

Global Virtual Research Communities

Abstract and Motivation:

All fields of Science have made a long way since ancient methods for time measurement to the today's rocket science or understanding genome.

Understanding and knowledge evolved so have the tools supporting research tasks. Hands-on science or, in other words, the capacity to experiment with the very big and very small brought new insights, new comprehension to the level of being able to replicate and control natural phenomena.

There has been always a virtuous cycle of building new instruments and their use for new (or better) scientific understanding. This, in a nutshell, is where research infrastructures appear as enablers of scientific excellence and ultimately, social wellbeing.

Our world that is enjoying unprecedented levels of access to information with the Internet and the Web provides opportunities for a new quality in the science domain and far beyond. This networked infrastructure allowing the sharing of scientific resources – the e-Infrastructure – enables new ways of carrying out science that have never been imagined before.

In particular, starting with the objective to have Europe in the lead of XXI century science, there is an opportunity to see how far and how fast Europe can evolve its scientific ecosystems to respond to these challenges.

Some of the challenges can be summarised in the build-up of world-leading infrastructures to attract the best minds and the best science projects. Other challenges relate to the need to look at the evolved organisational models to make all the positive forces resonate and to mitigate all potential barriers.

The rather tangible concept of **Global Virtual Research Community** is presented in this paper. Its main objective is to link advanced science to its supporting and underlying infrastructures enabling a new era for European research (and beyond).

1 Rationale

There is a revolution going on in the global world of research, underpinned by advanced communication infrastructures like the world-leading pan-European research network GÉANT, the advances in Grid infrastructures enabling new ways of scientific collaboration and resource sharing and the wider and open availability of repositories of scientific data: the **e-Science**.

Besides all the technical achievements that enable these new ways of research collaboration (called e-Infrastructures) their impact on the actual way on how science is carried out is at the heart of this roadmap.

Scientific work can now be done in real-time versus waiting weeks or months for results, rare, expensive and unique resources are made available and accessible through modern communication technologies. Therefore they create an equality of opportunity for regions that do not have these scientific instruments or can not afford them. The scientific resource is coming to the researcher instead of the researcher leaving his country and working at the instrument. This greatly alleviates the brain drain not only in the peripheral regions of Europe but also in developing countries where the power of e-Infrastructures allows researchers to stay in the country and still carry out state-of-the-art research.

Europe (DG RELEX and DG AIDCO) has financed advanced communication infrastructures across the planet. These joint initiatives have been received enthusiastically by the countries, as they directly empower their research communities and beyond (e.g. in areas like telemedicine, distance learning).

Consequently, a world-wide community of researchers has been created by connecting the best minds enabling ideas to be linked at the speed of light. This *global virtual research community* is innovating the scientific process.

There is a similar development going on in the field of higher education. The virtualisation of higher *education* has been going on for a quite a while now. Open universities in which students can study at distance are well established. A free internet encyclopaedia, Wikipedia, is growing day by day, becoming more and more accurate and living at the same time. However, the benefits of a decentralised control have to be balanced by appropriate mechanisms to ensure quality of information and scientific ground. There are however two major differences between the development of what is sometimes called the Global Open University movement - aiming at spreading higher education to underprivileged areas - and the **Global Virtual Research Community** that is discussed hereafter. The first difference is that the generic internet for all practical purposes fills most of the needs when it comes to electronic infrastructure. The second difference is that education on distance has been shown to have some limits. Teachers and personal tutoring are even more important elements in learning than in research and cannot easily be replaced.

2 Objectives

The perception is that we are creating a **Global Virtual Research Community** without really realizing it. This document tries to support the awareness rising of this process.

2.1 Improving productivity of researchers

The way *research* is being done has changed dramatically in the last ten years. Nowadays, powerful and affordable computing and simulation technologies enable researchers in such areas as physics, chemistry, biology, medicine and environmental sciences to use virtual models to simulate and solve complex problems before validating them through expensive and time consuming physical experiments.

This has allowed for dramatically decreasing costs of physical modelling and experimentation while at the same time improving the productivity of research processes. This is true not only for more theoretically-oriented areas such as high energy physics, but it includes brain research, research on climate change, drug discovery or nanotechnologies to mention a few. Car manufacturers develop their new models almost completely virtually before they start building real prototypes. It is not just engineers or other natural scientists that have discovered how cost-efficient it is to make systematic use of virtual models, including graphical representations. Archaeologists have found that it is really time-saving to take three dimensional photos of all pieces of urns and relics that they gather and let the computers help them put the pieces together rather than doing it by hand. And when museums all around the world start to take such 3D photos of everything in their vast collections totally new perspectives on how to do archaeological research open up.

