e-IRG roadmap 2009

Draft for consultation

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e-IRG
e-Infrastructure Reflection Group

www.e-irg.org

e-IRG and its mission

e-IRG is an inter-governmental policy body, with government appointed delegates from 31 member states and representatives from the European Commission. The mission statement of e-IRG is:

> *“The e-IRG mission is to pave the way towards a general-purpose European e-Infrastructure.”*

An overall vision of the state of the field of research e-Infrastructures is created as a synthesis of data from several channels. The fulcrum of the analytical process are the meetings of the e-IRG delegates, who have been appointed based on their knowledge and expertise related to both large-scale e-Infrastructure service provision and the policy issues related to it. These meetings focus on reflection and balancing of the different views received from expert consultations, open e-IRG workshops, e-IRG Task Forces on specific issues and contacts with projects that represent either e-Infrastructure users or service providers.

The role of the roadmap in this process is to provide a vision of the future and to motivate continued efforts to create links between different stakeholders in a way that maximises the socioeconomic value of the common e-Infrastructure for research. As the example of the World Wide Web has shown, the junction of leading-edge technologies and research is a very fertile ground for new groundbreaking innovations.

The roadmap will also outline the role e-IRG wants to play in this development and how the organisation plans to execute its mission if the recommendations to the external stakeholders are heard and followed up at a higher policy level.

Executive summary

The importance of the e-Infrastructure for research for the European competitiveness is now almost universally acknowledged. Sustainable and integrated networking, grid, data and high performance and commodity computing services will become essential tools for 40 million users in research and academia in Europe. The innovation potential of such a large-scale deployment of advanced services should not be underestimated. Acting in support of this innovation process, e-IRG is a forum where the service providers, technology developers and current and new user communities can join their forces and help to realise innovation and inclusivity goals of the i2010 strategy.

The ongoing expansion of the e-Infrastructure user communities is already producing new and updated requirements for the common e-Infrastructure. The junction of leading-edge research activities and e-Infrastructure supporting them has been identified as an area where considerable socioeconomic benefits can be realised. Inclusion of new user communities has also highlighted the importance of continuing the move from product- or technology-oriented ICT support models into the provision of e-Infrastructure services. This roadmap also illustrates how the e-Infrastructure acts as an 'innovation engine' by accelerating the transition of leading-edge ICT-applications for research into innovations that benefit the society as a whole.

Other major trends for future e-Infrastructures are the emergence of data intensive science, the threatening software crisis and the move towards service concepts. As concrete steps towards the goals mentioned above, e-IRG makes the following recommendations in this document:

- The adoption of an Infrastructure as a Service (IaaS) model should be strongly stimulated and supported with the aim to increase the sustainability of e-Infrastructures and to identify and provide innovative solutions which could find a larger use in the society.
- Commodity computing should be used to bring new users and user communities into contact with other components of the e-Infrastructure.
- Interoperability of e-Infrastructure components should be improved through global standardisation efforts.
- Access to the European know-how related to scientific software and exascale computing needs to be improved.
- Resources for the preparatory work for a general data management service should be reserved.
- Studies focusing on the impact of the new research networking technologies and policies on the innovation potential of the whole e-Infrastructure are needed.
- Seamless transition of proven e-Infrastructure collaboration models into broader use in the society should be stimulated and supported.

- Adoption of and access to e-Infrastructure by new user communities should be supported.
- The European e-Infrastructure experts should be enabled to contribute to global e-Infrastructure developments, also in leadership roles requiring long-term commitments.

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Acknowledgements and background

This document is a collective effort of the e-IRG and the experts in the e-IRG and ESFRI networks that have been contributing to it. The editorial process has been supported by the EC-funded e-IRGSP2 project throughout the year 2009, according to terms of reference agreed with the e-IRG delegates. The interim versions of this document have been presented for discussion in the following e-IRG meetings:

- 15th May in Prague, Czech Republic
- 17th June in Prague, Czech Republic
- 16th October in Uppsala, Sweden

The progress of the e-IRG roadmap was also discussed in most of the e-IRG board meetings during the year 2009. The editorial process has also been able to rely on groups and other consultations that we would like to acknowledge below.

