virtual Research Community (VRC).

1.3.3 Supporting Virtual Research Communities

Objective 3: The support for current heavy users of the infrastructure in Earth Science, Astronomy & Astrophysics, Fusion, Computational Chemistry and Materials Science Technology, Life Sciences and High Energy Physics as they move to sustainable support models for their own communities.

Continued support to the established heavy user communities was ensured through the User Community Board: it provides, for example, consultancy, advice and feedback on policy matters, technical roadmaps, engagement strategies, quality of services, technical requirements. The Virtual Research Communities – partly existing as users before the start of the project, and partly established during the course and hence at a different level of maturity) include the Life Science Grid Community, Hydrology (with the support of the DRIHM project), Structural Biology (with the support of the

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[18] http://www.egi.eu/community/collaborations/LSGC.html
[19] https://wiki.egi.eu/wiki/Distributed_Competence_Centre

WENMR project), WLCG, Astronomy and Astrophysics, AUGER, Computational Chemistry, Fusion and Earth Sciences, Digital Cultural Heritage.

Through activity SA3 (from PY1 to PY3) EGI-InSPIRE supported the development of community-specific applications and frameworks, promoting their reuse as applicable.

The infrastructure – progressively expanding towards cloud provisioning – provided secure and highly reliable solutions for data analysis throughout the lifetime of the project. However, the current status and sustainability of these communities greatly depend on the amount of effort devoted to the researchers of one's community to community building: this is a time consuming and demanding activity, though necessary to promote solutions internally and to aggregate user groups around, for instance, solutions, tools, user portals, workflows.

Following the best practices for federated service management and the business models activities of EGI, one of the main activities from 2015 will be the establishment of SLAs with a core set of providers granting high priority access to distributed resources, in order to replace in total or partially the current opportunistic use of the infrastructure.

1.3.3.1 Astronomy and Astrophysics

The main achievements of the long tail of science in Astronomy and Astrophysics – aggregated in the form of Virtual Organisation collecting different international research collaborations, projects, and research groups with common scientific interests and IT needs, including funded and unfunded activities, are the following.

- The development of a visualization Interface for the Virtual Observatory (VisIVO) service, which was ported to the grid.
- The release of parallel/MPI and GPU/CUDA VisIVO service enabled versions.
- The integration of HPC clusters and hybrid CPU/GPU systems.
- The access to databases of scientific relevance through grid interfaces and the interoperability with the Virtual Observatory (VObs) data infrastructure. The access to astronomical data and computing resources is provided via a single sign on mechanism using P-Grade technology.
- Community building and technology transfer involving both small scale and large scale projects such as SKA and CTA. A Virtual Team with CTA[20] designed a roadmap to implement a Science Gateway with authentication via an identity federated model to serve the astro-particle physics community at large.
- The STARnet Gateway Federation was formed in April 2013 and officially started as a pilot project in January 2014[21]. STARnet is a federation of A&A oriented science gateways designed and implemented to support the community and its needs. It aims at creating a network of Science Gateways to support the A&A community sharing a set of services for authentication, computing infrastructure access, and data/workflow repositories. The first implementation of STARnet provides workflows for cosmological simulations, data post-processing and scientific visualization. The applications associated to the SGs were developed and are maintained by A&A.
- INAF Astrophysical Observatory of Catania, Italy developed the VisIVO Science Gateway as a workflow-enabled portal providing visualization and data management services to the scientific community by means of an easy-to-use graphical environment

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[20] https://wiki.egi.eu/wiki/VT_Technology_study_for_CTA
[21] http://www.oact.inaf.it/STARnet/

- University of Portsmouth, United Kingdom supports the federation with a science gateway for the Large Simulation for Modified Gravity (LaSMoG) consortium to investigate large-scale modified gravity models.
- INAF Astronomical Observatory of Teramo, Italy aims at supporting the community of stellar evolutionary simulations with a science gateway that accesses numerical code for stellar model computations.
- INAF Astronomical Observatory of Trieste, Italy (OATS) developed a science gateway focused on applications related to simulations of the ESA Planck mission.
- The Astronomical Institute of the Slovak Academy of Sciences, Slovak Republic (AI SAS) science gateway focuses on applications related to studies of small bodies in the Solar System: COMCAPT (capture of comets from the interstellar space by the galactic tide) and MESTREAM (modelling the dynamical evolution of meteoroid stream)

The STARnet federation is using EGI, local clusters and cloud resources (IaaS). The A&A community is shifting from a grid approach to a IaaS / SaaS cloud approach.

Regarding community building, engagement with ESFRI projects continued in PY4-PY5, mainly with SKA, Euclid and CTA. These ESFRIs act as the reference projects for specific branches of the astrophysical research (e.g. radio, astroparticle physics) with a strong ability to aggregate large fractions of the end-users community.

1.3.3.2 Computational Chemistry and Materials Sciences and Technologies

Computational Chemistry and Materials Sciences and Technologies is a community resulting from the joint activities of the GAUSSIAN, CHEM.VO.IBERGRID and COMPCHEM VOs with minor participation of TRGRID aimed at introducing their members to the possibility of carrying out their jobs in a coordinated fashion on the Grid. This has led to funded and unfunded initiatives training the members to the use of the grid middleware and services. It has also led to the assembling of a Grid Empowered Molecular Simulator exploiting both data and flux common features. It has also generated activities aimed at building the Virtual Research Community named CMMST (Chemistry, Molecular, Materials Sciences and Technologies) setting the ground for designing possible Competence Centres and Virtual Research Environments for the related disciplinary area.

The main results range from application porting to GPU, MPI and Grid, and the integration of HPC clusters and hybrid CPU/GPU systems making underlying grid middleware aware of the resources.

The community was very active in engagement activities and training involving XSEDE in the United States of America and the Asia Pacific Region. A virtual team was created for this purpose, aiming at assembling of a comprehensive VRC out of the existing Computational Chemistry, Molecular & Materials Science and Technology oriented VOs of EGI and XSEDE leveraging on the applications, tools and other resources and services that NGIs and projects from EGI and XSEDE provide. The project reached this goal and by May 2014 it delivered a document[22] that:

- Captures motivational scenarios for a multi-national VRC in the CMMST domain.
- Identifies tools, services and resources that the VRC needs to develop or bring into EGI in order to operate as a sustainable entity for the CMMST scientific community.
- On the basis the above two, a proposal to establish a new CMMST VRC in EGI. Besides the technical aspects, the proposal will define the organisational and funding models for the VRC.

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[22] https://documents.egi.eu/document/2221

1.3.3.3 Earth Sciences

The Earth Science Virtual Organisation (ESR VO) gathered long tail of science user groups around applications and tools of common interest. Within SA3 the community ensured grid access to data and via community-specific interfaces and tools for GENESI-DR (Ground European Network for Earth Sciences Interoperations) and ESG (European System Grid).

The ESR VO has developed specific tools to manage collections of jobs. Its role is to control that all the submitted jobs are executed properly and provide valid output. The tools are used for flash flood prediction, to exploit satellite data, to create a database of pseudo-observations in order to validate a new instrument concept and of pesticide evolution in the soil according to different climatological situations and soils in the framework of the European project, footprint. It was also used to compute thermal brightness temperatures with a 3D Monte-Carlo code to simulate measurements of the atmospheric sensor IIR/CALIPSO in orbit since 2006.

Geographical Information Systems (GIS) are frequently used in Earth Science to treat and visualize data in a geographic framework. The Open Geospatial Consortium (OGC) is leading the development of standards for geospatial and location based services. It has defined specifications for many different geospatial services. Linking Grid computing to OGC Web services is well suited to accomplish high processing performance and storage capacity along with improved service availability and usability. In the hydrology domain, a specific Spatial Data Infrastructure built upon the Grid platform has been designed and implemented for the flash flood application and in the application of flood monitoring using satellite data, in situ sensors and simulations.

Support to seismology applications was ensured via the VERCE project[23]. A programmable Cloud service based on the seismological Python Library ObsPy was developed and is now offered as a service on the Federated Cloud. The service includes similar functionality to the GENESI tools, exploring metadata services and downloading data.

Another scenario currently under evaluation is the replication of valuable data for archiving. The challenge is to use iRODS to replicate the chosen data, at first around 500TB, at EUDAT CINES (France) and then to provide the possibility for further users to compute on EGI e-Infrastructure. Several stages have been defined, a learning phase and tests supported by the French NGI, which runs a national data management system based on iRODS. Objectives include the exchange of expertise, the definition of the data granularity in connection with the scientific community, and the development of a workflow to replicate data from the Institute Pierre Simon Laplace (IPSL) to a EUDAT site.

1.3.3.4 Fusion

The FUSION Virtual Organisation integrated the GridWay meta-scheduler with the Kepler workflow engine via a OGSA-BES interface, designed and exploited Kepler workflows to support a range of applications from the fusion field (VMEC, DKES, ASTRA, TRUBA, GEM, ISDEP, FAFNER, EUTERPE). In addition, a knowledge transfer programme on Kepler and Serpens towards computational chemistry and AA was organized.

1.3.3.5 High Energy Physics

The High Energy Physics (HEP) HUC represents the four Large Hadron Collider (LHC) experiment collaborations - ALICE, ATLAS, CMS, and LHCb Virtual Organisations – that make the Worldwide LHC Computing Grid (WLCG) VRC. Together these collaborations number some 13,800 physicists, all of which benefit from the work of the VO's on the EGI grid infrastructure. Today this community is truly global, and has members from every continent of the globe with the exception of Antarctica.

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[23] http://www.verce.eu/

The WLCG collaboration itself is funded by some 50 funding agencies from 45 different countries worldwide (including 17 countries outside of Europe). The collaboration with EGI is defined in a MoU[24] that was signed in 2012.

The activity carried out by the HEP community during activity SA3 of EGI-InSPIRE was in sync with that of the WLCG project, supporting ultimately the discovery of the Higgs Boson in July 2012.

In terms of resources, the collaboration has a formal yearly pledging mechanism. For 2015, the beginning of the second 3-year running period of the LHC, the contributed resources amount globally to: 2.3 million HEPSPEC06 (very approximately equivalent to 350,000 cores), 200 PB of disk space, and more than 200 PB of tape.

The data rates in LHC Run 2 are expected to significantly increase with respect to the first 3-year run, with some 50 PB of data a year anticipated from 2015 onwards. The resource requirements will increase each year as the total data volume grows, and with the higher energy and increased luminosity of the LHC, the processing requirements will continue to increase.

1.3.3.6 Life Sciences and Health and Medicine Science

The Life Science Grid Community[25] supports and promotes the High Throughput Data Analysis Soltuion in the medical, biomedical and bioinformatics sectors in order to connect worldwide laboratories, share resources and ease the access to data in a secure and confidential way through health-grids. The community maintains a production quality grid environment for the Life Science user community, by providing technical skills and manpower for the VRC operation and specific tools dedicated to the community.

Users were supported to better exploit the grid and resources rationalization. Several services were provisioned to achieve the goal: web gadgets (listing applications from AppDB, support, active monitoring.

The community currently includes about 840 registered users as well as the use of robot certificates, across 5 Virtual Organisations: biomed, vo.eu-decide.eu, lsgrid, vlemed and compchem. The Virtual Imaging Platform (VIP) robot certificate alone accounts for more than 500 registered users. The vlemed robot certificate accounts for more than 50 users registered to the Neuroscience and the docking Gateways. The number of active users is therefore probably in the order of 1000.

VIP has probably known the fastest growth in terms of users, with an average 10 users/month over the last 4 years. About 75% of the registered users have an email address in Europe. Users come from more than 20 different countries.

Resources for the LSGC come from 98 sites in 20 regions. From PY to PY5 the Virtual Research Community collectively submitted more than 60 Million jobs at increasing rate.

1.3.3.7 Structural Biology

The WeNMR project[26] has set the first steps toward providing e-Science solutions for integrative structural biology by bringing together the Nuclear Magnetic Resonance (NMR) and Small Angle X-ray Scattering (SAXS) communities. To facilitate the use of NMR spectroscopy and SAXS in life sciences the WeNMR consortium has established standard computational workflows and services through easy-to-use web interfaces. Thus far, a number of programs often used in structural biology have been made available through application portals (29 to date) that make efficient use of the European Grid Infrastructure (EGI). With over 650 registered VO users and ~1500 VRC users and a

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[24] http://www.egi.eu/community/collaborations/WLCG.html

[25] https://www.egi.eu/community/collaborations/LSGC.html

[26] www.wenmr.eu

steady growth rate, WeNMR is currently the largest Virtual Organisation in life sciences, gathering users from 44 countries worldwide (39% of users from outside Europe). The computational tools have been used so far mainly for NMR based structural biology with SAXS portals recently been put into production. Since the beginning of the project, more than 110 peer-reviewed articles have been published by consortium members and external users in high-ranking journals for the field[27]. It is mainly the user friendly access to software solutions and the computational resources of the grid that attract users, together with the excellent support and training offered by the scientists of the project.

The number of users is steadily increasing. Structural biology is supported across the whole of EGI including the Open Science Grid infrastructure in North America and the IDGF infrastructure.

1.3.4 New user communities and ESFRI

Objective 4: Interfaces that expand access to new user communities including new potential heavy users of the infrastructure from the ESFRI projects.

1.3.4.1 Engagement with Research infrastructures

Bringing international user communities to e-Infrastructures is a lengthy process due to young status of many RIs that are part of ESFRI, to the need to approach these communities with a coordinated pan-European strategy, and due to heterogeneous set of requirements within a single collaboration.

