Towards Management of Future Cloud Computing Environment

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Abstract. This paper provides general information about cloud computing. Several open source cloud toolkits, their features and differences are briefly explained. General architecture of cloud toolkits and their management aspects are covered including short introduction to commercial companies providing it as a commercial product. Research project being developed in ETRI is also briefly presented with its functional reference architecture.

Keywords: OpenStack, OpenNebula, Eucalyptus, Network management, RightScale.

1 Introduction

Cloud computing has got big hit during recent years. At the same time with providing IT cost saving for small and startup companies, it brings several advantages to the big industries as well. Organization can benefit from fast resource provisioning, on demand scalable computing and huge save of human operator hours through automation.

This paper presents insight to cloud computing technology itself via explanation of several open source cloud toolkits (a.k.a. Cloud Software). Next section provides general information about three widely known cloud toolkits, highlighting features provided and main design difference among them. Technologies emerging from cloud and others being developed for cloud are presented in the next section. General explanation of cloud resource management and approach being done in ETRI is presented in last section.

2 Cloud Toolkits

Nowadays there are dozens of cloud software depending on target service model – Infrastructure as a Service (IaaS), Platform as a Service (PaaS) or Software as a Service (SaaS). Depending on service model, there is a different value visibility to the

end user (left side of the Figure 1[1]). For example, users of IaaS is network or system architects. They build systems on provided IaaS platform in a very similar way as they used to build systems in bare metal [1], [2]. PaaS can be built on top of IaaS (or on top of existing IT infrastructure without IaaS). In this service model application developers are end users [3], [4]. Lastly, on the top of the reversed pyramid there is SaaS. It completely removes IT related installation tasks from the customer (be it huge company or single user). Customer uses all software installed in a remote host provided over network (mainly over internet). Examples include SalesForce.com [5] and SugarCRM [6]. This paper is about IaaS. Below three open source software toolkits are briefly introduced with quick comparison.

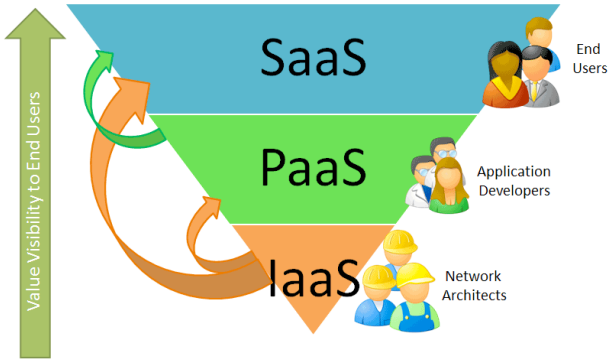

Figure 1. IaaS, PaaS and SaaS reverse pyramid

Initially, public utility computing was provided by Amazon. Service is called EC2 (Elastic Compute Cloud) [2]. Users get access to their remote virtual machines running on Amazon servers. This service is provided on demand computing capacity with "pay as you go" business model. Due to its scalability and highly reliability (99.95% uptime) it was very successful. EUCALYPTUS (Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems) [6] is open source implementation of Cloud Software to enable businesses to build their own public, private or hybrid Cloud. Eucalyptus provides ability for any company to provide service as Amazon does. One of success reasons of Eucalyptus is it's full compatibility to Amazon EC2.

Eucalyptus was starting point of Open Source Cloud Computing in general. Several other technologies were built on top of it. A number of big industries started to change their IT infrastructure to Eucalyptus based Cloud – NASA, HP, and DELL to name few [7]. However, scalability provided by Eucalyptus at that time was not enough for NASA and they have made changes to Eucalyptus core engine. Eucalyptus - being powered by Eucalyptus Systems (commercial company) didn't include patches made by NASA (as it was closed-core). It led NASA to build its own Cloud

[1] Figure source: http://www.saasblogs.com/saas/demystifying-the-cloud-where-do-saas-paas-and-other-acronyms-fit-in/

Software called Nebula. It is known as *massively scalable* cloud software. OpenNebula is not "open" version of NASA's Nebula. It is sponsored by C12G Labs [8] and it's fully open source and open core. OpenStack is another fully open source and community supported cloud software. Being jointly initiated by NASA and RackSpace [9] it is one of the recent and widely supported cloud software. Huge industrial and service companies worldwide are contributing to it. Their number exceeds a hundred - DELL, CITRIX, Intel, Cisco, KT, and HP also being amongst them.

