

Enhanced and Automated Virtual Machine Provisioning to Online E-assessment using Openstack Cloud

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Abstract: *This paper consist of system that efficiently uses the cloud resource provisioning for conducting E-Assessment and automates the resource maintenance in the cloud environment to reduce user activity in cloud management. Openstack is fully open source and it is supported by many popular organizations like Rackspace, HP, Cisco, etc. The proposed solution efficiently uses OpenStack cloud computing resources for provisioning resource to conduct online E-Assessment in order to have auto provisioning and manage load that comes in during situation where increase in users count who are trying to write exams in the Cloud.*

Keywords: OpenStack, Nova, E-Learning, Cloud Computing, Cloud Automation

1. Introduction

E-Learning provides many benefits such as flexibility, diversity, measurement, broad access and much more. E-learning systems usually require many hardware and software resources. There are many educational institutions that cannot afford such investments, and cloud computing is the best solution. If the institution tended to use open source e-learning application it would need more cost to hire professional staff to maintain and upgrade the e-learning application.

This paper presents the impact on using cloud computing for e-learning solutions. Openstack is the cloud operating system is used to deploy both public and private cloud that offers Infrastructure as a Service [1]. Openstack can be highly distributed across the world and it can be easily managed using a dashboard interface, it supports wide variety of existing hypervisors such as Linux KVM, VMware, Hyper-V, XEN and popular container technologies like Linux containers LXCE and Docker Containers. Openstack Cloud can be accessed in multiple ways using Built-in Dashboard component called Horizon and all components in cloud have API's using which user can interact with cloud environment. Advances in cloud computing has many advantages in education like cost effectiveness, secured resource, virtual classes etc. There are many proposed solution (Example [3][9][10]) in the fields of E-learning to utilize the cloud computing OpenStack cloud so as to enhance the usability of E-Learning and to make more flexible learning platform across the world.

Proposed system that manages the provisioning of the Virtual Machine to the exams for online E-Assessment that is to be conducted and manage resource efficiently in order to balance the load with scalable resources in cloud environment. Proposed solution offer simplified dashboard to user and reduces complexity in user interaction with cloud environment by automated management [8][9] of resources for the user. At the end user need not have knowledge about

using cloud therefore the user can concentrate only on E-Assessment Process, The developed system will take care of users Machines.

2. Openstack Architecture

Openstack has highly distributable components and offer flexibility for cloud architect to use resources effectively. The Figure [1] shoes the standard architecture of OpenStack cloud.

2.1 Keystone (Identity Service)

OpenStack Identity (Keystone) provides a central directory of users and acts as a common authentication system across the cloud operating system and can integrate with existing backend directory services like LDAP. It supports multiple forms of authentication including standard username and password credentials, token-based systems and AWS-style logins. Keystone provides identity, token, catalogue and policy services for use by OpenStack components. It involves in authenticating the VM for hosting E-Assessment. It has pluggable backend support various protocols (e.g. Basic Auth, OAuth, OpenID, PKI) for authentication and authorization, allowing clients to obtain security tokens to access different cloud services. Proposed Solution receives the Token from Keystone in order to communicate with the Assessment VM in cloud environment.

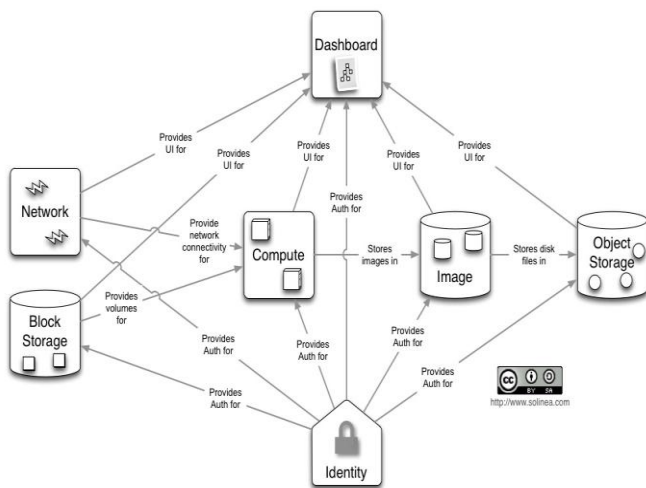


Figure 1: Standard OpenStack Architecture

2.2 Neutron (Networking)

OpenStack Networking is a system for managing networks and IP addresses and also provides networking models for different applications or user groups. Standard models include flat networks or VLANs that separate servers and traffic. OpenStack Networking manages IP addresses, allowing for dedicated static IP addresses or DHCP. Floating IP addresses let traffic be dynamically rerouted to any resources in the IT infrastructure, so users can redirect traffic during maintenance or in case of a failure. Neutron helps the user to access the cloud by providing the required network bandwidth and resource to conduct E-assessment. OpenStack Networking is a pluggable, scalable and API-driven system for managing networks and IP addresses. Like other aspects of the cloud operating system, it can be used by administrators and users to increase the value of existing datacenter assets.

