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Grid in Armenia: Present Status and Perspectives

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Abstract

The ArmGrid project of the Armenian e-Science Foundation (ArmeSFo), aimed at the introduction, development and dissemination of the Grid technologies in Armenia started in the year 2002. This paper introduces the current status of the project, our steps in the creation of the national Grid. In 2003, ArmeSFo established the first Armenian Certification Authority, ArmeSFo CA, which entered the European Policy Management Authority group for Grid Authentication in e-Science. The participants of the ArmGrid project have been integrated into the developers' team of the AliEn Grid infrastructure of the CERN ALICE experiment and are currently working on the port of the AliEn toolkit to Windows OS, which can essentially increase the number of potential AliEn users. Our plans in the deployment of the national scientific and educational Grids are presented. We also discuss the perspective of the creation of a common Grid infrastructure with the regional neighbouring states.

1 Introduction

The past few years have been marked by an intensive development of the Grid approaches to the effective collaborative use of distributed complex experimental facilities and instrumentation, high-volume databases and large scale computing resources. Large investments have been made in the leading industrial countries, providing a rapid evolvement of the Grid technologies from the R&D stage to the stage of their practical applications and promoting the globalization process in many branches of science and other areas of human activity. The Grid distributed computing infrastructures are actually deployed and intensively explored in numerous international and national Virtual Organizations (VOs).

The Soviet science, which was an inherent part of the world research program, has been inherited by the FSU republics with a tradition of active involvement in the international collaborations. The e-Globalization tendency of the research stipulates the development in these countries of the appropriate e-Infrastructures, allowing to maintain the high level of the national science. In this article, we would like to present the current status, difficulties, problems and perspectives in the development of the Grid technologies in Armenia. We hope that being interesting and instructive in itself, our experience could help specialists from other former Soviet republics, as well as those from the countries also possessing modest financial investment possibilities, in the construction of their national Grids.

2 The importance of the deployment of the Grid infrastructure in Armenia is due to the following factors:

- Several Armenian research centres participate in the international collaborations, which are intensively developing Grid infrastructures. An example is the LHC Computing Grid (LCG) project [1], which is aimed at the collaborative handling of the data produced in the future ALICE, ATLAS, CMS and LHCb experiments at Large Hadron Collider (LHC) [2] being built at CERN, Switzerland [3]. Since Yerevan Physics Institute (YerPhI) participates in the majority of these experiments, an appropriate local Grid node has to be deployed.
- Dissemination of the Grid technologies in Armenia will promote a larger involvement of Armenian organizations in the international collaborations. Various scientific and application Grids are either functioning or under construction and it will be possible to establish constructive contacts and collaborations with them too. Of special importance is the integration of the national seismology and environmental centres into corresponding Grids.
- The Grid architecture assumes interoperability and portability of different Grid applications through the development of standardized protocols and services enabling effective access to the remote resources and their processing across a heterogeneous environment embracing powerful computing and data storage nodes, small computer farms or even a PC. The last circumstance is very important for countries such as Armenia because it enables the integration into properly designed VOs of small research labs, high-tech and industrial enterprises, educational, medical centres and other governmental and non-governmental organizations that possess high intellectual potential and need more computing resources and access to the databases.
- The deployment of national Grids could give to national and international communities access to the large diversity of data accumulated in Armenia. These include high-energy and cosmic physics data, data on the Markarian Galaxies surveys, seismology and environmental data, biology, microbiology and medical data. The data refer also to investigation results in fundamental and applied physics, mathematics, Earth Sciences, computing, engineering and advanced technologies.

3 Armenian e-Science Foundation

The Armenian e-Science Foundation (ArmeSFo) [4] is a non-governmental and non-profit institution established in 2002. The goals of ArmeSFo are the introduction, development and dissemination of the e-Science technologies in Armenian scientific and educational centres and other organizations. A modest but very important and continuously stable support of the ArmeSFo activity is provided by Swiss "Fonds Kidagan", Calouste Gulbenkian Foundation, Armenian "Link Ltd" software developing and "Lans Ltd" computer hardware vending companies, "Web" Internet service provider.

