EGI-InSPIRE

EGI SUSTAINABILITY PLAN

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Abstract

The EGI ecosystem involves many different actors like EGI.eu, resource infrastructure providers such as National Grid Initiatives (NGIs) and European Intergovernmental Research Organisations (EIROs), technology providers, virtual research communities and public funding bodies. These actors undertake the provision or consumption of human, infrastructure and technical services within the ecosystem as well as provide essential funding for sustainability. Each of these different services needs to be supported by an appropriate business model. This document presents an updated taxonomy of services and a first outline of potential business models relevant to EGI serving as a basis for future discussion and exploration. This report will also be used to define the context and a set of recommendations for the accounting work taking place in JRA1 Task 1.4, "Accounting for different resource types", starting in project year two.



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II. DELIVERY SLIP

	Name	Partner/Activity	Date
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III. DOCUMENT LOG

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1	25/01/2011	Table of Contents	Steven Newhouse/EGI.eu
2	10/02/2011	First draft of content	Sergio Andreozzi, Sy Holsinger, Damir Marinovic, Steven Newhouse, Tiziana Ferrari/EGI.eu
3	12/02/2011	Revisions and restructures	Sy Holsinger, Damir Marinovic, Steven Newhouse/EGI.eu
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13	22/03/2011	Revised version for PMB review	Sergio Andreozzi, Sy Holsinger/EGI.eu

IV. APPLICATION AREA

This document is a formal deliverable for the European Commission, applicable to all members of the EGI-InSPIRE project, beneficiaries and JRU 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/.

VII. PROJECT SUMMARY

To support science and innovation, a lasting operational model for e-Science is needed – both for coordinating the infrastructure and for delivering integrated services that cross national borders. The EGI-InSPIRE project will support the transition from a project-based system to a sustainable pan-European e-Infrastructure, by supporting 'grids' of high-performance computing (HPC) and high-throughput computing (HTC) resources. EGI-InSPIRE will also be ideally placed to integrate new Distributed Computing Infrastructures (DCIs) such as clouds, supercomputing networks and desktop grids, to benefit user communities within the European Research Area.

EGI-InSPIRE will collect user requirements and provide support for the current and potential new user communities, for example within the ESFRI projects. Additional support will also be given to the current heavy users of the infrastructure, such as high energy physics, computational chemistry and life sciences, as they move their critical services and tools from a centralised support model to one driven by their own individual communities.

The objectives of the project are:

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.
2. The continued support of researchers within Europe and their international collaborators that are using the current production infrastructure.
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.
4. Interfaces that expand access to new user communities including new potential heavy users of the infrastructure from the ESFRI projects.
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.
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 infrastructure as they mature and demonstrate value to the EGI community.

The EGI community is a federation of independent national and community resource providers, whose resources support specific research communities and international collaborators both within Europe and worldwide. EGI.eu, coordinator of EGI-InSPIRE, brings together partner institutions established within the community to provide a set of essential human and technical services that enable secure integrated access to distributed resources on behalf of the community. The production infrastructure supports Virtual Research Communities (VRCs) – structured international user communities – that are grouped into specific research domains. VRCs are formally represented within EGI at both a technical and strategic level.

VIII. EXECUTIVE SUMMARY

The EGI ecosystem is a complex web of many different actors, from EGI.eu as a coordinating body to resource infrastructure providers such as National Grid Initiatives (NGIs) and European Intergovernmental Research Organisations (EIROs), technology providers, virtual research communities and public funding bodies. These actors undertake the provision or consumption of human, infrastructure and technical services within the ecosystem. However, coordinating and maintaining a quality infrastructure costs time and money. As a result, sustainability becomes the biggest factor not only from a technical perspective, but most importantly, from a financial perspective.

The European Commission has invested heavily in e-Infrastructures over the past decade, which is now being matched if not exceeded on a national level. The importance of these e-Infrastructures to the communities that use them have grown to the point where they are now essential for their daily work. It is therefore necessary that the discussions started in the EGI_DS project continue in order that all the stakeholders within the EGI ecosystem can collectively ensure its existence for years to come.

As a result, this document provides an updated taxonomy of services and a first outline of potential business models relevant to EGI serving as a basis for future discussion and exploration. The report defines the EGI ecosystem and presents a comprehensive list of provided on-going activities and services covering EGI Global Tasks, NGI International Tasks, Virtual Research Communities, External Resource Providers and Technology Providers broken down by human, infrastructure and technical services. Long-term, each of these different services needs to be supported by an appropriate business model. Therefore, a number of business models have been identified defining sources of revenue and support through fixed fee-based and usage-based models, free to use models, in-kind effort sources and public funding.

The report concludes by matching the defined business models to services provided within the ecosystem and outlines a set of recommendations and next steps moving forward.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1 INTRODUCTION

The main goal of the EGI-InSPIRE project is to support the establishment of a sustainable federated e-Infrastructure to meet the needs of researchers across Europe. The basis of the EGI model is to recognise that the services needed to establish such an environment are varied (human, technical and infrastructure) and that they need to be provided at many places in the infrastructure (e.g. a coordinating service used by all, services provided by the resource infrastructure providers, services by the individual resource centres, etc.). All of these services and their providers need to be sustainably supported in the future through appropriate business models in order for the consumers of these services, the users and operations communities to have confidence in adopting these services for the long-term.

At the heart of the EGI model is a new organisation, EGI.eu, which is dedicated to the coordination of the European Grid Infrastructure, supporting the National Grid Initiatives (NGIs) and European Intergovernmental Research Organisations (EIROs) who need to deliver coordinated trans-national access to their resources in order to support the collaborative research of their own communities. On behalf of the community, EGI.eu provides directly many of the coordinating services used by all participants in EGI, or coordinates their provision through technical expertise in the community. Sustaining these coordinating services and those provided by the participants of EGI.eu (e.g. NGIs and EIROs) is essential in ensuring that EGI as a whole is sustainable. Therefore, it is a fundamental next step to provide a list of services offered within the EGI ecosystem and systematically identify the relevance of each and through what channels will they be sustained both from an effort and economical standpoint.

2 EGI ECOSYSTEM

The EGI ecosystem is defined as a set of interdependent organisations or groups that interact to produce or consume services within the European Grid Infrastructure to form an integrated whole. The ecosystem comprises EGI.eu as the central coordination body, the participants within EGI such as NGIs and EIROs, Technology Providers, User Communities and the European Commission. These elements are highly interconnected and interdependent, and performs well only when it is given legitimacy from all activities (***Figure 1***).

The EGI ecosystem was first described in the EGI_DS project [R1] with its initial implementation started during the EGEE-III project [R21] and continuing its evolution in EGI-InSPIRE. In order to make the transition towards a sustainable ecosystem, the current EGI ecosystem community is supported by the European Commission and its partners in the EGI-InSPIRE project. One of the objectives of the EGI sustainability plan is to identify which components should be funded directly through national or European level funding mechanisms and what components could be supported by a mixture of fees and service charges.

