LONG-TERM GLOBAL COLLABORATION IN e-INFRASTRUCTURES

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chain reds

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Introduction

Introduction

The Research and Education community is increasingly relying on the availability of computing, storage, and data resources around the globe. This is due, on one hand, to the scale of current scientific challenges that require large scientific collaborations distributed in many countries, and on the other hand to the great potential of digital Infrastructures that facilitate the task of researchers working remotely on distributed resources.

Research is becoming global with international teams working on the key scientific topics of our time (e.g. Climate Change, Genomics, etc.). The national and regional initiatives implemented to provide e-Infrastructures with advanced services still face many barriers against truly connecting researchers across continents.

The CHAIN-REDS project aims at bridging this gap by coordinating and harmonising e-Infrastructures across continents.

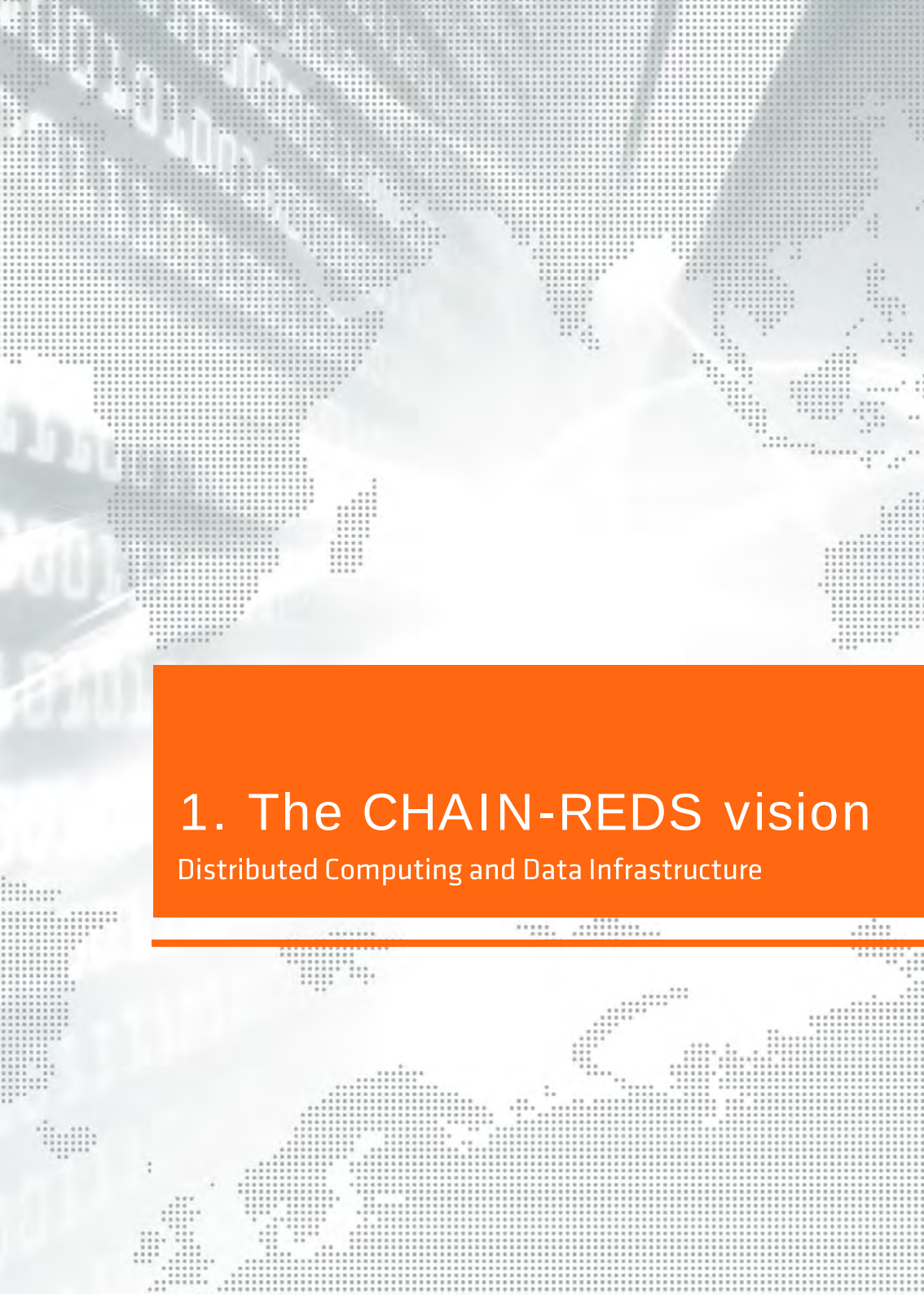
The vision is that all researchers from every continent can access, use and share computing, data and services, creating truly global Virtual Research Communities.

CHAIN-REDS is an FP7 project co-funded by the European Commission (DG CONNECT). Building on the outputs and significant momentum of the CHAIN FP7 project and expanding on a considerable background of knowledge and extensive international experience by the consortium members, the CHAIN-REDS project began on December 1, 2012 and ran for 30 months, becoming de facto a flagship EU project in the field of global e-Infrastructures.

This booklet shows that many of the Project's ambitious objectives are already translated into results and achievements and it gathers the opinions of relevant stakeholders of regional e-Infrastructures and policy makers.

The following chapters clarify the Project's vision and present its major achievements; then an impressive panel of international stakeholders take the floor and, in their interviews, they present their opinions and considerations about the current situation and the perspectives of e-Infrastructures.

The picture that emerges is one where the vision of a global interconnected e-Infrastructure has brought a plethora of benefits to researchers worldwide and increasing levels of institutional support in countries outside of Europe. The stakeholders' greatest concerns involve the uncertainty associated with current funding models, and difficulties in achieving equal partnership among countries.



1. The CHAIN-REDS vision

Distributed Computing and Data Infrastructure

The CHAIN-REDS vision is to promote and support technological and scientific collaboration across different e-Infrastructures operated in different continents, to facilitate their uptake and use by Virtual Research Communities (VRCs) but also by single researchers, promoting instruments and practices that can facilitate their inclusion in the user communities.

Scientific research is becoming increasingly global and has to address challenges that could not be managed by small groups or single researchers (e.g. High Energy Physics, Climate Change, Genomics). It's also very clear that most of the big scientific problems require resources (e.g. big accelerators, computing, storage, etc.) that would hardly have funding available in a single country. At the same time it would be impossible to concentrate a large number (thousands) of scientists in a single laboratory.

In the last 15 years electronic and digital Infrastructures, commonly referred to in Europe as e-Infrastructures, have created a solid basis for ubiquitous access to computing, data and other remotely accessible resources. In a global scientific environment, however, it's a fundamental requirement that worldwide-distributed resources could be used by Virtual Research Communities distributed at intercontinental level, sharing data and services. Europe can thus play a relevant role, not only in disseminating, exchanging and reinforcing the best practices currently adopted in Europe and other continents, but also in promoting the progress of interoperability among different regional e-Infrastructures.

The CHAIN-REDS partners are collectively engaged in studying and defining a path towards a global e-Infrastructure ecosystem that will allow VRCs, research groups and even single researchers to access and efficiently use worldwide distributed resources (i.e. computing, storage, data, services, tools, applications). CHAIN-REDS leverages the efforts and experience of previous cross-continental projects and also builds on the most recent developments in the fields of Clouds, HPC, and Data Sharing.

2. Use cases and achievements

The CHAIN-REDS project has made a significant and remarkable number of achievements. These are now branded as success stories to highlight their impact in terms of technology cooperation and available intercontinental services, and outreach to diverse user groups.

