Operational and organisation aspects of the Advanced Computing Services over national, regional and international networks

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Abstract

The CHAIN project aims to provide a vision of a harmonized and optimized interaction model for e-Infrastructures and specifically Grid interfaces between Europe and the rest of the world. The project deals with elaborating a strategy and defining the instruments in order to ensure coordination and interoperation of the European Grid Infrastructures with other external e-Infrastructures. Moreover, the project produces technical and sustainability-related guidelines for the Grid and wider Advanced Computing Services to support this coordination and interoperation. The project draws on previous national and regional experiences and lessons learned in other European eInfrastructure activities, consolidates them, and supports them.

This paper first gives a brief introduction and overview of the CHAIN project, and then focuses on a few key areas of particular relevance for Sub-Saharan Africa.

First, guidelines how to set up National Grid Initiatives are presented – briefly covering the operational, organizational and policy models on the national level. This is strongly based on the SEE-GRID model which has been trailed and tested successfully. Due to size of the paper, not all details can be provided and the reader is referred to supporting documentation.

Second, the paper also includes the case studies for regional organization of computational resource sharing and joint operations of Advanced Computing Services, enabling international research over a spectrum of scientific fields. The case study again is the South-East European region, including both Grid Computing and High-Performance Computing.

Finally, the sustainability-oriented recommendations for Africa are given, based on the work in the CHAIN project and the related sustainability study which has been carried out for Africa.

Keywords

Grid Computing, High-Performance Computing, Advanced Computing Services, National Grid Initiatives, Virtual Research Communities, regional operations and resource sharing.

1. The CHAIN project

The CHAIN project (EC Grant Agreement n. 26011) aims to coordinate and leverage the efforts made over the past years to extend the European e-Infrastructure (and particularly Grid) operational and organisational principles to a number of regions in the world. CHAIN uses their results with a vision of a harmonised and optimised interaction model for e-Infrastructure and specifically Grid interfaces between Europe and the rest of the world. The project is elaborating a

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

strategy and defining the instruments in order to ensure coordination and interoperation of the European Grid Infrastructure with emerging e-Infrastructures in other regions of the world (Asia, Mediterranean, Latin America and Sub-Saharan Africa). The CHAIN consortium consists of leading organisations in all the regions addressed by the project and ensures global coverage, and most efficient leveraging of results with respect to preceding regional initiatives. The project started on the 1st of December 2010 and the achievements are briefly described here.

A questionnaire has been prepared to collect up to date information about the state of the art of e-Infrastructures in all relevant regions, and the information obtained has been integrated with other data in a Knowledge Base that has been made available on the project web site with an attractive graphical interface. The information is further used for project analysis and design activities. The project has assessed the current state of the art of Grid infrastructures in the addressed regions and has produced a set of guidelines that will foster the continuity of e-Infrastructures (CHAIN, 2011). The activity promoted the emergence of agreed solutions for interoperation and interoperability across regions and middleware. The project has produced a comprehensive set of recommendations regarding technologies and taking into account organisational and regional specificities (CHAIN, 2011).At the same time, the consortium is studying a coherent scheme of cooperation and interoperation of EGI.eu with external e-Infrastructures taking into consideration the specificities of the different regions. CHAIN is also leveraging on the cross-region communities and applications and promotes inter-regional, e-Infrastructure based, research collaborations. A limited number of reference communities have been chosen but the activity also aims to promote the continuity of support to the large spectrum of other communities, mainly but not only, to those that are already supported by the existing regional projects. The Virtual Research Communities work will be presented in another paper in this conference. The world-wide interoperability demo has been given at the UGI Technical Forum this September, involving Grid infrastructures across the world and a number of VRCs..

2. National-level guidelines

2.1 National Grid Initiatives and the stepwise process

The national-level guidelines supported by the CHAIN project are based on previous work carried in a number of European initiatives, most notably the SEE-GRID series.

Full set of CHAIN guidelines is available at CHAIN website at the following link:

http://www.chain-project.eu/wiki/-/wiki/WIKI+Page/WP2

The staff of CHAIN project as well as the upcoming CHAIN-REDS project, are available to provide support for setting up the NGIs in Sub-Saharan Africa, according to these guidelines, and beyond.

