Bare metal Cloud Builder

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Abstract: Cloud computing is a major breakthrough that has happened in the year 1999 and it reached its major milestone with the so-called development of Amazon Web Services in 2002. Provisioning of the cloud plays a key role in many promising fields. Based on the extensive use of cloud in every possible field, the time to bring up a cloud deployed machine plays a key role in deciding the business value. The less time it takes, the sooner the software development life cycle activities will be taken up. This project takes care of OS provisioning and Cloud provisioning of a white labelled machine. In light of this, this project aims at providing a Bare metal cloud provisioning that aids consumer-grade simplicity.

1. Introduction to Cloud Computing and On-Demand IT Provisioning

The new filed in Internet Computing that has provided novel perspectives is Cloud Computing. There raises many issues in the architecture, design, and implementation of networks and data centres [1]. Many research activities are being taken up to overcome the issues being faced. The increasing demand for online access of work and the web being treated as a platform for business lead to a new paradigm shift wherein which usage of large-scale distributed computing has come into day-to-day lives. Cloud computing has changed the way in which Information Technology Provisioning (IT Provisioning) is being done. Cloud computing became the major destination of investing resources by many companies thereby building their own infrastructure and cloud service development in a very innovative manner.

Cloud computing is a very efficient way in which on-demand network access to shared pool of cloud computing resources can be done. Ever-faster and ever-cheaper computation can be achieved by cloud computing which has changed the way of IT Provisioning. The very important mandate that should be met by IT department is to provide stable, high-performance systems to the organizations that they serve. The urgent need for the modernization of digital services expects the IT to meet the mandate. But IT’s reluctance makes the business managers think of IT as a hindrance of business agility. Thus, Public cloud proves to be the best offering to meet the agility requirements against the internal IT of an organization. Gartner’s gave a definition for Bimodal IT model, that is managing the accurate and predictable Traditional IT mode and the fast delivery oriented Agile IT mode.

OpenStack is an open source cloud based computing technology that comprising a set of software tools that help in building and management of cloud computing platforms. The IT industry is in dire need of scalability, infrastructural cost reduction, speedy market arrival and maintenance [2]. This need of IT fosters the development of virtualisation solutions like bare metal cloud deployments. In case of OpenStack, interoperability and integration can be enhanced by adding new components as per users’ requirements. This ability of OpenStack has resulted in market’s Compound Annual Growth Rate (CAGR) of over 30%. Also as per segmentation analysis, analysts estimates that IT segment account for more than 67% of the total market share and adoption of OpenStack as open-source solution for cost-effective management of business enterprise’s data analytics, transactions is estimated to prevail till the end of 2020.

2. Literature Survey

This paper discusses the Design and the implementation of Open Science Data Cloud [3]. This portrays two major partitions or categories. The goal of Open Science Data Cloud is to provide data cloud infrastructure and relevant services for the scientists working with large quantities of data.

Open Science Data Cloud is being operated by Open Cloud Consortium, which is a not-for-profit that develops and operates cloud computing infrastructure for the research community.
Figure 1.1 shows the architecture of Open Science Data Cloud.

Figure 1.1 Open Science Data Cloud Infrastructure

Cloud computing is a major paradigm that has brought up easy computation, cost reduction, uninterrupted service and disaster management, Green computing. Many advantages made cloud computing as major option for IT Provisioning. The Table 1.1 shows the various definitions of cloud computing in different author’s perspective.[4]

Table 1.1 Denotations of Cloud Computing

<table>
<thead>
<tr>
<th>Aspect of Definition</th>
<th>Provisioning Type</th>
<th>Problem Associated</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning of Scalable IT capabilities using Internet.</td>
<td></td>
<td></td>
<td>Gartner[Plummer, Smith, Bitman, Cearley, Cappuccio, Scott, et al., 2009]</td>
</tr>
<tr>
<td>Scalable and manageable abstracted pool of resources</td>
<td></td>
<td></td>
<td>Forrester [Staten, 2008]</td>
</tr>
<tr>
<td>Illusion of availability of Computing resources</td>
<td></td>
<td></td>
<td>UC Berkeley [Armbrust, Fox, Griffith, Joseph, Kartz, Konwinski, et al., 2009]</td>
</tr>
<tr>
<td>Technologies used virtualization, grid computing and networking</td>
<td></td>
<td></td>
<td>[Vouk, 2008]</td>
</tr>
<tr>
<td>Dynamic provisioning of parallel and interconnected systems</td>
<td></td>
<td></td>
<td>[Buyya et al., 2009]</td>
</tr>
<tr>
<td>Large pool of hardware and software resources and accessing them</td>
<td></td>
<td></td>
<td>[Vaquero, Rodenm-Merino, Caceres, and Linder, 2009]</td>
</tr>
<tr>
<td>Model that provides on-demand network access to computing resources</td>
<td></td>
<td></td>
<td>NIST [Mell and Grance, 2009]</td>
</tr>
</tbody>
</table>