Formal international agreements

On the policy level CHAIN-REDS has directly supported and facilitated the signing of **4 Memoranda of Understanding** (MoUs) between the European Grid Infrastructure (EGI) and Regional Operation Centres (ROCs) in Africa & Arabia, China[1], India[2] and Latin America. These agreements define the framework for long-term persistent collaboration between EGI and the other regional Grids.

Intercontinental testbed facilities

An inter-continental Cloud Testbed was built to demonstrate standard-based cloud interoperability and interoperation, and to provide a platform for running some domain-specific and general-purpose applications. The CHAIN-REDS Cloud Testbed has been organised as a "virtual cloud", currently made up of resources belonging to **10 sites**, from **6 countries**, of which **one** owned by an SME located in Egypt. **Four** out of the ten sites also belong to the EGI Federated Cloud and **three** different and well known cloud stacks are supported, namely **Okeanos, OpenNebula and OpenStack.**

Science Gateways

The project has promoted the uptake and use of Science Gateways (SGs) additionally supporting the creation of EU-project-specific SGs such as **agINFRA's, DCH-RP's, EarthServer's, eI4Africa's** and of national SGs in **Algeria, Jordan, Italy, Mexico, Morocco, South Africa and soon in Tanzania and Zambia**. The **total number of people** registered in the SGs promoted and supported by CHAIN-REDS is **over 1,000** and the current **number of applications** integrated in Science Gateways is **25**.

Knowledge Base

A Knowledge Base (KB), available on the project's web site[3], provides information on the e-Infrastructures available in the countries and includes Open Access Document Repositories (OADRs) and Data Repositories (DRs). As of today, the KB contains about **2,500 OADRs and 600 DRs**. The total number of resources that are indirectly included in the KB is well above **30 million**.

[1] https://www.egi.eu/news-and-media/newsfeed/news_2014_013.html
[2] https://www.egi.eu/news-and-media/newsfeed/news_2014_025.html
[3] http://www.chain-project.eu/knowledge-base

Support for Big Data

CHAIN-REDS has implemented DART (Data Accessibility Reproducibility and Trustworthiness): fully based on standards and established components, DART is a complete data workflow that allows any user and/or collaboration to search and access **Data Repositories and Open Access Document Repositories**, extract datasets from them, seamlessly access the project **Science Gateway by Identity Provision**, use the previously selected datasets as an input of a code already running via the Science Gateway, collect the results and, if requested, store them with a **Persistent Digital Identifier** for future use.

A number of proposed use cases were analysed by the project and five of them were selected for support. All of these make use of the e-Infrastructure services promoted by CHAIN-REDS in the different regions, covering different and complementary sets of user requirements.

- **Use case no. 1: Astronomy LAGO**

The Latin America Giant Observatory is a recent collaboration that relies on Water Cherenkov Detectors in 9 Latin American countries, more than 80 Latin American researchers and a close collaboration with European teams such as IN2P3 in France and INFN in Italy. The LAGO use case success story is based on the DART challenge and currently the project is analysing the best strategy for assigning PIDs to the current datasets and to the new simulation data produced. LAGO will address three different phenomena thanks to the CHAIN-REDS DART workflow.

- **Use case no. 2: Population and health APHRC**

The African Population and Health Research Centre (APHRC) conducts research in a wide range of topics related to societal health and well-being. This use case is mainly devoted to assigning Persistent IDentifiers (PIDs) to the wide plethora of datasets that APHRC manages and curates. This is of strategic importance as these datasets are widely used by almost every country in Africa in order to improve societal health and well-being.

- **Use case no. 3: Proteomics TreeThreader**

Threading is the leading method for protein structure prediction, and it is exceedingly time consuming. The code is already available to the desktop computing community, and is now made available on a full-blown e-Infrastructure: virtual machines are launched from physical servers belonging to the China ROC and managed with OpenStack. These consumed around 15,000 CPU hours in July 2014. All TreeThreader jobs can be submitted both within China and Europe.

- **Use Case no. 4: Molecular dynamics GROMACS**

The GROMACS software package is used for molecular dynamics simulations. This kind of studies presents a huge computational demand. 14 European, Arab and Indian Grid sites have already been enabled with two GROMACS versions: an installation package and a Science Gateway portlet.

- **Use Case no. 5: Materials science ABINIT**

The introduction of ABINIT among the Grid services comes as a godsend for researchers in the fields of quantum chemistry and material physics, for whom the massive calculations in areas such as Density Functional Theory (DFT) are of crucial importanceA team of ABINIT users attended the CHAIN-REDS Science Gateway porting school held in Catania in June 2014 and ported to the Grid both sequential and MPI ABINIT versions. These versions have been installed in 6 European and Arab sites and the required portlet for job submission has been implemented; this will be extended to Latin America in the near future.

CHAIN-REDS supports eduroam deployment as the best and easiest way to promote an example of the benefits of Identity Federations. The promotion of eduroam began in the Arab countries and continued in Sub-Saharan Africa, where CHAIN-REDS supported eduroam deployment or identity consolidation (identity management) in Kenya, Zambia and South Africa; India is already connected to eduroam; in the Asia-Pacific region, where only Macau, Singapore and Thailand are connected, CHAIN-REDS supported the deployment in Malaysia and is collaborating with Taiwan and Indonesia colleagues to support their eduroam-related activities; there is also a pilot eduroam setup in China, in particular at Peking University; in Latin America most of the technical work is done within the ELCIRA project, where 8 countries have eduroam in production and 4 countries have pilot deployment, and CHAIN-REDS works with individual institutions to support their connection to the eduroam infrastructure, currently assisting Colombia in defining its eduroam infrastructure (possibly with the help of technologies that CHAIN-REDS is promoting).

3. The stakeholders' opinion

3.1 Africa

Moctar Yedaly
Head of information Society
African Union Commission

I have been involved in the e-Infrastructure field since 2009 through different African initiatives and EU-Africa joint programs.

What is the role of the AUC in the sector?

The role of AUC is mainly to create an enabling environment and supervise the establishment of intra African broadband connectivity with the aim of boosting Research, Technological Development and Innovation.

User needs in Africa

What are the major needs in terms of e-Infrastructure for researchers and educators in Africa?
The major need is an affordable broadband connectivity at the end user premises (research & learning centres / institutions). In addition the users will need:

- A more powerful computer to run an application
- A great number of these computers to deliver results faster
- Access to specialised High Performance Computing facilities
- Access to large data sources
- Access to software not available locally
- To collaborate with other scientists across the world
- Access to scientific literature resources
- To connect to specialised instrumentation for analysis
- To connect to sensors for data collection

• Access these facilities via a web-based portal or mobile device.

How connected are researchers in Africa to their peers abroad?

With the proliferation of submarine cables along its coasts, Africa is now quite well connected to the rest of the world. However, research and education centres are not fully benefiting from it. In general, they are still poorly connected.

How do you work with users to support the development of infrastructure and services that suit their needs?

We have been working with initiatives like AfricaConnect /GÉANT to facilitate the implementation of high-speed scientific networking infrastructures for researchers. We are also facilitating the implementation of continental (African) policies aiming at enabling African research and scientific networks.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

There are several examples, but I will name three of our major accomplishments:

• The establishment of National and Regional Internet Exchange Points in Africa for keeping intra-Africa traffic within the continent and promoting the creation of local contents
• Interconnection of major African cities through submarine cables as a result of the Programme for Infrastructure Development in Africa (PIDA)
• The creation of dotAfrica gTLD domain name.

Do you have an example of one service enabled by e-Infrastructures that changed the way R&E is conducted today in Africa?

Pan Africa e-learning network whereby learning nodes within 48 African member states are being connected via submarine cable and satellite links to learning centres/institutions

What is your main challenge for the next years?