During the 3 phases of the SEE-GRID project (ECproject002356, 2006) (ECproject031775, 2008) (ECproject211338, 2010) significant results have been achieved in South-East European countries in the area of set up and development of National Grid Initiatives (NGIs). In collaboration with pan-European Initiatives (eIRG, EGEE, EGI-DS), SEE-GRID has led the way in adopting the NGI philosophy as the central component of long-term sustainability of eInfrastructures. In all SEE-GRID countries NGI implementation was a priority on the agenda of Grid infrastructure development at the national level, and has been applied in all 14 countries.

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

At the SEE-GRID project level, a clear definition of the NGI concept has been adopted: "NGI is an open consortium of legal entities or a legal entity acting on their behalf that, for the benefit of research and education community, coordinates, promotes and implements Grid activities at the National level, focusing on Grid deployment and operations, according to a National strategy / research and deployment programme for this field."

The following requirements are attached to this definition:

It is officially recognized by the appropriate governmental entity responsible for research eInfrastructure;

It should be unique in this position and its legitimacy should be enforced according to a national level strategic document adopted at the governmental/ministerial levels;

Basic focus of NGI is on deployment and operations of the national research and education Grid infrastructure (NREGI);

It represents a relevant part of the research community and is open to accept any qualified research/educational entity as its member, according to its open character;

Both top-down and bottom-up approaches should be considered for the consortium enlargement, the former one being specific to the initial phase of NGI development;

It closely collaborates and is mutually recognized with NREN;

It contributes and adheres to international standards and policies;

Sustainability is core long-term objective of NGI; achieving critical mass of interested user communities should be a high priority target on the way towards sustainability.

Set up and consolidation of NGI in all partner countries in accordance with these requirements was a central objective of all 3 phases of the SEE-GRID project, and has been done for 14 countries.

In this section we provide a summary of the step-to-step guide for setting up a sustainable National Grid Initiative, based on SEE-GRID experience. In SEE-GRID-2 deliverable D2.2 (SEE-GRID OPCITE), three major area of interest for NGI implementation have been identified: organizational, policy and operational activities. For each of them a brief overview of relevant solutions was given, and recommendations have been formulated for each of the three areas. As a summary, the following steps were proposed by the SEE-GRID project to set-up an NGI. The steps have a form of a simple-to-use NGI cook-book.

1. Get in touch with diverse research institutes interested in scientific computing (i.e. HEP, Biomedical, Computational Chemistry, etc.), large computing centres, and National Research Network and get consensus towards common strategy for Grid development in the country.
2. Sign a MoU (Memorandum of Understanding) within the consortium which would define your common goal in setting up an NGI and developing the Grid infrastructure and general Grid activities in the country.
3. Write together a national strategy document. This would state major objectives and approach, and identify potential Grid resources and user groups in the country. This document could also define structure of the NGI and its decision mechanisms and internal organisation.

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

4. Approach relevant ministries (e.g. Science and Technology, Development, Education, Information Technology) with the national strategy document, and try to get a ministry to support your work. This can have the form of an official letter of support for the NGI. Also a ministry can officially appoint a task force.
5. Establish a legal entity or make sure an established legal entity represents NGI on behalf of the consortium.
6. With the support letter from the Ministry you can have an official inauguration event of the National Grid Initiative targeted at slightly wider public.
7. Seek national funding programme by proposing a national-level project. With support letters from Ministry and with proof of EU funding you have more chance with the national funding bodies to get some local funding for your Grid work.
8. Consider technical aspects: choice of middleware, establishing pilot resource centres even with basic resources, aim to support core services for the pilot national VO, use the VO to establish the sharing culture. Establish a web presence visible to a wider community.
9. Define and adopt the national-level policies.

These 9 basic steps established in the course of these projects are further expanded and categorized into three areas: organizational, policy, and operational.

The full set of recommendations can be found in (SEE-GRID OPCITE) and (Prnjat, 2008). In the following section we highlight most important points, relevant for Africa.

