Analysis of CloudStack Platform Suitability for Management of Different Cloud Infrastructure Configurations

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Abstract. This article discusses suitability of CloudStack platform for different configurations. In this paper we review cases of platform usage in commercial and non-commercial organizations. We summarized CloudStack out of the box functionality and rated functionality extension possibility based on public information resources. Also, we estimated possible expenses related to this platform usage. As the result, different cases of CloudStack suitability have been determined.

Key words: cloud platforms, virtual machines, open source systems, virtualization, CloudStack, hypervisor, IaaS.

1. Introduction

Cloud platforms are valuable for load balancing of independent tasks with different priorities. There are a lot of different platforms presented at the market, which provide functionality for virtual machine management on multiple hosts. It is meaningful to review one of presented systems with the goal to determine the best and the worst conditions for its usage. We will review CloudStack platform, which is a well-known free solution with open source. The research includes collecting of information from public sources, execution of installation and configuration experiments to discover possible flaws during the product evaluation.

Thus, the main topic of the article is analysis of CloudStack functional capabilities, and determination of the most applicable conditions for the CloudStack usage.

IaaS (infrastructure as a service) [1] provides access to compute resources, networking, storages. Usually, that kind of service is implemented using virtualization technology, yet it is possible to implement a solution based on hardware compute resource management (this approach is similar to virtualization) [2]. The most known IaaS open source systems are Eucalyptus, Nimbus, OpenNebula, CloudStack, OpenStack. There are a lot of proprietary systems, such as VMWare [3], Amazon EC2, Windows Azure, Google Compute Engine and others [4].
The main developer company at present is The Apache Software Foundation, and the solution is licensed under Apache License 2.0 [5]. The platform is in active development, has a good documentation base and supports wide number of hypervisors, which proves its relevance.

CloudStack is a management panel for data center compute resources. Such companies as Zynga, Nokia Research Center, Cloudcentral and others built their cloud solutions based on this platform [6]. Another example of usage is Citrix CloudPlatform. It requires mentioning that development of CloudStack platform was maintained by Citrix company for a while.

CloudStack system is independent as a control panel, yet it requires a hypervisor and an agent installed on every host for monitoring and management.

CloudStack works with libvirt [7] which provides uniform view of virtualized resources [8]. This library supports wide number of hypervisors:
- XenServer/XCP;
- KVM;
- Hyper-V;
- VMware ESXi with vSphere;
- BareMetal (via IPMI);
- LXC.

Administration panel interface supports:
2. Tools for global and per-instance monitoring of resources in use at the moment of time.
3. Logging of system events.

The system provides rich API, which includes support of Amazon EC2 API and Amazon S3 API [5].

It contains Adapter Framework for modifications to make it suitable for business use-cases. It supports plugins for subsystems such as user interface or inner components.

Each instance has separate compute resources in terms of security. The system allows role and user management. CloudStack provides functionality to monitor networking, compute resources and hard drive storage.

Automation functionality provides ability to make snapshots manually and using schedule. The platform supports integration with software and hardware firewalls and load balancers, including F5 and Netscaler, manages network services such as DHCP, NAT, Firewall [9], VPN etc.
With ESXi the platform uses vCenter API [10]. According to this fact, we can assume that platform integration into existing infrastructure built on VMware can be relatively simple.

The platform has advanced administration tools such as a web interface for cloud infrastructure management [11] as well as ability to integrate CloudStack with console designed by Rightscale. It has documentation for basic installation and configuration.

Below is a Table 1 with main list of specifications of the platform.