Lack of funding for sustaining existing programs or implementing new ones is our main challenge.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

The Internet of things, embedded M2M, and wearable computing will progress significantly between now and 2025. The biggest impact by 2025 will be in machine-to-machine interfaces, where devices talk to each other and accomplish programmed tasks at a much greater speed.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

Advocacy, capacity building and keeping decision-makers well informed.

Do you have a message to policy-makers in Africa?

Africa must be a significant player in this ever-emerging digital era and need not miss the train.

And to the EC?

Africa needs EC as much as EC needs an Africa being well positioned to catch the digital train for the challenges and threats that will have global ramifications.

CHAIN-REDS

Could you tell us which CHAIN-REDS activities seem the most relevant to Africa, and the benefits it can bring?

The African continent can undoubtedly benefit from all mentioned activities. If I have to name two, those would be:

- Developing Science Gateways
- Showcasing Data accessibility, reproducibility and trustworthiness tools.

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

Without a doubt, in Africa major steps forward are underway as the global high speed scientific networking infrastructure is being extended via AfricaConnect. The eI4Africa and PIDA projects are actively promoting e-Infrastructures in Africa and the support for these projects needs to continue so that all corners of the continent can ultimately reap the socio-economic benefits of having access to e-services as well as the realization of intercontinental e-commerce, and joint cooperation regarding common goals and combating threats such as the reinforcement of cyber-security and combating cyber-crimes, while respecting the rights of individuals and protecting their personal information.

Cheikh Mbackè Faye
Senior Research Officer
Statistics and Surveys Unit (SSU)
African Population and Health Research Center, Kenya

I have joined the Center in 2010 and have been involved in the e-infrastructure field for one year, in charge of developing an open access platform for APHRC to share research study documentation and datasets.

What is the role of APHRC in the e-Infrastructures sector?

Drafting data sharing guidelines, developing and managing the APHRC microdata portal http://aphrc.org/catalog/microdata/index.php/catalog. I supervise documentation of research data and process external data requests.

User needs in Africa

What are the major needs in terms of e-Infrastructure for researchers and educators in Africa?

African Researchers need to easily find and access datasets and study documentation about Africa. For a long time, they have been relying on data they were provided with by Western e-infrastructures. It's time for African Researchers to access data on Africa, from Africa!

How connected are researchers in Africa to their peers abroad?

Not a lot of connections as it's very difficult to access data from Africa.

How do you work with users to support the development of infrastructure and services that suit their needs?

For now, we are not tracking users to discuss with them about their needs. However, we are planning a couple of activities including an online user survey to get their feedback and meet their needs and an annual workshop between data producers and users.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

The main achievements are the development of an online microdata portal and the shared datasets and documentation for 24 studies in 6 months.

What is your main challenge for the next years?

- Sustaining the APHRC microdata portal in terms of staff costs for data documentation and management
- Engaging, through advocacy and training, other African research agencies to document and share their data through online platforms.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

I wish the World of Researchers would be more connected in terms of data sharing. Every researcher from anywhere in the world should have easy access to data and other research documents.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

Policy-makers should promote and support open access initiatives and raise enough funds for that.

Do you have a message to policy-makers in Africa?

They need to better understand the importance of sharing research knowledge in Africa.

CHAIN-REDS

Could you tell us which CHAIN-REDS activities seem the most relevant to Africa, and the benefits it can bring?

Technical support from Chain-Reds was most appreciated.

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

Yes, it has helped APHRC to bring innovations on data sharing with unique Digital Object Identifiers (DOI) assigned to each uploaded study.

3.2 Arab countries

HE Dr. Talal Abu-Ghazaleh
Chairman
Arab States Research and Education Network

We (ASREN) have been involved in developing research infrastructures since ASREN was launched in 2010.

What is the role of ASREN in the e-Infrastructures sector?

ASREN's role is to develop a Pan-Arab e-Infrastructure to link universities, educational institutions, and research centres across the Arab region. This involved the development of dedicated high-speed networks at the national and regional level as well as the deployment of services both network and research related. Network services include interconnection to regional networks in Europe, the US, Africa, Asia, and Latin America through ASREN PoP (Point of Presence) in London. Research services include seamless access for scientific resources and facilities through ASREN Science Gateway and eduroam access.

User needs in your area

What are the major needs in terms of e-Infrastructure for researchers and educators in your area?

The most urgent need for researchers and educators in the Arab region is the availability of dedicated high-speed networks that are interlinked to GÉANT and Internet2, and through which they can access a variety of resources, repositories, and computing facilities. The development of high-speed networks is still at a preliminary stage in many Arab

countries. ASREN's challenge has been to support the development of research and education networks in the countries where such networks do not exist, as well as to link developed networks to their counterparts in Europe and the US through its established PoP in London.

How connected are researchers in your area to researchers abroad?

According to a recent study conducted by ASREN, researchers in Algeria, Morocco, Egypt, United Arab Emirates, Qatar, and Saudi Arabia have access to high-speed networks and are well connected to researchers abroad. Researchers mainly collaborate in areas that require high computing resources and large data repositories such as high energy physics, bioinformatics, health, and the like.

How do you work with users to develop infrastructure and services that suit their needs?

ASREN mainly works with users through NRENs that are in close contact with ASREN activities. ASREN has been conducting a number of workshops that are directly related to users' needs. These include Federation of Identities, Science Gateways, IPv6 and network management, and Cloud infrastructures. ASREN has also been organizing a major e-Infrastructure conference – eAGE – since 2011. The conference is an international platform that brings together user communities, experts, and policy makers to debate and demonstrate successes and opportunities and debate issues of relevance to e-Infrastructures.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

Our main achievements to date have been:

- Supporting the development of e-Infrastructures in Lebanon, Iraq, Bahrain, Yemen, and Libya
- Establishing London PoP for peering Arab research and education traffic and linking to GÉANT, Internet2 and other regional research and education networks
- Supporting the development of AGE-OX (Arabian Global Education Open Exchange) in coordination with the US Internet2 and the UAE Ankabut
- Establishing Arabia Africa ROC (Regional Operation Centre) for grid infrastructure
- Establishing ASREN Science Gateway to provide seamless access to resources, facilities, and repositories as well as deploying applications of regional and international interest
- Supporting the development of eduroam for global wireless access in a number of institutions in the region.

Do you have an example of one service enabled by e-Infrastructures that changed the way R&E is conducted today?

Access to High Performance Computing facilities in Europe and the US through a dedicated high-speed network is crucial to many

researchers in the region, as the region lacks state-of-the-art facilities of similar kinds.

What is your main challenge for the next years?

Our most important challenges are:

- Developing mature national research and education networks in Lebanon, Bahrain, Kuwait, Yemen, Iraq, Libya, Djibouti, Syria, and Mauritania
- Developing regional research and education networks linking Arab NRENs through cross-boarder fibre connection
- Establishing exchange points or traffic aggregation points in the region to promote and facilitate regional collaboration
- Convincing policy makers to invest in the establishment of research and education networks
- Fostering regional collaboration in research on issues and problems of importance and relevance to the region
- Developing a regional structure of Federations of Identities to allow a harmonized and hierarchical authentication framework
- Integrating a unified regional science gateway for seamless access to applications, services, and repositories
- Developing a regional cloud infrastructure for research and education.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

The world of research and education will be inter-linked with capacities of large magnitude to accommodate integration of resources and to facilitate operating universities without borders in a massive open access learning structure. By 2025, e-Infrastructures would act as the main vehicle for e-Education and for research collaboration at the global level.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

Policy makers should support NRENs by investing in research and education networks and their interoperation and linkage at the regional and international levels so that the students, researchers, and educators in their countries are not left behind.

Do you have a message to policy-makers in your area?

To keep pace with the technological development in research and education and to provide the necessary investment to maintain up-to-date local e-infrastructures that link regionally and internationally with high-speed networks, so that young students and researchers have the right access and capacity to research and education resources and facilities that are available elsewhere.

