Developers Harness Open Source Cloud Management Platforms for Novel Applications

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Abstract— OpenStack is an scalable open source cloud operating system that is a global alliance of developers and cloud computing technologists producing the ubiquitous open source cloud computing platform for public and private clouds. OpenStack provides series of interrelated projects delivering various components for a cloud infrastructure solution as well as controls large pools of storage, compute and networking resources throughout a datacenter that all managed through a Dashboard(Horizon) that gives administrators control while empowering their users to provision resources through a web interface.

In this paper, we present a comparative study of Cloud Computing Platform such as, Openstack, Eucalyptus ,CloudStack and Opennebula which is open source software, cloud computing layered model, components of OpenStack, architecture of OpenStack. The aim of this paper is to show mainly importance of OpenStack as a Cloud provider and give the best solution for service providers .

Keywords— Cloud Computing, OpenStack ,Eucalyptus, cloudStack , Open Nebula

I. INTRODUCTION

Cloud computing is relatively a new concept for which the resources are dynamically extended, virtualized as well as provided as a service on the Internet, it also allow providers to give users access to a virtually unlimited number of resources i-e outsourcing of resoureces[1]. OpenStack was founded by NASA and Rackspace Hosting which is rapidly grown to be a global software community of developers collaborating on a standard and massively scalable open-source cloud operating system. Cloud computing is a quite new concept that brings together all technologies (Web services, virtualization, service oriented architecture, grid computing, etc.) and business models used to deliver IT capabilities (software, platforms, hardware) as a service request, scalable and elastic. OpenStack is an industry initiative based on a global collaboration of developers and cloud computing technologists producing the open standard cloud computing operating system for both public and private clouds.

Although there are as many ways to understand cloud computing as there are organizations planning to build a cloud, they mostly fall between two extreme cloud models:

- **Datacenter Virtualization**: On one side, there are businesses that understand cloud as an extension of virtualization in the datacenter; hence looking for a vCloud-like infrastructure automation tool to orchestrate and simplify the management of the virtualized resources.
- **Infrastructure Provision**: On the other side, there are businesses that understand cloud as an AWS-like cloud on-premise; hence looking for a provisioning tool to supply virtualized resources on-demand.

II. CLOUD COMPUTING

Cloud Computing [5] is a modern computing paradigm that providing IT infrastructure and it is very essential requirement for the IT companies. Cloud Computing providing essential service i.e. infrastructure as a service (IaaS), network as a service (NaaS), platform as a service (PaaS), software as a service (SaaS). Cloud computing is a model for enabling ubiquitous, on-demand network access to a shared pool of configurable computing resources such as network, servers, storage, applications, and services that can be rapidly provisioned and released with minimal management effort. Cloud Clients Can access and use the services of cloud applications using browsers, mobile devices, while all the data as well as software is stored on servers at a remote location, which are also used to perform all the heavy duty processing.

Infrastructure as a service (IaaS), is the most basic and essential cloud service model under which virtual machines, load balancers, raw block storage, firewalls and networking services are provided. In The platform as a service model, a computing platform including APIs, operating system, development environments, programming language execution environment and web server are typically provided. But In the software as a service model, cloud providers install and operate application software in the cloud.

Overall, a cloud computing layered model is very important as well as main aims to provide benefits in terms of lesser up-front investment in infrastructure during deployment, higher scalability, lower operating costs, ease of access through the Web, reduced business risks and maintenance expenses.
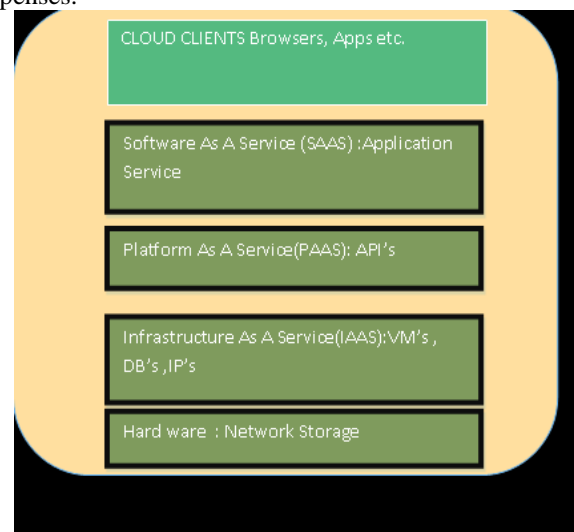