2.2 Core guidelines for NGIs

There is no silver-bullet solution for optimal NGI set-up. A number of alternatives exist, and they have been described in this document in considerable detail. Some key conclusions are as follows:

- Forming a Joint Research Unit (JRU) as a first step towards stable NGI creation is a baseline for setting up a sustainable organization at the national level, and is strongly recommended for all countries.
- The approval of the NGI set-up document (Agreement or MoU) signed between the initiating body and all members of NGI, at the governmental/ministerial level, is key for national recognition requirement. All countries should identify the relevant Ministry.
- The typical NGI membership would include the national infrastructure providers, the key national user communities, and National Research and Education Network. In many cases NGI can be embedded in NREN, especially in the Sub-Saharan Africa.
- NGIs should be introduced to the all grid related communities (users, developers, infrastructure providers, funding agencies, related public bodies, industry and etc.) via a set-up event.
- The main organizational forms of implementing NGI are task force, consortium, national project, professional association and legal entity; of which consortium is the most prevalent and is recommended.

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

- The juridical status significantly influences the efficiency of the NGI interaction with legal entities at both national and international levels. In this sense, the professional association and stand alone organization are the most stable, while the consortium has no juridical status as such, which can be solved either by: (a) nominating one member organization as its legal representative, or (b) migrating towards another form of organization with a clear juridical status.
- One of the core requirements for NGI sustainability is existence of funds: a balance between national and international funds should be achieved.
- Detailed assessment and planning of the national Grid should be done periodically.
- Management of Grid eInfrastructure should encompass functionalities such as national Certification Authority (CA), a network or Registration Authorities (RAs), core Grid and VO services (information systems, workload management, file catalogues, authorisation services), testing and monitoring of Grid services (Static information database; service availability monitoring; Information system monitoring; accounting portal); national helpdesk / ticketing system;
- Depending on the size of the NGI and already existing tools on regional/continental level, some of the management tools can be deployed on the regional instead of national level.
- User, application and VO support is crucial for a stable NGI, supported by the National helpdesk and National portal and/or user registration facility. The support should be provided to multi-disciplinary communities
- NGI should be defining/adopting and implementing a coherent configuration of policy documents in several domains: including National strategy documents (stating major objectives of NGI, and its activities towards achieving its mission); Policy documents that deal with relations between the National Grid infrastructure administrated by NGI and other entities involved in the efficient share and use of this infrastructure; and Operational policy documents that deal with a wide range of operational aspects.
- National strategy document should be initially written during the establishment of the NGI, to facilitate achieving the support, national recognition and legitimacy of relevant ministries/governmental bodies. Strategy document as other policy document has continuous nature and could be subject of intermittent amendments/adoptions.
- NGIs should review the policy and operational documents and evaluate their usage and necessity at the national level.

3. Regional organizational examples

The previous section provided some insight in crucial issues regarding the organization and operation of Advanced Computing Services on the national level, with focus on Grid computing, with the main tool being that of the National Grid Initiatives. These national efforts then can, and should, be combined at the regional level to allow for trans-national resources sharing and operations. The following sections present case studies for Grid Computing and High-Performance Computing organization on regional levels.

The staff of CHAIN project, as well as the upcoming CHAIN-REDS project, is available to provide support for strengthening the existing Regional Operations Centre for Africa&Arabia,

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

which provides the regional grid services for this region, and extend its operations to other Advanced Computing models such as HPC and cloud.

3.1 Grid Computing

An example used here again is that of the SEE-GRID project series [2][3][4]. At the end of 6 years of cooperation, the following regional model was in place, bringing together the resources shown below, from 14 countries of the region.

Figure 1 SEE-GRID regional Grid resources

The regional team operated regional Grid infrastructure, maintained deployed core services for SEEGRID Virtual Organizations (VOs) and three discipline VOs, as well as core services for ops.vo.egee-see.org VO used for testing of the infrastructure. The geographical distribution of new core services is such that it provides fault tolerance and load balancing for regional users. A set of operational and monitoring tools is maintained and used to manage and assess the status of the infrastructure. The average availability of Grid sites is higher than 90%, the average number of available CPUs above 3000 (only for dedicated regional collaborations), while the total available storage around 510 TB.

The key to successful regional operation was the distribution of the regional operational tools over a number of countries, as well as fail-over backup tool availability.