Table 1. List of specifications of the platform

<table>
<thead>
<tr>
<th>Host platform</th>
<th>Linux (CentOS 6.5, also Ubuntu 12.04 for control panel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>User roles</td>
<td>Yes. User roles and separate zones.</td>
</tr>
<tr>
<td>Ticket system (Resource requests)</td>
<td>No</td>
</tr>
<tr>
<td>Terminal client</td>
<td>SSH, VNC</td>
</tr>
<tr>
<td>Hypervisor support</td>
<td>libvirt (KVM, Xen, VMware ESX, Hyper-V, OpenVZ, LXC, BareMetal)</td>
</tr>
<tr>
<td>Storage types</td>
<td>Primary storage (for instances):</td>
</tr>
<tr>
<td></td>
<td>For XenServer: NFS, iSCSI, PreSetup.</td>
</tr>
<tr>
<td></td>
<td>For KVM: NFS, SharedMountPoint, RDB, CLVM, Gluster.</td>
</tr>
<tr>
<td></td>
<td>For vSphere: VMFS (iSCSI or FiberChannel), NFS.</td>
</tr>
<tr>
<td></td>
<td>For Hyper-V: SMB/CIFS.</td>
</tr>
<tr>
<td></td>
<td>For LXC: NFS, SharedMountPoint.</td>
</tr>
<tr>
<td></td>
<td>For OVM: NFS, ocfs2.</td>
</tr>
<tr>
<td></td>
<td>Secondary storage (for templates and images):</td>
</tr>
<tr>
<td></td>
<td>NFS, SMB/CIFS, S3, Swift</td>
</tr>
<tr>
<td>Image management</td>
<td>Yes</td>
</tr>
<tr>
<td>Image types</td>
<td>For XenServer: VHD.</td>
</tr>
<tr>
<td></td>
<td>For KVM: QCOW2, RAW, VHD, VMDK.</td>
</tr>
<tr>
<td></td>
<td>For vSphere: OVA.</td>
</tr>
<tr>
<td></td>
<td>For Hyper-V: VHD, VHDX.</td>
</tr>
<tr>
<td></td>
<td>For LXC: TAR.</td>
</tr>
<tr>
<td></td>
<td>For OVM: RAW.</td>
</tr>
<tr>
<td></td>
<td>For BareMetal: BareMetal.</td>
</tr>
<tr>
<td>Integration</td>
<td>Provides REST API, which has GET/POST methods for 3 main zones: Root, Domain Admin, User. Results of requests are available as XML/JSON. Includes support of Amazon EC2 API and Amazon S3 API</td>
</tr>
<tr>
<td>Customization</td>
<td>Yes, provides instrument named Adapter Framework</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Installs cloudstack-agent to each compute node. Shows resource consumption summary for the whole cluster and single guest machine. Provides IO operations report for each guest machine.</td>
</tr>
<tr>
<td>Load balancing</td>
<td>Yes, based on the documentation. Automates load balancing of compute, networking and storage resources using physical infrastructure based on load balancing policies</td>
</tr>
</tbody>
</table>
Table 1. Ending

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDI Implementation</td>
<td>Could be implemented using XenDesktop</td>
</tr>
<tr>
<td>Backups</td>
<td>Migration, snapshots</td>
</tr>
<tr>
<td>Automation</td>
<td>No automation for deployment of new compute nodes. Allows custom user-defined scripts</td>
</tr>
<tr>
<td>Use case</td>
<td>Cluster</td>
</tr>
<tr>
<td>Product costs</td>
<td>Free</td>
</tr>
<tr>
<td>Deployment costs</td>
<td>Average (Requires experienced engineer skills for deployment)</td>
</tr>
<tr>
<td>Maintenance costs</td>
<td>High (Requires experienced engineer skills for support)</td>
</tr>
<tr>
<td>Vendor support</td>
<td>No vendor support. Other companies offer paid support services.</td>
</tr>
<tr>
<td>Documentation</td>
<td>Clear documentation for basic configuration. No documentation for advanced configuration. Mature community.</td>
</tr>
<tr>
<td>Training courses</td>
<td>ShapeBlue company offers wide number of training courses</td>
</tr>
<tr>
<td>Available since</td>
<td>May 2010</td>
</tr>
<tr>
<td>License</td>
<td>Open Source (Apache license 2.0)</td>
</tr>
<tr>
<td>Programming languages</td>
<td>Java, C</td>
</tr>
<tr>
<td>Developer</td>
<td>The Apache Software Foundation</td>
</tr>
</tbody>
</table>

2. Model and method

CloudStack platform usage has its pros and cons, which makes analysis of the platform suitability to the goal necessary.

The system has a wide community, which actively participates in development, it also assists with additional tasks such as text translations, documentation and so on. The community also provides main support for developers and maintains a list of recommendations for product installation and configuration.

Despite the fact that the platform is well-known, it is not popular. According to information from public sources, installation and configuration process requires significant time and sufficient expert qualification. This statement has been proven during an experiment, so that affected the estimate of deployment and maintenance costs. Also, at the moment, there is no proof of the possibility to create an instance which will utilize all available hardware resources.

We’ve performed research of CloudStack suitability for a compute cluster. The result shows that CloudStack has its advantages over commercial solutions in heterogeneous environment only, when hosts have different hypervisors. Such advantage is achieved by the fact that every host in CloudStack-based cluster has installed agent, which interfaces with hypervisor and monitors system state (Fig. 1).

Due to this approach, as it is shown on the Fig. 1, the system provides unity of cluster nodes, regardless of hardware and software specifications [12]. With support of multiple hypervisors it is possible to achieve profitable terms using Hyper-V in union with
Windows Server, because Microsoft offers preferential licensing terms. Also, usage of CloudStack platform could be suitable if data center resource expansion strategy is not determined yet. One physical host is acceptable for platform deployment, so it allows to plan scaling strategy with minimal costs.

