MINISTRY OF EDUCATION AND RESEARCH
National Authority for Scientific Research

Pilot project for the implementation of the national Grid infrastructure

- Strategic Plan -

Bucharest, February 2006

TASK FORCE MEMBERS:

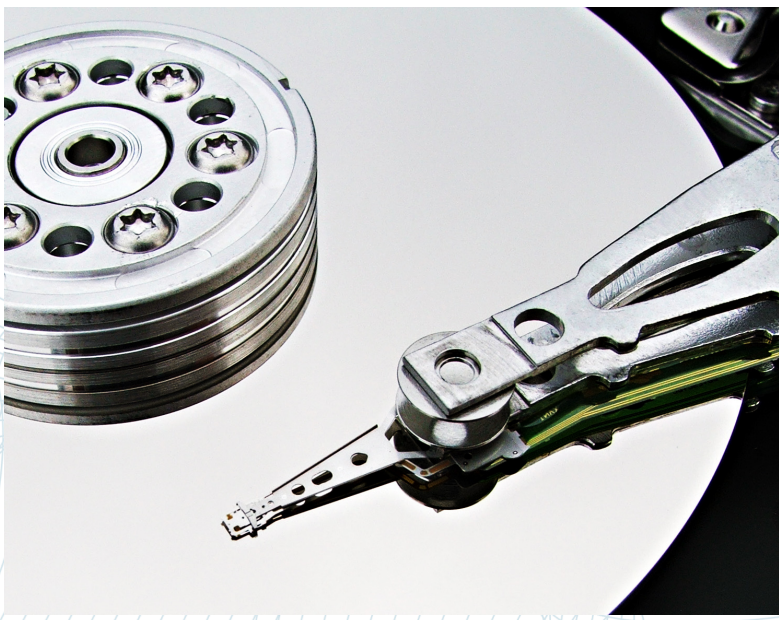
Sorin ZGURA	National Authority for Scientific Research
Sergiu ILIESCU	National Authority for Scientific Research
Camelia DOGARU	National Authority for Scientific Research
Doina BANCIU	National Institute for R&D in Informatics
Gabriel NEAGU	National Institute for R&D in Informatics
Eduard ANDREI	RoEduNet
Octavian RUSU	RoEduNet
Dana PETCU	e-Austria Institute Timisoara
Viorel NEGRU	West University Timisoara
Cosmin NISTOR	Romanian Space Agency
Ionel STAN	Institute for Space Science
Mihai PETROVICI	IFIN-HH
Serban CONSTANTINESCU	IFIN-HH
Mihnea DULEA	IFIN-HH
Cătălin NAE	INCAS
Valentin CRISTEA	"Politechnica" University of Bucharest

CONTENT

1. Introduction

GRID represents a vital component of a Knowledge-based Society. The development of a knowledge-based society in Romania and its integration at a European level assumes the utilization to the greatest degree of the available resources and of the predictable extensions in the very near future. The GRID model represents a promising solution of an efficient distribution of IT resources on a large scale.

In this context, in many countries, GRID implementing strategies are being mapped out and they take into account both national realities and the needs imposed by the compatibility at international level. Thus, the GRID concept becomes a national level component, incorporated in the GRID global structure.



2. Grid computing

The distributed environment enabling sharing and common use of computing, storage and other resources (e.g. sensors), aided by middleware, is called **Grid Computing** or just **Grid**.

This environment supports the development of information intensive applications and demand for access to Information at any geographic point regardless of the means.

Grids integrate through electronic networks computing, storage and other resources (e.g. sensors) distributed at local, national and international scale, scaling the potential of Information / Knowledge Society, like power grids were the catalysts to the Industrial Revolution respectively.

3. eInfrastructure

The integration of networks, resource and middleware layers into one single infrastructure aiming at distributed but homogeneous access to Grid resources is referred to as **Electronic Infrastructure** or **eInfrastructure**. The worldwide development of these infrastructures will provide researchers and economy a common market of electronic resources, accessible on a 24-hour basis, regardless of the place, and a unique tool for the development of collaborating applications.

Supporting projects that aim to build eInfrastructures Europe wide is a priority of the European Union **Framework Programme 6** on Research and Technology Development, Priority Thematic Area Information Society Technologies and Structuring the European Research Area / Research Infrastructures.

The role of academic and research communities is to provide first such infrastructure for their specific needs (eScience) and than to expand to businesses (eBusiness), public administration (eGovernment) and other areas as eCulture, eHealth, eLearning.

4. Priority to Coordinated actions

At the European level the **eInfrastructure Reflection Group – eIRG**, which consists of official delegations from the Ministries of Education of the various European countries, has the mission to coordinate the introduction of a Grid based infrastructure for e-Science. The main objective of the eIRG is to support on the political, advisory and monitoring level, the creation of a policy and administrative framework for the easy and cost-effective shared use of electronic resources in Europe (focusing on Grid-computing, data storage, and networking resources) across technological, administrative and national domains.

The action plan e-Europe 2005 "Information Society for All" has as the major goal to create an advantageous environment for the development and creation of new jobs, promote productivity, modernize public services to citizens and give all the opportunity to participate in global information society. eEurope 2005 aims at creating secure services, applications and content to all European citizens, based on a widely available broadband infrastructure network.

In a longer perspective, the document entitled **"i2010 – European Information Society 2010"**, proposed by the European Commission in April 2005, promotes an open and competitive digital economy and emphasizes the role of high bandwidth communication, innovative and competitive broadband services.

At the National level, considering the importance and long term impact of Grid infrastructure on Information Society development, in many European countries have been defined strategic approaches to Grid development and implementation, taking into consideration both national conditions and requirement to keep compatibility at the international level.

In Romania, the first attempt to coordinate actions towards the national Grid infrastructure was the setting up of the **RoGrid consortium**, in 2002, including seven organizations from research, academia and IT business. In 2003 the consortium proposed the first strategy for Grid development in Romania. In July 2005 the **Task Force for the national Grid infrastructure** was organized, including representatives from the Ministry of Education and Research, Ministry of External Affairs, universities, research institutions, and RoEduNet. The main goal of this Task Force is to promote a strategic plan for the **pilot project entitled "Implementation of the national Grid infrastructure"**.

5. The outline of the pilot project

The importance of the Grid infrastructure validates a strategic approach to a medium-term development of the domain, which is basically to set objectives, establish priorities and size up the necessary resources.

As far as the eInfrastructure is concerned, Romania needs to catch up with the other countries from the region (Czech Republic, Poland, Hungary or Greece).

The main objective is to organize, to develop and to put into operation a Grid infrastructure in Romania in view of increasing the accessibility, reliability, scalability, security and efficiency of using complex scientific and commercial applications.