And to the EC?

To continue to support the Mediterranean countries in developing their e-infrastructures, as many of these countries not only lack funding but also the knowledge and know-how that are necessary to

advance education and support research and innovation as a means for stability and prosperity as well as tools for fostering collaboration among the Euro – Mediterranean countries.

CHAIN-REDS

Could you tell us which CHAIN-REDS activities seem the most relevant to your organisation, and the benefits it can bring?

For us, the most relevant and useful activities are:

- Capacity building in Federations of Identities and implementation of Science Gateway
- Developing interoperation among regional e-Infrastructures to allow seamless access to resources, facilities, and repositories
- Developing cloud infrastructures for research and education

Could you provide an example of a service enabled/promoted by CHAIN-REDS that you are using or intend to use in the near future?

There are several examples all crucial to our activities:

- Africa Arabia ROC
- ASREN Science Gateway
- Federation of Identities and Eduroam
- Cloud infrastructure for research and education

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

Continuing EU support to projects of a this nature is crucial to developing intercontinental collaboration not only for interconnection and interoperation but also for increasing collaboration among scientists to foster advances in research and understanding between cultures.

3.3 China

Prof. Depei Qian
Professor
Beihang University, China

I have been involved in e-Infrastructures (High performance computing and Grid environment) since 1999.

What is the role of your institution in the e-Infrastructures sector?

Our institute is a major player in the key HPC service environment under China's high-tech program, mainly on developing middleware and monitoring systems.

User needs in your country / area

What are the major needs in terms of e-Infrastructure for researchers and educators in China?

The major needs are for computing and storage resources and application software meant to solve scientific problems.

How connected are researchers in your country to researchers abroad?

They are connected pretty well in the major cities, but less effectively in small cities. They mainly access resources in China. The connections to researchers abroad have become more extensive in recent years.

How do you work with users to develop infrastructure and services that suit their needs?

Users were involved at the very beginning in developing our e-Infrastructure, the China National Grid (CNGrid). The users were

asked to provide their requirements to the functionalities and user interface of the infrastructure. Also the users play a major role in developing applications over CNGrid.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

Our institute, working together with 20+ other institutes, developed CNGrid. A middleware was developed and deployed over CNGrid to support its operation and applications. My team developed the monitoring system, which is a major tool in CNGrid management. CNGrid has become the main e-Infrastructure in China for researchers and engineers.

Do you have an example of one service enabled by e-Infrastructures that changed the way R&E is conducted today?

CNGrid has supported a number of important applications such as new drug discovery, collaborative weather forecasting model development, and scientific data grid, etc. Two Virtual Organisations (VOs) have been established over CNGrid, one for industrial simulation and design optimization, and the other for computational chemistry and bioinformatics. The purpose of establishing Virtual Organisations is to facilitate usage of the e-Infrastructure and create a new business model for sustainable development of the e-Infrastructure.

What is your main challenge for the next years?

The main challenge is the quick and constant shift of interests of researchers and the public. We haven't solved the problems that the Grid and Cloud are supposed to solve, but fewer funding agencies and researchers are still interested in those issues. People are now pursuing funds in different areas such as big data. Unfortunately, if we keep changing our research focus for the sake of funding, nothing can be done. We need sustainable effort on the e-Infrastructures.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

It's hard to predict the world more than 10 years later. But I believe e-Infrastructure will play a more active role, in parallel with the development of more powerful hand-held mobile devices. Computing resources and storage resources will mainly be provided by the e-Infrastructures; more importantly, e-Infrastructures allow people to share and exchange information and knowledge more easily. Using e-Infrastructures will become a routine instead of a novel practice. Besides the basic computing and storage services, more knowledge-related and application-specific services will be provided by the e-Infrastructures.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

Besides requesting their insight to the future, we expect the policy-makers to put more sustainable effort in supporting research to reach that vision. A long-term plan and solid milestones are definitely needed.

Do you have a message to policy-makers in your country/area?

I wish the policy-makers in our country could realize the difficulty in establishing productive e-Infrastructures and support the research and development in this direction in a consistent manner.

And to the EC?

Same wishes to the EC policy-makers. International collaboration is important. Unfortunately it is sometimes limited by funding policies. The previous EC project FP863 was a bad example. The project was cancelled several months after its launch because of late matching funding from the Chinese government. (The MOST of China promised matching funding but could not provide it within the requested period.) This cancellation discouraged the participants on both sides.

CHAIN-REDS

Could you tell us which CHAIN-REDS activities seem the most relevant to your organisation, and the benefits it can bring?

We are more interested in solid work such as interoperability and interoperation between different e-Infrastructures, which is the basic requirement to establish a global virtual research community.

Could you provide an example of a service enabled/promoted by CHAIN-REDS that you are using or intend to use in the near future?

We are trying to deploy a drug discovery application over the joint e-Infrastructure composed of CNGrid and EU Cloud and Grid infrastructures, which could benefit users from China and European countries.

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

It's definitely needed. I hope that the funding agencies of China and EU have the insight to continuously support this practice.

Prof. Yifang Wang
Director
Institute of High Energy Physics
Chinese Academy of Sciences, China

I have been working in the field of high energy physics (HEP) for more than thirty years since the late 1980's. Thus I have been involved in the high performance field for many years.

What is the role of IHEP in the e-Infrastructures sector?

IHEP has been the most important user of e-Infrastructures in China. Also IHEP has been the most active institute involved in the development and deployment of e-Infrastructures both internationally and domestically. From the middle of 1980s, IHEP established the first international network link of the country and in 1994, IHEP set up the first web server in the country. In the following twenty years, IHEP collaborated with international partners, European partners in particular, to build computing and network systems for data process and physics analysis for experimental and theoretical HEP research.

User needs in your country

What are the major needs in terms of e-Infrastructure for researchers and educators in China?

The new generation of high energy physics research is always data intensive and needs broad international collaborations. We need a high performance e-Infrastructure to support high-energy physics experiments to deal with data acquisition, data storage and processing, to data sharing and research collaborations. An e-Infrastructure consisting of high throughput computing systems, large scale storage systems, high bandwidth international network links should be established and continuously developed to meet the increasing requirements.

How connected are researchers in your country to researchers abroad?

IHEP has more than thirty years of international collaborations. This is because HEP is the most active field of international collaboration in China. IHEP joined the HEP experiments in Europe, the US, and Japan. Some China based experiments, such as BEPCII/BESIII, Daya Bay neutrino experiment, Yangbajing cosmic ray

experiments etc., attracted many collaborators from the world. The collaboration in high energy physics largely facilitated the collaboration in e-Science between IHEP and international HEP organizations.

How do you work with users to develop infrastructure and services that suit their needs?

In IHEP, the computing centre is the division responsible for the development and operation of e-Infrastructure to provide services to HEP projects and multi-disciplinary research projects. The computing centre has always been led by physicists, which improved the bridge between physics and computer science. The e-Infrastructure is built by sticking to the 'application-driven' philosophy so that the infrastructure can closely fit the requirements of physics research activities. In every step to develop the e-Infrastructure, physicists and computer scientists work closely together to make sure the computer scientists completely understand what physicists need. On the other hand, the international collaboration in the development of e-Infrastructures is the most important practice. As I mentioned before, IHEP has long history of collaborations with international institutions in the field of e-Science. In particular in the last ten years IHEP collaborated with CERN, INFN, KEK etc. on the e-Infrastructure. IHEP also participated in EU FP6 and FP7 projects to build a Grid computing and Cloud computing platform. The platform successfully provides support to the HEP experiments including, among others, the LHC, BEPCII/BESIII, and Daya Bay experiments.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

IHEP has been the pilot for computer and network applications in the country in the last few decades. In recent years IHEP established a collaboration with CERN and EGEE to build the Grid computing system known as Worldwide LHC Computing Grid (WLCG), to support LHC experiments. A WLCG site was built at IHEP. High bandwidth network links to Europe and the US were established which greatly helped the Grid computing and data transfer among the LHC collaborations. The WLCG site at IHEP is among the best WLCG sites in the world with its good quality of operation and services. The technologies of WLCG are also adopted to build the Grid computing systems for the BEPCII/BESIII, Daya Bay, and Yangbajing projects. IHEP also built the distributed computing system by integrating Grid computing, Cloud computing and volunteer computing to support applications for protein structure prediction, nano-science and others.

