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A COMPARATIVE STUDY ON OPEN SOURCE CLOUD COMPUTING FRAMEWORKS

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Abstract: ***Cloud computing is a computing technique where sharing of resources rather than personal system or servers for applications. Cloud is used as a metaphor for Web applications. Cloud computing is a web based computing such as database, server applications etc. Main goal of cloud computing is high performance computing power. Virtualization is a technique to improve computing power. This paper aim a relative study on different frameworks used in cloud computing.***

Keywords: Cloud computing, OpenStack, Nimbus, Eucalyptus, C-Meter, Hadoop, OpenNebula

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1. Introduction

Cloud computing is a developing area that allows users to deploy applications with better scalability, availability, and fault tolerance. Cloud computing focuses on delivering network virtual services where the users can access services anywhere in the world with necessary Quality of Service requirements. Cloud computing is a technique where resources accessing and services needed to perform functions with on demand.

Advantages of cloud computing include

- Accessibility- With an internet connection data can be accessed from anywhere
- Low computing machines can be used at front-end and servers on the other end can do all the processing.
- Scalability of computing services at a reduced cost
- Availability of the increased storage space

2. Background Study

Cloud computing is a resource sharing approach both in hardware and software environment. Mainly there are three types of cloud computing services such as Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS) [4][5]. The following frameworks are coming under any of the cloud computing services. Mainly there are four cloud deployment models. Those are Private Cloud, Community Cloud, Public Cloud and Hybrid Cloud [6]. Nowadays many frameworks are used for cloud applications. Main goal of this paper is to focus on different frameworks for cloud computing.

Software as a Service (SaaS) is for the online delivery of software. SaaS runs on a Web browser. Main Drawback of SaaS is less ability to customize the applications like business. In Software as a Service (SaaS) users can access software applications hosted by the cloud vendor on pay-per-use basis. Infrastructure as a Service (IaaS) is for offering hardware related services like storage services. Platform as a Service (PaaS) is for offering platform for developing cloud applications.

There are mainly four types of cloud. They are private, community, public and hybrid.Private cloud is specific for an organization. The computing Infrastructure is not shared among any other organizations. The cloud infrastructure is shared by many numbers of co-operated organizations in community cloud. Community cloud supports a specific community that has a shared concern. In public cloud visibility and control over the computing infrastructure is available to the customer. The computing Infrastructure is shared among many organizations. Both public and private cloud is working together in hybrid cloud.

Hardware virtualization is extensively used to increase computation power as well as resource utilization of cloud computing services. Hardware virtualization allows single physical platform to run number of operating systems and software applications. Virtualization creates an abstraction layer between user and the physical resource. Virtual Machine Monitor (Hypervisor) establishes the abstraction layer. The Virtual Machine Monitor (VMM) runs on the original machine and allocates the resources to the Virtual Machines. Most common virtual machine managers include KVM, Xen and VMWare.

The cloud architecture [9] is depicted in figure 1. The various components of cloud architecture include

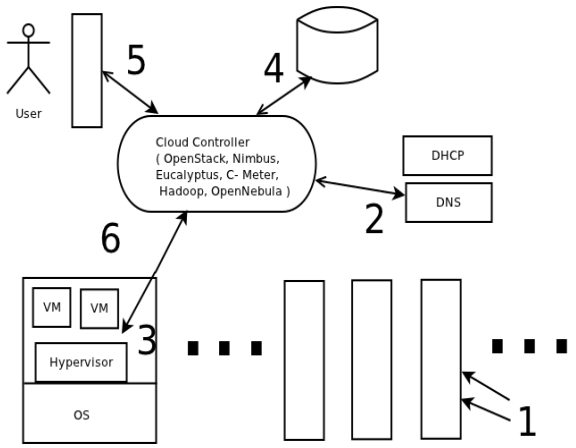

Figure 1: Cloud architecture [9]

3. Cloud Computing Frameworks

Cloud computing frameworks are used to run cloud applications. Nowadays many open and commercial cloud frameworks are available. This paper presents some of the important frameworks like OpenStack, Eucalyptus, Nimbus, C-Meter, Hadoop and OpenNebula.

3.1 OpenStack

OpenStack [10][11] is an open source framework founded by NASA and Rackspace in the year 2010. This framework is used by both public and private clouds. This framework supports scale out than scale up. OpenStack is mainly used for both small and large cloud applications. The components are:

1. *OpenStack Compute (Nova)*

OpenStack Compute is for managing large networks of virtual clusters and makes a redundant and scalable computing platform. Main properties are:

- Component based architecture-Can easily add new components
- High availability
- Fault Tolerant - cascaded failures can avoid by isolated processes
- Recoverable- Failures can be easily removed
- Open Standards
- API Compatibility
- Nova is following shared nothing architecture and message passing for communication. Multiple servers can use for running nova applications. Nova is a good interface with hypervisor.
- VM management and caching are the two functions of Nova.

2. *OpenStack Storage(Swift)*

OpenStack Storage is for scalable and redundant data storing. Swift has a self-remedial architecture and a waste file system. It has unlimited scalability.

3. *OpenStack Imaging Service(Glance)*

OpenStack Imaging Service is for guaranteed delivery mechanisms to virtual disk images.

4. *OpenStack Networking(Quantum)*

OpenStack Networking has got loosely coupled architecture. Quantum has a pluggable back end store. It provides good level of flexibility and unlimited scalability.

5. *OpenStack Dashboard(Horizon)*

Horizon provides a web interface management for task between end users. Horizon provides self-coupling capability.

6. *OpenStack Identity(Keystone)*

Keystone provides identity of cloud service among the list of users and services deployed in the OpenStack surroundings.

7. *OpenStack Block Storage(Cinder)*

Mainly used for Block storage applications where block storage is possible in multiple drivers too.