Figure 1. CloudStack deployment scheme for heterogeneous environment

This agent-based architecture has its benefits, but it has no advantages with cluster based on NUMA-architecture. Most of the key features are excess in such environment (fig. 2).

As it is shown on the Fig. 2, the key feature of the system to integrate different compute nodes isn’t in use. Simpler software products are preferable for that kind of environment, because computing resources of NUMA-architecture cluster are shared between all nodes [13]. Such products have appropriate functionality while the CloudStack functionality is excess. It is not recommended to use the platform in homogeneous environment, because of the product complexity.

CloudStack does not offer more advanced migration tools than other systems presented at the market. There is no public information on seamless migration functionality for migration between different hypervisors.

Despite the presence of step-by-step instructions on the project website, deployment of cloud infrastructure based on CloudStack is not a trivial task. During the configuration
experiments we've encountered an issue that the system is not solid enough for modifications. Therefore, any configuration changes have to be tested prior to integration to the production environment.

Modification without sufficient control could lead to different issues. For example:

- Inaccessibility of primary or secondary storage using NFS connection;
- Inaccessibility of VM instances using SSH or VNC client (including internal CloudStack tools).

Troubleshooting takes significant efforts in most cases. One of the reasons is insufficient logging: log files contain very limited information on issues. Despite the large community, probability of successful finding of a solution by issue description is small. It could be related to the fact that the platform is being used for companies internal purposes mostly and it doesn't have public community-managed solutions.

Administration panel offers rich management functional, but provides poor user experience. System notifications aren't verbal for proper understanding. For example, it isn't clear, which issue represents “Alert” VM status and what is the current state of the VM instance. At this moment of the platform development it is not suitable for end users and it does not have integrated ticket system for resource requests. Among the other cloud
Platforms such ticket system is presented in VMWare products only. Default CloudStack administration functionality is suitable for highly qualified personnel solely. The platform requires additional efforts to develop user interface suitable for commercial use.

CloudStack has no centralized repository with VM templates and images. It increases required efforts during the preparation of new VM templates for further instance creation. Process of ISO-image downloading is not clear enough, because current progress could be found on the detail information page under “Zones” section only, which is not obvious.

During one of deployment experiments, the product version 4.5 has been removed from public access due to malfunction issues. It leads to concerns about the system production use suitability.

One of the platform traits is usage of additional virtual machines for internal purposes. These instances have two types: Console Proxy VM; Secondary Storage VM.

The first type serves as proxy for establishing a connection to the VM instances using web-interface. The second one serves for management of secondary storage, which contains VM templates and ISO-images of operation systems [7].

CloudStack offers wide number of extension instruments, because it has API for external services, has its own framework for custom modifications, and it is an open source project.

The product vendor does not offer commercial support, but there are some third-party companies which can offer paid support services.

3. Conclusions

As the result of research, we reviewed the CloudStack platform, analyzed its functionality and reviewed other characteristics, which are valuable for building up a cloud infrastructure.

Usage of CloudStack without additional development is applicable to organization internal purposes only and it is not suitable for end user. It corresponds with high qualification requirements for personnel.

CloudStack integration and maintenance have differences from the same activities for commercial solutions. Most of expenses should be expected for maintenance services, specifically for technical personnel. Additional expenses would be necessary for test environment setup and maintenance because it is strongly suggested to compensate low modification stability.

The system is the most unsuitable for installation to a NUMA-architecture cluster, as well as for installation to a single host machine. Yet, installation to a single host is acceptable if expansion of hardware and software systems is expected.
Better results in comparison to other platforms could be achieved in case of heterogeneous environment, connected by a local network and without shared resources. Under such conditions the CloudStack platform provides an ability to manage all nodes regardless of operation system or hypervisor. Thus it allows to expand cloud infrastructure as needed and minimize possible costs in process.

References


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Анализ возможности внедрения платформы CloudStack для управления облачными инфраструктурами различных конфигураций

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Аннотация. В статье рассматривается применимость платформы CloudStack при различных конфигурациях. Рассматриваются сценарии применения платформы как в коммерческих, так и в некоммерческих организациях. Сформирован перечень функционала, входящего в базовую версию CloudStack и оценены возможности по его расширению на основе информации из открытых источников. Кроме того, дана оценка возможных расходов при эксплуатации данной платформы. Как результат, были определены условия, влияющие на степень применимости CloudStack.  

Ключевые слова: облачная платформа, виртуальные машины, система с открытым исходным кодом, виртуализация, CloudStack, гипервизор, инфраструктура как сервис.

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