Fig 1. The Cloud-computing layered model

III. Open Source Cloud Platform

A. *OpenStack*

OpenStack [3,5] is the fastest growing free open source software was announced in July 2010, but initial contributes are NASA and Rackspace. Rackspace contributed their "Cloud Files" platform (code) while NASA contributed their "Nebula" platform (code). OpenStack open source software is a collection of open source software project that cloud computing technologist can use to setup and run their cloud compute and storage infrastructure. OpenStack provides an Infrastructure-as-a-Service (IaaS) solution through a variety of complemental services. Each service offers an application programming interface (API) that facilitates this integration. Dashboard Service project name Horizon Provides a web-based self-service portal to interact with underlying OpenStack services, such as launching an instance, assigning IP addresses and configuring access controls. Compute service project name Nova Manages the lifecycle of compute instances in an OpenStack environment. Responsibilities include spawning, scheduling and decommis-sioning of virtual machines on demand. Networking service project name Neutron Enables Network-Connectivity-as-a-Service for other OpenStack services, such as OpenStack Compute. Provides an API for users to define networks and the attachments into them. Has a pluggable architec- ture that supports many popular networking vendors and technolo-gies. Object Storage project name Swift Stores and retrieves arbitrary unstructured data objects via a RESTful,age HTTP based API. It is highly fault tolerant with its data replication and scale out architecture. Its implementation is not like a file server with mountable directories.

Block Storage service project name Cinder Provides persistent block storage to running instances. Its pluggable driver architecture facilitates the creation and management of block storage devices. Identity service project name Keystone Provides an authentication and authorization service for other OpenStack services. Provides a catalog of endpoints for all OpenStack services. Image Service project name Glance Stores and retrieves virtual machine disk images. OpenStack Compute makes use of this during instance provisioning. Telemetry service project name Ceilometer Monitors and meters the OpenStack cloud for billing, enchmarking,scalability, and statistical purposes. Orchestration service project name Heat Orchestrates multiple composite cloud applications by using either the native HOT template format or the AWS CloudFormation template format,through both an OpenStack-native REST API and a CloudFor-mation-compatible Query API. Database Service project name Trove Provides scalable and reliable Cloud Database-as-a-Service functionality for both relational and non-relational database engines.

B. *Eucalyptus*

EUCALYPTUS[3,5] is the acronym for Elastic Utility Computing Architecture for Linking Your Program to Useful System, which is an open source private cloud software for building private or hybrid cloud resources for compute, network, and storage that are compatible with Amazon Web Service (AWS) APIs**.** It was developed by University of California-Santa Barbara for Cloud Computing to implement Infrastructure as a Service (IaaS). Eucalyptus [3] provide an Elastic Compute Cloud (EC2) - compatible cloud Computing Platform and Simple Storage Service (S3)-compatible Cloud Storage. Eucalyptus has some high-level components such as Cloud Controller (CLC), Cluster Controller (CC), Storage Controller (SC), and Node Controller (NC). The main benefits to use this open source software for private clouds which provide highly efficient, scalability, organization agility.

C. *CloudStack*

CloudStack,[9] initially developed by Cloud.com, it was purchased by Citrix then later on released into the Apache Incubator program. The first stable version of CloudStack was released in 2013 and in this time governed by the Apache Software Foundation and supported by Citrix. CloudStack support some commendablefeatures such as storage independent compute, new security features, Smooth Deployment, Scalability, Multi Hypervisor support, Detailed Documentation and Interactive Web UI. **CloudStack's followed monolithic** architecture which posed some challenges one of them being reduced installation flexibility.

D*. OpenNebula*

OpenNebula [3,5,10] was first established as a research project back in 2005 by Ignacio M. Liorente and Ruben S. Montero, which is used by many enterprises as an open, flexible alternative to vCloud on their VMware-based data center. OpenNebula is primarily used as a virtualization tool to manage virtualized infrastructure in the data center, which is usually referred as private cloud and supports hybrid cloud to combine local infrastructure with public cloud-based infrastructure, enabling highly scalable hosting environments. OpenNebula cloud infrastructure provide users with an elastic platform for fast delivery and scalability of services and also support Public cloud by providing cloud interfaces to expose its functionality for virtual machine, storage and network management.

IV. Comparision Of Cloud Solutions

The comparative study between OpenStack, Eucalyptus CloudStack and OpenNebula is based on the study of the architecture of respective open source platform. Each Open source software provide Infrastructure as a Service (IaaS) to delivers virtualization environment, in real world [5].OpenStack was initially developed by Rackspace and NASA, in summer 2010. OpenStack is led by a prevailing foundation contains more than 850 companies and 4500 members and has a broad range of support from major tech industry players, ranging from HP, Dell , IBM, RackSpace, NASA, Cisco, NetApp, Nexenta, and dozens of other companies. Eucalyptus Open source software was the originated by research project of the University of California, Santa Barbara, Department of computer science. Eucalyptus has an important community that contribute to platform development as well as assists in finding and fixing. CloudStack Open source software, initially developed by Cloud.com, it was purchased by Citrix then later on released into the Apache Incubator program, but in this time governed by the Apache Software Foundation and

supported by Citrix. CloudStack is relatively new in the open source IaaS space, so it lacks a large community support base. OpenNebula was founded initially by European infrastructure grants. Some big company such as Research in Motion, Telefonia, China Mobile also contribute to OpenNebula.