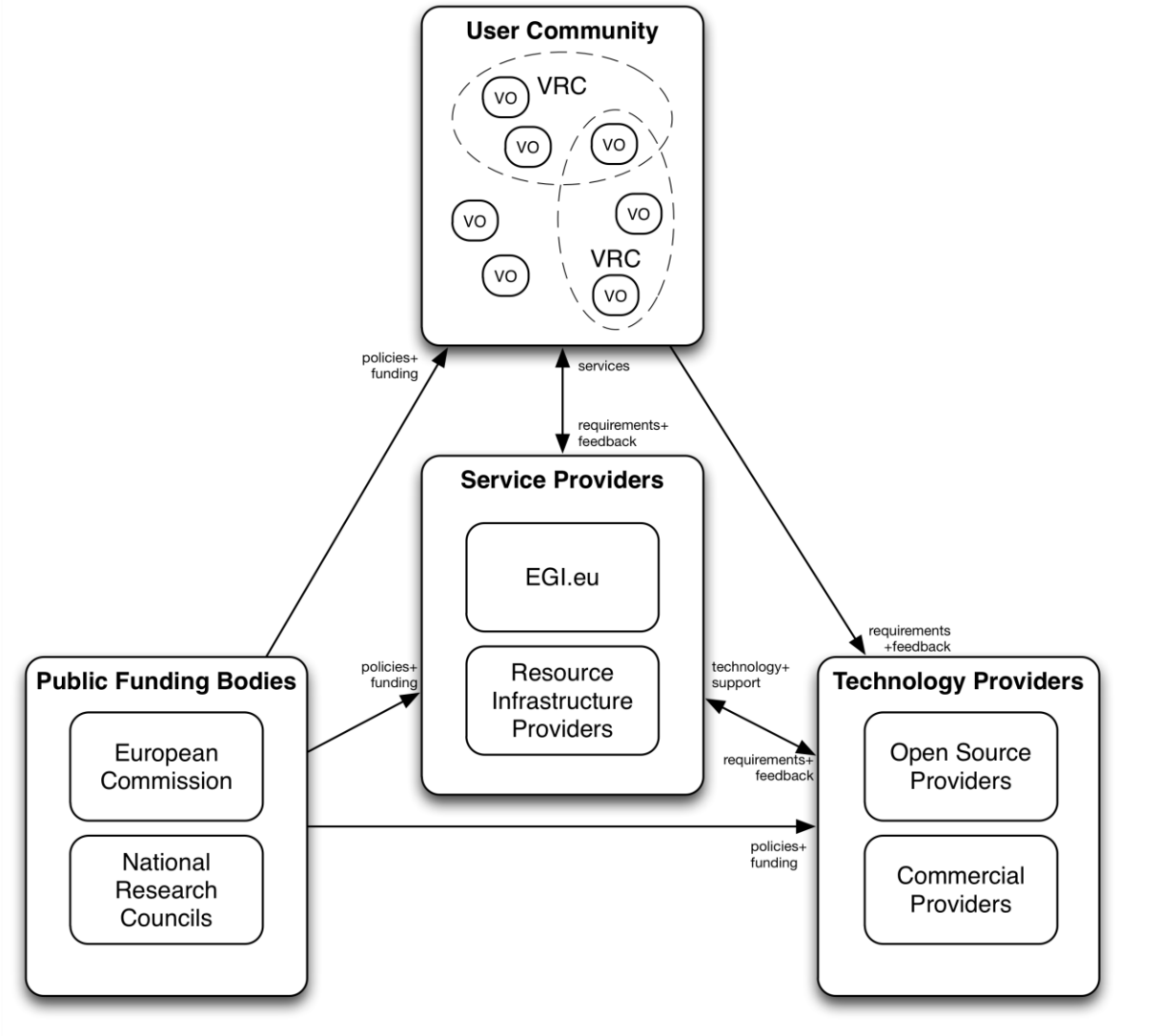

Figure 1 - EGI Ecosystem

Like any other ecosystem, the EGI ecosystem is in constant flux. As the interaction between the different elements in the ecosystem stabilises, the components that need to be sustained and the business models that could be used to support these components and services become clearer. The various components of the ecosystem are further defined in the following sections.

2.1 User Community

2.1.1 Virtual Organisations

Users of the EGI e-Infrastructure who need to formally share resources are organised into virtual organisations (VOs). A VO can be defined as a group of people (scientists, application developers, trainers, etc.) with common interests and requirements, which need to work collaboratively with other members of their collaboration and/or share resources (e.g. data, software, expertise, CPU, storage space) regardless of geographical location. A VO is therefore defined by a collection of rules and policies that govern the access and security rights for the users, resources and data in question.

EGI currently hosts more than 200 VOs for communities with interests as diverse as Earth Sciences, Computer Sciences and Mathematics, Fusion, Life Sciences or High-Energy Physics. The full list of registered VOs at any one time can be obtained from the Operations Portal [R12]. Due to the large number of VO's within EGI, representation is driven through the virtual resource community (VRC) model or representation through the NGIs, therefore, it is important that VOs are affiliated to a VRC (See next section). Aggregating VOs with similar scientific interests or use of EGI (e.g. in terms of usage) provides a much more sustainable route forward for communities as a whole to define areas of interest and a collaboration with other groups across Europe (and beyond) in their discipline and the use of e-infrastructure.

2.1.2 Virtual Research Communities

Large-scale scientific research projects are no longer being conducted within a single research group, single institutions or even in a single country, but in VRCs (i.e. large organised research collaborations) that span national borders encompassing many different organisations with a need to share ICT resources. These VRCs have their own internal structures and coordination activities that EGI seeks to leverage to scale out its interactions with user communities. It is noted that different VRCs will have different structures, and the EGI model is able to adapt to deal with this [R33]. The VRC model allows a community to have bi-directional interactions through defined points of contact with EGI across many areas.

- VRCs can access computing, data storage and other types of resources made available by EGI stakeholders through their affiliated Virtual Organisations (VOs).
- VRCs can securely integrate their own community's resources into EGI in order for them to be accessed by remote users from their community's own VOs.
- VRCs can provide their own dedicated support units and services (e.g. training, application porting, consultancy, etc.) through the EGI Helpdesk using it a single point of contact to access their own and other operational and user support services provided through the NGIs and EIROs.

- VRCs can establish their own VOs – collections of hardware, software and human resources – configured to share capacities, to collaborate with partners and to run data intensive simulations. The VOs can benefit from the resources provided by NGIs and other VRCs.
- VRCs can influence the evolution of EGI's services through representation in the User Community Board and the User Services Advisory Group. Based on requirements collected from its members, VRCs can advise EGI on its planning and operational priorities.

2.2 Service Providers

2.2.1 EGI.eu

Through the EGI_DS project, the EGI stakeholders decided to establish a dedicated central coordinating organisation. EGI.eu is a private legal entity defined by statutes and terms of reference [R3] operating as a Dutch foundation on a non-profit basis with Participants and Associated Participants. Participants can only be eligible NGIs[1]. Associated Participants can be EIROs, non-eligible NGIs and other organisations that contribute to the objective of the foundation. In order to become a member, Participants and Associated Participants have to be admitted by the Executive Board after approval of the Council.

The organisation's budget comprises financial contributions provided by the Participants and Associated Participants. Some of the organisation's activities may be supported by payments from the European Commission towards contracted project activities. Liability is limited since each of the Participants is fully liable only for their own activities within the foundation.

The foundation has the full autonomy and flexibility when it comes to the governance of the organisation. The EGI Council is the primary decision-making and supervisory authority that provides strategic decisions and determines the general direction to be undertaken by the organisation. It consists of one representative from each Participant and Associated Participant. The EGI Council and EGI.eu Executive Board have a common chair who is elected by the EGI Council. The Council meets at least twice a year to approve the budget for the next year and the accounts and auditor's report from the previous year. The EGI Council's voting power is distributed according to the member's financial contributions and the decisions are normally adopted by an ordinary majority, unless specified in the statutes that a qualified majority vote (two-thirds of votes) is needed.

The EGI.eu Director, who is advised by the Executive Board, manages the day-to-day coordination of EGI.eu. Technical activity across EGI's three main areas – Operations, User Community and Technology – is managed through dedicated boards containing representatives from the relevant stakeholders in each of these areas (Operations Management Board - OMB, User Community Board - UCB, Technology Coordination Board - TCB).

[1] *"Eligible NGI is a National Grid Initiative from a Member State of the European Union (EU) or from an Associated Country to the EU; an Associated Country is a country, in which legal entities are eligible for EU framework programme funding on the same as legal entities from the Member States" [R3]*

2.2.2 Resource Infrastructure Providers

From the infrastructure viewpoint, the smallest resource administration domain in EGI is called a "resource centre". It can be either held in one location or geographically distributed across multiple regions or countries (e.g. Nordic Data Grid Facility [R28]), providing resources and the functional capabilities necessary to make those resources accessible to authorised users. Resource centres federate together into a "resource infrastructure provider" that is a legal organisation responsible of establishing, managing, and operating directly or indirectly the operational services to an agreed level of quality needed by the resource centres themselves and the user community. Each resource infrastructure provider holds the responsibility of integrating them in EGI through the coordination of EGI.eu to enable uniform resource access and sharing for the benefit of their consuming end-users. There are three categories of resource infrastructure providers:

- Participants in EGI.eu - the European Intergovernmental Research Organisations (EIROs) and the National Grid Initiatives (NGIs).
- Providers outside of EGI.eu (generally non-European NGIs) with whom EGI needs to sign MoUs to commit to the operational principles as the participants of EGI.eu.
- Commercial providers, foreseen as a collaborative possibility as EGI moves towards new DCI technologies such as virtualised resources.

Further information can be found in D4.1 - EGI Operations Architecture [R2].

2.3 Public Funding Bodies

The e-Infrastructure community has been the recipient of significant public funds over the last decade, at both European and National levels. As a result of this funding, a community has been established across Europe and supports a production infrastructure that provides data and computing capability to many multi-disciplinary user communities. However, public policies are evolving from the evaluation of results over the years and are aligned with new long-term visions. In order for EGI to participate and contribute to the implementation of policies for the research community, it is important to continuously bridge the gap between user priorities and EU and National social-economic impact objectives. As a result, it opens opportunities through enabling continuous innovation and evolution of EGI's technological architecture providing access to public funding streams.