Especially for large Research Infrastructures that are still in their design phase or just about to start the implementation phase, the success of an engagement activity cannot be measured by simply looking at accounting data. The PY4 and PY5 good performance indicates that a lot of resources were allocated starting in PY4 to structurally approach Research Infrastructures of European relevance and by aggregating priorities and national roadmaps of the NGIs through a call for Competence Centres that was launched in June 2014.

Six of ESFRI Research Infrastructures are already experimenting EGI services and registered a Virtual Organisation: BBMRI, CTA, EISCAT-3D, ELI, KM3Net and LifeWatch.

PY5 ensured continued support to existing user communities and prospective ones and the coordination of user engagement activities across EGI through the NGI International Liaisons. The EGI Engagement strategy defined the areas of coordinated activity across NGIs. These included: agriculture and food sector, nanotechnologies, art and humanities (the DARIAH and CLARIN research infrastructures), natural sciences (ELI and KM3Net), life science (ELIXIR).

During its lifetime EGI has been supporting large user communities either in the context of MoUs with EC funded projects or direct participation, and through Virtual Teams targeted to specific use case requirements.

Examples of project collaborations are the letter of intent established with DARIAH and CLARIN[28], the MoU with the Hydro-Meteorology and the DRIHM project[29], structural biology and the WeNMR project[30].

Other projects such as **ENVRI** (environmental sciences), **BioVeL** (biodiversity), **DCH-RP** (art and humanities), **ER-Flow** (workflows) and **BioMedBridges** provided links and collaborations with research communities interested in using EGI. Overall, after four years, EGI has established a rich

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[27] https://www.wenmr.eu/wenmr/publications-acknowledging-wenmr

[28] http://www.egi.eu/community/collaborations/CLARIN_DARIAH.html

[29] http://www.egi.eu/community/collaborations/HMRC.html

[30] http://www.egi.eu/community/collaborations/WeNMR.html

network of collaborations that are contributing to the growth of the e-Infrastructures ecosystem in Europe and worldwide.

EGI established a partnership with the **iMARINE** project[31] for the delivery of IaaS services to the support of the Maritime and Fresh Water Biology sector, and to offer the possibility of hosting customised virtual research environments for that research sector based on the coupling of open data available from existing open distributed data repositories.

The second example of ESFRI-orientated engagement is a common project was defined by EGI and **ELIXIR** about integrating ELIXIR reference datasets within EGI[32] involving ELIXIR head nodes and EGI experts.

There has been significant work done in the EGI in the past to help the deployment and discovery of services, where "services" can be either computationally oriented (such as batch queues) or application oriented (such as web-services, ready-to-use applications embedded in portal gateways or encapsulated in Virtual Machine Images). However in bioinformatics many services used for analysis purposes rely on public reference datasets. Reference dataset are getting big and users struggle to discover, download and compute with them. There is an increasing demand to compute the data where the reference datasets are located. EGI members already host some biological reference datasets across the infrastructure, however currently EGI neither provides discovery capabilities for available datasets, nor provides guidelines for those who wish to use these datasets or would like to replicate additional datasets onto EGI sites.

The EGI community and the ELIXIR communities started a project in December 2014 to facilitate the discovery of existing reference datasets in EGI and to develop and deploy services that allows the replication of life science reference datasets by data providers, resource providers and researchers, and the use of these datasets by life science researchers in analysis applications. The project receives contributions from several NGIs, ELIXIR nodes, and e-Infrastructure and life science experts beyond EGI and ELIXIR. The foreseen length of the project is 9 months; the project started at the end of 2014 will continue in 2015. From 2015 Virtual Research Environment projects and the network of competence centres being established in PY5 by EGI will drive the EGI user engagement plan including the development of an EGI training programme customized to the needs of the user communities.

The new Virtual Research Communities that have been developing during EGI-InSPIRE are: CTA, Digital Cultural Heritage, LifeWatch, Gaia/Astra, Astronomy and Astrophysics, Hydrometereology and Engineering. The EC support to community building activities has greatly accelerated and facilitated the engagement process.

At a national level more than 100 collaborations have been started between 19 NGI institutes and 23 national nodes of various RI communities from the ESFRI roadmap. Some of these collaborations reached mature state during EGI-InSPIRE resulted adoption and further-development of national e-Infrastructure services for certain ESFRI use cases and services.

Under the coordination of EGI.eu the EGI community established joint workplans for the 2015-2017 period with seven RIs of the ESFRI roadmap: BBMRI, DARIAH, ELIXIR, EISCAT_3D, EPOS, INSTRUCT and LifeWatch. These workplans will be implemented in the form of Competence Centres that support the update and further co-development of EGI services, testing and pre-production activities.

1.3.4.2 EGI Engagement Strategy

In order to strengthen outreach to new user communities and stimulate the gathering of new technological requirements, an EGI Engagement Strategy[33] was defined. The strategy is a collaborative document that receives input from:

- The strategy and policy team, the user community support team and the communication team of EGI.eu,
- The NGI international liaisons, which bring the input of the National Grid Initiatives and the engagement priorities at a national level,
- The User Community Board and the EGI champions to reflect engagement opportunities that are pursued directly by the existing user communities of EGI within their research domain.

The document is periodically updated and reviewed in collaboration with the Executive Board of EGI.eu.

The Distributed Competence Centre (DCC)[34] was implemented as of January 2013 as technical arm for the implementation of the engagement strategy to user communities

1.3.4.3 Federated Cloud Solution: 50 new use cases and 200,000 VMs

After nearly two years of investigation and development, EGI launched the Federated Cloud as a production solution in May 2014. The new infrastructure is based on open standards and offers unprecedented versatility and cloud services tailored for European researchers. It is a connected federation of community clouds grounded on open standards.

With the EGI Federated Cloud researchers and research communities can:

- Deploy scientific applications and tools onto remote servers (in the form of Virtual Machine images).
- Store files, complete file systems or databases on remote servers.
- Use compute and storage resources elastically based on dynamic needs (scale up and down on-demand).
- Immediately workloads interactively (no more waiting time like with grid batch jobs).
- Access resource capacity in 19 institutional clouds[35] .
- Connect their own clouds into a European network to integrate and share capacity, or build their own federated cloud with the open standards and technologies used by the EGI Federated Cloud.

The EGI Federated Cloud is expanding the EGI capabilities by allowing the support of custom application, community-specific scientific appliances, long-running applications, elastic on-demand.

Since its launch, the EGI Federated Cloud has attracted many use cases from various scientific projects, research teams and communities. Among these there are large communities, such as the ATLAS, CMS and LHCb experiments of CERN, CSC with its Chipster tool used in the Finnish node of ELIXIR, the European Space Agency, WeNMR community and the EISCAT-3D ESFRI project.

In the last eight months of the project **50 use cases from 26 communities** were ported to the cloud. Of these, five have already completed their lifecycle and are in full production: the BioVeL Portal, OpenRefine, OpenModeler (from the BioVel project) and READemption (Univerisity of Wuerzburg).

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[33] https://documents.egi.eu/document/2079

[34] https://wiki.egi.eu/wiki/Distributed_Competence_Centre

[35] the number is growing, see up to date values at https://wiki.egi.eu/wiki/Fedcloud-tf:ResourceProviders#Fully_integrated_Resource_Providers

Of these 50 use cases, 18 are from biological sciences, 11 from physical sciences, 5 from earth science, and 5 are from the private sector: electric grids, digital archiving and music score analysis, virtual screening and data backup.

200,000 VM were instantiated for 11 VOs. Of the use cases 29 are using the rOCCI client and 12 adopted high level tools (CSGF, COMPSs, Slipstream, WS-PGRADE, DIRAC, VCYCLE).

1.3.4.4 Tools and policies for the long tail of science

During PY5 lowering barriers of access and simplifying access policies and instruments for the long tail of science were recognized of strategic importance. While keeping the engagement with international communities, EGI-InSPIRE invested effort in coordinating the provision of ad hoc tools and access policies that would ease the access for individual researchers and small research groups[36].

EGI-InSPIRE invested effort in the design and prototype of a new e-Infrastructure platform to simplify access to grid and cloud computing services for the long tail of science, i.e. those researchers and small research teams who work with large data, but have limited or no expertise in distributed systems. The activity focused on establishing requirements and a set of services integrated together and suited for the most frequent grid and cloud computing use cases of individual researchers and small research teams. It was decided that the platform will serve users via a centrally operated 'user registration portal' and a set of science gateways that will be connected to resources in a new Virtual Organisation. The project is an on-going effort that will continue in 2015.

1.3.4.5 Industry and SMEs

Following the success of various pilot activities undertaken by NGIs in collaboration with SMEs and Industry, the increasing interest in pay-for-use and the start of the EGI Federated Cloud solution, in PY5 the EGI Business Engagement Programme[37] was launched to provide an opportunity for both commercial and non-profit organisations to engage with the world's largest e-Infrastructure supporting European and global scientific and research collaborations to accelerate the adoption of the scientific outputs into society, to support innovation and knowledge transfer into the market.

EGI is open to engagement with a broad range of public and private companies of all sizes and sectors, and will develop specific offerings for different types and collaboration activities.

Participants can benefit in multiple ways ranging from promotion, market intelligence, and networking through to access to dedicated consultancy and support, to exploit EGI services for pre-commercial R&D and test proof of concepts. The opportunities for developing added-value services for reusing open research data sets will be particularly encouraged. The following are examples of possible collaboration types: offering of computing capacity, reuse of software products and provisioning of SaaS services, sharing of expertise and knowledge, the provisioning of big data for the purpose of commercial exploitation and/or research, market intelligence and promotion.

1.3.5 E-Infrastructure integration

> *Objective 5: Mechanisms to integrate existing infrastructure providers in Europe and around the world into the production infrastructure so as to provide transparent access to all authorised users.*

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[36] https://wiki.egi.eu/wiki/Long_tail_of_science_pilot
[37] https://documents.egi.eu/document/2339

1.3.5.1 Operational Level Agreements

During the project lifetime, EGI has created a complete framework of agreements supporting service delivery (Operations Level Agreement, Service Level Agreement) composed by the Resource Centre OLA, the Resource infrastructure Provider OLA, the EGI.eu OLAs, the EGI.eu Federated Operations SLA, the EGI User OLA, the EGI User SLA and the Technology Provider Underpinning Agreement. As part of EGI.eu service catalogue, Federated operations service has been defined to bring together the operational tools, processes and people necessary to guarantee standard operation of heterogeneous infrastructures from multiple independent providers, with a lightweight central coordination. This includes, for example, the monitoring, accounting, configuration and other services required to federate service provision for access by multiple research communities.

A federated environment is the key to uniform service and enables cost-efficient operations, while allowing resource centres to retain responsibility of local operations. This service is supposed to simplifies the day-to-day operations of a federated heterogeneous infrastructure avoiding duplication of costs and providing re-usable tools. In addition all activities which are part of the service were covered by signing an Operations Level Agreement document which describes expectations towards provisioning of the activity/tools and Service Level Agreement document between EGI.eu and Federated operations service customers (NGIs) have been agreed.

Besides a framework of service level agreements and operational agreements, an integrated service provision requires compatible access models and policies across the different e-Infrastructures. To date, these models and the related funding schemes are still largely incompatible and require harmonization.

1.3.5.2 E-Infrastructure Collaborations

EGI has been actively collaborating with various ESFRI cluster projects to investigate and demonstrate the reuse of EGI core operational and infrastructural services to meet common ESFRI requirements. Collaboration was established with the EUDAT and PRACE infrastructures and user communities aiming for the integration of data access and processing across the three infrastructures. Use cases are being collected for data access, transfer, replication and processing in various disciplines: (seismology, earth science, human physiology and hydrometeorology). Common data access and transfer tools and protocols that can be provided by all three e-Infrastructures will be identified.

A collaboration with EUDAT has been established on the evaluation of the EGI Service Availability Monitoring and its suitability to EUDAT deployment needs. The EGI service registry (GOCDB) has been adopted by EUDAT to support operations, and EGI-InSPIRE supported the implementation of EUDAT requirements through JRA1 development activities. The version released in PQ13 was tested, verified and deployed.

A collaboration with XSEDE was established in PQ09, a major research infrastructure providing HPC resources in US. A submission of Collaborative Use Examples (CUEs) for collaborating research teams utilizing resources in EGI and XSEDE (which includes resources provided by the Open Science Grid) was opened in PQ10 with the aim of getting a better understanding of the breadth of research activities and of the usage modalities that would benefit from a XSEDE and EGI collaboration. The collaboration refocused in PY4 to understand possible integration of helpdesk/support and security solutions.

1.3.5.3 The Unified Middleware Distribution

EGI successfully established the **Unified Middleware Distribution (UMD)** as the collection of verified and validated packages externally sourced, which are needed for the daily running of the

infrastructure, together with the procedures, tools and human networks for quality verification and staged rollout.

In addition, EGI-InSPIRE changed its processes and human coordination structures to move from project-orientated software releases to a working environment in which loosely coupled communities of developers coordinate release activities under the lead of EGI.eu

For what concerns software provisioning, as follow-up action of the end of the EMI and IGE projects, which until April 2013 had been responsible of third level software support in EGI, the new support levels offered in the EGI helpdesk – GGUS – by the EGI Technology Providers was completed and implemented, and is now documented in the GGUS helpdesk portal. In addition, the Unified Middleware Distribution of EGI is now capable of importing software packages that are released through third-party repositories like EPEL ("Extra Packages for Enterprise Linux").