3.2 Nimbus

The main aim of nimbus is to provide infrastructure semantics addressing [7]. Main components of Nimbus are:

- Workspace service- a group of VMs can deploy and manage by a remote client.
- Workspace resource manager- deployment of VMs with semantics.
- Workspace pilot-allows resource managers to deploy virtual machine to allow remote procedures to do virtualization without site configuration changes.
- Workspace control tools-to do start,stop and pause VMs.
- Infrastructure as a Service (IaaS) gateway-allows communication between two different IaaS.
- Context broker-permits the clients to coordinate large virtual cluster, which launches automatically and repeatedly.
- Workspace client- Give full access permission to the workspace services.
- Cloud client- access permission is allowed for only the selected functions.
- Nimbus storage service-security is provides fo storage devices.

3.3 Eucalyptus

Eucalyptus [1] is an open source cloud computing framework for large storage of data and large computations. Eucalyptus follows a simple, flexible and hierarchal modular architecture. Hypervisor used for Eucalyptus is Xen. Eucalyptus is useful in both private and hybrid clouds. Main components of Eucalyptus are:

- InstanceManager - Controls the execution of VM position where it runs.
- GroupManager - Collecting the information regarding VMexecution manager and virtual instance network.
- CloudManager-Entry point to the cloud for users and administrators.

Main terms and features of Eucalyptus are:

- Images-image is a group of software modules.
- Instances- If an image is using then it is called instance
- IP addressing-Instances will get both public and private IP addresses when it is created.
- Security is provided by firewall
- Networking-There are mainly three network modes. Managed mode, System mode, Static mode. In Managed mode, local network of instances are controlled where as physical LAN and cloud connection is established in System mode and in static mode DHCP server management and assigning IP addresses to the instances are possible.

- Access Control –Eucalyptus has an identity. This identity is grouped together for access control

- High availability, flexibility, better network and image management, security, elasticity, bucket-based, block-based and local block storage abstraction, robustness etc. are some of the advantages of Eucalyptus.

3.4 C-Meter

C-Meter [2] is used for evaluating the overhead and releasing the virtual computing resources. This compares different configurations, and evaluates different scheduling algorithms. C-meter is simple, scalable, portable, resource management and possible easy performance calculation. Main consideration for C-meter in performance calculations are:

- C-meter generates and submits both real and synthetic workloads. Then detailed overheads of resources can be obtained. This provides performance analysis reports to the users.
- C-meter allows the users to compare cloud computing with clusters and grids.
- C-meter can work with different configurations with different types of cloud and different amounts of resources.

The architecture of C-meter consists of three subsystems. The subsystems are:

- Core subsystem-This system Provides core functionality to C-meter. This system has three modules. They are :
  - Listener module-This module provides listening for job submissions
  - Job Queue-Job description will be listed in this module.
  - Job Submission module- This module is to copy the executable and job status files to an HTTP
- Cloud Interaction subsystem – This system provides interaction between cloud surroundings. This system has two modules. They are:
  - Resource Management - Manages and releases virtual resources
  - Connection Management -Enables connection among cloud surroundings.
  - Utilities subsystem-Provides basic utilities needed for the framework. This subsystem consists of Configuration Management module where all the configuration changes are managed, Statistics module, Job Submission Description Language Parser module and Profiling module

3.5 Hadoop

Hadoop is a framework for reliable and scalable distributed applications [8] [12]. Main components are:

- Hadoop Common-All utilities are included here.
- Hadoop Distributed File System (HDFS)-HDFS is the primary storage area which has high throughput access to data.
- Hadoop YARN-Job scheduling and resource allocation is operated by this component.
- Hadoop MapReduce-Application is running in parallel for BigData.

3.6 OpenNebula

OpenNebula [3] is an open architecture software toolkit for heterogeneous distributed applications. OpenNebula has dynamic access to any application. OpenNebula follows full management of infrastructure where infrastructure acts as service. OpenNebula is highly reliable, flexible, secure, and scalable and has high resource awareness.

4. Comparison

Table 1.a and Table 1.2 explain a comparative study of different frameworks [5].

Table 1.a: Comparison of cloud frameworks

Cloud Framework	*Cloud Computing Service*	*Codebase*	*Vendors*	*Hypervisor used*
OpenStack	IaaS	Python	Rackspace Hosting and NASA	KVM and XenServe, Hyper –V, LXC
Nimbus	IaaS	Python or Java	Amazon EC2	Xen or KVM
Eucalyptus	IaaS	Java, C	Amazon Web Services	Xen and KVM, VMware
C-Meter	IaaS	Python	Amazon EC2	VMware
Hadoop	PaaS	Java	Amazon EC2 , Cloudera, IBM	VMware, Xen
OpenNebula	IaaS	C, C++, Ruby, Java, Shell Scripts, yacc, Lex	Amazon EC2	Xen, KVM and VMware

Table 1.b: Comparison of cloud frameworks

Cloud Framework	*Type of Cloud*	*OS*	*Unique Feature*	*Networking*
OpenStack	Public or Private	Linux	Trusted Computing, Massive Scalability	Flat, VLAN, Open vSwitch,

				Ryu open source network OS
Nimbus	Private, public, community	Linux	Nimbus context broker	IP is assigned using DHCP
Eucalyptus	Private or Hybrid	Linux, Windows VMs	User management Web interface	Managed, Managed-novLAN, system and static
C-Meter	Private	Linux	Complete resource management	Well known Internet Protocols
Hadoop	Public or private	Cross Platform	Flexible framework for large scale data processing with fault tolerant and low cost	Ethernet, Many to one Communication, TCP Incast,
OpenNebula	Private, Public, Hybrid	Linux	VM migration support	Support Open vSwitch, Ebtable and 802.1Q

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