A Survey of Management Interfaces for Eucalyptus Cloud

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Abstract—Cloud Computing is a technology which is susceptible to a continuous development, because of its strong advantages of accessing data from any place in the world over the Internet without concerning about the infrastructure used and the problems involved by the installation and maintenance processes. The purpose of this article is to provide an overview of several management interfaces for Eucalyptus cloud by addressing the taxonomy and evaluation of the cloud management interfaces. The taxonomy proposed in this paper results from the work accomplished by experimenting the Eucalyptus community cloud.

First, an evaluation of the Eucalyptus architecture is presented, in order to emphasize the Eucalyptus platform involved in cloud management process, which facilitates the deployment, management and execution of Infrastructure-as-a-Service (IaaS).

The cloud management tools are described from two perspectives. The first perspective analyzes the cloud portals from the user roles, while the second perspective addresses them with respect to the type of the tools employed. The taxonomy presented in this paper is related with the 5 elements of the Common Cloud Management Architecture (CCMA), which was provided by Behrendt, et al. (2011) as one of the components of IBM Cloud Computing Reference Architecture. Thus, the first category of interfaces (i.e. the cloud portals from the user roles) encompasses the Service Consumer Portal, the Service Provider Portal and the Service Development Portal, while second category of interfaces includes the main components of CCMA: Operational Support Services (OSS) and Business Support Services (BSS).

Cloud management is a subject approached by researchers in the community and this can be observed by the big number of third party cloud management providers (i.e. RightScale, enStratus, IMOD Kaavo, CloudWatch, Scarl, Tapin, Cloudkick).

This article is motivated by the fact that cloud management is a fundamental support for all users of cloud services from the cloud marketplace.

Keywords: cloud management, Eucalyptus Community Cloud, euca2ools, Graphical User Interfaces, Cloud API, third party cloud management tools, instances management, volumes management, user/groups management, key management

I. INTRODUCTION

Cloud Computing is a technology which is susceptible to a continuous development, because of its strong advantages of accessing data from any place in the world over the Internet without concerning about the infrastructure used and the problems involved by the installation and maintenance processes. Cloud Computing is defined by the US National Institute of Standards and Technology (NIST) as “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction”. One of the main advantages of Cloud Computing is that it offers the possibility to pay only for the services that you use, an idea that was envisaged by John McCarthy in 1961 “computing may someday be organized as a public utility”. The widely accepted Cloud Computing definition provided by NIST is expressed by Joe Weinmann (2011) as an acronym: a Common, Location-Independent Online Utility on-Demand service, on the Axiomatic Cloud Theory.

Today, there are many providers that deliver cloud services for customers: Amazon Web Services, Microsoft Azure, Google Apps, IBM etc. These cloud services are delivered by commercial cloud platforms. A cloud platform corresponds to the cloud service provider, who has data centers where it runs applications and store data [4]. There are two types of cloud platforms: commercial and open-source. The cloud platforms deliver three types of cloud services: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS).

A previous research regarding the open source toolkits (i.e. Eucalyptus, Xen Cloud Platform, Open Nebula, Nimbus etc) was realized [5; 6; 7; 8]. The purpose of this article is to provide an overview of several management interfaces for Eucalyptus cloud by addressing the taxonomy and evaluation of the cloud management interfaces. The taxonomy proposed in this paper results from the work accomplished by experimenting the Eucalyptus community cloud.

Thus, the cloud management tools are described from two perspectives. The first perspective analyzes the cloud portals from the user roles, while the second perspective addresses them with respect to the type of the tools employed. These interaction styles emphasize the
modality by which the users (i.e. consumers, developers and providers) make use of the IaaS cloud services.

Cloud management is a subject approached by researchers in the community and this can be observed by the big number of third party cloud management providers (i.e. RightScale, enStratus, IMOD Kaavo, CloudWatch, Scarl, Tapin, Cloudkick).

Cloud management is a fundamental support for all users of cloud services from the cloud marketplace.

According with Tianfield (2011) the cloud architecture consists of Cloud Platform Architecture (CPA) and Cloud Application Architecture (CAA).

These two cloud architectures start the management process from the bottom side of cloud architecture: it begins with the operating systems, which manages the physical infrastructure.

After that, the management process is followed by the hypervisor, which has the job to dynamically provision and manage the virtual machines (VMs). The management process in the cloud platform architecture continues with Cloud APIs (Application Programming Interface), which include management and customer portals. Going forward on the CAA, the granularity of cloud management is increased by cloud brokers, which work with the associated cloud ontologies and the Business Service Process (BSP) layer which performs Business Service Management (BSM), Service Level Agreement (SLA), service orchestrations and process management [9].