Main action lines supporting the project objectives

A. Provide the legal and organizational framework

B. Develop and operate the INGrid infrastructure at national level

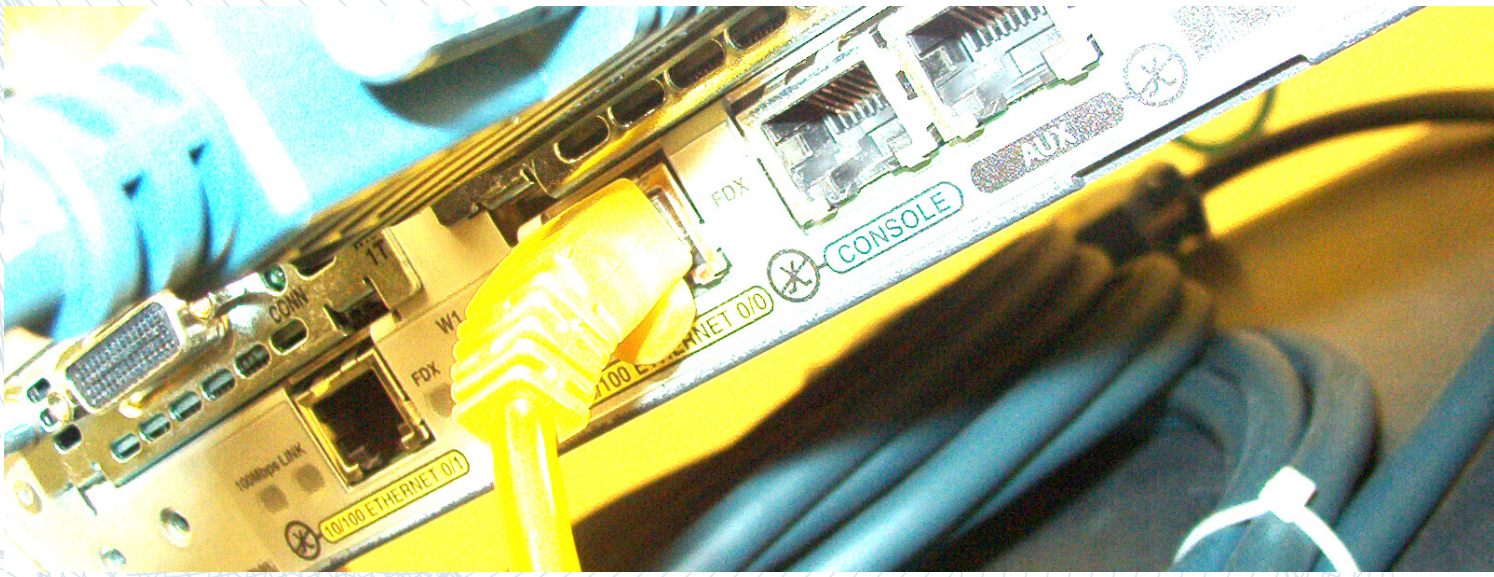
C. Exploit the developed infrastructure

6. Communication segment for the Romanian GRID framework

The creation of networks devoted to Research and Education (NRENs – National Research and Education Networks) across Europe contributes to an unprecedented availability of information and knowledge to millions of researchers, students and academic staff. Today users' need for more bandwidth fostered rapid advances in network technologies and deployment but also created a digital divide between Western and Eastern Europe.

For the GRID framework at the national level, the main foundation is the data communication infrastructure at the national and international levels. All over Europe and also in Romania, the communications system for the research and education is used for all GRID initiatives and these services are provided by National Research and Education Network (NREN). At the international level the communication infrastructure for the GRID applications is provided by GÉANT, the network interconnecting national research networks of the various European countries.

The organization that provides NREN services and GÉANT connectivity in Romania is RoEduNet.



7. Recommendations

The development of Grid infrastructure should be viewed in the overall development of the information society, as an investment in technology, education, human resources and the business-medium.

The Task Force will coordinate all actions aiming at defining and implementing the administration and usage framework for the national Grid infrastructure, as for example: set up of the Certification Authority for Grid community, administrate the national repository for Grid resources, propose solutions for related legal and policy aspects (quality of services, protection of both Grid services providers and users, service level agreements, use policies, adoptions of international standards in this domain), implement institutional solutions related with the administration and usage of the national Grid infrastructure.

At the first stage, the main beneficiary of the national Grid infrastructure will be the academic and research community, as the infrastructure is based on the existing networking support assigned to this domain (RoEduNet and RNC). Later on, the beneficiaries will be the public administration, the business medium, health-care, culture and other domains of economy and society.

The distributed environment enabling sharing and common use of computing, storage and other resources (e.g. sensors), aided by middleware, is called Computing Grid or just Grid.

This environment supports the development of information intensive applications and demand for access to Information at any geographic point regardless of the means.

Grids integrate through electronic networks computing, storage and other resources (e.g. sensors) distributed at local, national and international scale, scaling the potential of Information Society, like electric power grids were the catalysts to the Industrial Revolution respectively.

GRID represents a vital component of a Knowledge-based Society. The development of a knowledge-based society in Romania and its integration at a European level assumes the utilization to the greatest degree of the available resources and of the predictable extensions in the very near future. The GRID model represents a promising solution of an efficient distribution of IT resources on a large scale.

In this context, in many countries, GRID implementing strategies are being mapped out and they take into account both national realities and the needs imposed by the compatibility at international level. Thus, the GRID concept becomes a national level component, incorporated in the GRID global structure.

The overall objective of pilot project for the implementation of the national Grid infrastructure in Romania is to organize and implement a GRID infrastructure in Romania in order to increase the accessibility, reliability, scalability, security and the efficiency of using complex scientific and commercial applications.

According to this general objective, the plan defines specific objectives, principals applied and main action lines for the development of Grid infrastructure in Romania, taking into consideration the actual conditions of the ITC development at the national and international levels.

This proposal is based on the Strategy for Grid development in Romania, developed by the RoGrid consortium in 2003.

2. GRID COMPUTING

The term GRID was introduced in the mid 90's in order to designate the harmonized separation and utilization of resources in dynamic virtual organizations, in other words, the development of some virtual computing systems starting from geographically and institutionally distributed components. These systems are adequately incorporated so that they can provide services to their beneficiaries at the desired quality.

Initially formulated as a support of complex and scientific applications, Grid has become very important for commercial organizations, first of all in technical and engineer applications, later on in business applications. It is estimated that GRID will follow a trajectory similar to WEB, which was developed as a technology for scientific cooperation later on to be extended to business applications. As a matter of fact even in the current phase Grid mechanisms can implement a service-oriented architecture and the entire function of Grid may be incorporated in Web's services becoming usable in commercial applications. Therefore, a new outlook is opening up for providing, on commercial terms, different types of services (WEB hosting, content distribution, software applications, stocking and calculus) with high performance and at a low price in comparison with the traditional solutions.

