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RESEARCH ARTICLE

Open Source Solution for Cloud Computing Platform Using OpenStack

Rakesh Kumar¹, Neha Gupta², Shilpi Charu³, Kanishk Jain⁴, Sunil Kumar Jangir⁵

^{1,2,3,4,5}Department of Information Technology, JECRC, Jaipur, India

¹ rakeshkumar.it14@jecrc.ac.in, ² it.nehagupta@gmail.com, ³ shilpicharu@gmail.com

⁴ kanishkjain.it@jecrc.ac.in, ⁵ sunil.jangir07@gmail.com

Abstract— *OpenStack is a massively scalable open source cloud operating system that is a global collaboration 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 Eucalyptus, Openstack, CloudStack and Opennebula which is open source software, cloud computing layered model, components of OpenStack, architecture of OpenStack. Further discussing about how to install Openstack as well as how to build virtual machine (VM) in Openstack cloud using CLI on RHEL 6.4 and at last covering latest OpenStack releases Icehouse, which is used for building public, private, and hybrid clouds and introduce what new features added in Icehouse. The aim of this paper is to show mainly importance of OpenStack as a Cloud provider and give the best solution for service providers as well as enterprises.*

Keywords— *Cloud Computing; Eucalyptus; Icehouse; OpenStack; 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 Resource Outsourcing[1]. 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. 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. OpenStack mainly consists of three software projects such as OpenStack Compute, OpenStack Object Storage and OpenStack Image Service. Ninth release of the open source software which is Openstack Icehouse is used for building public, private, and hybrid clouds, new approximately 350 features are added to support software development, managing data.

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 important 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.

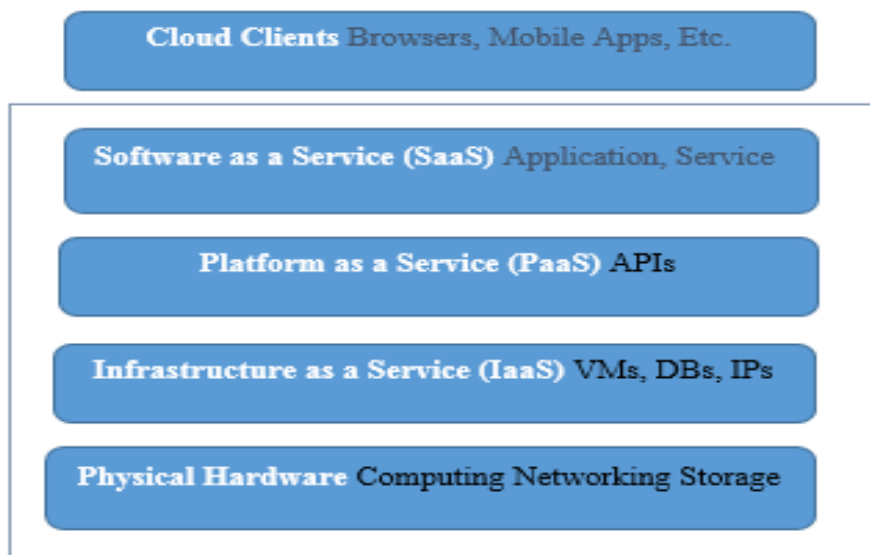


Fig 1. The Cloud-computing layered model

III. OPEN SOURCE CLOUD PLATFORM

A. 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.

B. OpenStack

OpenStack [3,5] is the fastest growing free open source software was announced in July 2010, but initial contributors 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 mainly consist of three core software project which are OpenStack Compute

Infrastructure (Nova), OpenStack Object Storage Infrastructure (Swift) and OpenStack Image Service Infrastructure (Glance).

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 commendable features 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. Llorente 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. COMPARATIVE STUDY OF CLOUD SOLUTIONS

The comparative study between Eucalyptus, OpenStack, 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].

A. Origin and Community Support

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 contributes to platform development as well as assists in finding and fixing. OpenStack was initially developed by Rackspace and NASA, in summer 2010. OpenStack is led by a powerful 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. 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, Telefonía, China Mobile also contribute to OpenNebula.

B. Architecture

Eucalyptus architecture mainly consists of five important component such as Cloud Controller, Walrus, Cluster Controller, Node controller and Storage Controller. OpenStack follows fragmented, distributed architecture. OpenStack consist of three core software projects which are OpenStack Compute (Nova), OpenStack Object Storage (Swift) and OpenStack Image service (glance). 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 monolithic architecture. OpenNebula follow classical cluster -like architecture with a front end and a set of cluster nodes to run the virtual machines (VMs).

