NCloud - Experimenting with Architecting and Facilitating Utility Services for Establishing Educational Cloud

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Abstract: Academic Institutions as well as Enterprises all over the globe have become heavily dependent on high performance computing systems for their day to day activities and hence it continues to seek opportunities to rationalize and optimize the utilization of resources. Continuous upgradations of software and hardware have become important items of those organizations meetings creating budget pressure. In such scenario, Cloud computing services could provide many of those organizations to enhance the productivity keeping the budget expenditure low. The paper discusses the experiments carried out on our educational campus for architecting the cloud – hereafter referred as NCloud (Cloud built on Nirma Campus), configured using open source tools and furnishes the utility services which are leading towards an establishment of a stepping stone for formation of knowledge cloud. Testbed formed for data center consists of 1 front-end and 16 worker node. By using NCloud, user will be able to fulfill the demand of infrastructure as a service in which user is provided an operating system with specific RAM and CPU cores. Utility oriented services in NCloud aims to charge user for what they use. For implementing utility oriented services, analysis of various major cloud providers is done including pricing models. Performance measures on heterogeneous platforms and the results obtained are included in the paper.

Key-words: Cloud Computing, campus cloud, knowledge cloud, IaaS, Usage pricing

1. Introduction

Cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented as one or more unified computing resources based on service level agreement as stated by Dr Buyya and authors in [4]. In the past few years cloud computing has been promoted as the most promising trend in the information technology sector[5][6].The potential and efficiency of using cloud computing in higher education has been recognized by many universities all across the globe. Cloud computing offers to universities the possibility of concentrating more on teaching and research activities rather than on configuring complex IT infrastructure[1]. Cloud computing is the latest trend in computing where the intention is to facilitate cheap, utility type computing resources in a service-oriented manner and can be used for imparting the knowledge. Any enterprise can easily provision, manage, and sustain (keep up to date and scale) their entire operations on a compute cloud for a fraction of the cost of owning the resources. [2]The cloud computing trend of replacing software traditionally installed on campus computers with applications delivered via the internet is driven by aims of reducing institutions IT complexity and cost. Authors of [3] has demonstrated that how an organizations across the world are taking advantage of the benefits which this technology is bringing not only in terms of cost but also efficiency and environment.

Architecting NCloud to provide service infrastructure performs the task of transforming existing infrastructure into cloud service serving system which can be used by the different departments of the university .Optimum Resource utilization and opting the current technological trend for dissemination of

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knowledge is the major motivation behind this work**.**
NCloud which is built using OpenNebula and couple of other tools on CentOS, is able to fulfill the user requirement of Infrastructure as a Service on demand. The user can specify the computational parameters according to the requirement and the request would be fulfilled by an automated cloud environment providing remote access of the virtual machine to the user.Work presened in this paper also demonstrates the experiments carried out for facilitating Utility Oriented Services in NCloud aiming to develop the usage meter for charging the user of NCloud for what they use. NCloud is private cloud but just for the sake of realizing the functionality of pricing model, this extended work is done to realize the core concept of Cloud Computing of "pay as you go". The developed cloud computing infrastructure is ready to accept the knowledge base and disseminate to the user on educational campus.

2. TestBed Formation

Cloud computing formed using OpenNebula[7] is comprising of two sections, one is Frontend and other is Worker-node as shown in figure 1.The frontend gets the request from the client and accordingly fulfills the requirement by getting the resources form the worker nodes.

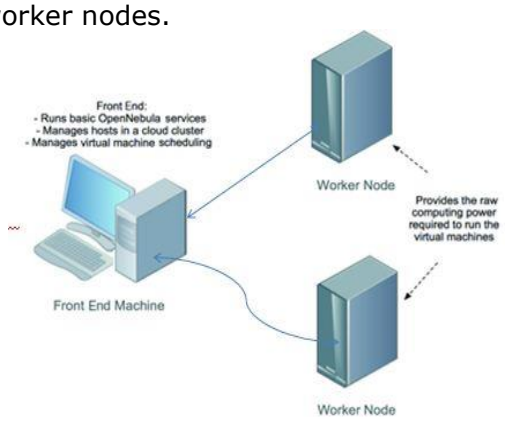

Figure 1. Components of OpenNebula

Frontends' prime section is responsible for controlling, monitoring, and most appreciable management task of the every kind of resources. Second section of Frontend is called image repository. Here image means operating system image and data storage images which can be given to the virtual machine (VM) according to user requirement. Third section is worker node which will actually execute the virtual machine according to the user requirement. Worker-node holds infrastructure in the form of physical peripherals of cloud. Worker-node is highly configurable, hypervisor enabled and necessary server (NFS, SSH) enabled computational resources. It must have virtualized technology enabled processor for best performance. Worker-node actually does the computation and execution task of the virtual machine. Figure 2 gives the general idea of OpenNebula component as a middleware which is heart of the cloud.