The support framework has been extended to adapt to the changes introduced by the end of the middleware development projects funded by the European Commissions (EMI and IGE). Now UMD is able to import packages from multiple technology providers, including community repositories such as EPEL or local repositories maintained by the product teams. The extension of the framework slightly reduced the possibility to automate the import process, but this has been compensated by the improvement in the verification process and release building. These improvements allowed verifying and releasing many more products than the previous year with the available resources.

Besides the technical changes needed with the new technology ecosystem, SA2 also coordinated the **UMD Release Team**, the group of technology providers sourcing software deployed in EGI. In the meetings the representatives of the product teams present their release plans, and topics relevant for multiple products or product teams are discussed. The URT meetings help to keep alive the communications channels between product teams and product teams and EGI.

1.3.5.4   Tools for e-Infrastructure integration

The operational tools of EGI were re-designed to make them technology agnostic and, now, they can be easily extended to meet the operational needs of any distributed Research Infrastructures.

A regionalisation solution is offered for each tool to allow multi-instance and/or multi-tenant provisioning models.

The GOCDB v5 was a major release in which the product team redesigned the tool's business logic. This was necessary to accommodate requirements and emerging use-cases. The GOCDB v5 supports multiple projects and is used to manage the relationships between different entities (e.g. grid, cloud) using a well-constrained relational schema It includes a comprehensive role-based permissions model and can be easily extended for project specific business rules and roles. The GOCDB scoping was extended to introduce multiple, non-exclusive scope tags to enable hosting multiple projects within a single GOCDB instance. Each GOCDB entity can be part of different arbitrary infrastructures and infrastructure-specific views can be created. As a first result, the GOCDB was adopted by the EUDAT production infrastructure and it is currently a stable working service for the EUDAT Operations team.

The Accounting Repository adopted the Secure Stomp Messenger (SSM) protocol v2 protocol to make easier the integration with other infrastructures and it is now able to account data coming from ARC, QCG, EDGI Desktop Grid, Globus and Unicore sites. Regional accounting repository and portal were released in May 2013 and can be connected with the central instance.

Service Availability Monitoring (SAM) – the EGI distributed monitoring framework – is fully regionalised and each NGI runs a local SAM regional instance. SAM was also adopted by EUDAT. Furthermore, ARC, Unicore, QCG, Globus and Desktop grid probes were integrated into the SAM availability and reliability calculations.

The xGUS helpdesk satisfies the regionalisation needs of the NGIs that do not have a custom solution for their own local ticketing system. The xGUS helpdesk template has been developed for NGIs and user communities who want to build up their own user support infrastructure. Currently, it is adopted by the MAPPER project and six NGIs: NGI_AEGIS, NGI_ArabiaAfrica, NGI_CH, NGI_CHINA, NGI_DE and NGI_SI.

The Operations portal provides central customized views for each Operations Centre of the Operations Portal. The operational tools are also able to serve cloud infrastructures thanks to the work done in collaboration with the Federated Cloud task force.

1.3.6 Technology integration

> *Objective 6: Establish processes and procedures to allow the integration of new DCI technologies (e.g. clouds, volunteer desktop grids) and heterogeneous resources (e.g. HTC and HPC) into a seamless production.*

Openness is one of the values driving the activities of EGI. This means in practice being able to support the continuum of science and research with the contribution of external partners: technology providers, Research Infrastructures, and e-Infrastructures in Europe and worldwide to provide integrated solutions to the IT problems of scientists, researchers and innovators.

To support openness, the EGI technical architecture was defined to be modular and extensible to new or externally provided capabilities, and EGI operations were developed by including the procedures needed to roll new DCIs into the production infrastructure.

A complete set of new operational procedures[38] were defined to facilitate the federation of generic and community-specific service types:

- *Adding new probes to SAM*, PROC 07
- *Cloud Resource Centre Registration and Certification*, PROC 18
- *Introducing new cloud stack and grid middleware in EGI Production Infrastructure,* PROC 19

1.3.6.1 Desktop Grids

Thanks to the collaboration of the International Desktop Grid Federation (IDGF)[39], IDGF is now fully integrated as Operations Centre of EGI. This means that job workloads can be transparently submitted to desktop grids, and be accounted for. Structural Biology and Health and Medicine are the first two disciplines of EGI who became active users. This is the result of a Virtual Team who in PY5 promoted the advantages of desktop grids to EGI user communities[40].

1.3.6.2 Middleware Integration

The services provided by EGI have been extended through the deployment of diverse grid middleware (gLite, ARC, GLOBUS, QCG, Desktop Grid, UNICORE) and cloud management frameworks (OpenNebula, OpenStack, Synnefo). During the project, with the collaboration of the technology providers developing these products the services have been progressively integrated in the EGI Operations framework and they are now monitored, supported by the service registry GOCDB and where applicable accounting information are generated to report resources usage.

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[38] https://wiki.egi.eu/wiki/Operations_Procedures

[39] http://desktopgridfederation.org/

[40] https://wiki.egi.eu/wiki/VT_Promoting_Desktop_Grids

1.3.6.3 Extension of the operational tools

The integration of new technologies and resources in EGI required extensions to almost all the operational tools, but in particular, GOCDB – the EGI service registry – which records service types and service instance, the SAM framework that has to monitor them and the accounting system (both repository and portal), which has to provide accounting information.

The number of GOCDB service types defined has been steadily increasing. At the end if PY5 GOCDB has **111 service types** registered for various middleware stacks and for various user platforms (thse were about 60 in PY2): gLite, UNICORE, Globus, iRODS, ARC, QosCosGrid, BES, Cloud, Torque, Squid, XRootD, COMPSs, Dirac, etc.

All new service type requests need to be assessed by EGI via a lightweight review process (through OMB and OTAG).

The SAM monitoring framework is now able to monitor services from the following middleware stacks: gLite, UNICORE, Globus, ARC, QosCosGrid and Desktop Grids. EGI services and tools are considered as service types and probes are integrated in SAM in order to check their availability. EMI probes were integrated and replaced many old metrics.

The EGI Accounting Repository based on SSMv2 is also able to account the following resource types: **Cloud (Virtual Machines), CPU, multi-thread Jobs and Storage**. Related views where developed in the Accounting Portal to show the accounting data retrieved by these resource types. Furthermore, the accounting team has worked with sites and developers running alternative accounting clients to use SSM to send their records to the Accounting Repository. There are now sites in production sending accounting data from ARC, QCG and EDGI Desktop Grid and Globus and Unicore sites have successfully tested.

GGUS – the EGI helpdesk system – is also indirectly affected by the inclusion of new middleware in the production infrastructure, in particular in what concerns the support units to be added to the technology helpdesk that must handle specific tickets for 1st and 2nd level support.

Concerning the federated cloud infrastructure, activities focused on the developments needed to make the operational tools prepared to serve the EGI Federated Cloud into production. For monitoring, a specialized SAM instance has been deployed and ad-hoc probes developed. Availability and reliability results collected by this new SAM instance are showed in the MyEGI central instance together with the data collected from the grid infrastructure.

EGI-InSPIRE supported the development of accounting to track usage of multiple types of resources and middlewares: Cloud, ARC/JURA, QCG, Globus and Unicore and desktop grids (in production) and parallel jobs and storage (prototype).

For accounting, the Cloud Accounting Usage Record has been defined according to the requirements of the providers of the EGI Federated Cloud. The repository was evolved to be able to collect the cloud accounting records and related views were developed in the portal. Furthermore, an activity was done to compare and make consistent, in term of format and type of data, the cloud accounting records collected from the resource providers employing different cloud technologies (e.g. OpenStack, OpenNebula, Syneffo). In the Operations Portal, the VO ID card was updated and it now allows the declaration of the use of cloud storage and computing.

1.3.6.4 Parallel computing

During the whole project support of parallel jobs has been consolidating and expanding across the infrastructure. The number of integrated high-performance cluster has been also increasing. The accounting infrastructure has been extended to support reliable accounting of parallel jobs, and the extensions are being rolled to the production infrastructure during PY5.

1.3.6.5 Cloud integration

One of the major achievements of the project was the launch of a new solution in May 2014: the EGI Federated Cloud. Technical investigation and targeted developments started in 2012 to study the architecture and define the technical integration needed for the implementation of a European "network" of community clouds and public clouds. The technical integration – carried out in WP4 – resulted in the beginning of the cloud operations at the beginning of PY5. This new solution – not originally planned in the EGI-InSPIRE DoW – allows to extend the capabilities of the High Throughput Data Analysis solution offering through a distributed IaaS the possibility to host customized application, and hence the flexibility to elastically allocate on-demand capacity, host long-running custom applications offering interactive features and discipline-specific tools, data, and workflows. The EGI Federated Cloud is operated through the same Core Infrastructure Platform that is used for the distributed HTC platform. This demonstrates the high-level of flexibility, modularity and scalability of the EGI operational tools. By PQ16, all cloud providers have been certified and run as production sites.

In PY4 as a result of a regular strategy review, the EGI-InSPIRE project included a new work package (WP8). This WP had the objective to "accelerate the EGI strategic goals" and through a coordinated set of short-lived focused projects it allowed the development of technologies for the federation of cloud providers through standard interfaces.

1.4 Impact, dissemination and exploitation of results

According to the EGI vision, *researchers from **all disciplines** have easy, integrated and **open** access to the advanced **digital services, scientific instruments, data, knowledge and expertise** they need to collaborate to achieve **excellence in science, research and innovation**".*

To achieve this vision, the mission of EGI is to provide solutions for **open science, research and innovation by federating IT capabilities, people and knowledge.**

The EGI vision and mission, together with our values – Leadership, Openness, Reliability, Innovation, Commitment, define the context of the project impact, dissemination and exploitation of results.

1.4.1 Potential Impact

1.4.1.1 Supply and use of data and computational infrastructures and services for academia and industry

With its four solutions, EGI-InSPIRE contributed to expand the operations of the largest distributed HTC infrastructure in the world. The launch of the Federated Cloud with its 50 use cases after 8 months of production activities allows EGI to better serve the demand from SMEs and Industries by expanding its offer, for example including Scientific software as Service on HTC and HPC cloud, the integrated provisioning of open datasets and a IaaS service for their exploitation, and consultancy services for application porting and scaling up. The first EGI business engagement programme was prepared in PY5 for discussion in early 2015.

Indicator	Time period	Value [Target for 2015]
HTC: CPU hours Used	PY1-PY5	HTC: 61.22 Billion hours
Federated Cores	Dec 2014	520,000 cores
Cloud: number of VMs	PY5	Cloud: 200,000
Online storage	Dec 2014	PB: 306

1.4.1.2 All researchers from all disciplines have access to the Commons (e-Infrastructure, data and knowledge)

Indicator	Time period	Value [Target for 2015]
Number of users (with personal certificate and accessing via robot certificates – estimated)	Dec 2014	38,000 [40,000]
Scientific disciplines increase their use of e-Infrastructure services	PY1-PY5	Astronomy, Astroparticle Physics, Structural Biology, Particle Physics, Hydrology and Climate Research, Medical and Health Sciences [Engineering and Technologies, Social Sciences and Humanities]
The long-tail of science uses EGI services	PY1-PY5	46% of the total new users [+60%]
Research Infrastructures use EGI services	Dec 2015	BBMRI, CTA Testing: EISCAT-3D, ELIXIR, ELI-NP, LIFEWATCH and KM3Net

The capability of serving the long tail of science increased in the project lifetime thanks to the active of several NGIs. Among all increasing disciplines, the long tail user group accounted for 46% of the new users, followed by Structural Biology and Particle Physics (Figure 2, left). Experience demonstrates that in order to increase impact of engagement activities, NGI user support efforts need to be complemented by the internal outreach conducted by the Virtual Research Community. The LifeScience Grid Community, WeNMR (Structural Biology) and the DRIHM (Hydrology and Climate Research) projects are a demonstration of the importance of EC funding and policies for community building activities for the ERA.

During EGI-InSPIRE we saw an increase in distribution of the number of users across different scientific disciplines, demonstrating the capability to serve a wide spectrum of the ERA. The scientific disciplines backed by the larger user communities are Natural Sciences (59%), Medical and Health Sciences (9%) and Engineering and Technologies (8%).

1.4.1.3 Foster excellence in science

All the efforts that EGI-InSPIRE invested into the engagement and support for existing and new communities resulted in European leadership in generating new knowledge. This value is provided through **more than 2000 peer-reviewed scientific publications supported by EGI** (reported in table A1), and by the awarding of the Nobel Prize for the discovery of the Higgs Boson.

A wealth of user-orientated publications is not counted in the indicator provided above. The collaboration with OpenAIRE[41] will continue to allow for an easier tracking of papers related to e-Infrastructures.

Indicator	Time period	Value
Cumulative number of peer-reviewed scientific publications that benefited from EGI	2004-2014	2,000 [2,500]

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[41] https://www.openaire.eu/

Number of research collaborations/projects using EGI	PY1-PY5	302 in total (2004-2014) 76 new (PY1-PY4) 220 active, Dec 2014

1.4.1.4 Researchers are digitally empowered through e-Science environments and tools without barriers

Researchers across disciplines are digitally empowered through e-Science environments and tools tailored to their specific needs, resulting in better collaboration and higher efficiency and creativity in research.

Indicator	Time period	Value
Number of production service end-points	Dec 2014	3,600
Number of registered applications and platforms that are ported to HTC/Cloud and available for reuse.	PY1-PY5	257

1.4.1.5 Promote the adoption of open standards

In all its solutions and for the Core Infrastructure Platform the technical federation in EGI is grounded on the adoption of open standards where available, or de facto-standards. EGI-InSPIRE with its funding promoted the development and implementation of cloud open standards, avoiding vendor lock-in and thus removing one of the most important barriers in adoption of cloud both by the private and public sectors.