C. Relation with Amazon

Eucalyptus, CloudStack, OpenNebula have embraced amazon Web Service-API Ecosystem. OpenStack, developers built powerful tools for manage their resources using the native OpenStack RESTful APIs or OpenStack APIs.

D. CLOUD IMPLEMENTATION

Eucalyptus is an open source platform for develop private cloud. OpenStack and CloudStack is an open source platform for develop private as well as public cloud. OpenNebula is an open source platform for deploying hybrid cloud, but it also deploys private as well as public cloud.

E. Programming/Scripting Language

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. OpenStack is written in mainly Python, XML, JavaScript and others languages. CloudStack is written in mainly Python and Java language. OpenNebula used many languages such as C++, Ruby and JAVA.

F. Hypervisors

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

G. Operating System Support

Eucalyptus support Linux operating system, but images of both Microsoft windows and Linux. OpenStack CloudStack and OpenNebula support CentOS, Debian, Fedora, RHEL open-SUSE, SLES, and Ubuntu.

H. Databases

Eucalyptus component support PostgreSQL to store their metadata and information. OpenStack support SQLite3, MySQL and PostgreSQL database. CloudStack support mainly MySQL database. OpenNebula supports SQLite backend in some versions while now it uses MySQL database backend.

I. Image Management

In Eucalyptus images are managed by Euca2ools. OpenStack open source software image service which is glance, provides functionality for discovering, registering and retrieving virtual machine (VM) images. 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. OpenNebula use image repository to allow administrator to set images.

J. VM Migration

Eucalyptus do not support VM migration, While OpenStack, CloudStack and OpenNebula supports VM migration from one resource to another resource.

K. Miscellaneous

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.

L. Production Readiness

OpenStack only available through any of the several vendor specific “stacks”. CloudStack, Eucalyptus, OpenNebula all are enterprise-ready and direct support from developers.

M. Source Code

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 combinedly 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].

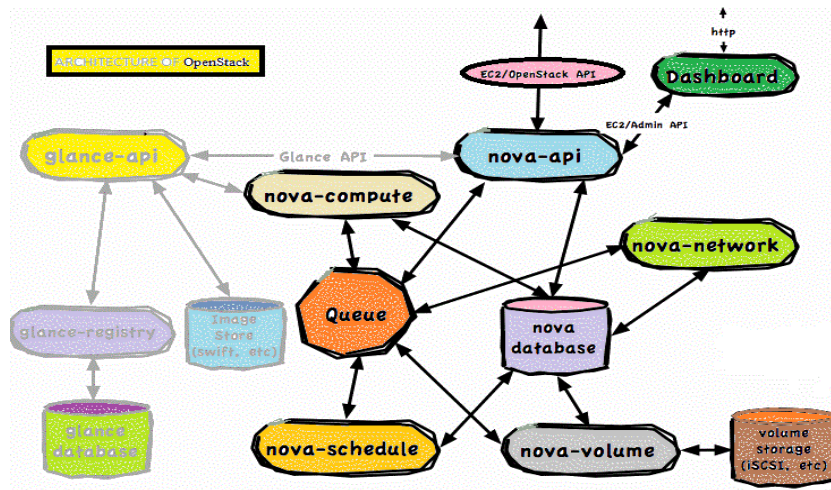


Fig 2. OpenStack Architecture

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. INSTALLATION PROCESS OF OPENSTACK ON RHEL 6.4

First of all I install RHEL 6.4 on my Personal Computer (PC), then follow these commands on Terminal to install OpenStack:

- i. `yum install kernel*openstack*`
`reboot`
- ii. check or verify kernel is openstack or not
`uname -r`
- iii. `yum install openstack-packstack`
- iv. `packstack --gen-answer-file=lxw.txt`
- v. `vim lxw.txt`
I change this information:
`CONFIG_NTP_SERVERS=ip address of the main server (for example: 192.168.0.254)` -line number 33 of the configuration file.
`CONFIG_HORIZON_SSL=y` -line number 225 of the configuration file.
- vi. `packstack --answer-file=lxw.txt`
- vii. `ovs-vsctl add-port br-ex eth0`
`dhclient -v br-ex`
- viii. `cd /etc/sysconfig/network-scripts/`
`mv ifcfg-br0 ifcfg-br-ex`
`vim ifcfg-br-ex`
I change this information:
// Bridge Networking Interface
`DEVICE=br-ex` -write in configuration file.
`ONBOOT=yes` -write in configuration file.
`USERCTL=yes` -write in configuration file.
`NM_CONTROLLED=no` -write in configuration file.
`IPV6INIT=no` -write in configuration file.
`PEERNTP=no` -write in configuration file.
`DELAY=0` -write in configuration file.
`IPADDR=192.168.0.10` -write in configuration file.
`GATEWAY=192.168.0.254` -write in configuration file.
`DNS1=192.168.0.254` -write in configuration file.
- ix. `vim ifcfg-eth0`
I change this information:
`DEVICE=eth0` -write in configuration file.
`ONBOOT=yes` -write in configuration file.
- x. service network restart
- xi. reboot

VII. OPENSTACK VM SETUP USING COMMAND LINE

I also have tested below setup in RHEL6.4 Version:

Here command for, how to upload OS image into Glance repo;

```
[root@desktop10 ~ (keystone_admin)]# glance image-create --copy-from
http://192.168.0.254/pub/LinuxWorld-Extra/BT5R3-GNOME-64/BT5R3-GNOME-64.iso --is-
public true --container-format bare --disk-format iso --name bt5r3
```

Get list of all image into glance with basic summary

```
[root@desktop10 ~ (keystone_admin)]# glance image-list
```

Get details list of particular image from glance

```
[root@desktop10 ~ (keystone_admin)]# glance image-show bt5r3
```

Where internally glance manage all images

```
[root@desktop10 ~ (keystone_admin)]# cd /var/lib/glance/images/
```

```
[root@desktop10 images (keystone_admin)]# ls
```

```
a55c3f12-bab9-4aca-a139-648f2676424b
```

Create network named “public” that we will connect to external world

```
[root@desktop10 images (keystone_admin)]# quantum net-create public --router:external=True
```

```
[root@desktop10 images (keystone_admin)]# quantum net-list
```

Create Subnetwork named “subpublic” into network “public”, from where we will assign floating ip to our VM

```
[root@desktop10 images (keystone_admin)]# quantum subnet-create --disable-dhcp --dns-nameserver 192.168.0.254 --allocation-pool start=192.168.0.200,end=192.168.0.210 --gateway 192.168.0.254 --name subpublic public 192.168.0.0/24
```

```
[root@desktop10 images (keystone_admin)]# quantum subnet-list
```

Create network named “private” that connect to our VM

```
[root@desktop10 images (keystone_admin)]# quantum net-create private
```

Create subnetwork named “subprivate” under “private” network from where our VM get IP address

```
[root@desktop10 images (keystone_admin)]# quantum subnet-create --name subprivate private 10.0.1.0/24
```

Create Router named “lwrouter” that connect our “public” and “private” network, so that VM can go to real world

```
[root@desktop10 images (keystone_admin)]# quantum router-create lwrouter
```

```
[root@desktop10 images (keystone_admin)]# quantum router-list
```

Router can only go to real world via our “public” network, set it

```
[root@desktop10 images (keystone_admin)]# quantum router-gateway-set lwrouter public
```

Connect one interface of router to “subprivate” to get internet connectivity to our VM

```
[root@desktop10 images (keystone_admin)]# quantum router-interface-add lwrouter subprivate
```

```
[root@desktop10 images (keystone_admin)]# quantum router-port-list lwrouter
```

Check network name space that managed by quantum or neutron

```
[root@desktop10 images (keystone_admin)]# ip netns
```

```
qrouter-8679bf29-304f-4485-834b-482f07b99f62
```

```
[root@desktop10 images (keystone_admin)]# ip netns exec qrouter-8679bf29-304f-4485-834b-482f07b99f62 bash
```


