Cloud Management Tools
1 Cloud Management Tools

Cloud management is to provide the automation in provisioning of resources as per the configuration requested. Once the resources are configured they are to be monitored for their utilization. They abstract the complexity involved in different architecture. It is also useful in providing integration of different type of cloud. Private, Public, and Hybrid are the three types of cloud deployment models. Selection of these clouds depends entirely on the size of company and the criticality of the data (Singh & Kumar, 2011). Among these models private cloud is the widely adopted model and consists of 47% of the overall share in the cloud, out of this 47% share, 21% is hosted externally (commissioned study, 2012). Second slot is occupied by hybrid cloud which consists of 38% share. These cloud deployment models provide the flexibility and dynamic use of resources, with minimum intervention of the service provider. This flexibility is possible because of the virtualization provided at the software level instead of hardware level which existed before (DMTF, 2011; SNIA, 2010). Many cloud offering such as Amazon, Salesforce and Cordys etc. also brought virtualization from infrastructure level to the application level and offering it as Software as a Services (Amazon, 2011; Salesforce, 2011; Cordys, 2010). However, clouds are becoming more and more complex with the increasing resources and services.

1.1 Need for Cloud management tools

Present reality is that problems occur in a systems and the environment well before it is notified, causing IT personnel to operate on a reactive mode. Traditional enterprises management applications are not catering the need of the present cloud computing. Traditional management applications have the following functionalities: Management tools are reactive not proactive.

- Resources may be healthy but customer service levels are not acceptable.
- Event describes problems, not corrective actions.
- Fixes are typically manual and inefficient.
- Lack of prioritization because impacts are unknown.
- Lack of vision and strategic direction increases cost.
To overcome these limitations IT is moving from reactive to proactive to predictive approach for cloud data center management. Complexity of the cloud management can be determined by recent survey conducted by Forrester on behalf of BMC to determine the need of cloud management software. As per the survey 61% of the users are agree on the fact that managing the cloud is one of the major challenges faced by the IT departments and support teams. The nature of ever changing business demands and market often put further strains on IT resources. A recent survey conducted by Forrester on behalf of BMC to know the need of cloud management software and its result is depicted in figure 3.1 (Source: Commissioned study, 2012).

Figure 1-1: Survey on Cloud Management Tool Requirement

To cater the need of on demand provisioning, implementation of resource policies, and chargeback rule to ensure optimal utilization of resources are some of the other need of cloud management tools. They provide better control on the environment and facilitates organizations in exploring the economic benefits of cloud computing within their own data center. This calls for the efficient tools for the management of cloud computing environments. Although, some service providers such as Amazon (cloud watch) are offering in-build cloud management tools, but they are not application extensive, and may not be able to solve the specific requirement of the users. Hungama digital adopted the Amazon for its application need and console, but the finer details of usage and alerts could not be met (Kallyanpur, 2011). Hungama finally adopted the management tools provided from third party i.e. Nagios and Cacti(Kallyanpur, 2011). To overcome the functionalities limitations of the in-build cloud management tools, a number of
proprietary cloud management applications are available in the market. These management tools provide the following functionalities:

- Dynamic object creation and destruction.
- Report generation and providing the status of availability, uptime, response time, quota use etc.
- Dashboard, for further drilling and analysis of information.

With the help of cloud management tools, job of the cloud user/administrator has become much easier. Majority of the functionalities are automated which increases the throughput and reduces the human error.

1.2 Integrated Application and Infrastructure Management

Majority of the cloud to rely on a mix of physical, virtual and cloud based application, and computer process which will need to integrate development and operation process, policies, and management tools across these diverse environments. Majority of the cloud users are using multiple cloud solutions. Majority of the enterprise organization and many smaller organizations will rely on hybrid cloud consisting of private, public and non-cloud resources. This use will continue for some more years due to the unique infrastructure and operational requirements of different applications being used by the organization (Turner & Mahowald, 2011).

IT organization opting for integrated approach due to various challenges they have to counter. Reducing the cost of operations is one such challenge. Other challenges and their impact has been shown in figure 3.2(Source: Turner & Mahowald (2011)).
Applications are required to be modernized so that it should support cloud computing. These applications required to be modified so that new requirement can be fulfilled. Such types of development platforms require improve accessibility for the development. Application developed should refresh the environment rapidly to provide the real status. It will lower the cost of monitoring without compromising the security.

