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The Comparative Analysis of Open Stack with Cloud Stack for Infrastructure as a Service

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Abstract

The idea of cloud computing refers to both the application conveyed as services over the internet and the servers and system software in the data centers that give those services. These services include offering computing resources on paid basis, and it reduces the initial investment and maintenance costs. Efficient and convenient usage of resource management is the major focus of cloud solutions around the marketing world along with scalability and adaptability to another working environment. OpenStack surpassed the market as a versatile, performant, and adaptable open-source software for private and public clouds just as utilizing from hardware resources either for entry-level or professionals. As a cloud computing practitioner, a brief understanding of the components of Open-source computing tools is must, so as to plan, design, and implement the enterprise level unique cloud computing solutions. In this paper, a brief overview of the open stack cloud computing platform and the advantages of these open-source cloud computing tools to the common users is described. Later, we have presented the issues and the recent developments by various researchers and in the industry over the open-source tools. In our paper we described mainly '6' widely used open-source cloud computing tools. Further, we described the Open Source IaaS followed by comparing the Open Stack with Cloud Stack.

Keywords: *Cloud computing, open-source tools, open stack, cloud stack, IaaS.*

1. Introduction

In the current scenario of Information Technology (IT), Cloud Computing (CC) has a predominant role in the context of IT. Though it is a new aspect, it has benefits over the rest of the existing technologies in IT and stood as one of the successful technologies. Dynamic, abstraction, sharing resources and virtually infinite scalability are the primary attributes of cloud computing [1] and it allows the users for accessing the local resources and other devices connected to internet. It turns all the IT-based possibilities as the services. CC provides platforms and applications as well via internet otherwise through Intranet [2]. Few of the considerable advantageous with cloud computing are hiding the complexity, optimum usage of resources and virtualized resources. Google App Engine, Amazon EC2, IBM blue Cloud and Microsoft Azure are some of the examples of cloud computing environments. Cloud computing enables sharing, assigning and aggregation of the software, computational and storage network resources based on requirement. Even though it is an early introduction to cloud computing there rise many issues and those

could be solved [3]. Firstly we analyzed the basic aspects of cloud computing like services and important deployment models under this section. SaaS, PaaS, and IaaS are the major services of cloud computing technology (See Figure 1).

Software as a Service (SaaS): SaaS provides 'software' as a service on the Internet, ignoring the necessity of installation and running an application over their self PCs and maintains good support.

Platform as a Service (PaaS): PaaS provides the user with a platform or a way as a service. It allows the deployment of the application with the least cost and complexity in purchasing and managing the basic layers both hardware and software as well.

Infrastructure as a Service (IaaS): IaaS provides computer-based infrastructure, sort of virtualization platform as a service to user. Users can purchase those resources like completely outsourced service rather than buying [2]. The deployment of the cloud may be in any of the following three categories. *Private Cloud:* The deployment of cloud infrastructure is done and can be handled and monitored for a particular organization. *Public Cloud:* There is availability of Cloud infrastructure to public by CSPs (Cloud Service Providers) commercially. *Hybrid Cloud:* Infrastructure of a cloud is having many sorts of clouds but the accessibility of clouds via interfaces allows the information and/or the applications must be transferred from a cloud to another cloud.

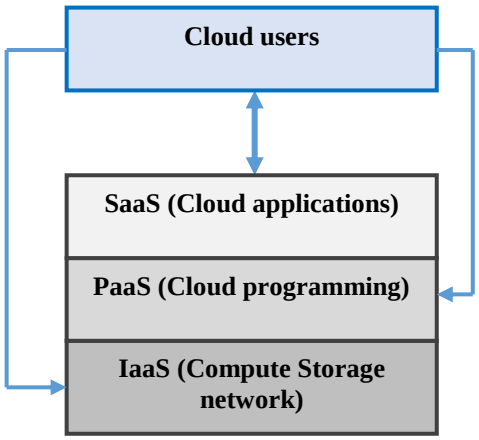

Figure 1: Basic architecture of a cloud.

