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Talking about e-science

e-Science in Horizon 2020

Horizon 2020, the European Commission's next funding cycle, is set to launch in January 2014. With less than a year to go, you may be wondering: what is Horizon 2020? What makes it different to the frameworks that preceeded it? Why the break from the simple numbered iterations, FP7, FP6...which began, as you might expect, with FP1...all the way back in 1984?

The commission is the executive arm of the European Union, a unique union of nations that has recently found itself the recipient of the Nobel Peace Prize – an acknowledgement of the successes of the European experiment – just as economic difficulties threaten to cause social and political unease across the union. It is safe to assume that politicians throughout Europe will be scrutinising the outcomes of EU-funded projects more closely than ever before. The overarching goal is to strengthen the economic and social ties within Europe, and to bolster the European economy in the longer term.

In EU member states, the economic situation means there is a renewed focus on investments giving returns in the short term, and this includes research funding. Indeed, for the EC too the economic vision has always been more pragmatic than purely Keynsian: there is room for 'blue sky' research, but projects have long been required to aim for sustainability post-funding; now, there is likely to be a greater emphasis on public-private partnerships. For research e-infrastructures, new funding models are being tested. Variations of pay-for-use, a model familiar both to industry and increasingly to academic research when it comes to cloud services, are being tested for grid. The need to act synergistically; to coordinate at the level of national research centres; minimise overlap when it comes to large-scale funding; emphasise centres of expertise and optimise governance, are all now acknowledged.

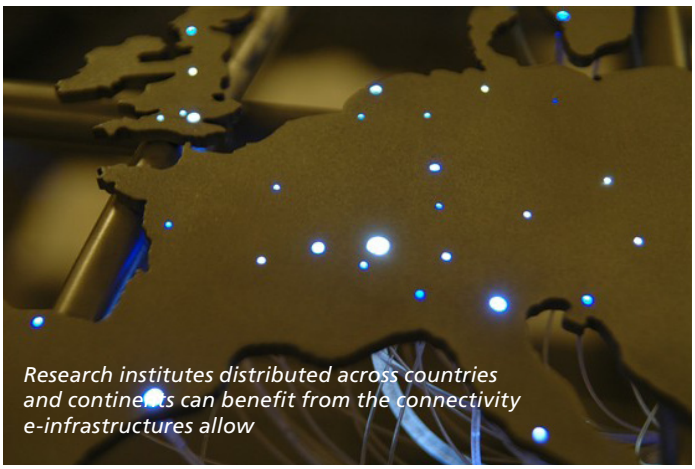
Neelie Kroes, Vice President, European Commission – *"As the Commission President has stressed, this budget can still be a catalyst for growth and jobs, and a tool to boost our competitiveness. The significantly increased investment Horizon 2020 will be making in EU research and innovation, including in the field of ICT, is a very vivid illustration of that. This is investing in tomorrow's growth; and by acting at European scale we can ensure research and its benefits spread as widely as possible, including across borders."*

e-infrastructures in 2020

At its heart, the focus of Horizon 2020 rests on three pillars: excellent science, competitive industries, and better society. These are the broad objectives that are hoped to be achieved in Europe by Horizon 2020. At the 10th e-infrastructure concertation meeting in Brussels, Kostas Glinos, Head of GÉANT & Infrastructure within the EC's DG Connect information society and media provided an overview of Horizon 2020 and what it would mean for e-science. e-infrastructures being developed need to reflect the societal and policy needs of Europe; they must integrate into the planning phase the specific innovation activities to be supported – the scientific projects they will allow. They must also go beyond science, reach out to industry and work for the benefit of society.

An important part of the Horizon 2020 strategy is a review of how e-infrastructures used for e-science operate; to maximise coordination and identify and build upon synergies across member states, so that successful areas can be developed while minimising overlap of effort. De-siloing is important: infrastructures built by and for specific research communities are often of use to the wider community, and they should be identified and made universally available where appropriate. Similarly, governance should be optimised: expertise in managing

projects should be identified and nurtured, or streamlined where required. The Horizon2020 framework preparations have identified areas of e-infrastructure development that already have solid foundations, in addition to areas where work is still required (such as the full HPC strategy implementation, still in progress), with the ultimate goal to 'make every researcher digital' by 2020. A set of funding instruments to help achieve this has been outlined (see box). The requirement for Open Access publication of data from ERC-funded science has been mandated since 2002, and the successful development and deployment of the OpenAIRE framework allows researchers to deposit their publications online where they can be freely accessed by other researchers. Open Access is an important stepping-stone to Open Data, the open sharing of data that will help researchers to more efficiently focus efforts when working to tackle some of the biggest challenges of the 21st century (see e-Sciencebriefing 22: 'Open Data, Open Science' . In addition to this, the international Research Data Alliance has been set up to push for convergence of standards on how data is stored and categorised. This data about data is called metadata, and was covered in e-ScienceBriefing 24:'Big Data'.