1.3 Benefits of Using Cloud Management Tools

Cloud management tools are having a number of benefits, some of them have been defined in the following sub-sections and the impact of these factors is demonstrated in figure 3.3(Source: Turner & Mahowald (2011)).
Figure 1-3: Major Benefits Cloud Management Tool

a) **Lower business risk**: Cloud monitoring tools provide the status of resources in use and resources needed, indicate failure that took place. This feature lowers the risk by enabling the adopter to take corrective action so that services should run as required.

b) **Business agility improvement**: Cloud management tools, which are using more than one cloud having the report of all the cloud and their status. It provides agility due to automation of corrective action required.

c) **Simpler application management**: Cloud management tools provide the status of all the applications which are running. Since, users are monitoring each application therefore; application management becomes simpler.

d) **Better compliance**: Different users need to enforce different regulations; customization at the cloud end becomes difficult. Management tools may be customized as per the requirement of each user for better compliances of regulations.

e) **Improved employee productivity**: In case of manual system managing many clouds become difficult due to multi locations. With the use of management tools multi locations data center can be managed from the same location, therefore it improves the employee productivity.
f) **Faster application provisioning**: Due to automation and single point of management, faster application provisioning becomes possible.

g) **Better application performance**: Due to isolation, application performance becomes better.

h) **Lower-cost application development/operations life cycle**: Utilization and use of any management tools depends on its feasibility, particularly the development cost. Developing the management tools is less costly; therefore overall cost of usage is reduced.

### 1.4 Categorization of Cloud Management Tools

Number of cloud management tools (sometime referred as brokers) exist in the market which are offering varieties of services. Some of these management tools are useful for the SaaS, and PaaS while others for the IaaS. Cloud management tools are available as open source (for free) and proprietary. This work has categorized the available cloud management tools broadly into two categories as:

1. Open Source
2. Proprietary

A number of open source tools are available for free and providing cloud management functionalities. However, some customized open source tools are also available as paid offerings to the users. The upcoming section describes the open source as well propriety cloud management tools available in both the categories.

#### 1.4.1 Open Source

Open source tools have gained huge popularity and constitute a sizeable market share. Majority of the organizations are adopting cloud computing to reduce their upfront cost, improving the existing services or need to support new services or new models etc. is realized. Open source is immensely useful in reducing the licensing cost needed for the software and provide greater flexibility of customization. Source code that is provided by the majority of open software can be easily customized to the individual requirement of the users. Open source software are the lifeline especially for the small and medium enterprises (SME’s).
In cloud computing a number of open source software have made their present felt and wide appreciation from the cloud community. Open Nebula, Eucalyptus and Hadoop are some of the examples of open source that can be used by wide variety of users. A number of organizations have adopted open nebula as their private cloud. Small organization having less than 20 nodes to the big organizations having hundred of nodes in their data centers have adopted cloud computing. Main reason for adopting the open source is due to the huge licensing fee or recurring charges of cloud. In such cases where huge investment is needed these organization have to adopt the open source cloud or no cloud at all. Two good examples in the public sector are Dutch supercomputing center SARA with its High performance computing (HPC) cloud facility (https://cfengine.com/cftimes/articles/0000000037.html) and Fermilab’s Fermicloud infrastructure. Hosting companies and telcos use open source to offer new cloud provision models for a specific market segment or geography. Alterway with its H₂O cloud and ChinaMobile with its bigcloud will support more than 600 million customers opted Open Nebula (http://www.opennebula.org/start).

Finally, collaboration between the open source software and the community is the huge advantage in cloud open source arena as it provides the updated feature at no cost. New feature developed by the technology provider or the contributor is very helpful in addressing many of the issues that are required for adoptability.

Open source software (OSS) provides the competitive advantage in the cloud computing paradigm by:

- Continuous and elaborative peer review from the community enabled by the publicly available open source. Errors and limitations can be identified and eliminated. Therefore, it provides more reliability and security.

- Unrestricted ability of modification provides the software to be modified as per the dynamic need.