Indicator	Time period	Value
Number of interoperable distributed data storage services available in EGI[42]	Dec 2014	159
CDMI Cloud Storage Interface end-point	Dec 2014	4
OCCI Cloud Compute Interface end-point	Dec 2014	13

1.4.1.6 Create a single market for knowledge, research and innovation

Europe needs a unified research area to attract talent and investment and called for the completion of the ERA by 2014, including by addressing any remaining gaps in order to create a genuine single market for knowledge, research and innovation.

EGI operates heterogeneous DCI technologies: High Throughput Data Analysis, Federated Cloud, Desktop Computing and Parallel Computing, and federates these in all regions of the world: Europe, Africa and Asia, Asia Pacific region, North America and South America.

1.4.1.7 Reinforce excellence across the whole of Europe

A reinforced ERA requires partnership for excellence and growth between Member States, stakeholder organizations and the European Commission.

Within EGI, NGIs have been developing at different speed across Europe and only for a subset of the countries a Research Infrastructure roadmap has been defined, including the national policy for ICT

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[42] Number of user interfaces to storage services providing capacity for data ingestion and management, registered in the EGI service catalogue.

provisioning to RIs. EGI.eu coordinated policy development activities trying to stimulate alignment and synergies across its members.

However, reinforcement of excellence requires community building and engagement with user communities at a national level, and not all NGIs have a level of maturity that allows them to reach out effectively.

In PY5 EGI evolved its governance to allow every national e-Infrastructure – regardless of the region of origin, also outside Europe – to join the Council as associate or full participant. In addition full membership was extended to International Research Organizations and ERICs. This will allow better participation of user communities to the EGI governance.

Indicator	Time period	Value
Number of federated countries	Dec 2014	EGI-InSPIRE partners: 39 Integrated partners: 15

1.4.1.8 Establish national e-Infrastructure roadmaps and transnational cooperation among them

The European Council acknowledged that "reforms of research and innovation systems are at the heart of ERA and that the Member States should accelerate national reforms, where necessary, to boost the the potential in research, development and innovation."

To do so, EGI-InSPIRE is promoting the Open Science Commons vision that advocates the collaboration of all stakeholders at national and European level to deliver an integrated Commons including: scientific instrumentation, data, a wide range of ICT services offering the capabilities requested by the users, and knowledge. The Open Science Commons is meant to align policies at national level between different stakeholders, and at a European level among e-Infrastructures of European relevance, to enable **interoperability, transnational cooperation and sharing**.

EGI-InSPIRE provided the transnational multi-disciplinary research collaborations within the ERA with a world class e-Infrastructure capable of allowing transnational access to ICT services and thus fostering sharing of available capacities between different user communities, and reuse.

Indicator	Time period	Value
Percentage of transnational usage: percentage of foreign resources (CPU normalized wall time hours) used by users of a given country aggregated across the whole of EGI	PY4-PY5	24.4% (average)
Number of federated countries	Dec 2014	EGI-InSPIRE partners: 39 Integrated partners: 15

The **Percentage of transnational usage** indicates the percentage of foreign resources (CPU normalized wall time hours) used by users of a given country aggregated across the whole of EGI. By allowing transnational access EGI contributes to: 1. **Support international collaborations** requiring federated access to distributed ICT capabilities, 2. Overcome the "**insufficient European-level pooling and sharing of resources and scarcity of resources**" that was identified by the EC as an issue[43], 2. Overcome **digital divide** in Europe.

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[43] http://ec.europa.eu/dgs/connect/en/content/einfrastructures-computational-infrastructure

However, structural problems for pan-European procurement of resources and the lack of mechanisms for claiming the costs of transnational access of EGI solutions, need to be addressed to allow the current indicator to significantly increase in a sustained way. The percentage of transnational usage allowed by EGI is very high in various large countries of EGI, as indicated in the map below.
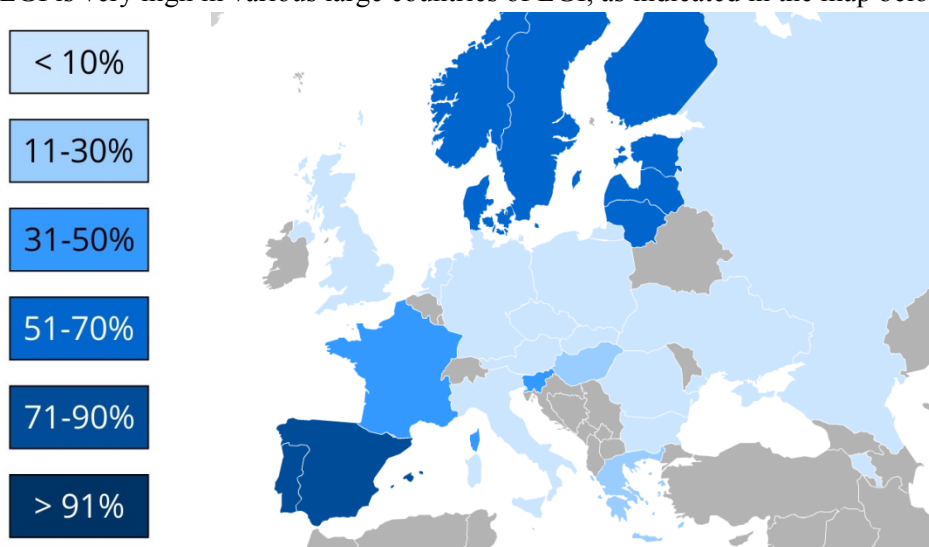
Figure 1. Percentage of transnational resource usage in each country. The percentage indicates the relative amount of resources from abroad used by the researchers from a given country. Information is extracted from the accounting portal. Association of users to countries is based on the Certification Authority that released the user certificate.

1.4.2 Dissemination activities

The dissemination activities carried under the umbrella of the EGI-InSPIRE project are listed in Table A2 provided as an annex to this report. This section provides an overview of the main initiatives and their results.

1.4.2.1 Online presence

Website. One of the main dissemination activities during EGI-InSPIRE was to create, maintain and update an online presence for the EGI community through the means of a website.

The EGI website was designed as a one-stop-shop for information about EGI, EGI.eu, EGI-InSPIRE and the other projects that EGI.eu is involved in, aimed at a generic audience (i.e., not specifically the EGI community). Using the EGI website as a starting point, users, the public, press, project members and other stakeholders should be able to gain access to the information that they need easily and transparently. In the last 32 months (May 2012–January 2015), the website received 397,532 unique page views.

Social media. EGI has set up a series of social media sites including Twitter, Facebook, Google+ and LinkedIn. These pull in the RSS news feed from the EGI website and also provides a channel for live reports on EGI events and meetings. The most active social media channels proved to be Twitter (1,815 posts and 1,376 followers), used as a lightweight communication channel for everyday news and mainly during events as a platform for discussion, and Facebook (294 'likes'), where we post photos from events, announcements and entertaining news aimed at community-building.

EGI Blog. The EGI Blog was set up for the community and anyone involved in EGI, EGI-InSPIRE or sister projects is welcome to contribute blog posts covering their work using their EGI Single Sign On account. As of the end of the project, the blog published 194 posts contributed by many actors in the community (e.g. Champions, NGI staff, EGI.eu team).

1.4.2.2 Publications

Newsfeed & newsletters: News from the EGI community. One of the main aims of EGI-InSPIRE dissemination activities was to create a sense of community and keep the community informed. The main channels for this were the EGI newsfeed and the EGI newsletter, *Inspired.*

The EGI newsfeed published 285 news items over the past four years, with announcements, success stories, updates from teams and contributions from the community. The newsletter *Inspired* was published quarterly and saw 17 issues with 156 articles, 28% of them contributed by NGIs, Champions, sister projects and research communities. The newsletter was set up to be delivered digitally by email. Each issue attracts around 1,800 visits which result on about 300-400 'reads'.

Media. During EGI-InSPIRE, the communications team issued nine press releases, a number that reflects a strategic decision to limit these type of initiative to high-level announcements (e.g. the launch of the EGI Federated Cloud) only, in order not to cause fatigue. As a consequence, EGI's press releases have achieved a fair coverage in trade publications, and even on generalistic media, such as Forbes, The Register or the Financial Times.

Outreach brochures. EGI.eu has published the following types of brochures (publication portfolio):
- *Stories from the grid...* (domain-specific brochures, aimed at scientists): earth sciences and life sciences;
- *The EGI Solution White Papers* (aimed at existing and new user communities): four papers describing the four EGI Solutions;
- *Services and applications for researchers* (aimed at existing and new user communities): User Community Support Team, The Applications Database, EGI Applications for Biophysics;
- *EGI leaflets* (aimed at a generic audience): a leaflet (several editions) with basic EGI facts;
- *Why EGI?* (aimed at policy-makers): a publication highlighting the added value of EGI to resource providers and research communities.
- *Annual Reports* (aimed at the EGI Community): with a round-up of the activities of the previous year.
- *Director's letters* (aimed at the EGI Community): focusing on month-to-month developments and EGI-InSPIRE updates.

1.4.2.3 Events

Events were a crucial part of EGI-InSPIRE's dissemination activities. EGI.eu organised eight flagship events, the EGI Community and Technical Forums, in Amsterdam, Vilnius, Lyon, Munich, Prague, Manchester, Madrid and Helsinki. The forums attracted in total about 3,400 attendants from all sections of the community and thousands of presentations, posters, demos, and workshops. In parallel, during the project, EGI organised thematic workshops in Amsterdam with focused content and lower attendance.

During the project, EGI.eu organised 72 training events, of which 33 were hosted by EGI forums and 13 were part of the EGI Webinar Programme.

In addition the members of the EGI dissemination team travelled to about 40 events aimed at diverse audiences, from gender aspects to focused scientific meetings, from technical workshops to wide, pan-European conferences on e-Infrastructures and policy.

1.4.2.4 EGI Champions

The EGI Champions Programme kick-started in early 2013 with the aim of recruiting enthusiastic scientists using grid computing for their research and keen to go to conferences and spread the word about the benefits of working with EGI. The first cohort numbered nine Champions, who interacted with the EGI community at flagship events and workshops and travelled to 16 scientific conferences in their fields to present talks and/or posters with EGI-enabled results. With comparatively modest financial support, they are able to spread the EGI message to the very heart of research communities and make contact with scientists that can positively influence others in the use of our infrastructure.

An added value of the EGI Champions, which was not foreseen at the start of the programme, was their active contribution to outreach and dissemination activities. The Champions lend their expertise of the field and their knowledge of their professional networks to tailor the communications to researchers on their fields.

1.4.3 Exploitation of results

Science today is no longer exclusively produced in single research labs or within national boundaries. Modern scientific challenges call for integrated solutions, cross-country collaborations and computing power with flexible usage to analyse vast amounts of data.

E-infrastructures allow scientists to share information securely, analyse data efficiently and collaborate with colleagues worldwide. The 'European Grid Infrastructure' collaboration (EGI) operates one of the largest, collaborative e-Infrastructures of the world. EGI supports the ERA through its pan-European infrastructure, based on an open federation of reliable ICT services, which provide uniform, cost effective, user oriented and collaborative access to computing and data storage resources in more than 30 countries. Identifying the various stakeholder categories, defining a proper service offering and efficient communication channels are key to achieve exploitation of the results, recognition and growth.

1.4.3.1 Target groups

Research Infrastructures

EGI provides a world-class e-infrastructure that can support researchers in pushing the frontiers of science, in particular within areas with massive data or computational requirements. In the next two years a growing number of Research Infrastructures (RIs) from the ESFRI roadmap and from national roadmaps are expected to reach implementation or operational stage. These RIs are already exploring the current and future needs of their user communities and thus they are key instruments in bringing together a wide diversity of stakeholders to look for solutions to many of the problems science is facing today. Given their international nature and awareness of the benefits of e-infrastructures ESFRI RIs, their preparatory projects, and other similarly large, multinational and structured scientific collaborations are considered as the primary potential beneficiaries of EGI services and therefore one of the prime targets of EGI Engagement activities. These projects and communities come with some advantages, and disadvantages, which need to be considered when engaging with them.

Advantages:

- Usually one point of contact, for example a technical coordinator exists.
- Requirement gathering should be simpler and can build on the established network of contacts of the RIs.
- Acceptance and integration of EGI into the ESFRI plans should lead to a long-term partnership between e-infrastructure and research infrastructures.

- Awareness of their problems and typically also of the benefits of using e-infrastructures in addressing them.
- More likely to have some internal expertise that can work with EGI and speed up collaborative work.
- Given their scale, using common resources and solutions is expected to imply a significant reduction in the global cost of development and provisioning.

Disadvantages:

- Convincing a large community of an outside solution could be difficult.
- Sometimes need to work with existing/previously chosen tools.
- The full pay off (i.e. scientific breakthrough enabled by EGI solutions) may not be seen for a number of years.

Small research collaborations

A second target group for EGI Engagement is the large number of highly dynamic, small research collaborations and research networks. Unlike RIs, these groups may scarcely, or not be aware of e-infrastructures, and their benefits to science, so discussions have to start at a more basic level. They come with different unique advantages and disadvantages that need to be recognised when engaging with them.

Advantages:

- Being usually more flexible on using new technologies and tools;
- Bringing new insights and tools that could have a wider use.
- Be the possible first step in integrating a much wider community.
- Be more suited to establish spinoffs and start-ups.

