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e-Infrastructures
in support of the Digital Agenda

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1.   Introduction

The Digital Agenda[1] – one of the seven flagships[2] of EC's 2020 Strategy[3] – describes Europe's strategy, policies and actions to allow the European economy and society to benefit from the Digital Revolution. Under Research and Innovation actions the Digital Agenda puts forward: "Europe should also build its innovative advantage in key areas through reinforced e-Infrastructures and through the targeted development of innovation clusters in key fields. It should develop an EU-wide strategy on "cloud computing" notably for government and science". Through its links to the e-Infrastructure community across Europe e-IRG is in a unique position to inspire and assist in the implementation of the Digital Agenda and to help ensure that any new actions in the field of e-Infrastructures will be within the general political context and framework of the Digital Agenda.

In this survey we first describe the essential role of the e-Infrastructure community for the realisation of the Digital Agenda and the importance of a proper e-Infrastructure governance. Next, recent e-IRG observations, recommendations and actions issued in White Papers and other e-IRG policy documents relevant for the Digital Agenda will be summarized and linked to the seven problem areas recognised in the Digital Agenda. The aim is to provide guidance on the developments and actions required to achieve the goals of the Digital Agenda.

1) http://ec.europa.eu/information_society/digital-agenda/documents/digital-agenda-
    communication-en.pdf
2) http://ec.europa.eu/research/innovation-union/pdf/innovation-union-communication_en.pdf
3) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:fin:en:pdf

2. The e-Infrastructure community plays an essential role in realising the Digital Agenda

In almost all action areas of the Digital Agenda the research and higher education community will be able to contribute by its unique capabilities of signalling new developments and trends and by supporting the first implementations and the scaling up and the internationalisation of new ICT-developments, being a real international group of leading edge users.

In the past, policy making was often based solely on the driving role of the supply side of the ICT industry and users hardly played a role in all this. This situation is now gradually changing and that trend needs to be accelerated also at the European level. The e-IRG aims to express the interests of more than 40 million European users and developers of the e-Infrastructure serving the combined Research-Development-Innovation-Education (RDIE) sector[4].

The research and higher education user community has traditionally been the early adopter – and often also the developer – of new information and communication technology (ICT) components and services. The close interaction between users, providers and developers of new technologies and services often instigates the creation of new service components and interfaces. For example, the e-IRG Data Management Task Force and the ESFRI preparatory phase projects have both indicated a need to add data-related services to the e-Infrastructure model. Research e Infrastructure user communities often have very specific and challenging needs ahead of the general ICT market; combined with a highly motivated commitment to overcome technological problems in order to achieve their research goals. Hence any new e-Infrastructure technology is immediately used in a multitude of ways, on many different operational scales, for different scientific processes, and under very close scrutiny. These user communities and related service providers constantly analyse how the new technology fulfils its promises and clarify any adjustments needed to render the service a better fit with user requirements. This process accelerates the technology adaptation cycle. Thus e-Infrastructure often acts as an innovation engine, accelerating ICT-related innovation in society as a whole. Open communication between the users and providers of any new technology in a virtuous feedback circle allows both groups to develop a rapid and realistic picture of the benefits and drawbacks and risks of the technology in question.

4) http://www.e-irg.eu/images/stories/eirg_roadmap_2010_layout_final.pdf

The success of this approach is exemplified in the networking arena, where National Research and Education Networks (NRENs) collaborate under the GÉANT label, serving over 40 million users in 34 European countries. This collaboration has led to several innovations in the regular networking market as well as in the research world. Recently and based on the success of GÉANT, the GÉANT Expert Group delivered a report to the European Commission with a 2020 vision for future European research and education networking and identifying an action plan to realise this vision[5]. Figure 1 illustrates a conceptual model of the role of e-Infrastructure in ICT innovation[6]. It shows how innovation in scientific network infrastructures has primary effects on innovation in the general networking market and in generic application services and specific ICT-applications.