The remainder of this paper is organized as follows: section II starts with an overview of Eucalyptus Community Cloud Interface Management. Further, a taxonomy of cloud management tools is discussed. Finally, the paper presents the concluding remarks section.

II. EUCALYPTUS COMMUNITY CLOUD INTERFACE MANAGEMENT

It was created an Eucalyptus Community Cloud (ECC) account in order to realize experiments with the IaaS service provided by the Eucalyptus team [10]. The Eucalyptus cloud made available for developers and testers a platform which facilitates the deployment, management and execution of IaaS services.

Eucalyptus is the acronym for Elastic Utility Computing Architecture Linking Your Programs To Useful Systems. It is an open-source cloud platform, which was developed by University of California for creating private and hybrid clouds. Now, it is supported by Eucalyptus Systems, a Canonical Partner. Eucalyptus Systems also provides for its customers a commercial version, called Eucalyptus Enterprise Edition [12].

According with administrator’s guide provided by [13; 14], the Eucalyptus architecture includes five components (Fig. 1): Cloud Controller (CLC), Walrus, Cluster Controller (CC), Storage Controller (SC) and Node Controller (NC).

The Node Controller (NC) is responsible for handling the hosting of virtual machines instances on every node and for the management of the virtual network endpoint.

The NC inspects the VM’s maturity from execution process to termination process [13].

On the next level of the architecture are the Cluster Controller (CC) and the Storage Controller (SC), for each cluster that is formed by a collection of NCs sharing a LAN segment [14]. The Cluster Controller is the element that collects information about VMs and it deals with the VMs scheduling on particular NCs. A condition that CC must meet is that it must contain NCs which are in the same broadcast domain (Ethernet) [13]. Cluster Controller decides where to place the request received from the Cloud Controller, by evaluating which Node Controller has sufficient free resources [5]. Each cluster also has a Storage Controller (SC), which was developed to have the same capabilities like Amazon Elastic Block Storage (EBS) and to be able to communicate with others storage systems (NFS, iSCSI etc) [13].

The module from Eucalyptus architecture that treats the incoming requests and provides high level resource scheduling is Cloud Controller (CLC). CLC realizes the scheduling component by collaborating with the Cluster Controllers [12]. Therefore, CLC decides where to place the request received from a Client, by evaluating which Cluster Controller has sufficient free resources [5; 15; 16; 17]. In addition, Cloud Controller has the competence of being the interface to the management platform, ability which is developed using the Amazon Elastic Cloud Computing (EC2) and a Web-based user interface. Situated at the same level in the architecture like Cloud Controller, Walrus module is used for storing data. It has compatible interface with Amazon S3 [12].

III. CLOUD MANAGEMENT TOOLS

This section presents the proposed taxonomy for the cloud management tools. Thus, the cloud management tools are described from two perspectives. The first perspective analyzes the cloud portals from the user roles, while the second perspective addresses them with respect to the type of the tools employed. The presented taxonomy is related with the 5 elements of the Common Cloud Management Architecture (CCMA), which was provided by Behrendt, et al. (2011) as one of the components of IBM Cloud Computing Reference Architecture. Thus, the first category of interfaces (i.e. the cloud portals from the user roles) encompasses the Service Consumer Portal, the Service Provider Portal and the Service Development Portal, while second category
of interfaces includes the main components of CCMA: Operational Support Services (OSS) and Business Support Services (BSS).

A. Cloud User Interfaces

In terms of user roles the interface is the same for all 3 types of the users (i.e. consumer, provider and developer), but it will have different rules, policies and constraints approached for each user role. Thus, it can be said that the provider interface encompasses the Service Consumer Portal, the Service Provider Portal and the Service Development Portal, because of the specific functionality of provider portal based on the user roles [1; 18].

Thus, the provider interface includes:

I. The Service Development Portal - is the interface used by cloud service developers to deploy new cloud services.

II. The Service Provider Portal - assures for its customers a service management of the following functionalities: operations, business and transition.

III. The Service Consumer Portal has the same management functions like the service provider portal with the difference that service consumer portal has involved different access rights with different capabilities: consumer service manager, consumer service administrator and service user [18].

Further, it is provided the taxonomy of the management functions that are met in the provider interface, which was realized by extracting each management service from the Cloud Service Management structure provided by Nationale Institute of Standards and Technologies [19] and by analyzing and integrating them in the corresponding functions of the provider interface from [18]:

1. Business management functions (also called administrative group by [20]) guarantees the following business supports:

   -customer management contains the following subfunctions: subscription management, customer account management and entitlement management
   -contract management
   -inventory management contains the following subfunctions: service offering management, service request management and order management
   -accounting and billing contains the following subfunctions: billing, clearing and settlement, accounts payable, accounts receivable
   -pricing and rating contains the following subfunctions: pricing, billing and service offering catalog
   -metering
   -SLA management

2. Operational management function (also called resource management group by [20]) - is reported to the provisioning/configuration operations and portability/interoperability operations from [19]. According with DMTF (2010b) the portability/interoperability operations compose the transition management functions.