Get the ip address listed on the router interfaces

```
[root@desktop10 images (keystone_admin)]# ip a
```

```
9: lo: <LOOPBACK,UP,LOWER_UP> mtu 16436 qdisc noqueue state UNKNOWN
```

```
link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
```

```
inet 127.0.0.1/8 scope host lo
```

```
inet6 ::1/128 scope host
```

```
valid_lft forever preferred_lft forever
```

```
10: qg-f2f60929-99: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP qlen 1000
```

```
link/ether fa:16:3e:03:8c:94 brd ff:ff:ff:ff:ff:ff
```

```
inet 192.168.0.200/24 brd 192.168.0.255 scope global qg-f2f60929-99
```

```
inet6 fe80::f816:3eff:fe03:8c94/64 scope link
```

```
valid_lft forever preferred_lft forever
```

```
12: qr-dd00f64a-97: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP qlen 1000
```

```
link/ether fa:16:3e:92:7d:dd brd ff:ff:ff:ff:ff:ff
```

```
inet 10.0.1.1/24 brd 10.0.1.255 scope global qr-dd00f64a-97
```

```
inet6 fe80::f816:3eff:fe92:7ddd/64 scope link
```

```
valid_lft forever preferred_lft forever
```

Get all the network exists with network ID that used in launching instances bcoz we have to provide with network our instance will launch

```
[root@desktop10 images (keystone_admin)]# nova net-list
```

Launch instance named “bt5instance” that use “private” network and using “bt5r3” image to boot or install OS

```
[root@desktop10 images (keystone_admin)]# nova boot --poll --flavor m1.small --image bt5r3 --nic net-id=39b77063-ecfe-48c2-81c2-266971a0e7a8 bt5instance
```

```
[root@desktop10 ~ (keystone_admin)]# nova hypervisor-list
```

Above command list all the hypervisor used for compute in our openstack, used in multi node cluster environment

```
[root@desktop10 ~ (keystone_admin)]# nova list
```

This SHOW list of all the active VM running in nova compute

VIII. OPENSTACK ICEHOUSE

Icehouse [8] is ninth release (April 17, 2014) of OpenStack which is available today, with new features reflecting a community-wide effort to bring the voice of the user into the rapidly maturing open source cloud software platform. The Icehouse release had only 1,202 contributors, as well as 32 percent increase from the Havana release six months ago. In Icehouse approximately 350 new features and 2,902 bug fixes were added. During the Icehouse cycle, OpenStack Dashboard (Horizon) now supports 16 languages, and the internationalization team translated nearly 700,000 words.

New Capabilities in OpenStack Icehouse:

In Icehouse approximately 350 new most important features added are a new program, OpenStack Database Service (Trove), which was incubated during the Havana release cycle and is now available in the Icehouse release also. Programs in incubation also include OpenStack Bare Metal (Ironic), OpenStack Messaging (Marconi) and OpenStack Data Processing (Sahara) which is most important features.

- OpenStack Compute (Nova): In Icehouse support for rolling upgrades minimizes the impact to running workloads during the upgrade process and also improved boot process reliability across platform services.
- OpenStack Object Storage (Swift): In Icehouse include a new feature which is discoverability, which dramatically improves workflows as well as saves time by allowing users to ask any Object Storage cloud what capabilities are available via API call.
- OpenStack Block Storage (Cinder): In Icehouse includes Mandatory testing for external drivers now ensures a consistent user experience across storage platforms, and fully distributed services improve scalability.
- OpenStack Networking (Neutron): In Icehouse handle better functional testing for actions that require coordination between multiple services and third-party driver testing ensure consistency and reliability across network implementations.
- OpenStack Identity Service (Keystone): In Icehouse manage First iteration of federated authentication is now supported allowing users to access private and public OpenStack clouds with the same credentials.
- OpenStack Orchestration (Heat): In Icehouse provides automated scaling of additional resources across the platform, including compute, storage and networking.
- OpenStack Telemetry (Ceilometer): In Icehouse support access to metering data used for automated actions or billing / chargeback purposes.
- OpenStack Dashboard (Horizon): In Icehouse the Dashboard is now available in 16 languages, such as German, Serbian and also Hindi added during this release cycle.
- OpenStack Database Service (Trove): In Icehouse a new capability included in the integrated release allows users to manage relational database services in an OpenStack environment easily.

IX. CONCLUSIONS

In last few years, cloud computing is an evolving 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. Open Source Softwares are those software their source code available to the user with or without fee. The Open source cloud platform is most important which provide an alternative to end-user for improved portability, flexibility, scalability. This paper compares the three most popular and commonly used open source software which are OpenNebula Eucalyptus and OpenStack; these all open source software allow users to choose better services according to their requirement. 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. Further research is going on in the new technologies that evaluate its performances in dynamic reconfiguration in an IaaS Cloud Computing.

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