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Virtualized Infrastructure for Integration Heterogeneous Resources

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Abstract

In the paper described directions of distributed and high performance computing (HPC) technologies integration. Presented analysis of trends in the development of computer technologies, which focused on creating conditions for solving complex problems with high demands of computing resources. The result of these studies is the following conclusion: the main development directions focused on integration of distributed Grid and parallel HPC facilities on the base of virtualization paradigm within integrated Cloud infrastructure in order to expand the range of opportunities for end-users by providing heterogeneous computing resources. Perspectives of utilization of Cloud technologies for integration of Grid and HPC clusters in heterogeneous computer infrastructures that are offering effective resources and end-user interfaces are considering.

Keywords: distributed computing technology, Cloud computing, High Performance Computing, computational clusters.

1 Introduction

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 [1]. New areas of works in this direction focused on integration of Grid, HPC and Cloud infrastructures and gain benefit to end users

from uniting computational resources of Grid and HPC clusters with effective users interfaces and infrastructure management tools offering by Cloud.

2 Approaches of Heterogeneous Federated Infrastructure realization

These 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 gEclipse (BSEC gEclipseGrid) supported by Black Sea Economic Cooperation Programme (http://www.blacksea-Cloud.net). For this project we selected middleware implementing 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 introducing the general idea of federated Cloud infrastructure, which can offer different solutions for universities, scientific and research communities [2]. 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, his jobs submit 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 services on demand for scientific and research communities;
— close collaboration between different resources providers;

3 Integration of Cloud and HPC/GRID resources using OpenStack

Future researches in creation of integrated heterogeneous distributed computing infrastructure continued within regional project VISEEM (VRE for regional Interdisciplinary communities in Southeast Europe and the Eastern Mediterranean) [3]. 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. This is advantageous step forward, because it will bring us elasticity in resources management, simplify administration and give researchers ability to solve a huge range of computational and visualization problems from small to big complicity in a unified elastic infrastructure. If user needs some kind of general-purpose software or smaller computer resources, that does not require high parallelism; he can use one of available Cloud images. Deployed infrastructure supports almost every mainstream Linux distributions (CentOS, Scientific Linux, Ubuntu, Debian, Fedora, etc.)

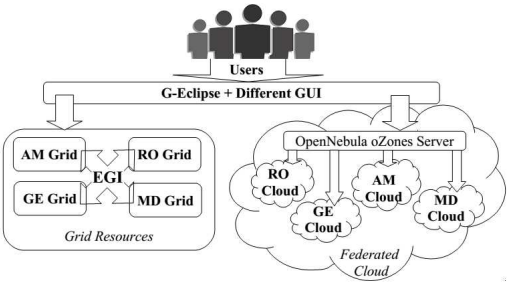

Figure 1. General structure of the proposed heterogeneous regional platform.

If he needs more computing cores more parallelism, he can easily provision a cluster of HPC nodes thru OpenStack GUI and add additional nodes if he wants. The main problem is that Cloud and HPC have differ principles of resources allocation. In Cloud we run virtual

machines but HPC bases on Bare Metal servers (nodes) combined into computing cluster. The approach of provisioning HPC nodes inside virtual machines in OpenStack seems to be the solution, but there are some problems. As high performance is the major constituent of High-Performance Computing, running HPC on virtual machines is not the best solution, because virtualization causes performance drop itself. To achieve better results we must run our HPC nodes on a Bare Metal serves. The solution based on applying results of the project called Ironic. It is an OpenStack development, which provisions bare metal (as opposed to virtual) machines. It may be used independently or as part of an OpenStack Cloud, and integrates with the OpenStack Identity (keystone), Compute (nova), Network (neutron), Image (glance) and Object (swift) services. When the Bare Metal service is appropriately configured with the Compute and Network services, it is possible to provide both virtual and physical machines through the Compute services API [4]. To achieve the initial idea and ensure heterogeneous resources management for HPC, Grid and storage access on the Cloud we re-deployed our Scientific Cloud (RSC) infrastructure by using OpenStack 13.1.1 Mitaka middleware. Now it consists of one controller node running on VM and three computing nodes (2 for Virtual Machines provisioning and 1 for Bare Metal provisioning). It has in total 24 CPU cores, 48GB of RAM and 2 TB HDD storage and two 1Gbit networks one for public access and the other for high-throughput interconnectivity between VMs. In RSC installed digital certificate TERENA SSL CA 3. Access to RSC resources provided via https://cloud.renam.md

4 Federated IdM to access integrated computing infrastructures

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. The practical results in the area of implementation of federated access to Cloud based on realization of EGI-Inspire AAI Cloud Pilot project Federated Authentication and Authorization Infrastructure (AAI) for services of Research and Educational Networks and other new results obtained during deployment and administration of OpenStack Cloud infrastructure [5].

5 Conclusion

Cloud technologies are spreading amazingly fast and already took the lead in many domains of IT application - Science, Medicine, etc. They still penetrating in new niches every year more and more supercomputers in the top lists are being powered by OpenStack, rather than traditional HPC approach. The reason is in its flexibility and diversity, combined with "modular design". It has couple of basic core components and a variety of optional (additional) ones, which used for creating infrastructure of any grade of complexity, heterogeneous ones that can combine virtual machines and bare metal nodes, making it more and more attractive to HPC and GRID users. Our combined HPC and Cloud RSC infrastructure proofed its functionality and reliability; anyway, it cannot be considered as a production-ready, as it does not provide necessary High-Availability backup and redundancy yet. In addition, it cannot boast of huge performance, it is more about proof-of-concept. However, it is a very good playground for studying Cloud and HPC computing, and for training IT specialists and researchers to work on HPC, Grid and Cloud clusters

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