Public funds enter into the organisations active in the EGI ecosystem through direct funding or indirectly through projects funding specific activity under contract. For instance, at the European level, the EGI-InSPIRE project brings together many of the participants in EGI.eu and provides support to the development of EGI during the first four years of its existence as it transitions towards sustainability. The programme of work within EGI-InSPIRE helps to establish EGI by committing the partners within the project to also work together by supporting the persistent structures within EGI that will remain after the project is complete.

2.3.1 The European Commission

The EGI-InSPIRE project is supported by the European Commission (EC) as part of the Seventh Framework Programme (FP7) in order to help the EGI community make the transition towards a sustainable ecosystem. This support has been available to the e-Infrastructure community in this and



previous Framework Programmes and has been closely aligned with the objectives of FP7. This has been shown in areas such as strengthening Europe's scientific and technology base and ensuring its global leadership in ICT, stimulating research, innovation and creativity through ICT use and ensuring that ICT progress directly benefits European citizens, economy and governments.

Through this support, the EC is not only financially supporting the EGI ecosystem through EGI-InSPIRE project, it is also strongly influencing the strategic and policy priorities set up by the EGI community. Therefore, the EGI community must be aware of the strategic initiatives coming from the EC in order to fully exploit emerging opportunities for financial support that the EC can offer to the EGI ecosystem. One organisational aspect that needs to be considered in this context is the additional funding opportunities that may be associated with the ERIC legal framework [R20].

Overall, if the EGI's strategic policy responses do not mirror EC expectations and their priorities, then it is possible that future European funding streams may be significantly reduced. In the next decade, it appears that the challenges identified in the Europe 2020 Strategy [R14] will drive the funding priorities in FP8 providing the greatest funding opportunities for the EGI ecosystem. Therefore, it is essential that EGI.eu continue to actively engage in the EU policy setting process and seek recognition from the EU for the central role it plays, which will have a direct impact on sustainability.

2.3.2 National Research Councils

Many National Grid Initiatives are supported primarily by their national research councils to deliver a service to their national research communities as part of a strategy to deliver innovative technology and economic growth. The financial crisis that is being experienced in Europe is having an impact on national funding objectives varying from significant reductions in science budgets, reduction in staff salaries in the public sector, freezing of international subscriptions, or withdrawal from international projects. However, funding of these activities are expected to continue, even if under reduced budgets, but with an increased demand of value for money.

2.4 Technology Providers

The EGI ecosystem encompasses technology providers as important stakeholders [R15]. Technology providers offer technology ready for deployment into the production infrastructure that satisfies the needs of its user communities – the end-users and operations staff. The availability of technology able to meet these needs from diverse sources – either from the mainstream open-source community, the open-source development community within EGI or commercial providers – is vital for the long-term sustainability of EGI.

EGI has to provide a technical infrastructure that needs to satisfy many stakeholders. From the technological perspective, the most important class of stakeholders are the VRCs and other end-user communities. These communities have many different approaches to using the infrastructure and different technologies are needed for federating the distributed resources provided by the collaborating resource providers in order to support these end-user communities.

There are two categories of technology providers: community supported international collaborations



that are based on open-source software and commercial providers based on proprietary software. More diversity allows the EGI to be technology neutral and to respond to the needs of its users – both the researchers using the infrastructure and the operations staff providing it – by selecting the best available technology for delivering the capabilities that are required.

At this moment the most relevant technological providers for the EGI technological infrastructure are EU funded open-source providers: The European Middleware Initiative (EMI) [R16], the Initiative for Globus in Europe (IGE) [R17] and StratusLab [R18]. The second category of technology providers are commercial providers based on proprietary software, like for example VMware or Platform Computing.

EGI needs to support the inclusion of new technology providers wishing to have their components considered into the technological architecture. Thus, in order to have sustainable EGI ecosystem, EGI needs to enable continuous innovation and evolution of EGI's technological architecture by gradual integration of Grid, Desktop, Virtualisation and Cloud technologies [R7].

3 ECOSYSTEM ACTIVITY

As the previous section identified several different organisations and groups that make up the EGI ecosystem, it is essential to also clearly define the set of services EGI provides and how it meets the needs of its users, ultimately leading to the identification of how the required activities can then be sustained.

This section identifies the work undertaken by the different organisations and the interactions they have with other components of the ecosystem. The activity in this ecosystem will evolve and change over time, and part of EGI.eu's role within the community is to provide mechanisms to identify and manage that change. The following services will continue to be defined, developed and refined during the course of the EGI-InSPIRE project as requirements, technology and the community change. Different mechanisms of funding may need to be identified for implementing change (e.g. through a new specific project to redevelop a service) as opposed to routine operation and development. Identifying, capturing and prioritising the needs of the community in order to change these services is an important service in its own right.

Within the following categories, the services are grouped as follows: 'Human Services' for coordination and community building; 'Infrastructure Services' for properly running and monitoring the infrastructure; 'Technical Services' for supporting the collaboration and interaction of the user, operations and technology communities.

3.1 EGI Global Tasks

The EGI Global tasks are technically coordinated and the responsibility of EGI.eu and are provided by the participants and associated participants institutions funded through EGI.eu, the NGIs and the EC through the EGI-InSPIRE project for the benefit and use of all.

3.1.1 Human Services

- **Governance** - The strategic direction of the EGI ecosystem and the collaboration between the individual activities is undertaken by the EGI Council. It also acts as the senior decision-making and supervisory authority of EGI.eu and as the organisation representing the EGI collaboration. The technical governance is delegated to a number of groups authorized by the EGI.eu Council through the EGI.eu Executive Board, which serve as the governing bodies of the groups. Each group follows and individually defined Terms of Reference.
    - *The User Community Board (UCB)* is a forum whereby representatives from self-organised virtual research communities (VRCs) meet to review and agree on the prioritisation of the emerging requirements for their use of EGI resources on a regular basis. The VRC model encourages researchers to identify and communicate with others in their field in order to capture the needs particular to their field of expertise and articulate them to EGI [R30].
    - *The Operations Management Board (OMB)* drives future developments in the operations area by making sure that the infrastructure operations evolve to meet the needs of the users and the resource centres and support the integration of new resources such as desktop grids, cloud computing and virtualisation, and high

performance computing resources. It does this by providing management and developing policies and procedures for the operational services that are integrated into the production infrastructure. The OMB is led by EGI.eu and comprises managers and leaders from NGIs and EGI global operational tasks [R31].

- *The Technical Coordination Board (TCB)* coordinates the interactions that EGI has with its technology providers. This involves combining the prioritised requirements from the operations and end-user communities into a technology roadmap. Elements from this roadmap are sourced from technology providers within the EGI community into the Unified Middleware Distribution (UMD). Before their inclusion into UMD these components are verified against the original requirements to ensure that these have been met [R32].

- **Administration** - An organisation needs a secretariat to support its governance functions, but also to support the community and the staff it employs. Within EGI.eu support is provided during Council and Executive Boards meetings, community support is provided through a range of IT services to local staff and to the collaboration (e.g. website, wiki, meeting planner, mailing lists, document server, timesheet tool). In addition the community organises two large meetings a year (the User and Technical Forums) to continue the building collaborations within EGI and a number of additional workshops as required to support the community's activities.
- **Technical Management** - A concentrated management effort is essential to guarantee a harmonious and coordinated implementation of the strategic policies approved by the governance bodies. Operations, Technology and User Community Managers have both reactive (dealing with the daily technical decisions needed to run a complex organisation) and a proactive managerial role (in identifying issues that need to be brought to the relevant management bodies). They provide technical direction and leadership to the staff within EGI.eu and those in the community engaged in the activity to ensure the proper definition and implementation of a professionally managed infrastructure.
- **Policy Development** - This activity is led by the EGI.eu Policy Development Team (PDT) and encompasses a number of important tasks. These include supporting the boards such as the UCB, OMB and TCB and other committees within EGI that draft policies and define procedures for evolving the technical infrastructure, for its operation and for access by the various user communities. Policy development includes the definition and implementation of the approval process of policies and procedures within EGI. It also includes the formulation and development of position papers, by gathering and elaborating material, to inform the EGI management bodies and the EGI community about the opportunities for aligning with strategic-level policies or for supporting a decision-making process. They also support the negotiation and monitoring of agreements via Memorandum of Understandings with external partners (specifically, technology providers, resource infrastructure providers and virtual research communities). The policy development team takes care of establishing and maintaining communications channels with policy makers from EGI.eu participants in order to fluently propagate policy-oriented information within the consortium.
- **Dissemination** - This activity is coordinated by EGI.eu on behalf of the European NGIs and projects, and other international partners. The aim is to communicate the work of the EGI and its user communities and target audiences for the dissemination outputs to new and

existing user communities, journalists, general public, grid research and standards communities, resource providers, collaborating projects, decision makers and governmental representatives. Means for dissemination include the project website, wiki site, materials and publications, media and public relations, social media channels and attendance at events in order to market EGI to new users.