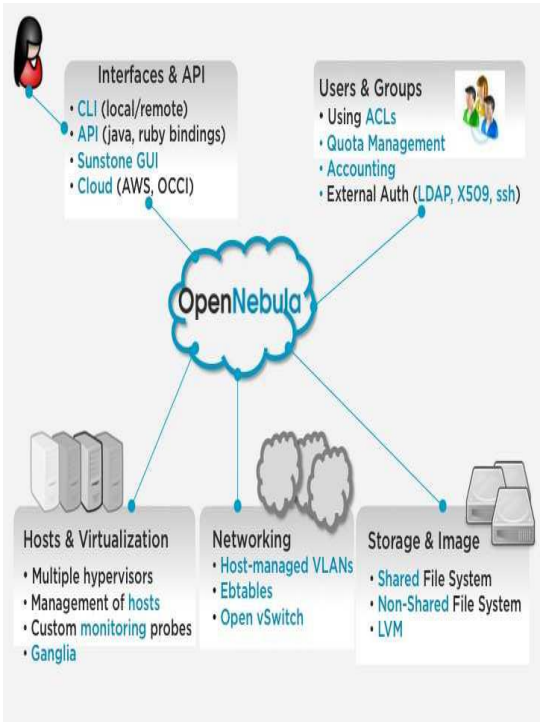

Figure 2. Components of OpenNebula Architecture

Interfaces & APIs, Users and Groups, Networking, Hosts and Virtualization and Storage and Images are core components facilitating the functionalities of middleware.
The supporting and required components used to built the NCloud are

SCons [8] software construction tool , Ruby[9]object -oriented programming language, Nokogiri[10] it is an open source library to parse HTML and XML in Ruby, Rake [11] it is a software task management tool, XMLRPC-C[12] is a specification and set of implementation that allow software running on different environment and operating system can make procedure call over internet. SQLite[13] is a in-process library that implement a self-contained, server-less, zero-configuration, transactional SQL database engine. VM placement decisions are made by the scheduler. The scheduler accesses all requests received by OpenNebula and based on them, it keeps track of allocations and sends appropriate deployment or enforcement commands to the Core. The default OpenNebula scheduler provides a scheduling policy that places VMs according to a ranking algorithm, which relies on performance data from both the running VMs and physical resources.

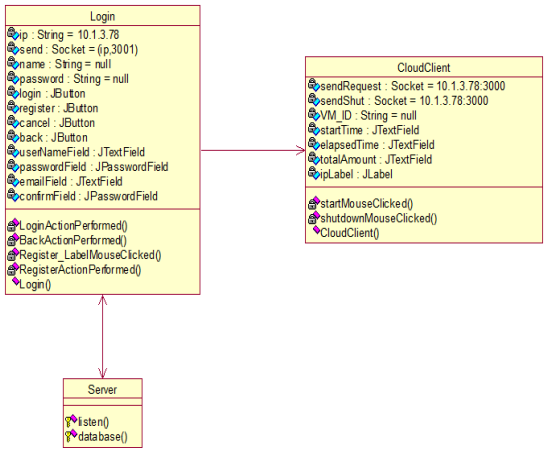

Figure 3. Class Diagram of NCloud skeleton

Figure 3 is one on the class diagrams prepared during the design of NCloud.Figure 4 shows User Screen containing following parameters to be chosen by the user during availing the services of NCloud.

- CPU: User is required to specify the no. of cores required for use.
- RAM: User can select the amount of primary memory required for the computation.

OS: User is required to select the linux or windows OS as the Infrastucture platform.

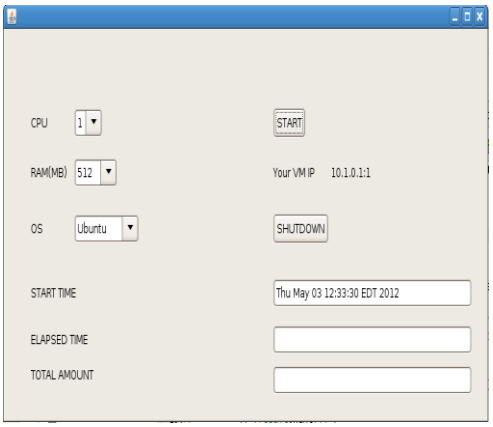

Figure 4. GUI for user

On successful deployment of the VM in the cloud the system provides the DNS, which is to be used for remotely accessing the cloud service. The user can use the DNS provided for different kinds of interface, for CLI user can SSH the system and for GUI the user can have access through VNC viewer or RMI. After the required usage of the VM the user can shutdown the VM to stop the VM execution in cloud.

3. Pricing Algorithm

As stated in section 2, though NCloud is private cloud, we have built pricing model just for experiencing Pay-per-use policy for cloud. For using NCloud's Infrastructure as a Service, user has to choose amount of RAM, No. of CPU cores, and OS. For charging user for IaaS facility of NCloud, proposed algorithm measures the usage time. Flow chart of this algorithm is given below.