2.3 Cinder (Block Storage)

OpenStack provides persistent block level storage devices for use with OpenStack compute instances. The block storage system manages the creation, attaching and detaching of the block devices to servers. User data and result of the users in E-Assessment could be stored in the attached storage from cinder and storage space can be increased when there is a need of storage for VM. Block storage volumes are fully integrated into OpenStack Compute and the Dashboard allowing for cloud users to manage their own storage needs. In addition to using simple Linux server storage, it has unified storage support for numerous storage platforms including Ceph, NetApp, Nexenta, SolidFire, and Zadara. Block storage is appropriate for performance sensitive scenarios such as database storage, expandable file systems, or providing a server with access to raw block level storage.

2.4 Nova (compute)

OpenStack Compute (Nova) is a cloud computing fabric controller designed to manage and automate pools of computer resources and can work with widely available virtualization technologies, as well as bare metal and high-

performance computing (HPC) configurations. KVM, VMware, and Xen are available choices for hypervisor technology, together with Hyper-V and Linux container technology such as LXC [3]. The proposed system has the Virtual Machine Manager which constantly communicate with the nova API in order to automate the assessment process and resource allocation to VMs. The OpenStack Compute component (codenamed Nova) enables you to provision and manage large networks of virtual machines, creating a redundant and scalable cloud-computing platform. It gives you everything you need to run instances, manage networks and control access through users and projects.

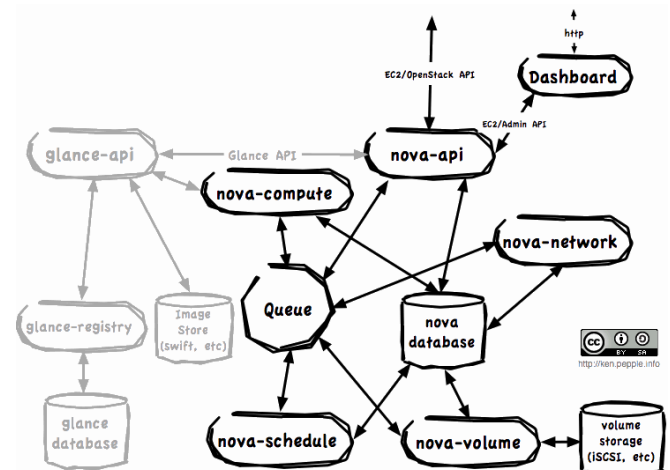


Figure 2: Standard Nova internal architecture

2.5 Swift (Object Storage)

OpenStack Object Storage (Swift) is a scalable redundant storage system. Objects and files are written to multiple disk drives spread throughout servers in the data center, with the OpenStack software responsible for ensuring data replication and integrity across the cluster. Storage clusters scale horizontally simply by adding new servers. Should a server or hard drive fail, OpenStack replicates its content from other active nodes to new locations in the cluster. Because OpenStack uses software logic to ensure data replication and distribution across different devices, inexpensive commodity hard drives and servers can be used.

2.6 Horizon (Dashboard)

OpenStack Identity (Keystone) provides a central directory of users mapped to the OpenStack services they can access. It acts as a common authentication system across the cloud operating system and can integrate with existing backend directory services like LDAP. It supports multiple forms of authentication including standard username and password credentials, token-based systems and AWS-style (i.e. Amazon Web Services) logins. Additionally, the catalog provides a query able list of all of the services deployed in an OpenStack cloud in a single registry. Users and third-party tools can programmatically determine which resources they can access. The proposed solution has the responsive design for cross platform access and it has separate dashboard which is aligned only to e-assessment management and connected to the OpenStack APIs.

