Building of National Grid Infrastructure in Republic of Moldova

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***Abstract* — Paper discusses problems related to building of National Grid Infrastructure and National Grid Initiative Consortium for science and education in Republic of Moldova in the framework of EU-supported SEE-GRID-2 project. Patterns Restoration using Neural Networks Simulation (PRNNS) as first grid application in Moldova is developing in the framework of SEE-GRID-2 project.**

***Keywords* — grid computing, eInfrasructure, National Grid Initiative, grid application.**

I. Introduction

Grid-computing is an advanced technology of the distributed parallel calculations intensively developed in Europe, America, Asia and in other regions of the world. Grid computing technology assumes a collective shared mode of access to network resources and to the services, connected to them using frameworks of globally distributed virtual organizations consisting of the enterprises and the separate experts. Actual Grid-networks consist of large-scale systems of calculations, monitoring, management, complex analysis services and globally distributed sources of the data capable to support structures of scientific, education, government organizations and industrial corporations and forming powerful eInfrastructure for e-science [1].

II. SEE-GRID-2 Project

RENAM association, representing national scientific - educational network of Moldova (NREN), starts to build National Grid-Initiative of Moldova Consortium, MD-Grid NGI that is creating with assistance of the South-Eastern Europe countries within the framework of the SEE-GRID-2 project of the European Commission [2], [3]. The project joins following 13 organizations which are its direct contractors: GRNET: Greece, CERN: Switzerland, SZTAKI Hungary, IPP-BAS: Bulgaria, ICI: Romania, TUBITAK: Turkey, ASA/INIMA: Albania, UoBL: Bosnia-Herzegovina, UKIM: Macedonia, UOB: Serbia, UoM: Montenegro, RENAM: Moldova and RBI: Croatia, and also 27 organizations - subcontractors from the same countries (fig.1).

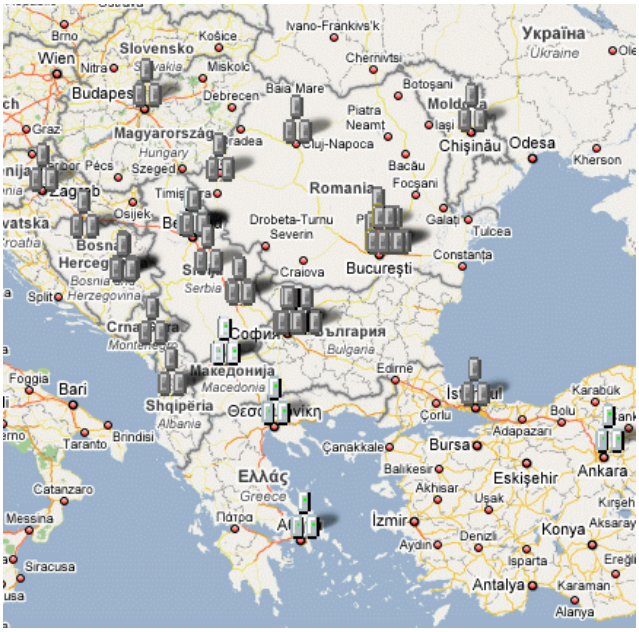

Figure 1. Map of SEE-GRID-2 e-infrastructure.

The main objective of the SEE-GRID-2 project is to penetrate and engage regional and national user communities via multi-disciplinary grids, involving a range of research and academic institutes and scientific communities in all SEE countries, with emphasis on the deployment and support of a range of Grid applications. Almost all SEE-GRID-2 project participants except FYR of Macedonia already had established their NGI.

III. National Grid Initiative of Moldova creation

MD-Grid - National Grid Initiative of Moldova was officially inaugurated on the plenary session “National Grid Initiative MD-Grid: presentation and inauguration” of RENAM Users Conference – 2007 on May, 14 2007 after receiving approval letters from Ministry of Information Development of Moldova and the Academy of Sciences of Moldova [4]. General Director of RENAM, academician of the Academy of Sciences of Moldova A. Andries opens MD-Grid NGI inauguration session and made a presentation entitled "National Grid Initiative: MD-Grid - Starting point and perspectives" (fig.2.).