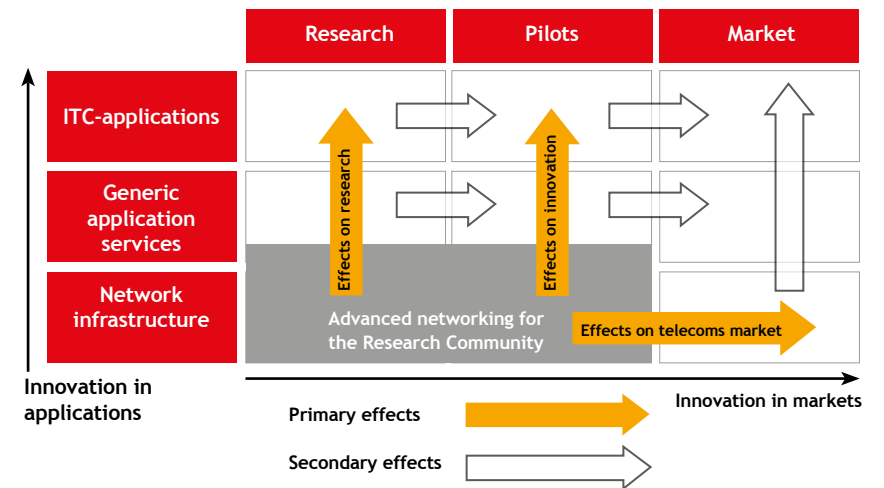Figure 1: Advanced Networking as an example of the impact of e-Infrastructure innovation

5) Knowledge Without Borders - GÉANT 2020 as the European Communications Commons, Report of the GÉANT Expert Group, European Commission, 2011
6) From e-IRG Roadmap 2010, based on experiences and observations from a networking, research, and large-scale piloting project 'GigaPort Next Generation Network' in the Netherlands (2004-2008)

3. Governance structure for e-Infrastructures needs improvement to be able to support the realisation of the Digital Agenda

In its White Paper 2011 e-IRG has concluded that changes in the governance system, its legal base and its financing mechanisms, will be necessary and should lead to strategic user empowerment, should guarantee the flexibility and internationalisation of the supply chain, and should safeguard the crucial role of e-Infrastructures in bringing ICT innovation to the users in its earliest stage. Such changes should include provisions that allow users to switch to services with different funding and charging mechanisms, e.g. moving from a centrally funded service to one that is partially funded from the user budgets.

More specifically the White Paper 2011 recommends:

- to establish a user-community-centric approach in strategic e-Infrastructure governance. This should include the appropriate funding mechanisms that make a clear distinction between the funding of service provision and the funding of innovation activities.

- to define the long-term financial strategy for e-Infrastructures aimed at a sustainable operation of services in a flexible and open environment that includes offers from commercial service providers.

- to address the problems of barriers to cross-border service delivery and quickly remove as many of these as possible.

- to introduce governance models that provide efficient and effective coordination mechanisms at all levels: regional, national, European and – where possible – global while providing the possibility for public and private research and cooperation via public-private partnerships (PPPs).

- to encourage important players in the use of e-Infrastructures, like ESFRI, Virtual Research Communities etc., to investigate the impact of strategic changes in e-Infrastructure governance and financing on the operation of and access to international Research Infrastructures.

- to investigate the effectiveness of legal structures, like ERIC, for e-Infrastructures.

4. Observations and Recommendations by action area of the Digital Agenda

4.1 A vibrant digital single market

Representing a pre-eminently international user community e-IRG recognises the necessity of a vibrant European single market to deliver the benefits of the digital area. The e-IRG community is in particular confronted with the negative consequences of today's fragmentation of the European digital markets in particular due to limitations in the access to digital content. The emergence of provisioning e-Infrastructures as a Service (IaaS) like cloud provisioning can have some drawbacks for the digital single market for instance in relation to data protection, lack of openness, vendor lock-in dangers etc. The e-IRG looks forward with interest to the forthcoming EU cloud strategy announced for the middle of next year.

Secondly the e-IRG community is confronted with the lack of a single European market for electronic communication and electronic communication services (Digital Agenda section 2.1.4). The latter presumably contributes heavily to the existence of a digital divide between end users in various member states, it creates barriers to cross-border service delivery, it causes inflexibility in international governance structures for networking and is seen as a blockade for e-Infrastructure providers to operate on a level playing field. e-IRG sees interoperability as a crucial enabler of the vibrant Digital Single Market in Europe, as is stated further in Section 4.2.

Looking at the actions mentioned for this action area in the Digital Agenda, e-IRG suggests that its community should play a leading role as a stakeholder in Key Action 1 - Simplify copyright clearances, management and cross-border licensing – while taking care that the particular interests of open access to information for higher education and research will be taken into account across Europe and beyond.

