

Integrated cloud infrastructure of the LIT JINR, PE “NULITS” and INP’s Astana branch

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Abstract. The article describes the distributed cloud infrastructure deployed on the basis of the resources of the Laboratory of Information Technologies of the Joint Institute for Nuclear Research (LIT JINR) and some JINR Member State organizations. It explains a motivation of that work, an approach it is based on, lists of its participants among which there are private entity “Nazarbayev University Library and IT services” (PE “NULITS”) Autonomous Education Organization “Nazarbayev University” (AO NU) and The Institute of Nuclear Physics’ (INP’s) Astana branch.

1 Service Implementation

The JINR cloud service [1] is based on an open-source IaaS system OpenNebula [2]. Two main components of the system can be marked out:

- front-end node (FN) which contains the system core and user interfaces to interact with the service;
- cluster nodes (CNs): the physical servers which host the users’ virtual machines (VMs) and containers (CTs).

Two user interfaces are available to access the service:

- command line interface (CLI);
- web-based graphical user interface “Sunstone”.

Figure 1 shows the interactions between the cloud service components.

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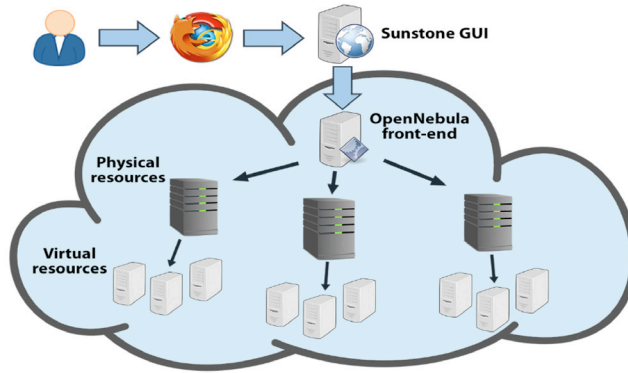


Fig.1. JINR cloud service structure scheme showing interactions between its components.

Currently the service uses two virtualization technologies to provide virtual instances (VIs):

- OpenVZ containers [3] (an operating system-level virtualization);
- KVM virtual machines [4] (full hardware virtualization).

The reason why two different virtualization technologies are used is to better fit the variety of the tasks: OpenVZ CTs are lightweight and fast but they are bound to use the hosts operating system kernel, while KVM VMs support any type of operating systems inside but have higher overhead. Originally OpenNebula had no OpenVZ containers support but extensible and modular architecture allowed us to add such support by implementing the custom driver.

The JINR cloud has two types of CNs:

- servers with two mirrored disk drives (RAID1) used to host highly reliable VIs;
- servers with one disk used for educational, research or test VIs.

The virtual instances can be accessed either with the use of an rsa/dsa-key or a password. A plugin implementing Kerberos authentication was developed for user authentication in Sunstone. To increase a security of the transmissions between the Sunstone and user's browsers an SSL encryption is used.

The architecture of the JINR cloud is shown on the Figure 2.

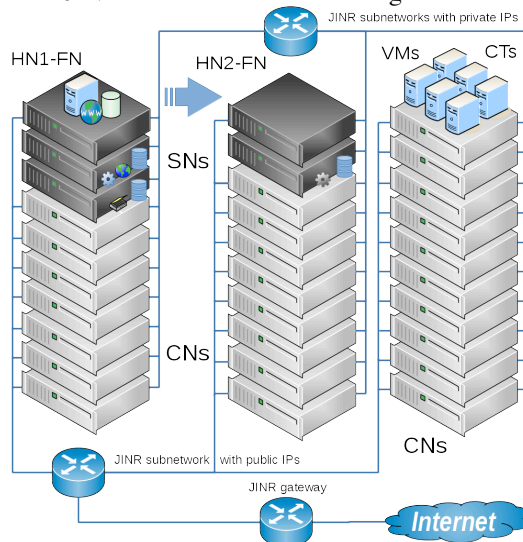


Fig.2. The JINR cloud architecture.

OpenNebula front-end (FN) consists of the following components: a core, a scheduler, a MySQL backend, a User (Web-GUI, CLI) and API (rOCCI) interfaces, OneGate and OneFlow services. The FN is deployed in OpenVZ container (CT) running on distributed replicated block device (DRBD) partition which is shared between two physical servers (marked on the Fig. 2 as HN1-FN, HN2-FN). They track each other's status with help of Heartbeat service. HN1-FN and HN2-FN are connected to different UPSes to increase the reliability. All VI images and data are stored on the distributed network file system (DNFS) based on LizardFS with automatic data replication. To split external and internal traffic all CNs are connected to public and private networks whereas storage nodes (SNs) – to the private one only.

2 Clouds integration

To join resources of partner organizations from the JINR Member States for solving common tasks as well as to distribute a peak load across them, a cloud bursting driver [5] was developed by the JINR cloud team. It allows one to integrate the JINR cloud with partner clouds either OpenNebula-based one (and in that case it is possible to enable real time external cloud resources monitoring) or any other cloud platform which supports Open Cloud Computing Interface (OCCI), but then statically defined values of external cloud resources are only possible. The driver is based on ruby implementation of OCCI (rOCCI) and OpenNebula XML-RPC interface. The reason why both interfaces are used at the same time is that OCCI allows one to better reuse the code, since it is provided by other popular cloud platforms like OpenStack, while OpenNebula XML-RPC is OpenNebula-specific and cannot be used for integration with other platforms. At the same time, OCCI does not provide monitoring operations, while OpenNebula XML-RPC does. It was decided to use rOCCI for management operations and XML-RPC for monitoring. The driver's scheme is shown in the figure 3.

