Chapter 26

CSCLab:
A Cloud-Based Platform for Managing Computing Labs

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ABSTRACT

This paper presents a platform to create and manage virtual computing laboratories using Cloud resources. Using this platform a professor can create a customized laboratory according to the class needs. The laboratory is composed of a set of virtual machines that students may use to get access to the necessary computing resources to attend the class. The platform aims at the creation of a solution to avoid proprietary lock in's, and it was designed to be agnostic to the cloud infrastructure. The machines of the lab can be accessed using some remote desktop protocol and managed by non-expert users.

INTRODUCTION

Computing laboratories are an essential part of the educational institutions but their creation and maintenance is usually expensive. In the universities, the use of virtual computing laboratories is already usual in areas like engineering, computer sciences and information assurance (Wuang, Hembroff, & Yedica, 2010; Burd, Luo, & Seazzu, 2013). Currently, the use of the Cloud to create these virtual laboratories has gained great prominence (Vaquero, 2011). The use of the Cloud enables the creation of highly flexible and configurable environments (Sclater, 2010; Nguyen, Nguyen & Huh, 2012; Patel & Patel 2013; Bora & Ahmed, 2013; Shunye, Dayong, & Zijuan, 2014).

The computing laboratories of education institutions (e.g., universities, secondary schools) present many challenges for the Information Technology - IT - departments of these institutions. These challenges include the preparation and management of the laboratories which need to be prepared with the necessary software for the class labs. Furthermore, building and management costs of these laboratories

are usually high (Xu, Huang & Tsai, 2012). The laboratories need to be prepared in advance, i.e., all the software necessary for the lab classes needs to be pre-installed. Furthermore, generally, the users have no administration rights, thus not being allowed to install new software. This way the lab classes are conditioned by the a priori available software. The IT department needs to prepare all the software and hardware, resulting in high costs for the institution (Uehara, 2013). Typical laboratories are conditioned by their reusability, flexibility and scalability (Xu, Huang & Tsai, 2012). This happens because the software and hardware necessary for different classes is not the same, then a specific laboratory configuration may be required by each of the classes. The scalability problem is raised by the limitation of computers in classrooms.

This paper proposes CSCLab - Computer Science Cloud Laboratory, a platform to provision and manage virtual computing laboratories - VCLs - using cloud resources through a web interface. This solution enables university professors and other university staff to create the laboratories necessary to teach a class. The machines of the virtual laboratory can then be accessed by the students using some remote desktop protocol (e.g., SSH, RDP). CSCLab is a platform that enables the control of IaaS cloud resources in order to create and manage flexible and configurable cloud virtual laboratories. The access to the platform can be made from any type of devices including mobile ones (e. g., smartphone, iPad) since it has a responsive interface.

The proposed solution was designed to be agnostic to the underlying cloud infrastructure. To validate it, a prototype using the IaaS OpenStack was constructed (see www.openstack.org). The implemented platform can easily be ported to other cloud infrastructure by following the platform architecture and design. CSCLab was also designed by taking into account the future users of the platform. This way, the platform could be easily used by non-experts without requiring hours of training and tutorials.

RELATED WORK

This section reviews the cloud computing model, the use of VCLs in educational institutions and the paper of the cloud in it. Finally, it describes the advantages of the proposed solution over existent ones.

The Cloud Model

There are many definitions of the Cloud (Armbrust et al., 1010; Marston, Li, Bandyopadhyay, Zhang & Ghalsasi, 2011; Jadeja & Modi, 2012; Patidar, Rane & Jain, 2012), which can be synthesized by the definition presented by the National Institute of Standards and Technology – NIST, that describes the Cloud model as a set of service and implementation models, as well as a set of essential characteristics. The NIST defines Cloud as a model for ubiquitous, convenient and on-demand network access to a pool of shared computing resources (e.g. network, storage, processing) that can be rapidly provisioned and released with a lower management effort and interaction with the service provider (Mell & Grance, 2012; Badger, Grance & Patt-Corner, 2012).

According to NIST, the Cloud is composed of three service models which are Software as a Service - SaaS, Platform as a Service - PaaS and Infrastructure as a Service - IaaS. Iaas is a Cloud service model that provides users with access to essential computing resources, being the less restrictive model for the Cloud clients. This model is composed by a Hypervisor (i.e., a Virtual Machine Monitor) which works on top of the hardware of the Cloud infrastructure (Imai, Chestna & Varela, 2012). This Hypervisor

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