In its White Paper 2011 e-IRG has stated that the direct help from national governments and the European Commission supports innovation and helps to establish a single market for electronic communications and communications services. It is expected that increasing bilateral, regional and multilateral cooperation between e-Infrastructure providers can help to narrow the digital divide

and can also generate sufficient political pressure to enforce a single market for electronic communication services in the EU. e-IRG recommends to investigate the causes of the digital divide between European researchers rigorously and combat this with the appropriate instruments. This investigation could be part of the actions related to Section 2.1.4 of the Digital Agenda and support a further discussion within the EU on action to be taken to overcome the problems described in the White Paper 2011.

4.2 Interoperability and Standards

Setting and implementing the right standards, for the right interfaces at the right moment is the key to improve interoperability between IT-products and -services. The e-IRG has expressed this early in its recommendations of the 2004 workshop, where it is stated that "We should continue to focus on Open Standards and avoid any vendor lock-in". The Digital Agenda mentions the Internet as the best example of the power of technical interoperability. The experience of the users and service providers within the e-IRG community might show the way to improve the effectiveness and the efficiency of European standardisation policy.

The recent policy development to also recognize de-facto and widely accepted industry and user community standards is a step in the right direction. Further steps need to be investigated in particular to speed up the standardisation process.

In its Roadmap 2010 e-IRG has already called to improve the interoperability of e-Infrastructures by pursuing global standardisation efforts. In its WP2011 e-IRG signals the necessity of worldwide interoperability due to the change towards infrastructure services and clouds. Particularly the issue of semantic interoperability and multilinguicity is important for creating the ERA. Also the interoperability of various national ICT service infrastructures, such as for e-Identity, requires attention. Interoperability issues in data management are another e-IRG priority.

Infrastructure as a Service (IaaS) and similar service-oriented solutions are emerging in both academic research and industry, e.g. by exploiting the opportunities provided by the clouds. These solutions respond to ever-changing requirements by means of on-demand provision of requested resources for a widening spectrum of diverse applications, and they also stimulate a service-oriented approach.

If this challenge of implementing changes to IaaS is to be met then important issues will have to be resolved by setting ambitious goals:

• Heterogeneity of e-Infrastructure services necessitates a strong focus on standardisation efforts, at the level of both the users and the service providers.

• Openness as well as adaptability of the standards is a must, in view of the diverse user needs. There is a serious threat of user lock-in in captive service offerings using proprietary standards.

• Service-oriented architectures should aid interoperation of e-Infrastructure services, if and where possible.

• Virtualisation should be used to build virtual research environments (VRE) and virtual research communities (VRC).

The e-IRG Report on Data Management[7] stresses the importance to ensure that scientific data is reachable and useful to other scientific fields, i.e. to enable cross-disciplinary Data Intensive Science. Therefore programmes that support

7) http://www.e-irg.eu/images/stories/e-irg_dmtf_report_final.pdf

cross-disciplinary access to digital objects and related services will have to be actively encouraged. More in particular the Report recommends:

- Encourage the development of non-discipline-specific frameworks and information architectures for interoperable exchange of data.
- Support communities for the definition of their requirements and their activities in the domain of semantic interoperability.
- Support interoperation activities within multinational and multi-disciplinary /community grids, e.g. OGF activities, or within EGI; the activity itself, however, is likely to be focused on a part of the infrastructure, e.g. authentication, job submission, or storage.
- Prioritise those interoperation activities aiming at standardising interfaces and/or protocols, or documenting current usage and limitations of existing standards for interfaces and protocols.
- Ensure that work is practical and realistic instead of theoretical "paperwork".
- Ensure that besides hardware and services, digital objects deserve infrastructure components in their own right: mediation services for metadata / semantic annotations of data; persistent linkage of research data with publications and other resources; policies for long-term preservation of data, maybe focused into dedicated centres (preservation activities plus consultation).
- Define proper governance structures and guidelines for (inter)national agreements for distributed heterogeneous data facilities.
- Highlight that the basis of proper data management is a proper repository setup with strict organizational guidelines that are supported as widely as possible by a proper repository system.
- Highlight that for achieving semantic interoperability in open scenarios the project oriented approach of formal ontologies seems to be problematic, suggesting that a separation between concept definitions and their relations is desirable (as is suggested by ISO 11179 and ISO 12620 for example).
- Highlight that state-of-the-art network infrastructures are needed that are capable of adapting flexibly to the needs of the applications and researchers relying on them.

4.3 Trust and Security

Innovation, open access to services and free movement of knowledge are important values for the e-IRG community, but it is as important to establish and maintain the level of mutual trust amongst users and service providers that is needed for an open ecosystem to function. As an e-Infrastructure matures and its user community grows, requirements for aligning authentication and authorisations grow as well. Security-related policy issues involve privacy, protection, confidentiality, ownership aspects, all of which need to be specifically addressed. These issues become even more important through commercial cloud related developments.

