CREATION OF CLOUD INFRASTRUCTURE OF INP'S ASTANA BRANCH - PRIVATE ENTITY «NULITS» AND ITS INTEGRATION WITH THE DISTRIBUTED JINR CLOUD INFRASTRUCTURE

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The article is devoted to the project of creating the cloud infrastructure of the Astana branch of the Institute of Nuclear Physics and the private entity «Nazarbayev University Library and IT Services» (Republic of Kazakhstan, Astana) on the basis of the resources of both organizations, its integration with the distributed cloud infrastructure of the Joint Institute for Nuclear Research (Russian Federation, Dubna). The motivation and implementation of the cloud infrastructure is being described, various mechanisms for cloud integration are being considered, and plans for using created infrastructure are being outlined.

Keywords: cloud infrastructure, VMware, OpenNebula, cloud bursting, DIRAC

1. Introduction

Currently, to provision the educational and business processes of the Autonomous Organization of Education «Nazarbayev University» and its subsidiaries with computing resources and data storage systems, the IT staff has built an infrastructure (Figure 1) based on the commercial product VMware [1], which provides virtualization of servers and desktops of employees.

Requests for the allocation of computing resources for the implementation of scientific calculations constantly increase.

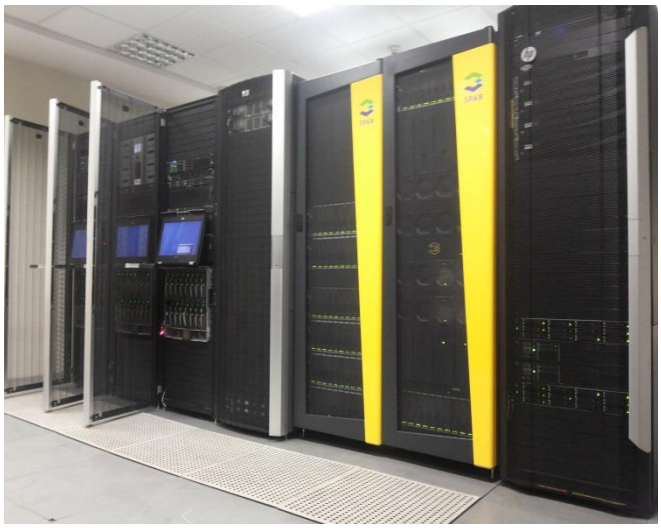

Figure 1. Data Center NULITS

Further development and research of the world experience in the management of computing resources introduces the following tasks:

- simplification of the interface / resource management mechanism. The ability to allocate a resource pool to the user, within which he himself redistributes tasks among them;
- the introduction of a billing system for user resource accounting;
- flexible reallocation of resources among pools / users;
- centralized use of resources of geographically dispersed data centers;

We consider a smooth transition from a virtual to a cloud infrastructure, as one of the ways to solve these problems.

A common model of cloud technologies consists of three parts; each represents a separate category of services:

- SaaS (Software as a Service) – applications running in the cloud, and end users receive access via the web interface;
- PaaS (Platform as a Service) – a set of tools and services that facilitate the development and deployment of cloud applications;
- IaaS (Infrastructure as a Service) – a computing infrastructure (servers, data storages, networks, operating systems) that is provided to customers to run their own software solutions.

Cloud infrastructure IaaS compared with the virtual one gives more capabilities to deploy computing capacity "on demand", and also allows transparent control over the allocation and the use of the provided resources. In the most common virtual environments (VMware ESXi, Citrix, Hyper-V Microsoft), monitoring of the use of resources and, especially, changing quotas for the use of resources is carried out using accounts with fairly high access rights. Also, many operations (creating / upgrading network resources, changing disk quotas, etc.) require a high qualification of the

administrator of the virtual data center and interaction with the customer's personnel, which seriously increases the risks of accessibility and efficiency of the virtual environment. Also, the monitoring / control tools, and, especially, the billing of the use of the resources in the virtual environment built into the basic packages are at the initial level.

Separately, it is worth noting the allocation of resources "on demand". In virtual environments, this functionality is often not provided, since it is not considered to be the main task. Therefore, the means for automatic deployment of virtual machines as a part of virtualization systems are either absent or have very limited capabilities. When implementing many projects, to provide this functionality, one must purchase and configure additional software and licenses, which is not always possible. For example, in the case of VMware it is necessary to purchase vCloud Director packages and licenses for virtual servers virtually, for billing – vRealize packages. These products are very expensive, have a significant additional functionality, which is often unnecessary and requires separate configuration and training of maintenance personnel.

To implement the task of transition to a cloud infrastructure, previously we considered VMware vCloud, which, due to its high cost, was not implemented. In collaboration with the staff of the Laboratory of Information Technologies of JINR, a pilot project on the implementation of the cloud infrastructure on the basis of OpenNebula [2] open source software has been considered and initiated.