- **Technology Roadmaps** - Maintaining the technology roadmap for EGI requires the collection, prioritisation and analysis of requirements from the user and operations communities. From these requirements, new features are sourced from technology providers currently known to EGI, or from open-source or commercial technology providers. Components coming from within the EGI community, in order to provide bespoke functionality needed within the production infrastructure that cannot be sourced elsewhere, are captured within the UMD Roadmap. This evolving document translates users requirements and technology evolution into a roadmap describing the functional aspects, release dates, maintenance support, acceptance criteria and dependencies for software components that are offered to the Resource Infrastructure Providers for installation.
- **User & Community Support** - The EGI.eu User Community Support Team (UCST) coordinates the work of the NGI User Support Teams around Europe. Much of the work focuses on an efficient information flow between the user communities and the NGIs and other EGI partners that provide the sites and resources that comprise EGI. The team drives coordination of the user community activities, the requirements collection and analysis, and the management of the user community technical services.
- **Operations Support** - EGI.eu coordinates and supervises operations and network support activities provided by the individual NGIs to ensure that operational issues are properly handled at both Resource Centre and NGI level. It is also responsible of handling of Resource Centre suspension in case of operational issues.
- **Ticket Process Management** - Through the EGI helpdesk [R22] support issues are routed through to support teams. Some of these requests may be related to specific support units but others issues relating to users' use of the e-infrastructure will require human intervention either from an operational or user support aspect.
- **Requirements Gathering** - A transparent requirements processing system is needed to offer a system where the user or operations community can provide requirements, or share them within the whole EGI community. All of these requirements are investigated, analysed and prioritised within a transparent and structured process. The prioritised requirements can then be acted upon by other parties as appropriate. Depending on the domain and potential impact, identified needs might be met by the User Support Teams or Operations within EGI or by technology providers external to EGI be they community-based, project-based or commercial. The progress and outcomes of whichever solutions are adopted will be fed back to the requesting community on a regular basis.
- **Coordination of development and maintenance of documentation** - Interoperation of operational activities relies on the development and adoption of common procedures and manuals, and on the availability of documentation in the form of best practices and FAQs. EGI.eu is responsible of coordinating this community effort.

- **Security** - Security vulnerabilities and risks presented by e-Infrastructures provide a rationale for coordination amongst the EGI participants at various levels. Central coordination groups ensure policies, operational security, and maintenance to guarantee secure access to users. In addition, security and incident response is provided through the EGI Computer Security and Incident Response Team by coordinating activities at the sites across the infrastructure. This coordination ensures that common policies are followed by providing services such as security monitoring, training and dissemination with the goal of improving the response to incidents.

3.1.2 Infrastructure Services

- **Software Rollout** - Updates of deployed software need to be gradually adopted in production after internal verification. This process is implemented in EGI through staged rollout, i.e. through the early deployment of a new component by a selected list of candidate Resource Centres. The successful verification of a new component is a precondition for declaring the software ready for deployment. Given the scale of the EGI infrastructure, this process requires careful coordination to ensure that every new capability is verified by a representative pool of candidate sites, to supervise the responsiveness of the candidate sites and ensure that the staged rollout progresses well without introducing unnecessary delays, and to review the reports produced. It also ensures the planning of resources according to the foreseen release schedules from the Technology Providers. EGI.eu coordination is necessary to ensure a successful interoperation of the various stakeholders: Resource Centres, Technology Providers, the EGI.eu Technical Manager and the EGI repository managers.
- **Monitoring** - A distributed monitoring framework is necessary to continuously test the level of functionality delivered by each service node instance in the production Resource Centres, to generate alarms and tickets in case of critical failures and to compute monthly availability and reliability statistics, and to monitor and troubleshoot network problems. The Monitoring Infrastructure is a distributed service based on Nagios [R23] and messaging. The central services include systems such as the MyEGI portal [R29] for the visualisation of information, and a set of databases for the persistent storage of information about test results, availability statistics, monitoring profiles and aggregated topology information. The central services need to interact with the local monitoring infrastructures operated by the NGIs. The central monitoring services are critical and need to deliver high availability.
- **Accounting** - The EGI Accounting Infrastructure is distributed and consists of different systems used at the NGI level. At a central level it includes the repositories for the persistent storage of usage records, and a portal for the visualisation of accounting information. The central databases are populated through individual usage records published by the Resource Centres, or through the publication of summarised usage records. The Accounting Infrastructure is essential in a service-oriented business model to record usage information. Accounting data needs to be validated and regularly published centrally.
- **Security** - The objective of a Security Infrastructure is to protect itself from intrusions such as exploitable software vulnerabilities, misuse by authorised users, resource "theft", etc., while allowing the information, resources and services to remain accessible and productive to its intended users. Through the coordination groups previously mentioned, a specifically

designed set of tools and services help reduce these vulnerabilities. These tools and services comprise monitoring individual resource centres (based on Nagios and Pakiti [R24]), a central security dashboard to allow sites, NGIs and EGI Computer Security Incident Response Teams to access security alerts in a controlled manner, and a ticketing system to support coordination efforts.

- **Configuration repository** - EGI relies on a central database (GOCDB) to record static information about different entities such as the Resource Centres, NGIs and service instances. It also provides contact, role and status information. GOCDB is a source of information for many other operational tools, such as the broadcast tool, the aggregated topology provider, etc. [R25; R26] It is foreseen that the GOCDB from a centralised model to a distributed one (by regions).
- **Operations portal** - EGI.eu provides a central portal that offers a bundle of different capabilities for the operations community and VO managers, such as the broadcast tool, VO management facilities, and a dashboard for grid operators that is used to display information about failing monitoring probes and to open tickets to the Resource Centres affected. The dashboard also supports the central grid oversight activities. It is fully interfaced with the EGI Helpdesk and the monitoring system through the message passing. It is a critical component as it is used by all EGI Operations Centres to provide support to the respective Resource Centres [R27].
- **EGI Helpdesk** – EGI.eu provides the central helpdesk as 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 (for example, those opened locally can be passed to the central instance or other areas, while user and operational problem tickets can be open centrally and subsequently routed to the NGI local support infrastructures).
- **Metrics portal** - This central portal provides easy access to the key performance indicators of the production infrastructure for various stakeholders in the ecosystem such as the NGIs, VRCs, VOs and EGI.eu.
- **Core services** - Auxiliary core services are needed for the good running of Infrastructure Services. Examples of such services are VOMS service and VO membership management for infrastructural VOs (DTEAM, OPS), the provisioning of middleware services needed by the monitoring infrastructure (e.g. top-BDII and WMS), the catch-all CA and other catch-all core services to support small user communities (central catalogues, workflow schedulers, authentication services).

3.1.3 Technical Services

- **VO Services** - The technical instantiation of a user community within the infrastructure is a VO. Members of Virtual Resource Communities are provided by various technical services to collect availability, accounting and monitoring information about their VOs. The VO Services group within EGI.eu currently provides a basic, Nagios-based, VO-specific testing and monitoring system for VRCs and is extending this service with additional components and capabilities as the communities' needs evolve. The team also evaluates other VO services producing white papers and manuals for VRCs who wish to operate such services themselves.

- **Software Acceptance Criteria** – Based on the prioritised requirements obtained from the operations and end-user communities, software acceptance criteria are defined to capture the key functional and non-functional features expected from the delivered technologies.
- **Software Validation -** Before new technology releases to EGI are made available for staged rollout, they are assessed to ensure that they meet the original requirements. This verification takes place by deploying and assessing the software against the publicly published criteria.
- **Software Repository** – The software repository provides the coordination needed by EGI for the release of software (UMD) into production. It manages the workflow as the software components are released by the technology provider, validates them to ensure they meet the defined quality criteria and moves them into the repository for subsequent staged rollout.
- **Application Database (AppDB)** - The EGI Applications Database stores tailor-made computing tools for scientists to use. It embraces all scientific fields, from resources to simulate exotic excitation modes in physics, to applications for complex protein sequences analysis. Storing pre-made applications and tools means that scientists do not have to spend research time developing their own software. The goal for AppDB is twofold: 1) to inspire scientists less familiar with programming to use EGI and its resources due to the immediate availability of the software that they need to use; 2) to avoid duplication of effort across the user community.
- **Training Services** - The training services are aimed at supporting cooperation between trainers and users in different localities by connecting the groups through the activities that are established within the NGIs and scientific clusters. The goal is to enable users to achieve better scientific performance when using EGI and guide the establishment of self-sustainable user communities. Among the provided services include training events list, which allows trainers to advertise their training events and to be made aware of other training events being run within the community, a repository of training materials, and a trainers profile database, which holds information about trainers across the EGI area.