Grids integrate different computer resources (PCs, clusters, large computer centers) and other electronic devices with heterogeneous technological implementations. Geographic coverage of Grid depends on the networking solution it relies on: local, metropolitan, national, regional or global area network. A Grid infrastructure is highly scalable requiring limited initial investments. Therefore it is affordable and may represent an efficient solution for bridging the digital gap at different levels, with the final goal of exporting useful knowledge, solving specific problems and promoting science and technology in favor of the entire user community. From this point of view Grid is the expression of globalization in the scientific activity. The main beneficiaries are user communities with high requirements for computing and storage resources in such domains as High Energy Physic, Meteorology, Bioinformatics, Computational Chemistry, Astronomy, Earth Sciences, Satellite Tele-detection, and so on.

The multilayer Grid infrastructure includes:

a. the network layer containing physical interconnections and network equipment;

b. the resource layer: computational, storage, domain specific electronic devices (sensors, telescopes etc.);

c. the middleware layer, which includes core services for access to resources, security, accounting, statistics;

d. the application and service layer for different scientific communities.

By its direct impact on the performance and efficiency parameters for the utilization of the national information infrastructure including its connectivity to the global infrastructure, the Grid infrastructure represents an essential domain and a priority for the information society in Romania.

The integrated configuration of the first three layers is called Electronic Infrastructure (eInfrastructure).

The integration of networks, resource and middleware layers into one single infrastructure aiming at distributed but homogeneous access to Grid resources is referred to as eInfrastructures. The worldwide development of these infrastructures will provide researchers and economy a common market of electronic resources, accessible on a 24-hour basis, regardless of the place, and a unique tool for the development of collaborating applications.

The main goal of Electronic Infrastructures is the uninterrupted, quick, secure and friendly access of millions of Internet users, not only to information sources, but to internationally distributed sources and services (eServices) implementing the Information/ Knowledge Society.

Supporting on projects that aim to build eInfrastructures Europe wide is a priority of the European Union **Framework Programme 6** on Research and Technology Development, Priority Thematic Area Information Society Technologies and Structuring the European Research Area / Research Infrastructures.

The role of academic and research communities is to provide first such infrastructure for their specific needs (eScience) and than to expand to businesses (eBusiness), public administration (eGovernment) and other areas as eCulture, eHealth, eLearning.

Relevant for this effort are such FP6 projects as: **GEANT2** (to further develop GEANT network providing high quality and speed services to the European educational and research community), **EGEE** - Enabling Grid for E-sciencE (to develop and support grid services at production level), **DEISA** – Distributed European Infrastructure for Supercomputing Applications (to create and operate a distributed supercomputing infrastructure in Europe), **SEE-GRID** – South East European Grid eInfrastructure Development (to create a human network in south-eastern Europe capable to promote Grid technologies and to implement Grid testbeds, in all countries of the area).

Also in the EU **Framework Programme 7**, which will be launched in 2006, eInfrastructure is addressed in two out of four specific sections of this program. In the section "Cooperation" the IST domain includes Intelligent infrastructures as an integration technology. In the section "Capacities" eInfrastructures are referred in the chapter regarding Research Infrastructures.

4.1. Initiatives at the European level

At the European level the eInfrastructure Reflection Group (eIRG) which consists of official delegations from the ministries of Education of the various European countries, has the mission to coordinate the introduction of a Grid based infrastructure for e-Science. The overall objective of the eIRG is to support on the political, advisory and monitoring level, the creation of a policy and administrative framework for the easy and cost-effective shared use of electronic resources in Europe (focusing on Grid-computing, data storage, and networking resources) across technological, administrative and national domains. The list of derived specific objectives includes:

- identify the fundamental fabric, services and resources needed to enable pan-European e-Science,
- recommend resource sharing policy guidelines to:
  - National Grid initiatives and
  - Regional & European – wide eInfrastructure projects
  - contribute to International policy forums
  - give input to other policy drafting bodies
- focus first on eScience application user groups (as enablers of novel architectures) but also address wider application domains (e.g. eLearning, eGovernment, eHealth, eCulture, eBusiness, etc.) within the ERIA (European Research and Innovation Area)
- identify, inform and promote GRID awareness among communities who can benefit from sharing resources
- address Governance issues of Grid deployment.

The action plan e-Europe 2005 "Information Society for All" has as the major goal to create an advantageous environment for the development and creation of new jobs, promote productivity, modernize public services to citizens and give all the opportunity to participate in global information society. eEurope 2005 aims at creating secure services, applications and content to all European citizens, based on a widely available broadband infrastructure network. The eEurope action plan is based on 2 sets of actions interacting and supporting each other:

- services focusing on e-government applications to citizens and e-business for the development of economy,
- infrastructures for the above, focusing on broadband networks.

According to this plan, the European Union must have:

- modern, electronic services for citizens
- electronic government infrastructures
- e-learning infrastructures
- e-health services
- full digital environment for the operation of e-business and infrastructure of the above
- wide dissemination of broadband networking services
- secure access.

The action plan includes four tools for the achievement of the above goals:

- interventions at administrative level for the adaptation of legislation at national and European level

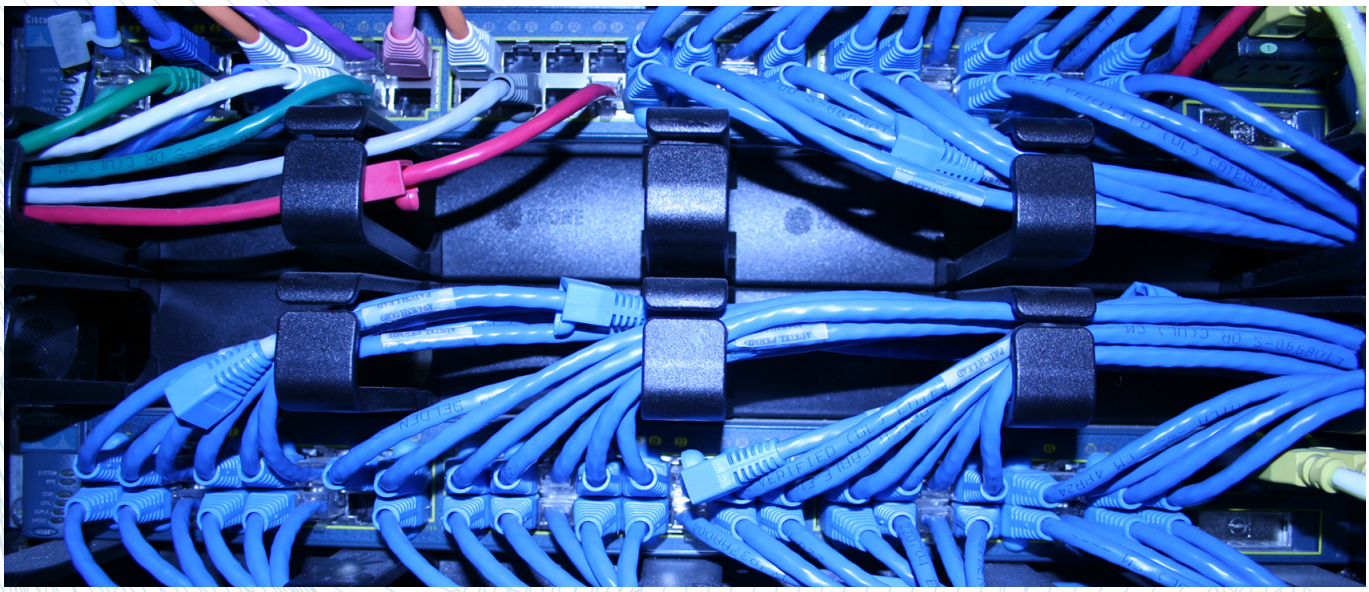
in order to support new services and to strengthen competition and interoperability of these services;