OpenStack consist of three core software projects which are OpenStack Compute (Nova), OpenStack Object Storage (Swift) and OpenStack Image service (glance). Eucalyptus architecture mainly consists of five important component such as Cloud Controller, Walrus, Cluster Controller, Node controller and Storage Controller. OpenStack follows fragmentated, distributed architecture. CloudStack Open source software designed for centralized management and massive scalability; it enabling the effective management of numerous geographically distributed servers from a single portal only and follow massive architecture. OpenNebula follow classical cluster -like architecture with a front end and a set of cluster nodes to run the virtual machines (VMs).Relation with Amazon

OpenStack, developers built powerful tools for manage their resources using the native OpenStack RESTful APIs or OpenStack APIs. Eucalyptus, CloudStack, OpenNebula have embraced amazon Web Service-API Ecosystem. OpenStack and CloudStack is an open source platform for develop private as well as public cloud. Eucalyptus is an open source platform for develop private cloud. OpenNebula is an open source platform for deploying hybrid cloud, but it also deploys private as well as public cloud.

Eucalyptus contains mainly five component in which Cluster Controller and Node controller are primarily written in C language while Cloud Controller , Storage Controller and VMWare -Broker are written in Java language. CloudStack is written in mainly Python and Java language.OpenStack is written in mainly Python, XML, JavaScript and others languages.. OpenNebula used many languages such as C++, Ruby and JAVA.

Hypervisor is a software abstraction of a physical hardware platform that manages multiple guest operating system (OS) to run concurrently on an only single physical machine.

OpenStack is compatible with KVM, Xen, LXC, QEMU, UML, Hyper-V etc. hypervisor. Eucalyptus is manageable with Xen and KVM hypervisor. CloudStack software supports multiple hypervisors, such as Citrix XenServer, Oracle VM, VMware, KVM and vSphere. OpenNebula, support Xen, VMWare and KVM hypervisor.

OpenNebula supports SQLite backend in some versions while now it uses MySQL database backend.Eucalyptus component support PostgreSQL to store their metadata and information. CloudStack support mainly MySQL database.OpenStack CloudStack and OpenNebula support CentOS, Debian, Fedora, RHEL open-SUSE, SLES, and Ubuntu.Eucalyptus support Linux operating system, but images of both Microsoft windows and Linux. OpenStack support SQLite3, MySQL and PostgreSQL database.

In Eucalyptus images are managed by Euca2ools. CloudStack is an open source software designed to deploy, manage large networks of virtual machines, as a highly

available, highly scalable Infrastructure as a Service (IaaS) cloud computing platform. OpenStack open source software image service which is glance, provides functionality for discovering, registering and retrieving virtual machine (VM) images. OpenNebula use image repository to allow administrator to set images.

Eucalyptus do not support VM migration, While OpenStack, CloudStack and OpenNebula supports VM migration from one resource to another resource.OpenStack Open source software has the largest active population in during the past few months. As well as in total, it has the largest population followed by Eucalyptus, CloudStack and OpenNebula. OpenStack only available through any of the several vendo**r specific "stacks". CloudStack,** Eucalyptus, OpenNebula all are enterprise-ready and direct support from developers.OpenStack, CloudStack and OpenNebula are fully open-source, Apache v2.0, but Eucalyptus is fully open-source, GPL v3.0 supports.