2.7 Glance

OpenStack Image Service (Glance) provides discovery, registration, and delivery services for disk and server images. Stored images can be used as a template. It can also be used to store and catalog an unlimited number of backups. The Image Service can store disk and server images in a variety of back-ends, including OpenStack Object Storage. The Image Service API provides a standard REST interface for querying information about disk images and lets clients stream the images to new servers. Glance is responsible for maintaining the VM templates generated for hosting E-Assessments.

3. Solution Architecture

The proposed solution gather Assessment data and user registration details , then generates the requirements of the VM corresponding to the exam that is to be hosted in that machine with the help of algorithms in the Virtual Machine manager module and uses heat template to create machines in the OpenStack cloud environment. It consists of various modules like VM manager, user manager, Result Generator, Dashboard Manager, Assessment module, and Heartbeat generator (Figure 3).

3.1 Dashboard Manager

The dashboard Manager manages facilitates the user interaction with the cloud environment and facilitates the user to set exam data and validation conditions and to write exams. The system consists of three types of user they are Administrator, Instructor, and Learner. Instructor is the one who request to conduct exams; the system takes the exam

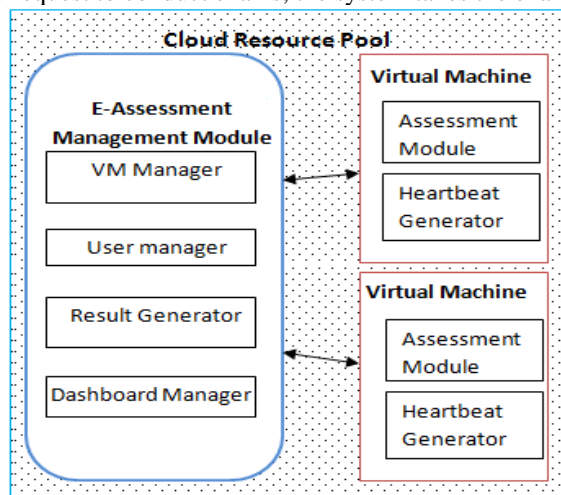


Figure 3: E-Learning cloud architecture

date, duration, validation criteria and settings of the machine from the user. The learner is the one who is going to write the exams and administrator is the prioritized user who has full access to the developed system who can manually configure, terminate, create VMs and can also manage users who are registered with the system. Advances in technology have considerably increased Smartphone usage across the world and hence the proposed system has responsive user interface design that is compatible with all devices.

3.2 Virtual Machine Manager

Virtual Machine Manager (VMM) agent is more related to cloud management that automates the management process in order reduce user workload in managing scalable cloud environment. Virtual machine manager consist of various subagents that holds each main activity separately. Openstack cloud offers API for third party designers and developers to access and communicate with the cloud agents. Virtual machine manager communicate with nova API (Figure 4) in order to execute the automation process whereby instructing the nova scheduler to take care of higher layer processes in the cloud. If the exams are conducted in multiple time slots the result is copied and machine is put to hold in order to use it for next slot depends on the frequency of slots. If the time slots are occurring with more time gap between each slots then VMM will decide in efficient way to utilize the resource by Saving the state of VM and reinitiating during next requirement[5].

3.3 Resource Requesting Module

The resource requesting module will generate VM specification for the exam that is to be hosted on to the virtual machine based on the user registration and current request of the users. The requirement is auto generated by predefined conditions according to the cloud administrator.

3.4 User Manager

User manager is responsible for managing E-Assessment cloud users. The user manager has the functionality of generating user rights, user groups and offer administrative privileges to selective user in order to manage existing assessment cloud environment and resources. The user manager tracks user activity from signing in to signing out of cloud and records for analysis and improvement of the existing system in future. Root user in the environment has token to control and configure user manager.