- create a framework that will facilitate the exchange of ideas, views and good practices in the fields above and to use pilot projects as the driving force to the promotion of applications and the exploitation of infrastructures;

- set up e-benchmarking tools for the evaluation of the successful implementation of the above;

- coordinate national initiatives in the above priorities to promote synergies at European level.

In a longer perspective, the document entitled **"i2010 – European Information Society 2010"** was proposed by the European Commission in April 2005 as a strategic framework laying out broad policy orientations. It promotes an open and competitive digital economy and emphasizes the role of high bandwidth communication, innovative and competitive broadband services.



4.2. Initiatives at the National level

Considering the importance and long term impact of Grid infrastructure on Information Society development, in many European countries have been defined strategic approaches to Grid development and implementation, taking into consideration both national conditions and requirement to keep compatibility at the international level.

e-Science Program in UK is a large national initiative for the promotion Grid technologies in scientific and technological applications. The goal of e-Science Grid in the United Kingdom is to provide the necessary infrastructures not only for e-Science, but also for e-Business, e-Government and e-Life. According to the statement made by the Research Councils Office of Science and Technology in UK, e-Science is about global collaboration in key areas of science, and the next generation of infrastructure that will enable it. Therefore the most significant result of this systematic national effort was the creation of the Grid Infrastructure used by a large community of scientists representing research and academic area, but also more than 50 companies from industry. This infrastructure supports a number of Grid projects developed by joint (research and industry) teams, in such domains as health, genome technologies and bioscience, astronomy, high energy physics, environmental sciences, chemistry and science of materials, even social and economics sciences. Industrial partners funded more than

At the first phase of the e-Science R&D Programme (2001–2003), the British government (represented by the Department of Trade and Industry and the

Office of Science and Technology) spent about 170 mil. EUR, while the industrial partners' contribution was about 40 mil Euros. For the second phase (2004-2006) the budget of eScience is cca.195 mil Euro, shared between Grid infrastructure (Core project) and application projects in various scientific fields.

Among the conclusions draw up so far from the e-Science program development may be mentioned the necessity to keep neutral the core infrastructure as a facilitator of collaboration, to make it standard and ubiquitous, to activate all kind of collaborations around the project: across disciplines (computer science and applications), across funding bodies (research and infrastructure stakeholders), across borders (political and commercial aspects).

The Grid initiative in Netherlands has been oriented on three objectives:

- to implement a networking infrastructure at gigabit interconnection speeds (SURFnet with projects Gigaport and Gigaport Next Generation)
- to develop a set of e-science applications under the Virtual Lab E-Science programme (also containing applications-actions from e-business)
- to set-up a large scientific community of users, from universities and research institutes.

The key role in implementing these objectives in played by The Amsterdam WTCW (Amsterdam Science and Technology Centre), with two significant achievements in the area of Grid infrastructures:

a) **e-Sciencepark** Amsterdam ('Global scientific collaboration and next generation enabling infrastructure') providing coordination and infrastructures for e-Science activities in the science and technology part in Amsterdam and all over the Netherlands, hosting a large number of modern infrastructures, providing national supercomputer service, maintaining the national research network SURFnet5, carrying out research and scientific activity for national and international cooperation.

b) **Virtual Lab e-Science**, a programme of a total budget of 55,6 mil Euro, with the following priorities: e-Science in applications, Generic Virtual Laboratory methodology, large scale distributed systems, scaling up to & validating in real life applications. The programme includes 21 collaborating agencies from Universities and research institutes.

The Grid.IT initiative in Italy was based on the contribution of INFN (Instituto Nationale di Fisica Nucleare), which is in charge for the creation and proper operation of the national Grid infrastructure.

The first project for the deployment of this infrastructure was initiated in second half of 1999 with the participation of more than 20 collaborating national agencies, over 100 experts from all fields and a budget of ~30 mil Euro. The infrastructure is supported by the national research network GARR. Later on the Grid Operation Service (GOS) was created, which supports both the operation of applications from various scientific fields of different Italian research and technology agencies.

The Italian eScience Grid.IT infrastructure, with a budget of 8.1 mil Euro for the period 2003-2005, supports the following scientific fields: astrophysics, biology, computational chemistry, geophysics and earth observation.

Another project entitled "Enabling Platforms for High-Performance Computational Grids Oriented to Scalable Virtual Organizations" constitutes the proposal of the most representative agencies in Italy, in the area of Grid technologies. The project budget is 23 mil Euro of which 8 mil Euro corresponds to own funds and 15 mil Euro from Ministry for Education, University and Research.

Finally, the IG-BIGEST (Italian Grid for eBusiness, eIndustry eGovernment, eScience & Technology) initiative was launched to promote participation of Italian agencies in R&T projects in the 6th framework programme and other international Grid actions. IG-BIGEST is coordinated by INFN and includes all Italian scientific institutes, the largest computational centres of the country and many companies which want to participate and invest in original tests on IG-BIGEST.

The major principles used by INFN in building the Grid Infrastructure are: use as much as possible what already exist (including available middleware); develop or take what is missing from EU or International projects as much as possible; complement with a national development program and GGF (Global Grid Forum) participation.

In Sweden, building the **SweGrid infrastructure** has been oriented toward the gridification of the existing high performance computing centers. In January 2004, as a result of a 3,6 mil Euro project, the SweGrid production test bed already included 6 HPC centers (600 CPUs) from main academic centers of the country, with 1 Gigabit connection to SUNET (10 Gbps). Long term vision is to have all HPC resources (computers & storage) in Sweden available through SweGrid, to extend further the infrastructure by connecting a great number of loosely coupled clusters of PCs, to implement an accounting mechanism.

