Grid Activities in Armenia*

H.V. Astsatryan, Yu.H. Shoukourian, V.G. Sahakyan

The grid infrastructure is recognized today in Europe and worldwide, together with the highspeed networking, as one of the basic components of the e-Infrastructure of research and education. The starting point of such perception of the grid infrastructure is the paradigm of the grid itself, which offers a flexible organization of geographically distributed resources (computing, data and information resources as well as, for instance, laboratory and experimental devices and equipment), with a consistent and simple access option and possibility to co-ordinately share them within collaborating virtual teams and organizations. In this paper it is given a brief introduction to Grid activities in Armenia, which aims to provide the National Grid Infrastructure for the benefit of the national research and educational community to carry out research; as well as to interconnect with international Grid structures and researchers.

1. Introduction

Increasing demands of the advanced scientific research can be fulfilled only by exploiting the existing computation resources in a more efficient way, by means of on-the-fly coupling and dynamic on-demand allocation of resources. Grid technology [1-2] aims to provide a solution for this problem. International Grid computing projects [3] and infrastructures are typically organized in multi-national ways, building on resources offered by several organizations and countries. International Grid infrastructures are typically characterized by rather homogeneous Grid middleware systems (gLite, Globus, Condor, etc.), which makes it rather easy to use the provided Grid infrastructures in a homogeneous way.

There also exist many national Grid efforts world-wide (Open Science Grid in the USA [4], Narengi in Japan [5], the e-Science program in the UK [6], D-Grid in Germany [7]) that usually share the objective to provide a Grid infrastructure at a national scale to support a variety of scientific user communities. The European Grid Initiative (EGI) [8] has the goal to provide a Europe-wide, sustainable Grid infrastructure that goes beyond the scope of traditionally funded Grid projects. This initiative foresees that each member country has only one Grid contact point organized as a National Grid Initiative (NGI), with the mandate to represent the scientific and Grid community of a country. Armenia has started to create such a national effort rather late. This means that several research groups and institutions are already part of different Grid projects that use a wide variety of different middleware systems. Due to this heterogeneity it is rather difficult to combine existing systems and knowledge communities in a seamless way. In the following article we will discuss our previous and current activities from taking the initial technical steps towards such a national Grid infrastructure.

2. Grid Activities in Armenia

In order to ensure that Armenia would not stay behind in this important area, an appropriate Grid infrastructure has to be deployed which would be accessible, at the same quality level, for all scientists and researchers independently of the physical locations of their institutes. Such a Grid should consist of homogeneous local Grid systems established within and between the main Armenian research and educational organizations and then be extended to become a heterogeneous global system in the South Caucasus region. The leading interested research and educational organizations in Armenia are the National Academy of Sciences of Armenia (NAS RA), Yerevan Physics Institute after A. Alikhanyan, Yerevan State University (YSU) and State Engineering University of Armenia (SEUA) (see fig. 1). The network connectivity within the institutions of the National Academy of Sciences of Armenia and links to the other research and educational organizations are provided by the Academic Scientific

* This work was supported by International Science & Technology Center Projects A-1451 and A-1606.

Network (ASNET-AM) of Armenia [9] that connects and supports all academic institutions. The ASNET-AM backbone consists of network communication nodes in 4 cities of Armenia which are interconnected by fiber-optics and wireless links. Each node connects the nearby scientific, research, educational and cultural organisations.

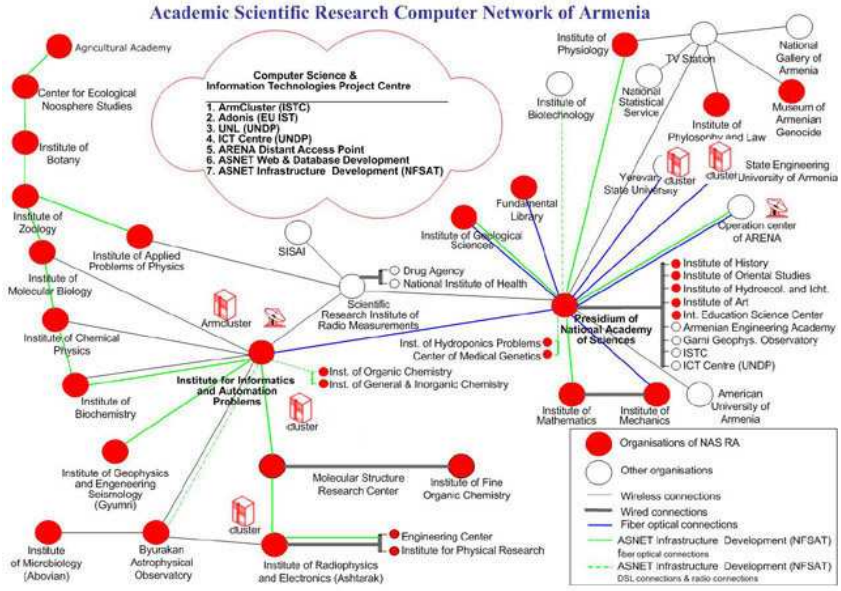

Fig. 1: Network infrastructure within those organizations

The activities include the deployment of appropriate national Grid infrastructure and integrate it with the international and regional Grid infrastructures, as well as development of applications in various fields of science.