Research institutes distributed across countries and continents can benefit from the connectivity e-infrastructures allow

In addition to the 'instruments' or tools available within the funding structure to help foster innovation in e-science, there is a HPC strategy, aiming at an integrated approach to HPC for industry and academia. HPC, or high performance computing, is often referred to as supercomputing. There are scientific and technological goals, notably the move into exascale computing, which in simple terms means a thousandfold increase in the number of calculations possible. This will lead to better and more accurate simulations across a range of scientific fields, from biomedicine to engineering and climate models. From the industrial side, public-private partnerships in HPC should bring economic benefits by tapping into supply and demand, for example by pushing forward innovation more rapidly and allowing for quicker adoption of disruptive technologies. This includes the use of GPGPU (general purpose computing on graphics processors), acknowledged to offer better performance when modelling complex phenomena such as climate, with the added benefit that graphics processors

Kostas Glinos, Head of e-infrastructures unit, EC *"The goal to make every researcher digital, through the development and deployment of e-infrastructures, and to achieve the digital ERA [European Research Area]. We need to look at not just how e-infrastructures can help with scientific research, but also how they can be used to address the needs of society overall."*

are becoming much cheaper much more quickly than CPUs (e-ScienceBriefing 23: Transferring Technology and Knowledge). Finally, there will be a focus on fostering centres of excellence for HPC applications or specialities in particular fields. These will form central hubs much like the established research institute (e.g. CERN, DESY) and help realise the ERA or European Research Area, allowing researchers from across Europe to tap into expertise in a very streamlined fashion.

The right tool for the job: Funding Instruments for Horizon 2020

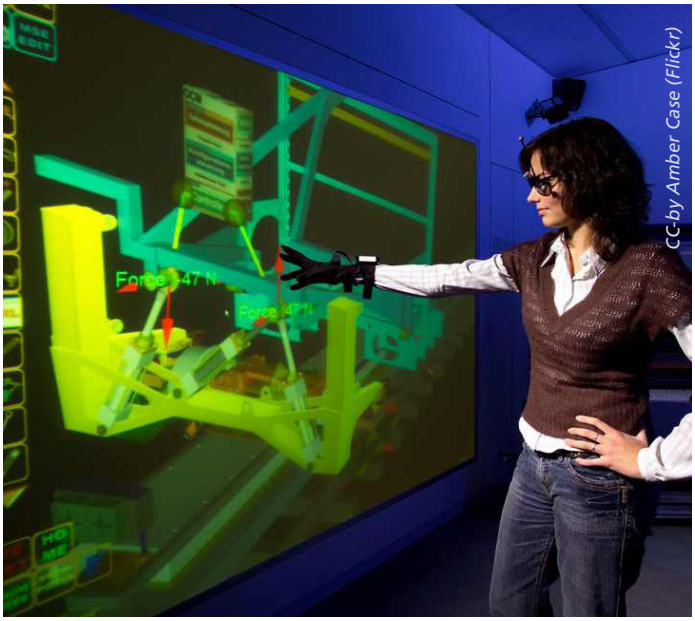
2020 Under Horizon 2020, there are a number of instruments available to the EC. For research and development, grants can be given up to 100% for each objective in a work package; for innovation, it's 70%. There remain places for coordination and support actions, examples in FP7 being the e-infrastructure reflection group (e-IRG) and e-ScienceTalk projects. Small-to-medium enterprises are allowed to apply to participate for grants at three stages: concept and feasibility assessment; R&D, demonstration and market replication (including prototyping, piloting); and commercialisation. To stimulate innovation in the private sector that can benefit the public sector, pre-commercial procurement (PCP) can steer development to fit public sector needs, while public procurement of innovation solutions (PPI) ensures that innovation in the market is rewarded by the public sector being the first buyer of these innovations. Prizes both recognizing innovations already taken to market, and also inducing companies to take those that are promising to market, also have their place.