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Figure 2. MD-Grid NGI inauguration session.

The MD-Grid NGI Consortium governed by RENAM as its Coordinating NREN joins 6 research, education and industry institutions that expressed their intent to participate in the processes of National Grid Infrastructure building and using:

- Research and Educational Networking Association of Moldova
- Institute of Mathematics and Computer Science of the Academy of Sciences of Moldova
- Faculty of Radioelectronics and Telecommunications of the Technical University of Moldova [3]
- Institute of Geology and Seismology of the Academy of Sciences of Moldova
- State Hydrometeorological Service
- School of Public Health, State Medical and Pharmaceutical University "N.Testemitanu".

MD Grid NGI is based on RENAM NREN and uses the form of Joint Research Unit (JRU) founded by signing the "Agreement on MD-GRID Joint Research Unit Consortium" by all current MD-GRID-NGI participants. The JRU collaborative model is encouraged by EU FP7 programme. The MD-Grid NGI Consortium is open for other potential participants.

The initial stage of construction of a Grid infrastructure of Moldova within the framework of the SEE-GRID-2 project started with getting support for national Grid-initiative by government: Ministry of Information Development of Moldova and the Academy of Sciences of Moldova inside the long-term program of national e-science and innovation strategy and infrastructure development.

Major steps in elaboration of MD-Grid NGI include:

- development and approval of MD-Grid NGI Foundation document (Consortium Agreement),
- development and approval of MD-Grid NGI Policy document,
- selection of and negotiation with potential MD-Grid NGI members,
- signing of the agreements about intentions and MoU with MD-Grid NGI potential members,
- planning of grid infrastructure enlargement, creation and setting up of at least four Grid-sites in research and higher educational institutions of Moldova at the beginning stage.

MD-Grid NGI Policy is a foundation document stating about NGI main objectives, structure and activity orientation. This document stipulates basic principles of NGI Consortium behavior and requirements for NGI supported services:

- NGI membership rules. It is expected that NGI member organizations should belong to four main categories: research, academia, industry and government.
- Accessible Use Policies and Services Level Agreements for resources and services.
- National Grid Certification (Registration) Authority policy and behavior.
- Core services structure and functions:
  - WMS - Workload Management System.
  - BDII - The Berkeley Database Information Index. Consists of two or more standard LDAP databases that are populated by an update process.
  - VOMS - Virtual Organization Membership Service. VOMS serves as a central repository for user authorization information, providing support for sorting users into a general group hierarchy, keeping track of their roles, etc.
  - R-GMA - Relational-Grid Monitoring Architecture.
  - LFC – LCG File Catalog.
  - Operational tools available for use: Portals, Wikis, Helpdesks, Monitoring tools.
- Established NGI enabled user communities, supported VOs:
  - VO types: international/ regional/ national
  - Activated user communities
  - Necessary level of utilization of Grid resources per VO types.
- Set of available NGI applications:
  - List and number of applications per type: identified, in development, supported
  - Applications areas.
- Available community services:
  - User support (including training activities): for Grid operation, for application usage
  - Cooperation forms with user communities, Joint action plans, Joint Task Forces
  - User community involvement in the NGI coordination.

During recent scientific seminars and negotiations with potential NGI members the consent to join MD-Grid NGI had stated next set of scientific and educational bodies:

Institute of Mathematics and Computer Science of Academy of Sciences of Moldova, State, Technical and Medical Universities Moldova.

The potential enlargement of MD-Grid NGI is possible after expected decisions of a range of institutions and organizations from Moldova that already expressed their interests in using grid computing technologies and development of gridified applications:

- The Institute of Ecology and Geography of ASM (climate and ecology applications);
- Faculty of Economical Cybernetics of the Academy of Economical Studies of Moldova;
- The Institute of Economy, Financing and Statistics of the Ministry of Economy and Trade (macro-economical models development applications);
- The Department of Exceptional Situations Protection (flooding problems applications).