Cloud computing is enabled by set of software, hypervisor being a key part of it. Hypervisor provides main virtualization ingredients, such as computing, networking and storage virtualization. Conceptual architecture is presented in Figure 2[2] by Ken Pepple[3].

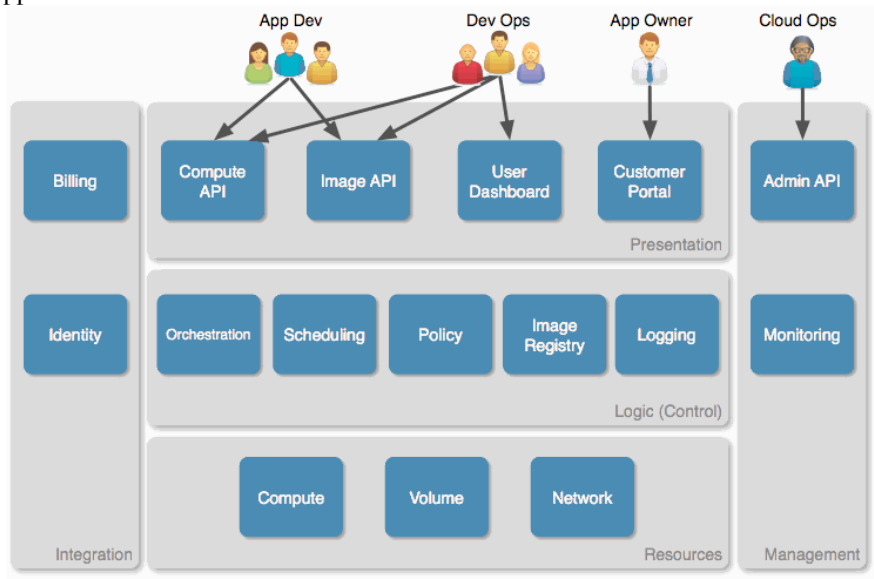

Figure 2. Cloud Provider conceptual architecture

As it can be seen in the figure above, Cloud Toolkits contain much more than hypervisor itself. Although different set of tools, protocols and APIs can be used for inter module communication, generally all IaaS cloud solution have similar modules as presented above. Companies may develop and use their own piece of software as a third party tool, thus joining particular Cloud Ecosystem.

[2] Figure source - http://docs.openstack.org/cactus/openstack-compute/admin/content/
[3] Ken Pepple homepage - http://ken.pepple.info/

3 Emerging Technologies from and for Cloud

Development of cloud computing brought and is still bringing more companies to get around this technology. They cover wide range of cloud services in all layers of cloud pyramid (see Fig. 1). There are a lot of big and small companies offering cloud computing solutions. There is an article listing 10 widest of them [9], which includes Amazon, AT&T, Microsoft, Google, Rackspace, GoGrid and others who are providing cloud computing or utilizing it for their service domains.

As this paper focuses more on management aspect of the cloud computing, we will mainly cover management part of it. Another article listing 10 cloud management companies was recently published [10]. We will briefly highlight few of them, which are in main target of this paper.

Jamcracker Platform provides centralized cloud services and life-cycle management for all models of cloud computing (IaaS, PaaS and SaaS). Enterprises can use different cloud services from various providers. As they get more and more, usage of services from different vendors will get more complex. It is better to have single centralized management dashboard for all of them. This is what Jamcracker exactly provides.

Another interesting cloud management solution is provided by Jitterbit to enable easy data integration. It integrates data in various formats to the cloud from local storage and from cloud to the local storage. It provides migration, synchronization and replication from and to cloud. Jitterbit offers point-and-click integration for CRM (Customer relationship management) applications, databases, ERP (Enterprise Resource Planning) systems, major SaaS applications, project management applications and XML.

Netuitive offers predictive analytics platform for physical, virtual and cloud infrastructure to customers. It is achieved via *behavior learning engine*. The engine continuously analyzes correlates and normalizes thousands of simultaneous performance variables from dozens of enterprise sub-systems, and builds a behavior profile for each data stream. It answers to several questions like how application is performing, is there any impending performance problem, where is the root-cause of the problem or what's the historical and trended performance. It is very good tool to predict physical or virtual resource demand coming future.