Advancing Synergies with e-Science

Global connectivity between researchers themselves and superfast connections between existing centres of excellence have, arguably, a more important role to play than ever. Funding the building of new research institutes is less justifiable in tough economic times when centres of excellence already exist, but clearly superfast research networks are not simply a cheap substitute for a new CERN. The goal of making every European researcher digital and the changing model of how research is being done makes these networks, such as GÉANT, an integral part of the fabric of the European Research Area. 'New'

institutes are likely to be centres of excellence with particular synergistic specialisms, geographically spread out but linked together through networks and virtual research environments.

Identifying synergies in research is an important first step. The Cluster of Research Infrastructures with Synergies in Physics (CRISP), for example, identifies and builds on commonalities in four areas: accelerators, instruments and experiments, detectors and data acquisition, and IT and data management. By sharing expertise and finding common solutions, CRISP hope to contribute to improving the efficiency of spending in large physics-focused research institutes. In biomedicine, on the other hand, BioMedBridges are linking up various life sciences communities through innovative e-infrastructures that, for example, allow sharing of disease data between scientists studying models of diabetes in mice and known data from humans. This kind of comparison, which was previously very difficult, is now possible and through these kinds of innovations, synergies are also being developed and exploited in the life science communities.



Virtual research environments could take any shape: from an electronic lab book to a virtual reality physics lab.

Virtual Research Environments (VREs) are a diverse range of collaborative platforms for researchers from across the sciences and humanities that support users in a variety of ways. On one level, they can act as an enabler of open-notebook science – either within specific communities or completely open to the public – allowing data to be recorded and shared with others. VREs can automate aspects of data recording, including metadata – for example by using a smartphone's GPS ability to record geographic location alongside other data recorded by researchers, such as for biodiversity studies. Modular, customisable workflows are another aspect of some VREs, which can be used by researchers to speed up the process of getting to the experiment and data collection stage. This is being done both for individual communities, such as solar sciences (CASSIS, for heliophysics) and hydrology (DRIHMS), to more generic tools for building gateways for a range of research communities (e.g. SCI-BUS). The diversity of nature and scope of VREs means that they represent more of an evolving ecosystem than a specific type of platform. There is a need to continue this flexible approach to user-configurable e-science environments, to help build communities and define what is needed.

Current EU initiatives have been been successful in the fields of cross-border collaboration, particularly in respect of mobility and harmonised access. TERENA's (Trans-European Research and Education Networking Association) eduroam® allows researchers to access wi-fi facilities in institutions across Europe and the rest of the world. GÉANT's web Single-Sign-On (SSO) service, eduGAIN, provides secure access to remote collaborators whilst maintaining data and access security. The ELCIRA initiative, meanwhile, will provide Web Conferencing, Wiki collaboration and data sharing secured by eduGAIN between Europe and Latin America.

Michael Krisch, CRISP coordinator, ESRF, *"Competitition in science has been something that has been very beneficial in the past because it stimulates progress. But as research infrastructures are financed by taxpayers' money, we have to be increasingly vigilant to spend funds in a very efficient way. One way of doing that is to identify commonalities across the european research infrastructures and find common solutions to problems, which we can then implement."*

Pay-for-use

Pay-for-use is a model familiar to many in the world of cloud computing; one of the reasons that cloud has taken off in industry while grid has struggled is that businesses understand the idea of paying for a service – paying for what they use. The marketplace in cloud is subsequently enormously diverse, a benefit due in part to the free marketplace that can quickly adapt to changing customer requirements. Competition means that commercial cloud providers now sometimes provide free cloud services to individuals with the offer of upgrading to a 'pro' package – more suited to a heavy user, or a business – for a recurring fee. The Helix Nebula project is piloting the use of commercial cloud services for eScience with a pay-per-use model in a public-private partnership that brings together major public research organisations, such as CERN, EMBL and ESA, with a range of European cloud service providers. So could the pay-for-use model work to bring similar benefits to grid computing?

Scientific research is not a business: there is the need to be cautious when considering pay-for-use, as it is a big change to scientists who have become used to central funding such services. On the other hand, some parts

of the community are already using commercial cloud providers to do everything from supercomputing, to storing large datasets. As they are already exploring the supposed greater agility, dynamism and adaptability of these services, they could be ready for a pay-for-use grid.