Disadvantages:

- The group is not visible, have no clearly identifiable contacts for engagement.
- Could be not as big a pay off from a usage perspective.
- May not be aware of their e-science problems and the benefits of e-infrastructures.
- Requirement gathering may not be straightforward.
- Might be lacking in technical expertise and funding.

SMEs and Industry. EGI currently operates within a publicly funded research and academic environment providing free of charge services at point of delivery made available to the whole community with resources acquired from dedicated grants or either by direct allocation or peer review. In principle, SMEs and large corporations (they make up an important part of the so called commercial sector or industry), are not currently using the services provided by EGI.

However, with the advent of cloud computing, business models and user expectations are shifting towards on-demand and pay-per-use service provision increasing flexibility and portability. This new paradigm provides motivation for EGI to explore new service models by enabling the possibility to provide ICT services that can be paid for, along with the more traditional procurement of resources managed and offered for free.

This approach also allows researchers and resource providers to better understand costs to access individual services and would enable the creation of innovative business models and pricing schemes (e.g. pay-per-use). In early 2013, the EGI Council approved a policy to explore business models for pay-for-use service delivery to couple together with the traditional method of free-at-point-of-use. The goal of this activity still is to support the implementation of this policy in collaboration with NGIs

through the definition and execution of proof of concepts. The mandate of the group is to create a proof of concept pay-for-use prototype[44].

The Pay-for-Use proof of concept will help to understand what can be offered, under what conditions, which will establish the basis for defining development of future service. The main goal remains being to support scientific and research work and including the industry is perfectly aligned with the objectives of Horizon 2020 programme.

1.4.3.2 Process

Exploitation of the project results in the form of solutions and/or individual services, requires the coordinated work of specific members of EGI, and the mobilisation/integration of specific tools. This is achieved by a process that aligns all the relevant elements into a single workflow that helps EGI runs continuously to reach new users and to support them reach scientific results through EGI services. This workflow runs in many instances, both at the national and international level. The workflow is consists of three phases:

- **Outreach**: This phase aims to identify those members of the ERA whose work could be lifted to the next level by EGI's e-infrastructure services. First contact is made with them (face-to-face or email/phone/skype) so they gain a basic understanding of the solutions that EGI provides and how these solutions could benefit specific scientific collaborations and applications. Using communication and marketing approaches this phase raises awareness of EGI within the ERA, and generates interest towards the EGI services within scientific communities. While some of these communities (or individuals from these communities) can immediately become active EGI users by following the manuals and tutorials that exists on EGI/NGI websites, complex and new ways of e-infrastructure usage typically requires expert assistance. Moreover changes and further development of EGI's solutions to be able to support the use cases of new communities may also be required. These complex cases have to be handed over to, and followed in the second phase of the workflow.

- **Scoping**: In this phase engagement with new users is deepened, and detailed requirements from their e-infrastructure use cases are captured and translated into focussed support project plans. The projects are formalised in collaboration with the prospective users and aim at e-infrastructure setups that can help these users solve their scientific problems with EGI's solutions. The projects are formalised as 'Virtual Team projects' assembling a team of experts with specific skills to carry out specific tasks for the new community within a 3-6 month timeframe. The primary output of this phase is project plans endorsed by both the EGI community and by the prospective user community. The plans are handed over to the third phase of Engagement.

- **Implementation**: This phase initiates, then executes the Virtual Team projects according to the endorsed plans. The projects, after successful completion, must enable the user(s) reaching new frontiers in science, and indirectly result in an increased and/or diversified use of EGI's solutions. During execution the projects are monitored by EGI.eu to ensure timely delivery.

1.4.3.3 Service Offering

The scientific communities are the most important customers of the EGI collaboration and the very reason for existence. Therefore, there have been developed the most diversified bundle of services to attend their needs and bring benefits.

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[44] More information available at https://wiki.egi.eu/wiki/EGI_Pay-for-Use_PoC:Home

The core Service for all researchers in the target groups is common and can be described very simply: supported computing and data managing capacity for running their research work. A series of services has been built for creating the actual services.

The concept of solution marketing was introduced to create a bundle of products, services, and knowledge known as the EGI solutions[45]. The solutions marketing is a relatively new and vibrant trend in marketing philosophy, which pursues the idea to start from the customer instead of the services or products that an organization has already developed and is prepared to offer. The basic idea is to focus on the customer needs, to deliver value and benefits that the customer expects and needs. The solutions components may come from any of the members of the EGI collaboration: e.g., EGI.eu, NGIs, Technology and Resource Providers, Service Providers and commercial partners.

The EGI solution portfolio was first developed during 2013 to present dedicated answers to specific user needs. As the users' requirements evolved or, the EGI Solutions were again fully redefined during the first half of 2014 to better reach better EGI's users, and to align within a business framework. The EGI solutions aimed to serve the broad research community are:

The **Community-Driven Innovation & Support solution**[46], which addresses the way EGI, responds to the researchers' support queries. Whenever researchers encounter a challenge accessing EGI resources, they can, as before, knock on many doors. But if the problem requires a new technology, it is now possible to summon a group of experts to put their brains together and create an innovative answer. This will then become part of the pool of previously existing applications, workflows or any other already existing approach. This solution is based in two basic services provided by EGI: **Technical consultancy and networking**: helps research communities take the first steps in working with the infrastructure by providing the best solutions for their requirements and get scientific applications up and running; **Helpdesk support**: Offers professional, reliable and efficient technical support to guarantee a well-run infrastructure with improved productivity and usability.

The **Federated Cloud solution**[47] is a seamless grid of academic private clouds and virtualised resources, built around open standards and focusing on the requirements of the scientific community. This is the long-awaited response to the demand for a European federation of academic clouds. With this solution, researchers obtain a single cloud system for their research activities, which they are able to scale to their requirements, which is fully resilient and free from vendor lock-in. The user-researchers can focus on their core work and obtain new, innovative approaches to their work.

The **High-Throughput Data Analysis solution**[48] represents the core of the EGI activity, which is the provision of high quality data and computation intensive resources in a distributed infrastructure. The infrastructure links hundreds of independent research institutes, universities and organisations delivering top quality computing resources. This solution is composed of a series of software services such as: the **Applications database**, which allows researchers to share, rate, use and re-use up-to-date scientific applications, and the **Training marketplace**, which provides a space for trainers and trainees to advertise and look for training events, online courses and training materials on a wide-range of scientific and distributed computing topics

The Marketing and Outreach services provided by EGI can be considered as a service for the researchers, as they fulfil the need of highlighting both the strategic value of the infrastructure for research in Europe and its scientific outputs to the general public, policy makers and potential users.

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[45] http://www.egi.eu/solutions/

[46] https://documents.egi.eu/document/2199

[47] https://documents.egi.eu/document/2197

[48] https://documents.egi.eu/document/2198

The Outreach service, which is fully described in this document, ensures knowledge transfer, promotes use cases to attract new users, and guarantees that existing users make the most of the available tools and services.

All the solutions and services described above are targeted to all the segments composing the scientific community of the ERA (Research Infrastructures (RIs) from the ESFRI and national roadmaps, the large number of highly dynamic, and the small research collaborations and research networks). They are however perfectly valuable for the long tail of science and SMEs and Industry.

1.5 Address of the project website, relevant contact details and list of beneficiaries

Address of the project website
http://www.egi.eu/about/egi-inspire/

Relevant contact details
Project director: Tiziana Ferrari, EGI.eu (tiziana.ferrari@egi.eu)

List of beneficiaries

ID	Partner Name (Country – if national structure)	Partner Short Name (Lead recipients of a JRU or the project partner are in bold)	Beneficiary / JRU Member Legal Name (English translation if available/required)
1	EGI.eu	**EGI.EU**	STICHTING EUROPEAN GRID INITIATIVE
2	ALBGRID (Albania)	**UPT**	UNIVERSITETI POLITEKNIK I TIRANES (Polytechnic University of Tirana, Albania)
		UT	UNIVERSITETI I TIRANES (University of Tirana)
3	IIAP NAS RA (Armenia)	**IIAP NAS RA**	INSTITUTE FOR INFORMATICS AND AUTOMATION PROBLEMS OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF ARMENIA
5	IICT-BAS (Bulgaria)	**IICT-BAS**	INSTITUTE OF INFORMATION AND COMMUNICATION TECHNOLOGIES - BULGARIAN ACADEMY OF SCIENCES
		IOCCP-BAS	INSTITUTE OF ORGANIC CHEMISTRY WITH CENTRE OF PHYTOCHEMISTRY - BULGARIAN ACADEMY OF SCIENCES
		NIGGG-BAS	NATIONAL INSTITUE OF GEOPHYSICS, GEODESY AND GEOGRAPHY – BULGARIAN ACADEMY OF SCIENCES
6	UIIP NASB	**UIIP NASB**	UNITED INSTITUTE OF INFORMATICS

			PROBLEMS OF NATIONAL ACADEMY OF SCIENCES OF BELARUS
	(Belarus)		
7	SWITCH (Switzerland)	**SWITCH**	SWITCH -TELEINFORMATIKDIENSTE FUER LEHRE UND FORSCHUNG
		ETH Zurich	Eidgenössische Technische Hochschule Zürich
		UZH	UNIVERSITAET ZUERICH (University of Zurich)
8	CyGrid (Cyprus)	**UCY**	UNIVERSITY OF CYPRUS
9	CESNET (Czech Republic)	**CESNET**	CESNET, ZAJMOVE SDRUZENI PRAVNICKYCH OSOB
10	Gauß-Allianz (Germnay)	**KIT-G**	Karlsruher Institut fuer Technologie
		DESY	STIFTUNG DEUTSCHES ELEKTRONEN-SYNCHROTRON DESY
		JUELICH	FORSCHUNGSZENTRUM JUELICH GMBH
		BADW-LRZ	BAYERISCHE AKADEMIE DER WISSENSCHAFTEN
		DFN-VEREIN	VEREIN ZUR FOERDERUNG EINES DEUTSCHEN FORSCHUNGSNETZES DFN VEREIN E.V.
		Fraunhofer	FRAUNHOFER-GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V
		LUH	GOTTFRIED WILHELM LEIBNIZ UNIVERSITAET HANNOVER
		D-Grid gGmbH	gemeinnützige D-Grid Entwicklungs- und Betriebsgesellschaft mbH
11	BiH NGI (Bosnia and Herzegovina)	**UOBL ETF**	UNIVERZITET U BANJOJ LUCI ELEKTROTEHNICKI FAKULTET
12	CSIC (Spain)	**CSIC**	AGENCIA ESTATAL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS
		FCTSG	FUNDACION CENTRO TECNOLOGICO DE SUPERCOMPUTACION DE GALICIA
		RED.ES	ENTIDAD PUBLICA EMPRESARIAL RED.ES
		CIEMAT	CENTRO DE INVESTIGACIONES ENERGETICAS, MEDIOAMBIENTALES Y TECNOLOGICAS-CIEMAT
		UPVLC	UNIVERSIDAD POLITECNICA DE VALENCIA
		UNIZAR-I3A	UNIVERSIDAD DE ZARAGOZA
		IFAE	INSTITUTO DE FISICA DE ALTAS ENERGIAS

		UAB	UNIVERSITAT AUTONOMA DE BARCELONA
13	CSC (Finland)	**CSC**	CSC-TIETEEN TIETOTEKNIIKAN KESKUS OY
14	NGI FRANCE (France)	**CNRS**	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE
		HEALTH	HEALTHGRID
		CEA	COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES
		UBPCI	UNIVERSITE BLAISE PASCAL CLERMONT-FERRAND II
		ULMDI	UNIVERSITE DE LA MEDITERRANEE D'AIX-MARSEILLE II
		UPS	UNIVERSITE PARIS-SUD XI
		UPMC	UNIVERSITE PIERRE ET MARIE CURIE - PARIS 6
		UNSA	UNIVERSITE DE NICE - SOPHIA ANTIPOLIS
		UCBL	UNIVERSITE CLAUDE BERNARD LYON 1
		INSA Lyon	INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE LYON
		IPDGP	INSTITUT DE PHYSIQUE DU GLOBE DE PARIS
		CNRS – IDG	Institut des grilles (UPS3107)
		CNRS – LPNHE	Laboratoire de Physique Nucléaire et hautes Énergies (UMR7585)
		CNRS – LPC	Laboratoire de Physique Corpusculaire de Clermont Ferrand (UMR6533)
		CNRS – UREC	Unité de Réseaux CNRS (UPS836)
		CNRS – LAPP	Laboratoire d'Annecy le Vieux de Physique des Particules (UMR5814)
		CNRS – CC_IN2P3	Centre de calcul de l'institut national de physique nucléaire et de physique des particules (USR6402)
		CNRS – CPPM	Centre de physique des particules de Marseille (UMR6550)
		CNRS – IPSL	Institut Pierre-Simon-Laplace (FR636)
		CNRS – LRI	Laboratoire de Recherche en Informatique (UMR8623)
		CNRS – I3S	Laboratoire Informatique, Signaux & Systèmes de Sofia Antipolis (UMR6070)
		CNRS – CREATIS	Centre de Recherche et d'Application en Traitement de l'Image et du Signal (UMR5520)
		CNRS – LAL	Laboratoire de l'Accélérateur Linéaire (UMR8607)