One more key technology being provided via cloud is called StrangeLoop. It has *Strangeloop Site Optimizer Service*, providing scalable, on-demand optimization for cloud-based Web sites; also available as a hardware network device or virtual appliance. Company provides explanation below to answer the question "how it works?" *Strangeloop Site Optimizer is an expert system that learns the resource usage patterns of a site and dynamically applies best practice coding techniques by rewriting pages, without requiring any source code modifications. It analyzes usage patterns and page content, and develops a dynamic repository of rules and cached resources. This technology can reduce the number of roundtrips required to render Web page content, execute client-side code in the most efficient order, preload resources that are likely to be needed for future requests, and tailor behavior to exploit the capabilities of the user's browser.* There are many more services being provided via or for the cloud.

4 Cloud Resource Management

Resource management is one of the most important factors in most of the systems. Cloud computing is not exception. Few widely known management companies were introduced in the previous chapter. Each of them covers some part of cloud resource management, whether it be application performance management, data integration management or IT planning management. This chapter is focused on cloud infrastructure management. In this chapter commercial company called RightScale [11] and approach being developed in ETRI are explained.

RightScale is a web based cloud computing management platform for managing cloud infrastructure from multiple providers. The RightScale platform enables the management of public, private and hybrid clouds. The company partners with private cloud providers Cloud.com [12] and Eucalyptus Systems to help enterprises easily build and manage their own private clouds. RightScale also enables users to migrate workloads between their private clouds and public clouds operated by Amazon Web Services (AWS) and Rackspace. RightScale provides fault management. In case cloud provider's service unavailability it can deploy IT infrastructure to different resource available zone or to different cloud provider. They also provide resource provisioning across multiple could providers.

An approach being developed in ETRI, Future Internet Architecture team is more networks management oriented, while it is supposed to provide resource provisioning, monitoring, fault tolerance and other management functions as well. It is being developed under a project titled, HiMang (Highly Manageable Network and Service Architecture for Next Generation). Figure 3 illustrates functional reference architecture which HiMang cloud management will be based on. This architecture is currently under development by ITU-T Focus Group on Clouds.

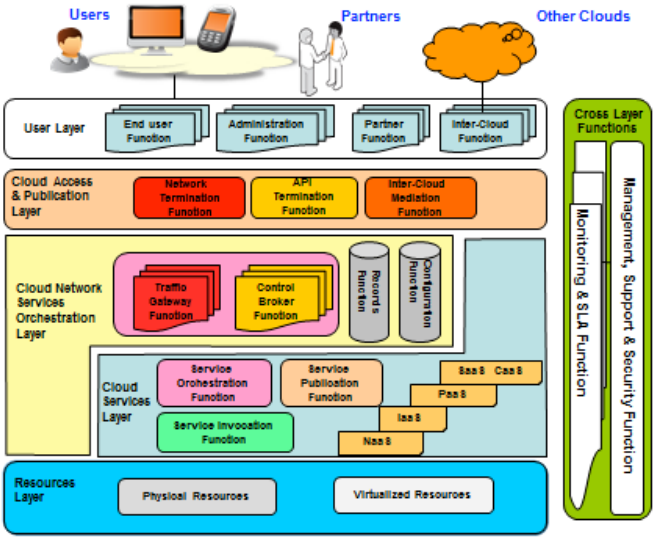

Figure 4. HiMang Cloud Computing Functional Reference Architecture

As it is presented above HiMang cloud architecture provides physical and virtualized resource management. Also, it covers all cloud service models including IaaS, PaaS, SaaS and NaaS (Network as a Service). At the same time with having Cross Layer functions, it provides service not only for service consumers, but also to partners and other clouds. More architectural and implementation details will be illustrated in a future works.

Conclusion

As most of small and big industries make a shift towards cloud computing, there will be more demand on its management. As it was illustrated in this paper, there are various management solutions to be provided in cloud. As open source cloud ecosystem grows, more management features will be embedded in default package itself. However, there will be still a need for integrated, reliable and advanced management solution. HiMang is planned to be one of solutions to provide those needs. It was briefly introduced in this paper and more detailed explanations are to be published.

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