2.1 Armenian Grid Infrastructure

In 2001, we decided to use computational resources of available servers of ASNET-AM network during the night times, when servers are not so much busy as during the daytimes. On the base of available servers that used Unix OS a distributed computing system was deployed on the base of Parallel Virtual Machine [10]. Then a web management environment had been developed on the base of the distributed system by using module oriented approaches [11]. The experiments showed that the suggested interface was not reliable and works fine when the interconnections between the parallel modules of distributed task are weak, because that time there were very limited bandwidths between the servers. Taking into account above mentioned, a high-performance computational infrastructure and distributed information-processing network in Armenia had been developed, that enabled to provide the scientists and engineers in the South Caucasus region with high-performance information sources and databases.

In 2004, in the Institute for Informatics and Automation Problems of NAS RA [12] the first high Performance computing cluster in the South Caucasus region had been developed, which consists of 128 Xeon 3.06GHz (64 nodes) processors. [13-14]. The nodes of the cluster are interconnected by Myrinet High bandwidth [15] and Gigabit networks. The Myinet network is used for computation and Gigabit for task distribution and management. The cluster achieved 523.4GFlops performance by HPL (High Performance Linpack) test. Many intellectual software packages to support the advance in the field of modeling and analysis of quantum systems, signal and image processing, theory of radiation transfer, calculation of time constants for bimolecular chemical reactions, a system of mathematically proved methods, fast algorithms and programs for solving of certain classes of problems in linear algebra, calculus, algebraic reconditibility, test-checkable design of the built-in control circuits had been developed. Being the most powerful computational resource in the field of science and education in Armenia the Armcluster constitutes the core of Armenian grid infrastructure.

An experimental scientific-educational Grid infrastructure between the Institute for Informatics and Automation Problems of NAS RA, YSU and SEUA had been deployed [16] on the base of Globus [17] within the framework of State Target Program. The experimental infrastructure enabled to make high-performance computations, provide accumulation of large information content in databases and organize information exchange.

The gLite [18] middleware that was developed under the umbrella of the EGEE project is used to build Armenian Grid infrastructure. It has a large user base and is deployed on many resources since it is the middleware of the LHC Computing Grid (LCG) project [19], the world's largest Grid infrastructure providing the computational power for analyzing data from CERN's LHC (Large Hadron Collider) experiments. gLite is based on a number of components from Globus, among them the GSI. gLite adds support for virtual organizations (VOs) and extends data management functionalities. Among the principal components of a gLite site are the computing element (CE) and the storage element (SE). The CE is a gateway between the external Grid and the site's compute nodes (termed worker nodes) by interfacing to a local batch scheduling system. The SE offers a number of data transfer-oriented services with standard interfaces and gives access to the site's disk and tape storage. The Workload Management System (WMS) comprises a set of Grid middleware components responsible for the distribution and management of tasks across Grid resources, in such a way that applications are conveniently, efficiently and effectively executed. The core component of the Workload Management System is the Workload Manager (WM), whose purpose is to accept and satisfy requests for job management coming from its clients. All resources announce their availability and capabilities through an information system which is used by the Grid resource management to render decisions on where to place jobs.

The main approach of the current activities is to build on existing infrastructures and extend them where necessary, rather than using a single, homogeneous Grid platform. Applications for various fields of sciences that have significant importance for local scientific research communities are developed. Currently various applications in fields of quantum physics, astrophysics, molecular dynamics, 3D periodic artificial microwave structures, IT infrastructure library performance, quantum 3D reactive scattering in the 3-body system, identification and recognition of objects from video images by using digital signal and image processing methods, two-dimensional cellular automata, decision-making and nonlinear boundary parallel algorithms have been developed.

The Armenian Grid Infrastructure (see fig. 2) has been extended within the the Project A-1451 entitled "Development of Scientific Computing Grid on the Base of Armcluster for South Caucasus Region" funded by the International Science and Technology Center [20].