"Until e-infrastructure providers try these models, how would we know what works?" asked Sy Holsinger, Strategy and Policy Officer at the European Grid Infrastructure (EGI), during a workshop at the EGI Community Forum in April 2013. After a paper from 2012 was endorsed by the EGI Council, the time was right to turn the 'thought experiment' into a real-world test. Exploring potential brokering models, EGI have tested 'matchmaker' and 'one stop shop' models, in addition to the 'independent advisor' model currently used. Matchmaker sees the federator (EGI) allocate resources from resource providers that match customer requirements, with the resource provider paying the federator for establishing the contractual agreement and the customer paying the resource provider. One stop shop sees the federator doing everything including collecting payment from the customer, then paying the resource provider. For pay for use, both of these models work better, with lower overheads, than the independent advisor model currently used by EGI, where interactions are more decentralised (incurring more overheads); the federator listing services offered by resource providers and being funded by a membership. So pay for use may mean a shift in the role that EGI – and other infrastructure providers – adopt.

Problems and challenges ahead? There are some. Some academic research centres cannot, by law or contract, resell services to third parties. There is the question of taxation. Many member countries have VAT, which could have implications for the purpose of invoicing.

Identifying Success: Going Beyond Science

Horizon 2020 comes at a very interesting point in the history of Europe. Despite the current financial situation across Europe, public perception of science and wider academic research is very positive, and support for funding science remains high. There has never been a better time to engage the public in scientific discourse, and e-science projects are learning how to better interact with the public. The project iMarine, for example, has released an app called Applifish that can be downloaded onto a mobile device, which contains species and location data for many types of fish through an attractive and easy-to-use interface. This can help the average consumer make decisions about the sustainability of the fish they put on their plate. Global Excursion, the extended curriculum for science infrastructures, is aiming to introduce e-infrastructures – what they are and what they have achieved – to school students aged 14-18. Their virtual science hub has also spawned a successful spin-off project, Mash-Me.TV, which has now been commercialised

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At the 10th e-Infrastructure Concertation meeting, Sonia Spasova, Communication Officer for DG Connect at the EC, highlighted the success of the e-ScienceTalk project in bringing the world of e-Science to a broader audience. Through the diverse communications channels that e-ScienceTalk employs including iSGTW.org, Gridcast.org, e-ScienceCity.org and GridGuide.org, the success stories of e-infrastructures in Europe and beyond are reaching a wider audience and hopefully inspiring young people to consider e-science as a career.

Going beyond science isn't just about communicating success stories. There is a need to formulate a translation pipeline to encourage instances of adoption of innovations and to recognise contributions outside of academia. Researchers may still require up-skilling and some hand-holding to help bring products to market, something that has been integrated into the 'rich toolbox' of instruments available within the EC funding framework.

Catherine Gater, e-ScienceTalk, *"e-ScienceTalk have pushed the message of e-science to a broader community. By delivering training programmes on communication, they've also been able to pass on what they've learned to other projects so that this incredible science can be made more public."*

Summary

It is clear now that 2020 is a goal-line. By shifting the emphasis to a date we can imagine, the EC is reframing the tasks ahead: to take on the Grand Challenges of the 21st Century with renewed focus. There is much change to come, but also an array of reassuring success stories that demonstrate the dynamism of e-infrastructures in the past. Taking on the Grand Challenges will require more coordination and strategic developments, but as synergies are identified within and between research communities, it is clear that research will continue to be more digital, more interlinked and more accessible than ever before.

For more information:

'Digital Science in Horizon 2020' (March 2013) – Kirsti Ala Mutka, DG Connect : http://www.euresearch.ch/fileadmin/documents/ICT/Digital_Science_in_H2020_final.pdf

Neelie Kroes blog - A budget for European growth: http://blogs.ec.europa.eu/neelie-kroes/eu-budget-innovation-cef/

Adding Pay-for-Use Models within EGI: https://www.egi.eu/blog/2012/12/03/adding_pay_for_use_models_within_egi.html

CRISP: www.crisp-fp7.eu
GÉANT: www.geant.net
eduroam: www.eduroam.org
EGI: www.egi.eu
Real Time Monitor: rtm.hep.ph.ic.ac.uk
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