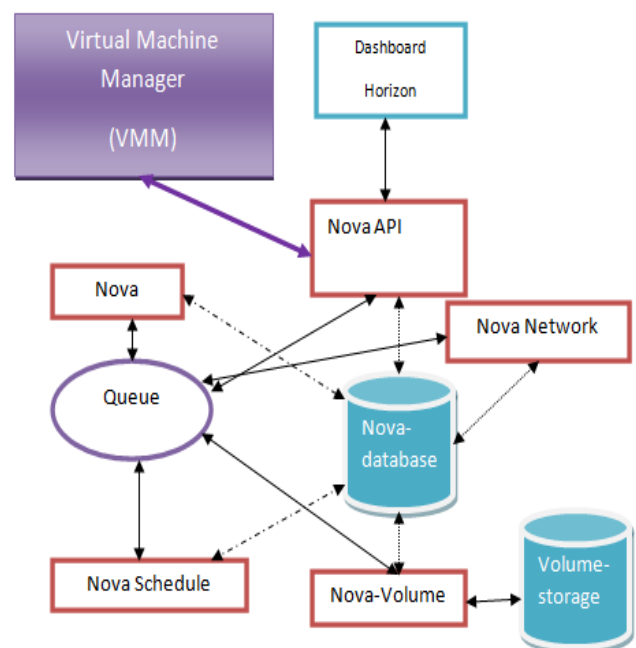


Figure 4: VMM integration to Openstack

3.5 Heat Template Generator

The heat template generator module will generate heat template for requirement that has been given by the previous modules and sets the configuration for VM for exam. The agent maintains the template database and it deletes the template once the VM is deleted after the assessment. And if template is not available for instance creation in the future the template is auto generated based in the current demand for exam among the user. It generates the Template in YAML format which is passed to OpenStack APIs[4].

3.6 Machine Manager

Machine manager is responsible for managing Virtual Machine life cycle process. The Virtual Machine manager receives the input from the heat template lists generated by the heat template and initiates the assessment process by executing automated methodology. Openstack have pre configured images with operating system installed along with the web server and database synchronization scripts. And hence once the request is made ,machine manager creates the Virtual Machine form the template that is available and provide additional functionality to Virtual Machine such as floating IP in order to assess outside local network , network , storage etc. once the online exam is over instance is terminated and virtual machine is deleted automatically. The Nova scheduler in OpenStack takes care of resource aggregation and clearance. The available is resource is given to other Assessment and VMs, there by the user need not care about resource maintenance and Virtual Machine maintenance in the cloud environment for the online E-Assessment system.

3.7 Log Manager

The log manager modules records activity of Assessment cloud activity in order to use it for multiple purposes such as failure analysis, also for future analysis to improve the template generation algorithms and Machine manager efficiency. Log manager is constantly communicating with the machine manger and logs the activity for each assessment and the corresponding Virtual Machine. Log files are generated on daily basis and maintained.log manager also generate alarm in machine critical situation like failure.

3.8 Assessment Module

Assessment module is responsible for conducting E-Assessment to users. This modules set timer and exam interface in order to make the process up on the Virtual machine. Assessment module can be managed flexibly such that user can set time, duration of exams on requesting the resource and it is automatically taken care by the assessment module. The assessment module communicates with the result generator and sends the user data to result generator to generate and publish results. Once the assessment module sends the user data to result generator it signals the process completion to VM manager and the VM manager terminates the Virtual machine and release the resources for other users in the cloud environment.

3.9 Result Generator

VM exist only during the time when the exam is online and hence the data has to be made safe once the machine is deleted. The result generator module taken care of preserving the exam data after VM is been deleted .once the exam is been over alert message is sent to result generator, and result generator communicate with the VM , generates result and store the data in local database. After this process is over the VM is deleted.

3.10 Heartbeat Generator

This is job that is running during lifetime of the VM that is been created. The heart beat generator is used to send message to Virtual Machine manager about the status of the VM. If VM manager dose not receive heartbeat it checks the nova compute database for existence of VM and VM state, if the virtual machine is found to be terminated the VM manager initiate the VM form the Image.

4. Conclusion

The above proposed solution is tested in the IaaS OpenStack cloud environment with the limited resource to test the availability of the OpenStack APIs and the resource utilization monitoring. The automation is done using python scripting that sends the commands to the nova API to operate the cloud. The implemented architecture can be distributed and hosted in remote machine that has access to the cloud environment. Rather than concentrating on the conceptual ideas, the proposed system is tested in order to learn about its flexibility and to measure its utilization of the cloud on comparing to other e-learning solution that are proposed. The system designed shows improvement in resource utilization in utilizing cloud for E-Assessment purpose.

5. Future Work

Improving the efficiency of the provisioning system, and to monitor the resource consumption pattern and analyzing the logs that has been generated to improve the decision making process in more optimized way. The interface design that has been developed will be tested across cross platform and browsers to optimize the compatibility and less memory utilization in the client's devices. To integrate the flexible solution to disaster recovery process in Openstack cloud and offer fully optimized high availability.

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