A Comparative Study for Cloud Computing Platform on Open Source Software

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Abstract
Paper discussed about cloud computing, its background, architecture and at last covering comparative study of the main open source software such as CloudStack, Eucalyptus, Nimbus, OpenStack and OpenNebula for cloud implementation and faults in cloud computing. The main goal of this paper is to present concept of cloud computing, comparison among the five main open source softwares for cloud implementation and support for developers in selecting best open source software which give the best solution for enterprises and service providers.

Keywords: CloudStack, Eucalyptus, Nimbus, OpenStack, OpenNebula

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1. Introduction
In the world of Information Technology, cloud computing [4, 6] become a most popular word in recent year. CLOUD means Computing Location independent Online Utility that is available on-Demand which allow users to access that are resides on local, remote and other Internet connected devices. The word cloud is used as a metaphor for “the Internet,” so the word cloud computing means “a type of Internet based computing,” where different types of services such as servers, storage as well as applications are delivered to an organization’s computers and devices through the Internet. Cloud computing is a different type of computing which relies on sharing computing resources rather than having local servers or personal devices to handle applications. Cloud computing supports some important key attributes such as dynamic, abstraction, resource sharing and virtually infinite scalability.

2. Cloud Computing
Cloud computing [4, 6] exists distributed computing on a network, where a program and application may run on many connected computers at the same time. Cloud computing relies on sharing of resources to achieve coherence as well as economies of scale, similar to a utility over a network. The cloud focuses on maximizing the effectiveness of the shared resources and cloud
resources are usually not only shared by multiple users but are also dynamically reallocated per demand. Cloud computing is mainly used to sell hosted services in the sense of application service provisioning which run client server software at a remote location. Cloud Computing provides some important services such as Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS), Hardware as a Service (Haas) and Everything as a Service (Eaas). These types of cloud services offered in a public, private or hybrid network. Some famous well-known cloud vendors are Google, Amazon, IBM, Oracle Cloud, Rackspace, Salesforce, Zoho and Microsoft Azure.

3. Backgrounds
Cloud computing [4, 6] concepts date back to the 1950s when large-scale mainframes were made available to academia and corporations. Due to the same reason such as cost of buying and maintaining mainframes, an organization wouldn’t be able to afford a mainframe for each user, so it became practice to allow multiple users to share access to the same data storage layer as well as CPU power from any station. In the 1970s, IBM also released an operating system called Virtual Machines (VMs) that allowed admins on their System/370 mainframe systems to have multiple virtual systems on a single physical node. Virtualization generalizes the physical infrastructure, which is the most rigid component, and makes it available as a soft component that is easy to use and manage and it became a huge catalyst for some of the biggest evolutions in communications and computing purpose. In the 1990s, telecommunications companies, who historically only offered single dedicated point-to-point data connections started offering virtualized private network services with comparable same quality of service, but at a lower cost. In 2006, Google Docs services are developed, which brought the power of cloud computing as well as document sharing directly to end users. In early 2008, Eucalyptus became most important first open-source and AWS API-compatible platform for deploying private clouds. In early 2008, OpenNebula, also enhanced in the RESERVOIR European Commission-funded project, which became the first open-source software for deploying private, hybrid clouds and also for the federation of clouds. In 2011, IBM launched the IBM SmartCloud framework to support Smarter Planet and in 2012, Oracle announced the Oracle Cloud. Oracle Cloud offering is posed to be the first to provide users with access to an integrated set of IT solutions, including the Applications (SaaS), Platform (PaaS), and Infrastructure (IaaS) layers. The present availability of high-capacity networks, storage devices, the widespread adoption of hardware virtualization, low-cost computers, service-oriented architecture, autonomic and utility computing have led to a growth in cloud computing. The main goal of cloud computing is to allow users to take benefit from all of these technologies, without the need for deep knowledge and also its aims to cut costs, and help the users focus on their core business instead of being impeded by IT obstacles.
4. Architecture of Cloud Computing

Cloud computing architecture contains the components as well as subcomponents required for cloud computing. These all components mainly consist of a front end platform such as fat client, thin client, mobile device and back end platforms such as servers, storage, cloud based delivery, and a network such as Internet, Intranet, and Inter-cloud. Combined, these all types of components make up cloud computing architecture.

A. Front End Platform

These clients comprise servers, fat clients, thin clients, zero clients, tablets as well as all types of mobile devices. These client platforms communicate with the cloud data storage via middleware, via a web browser, or through a virtual session. The zero or ultra-thin client initializes the network to collect required configuration files which tell it where its OS binaries are stored. All zero client devices run through the network. This generates a single point of failure; in this case, if the network goes down, the device is rendered useless.

B. Back End Platform

It mainly contains cloud server, cloud storage, cloud based delivery and network.

Cloud Storage: In online network storage, data is stored and accessible to multiple clients. Cloud storage is mainly deployed in the following configurations such as public cloud, private cloud, community cloud or hybrid cloud.

