RECOMMENDATIONS FOR IMPLEMENTING CLOUD COMPUTING MANAGEMENT PLATFORMS USING OPEN SOURCE

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ABSTRACT

In the development of the latest technology the use of Open Source (Operating System) has playing the important role in recent years, in particular in the fields of programming, operating systems, and application software. According to studies carried out by Gartner and Forrester the Operating System is not yet used intensively for structuring and managing cloud computing platforms. This is all the more remarkable in that it is in this field in particular that it would be possible to structure cloud management platforms efficiently and cost-effectively using the OS systems available today. They are available as alternatives to commercial suppliers and enable private, hybrid and community cloud solutions to be implemented. But many commercial enterprises, public administrations and other institutions do not take advantage of them, partly due to uncertainty and a lack of information about such possibilities. Therefore this article examines this subject, compares the existing Open Source cloud computing management platforms and provides specific recommendations for use.

Keywords: Open Source, Cloud Computing, Open Source Cloud Computing Management Platforms, Eucalyptus, OpenNebula, Abicloud, Nimbus
I. MOTIVATION
Without doubt cloud computing is currently undergoing a huge hype and many professionals see it as the future of IT. According to McKinsey, commercial enterprises in particular can achieve a savings potential of 30% to 40% with a needs-oriented and optimised use of infrastructure resources [1]. The scope for such exploitation has a long way to go before it is exhausted. For example, it is not well known that it is particularly appropriate for commercial enterprises in particular to build and manage their own cloud solutions with the help of Open Source resources. Platforms in this field provide cost-effective, independent, innovative and flexible solutions which can usually be implemented very easily. For this reason it is worth looking in detail into this use of Open Source as regards the science and the practical aspects.

II. INTRODUCTION
A. Cloud Computing
A common definition of the Cloud Computing concept has not yet been established in scientific literature [2]. However, for this work we use the definition from the National Institute of Standards and Technology (NIS) because it helps us to understand Cloud Computing Management Platforms in a good way. Regarding NIS is Cloud computing a model for enabling ubiquitous, 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 [3]. This cloud model promotes availability and is composed of five essential characteristics, three service models, and four deployment models (see Figure 1)

![Figure 1. Overview Cloud Computing [3]](image-url)
Cloud computing solutions can be differentiated by four essentially distinct features (see Reference [3]). First is the “private cloud” version, which can only be used by a single enterprise. In this version the resources and applications are located within the company’s own computer centre or within that of a computer services provider with dedicated access. Second, cloud computing sources can be set up as publicly accessible IT resource pools (“public cloud”). In this scenario the data and services used are located in the custody of the cloud supplier. The third feasible form is that of hybrid clouds, which combine private and public cloud architectures as required. The fourth option is that of “community clouds”. This can either be a conglomeration of several providers.

B. Cloud Computing Management Platforms

Cloud Computing Management platforms generally serve to construct and manage cloud architectures, regardless of the type of cloud involved. Using such platforms, commercial enterprises and public administrations can set up their own cloud architectures (private, hybrid and community clouds), building on existing infrastructure. The market for such platforms has undergone strong growth in recent years. Besides proprietary solutions, mainly implemented by public cloud providers, a host of standard management platforms is available, which can likewise be used to construct and manage cloud architectures.

Before delving into the different open source cloud computing management platforms, we will make quick overview of the entire cloud management platform ecosystem (see Figure 2). On the one hand there a cloud consumers which need flexible infrastructure on demand [4]. Cloud Consumers could be individual users, other clouds, PaaS and SaaS. On the other hand there is the cloud management platform. It provides remote and secure interfaces to the different consumers for creating, controlling and monitoring cloud platforms. The cloud management helps to set up and support different cloud deployment models (e.g. private clouds). For that it helps to manage different and various basic components. Open-source frameworks, unlike commercial frameworks, must be flexible enough to work with many underlying systems (e.g. different Hypervisors). Whereas, commercial clouds only need their system to work with the hardware and software they have [5].
From the perspective of the OS community it is particularly gratifying that increasing numbers of OS products are becoming established in this field [6], [7].

C. Research method used and structure of the article

In order to obtain a description, synthesis, evaluation and integration of the results of existing scientific works on the subject of OS cloud computing management platforms, we carried out research into the literature on the subject, based on the approach made by Webster and Watson (2002) [8]. In addition, some OS platforms were tested using a prototypical method. The article is therefore structured as follows: Following the introduction and motivation in sections 1 and 2, section 3 presents four different platforms. Section 4 uses the analysis of the literature and experience of the prototypes to present comparison criteria, and then proceeds to classify the platforms. In conclusion section 5 derives recommendations for use. Section 6 is a summary and a look ahead towards further research required.