In general, the environment of CC refers to the software and the technologies used by the organizations and public enterprises to build and handle their private cloud architectures. Developing their private clouds needs a robust and open-source management platform tool. Cloud management helps to set up and recommend various cloud deployment models and distinct fundamental components. In this paper, we addressed summary of basic architecture, components, supportive criteria and few of the most commonly used open-source cloud platforms. In conventional data centers and applications mapped to particular physical servers which are highly provisioned to cope with the workload surges and sudden failures [4]. Such irregular configuration makes the data centers more cost-effective so that to maintain unwanted energy and floor space, less usage of resources and considerable management overheads. With the virtualization technology, present Cloud data centers are having high flexibility, secure and on-demand allocations. One of the major technologies performs a crucial role in Cloud data center is resource scheduling. It is highly complicated to perform research extensively on these issues in real-world scenarios, as the application developers are unable to control and process network environment. The research on the dynamic and large-scale distributed environment is attained by establishing datacenter simulation system that supports visualized modeling and simulation in large-scale applications in Cloud infrastructure. Datacenter simulation system can depict the application workload statement that includes with the user details,

the number of users, data centers, resources in each data center. First, let us have a glance at some closely related work.

2. Background and Related Study

In this section, we have presented the advantages of the open-source cloud computing tools, and in the next section we will present the widely used open-source tools. As per the literature study, we identified the following are the basic advantages of open source CC tools.

On-demand self-service. Facilities of Cloud-like applications, servers, computation, and storage will be instantly provided as per user's requests even though there is no manual presence.

Broad network access. User has access over the cloud resources by internet anywhere at any cost of time by many kinds of platforms.

Resource Pooling: Virtual and non-virtual resources are placed in the cloud but no one has access over it and one cannot guess where the resources are placed.

Rapid elasticity: Computational resources are fastly provided and released; these can be done manually or instantly based on user requests. The resources seem boundless and can be purchased in any quantity at any time.

Measured service: Resources and the services of a cloud can be monitored with the help of CSPs based on the pay-per-click enterprise model. Users use these resources regularly.

Multi-tenancy: A model in which the software application instances will serve many clients and each of the clients is called a tenant. This tenant is provided access over some portion of application. OSS is said as highly secured and one of the best choices of software. OSS helps in hosting IaaS applications in cloud [5]. The advantages of OSS are mentioned in below.

Price: With OSS, a user is not required to pay for the proprietary software but just download OSS and is to be installed. Usually, there is no restriction in accessing the source code and enables the modification to meet the demands of the user.

Flexibility: Once the installation of OSS is done we can host an OSS application at any place. It represents that users need not to keep all its data with major CSP like Google. Users can also separate the software from connected hosts and get access to data.

Efficient System Integration can be achieved by using OSS and making it meet the company's requirements with minimum effort. Enterprises established the OSS basis so that to automate the heavy procedures like account billing, administration, provisioning, maintenance, and monitoring tasks. Python programming language, MySQL database, Django application framework, and the Ngnix and Apache web servers are being utilized as tools.

Cheap Enhancements: Unlike proprietary software, there is a chance to update or develop OSS at least cost. Besides, we can also enhance the virtualization technologies to ensure that a single VM does not separate the resources of connected hosts. For instance, an OpenStack SWIFT object-storage does not have the content delivery network and ability to upload file via FTP or SFTP, but can easily add such functionality.

Mobility: Based on the statement that all OSS related systems are web-based and are easy for users to work from anywhere. This is one of the OSS advantages. It enhances confidence levels rather than a commercial application. Ubuntu is an OSS used on desktops and laptops. Firefox is an example which is having high reliability to that of Microsoft Windows platform.

Transparency with No Lock-In OSS involves publishing the code and getting a developer's group to manage and enhance it. Additionally, the OSS must easily be understandable and so the necessity for transparency. OSS will store their information simply by using general databases like MySQL in which the data can be easily accessed.

The simple structure of MySQL allows data exchange easily between the systems and therefore simplifying the usage of OSS.

Increased Security: the Basic motto of OSS users is that OSS is highly secured when compared with the commercial related ones. OSS applications are open source and anybody can monitor them and also hack them. Nevertheless they are speedily identified by OSS developers group.

Most of the research work was done in the cloud computing domain, also on open source software and open-source cloud computing solutions. Under this section we have highlighted the work of veteran scientists and analyses the challenges that yet to be represented. Cordeiro et al. [6] addressed a comparative explanation on three well-known cloud computing solutions and those are XCP, Eucalyptus, and OpenNebula. Wind [7] explored four open-source platforms for brief comparison on its structures, cloud solutions and recommendations to implementation. It showed that commercial companies are already able to form cloud solutions based on open source platforms. Wen et al. [8] presented the contrasts between OpenStack and OpenNebula from provenance, architecture, hypervisors, security and other aspects and so on. Jain et al. [9] presented the comparative exploration of open source cloud computing platforms. The paper depicts the features of cloud computing, service model, deployment models, architecture and compares the five most popular and commonly used open-source software such as CloudStack, Eucalyptus, Nimbus, OpenStack, and OpenNebula. Ismaeel et al. [10] provided a basic explanation on most commonly used open-source IaaS service platforms. It also includes the explanations and differences of OpenNebula, Eucalyptus, Nimbus, OpenStack, and CloudStack platforms, and it should be open source. Serrano et al. [11] analyzed the cloud market and technologies. Vogel et al. [12] investigated and analyzed IaaS cloud solutions for implementing private clouds. This paper depicts their distinct capabilities through enhanced methodology that can be used for future studies as well as update the information of the surveyed tools.