The provisioning/configuration operations include the following tasks:

- rapid provisioning
- monitoring and reporting
- reporting and auditing

The transition management functions, also called workload management group by [20] has the following achievements:

- resource change
- data portability
- service interoperability
- system portability

B. Eucalyptus Management Tools

According with the above classification (i.e. service consumer portal, service developer portal and service provider portal), this section encompasses the Eucalyptus management tools for the consumer role. Like we know the service consumer portal has the following capabilities: consumer service manager, consumer service administrator and service user [18].

This section provides an overview of the several Eucalyptus management tools, by addressing the taxonomy and evaluation of the specified cloud management interfaces. The classification of the Eucalyptus Management Tools is:

I. Web based management: Eucalyptus Admin Interface

II. Client tools:

a. Command line tool: Euca2ools
b. API Client: Typica
c. Graphical User Interfaces (GUI) client: Firefox Plugins, Cloud42, tAWS Tanacasino, EC2 Dream

III. Web based management

The web based management interface of ECC IaaS cloud is also called administrator web interface. This is because administrators have more management tasks to achieve using this interface, comparing with the tasks that can be performed by users, who have other management alternatives. In the same time, the tasks of administrator using the web based management interface are smaller than the tasks of administrator using other management options. But, this administrator web interface plays a significant role because it's the first interaction of users with ECC IaaS cloud, who realizes the provisioning operation, which should be accepted by administrator. The management operations that are accessible by users are: user provisioning, catalog of available images, while administrators had the following management functionalities: Identity Management (adding users, user accounts Management), Configuration Management, Catalog of available images, Catalog of services [10].

It’s important to mention that ECC don’t allow end-users the images management capability, ECC having its
own catalog of images, which is created by administrator and it can be used by end-users.

The access of the users to the ECC administrative graphical interface is realized through the following URL: https://ecc.eucalyptus.com:8443.

II. Client tools

The client tools presented in this section encompasses the EC2 functionality of Eucalyptus cloud. There are discussed several management tools in order to provide an overview of these tools and to present the advantages and disadvantages of each client tools. First the command line based management (euca2ools) is discussed. Then an overview of a client Java library called Typica is presented as well. After that, several Graphical User Interfaces (GUI) are discussed: Firefox Plugins, Cloud42, tAWS Tanacasino and EC2 Dream.

a. Command line based management (euca2ools)

Euca2ools is based on Web-services software packages (Axis2, Apache and Rampart) and it has capabilities identical with Amazon EC2 [6; 15]. The authentication procedure to the Euca2ool requires obtaining the needed keys via a zip file which must be downloaded by users [6]. WS-security mechanisms are the solution for authentication, especially the X.509 credentials [12; 21].

The end-user interacts with ECC using euca2ools client software, which provides the following management drivers: SSH key management, security group management, image management, instance management, storage management and IP address management. These management functionalities of Euca2ools are well documented, which helps the Eucalyptus users (Table 1). Table 2 also present a limitation of euca2ools: it is slower compared with GUI clients, because it is a command line tool, which marks the lack of convenience functions.

a. API Client: Typica

Typica is a client Java library very useful for Java developers who work with the Amazon web services. Even if it has a poor documentation and it accesses the Amazon’s API at a low level, Typica was used in several projects (e.g. enStratus, g-Eclipse, AWS Manger, Cloud Studio, Elastic Web etc). Table 2 emphasizes the advantages and disadvantage of Typica [11; 22; 23].

<table>
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<tr>
<th>Command line tool</th>
<th>Strengths</th>
<th>Limitations</th>
</tr>
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<tbody>
<tr>
<td>Euca2ools</td>
<td>- management drivers: SSH key management, security groups management, image management, instance management, storage management and IP address management</td>
<td>-lack of convenience functions</td>
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<th>TABLE 1 EUCA2OOLS EVALUATION.</th>
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<td>Command line tool</td>
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<tr>
<td>Euca2ools</td>
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b. Graphical User Interfaces (GUI)

Firefox Plugins are graphical user interface and were built as an extension of Mozilla Firefox. First, it appeared the Elasticfox plugin, which had the advantages of managing the Amazon EC2 accounts and it is an easy to use interface. But, because of the restriction limitation to EC2 environment, it was deployed the Hybridfox plugin, which provides compatibility between a public cloud (Amazon) and a private cloud (Eucalyptus) and in the same time it supports more features of Eucalyptus than Elasticfox, being an extended Elasticfox project. Now, Elasticfox also provides managing features for Eucalyptus accounts, but it’s not working properly. Both Firefox Plugins have an easy to use interface, but they had the disadvantage of being installed locally on the user device. An evaluation with strengths and limitations of Firefox Plugins is presented in table 3 [23; 24; 25].