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1 Introduction

The crucial importance of the e-Infrastructure for research for the European competitiveness has been stated several times, perhaps most prominently in the recent Commission communication to the European Parliament. The communication noted that “e-Infrastructures make a major contribution to the objectives of the i2010 strategy” and re-iterated that despite the challenging economic situation, it is

> *“now more important than ever to explore ‘innovative funding for a wide range of infrastructure projects, including transport, energy and high-technology networks...’”*

There is also a growing consensus that e-Infrastructure services need to be provided in a sustainable manner to allow current and new user communities to rely on them in the long term. The growing requirements of new and existing user communities require continuous reassessment of the components of the e-Infrastructure service palette. This reassessment needs to be extended also to the way the interaction between users and service providers is structured. The changes in the underlying technology base will bring in new opportunities and challenges in this process.

This document will present the vision of the e-Infrastructure reflection group (e-IRG), detailing how Europe can reap the maximal benefits form the opportunities these fundamental changes in the sustainability, user communities and technologies of the e-Infrastructure services will bring. While predicting the development of technologies on detailed level is impossible, it is possible to describe a general process of adaptation to new technologies. This means developing organisational and financial principles, models and working methods for infrastructure use and innovation. E.g. by identifying best practices where new technologies and new ways of use can be shown, which will lead to a faster broad adaptation in research and in society as a whole later on.

The most important contribution of e-IRG in this process is to provide a forum for analysing different approaches, to make recommendations where possible and to ensure that the knowledge of the e-Infrastructure community is easily accessible in all of the e-IRG member states. As an additional benefit, e-IRG will also consolidate European visibility and position in the global arena and provide an easily identifiable European contact point for e-Infrastructure – related issues.

2 A view on e-Infrastructures and trends

2.1 The role of e-Infrastructures in ICT innovation.

The research community has traditionally been the first customer – and often also the developer of - new ICT components and services. The close interaction between users, service providers and developers of new technologies and services has often led into defining new basic service components and interfaces. As a concrete example of the continuous nature of this process, the results of the e-IRG Data Management Task Force and the initial discussions with the ESFRI preparatory phase projects indicate the need to add data-related services to the e-Infrastructure model and trigger a discussion how this may be done. However, it should be kept in mind that defining *a priori* what new services are going to be needed is challenging, and too early detailed formalisation and structuring of services may harm the innovation process.

In the e-Infrastructure domain the motivation to upgrade a technology is usually based on a need to keep up with requirements of the most advanced users, instead of optimisation of a commercial business opportunity. The e-Infrastructure user communities usually have very specific, challenging needs that are ahead of the general ICT-market and therefore impossible to fulfil using commodity solutions in standard configurations.

Because of this, a new technology will be immediately used under a very close scrutiny from several angles and on different operational scales. The user communities and the e-Infrastructure service providers themselves constantly analyse how the technology fulfils its promises and what kind of adjustments are needed to make the service a better fit with the user requirements. This speeds up the technology adaptation cycle. This way the e-Infrastructure often acts as an “innovation engine”, accelerating the innovation in the use of ICT in society as a whole. Open communication channels between scientific users and service providers allow both to develop a realistic picture of the benefits and drawbacks of the new technologies very quickly.

A good example of the success of this approach can be found in the networking area where NREN’s collaborate under the GÉANT label, serving over 40 million users in 34 European countries, which leads to innovation in the research world but also in the regular networking market.

The conceptual model of the impact of the e-Infrastructure on ICT-innovation in general is illustrated in Figure [1]. Its shows how the innovation of the scientific network infrastructure had primary effects on the speed of innovation in the general networking market, but also on innovation in generic application services and specific ICT-applications.