3. Open Source IaaS

IaaS provides the users with the basic requirements such as space, processing and the resources related to networks. There exist many well-known open source IaaS systems. For instance, Hewlett-Packard's HPE Helion Eucalyptus (www.eucalyptus .com) — elastic utility computing architecture to connect a set of instructions to helpful systems. OpenStack (www.openstack.org) provides a modular architecture that gives component-based way to generate clouds. Rackspace Inc. and NASA are the cloud computing vendors developed this and are supported by different companies like Hewlett-Packard, IBM, and Intel. Apache CloudStack (CloudStack .apache.org) supports KVM, VMware's vSphere, and Xen virtualization, and offers a management server with a web dashboard [13]. OpenStack is an open-source cloud environment and is software that manages huge pools of computation, space, and resources of network in a datacenter.

Control: Open Stack's flexible architecture and vibrant ecosystem mean you can customize the platform according to your company's requirements and can maintain your own destiny.

Agility: OpenStack's self-service dashboard and rapid resource provisioning that support the internal engineering teams, agile business processes and faster product delivery.

Cost savings: With cost-effective and complex licensing schemes, few of the cloud software compel you to perform decision making on the architectures. With OpenStack, the software is freely available under the Apache 2 license, which states that you have the freedom to use OpenStack based on your requirements. OpenStack Ecosystem. Above 400 leading technology enterprises all over the world are developing and building tools for the OpenStack. With many choices in commercial ecosystem, you can never lock to a vendor. OpenStack contains mainly three components. **OpenStack Compute:** Provision

and manage large networks of virtual machines. **OpenStack Networking:** Pluggable, scalable, API-driven network and IP management. **OpenStack Storage:** Object and Block storage for use with servers and applications (See Figure 2). Open stack can be used for IaaS The other tools that are used for PaaS and SaaS are also shown in Figure 3.