In Greece, the start of the **Hellenic Grid initiative** was based on the experience of the Greek research-academic community in edge technologies and the successful operation of the Greek Research and Technology Network GRNET. The Special Secretariat for the Information Society of the Ministry of Economy & Finance has set up **the HellasGrid Task Force** for the development of Grid Computing in Information Society for Grid Technologies (HellasGrid Task Force), aiming at developing a national strategy and coordinating user groups for the dissemination of the above technologies. Also the Task Force undertakes policy-making at national, community and regional level.

The Task Force is led by the Special Secretary for Information Society and includes representatives from the main research-academic groups operating in the area of networking, supercomputers and computer clusters, parallel systems, middleware and applications, as for example: main universities of the country, the Hellenic National Meteorological Service, the National Observatory of Athens, the Centre for Research and Technology Hellas, the Research Academic Computer Technology Institute, the Institute of Communication and Computer Systems, the Foundation for Research and Technology, the Institute of Accelerating Systems and Applications, the Centre for the Application of Communication and Information Technologies. A Scientific Committee has been also set up, supporting the work of the Task Force in all issues and recommending technical and organization solutions.

4.3. Romanian Task Force for national Grid infrastructure

The first attempt to coordinate actions towards the national Grid infrastructure was the setting up of the RoGrid consortium, in 2002, including seven organizations: National Institute for R&D in Informatics – coordinator, University "Politehnica" of Bucharest, National Institute for Physics and Nuclear Engineering, National Institute for Aerospace Research, University of Bucharest, Institute for Nuclear Research Piteşti and SIVECO Company. Acting as a national Grid initiative, its major results since than have been the followings: collaboration between member organizations in national research projects aiming at developing of the metropolitan Grid infrastructure, concerted participation (based on the Joint Research Unit concept) in EGEE and SEE-GRID FP6 projects, elaboration of the first strategy for Grid development in Romania, with a proposed budget on four years period of 7,9 mil Euro.

In July 2005, according to the decision of the Ministry for Education and Research, the Task Force for the national Grid infrastructure was organized, including representatives from the Ministry of Education and Research, Ministry of External Affairs, 7 universities, 7 research institutions, and RoEduNet. The main goal of this Task Force is to promote a strategic plan for the pilot project entitled "Implementation of national the Grid infrastructure". This strategic plan is described in the next sections, in terms of objectives, principles to follow, main action lines and expected results for the first year period.

5.1. Premises

- The importance of the Grid infrastructure validates a strategic approach to a medium-term development of the domain, which is basically to set objectives, establish priorities and size up the necessary resources.

- As far as the eInfrastructure is concerned, Romania needs to catch up with the other countries from the region (Czech Republic, Poland, Hungary, Greece).

- From the implementation point of view, the harsh absence of Grid type resources obviously affects the potential for development and efficient participation to the international cooperation in important scientific domains, mainly for the cooperation in CERN projects.

- In Romania there is a proved scientific and technical potential which can make up the minimum nucleus necessary to develop the proposed pilot project for implementation of the national Grid infrastructure.

- Participation of the Romanian institutions in the EU funded research projects aiming at implementing a European Grid Infrastructure provides a significant technological and operational support which should be consolidated at the national level.

5.2. Objectives

5.2.1. The overall objective

The overall objective of the pilot project is the following:

Organization, development and putting into operation of a Grid infrastructure in Romania in view of increasing the accessibility, reliability, scalability, security and efficiency of using complex scientific and commercial applications.

In order to better benefit from the efficiency and quality of the existing scientific and applicative potential in Romania, the resources distributed on the national level are integrated by this pilot project into a virtual system where the access is organized and provided using specific Grid technologies.

Also, by means of this pilot project, a new concept of collaborative work is promoted in the Romanian information society, initially being oriented towards research and academical activities, but which is going to be extended in all fields of activity at the society level.

The accomplishment of the general objective is based on an intensive international cooperation in many projects, initially orientated towards specific scientific research topics. The development of the INGrid infrastructure will be carried out taking into account the specific requirements of the Grid technology for hardware and software infrastructure.

The operation and exploitation of the INGrid infrastructure at national level has in view to attract new partners and financial resources for maintenance and prospective development.

This infrastructure is specifically designed for Grid and its main features are the following:

Dynamism and globalization. The domain of GRID related technologies is evolving, but different approaches are carried out in Europe and USA currently. Being based on equivalent principles the existing systems are expected to become compatible in the future.

Credibility and security. One of the priorities of GRID networks is to provide a secured access through last generation specific means. Also, access granting and information availability are carried out in GRID by the most advanced means existing at the moment. The improvement of the GRID system credibility is a dynamic process, which is strongly influenced by the increasing number of available applications and their users.

Availability and unlimited access to resources. These attributes depend on technical level of the local GRID system implementation. The user's access to the available software (applications) and hardware (computing) resources is provided under strictly observed conditions of authentication and accountancy.

5.2.2. Specific objectives

Based on the overall objective the following specific objectives are defined.

SO1: Gradual and balanced development of the national Grid infrastructure, based on active centers of competence and reuse of the results provided by national and international cooperation in the domain.

According to this objective the first version of the Grid infrastructure will include a limited number of nodes hosted by those organizations from academia and research that are already active in this area. Further versions of the infrastructure will integrate gradually new nodes.

SO2: Integration of the Romanian information society in a virtual global information

SO2 is a priority in view of achieving the minimal technical level required in order to provide compatibility and compliance with existing standards in Europe and USA for running international projects.

SO3: Increasing the scientific potential and the existing capacities for applied software development by integrating in a GRID global system; drawing of new resources for the research field; extending the impact of research results in economic and social fields.

This objective is supported by:

- Existence of international partnership and cooperation projects oriented on Grid technologies;
- Cooperation in FP6 and future FP7 international projects;
- Objective necessity to exploit research results by developing software applications of high complexity;
- Increasing the efficiency and work capacity in research activities by their orientation towards virtual laboratories;

- Increasing competitiveness of the Romanian research by exploiting the expertise accumulated in high performance interdisciplinary scientific software.

SO4: Promotion of new specific Grid technologies in Romania, orientation of academic, research and business communities towards the new virtual global medium, as well as the training and specialization of human resources, and provision of transition towards the new system.

There will be two categories of Grid users at the entire information society level in the INGrid infrastructure:

- The provider of information services (computing, storing, communications, applications) coming basically from research and academic fields, is the one that contributes to the developing of infrastructure resources either by means of developing specific applications or introducing new information. Software producers providing specific Grid applications are also included in this category.

- The beneficiary of services and resources that are placed at users` disposal through Grid applications.

The transition towards the new work medium presumes a specific specialization of these users through training activities. The main role in this direction is to be played by the academic community through developing of educational programs oriented on this new technology.

