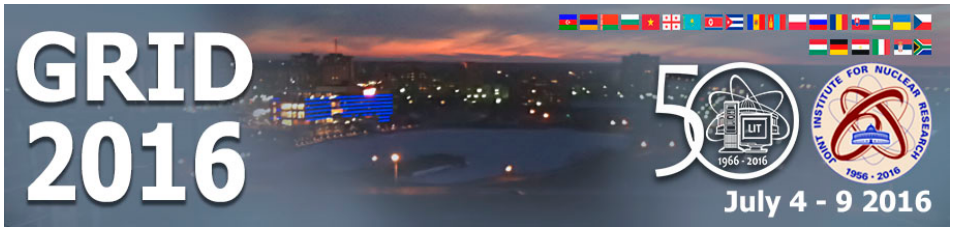

Contribution ID: **135** Type: **Plenary reports**

New developments of Distributed Computing Technologies in Moldova

Friday, 8 July 2016 12:30 (15 minutes)

The recent developments are using results of previous projects like the regional project "Experimental Deployment of an Integrated Grid and Cloud Enabled Environment in BSEC Countries on the Base of g-Eclipse (BSEC gEclipseGrid)"supported by Black Sea Economical Cooperation Programme (http://www.blacksea-cloud.net). In this project we selected middleware for implementation of computing architecture that provide a collaborative, network-based model that enables the sharing of computing resources: data, applications, storage and computing cycles. The project allowed to introduce the general idea of federated Cloud infrastructure, which can provide different solutions for universities, scientific and research communities [1]. The project was focused on implementation approaches to combine the Grid and Cloud resources together as a single enhanced computational power and offer the possibility to use Grid or Cloud resources on demand. As an example, if the user requires parallel computational resources, he will submit a job on the Grid, but if the user needs any specific software or environment to solve some special problem, he can use a dedicated Cloud service or virtual image for that purpose. Fig. 1 shows the skeleton of the suggested platform.
The proposed platform made possible to solve the following problems:
increasing the effective usage of computational resources;
providing additional different services for scientific and research communities;
close collaboration between different resources providers to solve common regional problems.

Figure 1: General structure of the proposed heterogeneous regional platform

The objective is to create an infrastructure, which uses resources provided by geographically distributed heterogeneous computing clusters. These sites are operated by independent organizations, which have total control on managing their own resources, including the setup and enforcement of special administrative policies regarding authorization and access, security, resource usage quota, monitoring and auditing of the local infrastructure. The resource providers delegate the control for a part of their infrastructure in a safe and efficient way, so a federated infrastructure can be build based on the resources available on these distinct administrative domains. This is a major challenge regarding the implementation of a federated Cloud infrastructure as it is sought to be achieved by the currently implementing initiatives.
These achievements we used for development of the national distributed computing infrastructure. The general scheme, showing the plan of the integrated computational infrastructure evolution in Moldova presented in fig. 2.

Figure 2: The prospects of evolution of the distributed computing infrastructure in Moldova

Future developments of integrated heterogeneous distributed computing infrastructure since 2016 continued within new regional project VI-SEEM (VRE for regional Interdisciplinary communities in Southeast Europe and the Eastern Mediterranean). During preparations for this new project the works were effectuated to unite in one regional infrastructure various distributed computing resources like Grid, HPC, storage and computing cloud. To achieve the initial idea to ensure heterogeneous resources management for HPC, Grid and storage access on the cloud we in Moldova continued works on development of relevant and flexible basic cloud infrastructure.
The first experimental infrastructure based on OpenStack middleware was deployed using the latest at the moment Ubuntu Server 14.04 LTS as a base operation system for all nodes and the latest version of OpenStack release "Juno". This infrastructure was interconnected via two dedicated Gbit switches - one for management and one for data network. External networking connectivity and internal networking for virtual machines provided via the Network Node. The Network Node runs SDN (Software Defined Network) technology software

–Open Virtual Switch. It created virtual network infrastructure for virtual machines and segregates different network slices using GRE (Generic Routing Encapsulation) tunneling protocol. It also supports many networking protocols including OpenFlow and it allowed us to implement very flexible and powerful instrument.
To develop OpenStack management capabilities and flexibility at the next step of cloud infrastructure extension we used Fuel open source deployment and management tool for OpenStack. Developed as an OpenStack community effort and approved as an OpenStack project under the Big Tent governance model, it provides an intuitive, GUI-driven experience for deployment and management of a variety of OpenStack distributions and plug-ins.
Fuel brings consumer-grade simplicity to streamline and accelerate the otherwise time-consuming, often complex, and error-prone process of deploying various configuration flavors of OpenStack at scale. Unlike other platform-specific deployment or management utilities, Fuel is an upstream OpenStack project that focuses on automating the deployment of OpenStack and a range of third-party options, so it's not compromised by hard bundling or vendor lock-in [2].
We deployed our Open Stack cluster using Mirantis Fuel project solutions. The cluster deployed is containing two computing nodes, one controller and now has in total 18 CPU cores, 36GB RAM and 1,1TB HDD storage. Fuel gives us the speed, ease and reliability of Open Stack cluster deployment, as well as the flexibility to configure the cluster on the fly. The current Open Stack cluster configuration is shown in fig. 3. New cluster' s components, such as computing nodes, controllers and storage nodes can be easily connected to an existing infrastructure or be removed from it when needed. The entire installation and configuration takes place automatically, followed by a set of special scripts that check system availability after cluster deployment (health check). Thanks to this, we are able to efficient use of the existing computing resources, reconfigure access to other virtualized facilities and save huge amount of time that was previously required to deploy and manage the distributed resources manually.

Figure 3: Configuration of the Open Stack cluster based on open source Mirantis Fuel project.

To ensure operation of federated mechanism to access distributed computing resources were finalized works to realize solutions that allow providing unified access to cloud infrastructures and be integrated in the creating Research & Educational identity management federations operated within eduGAIN inter-federation authorization & authentication mechanism (AAI) [3]. The practical results in the area of federated access to cloud implementation based on the EGI-Inspire AAI Cloud Pilot project "Federated Authentication and Authorization Infrastructure (AAI) for NREN services"and other new results obtained during deployment and administration of OpenStack cloud infrastructure.
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Summary

In the past years, development of distributed and high-performance computing (HPC) technologies for solving complex tasks with specific demands of computing resources are actively developing, including in Moldova. New areas of works in this direction are focused on integration of Grid, HPC and Cloud infrastructure and gain benefit to end users from uniting computational resources of Grid and HPC clusters with effective users' interfaces and computer infrastructure management tools offering by cloud.

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Session Classification: 4. Scientific, Industry and Business Applications in Distributed Computing System

Track Classification: 1. Technologies, architectures, models of distributed computing systems