Cloud42 is an open-source management interface for every EC2 compatible services, which includes 2 types of interfaces: web-based GUI and web service interface. Table 4 summarizes this important advantage of Cloud42 together with others strengths and limitations. Cloud42 also provides basic and extended functionality (e.g. file transfer functionalities from a EMI instance into another EMI instance, controlling EC2 server instances remotely) [11; 23; 26]. One of the limitation of Cloud42 is that it doesn’t have the support for Elastic IP addresses [23], feature that exists in Eucalyptus cloud.

<table>
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<th>TABLE 2 TYPICA EVALUATION.</th>
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<td>Strengths</td>
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<td>Typica</td>
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<th>TABLE 3 FIREFOX PLUGINS EVALUATION.</th>
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<td>Strengths</td>
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<th>Table 4 CLOUD42 EVALUATION.</th>
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<td>Strengths</td>
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| Cloud42 | -2 interfaces types: web-based GUI and web service interface |
|         | -provides basic and extended functionality |
|         | -support for Elastic IP addresses is missing |
TABLE 5 TAWS TANACASINO EVALUATION.

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Limitations</th>
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<tbody>
<tr>
<td>-Eclipse GUI management tool for Amazon EC2</td>
<td>-it’s not web based</td>
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<tr>
<td>-easy to work with it</td>
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<td>-provides basic functionality</td>
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TABLE 6 EC2 EVALUATION.

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<th>Strengths</th>
<th>Limitations</th>
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<tr>
<td>-free desktop admin client</td>
<td>-poor documentation</td>
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<tr>
<td>-same functionalities like Amazon EC2</td>
<td>-it’s not web based</td>
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**tAWS Tanacasino** is another GUI management tool for Amazon EC2, which should be installed and provides the same functionality like the Firefox plugin Elasticfox. Thus it is an easy to use GUI, but it is used only locally on the user device (Table 5) [11].

**EC2 Dream** is a free desktop admin client which has the same functionalities like Amazon EC2 command line. It is a hybrid cloud admin which manages the Amazon EC2, RDS, Eucalyptus, OpenStack Compute and CloudStack. In Table 6 it is showed also the EC2 limitations: the documentation of EC2 Dream is poor and it has the locally installed software limitation [11].

c. **Third party cloud management tools**

The cloud management is a subject approached by researchers in the community and this can be observed by the big number of third party cloud management providers (i.e. RightScale, enStratus, IMOD Kaavo, CloudWatch, Scarl, Tapin, Cloudkick). This third party cloud management tools are used in special by organization which want to manage their cloud infrastructure. All of these are commercial versions and provide free trials for a number of weeks (i.e. 1 or 2 weeks), with exception that RightScale gives the opportunity to create free account in order to manage the Eucalyptus cloud.

In this way, RightScale 3rd party management was tested. It creates an optimized user experience by providing a Dashboard with the cloud resources pool, which are automated [27].

IV. **Conclusions**

In the first part of the paper is presented an evaluation of the Eucalyptus architecture, in order to emphasize the Eucalyptus platform involved in cloud management process, which facilitates the deployment, management and execution of Infrastructure-as-a-Service (IaaS).

A taxonomy for the cloud management tools is also presented; it contains: cloud user interfaces and Eucalyptus management tools. It is important to point out that in terms of user roles the interface is same for all three types of users (i.e. consumer, provider and developer), but it have different rules, policies and constraints approached for each user role. Thus, it can be said that the provider interface encompasses the Service Consumer Portal, the Service Provider Portal and the Service Development Portal, because of the specific functionality of provider portal based on the user roles.

It can be observed the relationships between the cloud user interfaces and the Eucalyptus management tools. Eucalyptus has several management interfaces that users can use in order to interact with it. The first interaction is realized using the web-based management interface, which is an admin interface. The users can choose the client software for managing their cloud. In this way, after downloading the credentials from the web-based management interface, users choose to use the euca2ools command line interface, even if it has the lack of convenience functions, but it provides a good documentation.

Furthermore, users are pleased with Graphical User Interface (e.g. Firefox Plugins, tAWS Tanacasino, EC2 Dream) because of the easy to use of this interface. In the same time it can be observed the disadvantage of missing the web based capability. Thus, another cloud management option is Cloud42, which is web-based GUI and web service interface. Cloud42 was deployed from a client Java library called Typica, which is known by developers in the area.

Additionally, the third party cloud management tools were addressed.

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