The future IT tools and infrastructures thus enable the researchers and the developers to increase their *productivity* dramatically.

This new "virtual world" of research knows *no physical boundaries*. Whether you sit in a stuffed chamber in Cambridge, in the beautiful new library in Alexandria or on the 23rd floor of the new IT tower at Tsinghua University in Beijing does not matter as long as you have access to GÉANT (or similar networks) or its connections. In Europe we have some 25 joint major research facilities in which thousands of researchers are working every day. But there are about one million researchers that are benefiting from the capacities of these facilities, and are doing that by being remotely connected.

Increased *productivity* and the ability to do research in collaboration with others, *independent of geographical location*, are two key drivers behind the **Global Virtual Research Community** under creation

2.2 A new organisational model

How is the **Global Virtual Research Community** organized and what will make it different from how research has been done historically?

The first point to note is that the **Global Virtual Research Community** is being built *bottom-up* by independent virtual research communities. There is no global master plan. There is a *core of respected actors* at the centre of each community who have taken responsibility for making proposals and managing the projects when they are funded. This core is more or less self appointed and self recruiting. Moreover, the community is *open ended* and *self organizing*. To become a member it is enough to be recruited or selected by a senior member of the community. It is up to the participants to decide on their own quite *variable activity level*.

In the heart of a community you regularly see *a common virtual workplace* in which you find research results being made known before they are peer reviewed and published in scientific journals, most of which are still very traditional. In these workplaces the researchers get immediate feedback from other researchers interested in the same field.

Advanced virtual communities also *share resources*. They share computing capacities, share digital repositories, share simulation models and share access to sensors or other facilities. Communities of scientists and users define and agree on standardised ontologies so as to enable more effective document retrieval and knowledge mining at the global level.

The **Global Virtual Research Community** is complementary to the physical research centres; it is not replacing them. There is a reason why some research centres are perceived as better than others. That reason is the human factor. A research student may have access to the same information and the same tools in one place as in another but not to the same tutoring.

2.3 European strengths and positioning

The European Union has in the last few years been the biggest funder of advanced resource sharing and virtual research communities. This development has its own logic and it would probably have happened without the support of the European Union. But the financial backing of the Union and its Member States has quickened the process, made it more inclusive and has given European actors a more central position in the communities under creation than in the past.

Europe's relative openness together with the fact that we have taken a leadership role when it comes to the creation of global eInfrastructures could make Europe the natural centre of the emerging **Global Virtual Research Community** also going forward. In the FP7 Capacity Programme we fund virtual communities in many diverse scientific areas. The communities are supported by the development of simulation models that can benefit from the superior capabilities of a new generation of supercomputers. Also the neighbourhood and development programmes funded by the European Commission have realised and highlighted the power of connections to GÉANT and the European Grids as a priority going forward. The plans for the future will, to the extent that they can be fulfilled, strengthen the role of the European Research Area in the global context.

The **Global Virtual Research Community** is under way and it will arrive in some form or other with or without the engagement of Europe. With a continuous European leadership we can assure that it arrives in a way that is coherent with European values and in a form that is inclusive and supports the development of the European Research Area.

2.4 Motivation for the Global Virtual Research Community

A Global Virtual Research Community could be claimed to serve a purpose of global dimension for mankind, the inclusion of students and researchers all around the world in the highest level of the Knowledge Society. It allows the young - whatever the circumstances they are born into - to fulfil their aspirations. There is an altruistic almost compassionate dimension to that statement - that is admitted. That is why it is somewhat of a dream, not only a vision. But there are some very solid and rational motives too.

By engaging all parts of the world we enable *the best brains* to participate in the creation of new knowledge. This is important as mankind shares many urgent and *common research challenges* that are often too big to be tackled successfully by a single nation or region. It is in all our interests to know more about the inner secrets of nature, to protect our environment, to find cures for diseases such as AIDS and cancer. By working together we can better meet these challenges.