III. OPEN SOURCE CLOUD COMPUTING MANAGEMENT PLATFORMS

To carry out an international literature analysis we identified Eucalyptus, OpenNebula, Abicloud and Nimbus as being the most well-known OS cloud computing management platforms and selected these for our work. They are presented in brief below.
Eucalyptus (Elastic Utility Computing Architecture for Linking Your Programs to Useful Systems) came into being as a project of the University of Santa Barbara in California, and originally was used to construct an Open Source private cloud platform [9]. Since then it has been managed by the Eucalyptus System Company.

OpenNebula was published in 2008 by Ignacio M.Llorente and Rubén S. Montera and is the European Union’s flagship in the field of research projects with regard to virtualisation and cloud computing [10]. It has been successfully implemented at the central.

Abicloud was developed by Abiquo, a company in Barcelona, which is also responsible for its maintenance and enhancement [11].

Nimbus is an open source toolkit which makes it possible to convert a cluster into a cloud computing solution and offer it in the form of IaaS [12].

IV. CRITERIA AND COMPARISON FRAMEWORK

In order to be able to compare each of these platforms, criteria were derived from the literature analysis, intended - among other things - to answer some software-related questions. In addition, some prototypical installations were carried out in order to feed the experience gained into the analysis. Knowledge of the architecture, the programming language used and of the types of clouds supported is essential in order to understand how each of the platforms functions. We make a distinction as to which types of clouds (public, hybrid or community clouds) can be generated, and managed with the software [5].

To ensure compatibility with software already in use at the enterprise, an overview of the supported hypervisors is also indispensable [6]. Additionally, the type of data and VM memory offered is likely to have an influence on decision-making [13].

Over and above a basic understanding of the function, it is also necessary to take the intended use into consideration [14]. Each of the platforms is thus appropriate for different application areas, and has differently structured user interfaces. Another important factor to decision-making is which open source licences the software products use or which security precautions they offer. Robustness against malfunction, as well as interoperability, making it possible to transfer applications between clouds, or to use several clouds at once, both also play an important role in daily use [5], [6]. Compatibility with other machines could also well be relevant to decision-making [13].

A summary of the compared OS Cloud Management Platforms’ characteristics can be seen in table 1.
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<tr>
<th>TABLE I.  COMPARISON OF OPEN SOURCE CLOUD MANAGEMENT PLATFORMS</th>
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<tr>
<td><strong>Architecture</strong></td>
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<td>Distinctive web-based management functions</td>
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<td><strong>Programming language</strong></td>
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<td><strong>Cloud types supported</strong></td>
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<td><strong>Data/VM memory</strong></td>
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<td><strong>Area of application</strong></td>
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<td><strong>User interface</strong></td>
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<td><strong>Compatibility with public cloud providers</strong></td>
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A. Eucalyptus

Eucalyptus is the only platform to offer a hierarchical structure. There is an interface, known as the Client API, which enables communication and connection between each of the resources on the cloud computing platforms. Through this interface users have access to all the necessary resources, and are therefore connected with the core, known as the cloud controller (CLC). This serves as a component for answering global decision-making processes and it is connected to the cluster controllers (CC) which is where all the processes from each of the node controllers (NC) flow together. Several NCs on a virtual cluster, linked logically together, deliver data to the CCs and, as the lowest layer, represent a physical component on which all the virtual devices can run [9]. The probability of errors occurring in correlation is greatly reduced by the separate clusters within the architecture [13]. The user interface is realised by means of a command line interface (CLI), which requires more knowledge to operate, so for inexperienced users it cannot be controlled intuitively [5]. Data security is ensured by means of a code pairing for authentication [15]. Eucalyptus is operated as a single platform under the BSD licence (Berkeley Software Distribution). This means that the program can be copied and modified provided that the copyright annotation on the original program is not removed [16].

b. OpenNebula

OpenNebula is able to construct private, public or hybrid clouds and converts a physical computer cluster into a flexible, virtual infrastructure, which can dynamically adjust the resources required [10]. The user interface is provided by a command line [13]. Physically the software consists of three layers, the first containing “tools” functions for the administrators and users. On one hand it contains the command line for administrators, and on the other a planning module which can be used to position virtual machines. The second layer (“core”) contains components used to process user requests and control resources. The third layer (“drivers”) supports the various platforms below it, because this level contains drivers to regulate data transfer and to control the virtual machines that are on every host, independent of the hypervisors. Services from external clouds such as Amazon EC2 are also requested in this way [7], [17]. In the event of a malfunction the background program (Linux/Unix) can be restarted and all virtual machines running can be restored. This is done with the aid of a database which permanently stores

C. Abicloud

Abicloud can be used to generate public, private or hybrid clouds [11]. With its interoperability, the standard-based architecture enables applications to be transferred between different or multiple clouds [18]. The three main components of Abicloud are the Abicloud server, responsible for computer centre management and the user interface, Abicloud Web Services (WS), responsible for managing the virtual applications and the Virtual System Monitor (VWS), used as a plug-in monitor manager [6]. With its distinctive web-based management function the software is easier to control than by using commands on the command line, as is the case with other platforms [6], [11]. For example the “drag & drop” function can be used to create more virtual machines very easily and to manage the services they perform. It is also possible to duplicate an entire cloud and implement it elsewhere. This is very helpful - particularly with regard to transforming the work environment - and it makes the cloud application process easier and more flexible. The software is operated under the Common Public Attribution License.
D. Nimbus