Do you have an example of one service enabled by e-Infrastructures that changed the way R&E is conducted today?

As I already mentioned, the e-Infrastructure at IHEP has successfully supported lots of scientific research projects. Here I would like to show you a use case of

the Daya Bay neutrino experiment. The Daya Bay Neutrino Experiment is a neutrino-oscillation experiment designed to measure the mixing angle θ_{13} using anti-neutrinos produced by the reactors of the Guangdong Daya Bay Nuclear Power Plant in southern China. This experiment is an international collaboration with about 40 laboratories and about 250 physicists from Asia, the US and Europe. Data collected by the cylindrical antineutrino detectors should be transferred to IHEP and LBNL as central storage and processing centres, and distributed to other institutions for validation and analysis. An e-infrastructure consists of the distributed computing system, and the collaborative tools have been developed so that the experiment can be operated efficiently and remotely, and the data can be automatically transferred and processed worldwide. The data can also be easily accessed by all physicists in the collaboration. With the help of the e-Infrastructure the world-class physics discovery was obtained just after three months from the first data taking. It demonstrated that e-Infrastructure is essential for the large-scale scientific projects.

What is your main challenge for the next years?

The new scientific projects are sometimes related to big data and big collaborations. A carefully defined and well-developed e-Infrastructure is necessary to make the research projects possible. The most important issue is to have an internationally transparent and interoperable e-Infrastructure to accommodate the research collaborations.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

Big science will be a major trend in the next decades. HEP is a typical area. LHC is being upgraded. The International Linear Collider (ILC) might start being built. China is also thinking about the possibility to build a huge Circular Electron-Positron Collider (CEPC). Each of these projects is a large scale international collaboration with about 10 thousand physicists involved. E-Infrastructures should be established to provide services of experiment operation, data collection, sharing and processing. The collaborative tools are also necessary.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

The policy-makers or funding agencies should be aware that the e-Infrastructures are the essential part of scientific research projects. The visionary strategies of e-Infrastructures should be made and substantial financial support should be secured.

Do you have a message to policy-makers in your country/area?

More support is needed for the construction of e-Infrastructures for

scientific research. The international collaborations on development and operation of e-Infrastructure should be facilitated.

And to the EC?

EU should promote the EU-China Collaboration in e-Science, especially under the umbrella of Horizon 2020.

CHAIN-REDS

Could you tell us which CHAIN-REDS activities seem the most relevant to your organisation, and the benefits it can bring?

As I know, CHAIN-REDS is trying to establish a cloud computing system and facilitate the cloud gateway for the different platforms. This will be interesting for IHEP since we are also building a cloud computing system. As a member of CHAIN-REDS, the collaboration of cloud computing will be helpful for IHEP.

Could you provide an example of a service enabled/promoted by CHAIN-REDS that you are using or intend to use in the near future?

IHEP has set up a Regional Operation Center (ROC). And a Cloud computing platform is being established by integrating Grid computing and volunteer computing systems. All these activities are part of CHAIN-REDS. Some applications including HEP data processing and protein structure prediction will be deployed on the Cloud computing platform.

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

Yes for sure. There are already a large number of China-EU research collaborations. The long term China-Europe collaborations on e-Infrastructure is very essential. The supports from EU and China funding agencies are more than necessary.

3.4 Europe

Yannick Legré
Director
European Grid Infrastructure

I have been involved in the field for 15 years. Most of my time has been spent supporting and working for various user communities, such as biomedical and healthcare (HealthGrid), environmental and biodiversity. In parallel, I was quite strongly involved in working with the French National Grid Initiative (NGI).

What is the role of EGI in the e-Infrastructures sector?

The main goal of EGI is to reinforce the digital research through the support of large user communities but also smaller national or sectorial ones. Technology wise, EGI offers solutions related to Cloud, High Throughput and data Infrastructures. EGI aims also at supporting the emergence of Open Science Commons to bring grater cohesiveness to e-Infrastructures and their partners in user communities, and make it a more open landscape that lets communities do what they need with minimal barriers or concerns about technology.

User needs in your area

What are the major needs in terms of e-Infrastructure for researchers and educators in your area?

Researchers' and educators' needs are much the same as outside Europe as research is a global

community now. We face now the urgent need to allow all researchers from north to south and from west to east to access data, scientific tools, computing and storage capacities, data curation and archiving, produce, access and reuse knowledge without worrying where it comes from or where it will goes. There is a problem of fragmented national roadmaps in Europe. Nevertheless, Europe has a strong position, with world leading expertise but more coordination is needed in order to get the maximum benefit from it.

How connected are researchers in Europe to researchers abroad?

European researchers are heavily connected. In terms of Grid, where EGI began, you can look back to DataTAG in the early 2000s, which supported transatlantic connections, but the relationships were much older. The EC has also actively supported these international collaborations through numerous projects such as EUMedConnect and EUMedGrid, EU India Grid, EU China Grid, connections to Southern Africa and of course CHAIN and CHAIN-REDS. Information and ideas are not local; they are bigger than that, which in the modern era we develop together, across political and geographical boundaries. The Open Science Commons is a reflection on this idea.

How do you work with users to develop infrastructure and services that suit their needs?

Being user-driven is a key to EGI. In earlier phases we had to concentrate on the fundamental technology we used, but now this is quite mature. Instead we really focus on the user-driven innovations that it supports, through Virtual Research Environment, the European Strategy Forum on Research Infrastructures (ESFRI) and other groups. In fact, in our planned next phase for EGI, EGI-Engage, we will be building ESFRI communities directly into our community structure such that we can ensure we meet their needs.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of EGI in the e-Infrastructure field?

I think our achievements are clear and quite well known. We support multiple large-scale research communities, from the LHC and supporting the discovery of the Higgs Boson, to helping develop drugs to fight Malaria and neglected diseases in the life science sector, and increasingly in areas such as digital cultural heritage and preservation. However, in the end I think our biggest achievement is probably the community we have developed. Technologies can come and go, and scientific discoveries constantly appear, but the community we formed, which began in the late 1990s, has proved incredibly successful. It supported a move from an EU funded model to the hybrid model we see today in EGI, it supported a move from grid to Cloud and now to data, and it supports a really wide range of sciences. I was recently reading our new EGI case studies booklet (http://www.egi.eu/export/sites/egi/news-and-

media/publications/EGI_Case_studies.pdf) and even I was shocked at quite how broad our community is, it is easy to forget on a day to day basis but it is really quite a remarkable team we have within the EGI community.

What is our main challenge for the next years?

We are facing a two-fold challenge. First to continue our evolution to a sustainable model of operation and funding, likely based on a hybrid of European funding, membership fees and income from brokering or consultancy, and at the same time to continue tearing down barriers for users. Research must be portable, across countries and across providers. We want to work ever more closely with other e-Infrastructures and groups, such that the e-Infrastructure commons proposed by the e-IRG becomes a reality, and supports the larger Open Science Commons we foresee.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

Well for a start we want to focus on 2020. This is the arrival point decided by the EU and many others for a significant change in Europe, as we need to see the European Research Area functioning as intended by then, which remains challenging but is achievable. Within that timeline I see EGI as continuing strongly but at the same time becoming less visible to individual end user researchers, as we continue to mature and integrate with others. Researchers will access a community portal or environment, which lets them manage and process huge datasets using seamless national and European computation facilities. EGI will empower all of that but for the individual user, they will not need to worry about it, it will just work.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

Policy makers have worked hard to achieve the shared European visions we've discussed, but there is of course always more to do. Greater alignment of national roadmaps is really key to the next phase of work, ensuring that funding models, assessment schemes and priorities are aligned to achieve a whole that is greater than the sum of its parts.