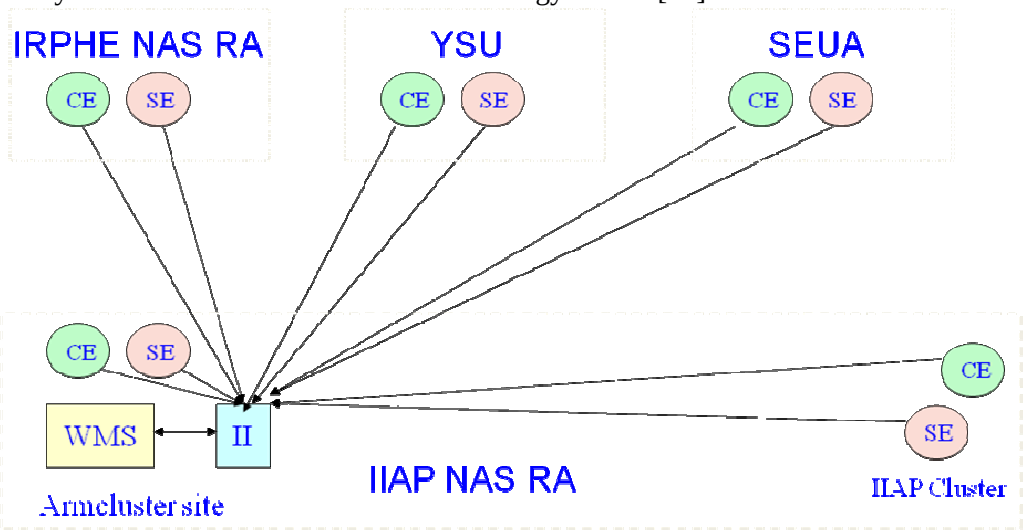

Fig. 2: Armenian Grid Infrastructure

Currently computational recourses of Armenian Grid infrastructure located in Yerevan and Ashtarak cities presented in the table 1.

Table 1: Computational Resources

Site/Site Location	Cores
Armcluster, IIAP NAS RA	176
YSU Cluster, YSU	48
SEUA Cluster, SEUA	48
IRPHE NAS RA Cluster, IRPHE NAS RA	48
Total	**320**

2.2. Integration with Regional and International Grid Infrastructures

One of the most important directions is to take place the regional and international grid projects actively. Several organizations are already actively involved in different regional (South Caucasus, South East Europe) and international Grid projects.

Particularly, Armenia participates in the EU FP7 Project entitled "South East European eInfrastructure for regional eScience (SEE GRID SCI)" [21]. The South-East European eInfrastructure initiatives are committed to ensuring equal participation of the less-resourced countries of the region in European trends. SEEREN initiative has established a regional network and its GÉANT connection and the SEE-GRID initiative the regional Grid. SEE GRID SCI leverages the SEE eInfrastructure to enable new scientific collaborations among user communities. SEE GRID SCI stimulates widespread eInfrastructure uptake by new user groups extending over the region, fostering collaboration and providing advanced capabilities to more researchers, with an emphasis on strategic groups in seismology, meteorology and environmental protection. The initiative thus aims to have a catalytic and structuring effect on target user communities that currently do not directly benefit from the available infrastructures.

The A-1606 Project entitled "Development of Armenian-Georgian Grid Infrastructure and applications in the fields of high energy physics, astrophysics and quantum physics" funded by International Science Technology Center [22] allows to deploy Grid site in Georgia and integrate the Georgian Grid infrastructure with the Armenian Grid Infrastructure. It is also planned to deploy additional grid site located in the Yerevan Physics institute.

3. Armenian National Grid Initiative (ArmNGI)

The grid infrastructure is recognized today in Europe and worldwide, together with the highspeed networking, as one of the basic components of the e-Infrastructure of research and education and soon of the entire knowledge-based society. The starting point of such perception of the grid infrastructure is the paradigm of the grid itself, which offers a flexible organization of geographically distributed resources (computing, data and information resources as well as, for instance, laboratory and experimental devices and equipment), with a consistent and simple access option and possibility to coordinately share them within collaborating virtual teams and organizations.

The Armenian National Grid Initiative (ArmNGI) [23] is an integral distributed computing environment consisting (in this stage) primarily of computing (processing) and data (disc and tape) resources, which are located in geographically distributed sites within the Republic of Armenia. ArmNGI is a common resource of the research and academic community and represents the fundamental infrastructure for the scientific research, use of new technologies and the integration of Armenia and Armenian scientists into the European Research and European Higher Education Area. Therefore, the grid infrastructure established for the needs and during the participation in the European research grid projects from Framework Programmes of the EU, especially the SEE-GRID-SCI Project, is considered as a part of ArmNGI. There is a significant number of central resources and services, such as the job management and job distribution system, the monitoring system or the system of authentication and authorization of the access right, whose proper functionality is very important for the entire infrastructure.