V. OPENSTACK

OpenStack [8] is a set of software tools for building and managing cloud computing platforms for public and private clouds as well as it is a collection of open source software projects which provides an Infrastructure-as-a-Service (IaaS) solution through a set of interrelated services. In July 2010 NASA and Rackspace Hosting combindly launched an open-source cloud-software initiative which is known as OpenStack. OpenStack [3] code came from NASA's Nebula platform and from Rackspace's Cloud Files platform. OpenStack, project is an open source cloud computing platform which provide the ubiquitous open source cloud computing platform for public as well as private clouds, also it is free and open-source software released under the terms of the Apache License. The cloud is mainly providing computing features for end users in a remote environment, where the actual software runs as a service on reliable, scalable servers rather than on each end users computer. OpenStack give facilities for deploy virtual machines (VMs) and other instances which handle different tasks for managing a cloud environment. It provides horizontal scaling very easy, which means that tasks which benefit from running concurrently can easily serve more as well as less users on the fly by just spinning up more instances[2].
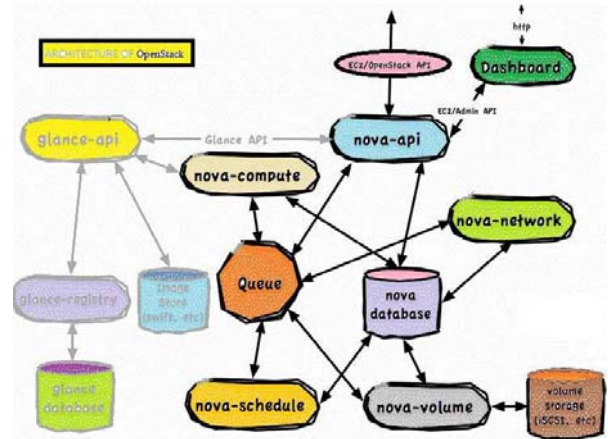


Fig 2. OpenStack Architecture

Components of OpenStack:

- Compute (Nova): OpenStack Compute (Nova) is a cloud computing fabric controller, which is used for deploying and managing large numbers of virtual machines and other instances to handle computing tasks.

- Object Storage (Swift): OpenStack Object Storage (Swift) is a scalable redundant storage system for objects and files. Objects as well as files are written to multiple disk drives spread throughout servers in the data center, OpenStack software only responsible for ensuring data replication and integrity across the cluster.

- Block Storage (Cinder): OpenStack Block Storage (Cinder) is a block storage component, which is more analogous to the traditional notion of a computer being able to access specific locations on a disk drive as well as it provides persistent block-level storage devices for use with OpenStack compute instances. In OpenStack, the block storage system manages the creation, attaching, detaching of the block devices to servers.

- Networking (Neutron): OpenStack Networking (Neutron) provides the networking capability for OpenStack and it is a system for managing networks and IP addresses easily, quickly and efficiently.

- Dashboard (Horizon): OpenStack Dashboard (Horizon) is the dashboard behind OpenStack which provides administrators and users a graphical interface to access, provision and automate cloud-based resources.

- Identity Service (Keystone): OpenStack Identity (Keystone) provides identity services for OpenStack or it is a central directory of users mapped to the OpenStack services they can access. It provides multiple means of access, and acts as a common authentication system across the cloud operating system and can integrate with existing backend directory services like LDAP.

- Image Service (Glance): OpenStack Image Service (Glance) provides image services to OpenStack, discovery, registration and delivery services for disk and server images, it also allows these images to be used as templates when deploying new virtual machine instances.

- Telemetry (Ceilometer): OpenStack Telemetry Service (Ceilometer) provides telemetry services, which allow the cloud to provide billing services to individual users of the cloud, it keeps a verifiable count of each user's system usage of each of the various components of an OpenStack cloud.

- Orchestration (Heat): OpenStack Orchestration (Heat) is a service which allows developers to store the requirements of a cloud application in a file that defines what resources are necessary for that application.

- Database (Trove): OpenStack (Trove) is a database as a service which provides relational and non-relational database engines.

VI CONCLUSIONS

In past years, cloud computing is an growing technology as well as it has emerged as a modern computing paradigm that providing IT infrastructure and can be used to meet the continuously growing storage and processing requirements of today's applications. The Open source cloud platform is most important which provide an alternative to end-user for improved portability, flexibility, scalability. This paper compares the four most popular and commonly used open source software which are OpenStack,Eucalyptus CloudStack, OpenNebula and; these all open source software allow users to choose better services according to their requirement.

OpenStack is the most popular open source cloud project, followed by Docker and KVM, according to a survey of more than 550 respondents conducted by Linux.com and The New Stack and announced today at Cloud Open in Chicago.[11]

Top Infrastructure as a Service Projects
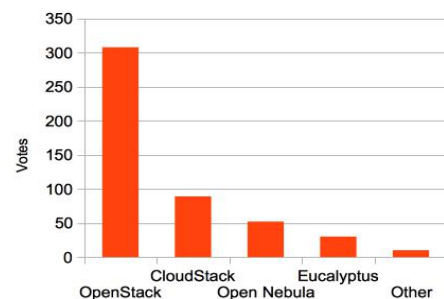
The four open-source CMPs will coexist and, in some cases, work together in a broad open cloud ecosystem. OpenStack is an open source software used for designed to allow researchers and administrators to deploy infrastructure as a service (IaaS) and provide tools for creating and managing virtual machines (VMs) on top of existing resources.

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