Table 1.2 Cloud Provisioning and related issues

<table>
<thead>
<tr>
<th>Provisioning Type</th>
<th>Problem Associated</th>
<th>Responsible for Solving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Provisioning</td>
<td>AppScale AND/OR AppPlace</td>
<td>AP</td>
</tr>
<tr>
<td>VM Provisioning</td>
<td>VmScale</td>
<td>AP</td>
</tr>
<tr>
<td>Resource Provisioning</td>
<td>VmPlace AND/OR ResScale</td>
<td>CP</td>
</tr>
</tbody>
</table>


IT Provisioning is required in almost all fields of industry, thanks to the Digitzation that have made every work computer needy [6]. Cloud computing has extended its usability in almost all possible fields. Cloud computing is emerging in eHealth and it is being observed that there rises a need to identify the challenges and the research areas for researchers and application developers. The way in which cloud is being adopted to achieve quality improvisation of the care being provided but not at the cost of investment needed to maintain cloud. To achieve this goal, research is being taken up in areas like cloud-based eHealth framework design, applications of cloud computing, security or privacy control mechanisms.

Computing utilities are likely to serve individual homes and offices across the country. The massive transformation of the entire computing industry is being envisioned as offering of computing utilities as service provisioning [7]. This phenomenon wherein which utility services are provided on demand, is expected to materialise by 21st century. Pay-as-you-use mechanism saves the customers from investing on building and maintenance of complex IT machines (PM), processors, memory, network, storage that are being hosted by cloud providers (CP). The customers for CP are Application Providers (AP) and they deploy applications[5]. Application providers (AP) develop applications and the infrastructure that is needed to deploy those applications are being provided by the CP. This paper highlights the importance of dynamic provisioning in order to meet the dynamic workloads of an application. A detailed discussion of varieties of dynamic provisioning with resources, techniques and technologies as parameters is being presented in this paper. Types of cloud provisioning and the associated problems are being tabularized as Table 1.2.

The technology that is there for today and tomorrow as well is Cloud computing. This paradigm enabled the customers to gain access to shared computing resources such as virtual machines(VM), physical
infrastructure. Numerous problems are being faced by the practitioners against the creation of software for millions and trillions of consumers. Figure 1.1 explains different paradigms in Infrastructure as a Service and its service delivery.

Critical QoS parameters need to be taken care by the cloud provider when offering cloud as a commercial service [8]. The crucial QoS factors like are time, cost, reliability and trust/security cannot be static, they need to be dynamically updated over time due to continuing changes in business environment. Dynamic support for SLA negotiation and mechanisms should be developed for the dynamic allocation of multiple timely resources.

The following are the requirements to be fulfilled in case of commercial offerings of market-oriented clouds:

- Customer – driven service management based on customer profiles should be supported.
- Incorporation of autonomic resource management models that can effectively satisfy the new service demands as well as existing service obligations.

Emerging Trend of the Cloud computing is being discussed in this paper [9]. this shows road map of this technology from 1961 to 2010. In the initial year as in 1961, great technical visionaries predicted the emergence of computation as public utility. Near to 1967, IBM have started the concept of virtualizing mainframe operating systems. In the twentieth century beginning, Amazon provided storage and computation services which are cloud-based. In range of 2008 and 2010, cloud models are being emerged.

This paper presents the overview of the research that is being carried out in the field of Cloud computing and the areas in which most of the research is being concentrated [10]. This Figure 1.2 is a pie chart that makes out the percentage of research took place still now in each area of Cloud Computing field.