3.2 NGI International Tasks

The NGI International Tasks are the responsibility of the individual NGI to deliver the task to a satisfactory level, funded through the NGI's own budget with currently a contribution from the EC through the EGI-InSPIRE project. Staff in EGI.eu is there to coordinate the staff undertaking the NGI International Tasks – they have no managerial control over them.

3.2.1 Human Services

- **Requirements Gathering** - While new requirements are gathered centrally, the collection of new requirements starts in the NGIs and EIROs. They have the contacts with the users and operations staff that are using or operating the EGI resources on a daily basis and can identify issues that need to be resolved.
- **Application Database** - The application database provides a mechanism for users to discover which applications are in use, or are being ported to use the production infrastructure. NGI staff has a vital role to play in adding new entries and keeping entries up to date as they work with their respective user communities.

- **Training** - Many NGIs are able to provide generic or specific training courses to help user communities use EGI resources. The training services (calendar, register of trainers and digital library) provide a means of enabling the coordination that NGIs need to do locally in collaboration with other NGIs to support particular user communities.
- **Consultancy** - The staff within NGIs represent an excellent source of local expertise for new users or new sites wishing to make use of e-Infrastructure. This expertise can be disseminated through training, but more frequently requires in depth one on one work with particular applications or user groups.
- **Policy Development** - Local policy development activities are integrated with those taking place within the EGI.eu Policy Development Team that supports the development of policies and procedures at a European level. It is the local partner who implements policies and procedures locally. Therefore, most of the NGIs responsibilities include implementing EGI policies and procedures, developing EGI policies and procedures by participation in EGI policy groups, communicating with national governments and national research councils about policy priorities for the DCIs, establishing agreements with Resource centres, and drafting national policies and procedures that are in alignment with EGI ones.
- **Operations Coordination** - NGIs are responsible for coordinating internal operational activities and to participate in operation boards such as the OMB, OTAG for coordination at the EGI level, various operation task forces as well as attend weekly meetings.
- **Operations Support** – NGIs provide operations and network support to the local Resource Centres to help local administrators to handle software deployment problems encountered in their day-to-day activities.
- **Documentation** – NGIs contribute with their knowhow to the maintenance and development of operational documentation, best practices and procedures.
- **Security** - NGIs contribute to software vulnerability assessment and to internal Computer Security Incident Response activities.
- **Dissemination** - NGIs promote their work and that of EGI to their local national audiences [R13]. Therefore, while the external liaison functions at a European level are coordinated by EGI.eu, NGIs are focused on dissemination and liaison at the regional and national level. NGIs also provide EGI representation at local and regional events. NGIs active on the international front are considered to represent themselves, but are of course free to propose coordination of any international activities with EGI.eu. NGIs report news stories and interesting user community events in their local area to the central EGI.eu team for further dissemination. They also get involved by providing people to be at these events. In addition, some of the NGI dissemination activities include publicising local success stories in suitable media, creating materials for various audiences (from politicians to scientists), pointing potential users in the right direction, etc.

3.2.2 Infrastructure Services

Infrastructure Services operated at the NGI–level are needed to integrate and complement the Global Tasks operated by EGI.eu described in section 3.1.2. This section only provides information about the NGI Infrastructure Services required for integration with EGI. Additional services can be individually provided by NGIs to address local needs, but these are out of the scope of this

deliverable.

- **Software Rollout** - While EGI.eu is responsible of the coordination and supervision of the process, individual Resource Centres are requested to participate as early adopters to staged rollout for proper verification of new deployed software releases in the production infrastructure.
- **Monitoring** - The EGI Monitoring Infrastructure is distributed. The NGI Monitoring Infrastructure is responsible of running periodic functionality checks. Results are stored and displayed locally through NGI portals, and are collected centrally at an EGI-level to provide an overall view of the EGI Resource Infrastructure status.
- **Accounting** - Usage records are collected by each Resource Centre. Depending on the customisable set-up chosen by the NGI, the data gathered can be directly published in the central databases, or alternatively can be persistently stored at an NGI level and summarised for publication at an EGI level. NGIs are responsible of the validation of the data gathered and to supervise the record publication process to make sure that records are regularly collected centrally.
- **Configuration repository and operations portal** - prototypes of the central configuration repository (GOCDB) and production-quality Operations Dashboard have been recently released for NGI deployment. These NGI tools are designed to allow for a greater level of customisation at an NGI-level. The deployment of such tools is currently optional.
- **Helpdesk** - A NGI support system fully integrated with the central instance – GGUS – is often required to support local users and Resource Centre administrators. This is typically required by medium and large NGIs. For small-scale NGIs operating a limited number of Resource Centres, the local support system can be simply implemented centrally through a dedicated support unit or through the xGUS system.
- **Core services** - Core middleware services for user information discovery, authentication, workflow management, file cataloguing etc., are often provided by NGIs to support users and the local Infrastructure Services. The actual set of services operated can vary, and depends on the scale of the NGI and on the number of VOs supported.

3.2.3 Technical Services

A resource infrastructure provider may choose to deploy technical services as part of their activity (but are not required to) in addition to services delivered through their federated resource centres whose availability and reliability they monitor. These services, made possible by external technology providers (e.g. EMI, IGE, StratusLab), enable to access capabilities at a site such as:

- **Compute Capabilities** - Allow an application installed or deployed onto a site to be managed and executed from data sets transferred into the site and results that may be transferred from the site to persistent storage.
- **Data Capabilities** - Provide for the storage and transfer of data (generally files) to or from the data store to other locations. This capability may be built on top of tape, disk, clustered, or other forms of back-end storage devices.
- **Virtualisation Capabilities** - Although not currently offered as a production service by EGI, is an area of increasing interest.

3.3 Technology Providers

EGI relies on a number of technologies for DCIs that have been developed over the last ten years through various open source middleware activities. The current technologies are mainly maintained by projects such as EMI and IGE, while StratusLab is working on enabling components to augment EGI with virtualisation and cloud-like capabilities.

3.3.1 Human Services

- **Requirements Gathering** - Collecting and prioritising requirements from the main users of their technology outputs in collaboration with EGI.eu in order to define changes in functionality that will meet their evolving needs.
- **Release Planning** - Ensuring the planned software components are documented as part of a product roadmap and to manage the work within the release and external dependencies to ensure the technology is delivered on time with the quality and functionality expected.
- **Training & Dissemination** - Maintaining the documentation relating to the technology releases and helping to promote the uptake of new software releases within the adopting communities.

3.3.2 Infrastructure Services

No infrastructure services are seen as part of the core offering coming from Technology Providers.

3.3.3 Technical Services

- **Software Engineering** - Provides the effort for the development of new features and the maintenance of existing features.
- **Software Release** - Ensures the release of quality assured components that meet the acceptance criteria and test plans.
- **3rd line support** - For a production infrastructure, responsive resolution of issues that cannot be resolved by the 1st and 2nd line support within the infrastructure is critical. In identifying an issue with a certain software component (e.g., a bug, a security flaw), it is essential that the technology provider is able to timely interact with the customer in order to investigate the issue and handle its resolution.

3.4 Virtual Research Communities

The VRC model allows communities to provide their own domain specific activities that are integrated with EGIs other support mechanisms and services.

3.4.1 Human Services

- **Governance & Coordination** - Providing the means to coordinate the work that is taking place within the VRC and to determine the strategic direction taken by the community. The governance and coordination function may vary considerably between VRCs depending on the needs of the community.
- **Training** - The provision of training on community specific tools, applications or services can be provided by those that are most familiar with the needs of the community they serve.

- **Dissemination** - The results obtained through the use of the infrastructure can be passed to the EGI.eu Dissemination team for communication within and outside the EGI community.
- **Applications** - A community may have dedicated support teams for developing and supporting their own applications on the e-infrastructure resources that they are using.

3.4.2 Infrastructure Services

- **Operational Services** - Some communities will operate their own services (e.g. group management, workloads management systems, file catalogues, dashboards, application-oriented monitoring) either directly (e.g. EIROs) or in partnership with some NGIs.

3.4.3 Technical Services

A VRC may choose to deploy Technical Services as part of their activity but it is not required.

3.5 External Resource Providers

The adoption of virtualisation by resource centres as a mechanism for hosting middleware services will enable external resource providers (such as Infrastructure as a Service providers) to be seamlessly integrated into the production infrastructure. In time, hosted software solutions (Software as a Service) and platforms (Platforms as a Service) provided by external resource providers, may be beneficial to new-user communities when their requirements are analysed.

3.5.1 Human Services

- **User Support** - May be available on-demand for payment from the external resource provider, but support may be limited from the provider itself, but available through 3rd party organisations as consultancy or professional services.