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[1]Based on the experiences and observations from a networking research and large-scale piloting project ‘GigaPort Next Generation Network’ in the Netherlands (2004-2008) http://www.surfnet.nl/en/innovatie/gigaport/Pages/Default.aspx

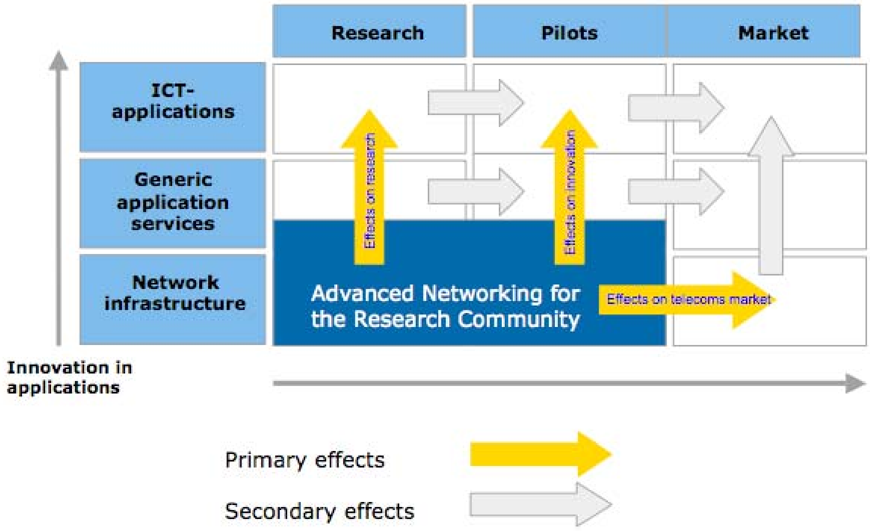

Figure 1: example of the impact of infrastructure innovation

2.2 A further move to service-orientation

A move to service-orientation (from technology- or product-orientation) is one of the major trends that becomes visible now in all of the e-Infrastructure components domains. While networking has already for a long time been seen more as supplying a service than supplying a product, this is not yet the case in other fields. For instance in many computing intensive applications, users have participated very actively in the development of the infrastructure itself. In addition, the users have often – e.g. in the case of High Energy Physics (HEP) computing – also been resource owners, running their own computing centres. As a result the user community was strongly involved in the development of middleware components, in the hardware choices and operating system support offered by Grid projects, instead of the "computing as a service" model. The use of the e-Infrastructure by more and more user communities with different characteristics and needs, especially by smaller groups with no dedicated IT infrastructure or support, will accelerate this move to service orientation to all infrastructure components.

Another related policy issue is raised by the commoditisation of some of the e-Infrastructure services. Commoditisation[2] occurs when goods or services from different vendors become practically impossible to distinguish from each other based on their technical features (from users' point of view in a particular market). Commoditisation of computing services is in the interest of users, since it makes the supply of services transparent and removes unnecessary lock-in situations. It also enables economies of scale that make

[2] http://en.wikipedia.org/wiki/Commodity.

large-scale deployment of external services attractive. These services are often supplied on a commercial base and in some cases are today competing with the dedicated internal services of research e-Infrastructures. Companies offering such services at large scale are consequently able to allocate large resources to develop and refine the implementations and their integration with the rest of the IT infrastructure, which may increase their advantage over the solutions that are specific to the research e-Infrastructure domain.

A challenge for the research e-Infrastructure is to represent the user interests in the commoditisation process by promoting standards for categories of commodity computing and by advising when a switch from research e-Infrastructure–specific solutions to commodity services is appropriate. A commercial offering, not complying with the standards for commodities may cause vendor lock-ins due to proprietary interfaces, and in that way harm future research activities. User controlled commoditisation should prevent this. However attempting to maintain solutions that directly compete with commercial ones may waste considerable amounts of resources, which may be equally harmful when taking the long-term ability of the e-Infrastructure to fulfil advanced requirements of the user communities into account. Current financing models are not sufficiently transparent to allow comparison of commodity services with the dedicated e-Infrastructure ones, which often complicates decision-making based on costs and benefits. Finally, legal compliance issues – such as ones related to non-proliferation[3] – can be even more complicated in environments where dedicated e-Infrastructure resources and commodity offerings are mixed together.

2.3 Paradigm shifts

While improvement of the price/performance ratio of the technical components is likely to continue, the paradigm shifts resulting from this trend may cause surprises in the leading-edge applications that are typical to the research e-Infrastructure.

It is obvious that some of the technologies underpinning the e-Infrastructures are at a brink of another fundamental change. Examples of developments replacing older technologies can be found in the networking (lambda networking and the deployment of "dark fiber"), HPC (massively parallel architectures) and commodity computing domains (virtualisation).