It will continuously check the state of VM (OS provided as a service). When VM is in running state, algorithm will measure the time in a temporary variable. When VM state is not running, its shutdown status is checked. If VM is not shutdown by user and it is not properly working due to any hardware crash in Datacenter, or user's local network failure, this time is not added in service time.

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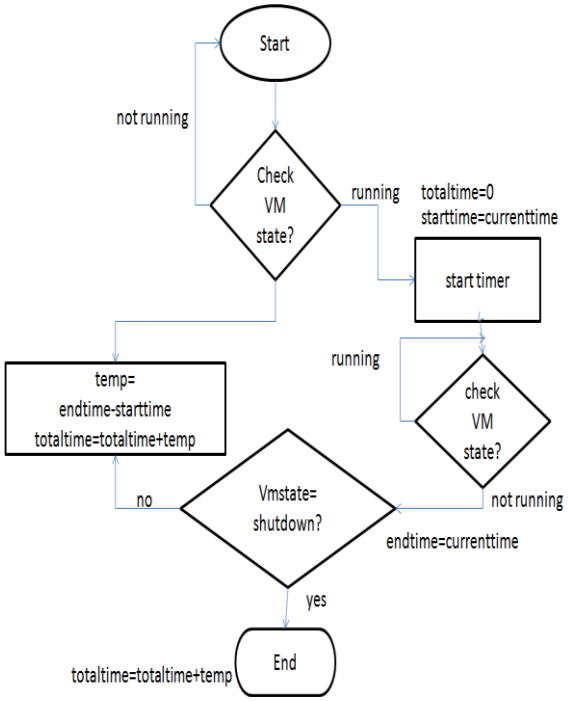

Figure 5. Flow chart for usage time measurement

After shutting down the service usage, user will get accurate detail of his/her total usage time. By using this usage time NCloud provider can charge the user according to pricing per unit time.

4. Results

Testing on NCloud for Infrastructure as a service was carried out successfully which helps in managing the resources on the campus. Figure 7 shows increased CPU usage in worker nodes.

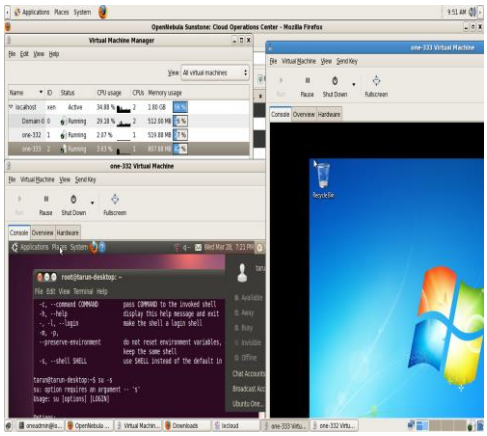

Figure 6. Running two different VM on single worker node

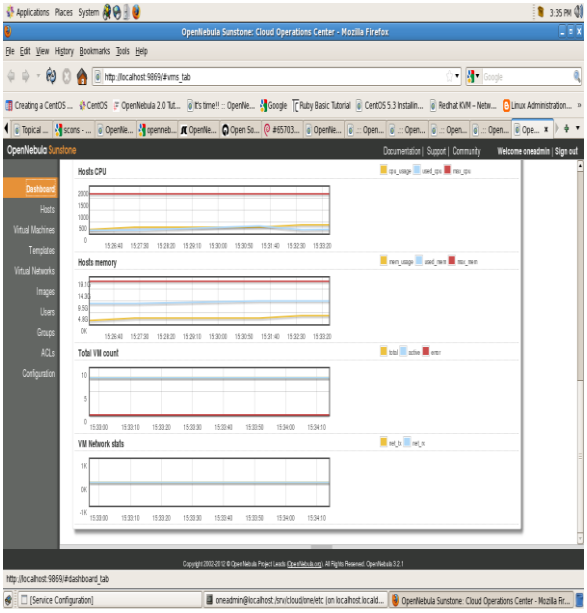

Figure 7. Increased CPU usage in worker nodes

Results obtained by running multiple VMs and following pricing model successfully for utilization of Iaas on NCloud, prompt us to manage the infratsrure on campus and build the knowledge cloud helpful to the users on the campus.

5. Conclusion and Future work

In this paper we have reviewed and implemented the work done for making a private cloud and provisioning Infrastructure as a Service for NCloud in our campus. An algorithm for measuring the usage time of cloud service is implemented and pricing model is devised. This Utility oriented services aims to charge NCloud user for what they use. Currently NCloud only provides Infrastructure as a Service to the registered user and setting up with knowledge base where educational material will be provisioned to NCloud user.It is planned to extend the boundaries of NCloud and make it available outside campus for imparting the knowledge base.

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