4 ArmeSFo Certification Authority

ArmeSFo Certification Authority (ArmeSFo CA) [5] is the first Armenian Certification Authority established in 2003. It issues certificates for the identification of individual users, machines and services. The ArmeSFo CA is maintained by the ArmeSFo as a courtesy service to the Armenian Grid community.

The ArmeSFo CA issued certificates have a common fixed component:

C=AM, O=ArmeSFo

The Distinguished Name of the ArmeSFo CA root certificate is:

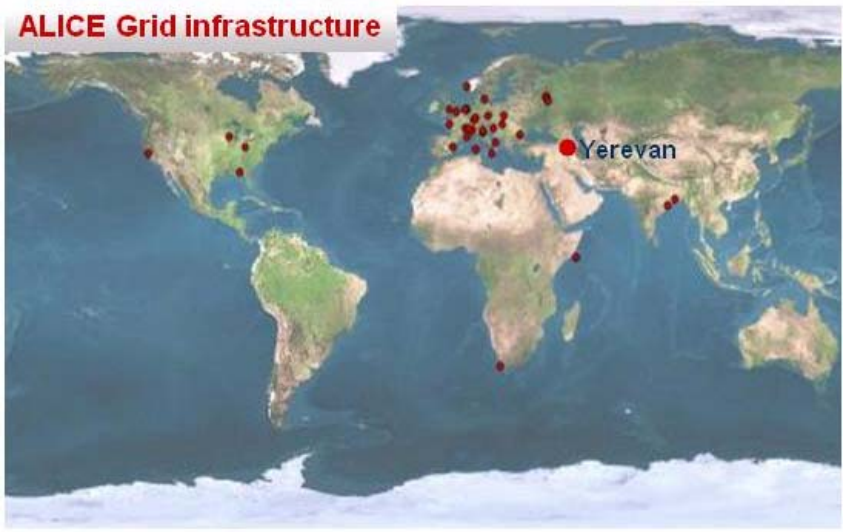
C=AM, O=ArmeSFo, CN=ArmeSFo CA

In 2003, ArmeSFo CA became the member of the European Data Grid CA group (EDG CA) [6] and its successors, European Policy Management Authority group for Grid Authentication in e-Science (EUGridPMA) [7] and LCG CA group [8].

5 ArmGrid project of ArmeSFo

ArmGrid [9] is the project of ArmeSFo for building Grid infrastructures in Armenia and promotion of the integration of national institutions in the international community. The project is aimed not only at the employment of the Grid technologies in Armenia but also at the active involvement of national specialists in the work on different aspects of Grids including security and authentication issues, development of the middleware and software for application layers in the national Grids and implementation of the interoperability and portability. ArmGrid project is realized through the active participation of students from the higher education institutions of Armenia. Currently, the project members are involved in development work for the AliEn Grid infrastructure and are planning to enter the EGEE (Enabling Grids for e-Science in Europe) international Grid project [10] (Section 8).

6 First and still unique Grid node in a vast geographical region



The first studies of the Grid in Armenia were initiated in 2001 by the team of the ArmGrid project including the participants of the CERN ALICE experiment from YerPhI and students from Yerevan State University (YSU) and State Engineering University of Armenia (SEUA). The Globus middleware toolkits 1.1.4 and 2.0 have been installed and tested. In 2002, the AliEn software was installed and the group entered the VO of the CERN ALICE experiment (Section 8). Unfortunately, a catastrophically low capacity of WAN in Armenia (see next Section) renders almost impossible a full-scale exploitation of the AliEn functionality by the physicists.