Do you have a message to policy-makers in Europe?

We spend a lot of time interacting with policy makers through our discussions with the EC, bodies such as e-IRG and many other forums. This is an important function of EGI.eu, as the EGI coordinator, which we undertake on behalf of our participants. We hope they continue to support us, and especially help make sure the steps needed to drive co-creation of an Open Science Commons occurs in the next few years.

CHAIN-REDS

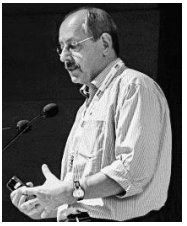
Could you tell us which CHAIN-REDS activities seem the most relevant to your organisation, and the benefits it can bring?

CHAIN-REDS had a very successful collaboration with EGI on the Federated Cloud service, tailored for European researchers: the use of EGI's open standards was key and the interoperability between the Federated Cloud and CHAIN-REDS cloud testbed opened up many new possibilities for collaborations between researchers from all over the world.
Some of the most relevant activities are:

- Disseminating EGI technology and vision
- Supporting and strengthening international collaboration and cooperation
- Stimulating the adoption of European technology

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

In almost all cases we see a hybrid model needed. For new innovation, EU funding is incredibly helpful and effective, but we must transit to sustainable models as ideas, technologies and communities mature. Many new communities and regions are still to be explored, where this support will be crucial, while for others perhaps we move toward partially self-supporting models.



Peter Wittenburg
Senior Advisor
Max Planck Institute for Psycholinguistics, The Netherlands

Since 2000 I have been working on standards, harmonization and infrastructures. This has resulted in finally setting up CLARIN as one of the ESFRI projects in the first round. I have also been involved in establishing EUDAT and RDA after having worked on Scientific Data and the "Riding the Wave" report.

User needs in your region

What are the major needs in terms of e-Infrastructure for researchers and educators in your area?

The main need for researchers in Europe is easy and efficient access to data and state-of-the-art tools/methods.

How connected are researchers in Europe to researchers abroad?

There is a close collaboration with first class researchers all over the world.

How do you work with users to develop infrastructure and services that suit their needs?

Our work is carried out in three main areas:

- In CLARIN we had a close interaction with the users and user organisations.
- In EUDAT we had a close relation with the ESFRI-related research infrastructures
- In RDA we have a close relation with what we call data professionals.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

Our core achievements:

- We have set up a number of infrastructure components such as for example ISOcat which are still in operation
- We have set up the archive and worldwide network for Documenting Endangered Languages worldwide (http://dobes.mpi.nl/)
- We have been driving force behind CLARIN and leading the

technology work

- We were amongst the driving forces behind EUDAT and RDA.

Do you have an example of one service enabled by e-Infrastructures that changed the way R&E is conducted today?

I have a few:

- The DOBES archive & network work changed attitude and workflows of linguistic field researchers fundamentally since many concepts such as a central archive, openness and sharing of results etc. were completely new; we can claim that DOBES revolutionized research
- also CLARIN had an enormous effect on researchers in our domain although not that strong as for example DOBES

What is our main challenge for the next years?

Our main challenge, looking forward, is working with data in academia and industry is known to be too inefficient and cost-intensive; we need to revolutionize the way we are creating and re-using data; RDA can be a way to change practices – this is why I will push hard to make RDA a success.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

I cannot answer this in simple sentences, but I expect that we have changed the way of dealing with data. I expect that in the future data-intensive science will be reproducible, and everyone will be able to easily access most of the data and automatically execute services on virtual collections of data.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

Policy makers should facilitate all the steps that are needed to achieve this dramatic change; they should fund projects and initiatives that are working in this direction.

Do you have a message to policy-makers in te Netherlands?

Not particularly, since we already have an intensive discussion with our ministry and they seem to be interested in taking this route as well.

And to the EC?

The same holds for the EC. On both levels we need a discussion about what are common and essential pillars of an eco-system of infrastructures to reduce heterogeneity and to save money. We also need more persistence for these common and essential pillars, which is not yet a reality.

CHAIN-REDS

Could you tell us which CHAIN-REDS activities seem the most relevant to your organisation, and the benefits it can bring?

Bringing people together worldwide to synchronize on the goals that I

mentioned (and probably some more) is essential and I see CHAIN-REDS fulfilling an important role.

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

Yes, we should use all the networks we have to improve interaction and collaboration on infrastructure issues.

3.5 India

Prof. Rajat Moona
Director General
C-DAC, Pune, India

As head of the premier government laboratory, I am involved in delivering multi-disciplinary, core research and development (R&D) for the design, development and deployment of advanced IT products and technologies tailored to the e-Infrastructure needs of the nation.

User needs in India

What are the major needs in terms of e-Infrastructure for researchers and educators in your area?

Our institute is a major contributor to the development of HPC, Grid and Cloud solutions as per the needs of researchers and educators of the country, and provides quality finishing school education in the areas of high-end computing. We believe that a major communication infrastructure supported by technologies such as HPC and grid is the major need of e-Infrastructure for researchers and educators.

How connected are researchers in your country/area to researchers abroad?

With the deployment of the National Knowledge Network (NKN), most researchers in the government institutes are connected to the e-infrastructures. However, a significant scope of enhancement exists in the areas of collaborative research and many scientific application domains, whereby a grid for researchers needs to be created

with sufficient compute and communication bandwidth.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

Over the years we provided key HPC resources and platforms to the researchers and scientists of the country to solve problems in multiple domains such as bioinformatics, computational fluid dynamics, weather forecasting etc.

Do you have an example of one service enabled by e-Infrastructures that changed the way R&E is conducted today?

Along with the HPC service, we also started connecting the HPC resources through Garuda grid as a part of our national grid computing initiative. This has resulted in the creation of various virtual organisations in many scientific domains, and the sharing and better utilization of expensive e-infrastructures and expertise available across multiple organisations in the country. We have also created state-of-the-art virtual classrooms in the country through which quality education is being provided by experts. The e-courseware by various experts has brought a major change in the way education is conducted today.

What is your main challenge for the next years?

The demand for e-infrastructure is growing rapidly among researchers and meeting their requirements both for computing and storage is a continuous challenge. Also with the rapid change of technologies both in the hardware and middleware, providing the users with appropriate training is a further great challenge for the optimum usage of the e-infrastructures. With expanding e-content and the increasing number of users, the major challenge is going to be the communication bandwidth and its availability to all.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

With the connected world, the big science and big discoveries involving effective collaboration is becoming a major necessity, especially in the research and education domain. With the provisioning of appropriate technologies for transparent collaboration, sharing of data and resources for e-infrastructure and manpower need to be developed in compliance with the local security rules and regulations. Achieving this target for the near term and long term will be a great achievement.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

The policy makers should take a holistic view of the need for e-infrastructures and allocate long terms funds both for development, operations and sustenance of these important resources for the

researchers.

Do you have a message to policy-makers in your country/area?

More deliberations and engagement with the researchers and educators are needed, to evaluate and support the long-term requirements, especially for international collaborative science and discoveries.

3.6 Latin America

Villie Morocho
Researcher and Director of Centre for Research, Development and Innovation, Faculty of Engineering
University of Cuenca, Ecuador

Overall I have about eight years' experience in the sector. I have also been director of CEDIA the Ecuadorian NREN, for four years.