- Reliance on particular vendor is reduced by the OSS.
Considering such a broad area of cloud management discipline, it can be categorized into provisioning, configuration management, automation and monitoring (Sibiraj, 2011). Each of them has been described in upcoming sections.

1.4.1.1 Provisioning

In networking provisioning is used in preparing and equipping network for new services. In cloud computing provisioning is used for installation of operating system and other software. Cobbler, FAI, Kickstart and Viper are some of the examples of provisioning tools. These provisioning tools are used in different operating system and build, using different languages for instance Cobbler, FAI, Viper and Kickstart are used for Debian operating system, while language for FAI and Viper is Perl and that of cobbler & kickstart is Phyton.

1.4.1.2 Configuration management

Configuration management tools (CMT) focuses on the performance of the system or the product considering its functional and physical attributes. It finds the operation requirement therefore requirement and design can be carried out accordingly. In cloud computing once the parameters are set at that time configuration management tools can start or stop the services to fulfill the criteria of given parameters. bcfg2, Cfengine, Chef & puppet etc. are some of the examples of CMT.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Tools</th>
<th>Language</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Bcfg2</td>
<td>Phython</td>
<td>Infrastructure management, Lifecycle configuration analysis, Service deployment and Configuration, auditing and reporting</td>
</tr>
<tr>
<td>2.</td>
<td>Cfengine</td>
<td>C</td>
<td>Automated configuration and management of large scale computer systems such as servers, desktops and embedded network devices etc.</td>
</tr>
<tr>
<td>3.</td>
<td>Chef</td>
<td>Ruby</td>
<td>Used for system configuration</td>
</tr>
</tbody>
</table>
### 1.4.1.3 Automation

Orchestration tools describe the automated arrangement coordination and management of complex system, middleware and services. It stitches the hardware and software together to provide the specific services and workflows when applicable to deliver the defined services. Some of the orchestration tools are given in Table 3.2.

*Table 1.2: Automation Tools*

<table>
<thead>
<tr>
<th>S.No</th>
<th>Tool</th>
<th>Language</th>
<th>Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>AutomateIT</td>
<td>Ruby</td>
<td>Infrastructure management, Lifecycle configuration analysis, Service deployment and Configuration auditing and reporting</td>
</tr>
<tr>
<td>b)</td>
<td>Capistrano</td>
<td>Ruby</td>
<td>Deployment automation framework, supports cross platform.</td>
</tr>
<tr>
<td>c)</td>
<td>Control Tier</td>
<td>Java</td>
<td>Two way authentication system under the Fedora project.</td>
</tr>
<tr>
<td>d)</td>
<td>Func</td>
<td>Phython</td>
<td>Automates routine and adhoc routine procedures in data center or cloud environments.</td>
</tr>
<tr>
<td>e)</td>
<td>Rundeck</td>
<td>Java</td>
<td></td>
</tr>
</tbody>
</table>

### 1.4.1.4 Monitoring

In cloud computing to monitor the health of the IT infrastructure, monitoring tools are used. Cacti, Nagios, Zabbix and Zenoss etc. are some of the major monitoring tools (Sibiraj, 2011). Characteristics of these tools are depicted in the table 3.3.
Followings are the popular open source cloud monitoring tools used widely:

\( a) \) **Abiquo**

It is a hypervisor independent [2, 3] cloud management solution, which has been created from ground up to meet the strategic objectives. It has also found a place in the list of cool vendor 2011[4, 5]. Abiquo has been designed for the management of virtualized infrastructure and currently available in two versions:

- Community
- Enterprise

Community version of Abiquo is free but not offering complete solution for the cloud management. Hence, to achieve the comprehensive management, user has to use enterprise management, consisting of wide options which are required for the management of commercial cloud. Another version for Abiquo is Enterprise version and is paid. Abiquo has the following features:

- Provides the global infrastructure management capability
- Allows multi-tenancy with delegated control, business policies, and autonomous virtual enterprises resource limit.
- Deep VMware integration.

These features are very useful in combining the local and remote datacenter. It can be used for private, public and hybrid cloud. Considering the widely used multi-tenancy and user access control, Abiquo cloud management tools uses hierarchical management that allows role based accessed to the user for authorization.