		CNRS – IPGP	Institut de physique du globe de Paris (UMR7154)
15	GRENA (Goergia)	**GRENA**	GEORGIAN RESEARCH AND EDUCATIONAL NETWORKING ASSOCIATION
16	HellasGrid (Greece)	**GRNET**	GREEK RESEARCH AND TECHNOLOGY NETWORK S.A.
		AUTH	ARISTOTELIO PANEPISTIMIO THESSALONIKIS (Aristotle University of Thessaloniki)
		NKUA	NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS (University of Athens)
		CTI	RESEARCH ACADEMIC COMPUTER TECHNOLOGY INSTITUTE
		ICCS	INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS
		FORTH	FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS
		IASA	INSTITUTE OF ACCELERATING SYSTEMS AND APPLICATIONS
		UI	UNIVERSITY OF IOANNINA
		UMESS	UNIVERSITY OF MACEDONIA ECONOMICS AND SOCIAL SCIENCES
		UP	UNIVERSITY OF PATRAS
17	SRCE (Croatia)	**SRCE**	SVEUCILISTE U ZAGREBU SVEUCILISNI RACUNSKI CENTAR (University of Zagreb, University Computing Centre)
18	NIIF (Hungary)	**MTA KFKI**	MTA KFKI RESZECSKE-ES MAGFIZIKAI KUTATOINTEZET
		BME	BUDAPESTI MUSZAKI ES GAZDASAGTUDOMANYI EGYETEM
		MTA SZTAKI	MAGYAR TUDOMANYOS AKADEMIA SZAMITASTECHNIKAI ES AUTOMATIZALASI KUTATO INTEZET
19	Grid-Ireland (Ireland)	**TCD**	THE PROVOST FELLOWS & SCHOLARS OF THE COLLEGE OF THE HOLY AND UNDIVIDED TRINITY OF QUEEN ELIZABETH NEAR DUBLIN
20	ISRAGRID (Israel)	**IUCC**	INTER UNIVERSITY COMPUTATION CENTRE
21	IGI (Italy)	**INFN**	ISTITUTO NAZIONALE DI FISICA NUCLEARE
		ENEA	AGENZIA NAZIONALE PER LE NUOVE TECNOLOGIE,L'ENERGIA E LO SVILUPPO

			ECONOMICO SOSTENIBILE
		CNR	CONSIGLIO NAZIONALE DELLE RICERCHE
		INAF	ISTITUTO NAZIONALE DI ASTROFISICA
		UDSDNFI	UNIVERSITA DEGLI STUDI DI NAPOLI FEDERICO II.
		GARR	CONSORTIUM GARR
		UNIPG	UNIVERSITA DEGLI STUDI DI PERUGIA
		COMETA	COMETA CONSORZIO MULTI ENTE PER LAPROMOZIONE E L ADOZIONE DI TECNOLOGIE DI CALCOLO AVANZATO
		SPACI	SOUTHERN PARTNERSHIP FOR ADVANCED COMPUTATIONAL INFRASTRUCTURES
		CASPUR	CONSORZIO INTERUNIVERSITARIO PER LE APPLICAZIONE DI SUPERCALCOLO PER UNIVERSITA E RICERCA
22	LitGrid (Lithuania)	**VU**	VILNIAUS UNIVERSITETAS
23	RENAM (Moldova)	**RENAM**	RESEARCH AND EDUCATIONAL NETWORKING ASSOCIATION OF MOLDOVA
		IMI AŞM	Institutul de Matematică şi Informatică al Academiei de Ştiinţe a Moldovei (Institute of Mathematics and Computer Science of the Academy of Sciences of Moldova)
		FRET TUM	Universitatea Tehnica a Moldovei
		SHS	SERVICIULUI HIDROMETEOROLOGIC DE STAT
24	MGI (Montenegro)	**UOM**	JAVNA USTANOVA UNIVERZITET CRNE GORE PODGORICA
25	MARGI (Macedonia)	**UKIM**	Ss. CYRIL AND METHODIUS UNIVERSITY IN SKOPJE
26	NCF (The Netherlands)	**NCF**	STICHTING NATIONALE COMPUTERFACILITEITEN
		FOM	STICHTING VOOR FUNDAMENTEEL ONDERZOEK DER MATERIE – FOM
		SARA	STICHTING ACADEMISCH REKENCENTRUM AMSTERDAM (SARA)
27	NorGrid (Norway)	**SIGMA**	UNINETT SIGMA AS
		UNINETT	UNINETT AS
		UIO	UNIVERSITETET I OSLO (University of Oslo)
		URA	UNI RESEARCH AS

		UIT	UNIVERSITETET I TROMSOE
28	Cyfronet (Poland)	**CYFRONET**	AKADEMIA GORNICZO-HUTNICZA IM. STANISBAWA STASZICA W KRAKOWIE
		UWAR	UNIWERSYTET WARSZAWSKI
		ICBP	INSTYTUT CHEMII BIOORGANICZNEJ PAN
		POLITECHNIKA WROCLAWSKA	POLITECHNIKA WROCLAWSKA
29	INGRID (Portugal)	**LIP**	LABORATORIO DE INSTRUMENTACAO E FISICA EXPERIMENTAL DE PARTICULAS
30	AEGIS (Serbia)	**IPB**	INSTITUT ZA FIZIKU (Institute of Physics Belgrade)
31	SiGNET (Slovenia)	**ARNES**	Arnes (Academic Research Network of Slovenia)
		JSI	INSTITUT JOZEF STEFAN
32	SlovakGrid (Slovakia)	**UI SAV**	USTAV INFORMATIKY, SLOVENSKA AKADEMIA VIED
33	TR-Grid (Turkey)	**TUBITAK ULAKBIM**	TUBITAK ULUSAL AKADEMIK AG VE BILGI MERKEZI
34	UK e-Science JRU (UK)	**STFC**	SCIENCE AND TECHNOLOGY FACILITIES COUNCIL
		UNIMAN	THE UNIVERSITY OF MANCHESTER
		Glasgow	UNIVERSITY OF GLASGOW
		Imperial	IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE
		UOXF.DL	THE CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF OXFORD
		UEDIN	THE UNIVERSITY OF EDINBURGH
		QMUL	QUEEN MARY AND WESTFIELD COLLEGE, UNIVERSITY OF LONDON
35	CERN	**CERN**	ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
36	Grid.dk (Denmark)	**UCPH**	Københavns Universitet (University of Copenhagen)
37	EMBL	**EMBL**	EUROPEAN MOLECULAR BIOLOGY LABORATORY
38	SNIC-SweGrid (Sweden)	**VR-SNIC**	VETENSKAPSRADET - SWEDISH RESEARCH COUNCIL
		LIU	LINKOPINGS UNIVERSITET
		UMEA	UMEA UNIVERSITET

		UNIVERSITET	
		KTH	KUNGLIGA TEKNISKA HOEGSKOLAN
		CTHA	CHALMERS TEKNISKA HOEGSKOLA AB
		LU	LUNDS UNIVERSITET
		UU	UPPSALA UNIVERSITET
39	IMCS UL (Latvia)	**IMCS-UL**	LATVIJAS UNIVERSITATES MATEMATIKAS UN INFORMATIKAS INSTITUTS
40	e-ARENA (Russia)	**E-ARENA**	NATIONAL ASSOCIATION OF RESEARCH AND EDUCATIONAL E-INFRASTRUCTURES "E-ARENA" AUTONOMOUS NON-COMMERCIAL ORGANIZATION
		RRCKI	RUSSIAN RESEARCH CENTRE KURCHATOV INSTITUTE
		SINP MSU	NAUCHNO ISSLEDOVATELSKII INSTITUT YADERNOI FIZIKI IMENI D V SKOBELTSYNA MOSKOVSKOGO GOSUDARSTVENNOGO UNIVERSITETA IMENI MV LOMONOSOVA
		PNPI	B.P.Konstantinov PETERSBURG NUCLEAR PHYSICS INSTITUTE RUSSIAN ACADEMY OF SCIENCES
		JINR	JOINT INSTITUTE FOR NUCLEAR RESEARCH
		ITEP	INSTITUT TEORETICHESKOI I EKSPERIME NTALNOI FIZIKI ITEP
41	NORDUNET	**NORDUNET A/S**	NORDUNET A/S
42	ASGC (Taiwan)	**ASGC**	ACADEMIA SINICA
43	ASTI (Philippines)	**ASTI**	ADVANCED SCIENCE AND TECHNOLOGY INSTITUTE
44	ITB (Indonesia)	**ITB**	INSTITUT TEKNOLOGI BANDUNG BHMN
45	KEK (Japan)	**KEK**	INTER-UNIVERSITY RESEARCH INSTITUTE CORPORATION, HIGH ENERGY ACCELERATOR RESEARCH ORGANISATION
46	KISTI (Republic of Korea)	**KISTI**	KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY INFORMATION
47	UNIMELB (Australia)	**UNIMELB**	UNIVERSITY OF MELBOURNE
48	NUS (Singapore)	**NUS**	NATIONAL UNIVERSITY OF SINGAPORE
49	UPM (Malaysia)	**UPM**	UNIVERSITI PUTRA MALAYSIA
50	NSTDA (Thailand)	**NSTDA**	THAILAND NATIONAL SCIENCE AND TECHNOLOGY DEVELOPMENT AGENCY
51	ICI (Romania)	**ICI**	INSTITUTUL NATIONAL DE CERCETARE-

			DEZVOLTARE IN INFORMATICA - ICI BUCURESTI
		UPB	UNIVERSITATEA POLITEHNICA DIN BUCURESTI
		UVDT	UNIVERSITATEA DE VEST DIN TIMISOARA (West University of Timisoara)
		UTC	UNIVERSITATEA TEHNICA CLUJ-NAPOCA (Technical University of Cluj-Napoca)
		INCAS	INSTITUTUL NATIONAL DE CERCETARI AEROSPATIALE ELIE CARAFOLI - I.N.C.A.S. SA (National Institute for Aerospace Research Bucharest)
		UB	UNIVERSITATEA DIN BUCURESTI (University of Bucharest)

2 PLAN FOR USE AND DISSEMINATION OF FOREGROUND

2.1 Section A

This section describes the dissemination measures, including any scientific publications relating to foreground, undertaken during the course of the project.

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES								
No	Title	Title of the periodical or the series	Number, date or frequency	Place of publication	Year of publication	Relevant pages	Permanent identifiers	Is/will open access provided to this publication

Table A1 is provided as an annex to this report.

TEMPLATE A2: List of dissemination activities								
No	Type of activities	Main leader	Title	Date/period	Place	Type of audience	Size of audience	Countries addressed

Table A2 is provided as an annex to this report.

2.2 Section B

This section specifies the exploitable foreground and provides the plans for exploitation. The content provided in this section is PUBLIC.

2.2.1 Part B1

Note. The applications for patents, trademarks, registered designs, etc. shall be listed according to the template B1 provided hereafter. The list should, specify at least one unique identifier e.g. European Patent application reference. For patent applications, only if applicable, contributions to standards should be specified. This table is cumulative, which means that it should always show all applications from the beginning until after the end of the project.

TEMPLATE B1: List of applications for Patents, trademarks, registered designs,					
Type of rights	Confidential YES/NO	Foreseen Embargo date dd/mm/yyyy	Application reference(s)	Subject or title of application	Applicant (s) (as on the application)

2.2.2 Part B2: Exploitable foreground

Table 2. (B2) Information on exploitable foreground

[*] Foreground shall be the property of the beneficiary carrying out the work generating that foreground.

Type of exploitable foreground	Description of exploitable foreground	Confidential YES/NO	Foreseen embargo date	Exploitable products or measures	Sector(s) of application	Timetable, commercial or any other use	Patents or other IPR exploitation (licenses)	Owner & other beneficiary involved
Software, CPU and storage	High Throughput Data Analysis Solution	No	None	Delivery of services for distributed data analytics via SLA	Research	Current: in use	N/A	Relevant beneficiaries [*]
Software, CPU and storage	Federated Cloud	No	None	Cloud Compute Cloud Storage	Research	Current: in use	N/A	Relevant beneficiaries [*]
Consulting	User-driven innovation and support	No	None	Consulting on e-Infrastructure setup for new communities (VRCs, ESFRI RIs etc.)	Research user communities wishing to use e-Infrastructures	Current: in use supporting European user communities (including ESFRI RIs)	N/A	Relevant beneficiaries [*]
Human coordination, tools	Federated Operations	No	None	Running of the operations of a distributed infrastructure	Research Infrastructures, Computational resource owners and federators (including e-Infrastructures)	Current: in use to support EGI	N/A	Relevant beneficiaries [*]
Operational tools	Range of operational tools developed by EGI in order to support federation of resources which can be used by other	No	None	Tools can be deployed to support federation of resources in other contexts in two modes: multi-tenant and multi-	Computational resource owners and federators (including e-Infrastructures)	Current: in use by other infrastructures (EUDAT)	See Table 3	Relevant beneficiaries [*]

	communities federating resources			instance				
Application Database software products	Software products (scientific applications, workflows, WM images, virtual appliances for cloud deployment)	No	None	Software products available for re-use	Research	Current: in use to run the federated cloud IaaS	Open Source	Relevant beneficiaries [*]
Unified Middleware Distribution	Open source software validated and verified for deployment in a distributed environment	No	None	Software packages	Cloud Providers and HTC and Data Service Providers	Current: in use to run the production infrastructure.	Open Source	EGI.eu
Experience: Resource federation	Experience developed in federating computational resources in the EGI federation.	No	None	Consulting on the challenges of federating computational resources.	Computational resource owners and federators (including e-Infrastructures)	Current: in use in supporting other infrastructures, including ESFRI RIs	N/A	Relevant beneficiaries [*]
Experience: Policy development	Experience developing policies to support resource federations and interaction with funding and policy bodies	No	None	Consulting with actors in European research domain on how to secure funding and interact with national and European policy	e-Infrastructure operators and user communities	Now	N/A	EGI.eu
Experience: Service management in e-Infrastructures	Experience deploying service management in e-Infrastructu	No	None	Consulting with e-Infrastructure provider and user groups in	e-Infrastructure operators and user communities	Current: in use supporting VRCs and new user communitie	N/A (creative commons license for FitSM standard	EGI-InSPIRE consortium (experience)

	res and developing e-Infrastructure ITSM solutions (based on FitSM standard developed externally)			how to professionally manage services		s in planning ITSM deployment	used)	
Experience: brokering & resource sales	Experience developing technical and management processes to broker resources from providers and charge for resource use	No	None	Consult other e-Infrastructure groups wishing to deliver brokered or paid services.	e-Infrastructure operators and resource owners	Now	N/A	Relevant beneficiaries [*]
Experience: security policies and management	Experience in setting up security polices and management approaches for e-Infrastructure security	No	None	Consulting other e-Infrastructures on how to manage security issues	e-Infrastructure operators and resource owners	Current: in use by other infrastructures (PRACE)	N/A	EGI.eu
Complex research support organisations	Experience setting up complex coordination organisations to manage and support research and research computing	No	None	Consulting on new national or regional bodies supporting research computing.	European countries and national research communities.	Now	N/A	Relevant beneficiaries [*]
Training delivery	Coordinating and delivering training on topics needed by members of the European e-Infrastructu	No	None	Consult on training needs and deliver coordinated training to communities.	e-Infrastructure operators and user communities	Current: supporting ITSM and security training to e-Infrastructure sector	N/A	Relevant beneficiaries [*]

re and research computing domains.							