7 Digital Divide in Armenia

Speaking about Digital Divide in Armenia, one has to note first of all the absence of any state policy in this field. Moreover, the state is a shareholder of the "ArmenTel" company, which is a long-term owner of all internal and external telecommunication lines of Armenia and the Internet prices imposed by this monopoly operator exceed the world prices by a factor of ten. The budgets of the research and educational institutions are too small to pay even modest WAN bandwidths and the typical figures of the Internet external connectivity are from a few Kbps to a few tens Kbps per institution. One finds a slightly better situation in YerPhI thanks to the help of the foreign collaborators that seem to be much more concerned than the local authorities in the maintenance of a traditionally high level of the high energy physics (HEP) in Armenia. Since 1994, NATO and DESY are paying a satellite connection which presently reaches 128/196 Kbps bandwidth.

In 2003, NATO launched the so-called Silk Virtual Highway project aimed at financing additional research WAN channels for South Caucasian and Middle Asian FSU republics. A 500 Kbps/(a few Mbps) bandwidth is allocated to Armenia within that project, implemented by Armenian research and educational association. The bandwidth is shared by a number of research and educational Armenian organizations for their everyday needs. It is thus evident that the current Armenian research international WAN bandwidth is too narrow and cannot provide a full-scale work in the running international Grids.

Thanks to the international funding (Soros Foundation, US NSF), a progress in the deployment of the national MAN has been observed over the last few years. The underground and air fiber optics channels have connected several institutions. After the deployment of the modern I/O equipment, the national science MAN channel speed could reach a few hundred Mbps.

To conclude this Section, one has to note that the development of science and higher education network in Armenia has been chaotic and sporadic until now and future progress is hardly possible without a dedicated national program. Having a clear vision of such a program, ArmeSFo is ready to elaborate its details in the cooperation with the concerned governmental and non-governmental organizations.

8 Development work can be carried out even with modest bandwidth and equipment

The Grid is an entirely new field, and most of the work is now centered on the development of software tools collectively known as middleware and application software. To participate in the development and testing of these tools even a very modest network and computing equipment is enough to start and carry out the work. In some sense the simultaneous presence of different network capabilities and Quality-of-Service is an additional test of the functionality and limits of the Grid middleware. Moreover, the very nature of Grid experimentation and development is such that small focused groups can fully participate in an activity at the leading edge of computing science from their home location even without a fully developed computing infrastructure around. Participation in this activity alone will result in a build up of expertise for the involved groups, with a training and technology fall-out effect. An illustrative example is the work of the ArmeSFo/ArmGrid team from YerPhI on the development of the AliEn software presented in the next Section.

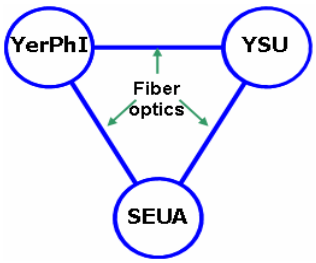
9 The work on the AliEn toolkit development

The ALICE (A Large Ion Collider Experiment) [11], one of the four LHC experiments, represents a typical next generation HEP collaboration involving ~1000 scientists from ~100 institutions. It requires large-scale simulations, heavily distributed processing and event storage, complex analysis of very large volume data (one event up to 2GB, 2 PB/year). To this end, the ALICE offline group developed a Grid architecture called AliEn (ALICE environment on the Grid) [12]. Based on the Open Source standard components (SOAP, Web services, etc), the AliEn framework is a lightweight, simplified but functionally equivalent alternative to full blown Grid. It provides good interface to different databases, easy Web integration, Application Programming Interface for different languages (Java, C, C++, Perl), standard means to invoke procedures (services) in the distributed environment. AliEn was put into exploitation at the end of 2001. Currently, the ALICE collaboration is using AliEn for the distributed production of Monte-Carlo data, detector simulation and reconstruction at more than 30 sites located on four continents. Several other HEP experiments as well as health care Grid projects (EU MammoGRID, INFN GP-CALMA) are exploiting AliEn or some components of it (see [12] for references).

