Rising skill of young researches of Moldova in using High Performance Technologies

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ABSTRACT
This article is an overview of the project for young researchers - "Systems and Technologies of Distributed Processing of Information and evaluating the effectiveness of their Use" and shows which are the goals of the project and the expected results.

Keywords
Distributed systems, parallel algorithms, distributed processing technologies, High Performance Computing (HPC)

1. INTRODUCTION

Adoption of HPC environment is quickly transformed from a competitive advantage to an operational necessity, facilitating innovation and thus allowing definition of new computational models and occurrence of new working opportunities. Also not less significant costs reduction by using techniques of parallel processing and storing data in the cloud, which being combined with increasing performance requirements of applications led to their successful use in various fields (bioinformatics, physics, mathematical modeling, web servers and database, the optimization of business decisions, medicine).

In this context, the idea emerged to develop a project that would help young researchers in obtaining experience required for more complex projects related to parallel programming.

Goal of this project is to study distributed processing systems and technologies and evaluating the effectiveness of their use. This will contribute to creation and development skills to use High Performance Computing infrastructures for distributed processing of data while solving various problems.

2. THE CURRENT STATE OF HPC INFRASTRUCTURES IN MOLDOVA

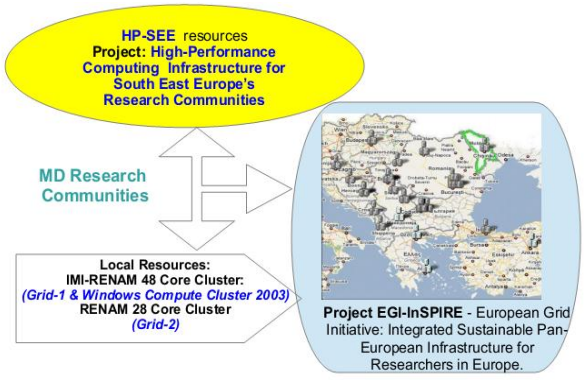
Scientific Computing Infrastructure, related technologies and services have begun developing for R&D communities of Moldova due to the support of a series of international and national projects. Current state of HPC and Grid infrastructures is on Figure 1.

MD-Grid - National Grid Initiative of Moldova was inaugurated on May 14, 2007 after receiving approval letters from Ministry of Information Development of Moldova and the Academy of Sciences of Moldova.
The development of national and regional scientific Grid infrastructures is coordinating by pan-European initiatives like EGI-InSPIRE project that is focused on supporting transition process from a project-based system (the EGEE series) to a sustainable pan-European e-Infrastructure. At present Grid infrastructure of Moldova unites three sites and has well determined perspectives for its further enlargement [1].

Another project is HP-SEE: High-Performance Computing Infrastructure for South East Europe's Research Communities. This project brings together 14 partners from the SEE region, while more than 10 institutions have been involved in the project as third parties. The aim of the project is to link the existing and upcoming HPC facilities in the region in a common infrastructure. For participating countries, which do not have such HPC resources (8 countries, including Moldova) - access to these resources in domains of computational physics, chemistry and life sciences have been provided [2].

For example, within the framework of HP-SEE project access for young researches granted to SGI UltraViolet 1000 supercomputer (1152 CPU, 6057 GByte of memory) at the National Information Infrastructure Development Institute located in Pecs, Hungary and HPCG cluster, located at the Institute of Information and Communication Technologies of the Bulgarian Academy of Sciences (576 computing cores; the storage and management nodes have 128 cores). Also partners participating in the HP-SEE project have established HPC training infrastructure for the successful organization of various training events, for applications elaboration, testing and debugging [3].

Figure 1. The current state of HPC and Grid infrastructures in Moldova



3. USED METHODOLOGY

In order to achieve research the following methods will be used:

1. Open MP - to control explicit and shared memory parallelism with multiple threads of execution,
2. CUDA - support the communication of "peer-to-peer" between GPUs or a single server stations work, allowing easier and faster programming systems "multi-GPU". Also this method provides a single unified space, memory system for main memory and GPU memory. Provides a collection of algorithms C + + open-source and data structures that facilitate easy programming for C + + developers [4].
3. MPI (Message Passing Interface) is a specification for those who use computer resources with non-shared memory like Grids.

Main resources of the regional HPC infrastructure support parallel programming paradigms like MPI and OpenMP.

4. STAGES OF ACHIEVEMENT

For 2013 are planned the execution of two stages:

1. Theoretical foundations of distributed processing systems and information technologies.
2. Access to the systems and technologies for distributed processing of information. Training program to get experience in parallel programming and various HPC resources using.

The first stage involves the study and analysis of theoretical and practical problems specific to parallel and distributed computation, study of parallel and distributed architectural models. Establishing design principles of parallel algorithms, concurrent programming, applications and specific algorithms for parallel computing. Computing systems performance analysis. Fundamental algorithms from distributed and parallel computing study. Rpresentative parallel and distributed systems study. Familiarity with specific technologies for parallel and distributed computing like OpenMP, MPI, CUDA.

The second stage involves the identification of problems related to the field of distributed processing systems and technologies. To study related information to develop and evaluate options and to implement architectural solutions. Carrying out the analysis and evaluating the effectiveness of parallel / distributed computing systems in different conditions.

At first stage were studied and established design principles of parallel algorithms, their connection with one of the formal methods of describing parallel processes named “Petri nets” formalism.

Important result of the first stage is the analysis of modeling advantages of workflow Petri nets to design the hardware and software component. Mechanisms for translating parallel processes in workflow Petri nets have been proposed.

Further research will be directed at identifying specific problems that can be solved using systems and technologies of distributed processing of information.

5. TECHNICAL EQUIPMENT

To run applications with parallel technologies at the Institute of Mathematics and Computer Science the 48 core IMI-RENAM cluster is used. At this cluster on virtualization platforms next Home Training Infrastructures were deployed:

- MS Windows Compute Cluster 2003, 4 Nodes, 12 Cores (CPUs: QuadCore Intel Xeon E5335 2,0 GHz, QuadCore Intel Xeon E5310 1,6 GHz) to run different tasks serial, parallel, parametric sweep and task flow;
- Grid-Site: MD-02-IMI, 4 Worker Nodes, total 16 VCPU, 1 GB RAM per 1 VCPU – to test applications and prepare them for porting from local clusters to EGI GRID and to HP-SEE regional resources.;
- on Virtual Machine: 64 bit Scientific Linux 6.3; Intel(R) Parallel Studio XE 2011 (4 cores, 4 Gb RAM) – for compiling and debugging of applications.

Additional materials to improve base servers technical characteristics will be purchased under the project.

6. EXPECTED RESULTS

Efficient processing of parallel algorithms in time and space can bring significant benefits in various fields such as medicine, biology, astronomy, forensics which are based on the use and interpretation of specific images, also can be used in the training of specialists (education) of different areas of interest.

The expected outcome of the project would be the development of parallel processing algorithms in order to solve specific problems (eg. parallel processing of images in order to increase performance and speed up medical examinations).

7. ACKNOWLEDGEMENT

This paper was elaborated within the project 13.819.18.06A Systems and Technologies of Distributed Processing of Information and evaluating the effectiveness of their Use.

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