Being often present in the early deployment phase of new ICT-Applications and services the e-IRG community has much to contribute to actions, projects and pilots - like proposed in Key Action 6 - aiming at a reinforced and high level network and information security policy.

In its White Paper 2009 the e-IRG recommends the promotion of a coherent framework that will act as a working base for the implementation of unified security services. In particular, the full extent of cross-disciplinary synergies of a coherent model for data security should be studied and exploited.

4.4 Fast and Ultra-fast Internet Access

In Section 4.1 e-IRG already stressed the absence of a European single market for electronic communication and electronic communication services presumably contributing to the Digital Divide for Internet Access amongst users in various member states or area's within member states.

The needs of the e-IRG community for 'Ultra-fast' Internet Access and or additional advanced regional and international connections using lightpaths, will remain years ahead of what the market in general can supply. Therefore networks for research have always been leading the innovations of electronic communication networks. They should play a more important role in the proposed Key Action 8 of the Digital Agenda, in accordance with their role as described in Chapter 2 of this report. In order to be able to do so the e-IRG White Paper 2011 recommends:

- To innovate in network provisioning and network governance to satisfy user demand and stay competitive at the global level.

- To use the planned GN3 foresight study led by TERENA to draft an Innovation Agenda for research networking to be used by all stakeholders.

- To build the networks as a federative and open system, giving flexibility and worldwide connectivity to public and private researchers and with seamless integration with other e-Infrastructure service providers.

- To investigate rigorously the causes of the digital divide between European researchers and combat this with the appropriate instruments.

4.5 Research and Innovation

In the competitive market for ICT-products and services, the research and innovation activities should be international by nature and enabled by a seamless leading edge European e-Infrastructure. The role and impact of the e-Infrastructure demands growing and sustainable funding at the European level and effective, efficient and transparent governance mechanisms in the 2014-2020 period for e-Infrastructure development and operation. Equally reliable, consistent and secure financial support on a national level is an absolute necessity. It is not realistic to assume that a model where costs are fully charged to the user can support the necessary continuous innovation of a stimulating service portfolio that requires the high quality e-Infrastructure facilities. Insufficient EU and national funding would result in a situation where Europe will quickly and seriously lag behind the rest of the world and a rapid weakening of the European Research Area. This will thus defeat the objective of realizing ERA by 2014. The ultimate consequence might well be the degradation of the European e-Infrastructure, and consequently a fast weakening, if not collapse, of the R&D activities – with unforeseeably huge consequences.

Recommendations from the e-IRG Blue Paper 2010

- Recognise new RI as 'innovation engines' in research network evolution, and encourage them to engage with this role by defining, testing and using new networking services.

- Encourage RI to participate in networking coordination bodies to secure an ongoing exchange of information on the development of advanced networking services.

- Encourage advanced users and research network providers to ensure that national and European authorities support appropriate governance and financial models.

Software and computing are increasingly essential to all areas of research and innovation, which in turn drive the generation of innovative software solutions of much wider application. Europe has a recognized strength in software development across a wide range of domains but we face a number of challenges in the face of the rapidly evolving technology landscape. The existing landscape of complementary High Performance Computing (HPC) architectures is

advantageous and enables HPC to match the requirements of a broad range of user communities. This advantage should therefore be retained for future exascale computing. Actions of the EU and member state governments to increase investments in ICT-research are also indispensable because innovation of the e-Infrastructures needs more input from research activities in Europe.

Recognising the essential role of software and computing, the White Paper 2011 recommends:

- To dedicate resources to the study of new programming models, algorithms and languages, porting software libraries and software tools to exascale environments, and preferring open source software solutions to leverage existing know-how in a cost-efficient way.

- To identify new grand challenges in science which are able to utilise the exascale platforms.

- The partnership between users of exascale computing, industry and computer scientists must be encouraged, and scientists should be given the opportunity to liaise with programming experts.

- Specialists must create training materials, including robust and easy to use "cook books" for users, especially for those who are not computer scientists.

5. In conclusion

As demonstrated in this paper the e-IRG makes a substantial and essential contribution to driving the European Digital Agenda forward. The relevant policy makers are encouraged to exploit better the knowledge, know-how and experience bundled in the e-IRG and expressed in its publications. The e-IRG is ready to play its role in this respect.