What is the role of your institution in the e-Infrastructures sector?

Due to the national and international relationship established when I was CEDIA's director, there was openness to new ideas and work areas, such as Grids. Participation in the GISELA allowed us to integrate other researchers who had not had the opportunity to join programs or research projects. People needed motivation and support. There is a particular case of a researcher who just finished his doctorate and returned to Ecuador a few months after I left CEDIA, who was able to join the project, which, according to me prevented him from leaving Ecuador. A whole range of possibilities opened up for research groups.

User needs in Ecuador

What are the major needs in terms of e-Infrastructure for researchers and educators in your area?

There is a lack of training in the use of the e-infrastructure, of people that understand how to make an efficient use of it, there have to be campaigns on the potentials of the e-Infrastructure. Generate more technical support and strengthen the technical and user relationships,

between the researchers that generate ideas and the technicians that provide technological possibilities. In Ecuador, I think climate and hydrography are priorities and these users should be educated in the use of the e-Infrastructure. Furthermore, research in petroleum, mining, pharmaceuticals, among others are areas that should find support in understanding how to leverage e-infrastructures.

How connected are researchers in your country to researchers abroad?

The use of the e-infrastructure (national and international) by the academic community begins with CEDIA, which is a meeting point for researchers that require the use of advanced computational tools. In these moments CEDIA and the Ministry of Higher Education, Science, Technology and Innovation (SENESCYT) promote the use of the tools through funding programs. Nanoscience and nanomaterials are the most mature areas in Ecuador that require a greater e-infrastructure. Recently hydrology and climate are beginning to demand resources.

How do you work with users to develop infrastructure and services that suit their needs?

Through the financing programs CEDIA has generated cooperation between research groups in Ecuador. This cooperation has exceeded scientific zeal, has created relationships of trust between researchers and has made more successful the academic activity. We have created thematic networks and working groups in which new investigators are trained by exposing them to more experienced ones.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

CEDIA is a work and research integration hub. SENESCYT is also playing a role in the integration of researchers. CEDIA financed projects and managed for researchers to begin to share interests and needs.

CEDIA has 2 large support points: The first is a program, CEPRA, where people propose projects and the program integrates other researchers, encouraging collaboration rather then competition, and allowing researchers and institutions to share resources and skills. The second is to support established groups through proposals: working groups where researchers with common interests are integrated with a minimum of two institutions, to promote cooperation and the generation of joint programs and projects. CEDIA marks a shift towards infrastructures, continuing to drive their evolution.

Do you have an example of one service enabled by e-Infrastructures that changed the way R&E is conducted today?

The materials chemistry group is the primary user of the e-Infrastructure. It has strengthened

and it currently integrates five universities and 15 researchers.

What is your main challenge for the next years?

Facilitate the use and adoption of e-Infrastructures. We must expand the use of e-infrastructure to undergraduates and graduate students. Sustain the use of this technology with on-going technical support, which will make life easier for researchers and research groups, and lead to its increased popularity. The development of interfaces that hide the complexity in the use of e-Infrastructures is crucial for generating widespread use at all levels in research training.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

Students must master the technologies and must have an opening to use the platforms. We must democratize and expand the use of advanced computational tools. We've talked a lot during the development of GISELA and now with CHAIN-REDS. We need to engage students in early knowledge production and hence the use of technology is essential. It is imperative that these students become accustomed to the daily use of advanced computational resources, thus when they become professionals and go to the industry they generate demand from their practice.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

Currently the situation is quite favourable politically in Ecuador. We should show success stories that reinforce and convince politicians that this is worth it. Areas such as oil, mining, gas, climate, risk management, are areas of national interest. If we get useful results in these areas we will have the support of politicians.

Do you have a message to policy-makers in your country?

I would show the success stories we have in Ecuador as well as other highly visible ones in Latin America.

And to the EC?

The EC should continue and intensify financial support. It helps to convince politicians. We miss projects such as EELA, EELA-2. The advantage of the economic support from the EU is that it is a guarantee for national funds. Through our participation in these projects it was possible to incorporate some advanced resources now used by our academic community.

CHAIN-REDS

Could you tell us which CHAIN-REDS activities seem the most relevant to your organisation, and the benefits it can bring?

All the activities that are related to letting people know about the advantages of the use of resources are important. There are many islands of researchers and achieving a critical mass of relevant researchers that support-sharing

resources would make this more familiar.

Could you provide an example of a service enabled/promoted by CHAIN-REDS that you are using or intend to use in the near future?

Science Gateways with human support is what I see as more relevant.

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

I agree that we must continue to support intercontinental connectivity and interoperability, if the EU continues to fund projects like this … where do I sign?

Alvaro de la Ossa
Executive Director
Advanced Research and Education Network of the National Council of Rectors (RedCONARE) and member of RedCLARA

I have five years' experience being involved in the management of Costa Rica's advanced network and during this time I have also been the representative of RedCONARE in RedCLARA.

What is the role of your institution in the e-Infrastructures sector?

RedCONARE is part of CeNAT, the National Centre for High Technology, which plays a central role in the development of e-Infrastructures for the academic sector in Costa Rica.
One of CeNAT's characteristics since 2007 has been its regional reach. There is no similar advanced computing centre in the region. To improve our success in this role, we are now carrying out research workshops in different countries of the region, with the decisive support of the German Academic Exchange Service, DAAD, with a group of colleagues and advanced students of all the Central American countries, and a group of Costa Rican researchers from the Research Network for Scientific Computing. In November 2014 at the Autonomous University of Chiriqui, in Panama, we held the first Mesoamerican workshop on scientific computing, and during 2015 we will conduct a second meeting under the auspices of the Mesoamerican Centre for Theoretical Physics (MCTP) in Mexico. I think Costa Rica, and CeNAT in particular, have a very important role to play in promoting regional research and training human resources.

User needs in your country / area

What are the major needs in terms of e-Infrastructure for researchers and educators in your area?

The main needs for users in Costa Rica and neighbouring countries are:

- Ubiquitous and transparent access.
- Integration of infrastructure services to facilitate access.

Ubiquitous and transparent access to instruments, people, applications (simulation, visualization) and collaboration tools. People have the

perception that access is dispersed in the network. Researchers keep asking us, where are the tools? We have to offer a single point of access to these services. The idea is that researchers can access the advanced network services from anywhere in the connected universities and using the widest possible range of devices.

How connected are researchers in your country to researchers abroad?

There are many Costa Ricans researchers linked with peers abroad, in all areas of knowledge and all the regions of the world. The four state universities have exchange programs with universities in other countries, and bonding with partners abroad is promoted as a means to improve conditions.
With who do CR researchers connect? The answer depends on the discipline: Health Sciences with the US and the others with Europe. In advanced computing we bond, initially with US, but this has been changing. When we started working with RedCLARA the cooperation with Europe increased and now it is stronger with Latin America. That is because at CeNAT we want to look at the south.
The UCR (Universidad de Costa Rica) is closely tied with the US.

How do you work with users to develop infrastructure and services that suit their needs?

Besides being RedCONARE's Executive Director, I direct the National Collaboratory for Advanced Computing, or CNCA, from CeNAT. One of the most important activities of the CNCA, in fulfilling its mission, is to promote scientific computing and high performance computing in the country, precisely to develop services to support e-Science. The CNCA works with researchers in universities to help them find or develop the means needed to process, classify, analyse, visualize and curate research data. The end result of this process is almost always twofold. On the one hand, a service for scientific data processing is installed in our computational cluster and adapted to the needs of the researchers, and on the other, a link is established between these researchers and groups in Costa Rica or elsewhere who work on related topics.