Cloud based Delivery: Service models of cloud contain such as Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

5. Open Cloud Platforms

A. CloudStack

Apache CloudStack [2, 15] is a top-level project of the Apache Software Foundation (ASF) and it is quickly gaining momentum amongst several organizations. CloudStack [15, 16] is open source cloud computing software for creating, managing, and deploying public as well as private Infrastructure-as-a-Service (IaaS) clouds. It uses several hypervisors such as KVM, vSphere, and XenServer/XCP for virtualization. CloudStack was developed by Cloud.com, formerly known as VMOps and its first stable version of CloudStack was released in 2013. CloudStack [13] support some key features such as Hypervisor agnostic, Snapshot management, Usage metering, Built-in high-availability for hosts and VMs, AJAX web GUI for management, AWS API compatibility, Network management (VLAN’s, security groups), Virtual routers, firewalls, load balancers, Multi-role support.
B. Eucalyptus
Eucalyptus [1, 2, 17, 18] is free, open-source computer software for making Amazon Web Services (AWS) compatible private and hybrid cloud computing environments marketed by the company Eucalyptus Systems. Eucalyptus [13] enables pooling compute, storage, and network resources that can be dynamically scaled up or down as application workloads change. Eucalyptus has six components such as Cloud Controller (CLC), Walrus, Cluster Controller (CC), Storage Controller (SC), VMware Broker, and Node Controller (NC).

C. Nimbus
The Nimbus [3, 19] is an important toolkit which, once installed on a cluster, provides an infrastructure as a service cloud to its client via WSRF-based or Amazon EC2 WSDL web service APIs. Nimbus [20] is free as well as open-source software and subject to the requirements of the Apache License, version 2. Nimbus [19] supports Xen and KVM hypervisors as well as virtual machine schedulers Portable Batch System and Oracle Grid Engine. Nimbus allows deployment of self-configured virtual clusters via contextualization and also it is configurable with respect to scheduling, networking leases, and usage accounting. Nimbus Infrastructure is an open source EC2 or S3-compatible Infrastructure-as-a-Service implementation specifically main targeting features of interest to the scientific community such as support for proxy credentials, batch schedulers, best-effort allocations and many more.

D. OpenStack
The initial contributes of OpenStack [2, 5, 7] are NASA and Rackspace in 2010. OpenStack is the fastest growing free open source software as well as a collection of open source software project which developers and cloud computing technologist can use to setup as well as run their cloud compute and storage infrastructure also. The OpenStack [13] project consists of combination of three main components such as OpenStack Compute Infrastructure (Nova), OpenStack Object Store Infrastructure (Swift) and OpenStack Image Service Infrastructure (Glance). OpenStack [9] Compute Infrastructure is the main part of Infrastructure as a service as well as it also is the computing Fabric controller for the OpenStack cloud. OpenStack Object Store Infrastructure offers a distributed, consistent virtual object containers in which lots of data can be store, manage and from which data can be retrieve it is capable of storing large number of object distributed across nodes. OpenStack Image Service Infrastructure is a lookup and retrieval system for virtual machine images.

E. OpenNebula
OpenNebula [2, 7, 21] is a cloud computing toolkit which is used to managing heterogeneous distributed data center infrastructures. OpenNebula toolkit controls a data center’s virtual infrastructure to build private, public as well as hybrid implementations of Infrastructure as a Service (IaaS). OpenNebula [9] orchestrates storage, network, virtualization, monitoring, and security technologies to deploy multi-tier services such as compute clusters as virtual machines on distributed infrastructures, combining both data center resources as well as remote cloud resources. OpenNebula [13] is a cloud computing toolkit includes main features for integration, management, scalability, security and accounting. It also claims standardization, interoperability, portability, providing cloud users and administrators with a choice of several cloud interfaces such as Amazon EC2 Query, OGF Open Cloud Computing Interface and vCloud and hypervisors such as Xen, KVM and VMware, and can accommodate multiple hardware as well as software
combinations in a data center. OpenNebula cloud computing toolkit is used by such as hosting providers, telecom operators, IT services providers, supercomputing centers, research labs, and international research projects.

6. Comparative Study
The following table defines some features of platforms such CloudStack, Eucalyptus, Nimbus, OpenStack, and OpenNebula [1, 12].