2.2.2.1 Exploitable foreground: general description

Table 3. General description of the EGI Solutions including the operational tools for Federated Operations and the Unified Middleware Distribution

Name	Purpose	Owner	License
Federated Cloud Solution	A single, standards-based, open system to federate academic clouds from multiple providers, offering scalable computing resources with increased flexibility. http://www.egi.eu/solutions/fed-cloud/index.html	EGI.eu	NA
Federated Operations Solution	The technologies, processes and people required to manage the operations of a heterogeneous infrastructure and to integrate resources from multiple independent providers with a lightweight central coordination. http://www.egi.eu/solutions/fed-ops/index.html	EGI.eu	NA
High-Throughput Data Analysis Solution	A global high-throughput data analysis infrastructure, linking hundreds of independent research institutes, universities and organisations delivering top quality computing resources. http://www.egi.eu/solutions/htc/index.html	EGI.eu	NA
Community-driven Innovation and Support Solution	Expertise provided by panel of experts to facilitate the access and improve the use of the EGI infrastructure. http://www.egi.eu/solutions/community-innovation-support/index.html	EGI.eu	NA
Operations Portal	The Operations Portal provides VO management functions and other capabilities that support the daily operations of EGI.	CCIN2P3	Apache 2.0
SAM/ARGO Framework	SAM is a system for monitoring distributed grid services, which are part of the EGI infrastructure. The service covers storage and computation of status and availability of services, generation of EGI league monthly report, web interface and web APIs to access stored data retrieval.	CERN/GRNET, SRCE, CNRS	Apache 2.0

GOCDB	Service Registry (GOCDB) is a central registry to record information about different entities such as the Operations Centres, the Resource Centres, service endpoints and the contact information and roles of people responsible for operations at different levels.	STFC	Apache 2.0
Accounting Portal	The Accounting Portal provides data accounting views for users, VO Managers, NGI operations and the general public.	CESGA	Apache 2.0
Metrics Portal	The Metrics Portal aggregates metrics from the EGI Infrastructure from activity leaders and NGI managers in order to quantify and track the infrastructure evolution.	CESGA	Apache 2.0
Message Broker Network	The message broker network is a fundamental part of the operations infrastructure ensuring message exchange for monitoring, the operations dashboard and accounting.	GRNET, SRCE	Apache 2.0
Pakiti	The EGI Security Monitoring provides an oversight of the infrastructure from the security standpoint.	CESNET	BSD 2
Certification web site	Website allowing NGIs to add sites to the EGI Catch All Top Level certification BDII.	GRNET	GPL
e-Grant	e-GRANT is a tool supporting Resource Allocation process. It allows researchers to request: an amount of compute and storage resources, FedCloud resources for a given amount of time. e-GRANT handles all activities involved in RA Process which leads to SLA signing.	ACC Cyfronet AGH	Apache 2.0 (e-GRANT is using Agreemount Framework (software package) based on proprietary license which is granted to Cyfronet on unlimited in time use for one instance.)
Accounting Repository	The Accounting Repository stores user accounting records from various services offered by EGI.	STFC	Apache 2.0
GGUS	Incident Management (Helpdesk) is the central helpdesk provides a single interface for support. The central system is interfaced to a variety of other ticketing systems at the NGI level in order to allow a bi-directional exchange of tickets. GGUS is part of the EGI	KIT	BMC Software Inc.

	Collaboration Platform and is needed to support users and infrastructure operators.		
Repository	The software-provisioning repository provides the technical tools to support the UMD release process from pulling packages from the developers' repositories to the build of a release.	GRNET	Apache 2.0
rOCCI-* (core, api, cli, server)	A Ruby OCCI Framework	CESNET	Apache 2.0
RT scrips and tools	Scrips and tools maintained against RT version 3.8.x	CESNET	Apache 2.0
DocDB extensions	DocDB extensions	CESNET	GPL2
Perun	Identity and Access Management System	CESNET	FreeBSD
oneacct-export	Exporting OpenNebula accounting data	CESNET	MIT
jOCCI-* (core, api)	A Java OCCI Framework	CESNET	Apache 2.0
Cloud-BDII-provider	The Cloud BDII provider generates a GlueSchema v2 representation of cloud resources for publihing it into a BDII	CSIC	ASL 2.0
OCCI-OS	OCCI for OpenStack	CSIC	ASL 2.0
OSSSM	APEL/SSM Openstack connector for EGI Fedcloud accounting system	IN2P3	GPL2
cASO	cASO is an OpenStack Accounting extractor.	CSIC	ASL 2.0
keystone-voms	This module is intended to provide VOMS authentication to a Grizzly OpenStack Keystone. It is designed to be integrated as an external authentication plugin, so that Keystone will preserve its original features and users will still be able to authenticate using any of the Keystone native mechanisms.	CSIC	ASL 2.0
Glancepush-vmcatcher	Openstack handler for vmcatcher	CSIC	MIT
OSGC - OpenSource Geospatial Catalogue	OSGC is an Open Source implementation of an OpenSearch GeoSpatial Catalogue compliant to OGC 10-32r3 specification, developed by EGI.eu under the ENVRI project.	EGI.eu	GPL v3
synnefo connectors	Synnefo is open source cloud software, used to create massively scalable IaaS clouds.	GRNET	GPL v3
Application Database	The EGI Applications Database (AppDB) is a central service that stores and provides to the public, information about:	GRNET	Apache 2.0

	• software solutions in the form of native software products and/or virtual appliances, • the programmers and the scientists who are involved, and • publications derived from the registered solutions		
Training marketplace	The EGI Training Marketplace is a service to coordinate training across communities, projects and national teams. It enables trainers to advertise events and resources, and users to locate, comment on and suggest training material and events that meet their needs.	STFC	Apache 2.0
Unified Middleware Distribution	A distribution of software not produced within the EGI-InSPIRE project, but sourced from external technology providers. UMD adds an additional quality control on top of the software releases, adding an "EGI seal of approval". The software licensing is a decision of the individual developers, although all the software is released as open source (UMD does not release closed software) the sources are made available by the developers.	EGI.eu	EGI.eu

There are four main groups of exploitable foreground: the EGI solutions including for Federated Operations the operational tools, consultancy and knowledge, the experience or setting up and operating EGI and training services.

EGI operates on a policy of openness in that it seeks to coordinate many European groups and enhance their impact. While some aspects (including operational tools) might generate potentially commercial IPR, the atmosphere of the consortium and larger European context makes this not a desirable outcome. As a result, while EGI-InSPIRE offers great current and potential impact in terms of the IPR and exploitable experience it created but not patents and commercial IPR.

Consulting experience also provides opportunities to serve other communities. This can be through several delivery models. EGI has and will continue to provide consultancy and support to other communities, such as EUDAT and emerging data infrastructures, peer organisations like PRACE and to the emerging and developing research communities such as ESFRI RIs, but on a best effort basis. However this could also be provided on a paid basis in future. It could be delivered by individual consortium members or by EGI.eu, brokering delivery of staff from EGI participant organisations.

For consulting, IPR is not really an issue, though some aspects such as service management and project management would use external frameworks and standards that have their own IPR protection. However EGI has strived to use bodies of knowledge with open licenses wherever possible.

This set of skills must continue to be maintained, and as a result retention of key staff and careful documentation of experiences, processes and procedures is important to maintain the skill-base that it draws on. The impact of consulting can be high, and is already significant in the sustainability of EGI.eu as it helps justify the fees paid by participants.

There is a renewed need for training within the community as rather than basic introductions to using e-Infrastructure, there is a need for training of consortium members and community representatives on specific topics that require specialist skills. EGI has developed skills and training capacity in security policy development and service management standards and coordinated and delivered training to community members. This emerging area offers opportunities based on the consortium's understanding of the needs of e-Infrastructure provider and user communities.

This area does not involve IPR of the exploitable knowledge and has opportunities for revenue generation as training coordination and capacity development is likely to be too expensive for many groups or organisations needing to increase skills. However, EGI can centrally survey communities for common needs, pilot and deliver training courses and ultimately provide train-the-trainer courses where appropriate to let community members develop internal training delivery capacity. This is attractive as many organisations have budgets for staff training and EGI could add value to the community be identifying the key skills needed and the training needed to enable them.

3 REPORT ON SOCIETAL IMPLICATIONS OF THE PROJECT

A - General Information

Grant agreement number	RI-261323
Title of the project	EGI-InSPIRE
Name and title of the coordinator	Tiziana Ferrari, EGI.eu Technical Director

B - Ethics

Grant agreement number	RI-261323
Title of the project	EGI-InSPIRE
Name and title of the coordinator	Tiziana Ferrari, EGI.eu Technical Director

C - Workforce Statistics

Workforce statistics for the project: please indicate in the table below the number of people who worked on the on project (on a headcount basis)		
Type of position	**Number of women**	**Number of men**
How many additional researchers (in companies and universities) were recruited specifically for this project		
Grant agreement number		
Title of the project		
Name and title of the coordinator		

D - Gender Aspects

The EGI-InSPIRE developed a Gender Action Plan, aimed at promoting the achievements of women in Europe and to attracting talented professionals, both male and female, to drive forward the work of the European Grid Infrastructure. By supporting thousands of researchers across Europe, EGI is a key part of the Digital Agenda for Europe and will help to increase the economic health of the European Research Area.

The activities of the Gender Action Plan were reported in three deliverables:
- D1.2 https://documents.egi.eu/document/171
- D1.6 https://documents.egi.eu/public/ShowDocument?docid=982
- D1.10 https://documents.egi.eu/document/1270

The project's Gender Action Plan was praised in a position paper on gender policy published by the European Centre for Women and Technology (ECWT)[49]. The policy paper listed EGI as one of the "most active actors in promoting European girls and women's advancement".

D5. Did you carry out specific Gender Equality Actions under the project?
YES

D6. Which of the following actions did you carry out and how effective were they?
[X] - Design and implement an equal opportunity policy [Somehow effective]

D7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?
NO

E - Synergies with Science Education

EGI aims at contributing to the realization of an integrated European network of centres of excellence, for the implementation of the Knowledge Commons, meaning the capability to easily share and access knowledge, training facilities, open source software, and other digital assets necessary for Open Science by federating European training and education programmes. EGI is committed to develop and sustain a training programme for distributed data management and computing suitable to the needs of the long-tail of science, European international research collaborations (e.g. high energy physics, astronomy and astrophysics, computational chemistry and material sciences, earth science, life science, structural biology) and flagship European Research Infrastructures on the ESFRI roadmap including BBMRI, DARIAH, EISCAT-3D, ELIXIR, EPOS, INSTRUCT and LifeWatch. The EGI training programme will be integrated into a single offering to the European Research Area in collaboration with other e-Infrastructures of European relevance: EUDAT and PRACE.