\( b) \) **Cloud Stack**

It is Infrastructure as a service cloud software platform of cloud computing environments [6]. It provides simple and cost effective deployment, management and configuration of cloud computing environment. Cloud stack provides solution in different layers, which are having unique functionality to achieve the desired goal. Basic features of cloud stack are as follows:
• Provide an orchestration layer that interacts with compute controller, storage controller and interface among them.
• Provides business logic layer which is used for calculating historical usage reports and create billing invoices by integrating with metered data generated.
• Provides multi role support, and divide the roles in Admin, Domain-admin, and User. Admin role can manage both physical and virtual resources. Domain-admin can manage only the virtual resources of their domain. While admin role can manage virtual resources of its own.

c) Apache Hadoop

Apache Hadoop is a framework for running large application on computing clusters. Hadoop provides fault tolerance, scalability for data storage and processing. Due to its economy and reliability, it is perfect to run applications on commodity hardware. Hadoop is highly suitable for analysis and detailed computational work across large collection of data. Since, it supports distributes environment therefore there is a need to maintain the records of the activities that are carried out, by whom it is carried out, and when it is carried out. Beyond, it also provides the analysis that can applied on range of applications including multimedia. Analyses which are supported by Hadoop are:

i) Log processing

ii) Data warehousing

iii) Video/Image analysis.

Hadoop is highly suitable for data intensive distributed applications. To support distributed system and highly computational need it supports Hadoop Distributed File System (HDFS) [7] and MapReduce [8]. Hadoop creates cluster of machines and co-ordinates with these machines for getting work done as submitted by the users. These clusters can be built and scaled out with cheap computers. HDFS is very useful in distributing the data across the servers. Replication is followed at data centre to prevent data loss in case of multi node failures. Hadoop uses Mapreduce for distributing the work submitted to the massive servers.

d) Open Nebula
Open Nebula is fully open source toolkit for the IaaS management in private, public and hybrid cloud. It can be used to combine private cloud to public cloud. Toolkit exposes interface to access private and hybrid cloud. Infrastructure users can be benefitted by open source by its elasticity, resources can be scaled up or down as per the need. This feature is very useful where the dynamic and unpredictable need arises. Users can submit their services which can be effectively controlled and monitored using Open Nebula or any Open Nebula operations interfaces like:

- Command Line Interface (CLI)
- XML-RPC API
- Open Nebula cloud API’s
- Libvirt virtualization API

Main functions of Open Nebula are as follows:

- Manages network, computing storage by orchestration.
- Management of virtual machine life cycle and allocation of resources.
- Placement of workload for load balancing.
- Manages information and accounting for diagnosis.
- Corrects the operation of virtual machines servers.
- Management of security by defining cloud security policy and accessibility of resources to authorize users.

e) **Eucalyptus**

Eucalyptus is a university project in MAYHEM labs of the computer science department at university of California, Santa Barbara. The name EUCALYPTUS is an acronym for Elasticity, Utility, Computing Architecture For Linking Your Programs To Useful System. In 2009 a company was started for Eucalyptus and provided open source project and Eucalyptus Enterprise Edition (EE) as a commercial version of Eucalyptus (http://www.eucalyptus.com).

Eucalyptus is used to manage IaaS on private cloud which is based on Linux and primarily found in modern data centers. Eucalyptus also supports other Linux based operating systems like Ubuntu, SUSE Linux, Red hat enterprise Linux (RHEL), Open SUSE and Fedora. Eucalyptus is
most suitable for the existing resources and does not require any replacement of the existing IT infrastructure. IaaS private clouds builds by Eucalyptus are well accessible by Amazon EC2 and Amazon S3. Workload can be moved from Amazon Web Service (AWS) to data center without changing the code. Virtualization, which is heavily used in the cloud computing for the optimum utilization of resources, is supported by Eucalyptus. Major virtualization technologies like VMware, Xen and KVM are well supported by this application. Use of Eucalyptus facilitates the user in provisioning of the cloud resources on self-service basis and can be deployed on any legacy hardware and software. Eucalyptus usage reduces the operating cost of cloud and maximizes the resources utilization.