3.5.2 Infrastructure Services

The capability provided by the external resource provider is made available to the consumer through a defined interface and operating model.

- **Infrastructure as a Service (IaaS)** - The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications.
- **Platform as a Service (PaaS)** - The capability provided to the consumer is to deploy onto the infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider.
- **Software as a Service (SaaS)** - The capability provided to the consumer is to use the provider's applications running on the infrastructure. The applications are accessible from various client devices.

3.5.3 Technical Services

Generally, an external resource provider does not offer technical services as defined previously.

4 BUSINESS MODELS

The future of EGI relies heavily on the sustainability of the NGIs and EIROs. During the start up of EGI.eu and with EGI-InSPIRE, structure support has been provided through the combination of European Commission (EC) and national funding. Even though the maturity of NGIs varies widely across Europe, over 30 NGIs and EIROs have committed to paying the annual EGI membership fees as specified in the EGI.eu statutes [R3] for services provided to the community as a whole, and to continue to invest significant additional funds in the development of their own national e-Infrastructures and supporting staff. The associated effort and costs of providing the production infrastructure in the context of the EGI-InSPIRE project is conservatively estimated at more than €330M with the €25M contribution from the EC specifically for the project representing 7.5% [R19] of the overall costs. This provides a clear demonstration of the commitment by the partners and their funding organisations to EGI. However, due to the economic crisis and financial constraints now being felt by the stakeholders of EGI, these funds are now coming under pressure.

As a result, EGI must continually assess its funding models for both its managerial, technical and operational structures over the next four years. One crucial aspect of this includes the identification of suitable business models for funding the different services delivered to the community either at a national or a European level. It is becoming clear that in FP8, European funds will be focused in activities and areas that support Europe's long-term goal to transform the EU into a smart, sustainable and inclusive economy. Other sources of revenue will be needed to ensure the *long*-term sustainability of operational services. Therefore, an eventual split could foresee operational services being covered by certain revenue models with innovation being driven through EU and national funding.

The following sections examine different business models to be discussed moving forward such as fixed fee- and usage-based models, free to use models, in-kind efforts and public funding as well as identify the opportunities for the EGI ecosystem to be both consumers and providers. The information provided is to understand what models are available and the areas of EGI that could potentially apply in order to generate revenue for covering or redistributing operational costs and services provided and does not intend to be a complex action plan of components and functions for implementation. It is foreseen in the following months to hold discussions with the community to start to move to a more complex analysis and business model canvas with step-wise documentation.

4.1 Fixed Fee-based Revenue Models

4.1.1 Subscription

A subscription is when a customer must pay a monthly or yearly fee to have access to the product/service, which has been common in the publication sector (i.e. magazines, newspapers), but is now used by many businesses and websites such as Netflix, web hosting companies, etc. Usage of the services covered, as part of the subscription, is generally un-metered.

The fees currently paid to EGI.eu by its participants are effectively a "subscription" for all of the services provided by EGI.eu and its partners regardless of use. The participants pay an annual

participation fee in order to support the required coordination efforts provided by EGI.eu and its partners that is based on a scheme that links a participants Gross Domestic Product (GDP) to their fess and votes. An evolution of this model may include modification of the GDP based key or identifying services that can be transitioned to other business models described in this section. Under this model, greater transparency leads to improved sustainability by accurately allocating costs to particular services and allow specific communities to pay according to what they need and use.

4.1.2 Freemium

A basic product or service based Freemium model provides a product or service free of charge (e.g. software, web service) while charging a premium for advanced features, functionality, or related products and services [R4]. For example, Google Apps offers basic features for free, but provides more extensive customisation and branding options for a fee.

This is a potentially interesting model for EGI to follow through the identification of a set of basic services that both EGI provides to the NGIs and that the NGIs provide to their end users. This basic set of services would serve as the “free to use” package. A set of more specific services that need to be tailored to specific users communities with heavy usage, complex management or bespoke functionality could be offered as part of a premium package on top. This could then be considered as part of a ‘free’ (at the point of use) package. It is paramount that these services be clearly defined in order to map which services are covered as part of the basic free model and how they could be paid (e.g. membership fees), and those services that would be charged back to the organisations benefiting from them.

4.1.3 Professional Services

Many EGI technologies are developed on a purely open source basis within the EGI community. Companies like RedHat have proven that open source does not necessarily mean, “free”. Many companies, which have an open-source code base, develop functionality on demand through consultancy activities on top of this open code base. It is generally accepted in software engineering that the effort required to develop the initial working code may be only 10% of the overall cost of the software (considering maintenance and support costs) during its complete life cycle.

Potential professional services within EGI include:

- **Application Porting** - Using external application experts to port applications to e-Infrastructure resources can provide a cost and time effective alternative to developing these skills in house.
- **Brokerage** - As grid is a distributed environment, services could be provided by a variety of different organisations spread across Europe. This would imply that payments be made to a central organisation then distributed accordingly. EGI has the opportunity to leverage its buying power in order to obtain a reduction for services on behalf of the community but provided by External Resource and Technology Providers.
- **Helpdesk** - Requests to the “EGI Helpdesk” would be split into two groups. Issues relating to bugs or failing services may be dealt with for free, while professional support (e.g. debugging application issues or application configuration) may require payment.

- **Support and Consultancy** – Within the ecosystem, there is a place for EGI.eu or dedicated experts from the community (e.g. the NGIs) to sit between the VO and resource providers as a pool of experts providing support and consultancy between the two. Expertise in one area held by one organisation could be made available to those not having that specific expertise.
- **Training** - The costs of providing on-line training packages or delivering training courses in person could be charged for to cover costs of preparation and delivery. Accreditation of these training materials (e.g. basic, intermediate, and advanced courses) could improve their quality and define the value added to the skills of those undertaking the courses.

4.2 Usage-based Revenue Models

By implementing detailed accounting and billing tools, EGI would have the ability to record usage and identify the consumer(s) and charge for the cost of the resources that they have used. Currently, such accounting is done for "jobs", but further metered quantities could include other resources and the services that deliver them (e.g. storage, processing, bandwidth, active user accounts, etc.). Resource usage could be accounted for, monitored, controlled, and reported providing transparency for both the provider and consumer of the utilised resource. Payments would then be associated with actual usage.

4.2.1 Freemium

A metered Freemium model offers a basic volume of a resource free of charge (e.g. storage), while charging a premium for greater usage volumes. For an example, Dropbox [R5], an online storage facility, offers a free account with 2GB of space that users can use for as long they like, with payment models for extra space required - 50GB $9.99/month or 100GB $19.99/month. Others businesses provide a 100% premium model, perhaps offering a short free trial period and then requiring a monthly payment to continue using the service.

Such a model would allow EGI to provide a free "entry-level" service for new consumers of a service (e.g. a new VO or Resource Infrastructure Provider), while allowing high-volume users of a service to be charged for the resources they use in a "pay as you go" model.

4.2.2 Pay As You Go

The recent emergence of cloud computing as a business model, has demonstrated how new technologies (i.e. virtualisation) can enable dynamic execution environments or on-demand elastic service deployment with new, clear cost measurements and charging schemes. The ability to provision resources on-demand has shown the use of virtualisation to deliver Infrastructure as a Service (IaaS), hosted environments to provide a Platform as a Service (PaaS) and hosted applications to access Software as a Service (SaaS) [R7]. Billing according to usage is applicable to services that can be quantified numerically.

A more detailed look at accounting tools is provided below:

- **Accounting of computing usage –** The attribution of the user and their VO that has executed a job on the production infrastructure (regardless of the application – see below) is already account for. Billing organisations (or their users) for their usage could be achieved by extending the accounting portal.

- **Accounting of application usage** - Accounting for the use of particular applications by specific communities would help resource providers, VO managers, and application developers improve the services they offer their respective stakeholders (e.g. performance tuning effort could be applied to heavily used applications). Application-usage data could be collected through the established accounting repository and linked back to the application database maintained by EGI of applications that have been ported to run on the production infrastructure. The accounting portal would be extended to produce reports of application usage per community and rank applications per consumed CPU usage.
- **Accounting of capacity and cloud computing usage** - The introduction and integration of capacity computing and virtualised resources into the production infrastructure is foreseen during the course of the EGI-InSPIRE project. These resource types will need to be accounted for within the infrastructure. Integration requires the capability to collect usage records from all types of computing infrastructures to provide a unified view. Activities therefore need to focus on the collection of accounting information from the individual resource type and distinct itself from the on-going work that extends the accounting tools to store accounting information from additional resource types.
- **Accounting of data usage** - Many communities recognise the value of data – either by restricting access (e.g. the medical community, digital repositories, etc.) or by using it as an income stream (e.g. stock market data, spatial data, etc.). For both kinds of data it is necessary to account for access, either for pricing or auditing reasons.
- **Accounting of storage usage** – Storage of the some 100PB of data differs from data access or transfer and correlates to real costs for hardware (e.g. disks, tapes) and is a large investment provided by the community as a whole. Accounting for this storage and implementing associated pricing models will help offset these costs ensuring long-term sustainability.
- **Billing** - A usage-based model depends on assigning a cost to the use of a resource or service made available by the infrastructure by particular groups, whether real or virtual. Integration of a billing function onto the accounting repository would enable different resource usage to be accounted for and a bill generated – analogous to a phone bill containing text, voice and voicemail charges.