<table>
<thead>
<tr>
<th>Features</th>
<th>CloudStack</th>
<th>Eucalyptus</th>
<th>Nimbus</th>
<th>OpenStack</th>
<th>OpenNebula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial release date</td>
<td>2010-05-04</td>
<td>2008-05-29</td>
<td>2009-01-09</td>
<td>2010-10-21</td>
<td>2008-03-??</td>
</tr>
<tr>
<td>Focus</td>
<td>Infrastructure</td>
<td>Infrastructure</td>
<td>Infrastructure</td>
<td>Infrastructure</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>License</td>
<td>Apache license</td>
<td>Proprietary, GPL v3</td>
<td>Apache License</td>
<td>Apache License</td>
<td>Apache License</td>
</tr>
<tr>
<td>Cloud Implementation</td>
<td>Public &amp; Private</td>
<td>Private &amp; Hybrid</td>
<td>Public</td>
<td>Public &amp; Hybrid</td>
<td>Private, Hybrids &amp; Public</td>
</tr>
<tr>
<td>Form of cloud</td>
<td>IaaS</td>
<td>IaaS</td>
<td>IaaS</td>
<td>IaaS</td>
<td>IaaS</td>
</tr>
<tr>
<td>User access interface</td>
<td>Rich Management, Brand-able Self Service User Interface</td>
<td>Web Service, Command-line, WSDL, WSRF</td>
<td>EC2, S3</td>
<td>Web-interface</td>
<td>libvirt, EC2, OCCI API</td>
</tr>
<tr>
<td>Scalability</td>
<td>Scalable</td>
<td>Scalable</td>
<td>Scalable</td>
<td>Scalable</td>
<td>Dynamical, Scalable</td>
</tr>
<tr>
<td>Service Type</td>
<td>Service, Disk, Network Offerings and Templates</td>
<td>Compute, Storage</td>
<td>Compute, Storage</td>
<td>Compute (Nova), Storage (Swift)</td>
<td>Compute, Storage</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Support Amazon EC2 and S3 APIs</td>
<td>Support EC2, S3</td>
<td>Support EC2</td>
<td>Supports multiple platforms</td>
<td>open, multi-platform</td>
</tr>
<tr>
<td>Web APIs</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Deployment</td>
<td>Dynamic</td>
<td>Dynamic</td>
<td>Dynamic</td>
<td>Dynamic</td>
<td>Dynamic</td>
</tr>
<tr>
<td>Virtualization</td>
<td>embedded software-based network management and VLAN</td>
<td>Xen (versions 3.0), KVM Hypervisor Support</td>
<td>Xen</td>
<td>Xen and KVM</td>
<td>VMWare, Xen and KVM</td>
</tr>
<tr>
<td>OS support</td>
<td>Windows, Linux, and various versions of BSD</td>
<td>Linux</td>
<td>Linux</td>
<td>Linux, Ubuntu</td>
<td>Linux</td>
</tr>
<tr>
<td>Programming Framework</td>
<td>Java, Python</td>
<td>C, Java</td>
<td>Java, Python</td>
<td>Python</td>
<td>C++, C, Ruby, Java, Shell script, lex, yacc</td>
</tr>
</tbody>
</table>
The following table 2, defines comparison of open cloud platform characteristics [1].

<table>
<thead>
<tr>
<th>Features</th>
<th>CloudStack</th>
<th>Eucalyptus</th>
<th>Nimbus</th>
<th>OpenStack</th>
<th>OpenNebula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk Image Options</td>
<td>Users can manage their cloud with an easy to use Web interface, command line tools, RESTful API</td>
<td>Options set by admin</td>
<td>Depends on configuration</td>
<td>Glance has RESTful API</td>
<td>In private cloud, most libvirt options left open.</td>
</tr>
<tr>
<td>Disk Image Storage</td>
<td>iSCSI or NFS</td>
<td>Walrus, which imitates Amazons S3</td>
<td>Cumulus (recent update from GridFTP)</td>
<td>Nova</td>
<td>A shared file system, by default NFS, or SCP</td>
</tr>
<tr>
<td>Hypervisors</td>
<td>VMware, KVM, XenServer, Xen Cloud Platform (XCP) and Hyper-V</td>
<td>Xen, KVM (VMWare in non-open source)</td>
<td>Xen, KVM</td>
<td>Open Virtualization Format (OVF)</td>
<td>Xen, KVM, VMware</td>
</tr>
<tr>
<td>Unique Features</td>
<td>Clustered LVM, NetScaler Support &amp; LDAP Integration</td>
<td>User management web interface</td>
<td>Nimbus context broker</td>
<td>Unified Authentication System</td>
<td>VM migration supported</td>
</tr>
</tbody>
</table>

7. Faults in Cloud Computing
In cloud computing [10, 14] processing is based on remote computer so there are more chances of errors generate. To minimize failure impact on the system, application execution, failures should be anticipated as well as proactively handled. Fault tolerance is used to predict these types of failures and take an accurate action before failures actually occur. There are some faults which can occur in cloud computing [14].

A. Memory Threshold
Memory threshold, in which, some memory and threshold value is given by the cloud server to the client. If the client is accessing files beyond its limit then it automatically consider as a fault [14].

B. Credential Fault
In credential fault, unauthorized user tries to accessing the files from the cloud by modifying the existing files. Various types of fault tolerance techniques can be used that can either be task level and workflow level [14].

8. Conclusions
Open Cloud platforms provide flexibility, on demand services and allow great amount of customization. The open source cloud platform provides features to end-user for improved scalability, portability, and flexibility as well as on-demand basis services. The paper explained characteristics 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. The analysis and summarization would help the users to understand the characteristics and would allow users to choose better services according to their requirements and also make more unified decision on the open source cloud platform according to their compatibility, scalability, implementation, interfaces, deployment requirement, and development support. Since cloud computing is a most important and evolving
technology there are many features which are being added the comparison is based on the current features as well as technology available in these all open source platform however there is need for incorporation, enterprises of more features to improve these framework.

References