2.3.1 The Data Deluge

Perhaps the most important paradigm shift will come from the breakthrough of Data Intensive Science, which will have an enormous impact on the need for e-Infrastructure services.This development is quietly changing the way science and research in most disciplines is being conducted. While the unprecedented capacities of new research instruments and the massive computing capacities

[3] The issue of non-proliferation in Grid environments have been studied e.g. in a recent paper "Problem description for non-proliferation issues in Grids" by W. Juling, K.Schauerhammer, M. Spiro, K. Ullmann, D. Vandromme.

needed to handle their outputs occupy the headlines, the growing importance and changing role of data is rarely noticed.

Indeed, it seems that the only hints to this revolutionary issue are mentions of heights of hypothetical stacks of DVDs intended to illustrate massive amounts of “raw, passive fuel” for science. However, a shift from a more traditional methodology to Data Intensive Science – also sometimes called the *4th Research Paradigm* – is happening in most scientific areas and is making data an active component in the scientific process. This shift is also subtly changing how most research is planned, conducted, communicated and evaluated. This new paradigm is based on access and analysis of large amounts of new and existing data. This data can be the result of work of multiple groups of researchers, working concurrently or independently without any partnership to the researchers that originally gathered the information.

Use of data by unknown parties for purposes that were not initially anticipated creates a number of new challenges related to overall data management. Long-term storage, curation and certification of the data are just the tip of the iceberg. The so called Digital Data Deluge, for example, caused by the ease with which large quantities of new data can be created, becomes much more difficult to deal with in this new environment. Large amounts of data are created not only by state-of-the-art scientific instruments and computers, but also by processing and collating existing archived data.

2.3.2 The threat of a Software Crisis

An example of a technical development that has a clear policy impact is the so called *“Software crisis”* that is foreseen as a result of multi-core architectures becoming the dominant approach in computing. Harnessing a very large number of processing units efficiently in supercomputing applications is technically challenging. Addressing this technical challenge has already lead into forming of a global initiative (the above mentioned Exascale project). However, this kind of fundamental paradigm shifts may require broader, proactive policy changes. For example European funding policies may need to be adjusted so that new architectures and programming techniques can be taken into use in the research e-Infrastructure (and applications using it) without compromising maturity and reliability.

2.3.3 Resources related to addressing paradigm shifts

In addition to the expert network of the e-IRG itself, the organisation can leverage knowledge from a large group of ICT projects and initiatives it is in contact with. At the time of writing this roadmap, there are several sources of technology surveys that e-IRG is in contact with:

- FIRE – Future Internet Research & Experimentation published a draft version of its White Paper[4] that provides detailed use cases and a list of initiatives working towards the network of the future.
- PRACE initiative developing the European HPC service has published several documents[5], ranging from matching of the user requirements to

[4] http://www.ict-fireworks.eu/publications/papers.html

actual and possible future computing systems to procurement strategies to be employed by the HPC service.

- European Science Foundation's Lincei initiative[6] and the International Exascale software project[7] study the HPC software status and development for present and future supercomputer systems with a very large number of processors.

2.4 From e-Infrastructure components to e-Infrastructure service components

From the users' point of view the e-Infrastructure needs to be a collection of seamlessly interacting services. However, there are both historical and practical reasons why these services are traditionally divided into certain categories. For example, the HPC model is naturally based on relatively small number of large-scale installations providing services in relatively centralised manner. Networking service requires a model that takes into account variations in the geographical constraints and organisational models not only between different countries, but also between the numerous campus networks within the countries. The model for providing Commodity Computing services seems to be least constrained by external factors. However, this freedom may have made it more challenging to reach consensus about fundamental financial and organisational structures that affect the working models, benefits and the necessary investments for the different stakeholders.

The launch of more and more advanced data services and increasing understanding about the processes and policies governing their use will add further details into this vision. Both HPC and Grid services already incorporate solutions to store data on large-scale infrastructures, and there is already a large body of expertise in the digital library community. Nevertheless, keeping in mind the rapidly evolving role of data in the scientific process, it is possible that truly innovative data-related services may have to build their solutions in a way that does not complement and integrate existing solutions and services – especially if they impose constraints that limit the benefits that can be achieved by efficient e-Infrastructure support for Data Intensive Science.