Today's e-Infrastructures: what works and what can be improved

Could you tell us about the main achievements of your organisation in the e-Infrastructure field?

The configuration and operation of the national physical network has been a very valuable learning process for the groups in charge of information technology in the CONARE and the universities attached to RedCONARE. That effort has already produced very positive results: all members of RedCONARE are guaranteed connectivity to the advanced network from all its regional offices around the country. This has been a coordinated effort between CONARE and the universities.
At this time CNCA offers 22

applications as a service. We have saturated the cluster and are very satisfied. Some of those services were developed by us, and others have been adapted by our team. Having these services is a real achievement. We set up the Scientific Computing Research Network, RICC to form HR. We have a weekly seminar that is conducted via streaming. The topics cover e-infrastructures and applications. This year we also began an activity whose purpose is to influence the curriculum for scientific computing in state universities.

Do you have an example of one service enabled by e-Infrastructures that changed the way R&E is conducted today?

I don't see a dramatic change, but certainly with these 22 applications researchers have changed their practice: they access services available through the network operated by CR and free themselves of the enormous amount of administrative tasks typically required in the search for those resources.

What is your main challenge for the next years?

The consolidation in the use of some services that we see as strategic: eduroam, telemedicine (including videoconferencing with HD video), remote instrumentation and management of academic content.
Next year I will be a researcher and no longer the Director of RedCONARE and the National Collaboratory for Advanced Computing. I will continue to contribute to the scientific computing community as a member of RICC, and as a CNCA and University of Costa Rica researcher. My challenge is to maintain the interest of students in this area. Researchers are needed and keeping them active in this area is difficult. There are many software development companies in CR that pay better salaries than academia. It is very difficult to compete with industry. My challenge is to maintain a critical mass of human resources in research.

Your vision for 2025

How do you see the world of Research and Education in 2025? What services will e-Infrastructures provide in 2025?

I see a world where the tools available in the e-Infrastructures facilitate the integration of and access to information about researchers and their research, so that collaboration is encouraged. In this world of the future, many of the processes and tasks carried out by researchers in their daily work will be performed by robots in the network, so as to remove from the researcher's back the burden of administrative or routine tasks in his or her scientific work. I see a work environment in which researchers, teachers and students have ubiquitous access to information produced in research projects, making it easier and faster to transfer knowledge and training new scientists and professionals.
In CR in particular, things will be slower, I dream and work to decrease the researcher's

administrative load and let him or her dedicate more time to research.

The role of policy-makers

What should be the role of policy-makers in reaching that vision?

Their main role should be to develop public policies focused on the adoption of concrete measures to promote the development of open technologies, open access and interoperable strategies. In my vision for 2025 e-Science goes beyond the use of the network to improve research practices. I see the scientist more concerned with the heart of his research than with peripheral logistical matters: administration, fund management, preparation of management reports, etc. This will be possible if we in part remove from the back of the researchers the huge amount of administrative and logistical tasks that they have to perform today.

Do you have a message to policy-makers in your country/area?

The same as in the previous question, the development of e-science should focus on open technologies, open access and interoperability.
A deep, ideological change in education, so as to encourage solidarity and inclusion. At a second level a focus on public policies that favours society and not corporations.
I recommend to focus on legislation to create access to and promote open technologies. So far politicians have focused on encouraging private companies to develop proprietary software. If government agencies don't spend as much in software licenses, they could use those resources to develop and use their own technologies.

And to the EC?

I cannot think of a message to the EC related to e-Infrastructures, without putting my words in a geopolitical context.
There is discomfort with the EU policy towards Latin America. Throughout the FP6, FP7 and H2020 programs LA actors remain invisible, there is no encouragement to collaborate as peers. Linking is encouraged but there is no real relationship between academic partners. Clearly there will be exceptions, but in general I guess Brazilian researchers will prevail, while the other countries tend to remain behind.
There are particular cases such as the German Academic Exchange Service, DAAD, which is not an agency for academic exchange funded by the German government. With them we have been able to work much more directly and begin to leverage the development of scientific computing in Central America. These contributions from DAAD have helped us a lot in training staff.

CHAIN-REDS

Could you tell us which CHAIN-REDS activities seem the most relevant to your organisation, and the benefits it can bring?

For us, the most relevant and useful activities are:
- Dissemination of knowledge
- Development of portals / gateways
- Technical Dialogue.

Could you provide an example of a service enabled/promoted by CHAIN-REDS that you are using or intend to use in the near future?

The best example is the Science Gateway, a central point of access to scientific computing tools.

Do you see the need for a continued support from EU-funded projects to further improve intercontinental connectedness and interoperability?

Definitely yes, along the lines I mentioned above, as peers, a joint cooperation is strongly needed.

Conclusions

The challenges faced by researchers in connecting globally in the context of large scientific collaborations are still significant, but the CHAIN-REDS project and its predecessors have made great strides in addressing some of the more pressing technological aspects of these challenges.

Testimonials from stakeholders in four continents highlight the crucial role these projects had, and continue to have, in the development of a truly global digital environment, where different e-Infrastructures are becoming interoperable, and where partners from developing countries are beginning to have the same opportunities as those in the traditional first world countries.

Thanks to CHAIN REDS and its predecessors, many countries are increasingly able to attract their home-grown talent to work locally in their new and emerging research facilities, with growing support from their local governments.

EC support for global projects of this kind is broadly seen as a catalyst for local government support, but there are also perceived risks associated with the uncertainty and short lifespan of funding cycles, the occasional mismatch in timing between EC support and local government support, and other general concerns about equal partnership and reciprocity.

While hopes for the future remain high, the stakeholders broadly agree that these collaborations are in need of a more sustainable form of support, both by the EC and by local governments.

Glossary

API	Application Programming Interface
CDMI	Cloud Data Management Interface
CHAIN	Co-ordination and Harmonisation of Advanced e-Infrastructures
CHAIN-REDS	Co-ordination and Harmonisation of Advanced e-Infrastructures for Research Education Data Sharing
CNRI	Corporation for National Research Initiatives
DART	Data Accessibility, Reproducibility and Trustworthiness
DCI	Distributed Computing Infrastructure
DCMI	Dublin Core Metadata Initiative
DoW	Description of Work – Annex I to the GA
DR	Data Repository
EC	European Commission
EGI	European Grid Initiative
FOAF	Friend Of A Friend – machine readable ontology
FP7	European Commission's Framework Programme Seven
GA	Grant Agreement
ICT	Information and Communication Technology(ies)
IVOA	International Virtual Observatory Alliance
KB	Knowledge Base
MoU	Memorandum of Understanding
NMR	Nuclear Magnetic Resonance
OADR	Open Access Data Repository
OAI-PMH	Open Archives Initiative Protocol for Metadata Harvesting
OCCI	Open Cloud Computing Interface
OWL	Ontology Web Language
PID	Persistent Identifier
RDF	Resource Description Framework
ROC	Regional Operation Centre
SKA	Square Kilometer Array

Glossary

SPARQL	SPARQL Protocol and RDF Query Language
VRC	Virtual Research Community
VRE	Virtual Research Environment
WP	Work Package
XML	Extensible Markup Language

CHAIN-REDS (2012-2015) is a FP7 project (GA #306819) co-funded by the European Commission (DG CONNECT) aiming at promoting and supporting technological and scientific collaboration across different e-Infrastructures established and operated in various continents, in order to define a path towards a global e-Infrastructure ecosystem that will allow Virtual Research Communities (VRCs), research groups and even single researchers to access and efficiently use worldwide distributed resources (i.e., computing, storage, data, services, tools, applications).

ASREN
Arab States Research and Education Network

सी डैक
CDAC

CESNET

Ciemat

grnet

INFN
Istituto Nazionale di Fisica Nucleare

Institute of High Energy Physics
Chinese Academy of Sciences

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