This choice was due to the fact that the OpenNebula product has the virtual server creation on demand and billing functionality already built into the cloud (OneFlow and OneGate components), and the user's self-service portal is included in the software solution (Figure 2).

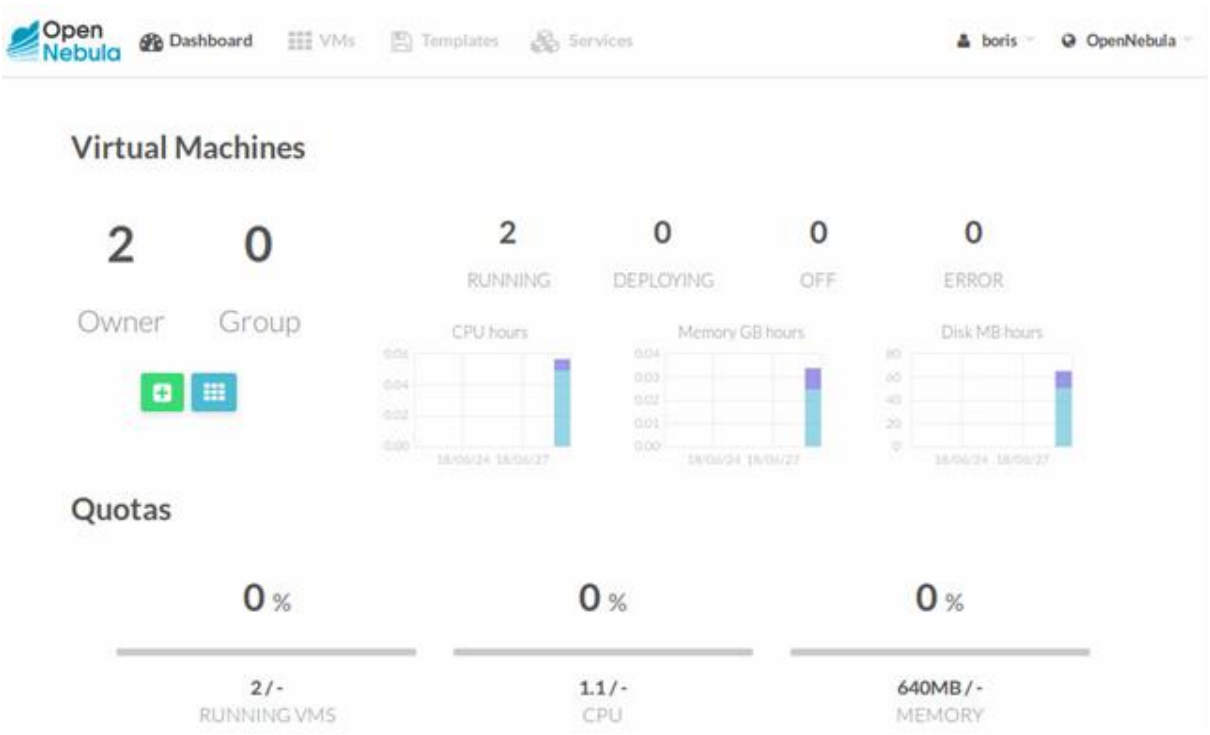

Figure 2. Sunstone user portal

Working with OpenNebula, the administrator of the entire system needs to provide the user access rights to the self-service portal only, where he performs basic operations with his virtual machines, and the administrators of virtual data centers provide access to the management interface, which dramatically increases the security of the data center in general as well as the security of the deployed virtual servers. It is possible to use both external data storages, such as SAN (Storage Area Network), NAS (Network Attached Storage), and distributed file systems (CEPH, Gluster). In the absence of separate expensive storage systems, OpenNebula makes it possible to achieve fault tolerance accessing any disk subsystems. The advantage and convenience of this solution is the capability to simultaneously use various types of disk resources (NAS, NFS, SAN, local file systems, CEPH and others). This makes it completely transparent for virtual machine users to migrate virtual

servers between different types of storages, as well as to simplify the procedures for synchronizing and increasing the availability of separate virtual servers between data centers and the data center as a whole.

It worth noting that considering cloud solutions based on open source, the big advantage is the presence of large and active communities supporting this product, the availability of extensive knowledge bases and thematic forums, as well as the ability to quickly upgrade the product to the needs of the organization without losing compatibility with deployed installations (for example, the cloud bursting driver developed at JINR [3]).

2. The implementation of the cloud infrastructure of the Astana branch of the INP - the private entity «NULITS».

Currently, the pilot project is implemented in the form of two main components:

- the primary node is a virtual server that contains the core of the system and user/service interaction interfaces;
- work nodes – 4 physical servers running user virtual machines. There are two access interfaces to the OpenNebula service:
- full-featured command-line interface (CLI);
- the graphical web interface provided by the Sunstone component.