1.4.2 Proprietary Tools

In case of the proprietary tools, users need to subscribe, even though free version are also provided by some of the vendors like RightScale but they provide limited functionalities. Some of these vendors are also providing demo version for limited duration after which user has to pay to continue the services. Some of the popular proprietary tools are:

a) Kavoo’s IMOD

It solves the challenge of deploying and managing distributed business application [8] and workloads in the cloud. Majority of the applications are using bottom up approach [10], while Kavoo’s works with a top down application focused approach. These different features of Kavoo help the organization in saving time and cost. Time can be reduced to minutes where it used to take months [11]. It’s auto-pilot features provides automation for the event scrip to be fired and dynamic service level agreement management that frees the administrator from the management of complex functions and to concentrate on other task. Some of the key uses of Kavoo’s are as follows:

- Simple Deployment of application.
- Runtime service level agreement management.
- Unified cloud resource management.
- Accounting system for metering and billing.

It delivers the benefits like lower deployment cost, improved time to market and improved quality of service. Administrative cost reduction of upto 40% [12] and improvement in efficiency
upto 20% have been reported for this application. It has been recognized as six rising cloud computing stars to represent next generation in the cloud [13].

b) Right Scale
Right Scale is used to run the business critical applications hosted in the cloud. It requires support for complex deployments, provides complete automation [14] yet gives the flexibility, control and portability needed. It can be used on private, public and hybrid clouds. Right Scale has cloud ready server template that abstracts architectural complexity of the cloud. It enables the user to work instantly without any further modifications. It provides the following functionalities:

- Manages entire system or entire deployment rather than only servers, hence task of administrator becomes easier and effective.
- Supports automation for interactivity with different cloud during the life cycle and interoperability among cloud.
- Offers transparency and visibility in managing, monitoring, testing, troubleshooting and re-launches applications with total control.

It addresses three stages of cloud application deployment which are:

**Design:** In this phase Rightscale helps in designing to cater particular need.

**Deploy:** All the servers in a cluster are launched in complex website, using single click.

**Manage:** Services of one or more cloud can be managed using dashboard. Hence, it is quite effective and cheap for managing the cloud.

c) Monitis
This is another cloud management tool provides time saving and unlimited [16] monitoring of the cloud assets. It assist IT managers, Engineers and system administrator in performing day today activities. Monitis provides a powerful and customizable simple dashboard for user interface. It facilitates website uptime monitoring service that enables to check the website response time from multiple locations using Monitis agent. Health of IT infrastructure can be checked for internal monitoring using agent based and agent less windows, Linux, FreeBSD,
Solaris server monitoring with distributed data centers protected by multiple firewall. One of the good features of Monitis is that it provides monitoring using the mobile devices including iphone, Android, Blackberry and Symbian. This feature is very useful to check the response time and performance from multiple geographical disperse locations as well as servers CPU, memory etc.

This tool can be used to find uptime, automates agent deployment on each virtual server and performance data. Monitis allows analyzing the failure and root cause configuration management. With the help of Monitis we can monitor website uptime, full page load, server health, network health, web traffic, web load test etc. It can be used for monitoring platform.

**d) Path X6**

Path X6 offers push down automation and cloud management for enterprise software systems. To enables rapid delivering deployment and conflict free change for consistent and correct IT services. It can be considered as factory for constructing services, component and their life cycle management. New metaphors and graphics offering it helps it in simplifying the complex model to broad categories of users. It can support physical and virtual based cloud environments. There are two advantages of using path X6:

- Visual interface to enable the drag and drop user interface (UI).
- Full life cycle management for configuration data.

This combination makes availability of push down button for deployment of physical, virtual and cloud environments, which provides the control and speed at fingertips. It uses multi-layered for configuration under a unified lifecycle.