The INGrid strategy requires a partnership-based involvement of major software producers. The latter are going to develop specific applications based on GRID technologies that will be promoted initially in the academic community and research network, and then will continue at the entire society level through specific promotion and dissemination activities.

5.3. Principles

The principles that make up the basis of current strategy are the following:

P1. - Achieving an open infrastructure, compatible with similar infrastructures at regional and European levels

The strategy is oriented toward the goal of organizing and exploiting an infrastructure that, after the first phase, it should allow drawing of financial resources that would lead to the reduction of investment efforts. Finally, it is expected a development stage that would enable the self-financing status.

The open architecture of the system will permit to adapt priorities towards potential users, the goal being to rapidly promote specific applications with impact in civil society.

P2. – Providing a balance between investments in three main category of resources specific to this infrastructure: communication and networking, Grid hardware and software infrastructure, and in developing of application software

In order to reduce the investment effort it is intended to draw into INGrid providers and owners of telecommunications networks through partnerships materialized in specific applications of Grid technologies. In this way, the costs of developing and maintaining the hardware infrastructure will be reduced while available resources will be reoriented to applications development.

P3. - Exploitation of internal production of scientific software

On the middleware level, the existing and available open source solutions will be adopted initially. While the standardization process advances, these solutions will be incorporated in new specific interfaces, which might be developed in Romania. On the application level priority will be given to those projects addressing larger user communities, as for example projects envisaged to generate scientific information that might be of interest for the **INGrid users.**

P4. - Providing the necessary conditions for the INGrid infrastructure to penetrate and operate in various domains of economic and social life

It will be possible to exploit the INGrid infrastructure will in different fields such as: education, business, transports, healthcare, environment protection, meteorology, decision making in force major situations (nuclear disasters, cataclysms) etc. Education, training and dissemination will be the main enablers of this penetration process.

5.4. Action Lines

The Overall Objective is concerned with three directions of action with specific subsequent objectives:

A. Provide the legal and organizational framework

- Develop of a INGrid organizational structure at the national level, coordinated by the Task Force, based on regional nuclei, compatible with similar Grid structures in EU and USA;
- Develop the legal and institutional framework, which should provide appropriate protection of Grid users and providers;
- Provide specific regulations for the cost system related to the access to specialized software and hardware service, available in virtual global system based on fast identification, access and operation of Grid services at the user level.
- Promote Grid technologies by means of standardization in the area of application software design, as well as in development of computing and telecommunication equipment.

B. Develop and operate the INGrid infrastructure at national level

- Basic transformation in the information generator's mentality by shifting from the on local information based approach toward the semantic GRID, with higher capabilities regarding generation, discovery and transport of scientific information;
- Stimulating the setting up of application oriented, dynamic collaborative groups / consortia using virtual working infrastructures;
- Development of new techniques for performance monitoring and assessment in virtual collaborative environments;
- Development of some adaptation and personalization techniques of resource requirements in INGrid, while maintaining originality and security characteristics for the results;
- Development of the secured (granted acces for authenticated and identifed user) and trusted (in sense of credibility granted to the information during a work sesion) access to infrastructure.

C. Exploit the developed infrastructure:

- Involvement of industrial and bussiness partners in Grid projects;
- Dissemination and exploitation on the market of the Grid services developed in research projects;
- Promoting of the new concept of collaborative working environment in administrations and bussiness;
- Putting of national scientific potential in advantage by means of eScience distributed applications.

6. COMMUNICATION SEGMENT FOR THE ROMANIAN GRID FRAMEWORK

The creation of networks devoted to Research and Education (NRENs – National Research and Education Networks) across Europe contributes to an unprecedented availability of information and knowledge to millions of researchers, students and academic staff. Today users' need for more bandwidth fostered rapid advances in network technologies and deployment but also created a digital divide between Western and Eastern Europe.

Today, most of western European countries NRENs are featuring a multi-Gigabit per second backbone and offering advanced services. In the eastern countries, the amount of available bandwidth is measured in hundreds of Megabits or less. This is an issue that has been addressed by many European programs and funded projects, like Study into European Research and Education Networking as Targeted by eEurope - SERENATE, South-East Europe Fiber Infrastructure for Research and Education - SEEFIRE and South-East Europe Research and Education Network - SEEREN.

At the European level, GÉANT, the network interconnecting national research networks of the various European countries, is the most advanced network used for research and education. The most important achievements of GÉANT are: the first network that used 10 Gbps in the core, wide spread of 2.5 Gbps links, use of dark fiber for the international connections and, maybe one of the most important results, is the creation of a network of people from all over Europe, devoted to networking of excellence. Similar developments as in GÉANT are expected at the national and local level of research networking.

For the GRID framework at the national level, the main foundation is the data communication infrastructure at the national and international levels. All over Europe, and also in Romania, the communications system for the research and education is used for all GRID initiatives and these services are provided by National Research and Education Network (NREN). At the international level the communication infrastructure for the GRID applications is provided by GÉANT.

The organization that provides NREN services and GÉANT connectivity in Romania is RoEduNet.

The following components of the communication system to be used by the GRID providers and the users are:

- The connection between RoEduNet and GÉANT and the associated networking equipments
- The national communication infrastructure of RoEduNet
- The metropolitan area networks and the associated equipments
- The communication system used by the beneficiary institutions and/or the GRID provider. This system includes the local loop between the institution and the metropolitan area network or one of the RoEduNet node and the routing/switching equipments at the beneficiary premises.

We will analyze the requirements for all these components to be fulfilled so the whole system provides necessary performances for GRID applications.

6.1 International Segment

At this time the connection between RoEduNet and GÉANT is provided within GN2 project, with half of the total costs provided by RoEduNet and half by the project. Two STM4 connections are in testing phase and for the near future will provide about 1.2 Gbps. These links to Budapest are using two different physical paths and will work using load-balancing to provide the maximum bandwidth and backup at the same time (if one link is down the second will be operational due to the fact that each link uses a different path). This solution was used taking into account the total amount of funds available within the RoEduNet budget. For the Romanian GRID the total amount of external connectivity should be at least 10 Gbps and a backup link should also be used (considered).

There is no available information about the costs for the 10 Gbps links in Romania. To estimate the costs for such a link, the results of the SERENATE project will be used. Also, the study for the SEELight project will be presented taking into account that this project, initiated by the Greek NREN (GRNET), aims to provide dark fiber connection between Bucharest and Budapest and Bucharest and Sofia.

Using the SERENATE deliverable D14 available as a public document on their website, we will calculate the costs to operate the Bucharest to Budapest connection.

There are some options to be used to achieve 10 Gbps bandwidth:

- Own fiber
- Dark fiber (IRU – Indefeasible Right of Use)
- Lambda

The distance between the two cities is about 800 km, but we should consider a longer distance because of the installation conditions. We believe that adding 20% to this length should be enough for our calculations and we will consider a link with a total length of 1000 km.