4.3 Free to Use Models

For many consumer oriented web portals, users have become accustomed to zero cost services (e.g. web mail, search engines, etc.) that are supported by advertising and other income streams. Such services are made freely available to the consumer in many cases as the incremental cost of delivering the service to a new user is close to zero. Clearly, EGI at the moment is unable to deliver its services at the same scale and incremental costs as commercial organisations, such as Google or Microsoft. However, some services may emerge as each are specifically mapped to business models that is deemed not worth accounting or charge for its provision to the community.

4.4 In Kind Effort Sources

Commercial services are rarely provided free of charge. One model that has gained some publicity is a barter based model where individuals exchange services when the value of the services is defined dynamically by the parties involved in the transaction of comparable value or mutual interest on a trust basis. Neither party is “paid”, but receives something that would only have had to be converted

to physical currency [R9]. The economic crisis has caused a rise in Internet bartering, as more organisations are being more careful with “cash”, which has been seen through web sites and business organisations promoting cash-free transactions. About $12B worth of business-to-business bartering happens each year around the world [R10]. Clearly the parties concerned need to identify services that they are willing to exchange and define a way of ensuring the value of the services exchanged are equal – either in a single transaction or over the longer term as part of a series of transactions. Such concerns do not arise in cash based transactions.

Within EGI, many research partners are willing to provide services to each other as part of research collaborations. These collaborative exchanges can work very well when each party is happy with the service being provided and the community as a whole is happy that the relationship between the parties is equal. It is very hard to balance these models when one party either consumes or has to provide more services than the others, or provides these services at a quality that the rest of the collaboration finds unsatisfactory, yet there is no opportunity to transfer the service to another provider as part of the collaborative activity.

4.5 Public Funding

4.5.1 Project

Project based models recognise that some activities require a significant investment to develop but have a very low operational cost. Such a “Fee In, Free Out” model charges the first client a fee for developing a service to meet their specific needs, while offering that service free of charge to subsequent clients who are able to use it with no further modification. The model is appropriate, for example, digitisation services, where there is a one-time cost to develop a product or service but little or no cost involved in its subsequent distribution [R8].

This is a model frequently used by public funding bodies (e.g. research councils) that are willing to commit expenditure for a specific activity for a defined duration. In considering this model, it is essential to identify the initial stakeholder(s) willing to pay for the work and how the general community and its investor would benefit from the work. It also opens up opportunities for commercial involvement through pre-competitive research through joint collaborations or development of specific products or services ultimately driving innovation and economic stimulus.

4.5.2 Recurrent

A recurrent funding model recognises that when e-Infrastructures have matured and are seen as part of the critical infrastructure within a county, they will be directly funded as a fixed budget line item. Although funding levels are by no means guaranteed in such a model any changes will be part of long-term planning cycles.

4.6 Consumers and Providers

Many of the models examined in this section assume a service is being provided for something to consume in return for a financial transaction. Therefore, even assuming a combination of these models can be applied to the services provided within EGI and the cost of providing these services can be accounted for, a legal entity needs to be found for the bill to be sent to for the consumed

usage. The entities that are part of the EGI ecosystem that could be billed for consuming resources or might provide services are described below:

- **EGI.eu** - As the central coordinating body of EGI, EGI.eu already has assumed responsibility for allocating funds to participating partners within the project model based on efforts carried out. In the future, this position can only be foreseen to increase as it potentially assumes responsibility for EGI branded services, accepts, and redistributes appropriate funds from revenue sources and serves the key negotiator with technology providers. It could act as a financial intermediary in some of the payment based business models.
- **Resource Infrastructure Provider** - This is the organisation that represents, coordinates and provides services on behalf of a group of resource centres. They are generally (within Europe) aligned to participation in EGI and therefore have a defined contact point and legal entity. EGI.eu provides services to resource infrastructure providers outside of Europe, who are generally not part of the EGI.eu governance structure.
- **Resource Centre** - All resource centres are associated with a physical infrastructure that must be part of an organisation and are all affiliated to a resource infrastructure provider. It is possible that could choose to be billed directly for a resource centre's costs and to either absorb or pass on any identified costs as well as revenue generator for services provided.
- **User Community** - All end-users are members of virtual organisations and activities within the infrastructure can always be tied to each of them. Capability of accounting individual end/user activities and the knowledge of user membership to VO, enable to measure group-based usage. However, in some communities an individual may have a responsibility to consume resources on behalf of that community. Also, billing virtual organisations for their use of the infrastructure creates issues as to whom the bill can be sent, as a VO is not usually a legal entity, thus emphasising the importance of tracing the employing institution of users. On the other hand, it should also be considered that much of the expertise lies within the community, therefore opening opportunities for generating revenue through service offerings as well.
- **Technology Provider** - A key component in the EGI life cycle, delivering software components based on user requirements, and new innovative tools and services, while supporting existing legacy software. They provide the innovation needed by EGI to satisfy its users that sometimes cannot be found in the commercial or mainstream open source community. The costs of these providers need to be covered regardless of the selected business model.

Due to the interdependencies within the EGI ecosystem, this new direction offers a unique opportunity for creativity and flexibility to keep cash flowing between the EGI community, who could serve as both consumers and providers. By implementing a combination of business models and the necessary tools to support them, the relevant products and services needed by the user community will inevitably be brought to the surface. Consequently, any unnecessary ones will automatically be streamlined through exploiting free market forces. Ultimately, these practices will not only reduce costs and effort, but also create opportunities to meet the needs of new users, expand and refine products and services, forge new relationships and review current practices. A challenge to any business model discussion will be the difficulty in changing the mentality around charging for a service that has been 'free' to its user community for the last decade. Either way, a realistic discussion needs to take place now, especially given the complexities of the infrastructure and ecosystem, in order to properly position itself in market for the long-term.

5 MATCHING SERVICES AND BUSINESS MODELS

As a starting point to further develop a detailed canvas through discussions in the coming period, this section offers a summary of EGI services, a preliminary assessment in matching business models to services from the last EGI Council workshop as well as an initial analysis of infrastructure services that could be accounted under a fee- or usage based model. This section also provides a brief look at how the various actors of the EGI ecosystem fit within this picture.

Table 1 below summarises the classification of the identified services provided by the EGI ecosystem.

	Human Services	Infrastructure Services	Technical Services
EGI Global Tasks	Governance, administration, technical management, policy development, dissemination, technology roadmaps, user & community support, operations support, ticket process management, requirements gathering, security	Core services, accounting, software rollout, configuration repository, operations portal, helpdesk, monitoring, security, metrics portal	VO Services, software validation, software repository, application database, training, operations tools
NGI International Tasks	Requirements gathering, application database, training, consultancy, policy development, operations coordination, security, dissemination	Software rollout, accounting, core services, configuration repository, operations portal, helpdesk, monitoring	Capabilities such as compute, data, and virtualisation
VRC	Governance & coordination, training, dissemination, applications	Operational services	
Technology Providers	Requirements gathering, release planning, training & dissemination,		Software engineering, software release, 3rd line support
External Resource Providers	User support	IaaS / PaaS / SaaS	

Table 1 - Summary of EGI ecosystem activities

Table 2 offers a snapshot preliminary assessment matching services to business models from discussions held during the EGI Council workshop in Santander (Spain) 17-18 February 2011, which was based on a draft version of this document. During the course of activities throughout the year, further investigation will be made in order to reach a consensus and move towards a complete canvas. Each box is labelled as follows:

'√': the business model is definitely suitable for the service
'X': the business model is definitely not suitable for the service
'*': the business model may be suitable for the service
'?': more investigation is needed

Where no services have been identified in ***Table 1***, the corresponding space in ***Table 2*** is blocked out.