Configuration management is needed as Cloud computing is huge. Running OpenStack needs a tool definitely as it is highly complex. It has got a tendency to change very often as it is a open source project with rapid upgrade rate. Consistency is one of the important factors to be maintained as OpenStack clusters are sometimes mirrored on to many environments. Compliance and quality parameters are the deciding factors that make any appliance feasible to use, same case in OpenStack too. This Figure 1.3 shows a survey on the Configuration management tools usage.[11]

Bare metal Provisioning frameworks are being discussed in this paper. They help in the provisioning of the machine based on its MAC address and they are responsible in managing the cloud deployment or Hadoop setup on it. Emulab is the bare metal provisioning framework but it is very time consuming to deploy. Cobbler is the framework which is fairly easy to setup but it has to be paired with configuration management tool.[12]

Resources held by data centers should be utilized in an optimal way or else severe breakdown in
income be occurred. Resource consumption should be shaped in a agile manner. Strandring and fragmenting of resources should be avoided. Geo-diversity is the better solution figured out as it helps in fast servicing of customers.[13]

Interoperability issues and the security issues are being discussed in this paper. Resource provisioning is more prone to security issues. Hacking attacks to the data stored in the virtual resources. Also the efficiency to be met during the on-demand provisioning of resources has to be maintained. Estimates on the consumer demand some times may lead to overestimating of resources’ provisioning.[14]

Razor and Cobbler are the two major OS Provisioning servers available. The number of contributors for Cobbler are more compared to that of Razor. VLAN support, Network Topology. Also it is been noted that Cobbler is mostly used as the provisioning support for many Cloud deployment schemes.[15]

3. Motivation

Cloud computing has made IT provisioning via internet a reality. Infrastructure-as-service is the very prominent service model that is being offered. Over-provisioning and under-provisioning of IT resources may lead to under utilization of resources, whereas under-provisioning does not provide enough prerequisites for the application developer to host an application. Dynamic provisioning is a very important phenomenon that is being adopted.

4. Problem Definition

Time to IT Provision an organization has become one of the important factors that decide the business value of an organization. Traditional mode of IT Provisioning lacks efficiency to provision in a stable way. A Fast-delivery oriented Agile mode of IT provisioning is needed to meet the needs of developer community. Human intervention leads to errors and parallel execution should be introduced to speed up the setup of so many machines as per the requirements of the developers. User-friendliness is lacking in Traditional way of IT Provisioning. Bare Metal Cloud Builder aims at provisioning the cloud in a white labelled machine with minimal manual intervention thereby reduces human prone errors and helps in parallel execution in a user friendly manner.

5. Objectives

Bare Metal Cloud building is a process in which two processes namely Network Booting with Cobbler server Main Objective is identification and network booting of the white labelled machines based on its MAC address. This is done by updating the kickstart file with the ISO image profile definitions. Chef cookbooks should be written very efficiently that all dependencies needed to setup cloud should be provisioned..

6. Methodology

Wherever Times is specified, Times Roman, or New Discovery of the bare metal device should be done and it should undergo network booting. For the bare metal device to undergo network booting, the prerequisite needed is set up of the pre-boot execution environment and also the bare metal devices should be PXE (Pre-boot Execution Environment) enabled clients. On the client side it requires only a PXE-capable NIC (Network Interface Controller), and uses a small set of industry-standard network protocols such as DHCP(Dynamic Host Configuration Protocol) and TFTP(Trivial File Transfer Protocol). The OS provisioning on the bare metal device is being carried out with the driver that runs the script to build the setup environment, fetch an ISO(International Organization for Standardization) image and a kickstart profile definition. Kickstart file definition is a mechanism which provides ease-of-use for customizing image contents. OS provisioned node gets authenticated with Chef server and the cookbooks are uploaded to the node using knife. [16] Setting up the cloud needs many dependencies to be resolved and in-time setup should also be taken care of. Development of this entire builder system is done using Chef, a configuration management tool using which infrastructure can be taken as a code resulting in ease of configuring the code. Thus cloud infrastructure can be configured in terms of code. Thus can infrastructure can be managed easily by managing the code. So configuration management have become the most promising field.

7. Overview of Bare metal Cloud Builder

The overall aim of this project is to build cloud on a bare metal also known as white labelled machine with minimal user interposition. This project is comprised of cobbler server, python, chef server and chef workstation. Cobbler Server implements network booting, kickstart profile definitions are being feded as input. Pre-boot execution environment setup includes setup of kickstart profile definitions, ISO(International System Organizations) images of OS(Operating System) distributions. OS Provisioning is followed by Openstack deployment. Python script is used to orchestrate both the activities namely OS Provisioning and OpenStack deployment in a seamless way. As soon as the cobbler server finishes OS Provisioning, the control is being moved to chef workstation. Chef cookbooks are being uploaded to
the chef server, setting up of chef client in the node that enables running of the chef cookbooks. This cloud builder enables OS Provisioning followed by building cloud on it using cobbler server and chef configuration management tool. This cloud builder provisions cloud setup on all in one node scenario.