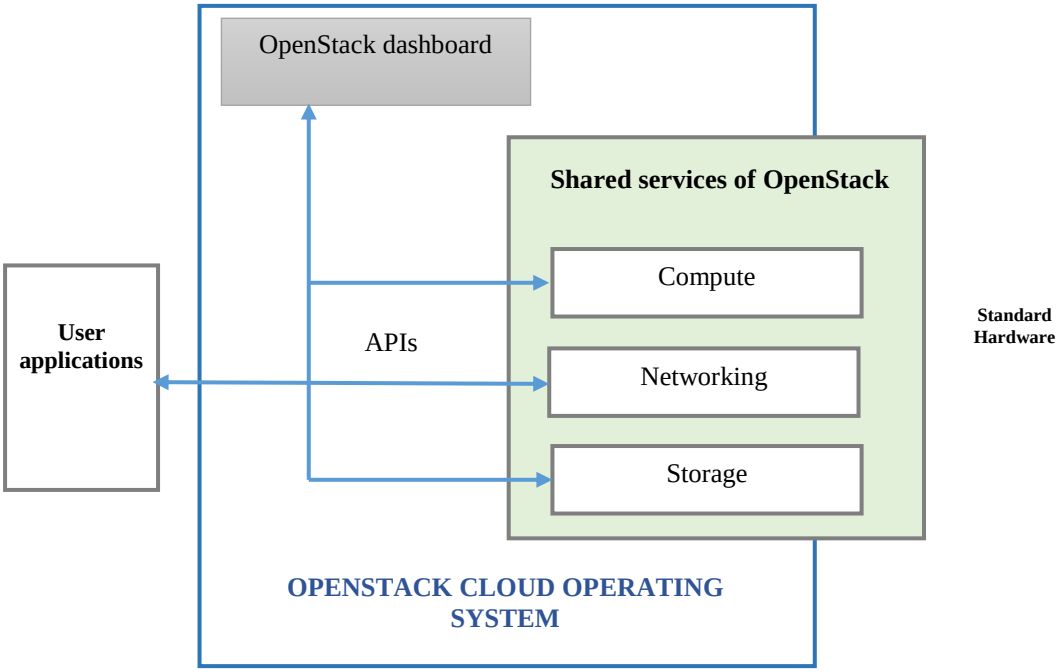

Figure 2: Components of Open Stack

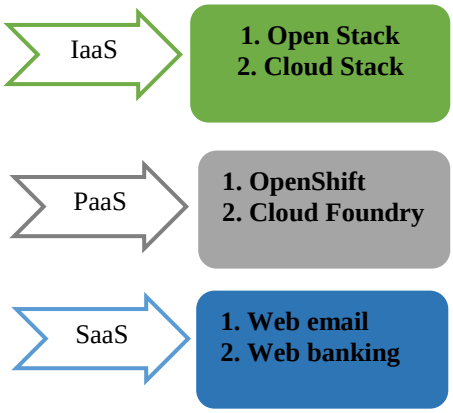

Figure 3: Open source tools for numerous cloud computing services

Open Stack Deployment

We can implement and run the OpenStack on Linux Ubuntu, CentOS, and Red Hat operating systems. For this, KVM [14], Xen [15], UML [16], and Hyper-V [17] hypervisors are helpful. Single Node, Dual node, and Multiple Node are the three key distinct nodes that help in implementing OpenStack. In single node, every nova-service is implemented only over the physical server that hosts the instances of VMs. The deployment of dual node can be done with the help of two physical servers. One is the CNN (Cloud Controller Node) and the other is Computer Node (CN). CNN can be used as a cloud controller that runs every nova service by putting nova-compute aside. CN uses nova-compute to instantiate the instances of VMs. In multiple nodes, specific CNs can be

installed. A volume controller and a network controller can be included as additional nodes during complex and multiple node installation [18] are doing. Major services OpenStack are described in the following.

Core Services

Compute: The major part of IaaS system is a cloud computing fabric controller, developed to control and automate the pools of computer resources and cope with highly available virtualization technologies.

Networking: a system to control the networks and the IP addresses to make networks congestion-free and allows the users to attain self-service ability.

Block Storage: gives persistent block-level storage devices to make use with OpenStack compute instances and maintains the development, connecting and disconnecting the block devices to servers.

Identity: provides a central directory of users connected to the services of OpenStack services and acts as a basic authentication system in a cloud operating system.

The **image** provides identification, registration, and delivery of the services to disk and server images.

Object Storage: a scalable redundant storage system in which the objects and files are written to different disk drives spread throughout the servers in a data center. In addition to these core services the following are the optional services included in the open stack.

Dashboard: gives GUI to admins and to users in order to access and monitor the cloud-related resources and is able for service providers and other commercial vendors who wish to utilize it.

Database: a database-as-a-service provisioning relational and non-relational database engine.

Elastic Map Reduce: a component helps in the easy and rapid integration of Hadoop clusters, in which users can address different metrics like Hadoop version number, the cluster topology type, node flavor details, and others.

Messaging Service: a multi-user cloud messaging service to Web developers are having access in sending texts to many components for its SaaS and also mobile applications.

Shared File System: an open API handles shares in the vendor-agnostic framework along with the capability of creating, deleting and providing access on share and can be used standalone or under various network platforms.

4. Open Source CC Tools

The frameworks of Open source IaaS will take advantage of open source code which can be altered by the users for creating a functional package that is applicable to huge servers and space to yield IaaS. OpenStack, Apache CloudStack, OpenNebula, Eucalyptus, and Nimbus are the five topmost projects that dominate the business for IaaS open source. These are said as popular among overall Open Source Cloud Computing solutions [13].

a. OpenStack

OpenStack software enables the data centers to integrate computation, storage, and networking resources and handles those via a dashboard or OpenStack API. A free, open-source platform, OpenStack was designed with the aim of providing IaaS to users fastly. Present it is one of the most popular open-source cloud projects like eBay and Walmart which is framework dependent. Enterprises are seeking to build a cloud environment with OpenStack [19].

b. CloudStack

Apache CloudStack is modeled to implement and handle huge networks of VM's. This Apache Project provides turnkey IaaS cloud computing environment. It can be accessed by public cloud computing users and by organizations holding their self-private clouds CloudStack Glance has a client-server architecture that gives REST API to a user via requesting a server. A Glance Domain Controller controls the operations of an internal server are classified into layers. Particular activities are deployed by every layer. All the file (Image data) operations are done by using glance store library, which is responsible to interact with the external storage back ends and (or) local file system(s) [20].