The first option is, in our opinion, not suitable because of the investment and the maintenance costs, but cost calculations are presented anyway.

The second option is the most interesting because once the fiber is leased and the equipment installed; the costs for future upgrades or to implement new transmission technologies will be minimal. However, an IRU contract usually stipulates that the contracting period should last for more than 10 years and the fee should be paid at the beginning of the contract or in the first 2-5 years. Also, some costs for the collocation of the NREN's equipments at the carrier premises should be considered. There are also some options to be considered:

- Dark fiber with amplification – the inline amplifiers will be installed and maintained by the carrier
- Dark fiber with amplification and regeneration – the inline amplifiers and the regeneration equipments (typically OEO) will be installed, maintained and managed by the carrier

The last option, lambda leasing, provides also 10 Gbps data communication channel, but does not provide scalability.

For a second connection from Bucharest to Sofia the costs are about 65% of the Bucharest – Budapest link (for the equipments and for the links.)

The SEELight project mentioned above estimates that the total costs of the fiber leasing, equipments for the first five years, operation and maintenance for two links: Bucharest-Budapest and Bucharest-Sofia, is about 6.5 million euros. The solution proposed in the project is dark fiber lease.

The amount of money that should be Romanian contribution to the SEELight project is 1.3 million Euros because the funds for the project are expected to be provided within HiPERB program. The contribution of the beneficiary countries is 20 % of the total costs, 80 % are provided by the Greek government.

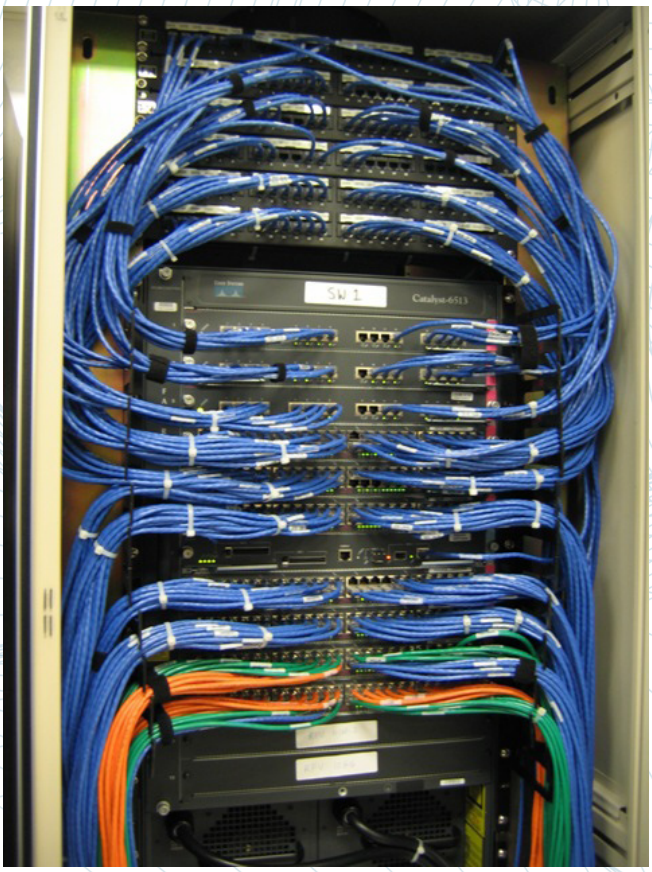
Using the dark fiber for the international link could solve also some national links (at least one of the main national paths, Bucharest - Cluj Napoca) with minimal costs, due to the fact that increasing the number of wavelengths does not involve supplementary costs for the leasing of fiber and only minimal costs for the transmission equipments must be supported

Lambda leasing is an affordable solution but is the most expensive in the terms of upgradeability because the costs will linearly increase. This is not a long term option because it is well known that the capacities should be doubled every one and a half year.

The main goal of RoEduNet is to provide connectivity both at national and international level. Most of the NRENs in Europe already use for the national network links with 1, 2.5 and 10 Gbps. These links are leased lambda or dark fiber and, in some cases, own fiber (Poland). All European NRENs tend to use dark fiber due to the fact that the cost per Mbps is continuously dropping and because research test beds could be easily implemented in parallel with the production network. We should mention that the SDH services are used only in the countries where either the budget for NREN is very tight either the lambda or dark fiber services are not available. Also, a very good reason to use dark fiber is the fact that different logical networks could be provided using separate lambdas without supplementary fee to the carriers. As an example, in Poland there is a single physical network able to supply different lambdas for education, for research, for test new transmission technologies and also for other governmental networks (administration, army etc.).

It should be noted that in all countries where the budget for the NRENs is limited, a number of facilities have been provided by the government. The optical network in Poland was funded by the government and is used only for the government applications; a similar situation is also in Czech Republic etc. A very good start was made in Serbia, where the government signed a decision which states that the Serbian academic community is able to use a pair of optic fibers provided by Telekom Serbia. This was not possible in Romania until now, but there are some situations where the state owns through state owned companies optical national networks. A project that aims to build a modern communication infrastructure based on the previous idea and using DWDM and CWDM, has been submitted by RoEduNet to the Ministry of Education and Research this year. The total amount of money to be invested in such a network was calculated to about 9 million Euros and the result is that each county capital will benefit of 1 Gbps connection and the main academic cities will have 10 Gbps channels in a mesh topology. The future upgrades will include only the costs for the necessary equipments.

For the GRID communication infrastructure at the national level at least three high speed links should be installed: Bucharest – Iasi, Bucharest – Cluj Napoca and Bucharest – Timisoara. The length of each connection exceeds 500 km, physical paths of the fibers must be considered. Using the information



available from different carriers the distances could be estimated as follow: Bucharest – Iasi: 600 km, Bucharest – Cluj Napoca: 550 km and Bucharest – Timisoara: 600 km. If dark fiber is used, to minimize costs a common fiber segment Bucharest - Sibiu of about 400 km can be used for both Timisoara and Cluj Napoca links, but backup link(s) should be considered.

Although from the estimated costs analysis the solution using leased lambda is the cheapest one, we recommend the dark fiber variant because of flexibility and scalability, eventual upgrades being possible with minimal costs.

It is also recommended as an initial stage, to deploy a pilot national link between two main cities, using WDM technologies on dark fiber, as it is depicted in the proposal submitted by RoEduNet to the Ministry of Education and Research this year. This will permit a better estimation of costs for the entire national communication infrastructure, also various problems and their solutions can be researched before deploying other links, minimizing possible unforeseen (unexpected) expenditures.

6.2 Metropolitan Area Networks

There are already Metropolitan Area Networks (MAN) installed in Bucharest, Iasi and Cluj-Napoca which consist of dark fiber installed between the main Universities and Research Institutes. Unfortunately, most of the direct links are operating at 100 Mbps, but for GRID applications the interested institutions can easily upgrade their connection to the RoEduNet NOC to 1 Gbps at affordable prices for the equipments. Higher data rate is not available using common equipments and, if it is necessary, investments for new switches are required.