Within its final phase, the regional infrastructure supported three champion VOs. Seismology VO has six applications ranging from Seismic Data Service to Earthquake Location Finding, from Numerical Modeling of Mantle Convection to Seismic Risk Assessment. Meteorology VO, with two large-scale applications, follows an innovative approach to weather forecasting that uses a multitude of weather models and bases the final forecast on an ensemble of weather model outputs. The other problem tackled within this VO is the reproduction/forecasting of the airflow over complex terrain. Environmental (Protection) VO supports eight applications focusing on

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

environmental protection/response and environment-oriented satellite image processing. These applications typically involve a number of diverse research groups across the region. Moreover, strong regional collaboration has been encouraged in all the three scientific domains supported by the project via the deployment of specific support mechanisms that facilitate their communications and exchange of expertise.

The SEE-GRID regional infrastructure was successfully merged with the pan-European EGI (European Grid Infrastructure) in 2010.

3.2 High-Performance Computing

Currently, the HP-SEE project (EC project261499, 2012) is currently active in the region, where the joint regional operations of High-Performance Resources are deployed. The infrastructure offers a total of more than 116 Teraflops CPU power and comprises now of two IBM Blue Gene/P supercomputers – one with 8192 cores, 27 Tflops and another with 4096 and 13 Tflops, several HPC clusters with low-latency interconnection, one big SMP machine, SGI UltraViolet 1000, and substantial GPU resources (more than 16 TFlops, with NVIDIA M2090 cards).

Figure 2 HP-SEE Regional HPC resources

A comprehensive set of management tools supports the transparent access, monitoring and accounting of the use of this infrastructure by the applications from the target Virtual Research Communities. The monitoring system records excellent availability of the resources – the average availability of more than 94% for the year is standard. The 26 applications are running, consuming tens of millions of CPU hours' usage and achieving significant scientific results. A small-scale training infrastructure, comprising of more than 100 CPU cores and 2888 GPU cores is also supported for the users. The software and libraries installed at the resource centres were upgraded following recommendations from users and VRC managers to achieve further homogenization of the execution environment. The authentication, resource management and accounting systems have been enhanced so as to support the access to infrastructure with a Fast Track process and within the Pilot Call for new applications, which provides a vehicle for continuous transitional resources sharing. Significant resources have been ensured for the Pilot

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

Call - around 4.6 Million CPU core hours and 1.8 Million GPU Core hours, with the number of cores in the target HPC systems between 256 and 4096 for the CPU based systems, and from 480 to 3584 for the GPU systems.

4. Sustainability recommendations for Sub-Saharan Africa

In the course of its 2 years, the CHAIN project has defined and followed up some basic recommendations for Sub-Saharan Africa. In summary, the key line of action was to promote and support the nascent NGIs. It was identified that embedding the NGIs into the existing NRENs in the countries would be the most suitable approach. Contact was carried out in 10 countries and documentation provided. On the regional level, Africa&Arabia Regional Operations Centre provides a centre of gravity.

More importantly, a sustainability analysis was carried out for the Sub-Saharan Africa. A detailed sustainability analysis for all world regions has been carried out (CHAIN 2012), via the internal and external audits, directional policy matrices, SWOT analyses, and strategy formulations. Specifically for the Sub-Saharan Africa region, the most important finds include the SWOT analysis and strategy formulation, given below.

Strengths	Weaknesses
• The Africa & Arabia ROC is functional and the technical know-how exists there • UbuntuNet Alliance is a trusted agent on the African continent with a wide network of contacts • There are attempts at regional dissemination of advanced computing services particularly through the training carried out through EPIKH. • The EU –funded AfricaConnect project building the regional backbone (with UbuntuNet Alliance as local implementing partner) has the potential to be a major catalyst to collaborative eInfrastructures-based research • The implementation of the SKA	• The absence of Regional Body for Grid Coordination; • There is a huge legacy of underfunding of tertiary education and research; • Brain drain; • Loss of critical mass of researchers to consultancies and the NGO sector; and therefore not a huge body of research to gridify • The current underdevelopment of the network. • Inadequate human capacity to address requests for development and training
Opportunities	**Threats**
• Visibility of research communities in areas that demand high processing power such as genomics/bioinformatics • The existence of SAGrid, from which a great deal can be learned and shared • Because of coming late on the scene, opportunity to learn from early adopters and avoid earlier pitfalls • Willing partners across the globe • Existing regional coordination bodies for NRENs which could be tasked with creating and stabilizing the RBGC in various regions.	• Tough economic times for certain sectors • Lack of awareness by the political cadre of the opportunities available • Nationalistic rather than regional or global embracing by national decision makers • Lack of sustainable funding model for computing resources • Perceived fragmentation of international DCI's • Slow response to many researchers' requests due to capacity constraints could present a negative picture of the RBGC