c. OpenNebula

OpenNebula was made for the purpose of research to help the organizations to build simple, cost-effective, reliable, open enterprise clouds on the available infrastructure of IT. It offers flexible instruments for storage, network for enabling the various services. The three layers of the components are: The Driver layer involves creation, start-up, and shutdown of virtual machines (VMs), space allocation for VMs. The Core layer controls the VMs' complete life cycle, along with the setting up of virtual network dynamically. The Tool layer provides the Command Line Interface (CLI) to interact with the users and can manage VM. A scheduler handles the functionality from core layer. The tool layer provides the interface to the External users for functionalities [21].

d. Nimbus

It is an open-source software cloud computing component coded in Java and Python particularly to meet the scientific requirements of community, but also assisting the other business people [22]. The major component is the Workspace service that represents a standalone site VM manager with distinct remote protocol frontends that support Nimbus WSRF frontend and especially Amazon EC2. While Workspace service represents a compute cloud, there is also a quota-based storage cloud solution Cumulus, modeled to define the scalability and many configurations of storage clouds.

e. Cloudify

The design and development of Cloudify are done on the criterion of openness to increasing the revolution of IT transformation. Organizations are allowed to build and develop many applications and also the network-related services. This Cloudify has best support for the NFV (Network Function Virtualization). It's TOSCA (Topology and Orchestration Specification for Cloud Applications) based, open and pluggable design gives end-to-end management and orchestration (MANO) of the NFV lifecycle. Following are the key features of Cloudify [23]:

- Cloudify enables the portability of a cloud and makes the businesses for free from the vendor lock-in, ensues with high flexibility.
- We are provided with native cloud experience.
- Helps in reducing the time complexity during deployment maximize the performance of a cloud with streamlined procedures, increasing manageability and optimizing error and so on.
- Cloudify is expensive and is helpful in minimizing the usage of a cloud.

f. Cloud Foundry

It is an open PaaS that provides many clouds, developer frameworks, and application services. Cloud Foundry makes it fast and easy to design, test, implement and measure applications [24]. The following are the features of Cloud Foundry:

- Multi-provider ecosystem
- authentication and authorization
- Data and Web services brokers for cloud brokering
- Integrated real-time logging API
- Linux container management (LXC)

g. OpenShift

OpenShift is Red Hat's cloud computing that offers PaaS and is an application environment in a cloud where app developers and teams can build, test, deploy and run their applications [25]. Features of Open Shift are typically enlisted in below:

- Auto scaling, that helps to scale the applications by including extra instances
- Supports the frameworks ranges from spring and Rails to Play, etc.
- OpenShift by Red Hat is built on open source technologies (Red Hat Enterprise Linux- RHEL)
- It provides one-click deployment

5. Comparison of Open Stack and Cloud Stack

The initiation of OpenStack is an integrated project of Rackspace Hosting and NASA in 2010. It includes the software parts which are aimed in providing better cloud services with the help of virtualizing network, storage and the resources of a computer. The outline architecture of OpenStack is represented in Figure 4 [4]. Compute node (for virtualization), Network node (for networking) and Controller node (for controlling the environment) are the three major nodes. Internally the communication among those nodes is done with the help of management network. The tunnel network helps to interact with the other nodes virtually and the external network allows the nodes to interact externally. Cloud.com was the first which developed CloudStack and then Citrix gave support to it. At present it is an incubator project called Apache CloudStack. The outline architecture of CloudStack is shown in Figure 5 [5]. It includes Supervisor node to manage the complete network, VM creator to create the virtual machines and Storage server to store disk images. No separate networks are added to communicate. Internally the interaction happens via internal network whereas the normal internet helps to interact externally. The basic installation of OpenStack and CloudStack is done with an individual node that is capable of holding three functionalities like managing, networking, and computing in an individual system. OpenStack community has developed DevStack - and opted script for quick installation of OpenStack on one node.