8. Requirement Specification of Bare metal Cloud Builder

This project has used Cobbler Server for the initial Operating System provisioning on the bare metal. Chef configuration management tool is used to build OpenStack on the OS provisioned bare metal. These two processes namely OS provisioning and cloud building are being orchestrated by using python scripting roles.

8.1 Cobbler Server

Cobbler server enables OS provisioning of the bare metal white labelled machines using network booting, by setting up the Pre-Boot execution environment. Kickstart file definitions should be done and they are supposed to be made available via network location.

8.2 Chef Configuration Management Tool

Chef configuration management tool helps in setting up the cloud environment on the OS provisioned node. Chef is based on the client-server model.[17] Chef server makes store of the chef cookbooks and it also maintains other configuration details. Storing of the chef cookbooks in the chef server allows easy provisioning of new servers using the mechanism called knife.

8.3 Python Support

Python script enables the user to provide the necessary information to command line prompt. These details are needed in setting up the operating system environment and the cloud environment as well on the bare metal machine. This project follows All-in-one scenario of building cloud. The initial inputs being asked for helps the cobbler server to proceed with the OS Provisioning and Chef configuration tool with the cloud building by uploading and running of cookbooks.

9. System Architecture of Bare Metal Cloud Builder

This work was supported in part by a grant from the National Science Foundation. System Architecture is conceptual modelling of a system that helps in defining its functional and behavioural attributes. Any system can be dissected into disjoint integral parts which performs certain set of services. can be done by Large systems are decomposed into sub-systems that provide some related set of services. Architecture design is the initial process of internal sub-system identification, control flow and communication among the sub-systems. This architecture design is being followed by the description of architecture in terms of software. Identification of the integral parts of the system is the basic aim of System architecture.

The system architecture of Bare metal Cloud Builder is as shown in figure 9.1. The system architecture portrays the blocks required in this project.

![Figure 9.1 Bare metal Cloud Builder Architecture](image)

It consist of three main modules OS provisioning module which comprises of Cobbler server equipped with Distributions images and kickstart file definitions, Configuration management module in which Chef workstation through which user operates, Chef server as the managing and the central repository and the OpenStack components repository. All these modules should function in a coordinated way using the python programming language which provides the communication between user and the interface. User communicates to the command line interface when some input is required.

10. Results Obtained

Bare metal Cloud Builder in a nutshell should boot the bare metal from network and thereby should take up the cloud building process from Chef server.

10.1 Booting Process

Initially the process starts with the booting mechanism initiated by cobbler server and that is as shown in Figure 10.1, Figure 10.2 shows selection of Operating system and Figure 10.3 shows that successful OS Provisioning.
10.2 Cloud Building Process results
Building the cloud using Chef helps in resolving many issues that arise and the tedious tasks can be made easy by using the Configuration tool. Figure 10.4 shows the All in one node scenario setup being done from workstation and the Figure 10.5 shows the processes going on in the target node.

Figure 10.1 Network Booting
Figure 10.2 Selection of OS
Figure 10.3 Completion of Booting Process
Figure 10.4 Chef initial process invoked by python in workstation.
Figure 10.5 Target node getting accessed from the Workstation.

The remote node built by the Cobbler server will get the cookbooks implemented in it, thereby advancing for further steps. Figure 10.6 shows the successful installation of the Keystone service of Openstack.
Thus the basic functionality of the project is made clear by demonstrating the results obtained.

11. Conclusion

This project is aimed at improving the provisioning aspects of the IT thereby providing a better IT support to the developers at a faster rate. OpenStack is widely accepted by many of the sectors of the society. This bare metal cloud builder makes use of the booting technology by adopting a server called Cobbler server, Chef as the configuration management tool and Python as the binding technology to integrate all the technologies used. OpenStack is the open source technology and it is a project contributed by many active participants. It allows easy customization and it is getting matured day by day and that is the interesting thing about it. This projects uses network booting concept that has many advantages and it removes all the hassles in the booting process thus reducing the boot process time. Chef being a very effective tool to complement the difficulty attributes involved in the OpenStack deployment. Chef bring up the infrastructure as a code theme to make the Devops engineers job easy.

11. References