Services		Business Models[2]								
		Fee-based			Usage-based Revenue Models		Free to Use Models	In Kind Effort Sources	Public Funding	
		Subscription	Freemium	Professional Services	Pay as you go	Freemium			Project	Recurrent
EGI Global Tasks	Human	√							√	√[3]
	Infrastructure	*			√	√			√	√[4]
	Technical	√				√			√	√[4]
NGI International Tasks	Human	X			X	√			√	√
	Infrastructure	*			?	√			√	√
	Technical	X	√	X	√	√	√	X	√	√
VRC	Human	X	X	X				√	√	√
	Infrastructure	*	X	X	?			√	√	√
	Technical	X	X	X				√	√	√
Technology Providers	Human	√		√		√				
	Infrastructure									
	Technical	√		√		√			*	
External Resource Infrastructure Providers	Human				√					
	Infrastructure	√			√					
	Technical									

Table 2 - Matching EGI Services to Business Models – EGI Council Workshop Initial Feedback

[2] Legend: Yes (√) No (X) Depends (*) More investigation (?)
[3] Potentially through the ERIC framework [R20]

In principle all infrastructure services could be meterable against usage, thus opening the possibility to apply a usage-based business model. However, not for all it is reasonable to apply such a model. ***Table 3*** provides a preliminary analysis of which infrastructure services that are suitable for such models. This analysis will be further developed in the coming months.

	Fee-Based	Usage-Based
EGI Global / NGI Int'l Services		
Configuration Repository	√	
Core Services	√	√
Helpdesk		√
Monitoring	√	
Operations Portal	√	
Security	√	
Software Rollout	√	
VRC Services		
Application-oriented Monitoring	√	
Dashboards	√	√
Group Management	√	
VO Grid Technical Services	√	√
Technology Providers		
IaaS / PaaS / SaaS		√

Table 3 – Fee- and Used-Based Infrastructure Services

5.1 EGI Global Tasks

Many of the human services provided at a European wide level are focused around coordination activities. Determining how much of these services a particular consumer (e.g. NGI, VRC) has benefited from would be very difficult and these services are best funded from a subscription model. As these tasks directly benefit consumers outside a single country justifying this activity as a recurrent funding line may only be feasible through an international legal entity such as an ERIC. Where service consumption can be metered (e.g. GOCDB, accounting repository) and the consumer with his/her employing institute identified, these services could be supported by a usage-based business model. Due to the importance of sustainability at a European level project funding is generally not suitable for these tasks, but could provide a source of funds to develop specific new capabilities that are then supported operationally by other business models.

5.2 NGI International Tasks

As an NGI provides services to the resource centres within a single country public funding models are very common. Passing these costs onto particular centres or communities through a subscription model is not seen as viable, but usage costs could be passed on to the relevant consumer (e.g. via their institution). However, usage of site technical services (e.g. job execution, data movement) could be identified and charged for.

As previously stated, due to the interdependencies of the ecosystem and in order for EGI to function, the NGIs and resource centres need to be sustainable. It is essential to start a flow of communication to understand how the individual NGIs are focusing on this area and what future trends EGI could foresee (e.g. increased usage of commercial providers; concentration of resource centres) and what effects this will have on EGI overall.

In order to start to tackle this very issue, the EGI Policy Development Team is organising a dedicated session at the next EGI User Forum. The workshop serves as an opportunity to directly engage policy makers within EGI and better understand of their legal and organisation structures, policy related activities, cost models and sustainability and future plans.

5.3 VRCs

As VRCs originate from the research community and are primarily driven through international collaborations, the identification of legal entities to be billed may prove to be difficult and will depend on agreements through mutual interest. Therefore, business models such as public funds and in-kind contributions are seen as highly suitable.

5.4 Technology Providers

Sustainable business models for Technology Providers are based around licensing (i.e. subscription) and professional services for consultancy, training and support. Many open-source technology providers use a Freemium model where an entry-level version of the product is freely available but greater functionality can be obtained through additional charges.

5.5 External Resource Infrastructure Providers

As most external resource infrastructure providers will be commercial providers it will (from their perspective) be vital that any usage can be billed directly to an identified consumer.

6 RECOMMENDATIONS AND NEXT STEPS

Activities within the EGI-InSPIRE project have foreseen the expansion of a number of services that will need to be metered if they are able to support usage-based business models. In Table 1, a number of these have been identified such as EGI Core Services, Accounting, Software Rollout, VRC Operational Services, and the IaaS, PaaS, and SaaS models from external resource providers. The community needs to understand the usage of these resource by different groups (e.g. NGIs, VRCs, etc.) to better understand the most effective way to meter usage of these services and to then generate bills for their usage.

The work plan within JRA1 already has effort allocated for improving the ability to account for the use of applications, data services, HPC resources and virtualised resources, and to add the ability to convert stored accounting records into bills. Information provided throughout this report will serve as a basis for this established work plan to be detailed in MS706 in May 2011, and updated annually, in order capture usage data relating to the requested resource types. Update this plan as the understanding of the potential EGI business model evolves.

	Recommendation	Priority
1. Metered Services	Breakdown of the services in Table 1 and assess how each could be metered and the possible usage aggregation level (e.g. user, group, VO, employing institution, NGI). Consider tracing of the user employing institution as an important feature for developing future billing. Define implementation plan priorities in agreement with NA2.3/NA3/SA1/SA2 management.	High
2. Technology Providers	Provide technology providers through established MoUs with requirements on extensions for enabling usage accounting of services. (e.g. to enable storage accounting)	High
3. Usage Record Format	Assess available record usage format besides OGF UR covering IT services.	High
	Participate in OGF for the definition of a generalised usage record format in order to accommodate future / unforeseen service categories. Ensure usage record format contains information not only user identity but also, group, VO, employing institution, and NGI.	Medium
4. Usage Record Generation	Assess how non-repudiation, integrity, confidentiality can be accomplished when generating, transferring and storing usage records.	High
5. Billing for CPU Usage	Usage records are already available; Develop a billing service for CPU usage; the service should generate periodic bills per identified group based on available accounting records related to computing resources; the service should be design to encompass different usage record types in the future; assess the potential of a virtual bill to inform consumers of the value of consumed services as an initial step prior to full integration.	Medium
6. Billing for Storage usage	SPG plans to generalise storage usage record policies; once the accounting repository storage usage records, extend the billing service to consider this type of resource;	Low
	Ensure that technology providers provide storage manager components offering accounting information to be then collected. (See recommendation 2)	High
7. Event Participation	Participate in EGI Cloud Workshop and ensure to inject requirements of usage accounting of VMs (https://www.egi.eu/indico/event/415).	High

Table 4 – Recommendations for JRA1

As mentioned, this report will feed into JRA1 year 2 activities that will define an action plan for related activities reported through a milestone report. Coordination between activities and project management will be essential in defining these activities and starting off the second year of the project in the right direction. Discussions will continue at key events such as the EGI Technical Forum and EGI Council meetings. EGI.eu will produce a short position paper by year's end in order to communicate the progress on the analysis of EGI sustainability plans ensuring an open process with the community. All information and monitoring of activities will be officially report in the next iteration of this sustainability plan next year.

7 CONCLUSIONS

The EU has invested heavily in e-Infrastructures over than past decade. In fact, due to the e-Infrastructure's community dependence on public funding sources, further change is being forced upon it. It is clear that public funding of all activities is coming under increased scrutiny in the current economic climate and dependency for maintenance and general operations is expected to decrease with each passing year. As coordinating and maintaining a high-quality infrastructure costs money, the focus in the EGI-DS and now EGI-InSPIRE projects has been to move towards ensuring sustainability, therefore transferring recurring operational costs to the communities that benefit from it is the logical next step.

Users (or their NGIs or institutions) will eventually need to pay in some form or another for the resources they currently use for 'free'. As the community shifts to a more service oriented model, the pressure on the providers to ensure that the services offer 'value for money' will certainly increase, as will the community's ability to compare costs to commercial cloud providers and evaluate the value that e-Infrastructures provide. The revenue gained from charging for service use will make it easier for those services to be maintained sustainably, and for user communities to focus on research rather than being involved in running the services they use. Opportunities will also arise for the community members to provide the necessary services as well.

This report has provided a comprehensive list of the wide range of services that the EGI provides and has taken a proactive approach in defining potential business models in order to sustain these services. A preliminary assessment of which services could be supported by a particular business model has been made, providing a means to structure and direct future discussions and dedicated activities with JRA1. This will take place through consultative workshops amongst the stakeholders in the months to come in order to assess the true viability of the different services to different business models using this taxonomy. To enable such discussion, a list of services that could be supported by usage-based business models, but where usage is not currently available, have been identified as a priority for future development.

Many public funding bodies are seeing e-Infrastructures as way to drive innovation and economic growth nationally and across Europe, and do so in a way that is sustainable for the long-term. Although no new funding sources are likely to emerge in the immediate future, the distribution of costs amongst the stakeholders in the EGI ecosystem to better reflect usage is one short-term change that can start to take place.

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