The process of defining the sustainable models for provision of the key services – networking, data, HPC and Grid computing – is well on its way, but providing the users a coherent model of the e-Infrastructure service requires close coordination between these four components. Due to its composition and mandate, e-IRG offers a natural forum for optimising this cooperation and linking it with the engagement with the user communities.

The following paragraphs summarise the current key issues in each of the infrastructure components.

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[5] http://www.prace-project.eu/documents/public-deliverables-1/

[6] http://tinyurl.com/ydbessl or http://preview.tinyurl.com/ydbessl

[7] http://www.exascale.org/

2.4.1 Networking services

The networking services are entering an era that is characterised by a broad uptake of the new hybrid networking model enabling the use of lightpaths next to IP-based services. This move from the “best effort IP” model will give new opportunities to optimise the quality of service provided to high-end users, especially once these services are integrated with the other e-Infrastructure services. On the other hand, being able to prioritise, measure and potentially also to bill traffic more accurately may prevent the kind of fortuitous innovation that has been made possible by the “Internet traffic is free”[8] model.

This feature of “normal” IP traffic has extended also to the initial pilot and testing stages of the ventures that aim to utilise these innovations. It is thus important to develop accounting and acceptable usage policies that strike a balance between optimal allocation and accounting of the on-demand lightpath-networking resources, while at the same time providing enough room for bottom-up activities that feed the innovation ecosystem. A related technical challenge will be enabling user-controlled dynamic lightpath networking.

Networking user communities are increasingly heterogeneous, ranging from academia, public and private research institutes and corporations to non-profit organisations cooperating in public-private partnerships. Access to the same network infrastructure is essential for success of these kind of collaborations. There is an increasing need for new governance principles and methods for managing and financing this kind of mixed use of the network infrastructure.

Finally, an important innovation-related aspect of the networking services is the transfer of application and service concepts from the research network into the commercial domain.

2.4.2 High Performance Computing (HPC) services

The creation of a persistent HPC service will have an important impact on European competitiveness. HPC computing has a long track record as being one of the key enabling technologies for optimisation of product and process designs in both academia and in the industry. This often addresses quite directly Grand Challenges, such as energy, health and mobility. The persistent HPC service will also have an important role in imparting the necessary skills on the university students, so that when today’s high-end HPC systems become affordable enough to be acquired by SMEs, there will not be a shortage of skilled workers to use these tools efficiently.

As mentioned earlier the technological basis of the HPC services is at the moment undergoing a change of generation that is challenging several assumptions related to the design of efficient application software. The move to the massively parallel “*multi-core*” architectures may require a thorough re-examination of large number of software suites in use today.

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[8] Or if not free, at least even relatively demanding large-scale usage did not require advance authorisation.

2.4.3 Commodity Computing services

The concept of Commodity Computing service will in the near future encompass seamlessly solutions from several distinct origins: from Grid and Data Grid solutions all the way to various Cloud, cluster and cycle-scavenging systems. From the users' point of view the value of commodity computing services is based on flexibility and fast access to resources, which reduces the opportunity costs of extending the processing beyond the personal workstation[9]. Rather than making completely new kind of problem solving possible, commodity computing will make the research processes much more efficient by erasing delays caused e.g. by procurement and installation of new computers in the local IT infrastructure.

In addition to this facilitating and enabling role, the availability of commodity computing services play an important role by being the most common first conscious contact an individual researcher has with the e-Infrastructure. Thus in addition to providing the commodity computing services, providers need to be able to identify applications and research problems that can benefit from other resources and services from the whole e-Infrastructure palette.

On the policy level, the key challenge related to commodity computing is creating transparency by setting standard requirements – such as performance and reliability – and agreeing on the methods to accurately compare the actual costs of the different solutions. Currently there are large variations on how the costs of the various computing solutions are measured – not just between countries, but also between different organisations within the same country. This poses challenges in determining which kind of resource is most economical in any given situation.