Use of Patch X6 shrinks the deployment cycles from months to minutes. Use of X6 can lowers the cost, improves the performance and reduces the risk. Tool is very helpful in improving system administrator efficiency by 6-10 X and reduces the risk of infrastructure lock-in by making workload portable.
e) IBM Tivoli’s

Tivoli is management software from IBM and provides design, build and manage dynamic infrastructure capabilities that improve services, reduces the cost and manage risks[17, 18, and 19]. It is an integrated service management tool and provides the following solution.

i. **Asset Management:** Manages all the asset types of single platform.

ii. **Network and Service Assurance:** Manages the network and assures the clients for the satisfaction of the services by keeping the uptime of network high.

iii. **Security, risk and compliance management:** Used to increase security and to minimize the risk, works as per the specified regulatory compliances.

iv. **Service availability and performance management:** Increases the customer service.

v. **Service delivery and process automation:** Manages the availability and performance of infrastructure.

vi. **Storage management:** Used for the management of storage and makes it more responsive and resilient.

f) Enstrates

Enstrates is cloud infrastructure management solution for deploying and managing enterprise class applications in public, private and hybrid cloud. It is highly suitable for the organizations managing 10 or 100 of applications in the cloud. It automates variety of tasks such as auto provisioning, auto scaling, automated recovery, automated backups and smart cloud topology. All the features offered are cloud independent. Abstraction provided by the Enstrates helps cross cloud application portfolio management and enables the user in leveraging all the benefit of cloud provider. Enstrates is very useful in the following:

- Mitigation of risks that using single cloud provider can represent.
- Offering flexibility as the cloud services market is maturing.
- Majority of the user are using only a few server but require managing many workloads.
- Workloads have different ownership, compliance needs and integration requirements.

### 1.5 Comparison of Cloud Management Tools

Above discussed management tools are offering wide variety of services in cloud computing paradigm. Some tools are useful in one type of cloud deployment model while others can be
useful in multi cloud deployment model. Support to operating system varies from one cloud management application to others. Considering the variation in offering of the cloud management application, features comparisons are provided in table 3.3.

**Table 1.3: Comparison Of Cloud Management Tools**

<table>
<thead>
<tr>
<th>Vendor name</th>
<th>Types of OS supported</th>
<th>Types of cloud supported</th>
<th>Open Source/Proprietary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abique</td>
<td>Linux, Windows, Mac</td>
<td>Public, private</td>
<td>Open source</td>
</tr>
<tr>
<td>Kavoo’s IMOD</td>
<td>Linux</td>
<td>Public, private, hybrid</td>
<td>Proprietary</td>
</tr>
<tr>
<td>Right Scale</td>
<td>Windows, Linux</td>
<td>Public, private</td>
<td>Proprietary</td>
</tr>
<tr>
<td>Apache’s Hadoop</td>
<td>Linux</td>
<td>Public</td>
<td>Open source</td>
</tr>
<tr>
<td>Monitis</td>
<td>Linux, Windows</td>
<td>Public, private</td>
<td>Proprietary</td>
</tr>
<tr>
<td>rPath</td>
<td>Linux, Windows</td>
<td></td>
<td>Proprietary</td>
</tr>
<tr>
<td>Cloud Stack</td>
<td>Linux, Windows</td>
<td>Public, private, hybrid</td>
<td>Open Source</td>
</tr>
<tr>
<td>IBM’s Tivoli</td>
<td>Linux(SUSE, RHEL), Windows Server 2008,</td>
<td>Private, public</td>
<td>Proprietary</td>
</tr>
<tr>
<td>Open Nebula</td>
<td>Linux</td>
<td>Public, private, hybrid</td>
<td>Open source</td>
</tr>
<tr>
<td>Eucalyptus</td>
<td>Linux, Windows</td>
<td>Public, private, hybrid</td>
<td>Open source</td>
</tr>
</tbody>
</table>
1.6 Challenges and Opportunities

Cloud monitoring tools facilitates cloud administrator as well as cloud developer. Even though cloud monitoring tools are aiding to all types of users but some of the issues which are to be addressed by monitoring tools are as follows:

a) **Monitoring in PaaS**: Currently customers are unable to monitor the end to end performance effectively and unable to embed corporate security requirements. Lack of appropriate skills lead to projects costs being higher than expected.

b) **Cloud Provider’s Tool**: Many customers expect that monitoring tool to be provided by the cloud provider for monitoring and to provide security. Cloud provider supplied tool will provide better compatibility. It will also prevent any blame game i.e. provider on third party and vice versa.

c) **Non technical Issues**: There are some nontechnical issues such as internal IT culture, selecting right application, and lack of cloud application development skills of right type are posing the challenges to monitoring tools.