There are *specific research challenges in the developing countries* that are poorly met today. An example is the research around most tropical diseases that is almost non-existent. A global eInfrastructure for research enables a gathering of information from the field that is essential as well as creating a critical mass of cooperation between researchers in those developing countries and the established universities.

By spreading knowledge we create in more countries *the basis for democracy, the rule of law and human rights*. An educated middle class is a must if you want to see decreased tensions and more tolerance between religions and between ethnic groups. Democracies established in countries where knowledge is restricted to the upper class and illiteracy is widespread have never been stable. As knowledge and tolerance are two sides of the same coin the sharing and spreading of knowledge contributes to *our own security*.

3 Open and restricted communities

It is no coincidence that the **Global Virtual Research Community** has started to grow in areas of *joint concern to mankind*. We all want to know more about space; so our radio astronomers now work together on-line. We want to understand the basic elements of nature; so our high energy physicists are cooperating. We want to understand the consequences of climate change and other environmental threats; so meteorologists, oceanographers and geologists around the world need to combine their knowledge and their efforts. In these areas of research that sometimes are called *pre-competitive research* we have all the reasons in the world to be open and cooperative.

The question is how we should act when it comes to *competitive research*. The vision of the **Global Virtual Research Community** has to be qualified. Innovation is an area where there is competition with a geographic dimension where we compete with the US, with Japan, China and India and with all other emerging economies.

Now what to do about the communities in other areas where we compete? Take one example: There is a Joint Technology Initiative under way in Innovative Medicines. The objective is to boost European competitiveness in the biopharmaceutical sector through pre-competitive research collaborations between academic researchers from universities or clinical centers, Small- and Medium-Size enterprises (SMEs) and the industrial community in a program jointly financed by the public and the pharmaceutical industry. In certain domains, like e.g. "Knowledge Management", representing one of the four pillars of the research to be conducted, joint research facilities are discussed including the creation of an advanced virtual community that shares data, simulation models and computing capabilities. The community is not planning to close the door to participants from other parts of the world but they aim at setting up rules, to protect their intellectual property rights and to get paid for any shared benefits. They have good reasons doing it: Even *when we are in a pre-competitive research area we have to take measures allowing for a commercial approach if we want to support European competitiveness*. However, this also means that forms for cooperation can and will vary from one area to another depending on the preconditions.

The *European Institute of Technology* aims at creating virtual knowledge communities in areas of interest for European competitiveness, thus addressing the issue at a more downstream level. Europe is not trying to copy MIT or other world class universities and create a new one but to build a competitive advantage by being better at using the tools for virtual cooperation now available to the research communities. These communities will, when they are addressing *competitive research*, be of a different character. They will be more organized from the top, have a more formal involvement of industry. Above all, they will be *restricted virtual communities*.

The *European Research Area* will obviously contain both types of virtual communities; the *open* virtual research communities that will be leading the way into a Global Virtual University and the *restricted* virtual communities that will support European competitiveness and that will cooperate with the world around us whenever commercially motivated. This movement from an information society to a virtual knowledge society will have a deep impact on the way the European Research Area will develop. Physical cooperation will still be an important element but it will be complemented more and more strongly by the virtual cooperation.

4 Sustainability

These global virtual research communities are now often financed as projects and they have to renew the organization and the funding at least every third year. As we are building more and more of these communities we need to find a more stable platform for them; e.g. an organisation called DANTE, owned by the National Research and Education Networks has been created to support the operation of the GÉANT e-Infrastructure. A similar structure is under discussion for the long term support of the Grids. Qangos (QUasi-Autonomous National Government Organisations) seem to be a suitable model in this context.

There is a long term question on where support is needed. It has often been claimed that GÉANT is a temporary necessity and that the commercial networks one day will be able to take over its role. The truth is that the horizon has been steadily moving forward. GÉANT has always been five years ahead of the commercial networks. Now that it has reached basically unlimited capacity there is obviously only one way forward and that is for the commercial networks to catch up. The question is if they will do it. Can we foresee a commercial demand large enough for the networks to do the investment? The answer is probably yes as the investment is reasonable from a telecom operator's perspective. This clearly demonstrates the large impact global virtual research communities have onto the public at large within a short timeframe of only 5 years.

It is clear at the same time that more and more of the value of the e-Infrastructure will lie in the services and in the virtual communities – in the Grid structures, in the shared repositories and shared models. A larger proportion of the EC support will by necessity be directed towards these added value levels and services in the future.

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