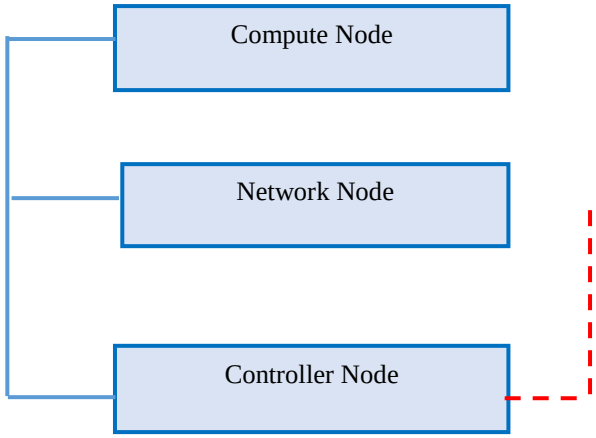

Figure 4: Outline Architecture of OpenStack

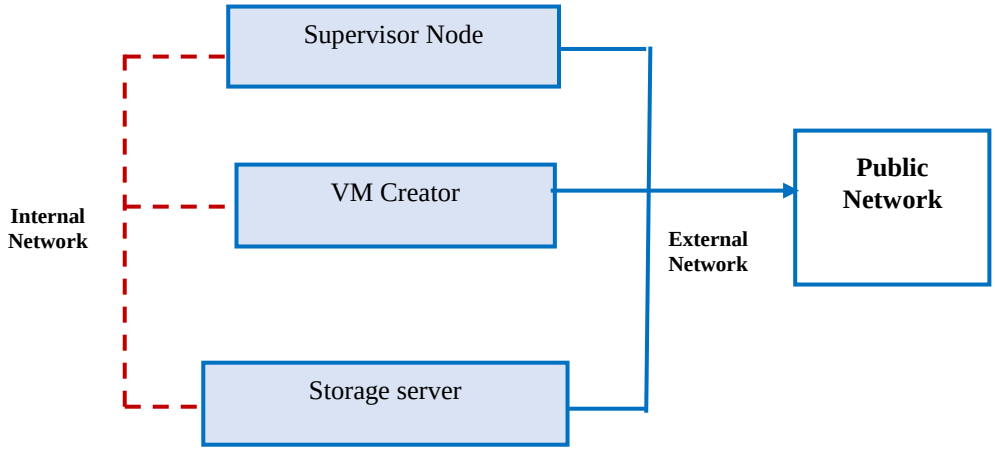

Figure 5: Outline Architecture of Cloud Stack

The noticeable thing here is that the OpenStack and CloudStack are the open-source software to build the IaaS clouds. The major differences are shown in Table 1. Both are under the Apache License, which enables to create the derivative projects, and even close sourcing them as long as you maintain the copyright notices. They represent a new wave of open software, where companies open their code to pool resources to other interested parties (another relevant example of that trend is CloudFoundy to create PaaS).

6. Conclusion

The deployment of open source cloud computing is a troublesome choice in most of the organizations, particularly in the main specialized organizations of the world. This paper has introduced a state-of-the-art subjective review of the fundamental open-source frameworks in the view of IaaS. In this paper, first we have presented a brief introduction to CC and the services it. The benefits of open source computing tools and the recent-

Table 1: Differences between CloudStack and OpenStack

Compare context	CloudStack	OpenStack
UI	1. Usage is easy. 2.. User-friendly 3. It depends on JQuery and JSP.	1. Simpler functionalities. 2. It depends on Python Django framework.
Architecture	1. Monolithic controller 2. Datacenter model. 3. Insufficient object storage	1. Segmented to a sort of piece. 2. Not shareable.
Networking	1. common-mode (security group) 2. Enhanced mode (Vlan based).	1. Flat mode. 2. Flat DHCP and Vlan DHCP mode.
Storage	Classified under primary and secondary.	Block storage cinder, object space swift.
Deployment	Deployment is very easy.	To deploy puppet or chef tools are needed.
Supportive systems/hypervisors	Supports KVM, vSphere and Citrix XenServer.	Supports KVM, LXC, VMware ESX/ESXi, Xen, PowerVM and Hyper-V
Compatibility	Highly compatible	Early-stage in enhancement.
Capabilities	Required a medium level of time and expertise, a strong GUI and Amazon EC2-like command-line interface, offering baseline security ties and offering some load balancing capabilities.	Has a strong, token-based security system, and uses Swift – the OpenStack massively scalable redundant storage system as the linchpin of its high availability story.

-works are addressed. Further the outline of the components and the major services are presented. Then, we have given a brief review of the six different open source CC tools and compared open stack with cloud stack. With the assistance of the comparison of these platforms can be used to construct the cloud in a superior way and make more profound research to improve the performance of the cloud service providers. A few highlights and functions are included in or refreshed with the advancement for further research and development of these open-source tools. The principle aspect here is to continue the research so as to guarantee better quality services to the users with no sort of disappointment.

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