

## CLOUDS OF JINR, UNIVERSITY OF SOFIA AND INRNE — CURRENT STATE OF THE PROJECT

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JINR established a cloud based on OpenNebula. It is open for integration with the clouds from the member states. The paper presents current (first year) state of the 3 years project that aims to create a cloud backbone in Bulgaria. University of Sofia and INRNE participate in that initiative. This is a target project funded by JINR based on the research plan of the institute.

Keywords: cloud, cloud federation, cloud bursting, OpenNebula.

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## 1. The Project

“Creation of distributed information and computing infrastructure using cloud and grid technologies based on resources of the Laboratory of Information Technologies of the Joint Institute for Nuclear Research, Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Science and Sofia University “St. Kliment Ohridski” is 3 years project with priority funding in the period 2017-2019.

Current state of this project is reported in this paper.

At this time, OpenNebula clouds are installed at JINR, University of Sofia and INRNE. For more information on OpenNebula read next section of this paper.

During the first year of the project, an initial integration has been attempted between the JINR and University of Sofia clouds based on rOCCI server combined with OpenNebula Cloud Bursting. For more information on rOCCI read the section “EGI Cloud & OCCP” of this paper.

As result of that, University of Sofia cloud opens its resources to JINR cloud. This is an EGI Cloud integration based on the open OCCI specifications for OpenNebula clouds integration. The opposite integration of JINR cloud to open its resources to University of Sofia has been abandoned.

The problem of this kind of integration is that two times client-server architecture is used. In that case, the server is the cloud of University of Sofia and the client is JINR cloud. Integration of JINR cloud resources with University of Sofia cloud has been planned to be done in the same way. This integration opens resources of the server cloud to the client cloud, but retain full control on them and server accounting must be used.

Better approach is OpenNebula Federation, but in that case, only OpenNebula clouds can be integrated with common centralized accounting. Other kind of resources like grids, clusters, HPCs etc. is impossible to integrate.

JINR idea is to share clouds, grids and HPCs with the collaborating parties. For that purpose, DIRAC is used. For more information of DIRAC read the corresponding section in this paper.

DIRAC supports OCCI integration of clouds and grids, but not of HPCs. It has to be extended to support that. Such an initiative is on a way at LIT JINR now.

DIRAC is open to support many accounting systems. So, DIRAC extended to HPCs will be the base for this new integration.

## 2. OpenNebula Basics

OpenNebula [1] is an open source code platform for IaaS clouds (public, private and hybrid). It is based on two main hypervisors: KVM and vCenter.

OpenNebula with KVM (Kernel-based Virtual Machine) for Linux kernel offers full its functionality.

OpenNebula on vCenter of VMware concept is “cloud of clouds”. It is a multi-tenant cloud layer on existing VMware clouds – a kind of virtual datacenter.

OpenNebula is open for many other hypervisors.

OpenNebula architecture consist of:

- Front-end running OpenNebula services;
- Hypervisor-enabled hosts providing its resources;
- Datastores for virtual machine images;
- Physical network connecting all components.

OpenNebula supports UNIX like centralized user accounting for administrators, regular users, public users and service users. Regular users access most of the OpenNebula functionality, public users – only basic functionality, and service-users are services accessing OpenNebula functionality.

OpenNebula Federation is a cloud layer on clouds. It consists of one master and many slave clouds. Slave clouds are called “zones”. The master centralizes accountings of the zones. Users can choose in which zone to work. Federation of federations is not supported.

OpenNebula is an alternative to OpenStack, which is fragmented, immature and too complex, and to VMware, which is too expensive and inflexible.

OpenNebula Cloud Bursting unifies local resources with that one provided by remote cloud providers. It offers two specialized drivers for Amazon EC2 and Microsoft Azure, but it is opened to any cloud provider.

OpenNebula Cloud Bursting is transparent to administrators and end-users in sense that remote clouds are treated as hosts and hybrid virtual machine templates can run on local hosts and on remote clouds.

OpenNebula Cloud Bursting scales local OpenNebula cloud resources with that provided by the remote clouds, but it does not share local resources with the remote clouds. OpenNebula Federation share zone's resources, but requires centralized accounting management.

## **4. DIRAC Basics**

DIRAC (Distributed Infrastructure with Remote Agent Control) [2] is a software framework for distributed computing. It offers common interface to heterogeneous storage and computing resources providers.

DIRAC interfaces are API, REST, Web and CLI. Integrated providers can be grids, clouds, clusters and HPCs.

End users access DIRAC Web portal or DIRAC CLI interfaces to run a job on the integrated environment. The job consist of single executable file for a fixed platform supported in the environment, input parameters to the executable file, input and output data (files), error file, input and output sandboxes, target site, banned sites, maximum CPU time etc.

Programmers can access DIRAC API for Python or SOA DIRAC REST to develop its own sophisticated systems.

Originally, DIRAC uses Virtual Organization accounting with Grid Certificate for some community, but it is open for other accounting systems.

## **5. EGI Cloud & OCCI**

EGI Cloud [3] is a federated cloud of OpenStack, OpenNebula and Synnefo clouds. It is as a hybrid IaaS of public, community and private clouds. The user can interact with IaaS cloud resources via API, CLI or Web portal.

OCCI (Open Cloud Computing Interface) [4] is a protocol and API. It was originally initiated to create a remote management API for IaaS model based Services, allowing for the development of interoperable tools for common tasks including deployment, autonomic scaling and monitoring. It has since evolved into a flexible API with a strong focus on integration, portability, interoperability and innovation while still offering a high degree of extensibility.

OCCI is a boundary API that acts as a service front-end to an IaaS provider's internal infrastructure management framework. OCCI users are end-users or other systems. This is an open wrapping for clouds.

rOCCI server is an OCCI 1.1 compliant server implementation written in Ruby. It is a part of OpenNebula stack. rOCCI can as virtual machine in OpenNebula or on physical host. Another system can be a rOCCI user.

## **6. Conclusion**

Now, at University of Sofia, new physical resources are integrated in the cloud: new servers, GPUs, storages, network capabilities etc. This cloud is a further extension of the effort "Grid framework for e-learning services" [5] at University of Sofia.

When above-mentioned DIRAC extensions will be ready for deployment the clouds of JINR and University of Sofia will be integrated for testing.

The best way for Bulgarian part is OpenNebula Federation to be used, because in that case only one collaborator with centralized accounting will be responsible for the integration with JINR. Such an institution can be University of Sofia.

Our experience with the Grid from the past shows that the individual participants “die” soon after the project ends. Usually, young researchers in the area of computer science and further funding are not available.

Another lesson from the past is “Never use old servers even if you obtain them at no cost”. Old hardware consumes enormous electricity power. The practice shows that clusters and supercomputers that are not intensively used have been shut down for that reason.

JINR is a priority initiative in Bulgarian science infrastructure road map. Funding for development of computing infrastructure with JINR is provisioned. The results must be ultimately demonstrated and the right way for that is OpenNebula Federation in Bulgaria.

Above considerations show that in Bulgaria OpenNebula Federation must be developed and integrated with JINR infrastructure to access Grid and supercomputer resources. Nevertheless, administrative barriers stay today as hard as in the past.

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