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

UbuntuNet Alliance should work with Africa and Arabia ROC to provide coordination and management functions. Efforts will be made to convince the Grid stakeholders in Sub-Saharan Africa to support this process.

The core activities then should be:

- Disseminate at the policy level, the role of Grid computing and establishment of VRCs through presentations and demonstrations at appropriate high level regional fora;
- Work with the eInfrastructures owners to develop sustainable business models;
- Identify and support champion e-science leaders and projects to become lighthouse demonstrators in the region;
- Supporting the development of NGI in every country within the framework of the NREN where appropriate

Regular reflection will be necessary to mark progress and refocus resources where results can be maximized. The expertise in the CHAIN-REDS team should assist in moving the region to the next level.

5. Conclusion

This paper first gave an introduction and overview of CHAIN project, which provide a vehicle for intercontinental interoperation and sharing of Advanced Computing Services.

In order to facilitate intercontinental collaboration in this respect, both national-level and regional-level structures have to be available and stable.

Thus, this paper provides first the guidelines how to set up National Grid Initiatives – briefly covering the operational, organizational and policy models on the national level. This is strongly based on the SEE-GRID model which has been trailed and tested successfully. Due to size of the paper, not all details can be provided and the reader is referred to supporting documentation. However, concrete suggestions for the region are given.

Second, the paper also includes the case studies for regional organization of computational resource sharing and joint operations of Advanced Computing Services, enabling international research over a spectrum of scientific fields. The case study again is the South-East European region, including both Grid Computing and High-Performance Computing. These can be used as examples for best practice. The current recommendation for Sub-Saharan Africa is that the Regional Operations Centre for Afica&Arabia is strengthened, in collaboration with UbuntuNet Alliance.

Finally, the sustainability-oriented recommendations for Africa are given, based on the work in CHAIN project and the related sustainability study which has been carried out for Africa.

6. References

CHAIN deliverable D2.2. (2011),"Interoperability and interoperation guidelines".

South Eastern European GRid-enabled eInfrastructure Development, EC project contract number 002356. (2006) http://www.see-grid.org/

ISSN 2223-7062 Proceedings and report of the 5th UbuntuNet Alliance annual conference, 2012 pp 82-91

South Eastern European GRid-enabled eInfrastructure Development- 2, EC project contract number 031775, (2008). http://www.see-grid.eu/

SEE-GRID eInfrastructure for regional eScienceEC project contract number 211338,(2010). http://www.see-grid-sci.eu/

Project SEE-GRID-2.(SEE-GRID =OPCITE) – 031775.(2008), - Sustainable Organisational and Operational Approach – Deliverable D2.2, 25.03.2007.

Prnjat, O et al-.(2008), "National Grid Initiatives Set-up and Monitoring Guidelines", in *Proceedings of the First EELA-2 Conference*, B. Marechal et al. (eds.), CIEMAT

HP-SEE High-Performance Computing Infrastructure for South East Europe's Research Communities,EC project contract number 261499, (2012), http://www.hp-see.eu/

CHAIN deliverable D2.3,(2012),"Regional sustainability report".

Biography

Dr Ognjen Prnjat has been deeply involved in setting up and running electronic infrastructures in Greece, South-East Europe, Europe, and worldwide for the past 10 years. Ognjen has acted as manager of the SEE-GRID series of projects; as the Regional Operations Manager for South-East Europe for the pan-European EGEE grid project; as the manager of SEERA-EI project focusing on policy and programme management in the area of eInfrastructures. Currently he manages HP-SEE project and is a core team member of the CHAIN project. Ognjen holds PhD in network management and MSc in telecoms degrees from University College London and BEng in Electronics and Electrical Engineering from University of Surrey.