Taking this into account, the following interested organizations in Armenia strive to work together towards establishment of the National Grid Initiative in Armenia, which aims to provide the National Grid Infrastructure for the benefit of the national research and educational community to carry out research; as well as to interconnect with international Grid structures and researchers.

1. Presidium of the National Academy of Sciences of the Republic of Armenia
2. Ministry of Education and Science of the Republic of Armenia
3. State Engineering University of Armenia
4. Yerevan State University
5. Yerevan Physics Institute
6. Institute for Informatics and Automation Problems of the National Academy of Sciences of the Republic of Armenia
7. Armenian e-Science Foundation

The main target is to create and support an Armenian National Grid Infrastructure, which will be an integrated distributed computing environment consisting primarily of computing (processing) and storage (disc) resources. The resources will be located in the geographically distributed nodes within the Republic of Armenia. Primarily, those nodes are hosted by Institutions which are parts of the science and higher education system of the Republic of Armenia. It will be an important national resource for the academic and research community and for other segments of the society as well, has been built and operates under the financial and organizational support of competent government bodies, especially the Ministry of Science and Education. There is a significant number of central resources and services, such as the job management and job distribution system, the monitoring system or the system of authentication and authorization of the access right, whose proper functionality is very important for the entire infrastructure.

References

1. I. Foster, C. Kesselman, S. Tuecke, The Anatomy of the Grid- Enabling Scalable Virtual Organizations, International J. Supercomputer Applications, 15(3), 2001.
2. I. Foster, C. Kesselman, Computational Grids Chapter 2 of "The Grid: Blueprint for a New Computing Infrastructure", Morgan-Kaufman, 1999.
3. Enabling Grids for E-sciencE, http://www.eu-egee.org.
4. Open Science Grid, http://www.opensciencegrid.org.
5. NAREGI: National Research Grid Initiative, htpp://www.naregi.org.
6. UK National Grid Service, http://www.ngs.ac.uk.
7. D-Grid: German Grid Initiative, http://www.d-grid.de.
8. European Grid Initiative, http://www.eu-egi.org.
9. http://www.asnet.am.
10. V.S. Sunderam, G.A. Geist, J. Dongarra, and R. Manchek. The PVM concurrent computing system: Evolution, experiences, and trends. Parallel Computing, 20(4):531--546, 1994.
11. H. V. Astsatryan, The Organization of Distributed Systems by Means of PVM, Transactions of the Institute for Informatics and Automation Problems of the National Academy of Sciences of the Republic of Armenia and the Yerevan State University, Mathematical Problems of Computer Science, volume XXII, ISSN: 0131-4645, Yerevan, Armenia, 2001, pp. 60-63.
12. http://iiap.sci.am.
13. H.V. Astsatryan, Yu. Shoukourian, V. Sahakyan, The ArmCluster Project: Brief Introduction, Proceedings of the International Conference on Parallel and Distributed Processing Techniques and Applications (PDPTA '2004), Volume III, ISBN: 1-932415-25-4, pp. 1291-1295, CSREA Press, June 21-24, 2004, Las Vegas, Nevada, USA.
14. H.V. Astsatryan, Yu. Shoukourian, V. Sahakyan, Creation of High-Performance Computation Cluster and DataBases in Armenia, Proceedings of the Second International Conference on Parallel Computations and Control Problems (PACO '2004), ISBN: 5-201-14974-X, pp. 466-470, October 4-6, Moscow, Russia.

15. Myricom Inc, http://www.myri.com.
16. H. Astsatryan, V.Karamov, V.Sahakyan, Yu. Shoukourian, Development of Grid-segment based on Armcluster, YSU and SEUA Clusters, Proceedings of the Fifth International Conference on Computer Science and Information Technologies (CSIT ‘2005), ISBN: 5-8080-0631-7, pp. 363-366, September 19-23, 2005, Yerevan, Armenia
17. Globus Toolkit Version 4: Software for Service-Oriented Systems. I. Foster. IFIP International Conference on Network and Parallel Computing, Springer-Verlag LNCS 3779, pp 2-13, 2006.
18. gLite, http://www.glite.org
19. Worldwide LHC Computing Grid, http://lcg.web.cern.ch/LCG
20. http://www.istc.ru/ISTC/sc.nsf/html/projects.htm?open&id=A-1451
21. http://www.see-grid-sci.eu
22. http://www.istc.ru/ISTC/sc.nsf/html/projects.htm?open&id=A-1606
23. http://www.grid.am