IV. First Grid Application Development

A. Application Domain

Patterns Restoration using Neural Networks Simulation (PRNNS) is the first grid application that is developing in Moldova in the framework of SEE-GRID-2 project. Patterns are treated as been visual, but they can be of any other nature of digitized patterns as well.

The problem of restoring of true object images having available only corrupted images exists first of all when there is a need to take decision in the absence or lack of true visual information, when solving classical identification tasks, when analyzing scenes or classifying objects by insufficient or corrupted information, or possessing only damaged pictures.

In addition the problem of recreating images appears in archaeology when identifying old half-obliterated coins, half-reduced manuscripts, and petroglyphs. In cryiminalistics indicated problem need solution when analyzing indistinct fragments of finger prints and approximate photofit picture. In physics there are cases when the images are being distorted by scientific equipment or environment. Especially in astronomy when taking photos of distant planets, galaxies, when observing cosmic bodies, there often is a need to recover true images from received images. Not less actual task is the object recognition when analyzing aerial photography images, satellite-borne photography images. Another example of image restoration domain is biological and medical images processing, such as X-ray films, thermograms and echographic diagnostics images.

PRNNS grid application is concepted as a neural network based image processor. The main goal of this application is to restore damaged images, basing on available information about the image.

B. Neural Network approach

One of the most optimal approaches for solving such tasks consists in using trained Neural Networks simulation. PRNNS uses three different types of neural networks:

1) Feed-forward Back Propagation, containing 3 hidden layers. Training Algorithm – Resilient back propagation.

2) Associative Memory of Hopfield [5], [6]. Training Algorithm: Calculation of the generalized vector of synaptic weights.

3) Self-organizing Kohonen map [7]. Training Algorithm: Self-learning without teacher using accreditation method.

C. Problems and limitations running application on single PC

Although neural network technology allows solving above tasks, the implementation requires large computing resources. For example running the non-grid version of application on single PC XP Intel® Pentium® 4 CPU 2,40 GHz, 512 DDR allowed to restore images with following resolution and corruption percentage required many tens of hours of processing time:

1) First Type:

- maximal resolution: 150x150px
- corruption level: 10%÷30%

2) Second Type:

- maximal resolution: 55x55px
- corruption level: 10%÷60%
- noise level: 80%÷90%

3) Third Type:

- maximal resolution: 100x100px
- corruption level: 30%÷60%.

Grid infrastructure can allow the application to process larger resolution images. The usage of grid technology should shorten the neural network training time and permits process more complex scenes.

Enabling a neural network to run on the grid is a complex task which requires solving some key point subtasks, such as organizing neural network training process into a single task (job), parallelizing it first of all on one CE and then between two or more CEs, automating job submitting and results retrieval.

D. Possible Ways of Gridification

There are several approaches to gridify the PRNNS application.

First of all the application was originally built using Matlab and for better performance on the grid should be rebuilt using Java. Then it will be ready to be executed on the grid.

First step is to execute the application on the grid as a single job using the workload management system and data management system commands manually. The purpose of this step is to test the application on the Gird and try to parallelize the execution process using MPI.

The second step is to write additional module which will

automate the neural network training process, managing packages of the input data. The main goal of the step is to try to shape the schema of neural network training process and test the application in executing more realistic tasks (processing larger images).

The third step is to create single user interface module which will manage dynamic task submitting and result retrieval. The main point of this step will be to try to parallelize the application between two or more CE's. This goal could be achieved only by storing the neural network weights in one place probably locally or on a single remote storage element (SE) and breaking the training process into subtasks and sending them to different CE's. In this case it is essential to automatically retrieve the results and combine them into a single result. So finding a way to do it is the main task for this step.

The main point of this application gridification is: the larger is the parallelization scale, the more complex images could be processed. This should be achieved because the less calculations quantity needs to be done on a single CE, the more resource time each calculation gets, which increases the calculation acceptable complexity. And on the other side it increases the calculation speed.

The gridification of PRNNS application will allow:

- To significantly decrease general processing time.
- To give the possibility to restore high resolution images.
- To try to parallelize the task between many computing elements (CEs) of single grid cluster and to scale application to full-grid mode running.
- To facilitate potential user communities to widely use the application.

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