To overcome these costs for the new equipments it would be a good option if the main GRID beneficiary institutions could use specialized connections. The main idea is that in most cities specialized GRID clusters could be installed close to the RoEduNet NOCs to provide GRID services for the institutions already connected to the MAN. This solution is also benefic for the Romanian GRID evolution because it could create centers of excellence in middleware domain.

Unfortunately, apart from the mentioned cities there are no MANs installed and, as a consequence, investments should be considered.

For the initial phase of the GRID development in Romania the existing metropolitan infrastructure could be used and minimal investments to upgrade some links from 100 Mbps to 1 Gbps should be considered.

6.3 Local loop

The local loop section consists of the final segment to connect an institution to the MANs or directly to the RoEduNet NOC. This segment is installed and maintained by the beneficiary institution and, usually, does not exceed 1 km.

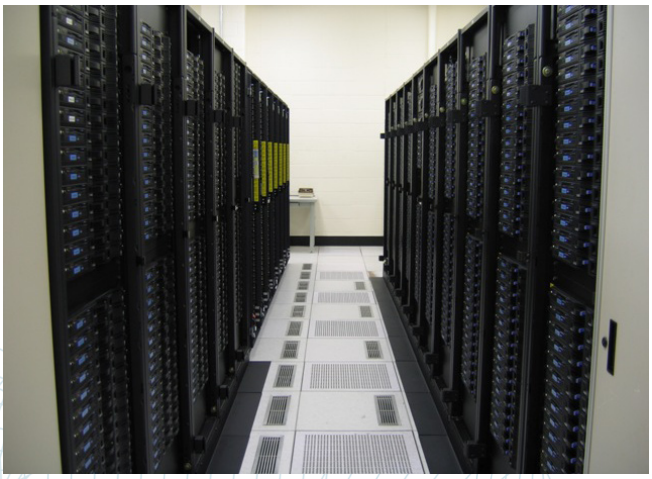
If this segment is connected to the MAN there are two options, the segment ends up in fiber cross connect panel connected to a switch by using a fiber patch cord or this segment is spliced with a fiber or a pair of fibers from the MAN optical cable. For GRID intensive application the second solution is recommended to provide point-to-point link to the NOC and not involve a shared segment within the MAN.

Another scenario should be considered if in the city RoEduNet does not own or could not use a MAN.

In this case it is much more difficult for the beneficiary institution to lay down the cable because of local taxes to be paid and possible difficulties in obtaining project approvals. These problems could be overcome with the help of the Ministry of Education and Research.

Another important issue in the local loop segment is the equipments at the beneficiary premises. It is relatively well known that the investments in the routing/switching area are very low, and many institutions do not use the most appropriate equipments. This could lead to some difficulties in traffic management and DoS (Denial of Services) handling.

We recommend to all institutions involved in GRID activities to invest in border equipments, to connect the computer clusters using high speed Local Area Network directly to the border router using a separate interface and, also, to install or lease the fiber segment for the local loop section.



6.4 References

a. http://www.serenate.org

b. http://www.seefire.org

c. http://www.seeren.org

7. RECOMMENDATIONS

The development of Grid infrastructure should be viewed in the overall development of the information society, as an investment in technology, education, human resources and the business-medium.

The Task Force formulates the following recommendations regarding the development of the pilot project for the national Grid infrastructure:

7.1. For planning and coordination reasons the pilot project will be implemented as a national research programme, structured according the main layers of the Grid infrastructure: Broadband communication network, Grid architecture (resources and middleware), and Applications.

7.2. The Task Force will be in charge with the evaluation of results produced by the projects financed within the programme in order to assure their mutual compliance and their convergence with the programme objectives.

7.3. Grid infrastructure development and deployment processes will be based on reuse and exploitation of the results produced by EU co-funded research projects with Romanian participation; more specifically, the EGEE infrastructure solution will be implemented with the benefit of assuring the interoperability at regional and European level.

7.4. For the first two years period the programme resources will be concentrated on the following short term results that will be used as best practice references for further extension of the infrastructure:

a. for the network section:

- Provide Gigabit connectivity (10 Gbps) of the RoEduNet national operation center to the GEANT 2 European network for research and education;
- Improve the national research network infrastructure: assure Gigabit connectivity (2,5-10 Gbps) between main university centers of the country (Bucharest, Cluj Napoca, Iaşi, Timişoara).
- Improve the local-area networks at universities and research institutes (autonomous institutions with own responsibility to invest in the upgrading of their internal network infrastructure): Ministry of Education and Research could start a dissemination campaign making the university managers aware of research networking and the associated benefits and costs
- Implement Gigabit connectivity (1-10 Gbps) of Grid resources to the network backbone

b. for the Grid infrastructure section:

- implement EGEE compatible centers of resources in all academic and research institutions nominated by the Task Force taking into account the architectural requirements and the existing technical potential to set up, properly maintain and administrate this production centers;
- administrate this infrastructure according to the rules and use policies specific to the European EGEE infrastructure;

c. for the Application section:

- migrate to the Grid environment those computing and storage intensive applications that really depends on this technological support
- build demo versions and carry out training and dissemination activities to increase awareness at the potential users' communities level about Grid infrastructure benefits.

7.5. The Task Force will coordinate all actions aiming at defining and implementing the administration and usage framework for the national Grid infrastructure, as for example: set up of the Certification Authority for Grid community,

administrate the national repository for Grid resources, propose solutions for related legal and policy aspects (quality of services, protection of both Grid services providers and users, service level agreements, use policies, adoptions of international standards in this domain), implement institutional solutions related with the administration and usage of the national Grid infrastructure.

*

* *

The main beneficiary of the national Grid infrastructure will be, in the first stage, the academic and research community, as the infrastructure is based on the existing networking support assigned to this domain (RoEduNet and RNC). Later on, the beneficiaries will be the public administration, the business medium, health-care, culture and other domains of economy and society.

8. BIBLIOGRAPHY

The Strategy for Research and Development in Information and Communication Technologies (ITC) in the context of integration in the European Research Area. Research Programme CERES, 2004.

RoGrid Consortium: Proposal on the Strategy for Grid Development in Romania, March 2003.

EGEE Project (Enable Grids for E-sciencE): http://public.eu-egee.org/

SEE-GRID Project (South East European Grid eInfrastructure Development) – www.see-grid.org/

Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions: "i2010 – A European Information Society for growth and employment", 10.06.2005.

Proposal for a Decision of the European Parliament and of the Council concerning the seventh framework programme of the European Community for research, technological development and demonstration activities (2007 to 2013), Annex 1, 06.04.2005.