Nimbus is an Open Source toolkit which is also particularly suitable for creating a community cloud. It consists of many different function components to support the various modules on the platform. Nimbus was originally developed for scientific research and its structure is therefore more complicated than other platforms. Commands and results are entered in command lines, which make Nimbus appear to be very complex because of the specific applications [13]. On the other hand the software is particularly distinctive for its high degree of flexibility because it supports most known hypervisors. However, a negative factor is the lack of support for VMware. With regular back-ups of work nodes, data loss is prevented in the event of a malfunction. Like OpenNebula, Nimbus is supplied in the Apache Licence version 2. Under this licence the software may be freely used, modified and distributed [16].

For the sake of completeness, we mention the following with regard to generating community clouds: Although OpenNebula, Eucalyptus and Abicloud do not specifically have the option of generating community clouds, it is to be supposed that it is nevertheless possible. Since these platforms are also suitable for generating hybrid clouds, it is likely that private clouds can also be connected to one another, thus generating a community cloud.

V. RECOMMENDATIONS FOR IMPLEMENTATION

The comparison clearly shows the differences between the platforms. From these differences it is possible to draw conclusions with regard to different fields of implementation, which are explained below.

A. Eucalyptus

With its compatibility with EC2 and S3 Eucalyptus can offer the same services as Amazon and it is therefore a cost-effective alternative [14]. Very versatile forms and methods of implementation are feasible; for example by large companies who serve their customers via their websites. Using Eucalyptus it is possible to prevent the website from becoming overloaded, because it provides the elasticity required to cover varying levels of demand. Likewise, the platform can be implemented within enterprises for the development and test phases of new software products, because the necessary resources are available at any time. Further, Eucalyptus is well suited for institutions dealing with very large amounts of data, or which need to carry out major calculations. A hybrid cloud could be required for this purpose, because it is possible that the resources of a private cloud would not suffice. Likely candidates here are scientific or research institutions, but also commercial enterprises in the financial sector or in the automotive industry. [9].

B. OpenNebula

OpenNebula is suitable both for companies and research institutions and universities looking for an open, flexible and scalable cloud solution for their scientific simulations and calculations [10]. And, similar to Eucalyptus, the option of dynamically adjusting the resources required is an advantage. Any institution wishing to improve its current network solution can use OpenNebula, because it is designed in such a way that it can be incorporated into any existing solution [17]. Installing OpenNebular is relatively straightforward because an installation guide illustrating the various installation options is made available on the website. It means that even fairly small institutions are able to use the platform without having to employ specialist personnel
C. Nimbus

Nimbus is a cloud computing solution which is principally suited for use in the scientific domain, because the platform requires intensive user orientation into the system [12]. Subject to that reservation, it can, however, have a high beneficial effect. For example it is possible to learn to operate a cloud in itself using specific tools. Moreover, compared with other platforms, a cloud can be adapted in a much more individual way, for example with regard to supporting different hypervisors or user interfaces [6], [12], [19]. This is especially essential in the field of scientific research. Thus, in April 2010 a French student was able to build one of the biggest clouds ever with over 1000 nodes at six different sites in the USA and France [20].

D. Abicloud

Abicloud is very easy to scale and is therefore very versatile in use. For example small groups of developers as well as large companies can use Abicloud because it is possible to manage any number of virtual machines equally well. This platform places small, medium-sized and even large companies in a position to manage their entire infrastructure and to expand it without additional expenditure. With the option of creating a hybrid cloud, just like Eucalyptus or OpenNebula, it is suitable for large companies, because even huge quantities of data present no problem, and can be easily managed [11].

VI. SUMMARY AND PROSPECTS FOR THE FUTURE

In this work four Open Source platforms have been subjected to a detailed comparison with regard to structuring cloud solutions and recommendations for their implementation have been drawn up. This has shown that commercial enterprises are already able to construct cloud solutions on the basis of open source platforms. OS is also particularly suited for this purpose. However it is important to have detailed information about the features and differences of each of the products. This has been achieved in this article by looking at two aspects: Firstly, it has explained the different functional methods in more detail, and it has drawn up a list of the commonalities and differences of the four most established platforms. Finally, it has been possible to derive specific recommendations for using the platforms under consideration.

However, Open Source platforms for cloud computing have by a long way not yet reached their limit in terms of development options. This technology is still very young and is currently subject to an extremely dynamic development process. There is a need for future research into the structure of community clouds with Open Source platforms, and further development of the OS Cloud Platforms. The comparison clearly indicates the differences between the platforms.

REFERENCES


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