The EGI vision includes the concept of a 'Knowledge Commons' which represents the community knowledge and understanding needed to conduct e-Science, including the needs for data science. The Knowledge commons concept also includes the mechanism for transfer of knowledge. EGI.eu aims at contributing to the realization of an integrated European network of centres of excellence, for the implementation of the Knowledge Commons, meaning the capability to easily share and access knowledge, training facilities, open source software, and other digital assets necessary for Open Science by federating European training and education programmes.
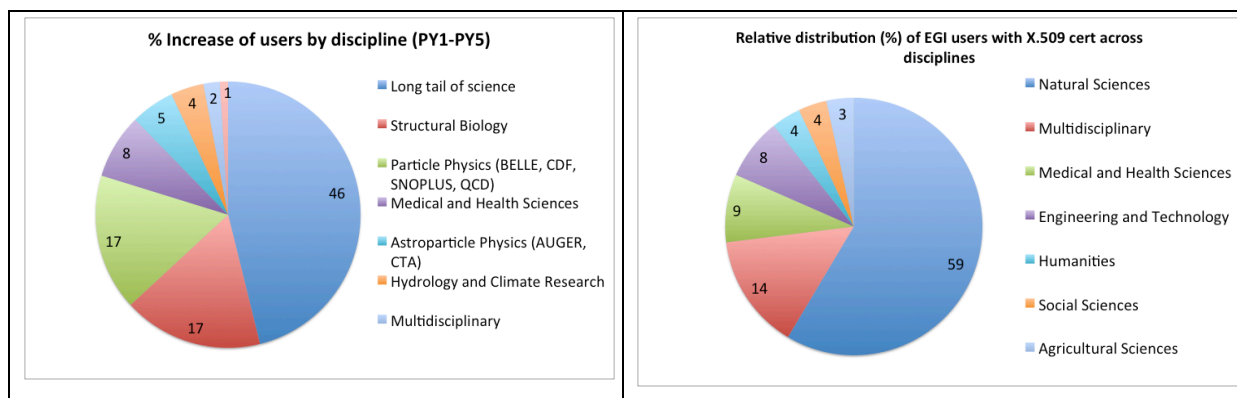
F - Interdisciplinarity

During EGI-InSPIRE we saw an increase in distribution of the number of users across different scientific disciplines, demonstrating the capability to serve a wide spectrum of the ERA. The scientific disciplines backed by the larger user communities are Natural Sciences (59%), Medical and Health Sciences (9%) and Engineering and Technologies (8%) – see Figure 2 (right).

EGI enables international collaborations beyond the boundaries of Europe. The majority of the user communities have members from other regions of the world: Asia Pacific, North and Latin America, and Africa.

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[49] http://www.asszisztencia.hu/ntit/down/Position_Paper_ECWT.pdf

% Increase of users by discipline (PY1-PY5)

- Long tail of science — 46
- Structural Biology — 17
- Particle Physics (BELLE, CDF, SNOPLUS, QCD) — 17
- Medical and Health Sciences — 8
- Astroparticle Physics (AUGER, CTA) — 5
- Hydrology and Climate Research — 4
- Multidisciplinary — 2, 1

Relative distribution (%) of EGI users with X.509 cert across disciplines

- Natural Sciences — 59
- Multidisciplinary — 14
- Medical and Health Sciences — 9
- Engineering and Technology — 8
- Humanities — 4
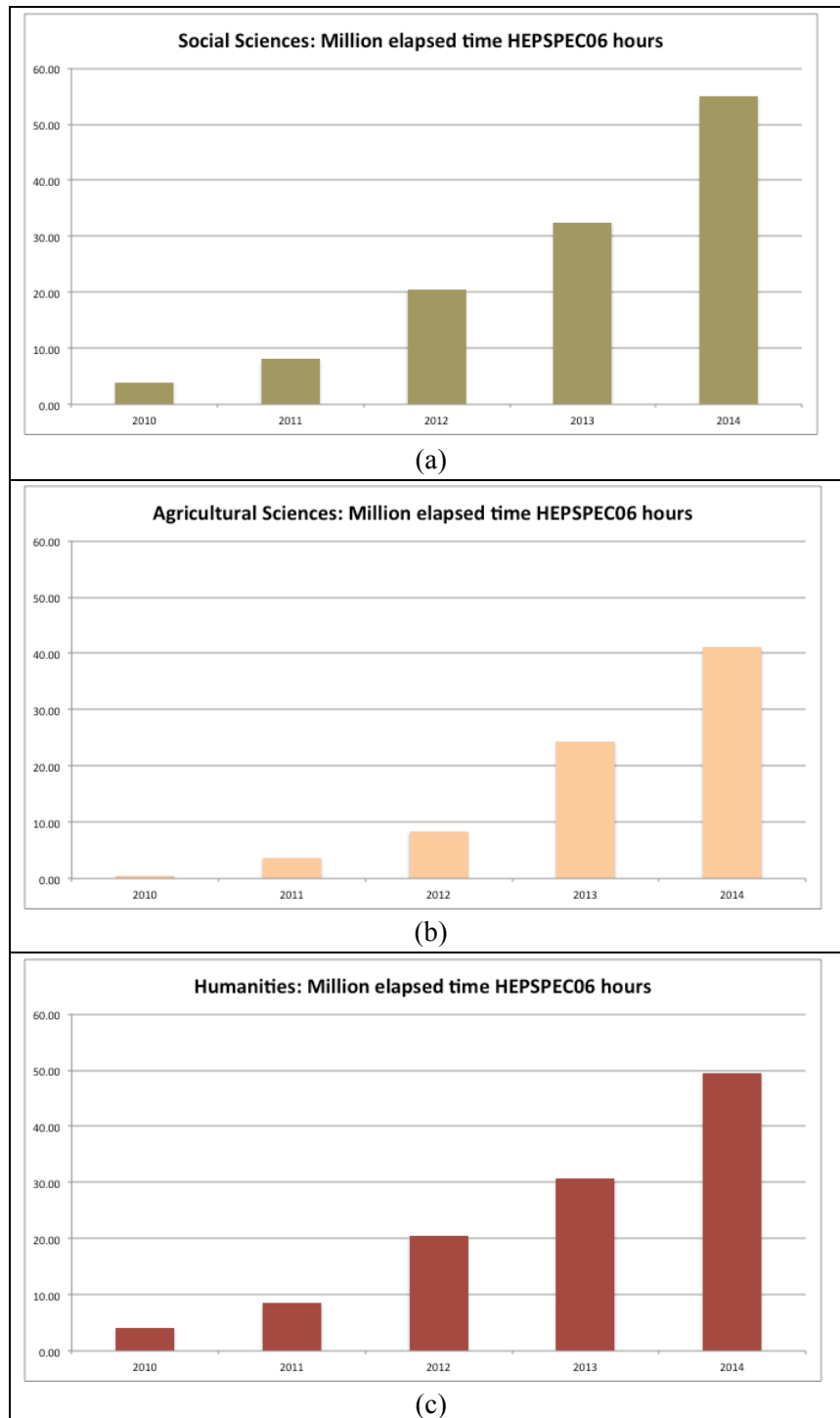- Social Sciences — 4
- Agricultural Sciences — 3

Figure 2. Impact of EGI.eu, NGI and Virtual Research Community engagement activities in the various scientific domains of the ERA: distribution of new users across the disciplines for the period PY1-PY5 (left) and distribution of the user community across the top-level scientific disciplines (right).

The figure above shows the resource usage, grouped by disciplines. Increase in usage has been constant through the years for all disciplines. Sizeable increases in usage in most of the disciplines, with big relative increases in all of the non-physical disciplines. Biological sciences and medical sciences are those that experienced the higher relative increase, stimulated by the outreaching activities in these areas also facilitated by the participation to the BioMedBridges and ENVRI ESFRI cluster projects, and the presence of a well internally organized Virtual Research Community: the "Life Science Grid Community"[50].

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[50] http://www.egi.eu/community/collaborations/LSGC.html

(a)

(b)

(c)
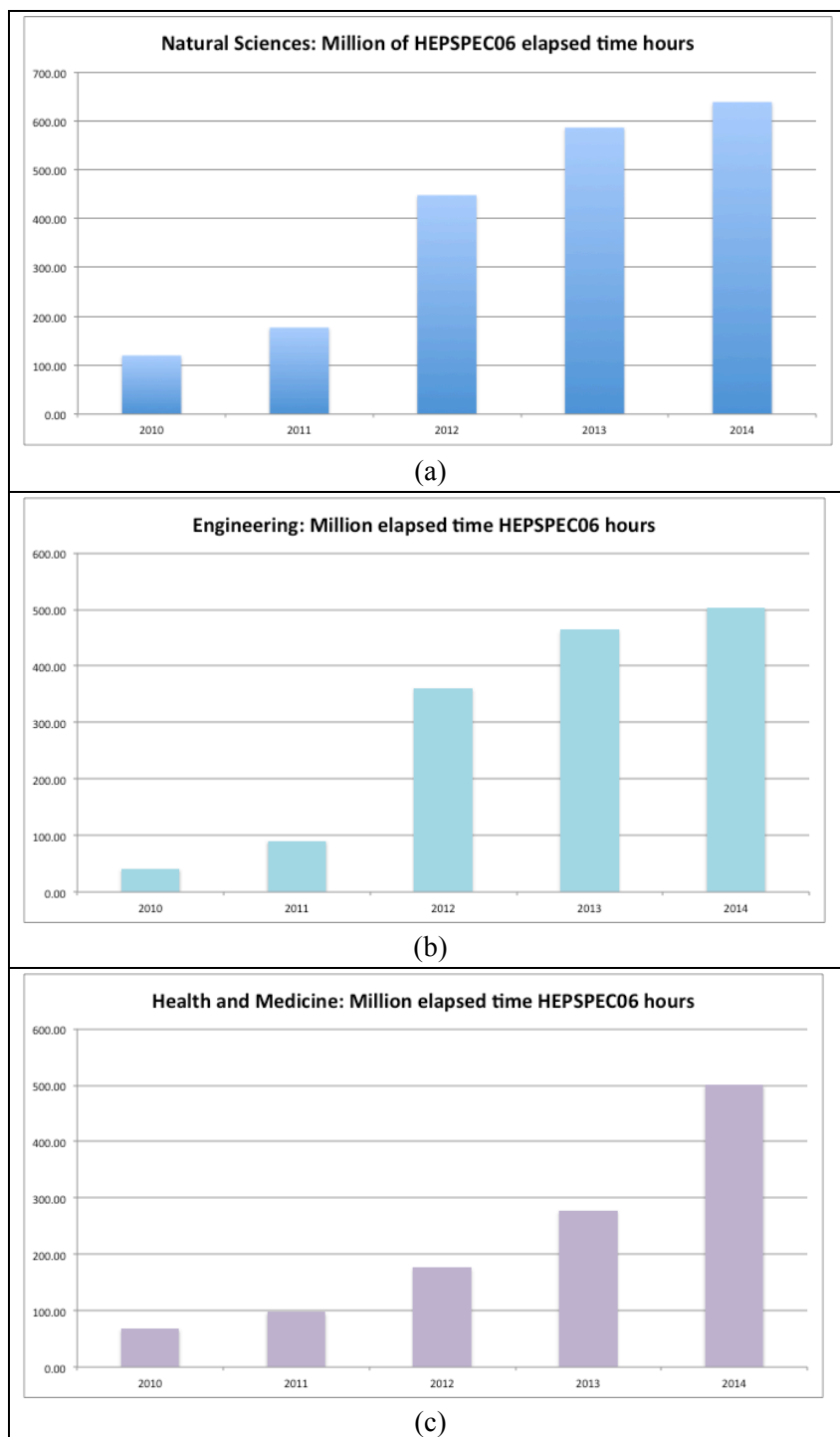
Figure 3. Computing resources usage (HEPSPEC-06 elapsed time Million hours), grouped by discipline: Natural Sciences, Engineering, Health and Medicine.

(a)

(b)

(c)

Figure 4. Computing resources usage (HEPSPEC-06 elapsed time Million hours), grouped by discipline: Social Sciences (a), Agricultural Sciences (b), Humanities (c).

G - Engaging with Civil Society and Policy makers

Policy makers do not have a need for high throughput analysis or operation and production services. However, during the last few years our need for more meaningful communication with policy makers at different levels (European, National, Regional and Local) has risen. Improved communication about the value emerging out of e-infrastructure activities is needed in order for the funding bodies to design the general policy of research at European and at the national level.

Policy makers can also directly benefit from the services provided by EGI Marketing and Outreach, which can became an added value for the e-Infrastructure and the whole EGI collaboration, including NGIs, Resource centres, Technology providers and the supported communities. They can get advantage from an activity that makes aware the society about the use of the funds raised by their taxes, and of the scientific advances achieved and exploited to create innovation, to enhance economic and to boost the market labour, and to tackle the challenges that the modern society has to face now and in the future.

Marketing: Showcases both the strategic value of the infrastructure for research in Europe and its scientific outputs to the general public, policy makers and potential users.

Outreach: Ensures knowledge transfer, promotes use cases to attract new users, and guarantees that existing users make the most of the available tools and services.

H - Use and dissemination

H14. How many Articles were published/accepted for publication in peer-reviewed journals?
1,970

To how many of these is open access provided? Not possible to calculate
How many of these are published in open access journals? Not possible to calculate
How many of these are published in open repositories? Not possible to calculate
To how many of these is open access not provided? Not possible to calculate

H15. How many new patent applications ('priority filings') have been made? ("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).
Does not apply.

H16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).
Does not apply.

H17. How many spin-off companies were created / are planned as a direct result of the project?
Does not apply.

H18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:
[X] None of the above / not relevant to the project

I - Media and Communication to the general public

I20. As part of the project, were any of the beneficiaries professionals in communication or media relations?
NO

I21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?
YES

I22. Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?
[X] Press Release
[X] Coverage in specialist press
[ ] Media briefing
[X] Coverage in general (non-specialist) press
[ ] TV coverage / report
[ ] Coverage in national press
[ ] Radio coverage / report
[ ] Coverage in international press
[X] Brochures /posters / flyers
[X] Website for the general public / internet
[X] DVD /Film /Multimedia
[ ] Event targeting general public (festival, conference, exhibition, science café)

I23 In which languages are the information products for the general public produced?
[ ] Language of the coordinator
[X] English
[ ] Other language(s)

4 FINAL REPORT ON THE DISTRIBUTION OF THE EUROPEAN UNION FINANCIAL CONTRIBUTION

To be provided.