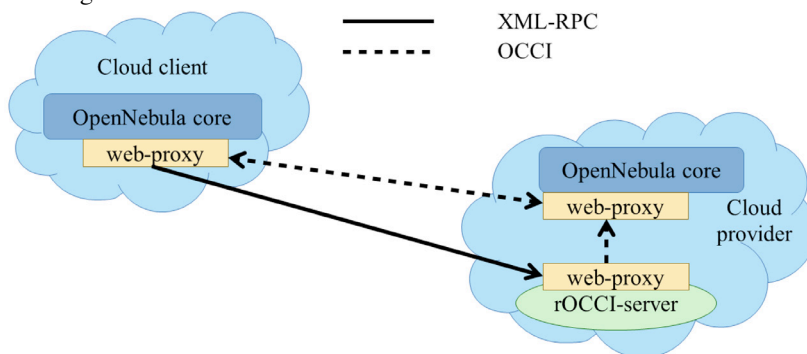


Fig.3. Cloud bursting driver.

The JINR cloud is a core of the distributed cloud infrastructure. At the moment, the integration of the clouds of the JINR Member State organizations is at different stages, in particular:

- Institute of Physics of Azerbaijan National Academy of Sciences – IP (Baku, Azerbaijan, integrated);
- Bogolyubov Institute for Theoretical Physics of the National Academy of Sciences of Ukraine – BITP (Kiev, Ukraine, integrated);
- Plekhanov Russian University of Economics – PRUE (Moscow, Russia, integrated);

- Research Institute for Nuclear Problems of Belarusian State University (Minks, Belarus, integrated);
- Nazarbaev University (Astana, Kazakhstan, deployment);
- Institute of Nuclear Physics (Astana, Kazakhstan, deployment);
- Institute for Nuclear Research and Nuclear Energy (Sofia, Bulgaria, deployment);
- Sofia University (Sofia, Bulgaria, deployment);
- Yerevan Physics Institute (Yerevan, Armenia, deployment);
- Georgian Technical University (Tbilisi, Georgia, deployment);
- University “St. Kliment Ohridski” (Bitola, Macedonia, negotiations).

Figure 4 shows on the map the locations of such distributed cloud infrastructure participants.

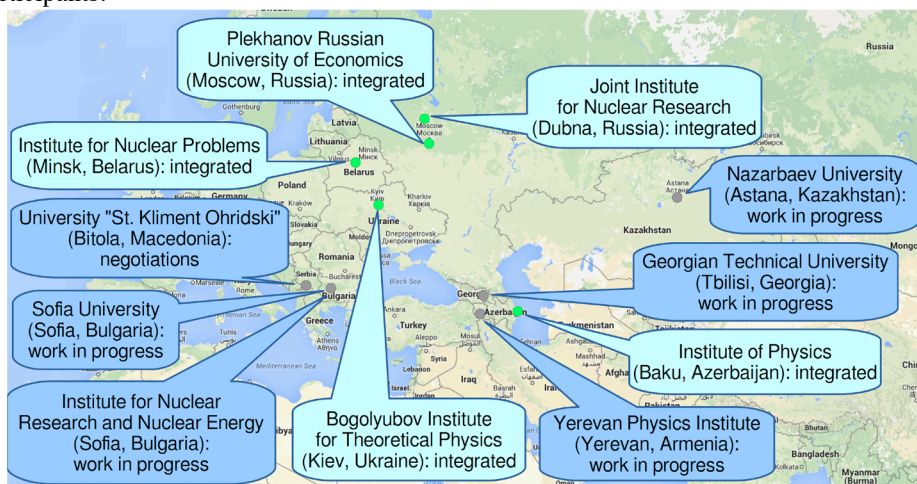


Fig.4. Map with the distributed cloud infrastructure participants.

An activity related to the integration of PE “NULITS” and INP’s Astana branch resources into the distributed cloud infrastructure is ongoing within framework of 3 years project with priority funding in the period 2017-2019.

Working plan for the integration of the JINR, PE “NULITS” and INP’s Astana branch clouds is presented below:

1. a research of possible solutions for joining resources of LIT JINR and AO NU (2017);
2. purchase of an equipment and building of a testbed based on the selected solution (2017);
3. conducting training events for Kazakh specialists (2017);
4. integration the resources of LIT JINR, PE “NULITS” and INP’s Astana branch into a single distributed information and computing environment (DICE) (2018);
5. testing of the DICE (2018);
6. involvement of potential participating organizations in the project (L.N. Gumilyov ENU, E. Buketov State University, Al-Farabi Kazakh National University, private companies) (2019).

3 Conclusion

Studies were carried out on the possible ways of integrating the LIT JINR, PE “NULITS”, INP’s Astana branch resources. The cloud bursting approach was considered as an optimal one. A set of training events for specialists from Kazakhstan on the OpenNebula deployment and DICE resources usage was organized and conducted. As a prototype a testbed at PE “NULITS” was installed on the currently available equipment. It is expected that resources integration will help to speed up a new scientific results and achievements in various domains the JINR and its Member States in common and Kazakhstan in particular are involved in as well as it will become a basis for conducting training events for students, researches and IT-specialists to use modern information technologies for storing, processing and analyzing large volumes of scientific data.

References

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