The main node is a virtual machine deployed outside the OpenNebula service. The virtual machine is deployed on its own VMware cluster. This implementation allows fast reconfiguration during testing to minimize downtime and allows quickly roll back the changes made using the proven mechanisms of VMware.

To implement the work nodes, 4 physical servers are used with the following configuration:

- 4 x CPU E5-2660 v4 2.00GHz;
- RAM256GB;
- 2 x HDD SAS 600GB in RAID1 mode (mirroring);
- 2 x 10G + 4 x 1G + 2 x FC.

All servers of the pilot project use Linux OS - Centos 7.2 x86_64.

The main node provides services Sunstone, OneFlow and OneGate, as well as services OCCI/rOCCI (v1) for integration with external clouds (figure 3):

- Sunstone – web management interface OpenNebula;
- OneFlow – allocation of resources on demand;
- OneGate – configuration of virtual machines, billing;
- OCCI / rOCCI (v1) – interface with external clouds;
- CloudBursting – driver integration with the external cloud.

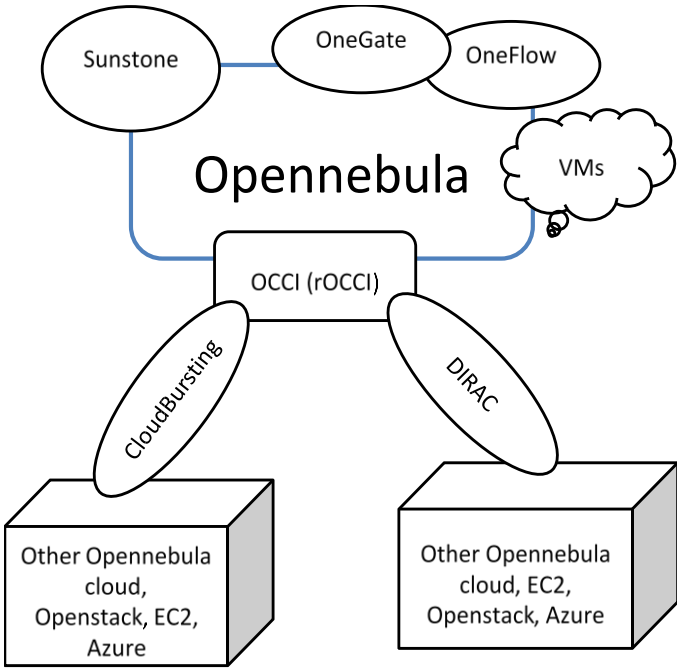

Figure 3. Scheme of the OpenNebula interaction with external clouds

Integration with the distributed cloud infrastructure of JINR at the moment is implemented using a driver based on the peering model cloud bursting [4].

In the process of use, the instability of the driver has been revealed when using new versions of OpenNebula packages, as well as its low scalability. Currently, the mechanism of cloud integration using the DIRAC grid is being considered [5].

DIRAC (Distributed Infrastructure with Remote Agent Control) INTERWARE is a software framework for distributed computing. It provides a complete solution to one (or more) user community requiring access to distributed resources. DIRAC builds a layer between the users and the resources offering a common interface to a number of heterogeneous providers, integrating them in a seamless manner, providing interoperability, at the same time as an optimized, transparent and reliable usage of the resources.

The Workload Management System with Pilot Jobs introduced by the DIRAC project is now widely used in various grid infrastructures. This concept allows to aggregate in a single system computing resources of different source and nature, such as computational grids, clouds or clusters, transparently for the end users [6].

Unlike the driver, the DIRAC platform allows using different computational resources with the help of pilot tasks. This method of integration is used by leading scientific data centers.

Virtual machines are stored on server disks (basic settings of OpenNebula), in addition, all working nodes have access to the shared disk space on the disk storage (LUN).

3. Conclusion

At the time of this writing, the cloud infrastructure of the Astana branch of INP and the private entity «NULITS» was created on the basis of resources of both organizations based on OpenNebula open source solution. Its technical integration with the distributed cloud infrastructure of JINR for the peering model cloud bursting has been completed. Works on cloud integration using the DIRAC grid are underway.

Within the framework of this project, it is planned to work out the interaction schemes between various components of OpenNebula and determine the list of components necessary for the minimum configuration; to launch a number of research tasks of the faculty staff in order to reveal the strengths/weaknesses of this cloud implementation; compile a detailed administrator's guide to facilitate the deployment of cloud services based on OpenNebula in the future.

In conclusion, we would like to note the invaluable contribution of the leadership of LIT JINR in the person of V.V. Korenkov and staff of the cloud LIT team for the initiation of this project, constant attention and encouragement of ongoing work, without which the implementation of this pilot project was not possible.

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