In addition to the accounting practice, the technical interoperability of different computing solutions needs to be improved. Once interoperability has been reached, standardisation will have an important role in codifying the achieved interoperability and allowing it being easily used as a criteria e.g. in public procurement processes.

To achieve commoditisation in a way that is in the interest of the users and to reach the required level of interoperability, it is important to approach it from several angles simultaneously, instead of relying on any individual solution. This palette should consist of at least:

- Monitoring the development of *de facto* standardisation to ensure that the impact of formal standardisation efforts justify the investments
- Formal standardisation processes, with an emphasis on standardisation organisations that are seen as relevant by large number of stakeholders
- Third-party interoperability testing and development[10]

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[9] There are notable exceptions to this, for example the HEP computing where the volume of the data is such that managing large number calculations and reliably storing their results becomes a key issue.

[10] This means tests and development done by parties that are not participating in the development of any of the individual solutions. This could be organised as a service contract, public interoperability test events or open competitions.

- Policy actions aiming at distinguishing the roles of software, solution and service providers clearly from each other.

On the organisational level the commodity computing is (similarly to HPC area) in the process of being consolidated across the European organisations. Clarification and strengthening of the roles of the National Grid Initiatives (NGIs) will create a contact network that can efficiently provide support for any scientific discipline that needs to share resources or do e-science – independent from the capacities that are available locally.

2.4.4 Data-related services

Data management is an area which is both crucial to almost all research disciplines and likely to allow mapping of the requirements from different application domains to a common set of basic services. This is reflected also in the recently published ESFRI roadmap update, that states

> *"Access to and common exchange of data is a prerequisite for the fruitful utilisation of the possibilities offered to the Humanities and Social Sciences by the emerging technologies."*

The amount and complexity of the human knowledge available through an Internet connection has grown in an explosive fashion. The models, algorithms and technical innovations integrated into the system to process all that data have become more and more numerous and advanced. The number of users of these advanced e-Infrastructure technologies has grown several orders of magnitude.

A new term, "Data Intensive Science", has been coined to describe this trend. In 2009 a particular field may have produced scientific publications at a rate of two per minute. In 2020 individual fields and their interdisciplinary combinations may produce a flood of published knowledge (articles etc.) that rivals the flood of raw data today. At the same time the amount and complexity of data that can be – and in many cases needs to be – analysed as a part of the research process has grown in a similar manner. The recently completed e-IRG Data Management Task Force report[11] contains a detailed picture of the status of the data management initiatives, and recommends that current data management practices should be augmented by services focusing on metadata[12], quality and interoperability.

The rapid growth in data-intensive research will require facilities that combine data and computation, e.g. by providing services to run researchers computations close to data and by balancing IO capacity with CPU speed[13]. This may also set new requirements for the architectures of future data networks.

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[11] The report is published on the e-IRG Task Force reports page: http://www.e-irg.eu/index.php?option=com_content&task=view&id=38&Itemid=37

[12] Descriptions of the data itself and the services related to it

[13] The issue has been a focus of several scientific papers, e.g. the following: Gordon. Bell, Tony. Hey, and Alexander S.. Szalay. "Beyond the data deluge". Science, 323(5919):1297–1298, March 2009

2.5 Organisational structure behind the user experience

Compared to the situation of an individual researcher, the management practices of a research institute will change more dramatically. However, in this case the change is driven less by the e-Infrastructure development than by the increasingly global and competitive research marketplace that brings in new requirements and methods steering research activities. Naturally increasing competition will also create a pressure to use – when possible – computational resources that do not require dedicated hardware and personnel investments to run. Use of such services – provided both within and outside the research communities – will be driven by the cost-effectiveness that can be achieved through economies of scale and the minimisation of the amount of "extra" capacity needed to accommodate peaks in the resource usage.

The role of the common e-Infrastructure in this competitive market is to avoid the risks of the two extremes: ICT resources managed completely "in-house", or completely outsourced to external providers. By offering an organisational interface that understands the issues of research applications and offers the researchers a role in the governance of the service provisioning, use of common e-Infrastructure is for many services more likely to produce good results than outsourcing e.g. via a commercial tendering process. As the European e-Infrastructure community distils generic requirements from the research use cases, it can feed these findings back to the marketplace coupled with the evidence of large enough user-base to support emergence of commercial commodity solutions that can support the original research use case. To accomplish this, the organisational model will need to:

- Address the integration of the local/global/outsourced resources
- Be able to account for their use – including the use of resources like helpdesks
- Be service-oriented across the organisational boundaries. For example be able to give partial refunds to keep a customer happy, even if the refund concern services produced by another organisation.