A continuous work on the further development of AliEn is underway with the aim to provide long-term stable interface to Grid(s) for the ALICE users. The YerPhI group, represented mainly by students from YSU and SEUA, has been participating in this work since the end of 2002. After a short period of work on the authentication aspects of AliEn, the group undertook the AliEn port to Windows OS. The necessity of the port is stipulated by two circumstances. First of all, it will give access to AliEn to the army of Windows users. Secondly, the AliEn toolkit has been chosen by the middleware re-engineering and integration team of the European EGEE project [13] for its activity of the integration of the middleware of the leading Grids. The aim of the team is to provide robust middleware components, deployable on several platforms including Windows.

The port of the AliEn toolkit is successfully advancing. Its actual status is presented at this Conference [14].

10 Further steps. Building national Grids



ArmeSFo considers it important to proceed to the phase of its experience transfer to the Armenian institutions. The acquired knowledge and availability of a high-speed MAN make possible the deployment of the national Grids, which is foreseen to perform in two stages.

Since the ArmeSFo/ArmGrid team embraces representatives of YerPhI, SEUA and YSU, it seems natural to construct at **the first stage** an educational Grid involving these institutions. This educational Grid will enable both specialists and students to get first hand experience of the whole Grid architecture and its functionality. Regularly running testbeds will allow

participants to acquire skills in the practical use of the Grid, to learn cooperative work within the VOs and to perform original developments. The educational Grid could be constructed on the basis of the AliEn open-source software, with properly designed VOs and appropriate application software. The functionality of the other international Grids (LCG, EGEE, etc) could also be studied and tested within the educational Grid. **At the second stage**, the acquired knowledge will be offered to other Armenian scientific institutions, such as the Byurakan Astrophysical Observatory, Armenian Academy of Sciences, Earth science and Seismic centres and computing science centres. It is also foreseen to build national Grid environment with the integration of research, educational centres, enterprises and health-care centres located both in Yerevan and in other cites of Armenia.

11 Embedding regional states into a common Grid environment

Armenia, Azerbaijan, Georgia, Iran and Turkey constitute a complex world region with a diversity of national mentalities, religions, traditions as well as economical, social, scientific and technological development. Creation of a common e-Infrastructure would have a positive socio-political and socio-economical impact on this region. It would promote the dissemination of modern information technologies in the region, initiate the exchanges between the scientists and other specialists and would finally serve to improve the morale climate and relations amongst the populations. Taking into account that all these five regional states are participating (to a different extent) in the LHC experiments, the creation of a common e-Environment could begin with the deployment of a HEP Grid infrastructure complying with Tier2 (or 1) standards of the LCG project. Creation of a regional Grid federation is a very challenging task since its achievement requires a lot of coordination and technical skills. However the goal is worth pursuing since it would help to reduce numerous scientific, technological, social and political divides that exist in this very large geographical region and would finally promote the involvement of this region in the international e-Globalization process. Launching this initiative, ArmeSFo is ready to share its experience and knowledge with its colleagues-neighbours. Meanwhile, the complexity of the task will, of course, require for its successful completion the support and coordination by the international HEP community. However, due to psychological problems, even this support and coordination might not be sufficient for the organization of cooperative work of the regional specialists and non-ordinary approaches are needed. In light of this, we would like to outline the positive role that might be played by the generation of young scientists and students. We believe that this generation is not burdened by historical prejudices and can take full responsibility for the construction of a collaboration climate in the region.

12 Conclusion

Despite numerous problems, ArmeSFo is steadily advancing in the practical realization of its pioneering initiative of the e-Science introduction in Armenia. The first, most important stage of obtaining professional understanding of the Grid technologies and overcoming the psychological difficulties, which naturally arise when studying such innovative and complex technologies, seems to have been successfully completed. A compact and actively working team, which consists mainly of young perspective specialists-students, is created. The team shows the capacity to contribute fruitfully to the development of leading edge technologies of the Grid.

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