Addressing these challenges has a policy dimension that needs participation of the technology developers, service providers and user communities for an optimal solution. The e-IRG – ESFRI joint efforts will serve as one of the important starting points for this development.

3 Recommendations

In order to reach the "ideal e-Infrastructure" model presented in the previous chapters and to make possible maximal socioeconomic benefits described earlier, e-IRG proposes a number of concrete, near term actions. The following recommendations are ordered based on their impact and urgency, starting from the highest priority.

3.1 Infrastructure as a Service (IaaS)

The adoption of an Infrastructure as a Service (IaaS) model should be strongly stimulated and supported with the aim to increase the sustainability of e-

Infrastructures and to identify and provide innovative solutions which could find a larger use in the society

3.2 Commodity Computing

Since commodity computing to run applications is the most common "first e-Infrastructure contact point" for new users and user communities, e-IRG recommends strengthening and clarifying the roles of the National Grid Initiatives and the European Grid Initiative.

e-IRG also recommends that organisational structures and incentives are put in place that ensure that all the actors in the commodity computing domain will have an interest to – when technically appropriate – bring these new users and user communities into contact with other components of the e-Infrastructure.

3.3 Standards and Interoperability

e-IRG recommends continuing[14] interoperability benchmarking through global standardisation. In addition to making it easy to benchmark in terms of their suitability, dependability and cost-effectiveness in different application domains, this will ensure long-term interoperability of different implementation technologies used for providing e•Infrastructure services and create a marketplace for commercial offerings.

3.4 High-performance computing

e-IRG recommends establishing organisational structures and processes that ensure that the European know-how related to exascale computing can be rapidly accessed. This requires designing optimal support structures that ensure that all of the European expert communities can freely and efficiently share information, both about specific solutions and general best practices. International efforts, such as IESP, should be followed.

3.5 Sustainable Data management infrastructure

e-IRG recommends that sufficient EU and national resources are reserved for preparatory work to create a blueprint for enabling data-intensive research. e-IRG also recommends that the already established e-Infrastructure initiatives appoint a representative to liaise with this new initiative. e-IRG will commit its expertise and contacts to policy makers and data management experts to support this initiative.

3.6 Networking

e-IRG supports Pan-European efforts focusing on the impact of the new research networking technologies and policies on the innovation potential of the e Infrastructure on the one hand, and on the impact of the cost and policy differences in the member states on the commercial deployment on the other.

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[14] As stated e.g. in the report of the e-IRG Task Force on Sustainable e-Infrastructures in 2006.

More efforts should be targeted towards ensuring that the new networking technologies are taken into use as rapidly and broadly as possible.

3.7 Commercial uptake

e-IRG recommends gathering information about successful commercial uptake of e Infrastructure–related innovations to identify policy, funding and other mechanisms that would support seamless transition of proven e Infrastructure collaboration models into broader use in the society.

3.8 New user communities

e-IRG recommends that the member states, EC and the sustainable e-Infrastructure initiatives propose and provide resources for mechanisms that will:

- Speed up the adoption of sustainable e-Infrastructure services by new user communities
- Complement the competitive call for projects approach with a faster mechanism to target resources to popular e-Infrastructure services
- Identify partners and collaborative processes to support the organisational development of the new user communities in areas not directly related to the use of the e-Infrastructure.

3.9 International collaboration

e-IRG recommends that funding agencies and organisations hosting the researchers ensure that policies related to funding and human resources are flexible enough that – when such opportunities present themselves – European e-Infrastructure experts will be able to accept visible leadership roles in global groups without sacrificing their career development within ERA. This will maximise the positive, global impact of European e Infrastructure investments in the global arena.

This empowering of individual European experts should be matched with policy-level actions to align procedures, to maximise information exchange and overall strengthening of cooperation on international matters.