Cloud Computing: Fundamentals

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Abstract
Deepening the concept of Cloud Computing, describing and analyzing the underlying technologies in this concept's technological implementation. The relationship of distributed computing and virtualization with Cloud Computing. The need for automation in Cloud Computing.

Keywords
Cloud Computing, Virtualization, Distributed Computing, Grid Computation

I. Introduction

This paper's main purpose is to establish the main fundamentals of Cloud Computing (hereinafter referred to as CC). The main concepts will be specified and the main CC paradigm analyzed, we will also discuss what Grid Computing consists of, we will analyze if there is an irrefutable utility for this computing model, we will make reference to hardware virtualization, hence it is the technological basis of CC architecture, and we will also discuss the concept and foundation of autonomous computing.

The term Cloud Computing has become somewhat of a sensationalist term, almost everyone in industry has its own definition of CC, in this paper we will apply CC's definition adopted by the National Institute of Technology and Standards (NIST) [1]: "Cloud computing is 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. This cloud model promotes availability and is composed of five essential characteristics (On-demand self-service, Broad network access, Resource pooling, Rapid elasticity, Measured Service); three service models (Cloud Software as a Service (SaaS), Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS)); and, four deployment models (Private cloud, Community cloud, Public cloud, Hybrid cloud). Key enabling technologies include: (1) fast wide-area networks, (2) powerful, inexpensive server computers, and (3) high-performance virtualization for commodity hardware.

The Cloud Computing model offers the promise of massive cost savings combined with increased IT agility. It is considered critical that government and industry begin adoption of this technology in response to difficult economic constraints. However, cloud computing technology challenges many traditional approaches to datacenter and enterprise application design and management. Cloud computing is currently being used; however, security, interoperability, and portability are cited as major barriers to broader adoption.

The long term goal is to provide thought leadership and guidance around the cloud computing paradigm to catalyze its use within industry and government. NIST aims to shorten the adoption cycle, which will enable near-term cost savings and increased ability to quickly create and deploy enterprise applications. NIST aims to foster cloud computing systems and practices that support interoperability, portability, and security requirements that are appropriate and achievable for important usage scenarios" [2].

II. General Concepts

For many authors in physical terms they don't exist, due to their elasticity [3]. These limits may include the availability of physical technologies to support it as well as the ability to develop applications to support it. Two other limits will be security and standard support models. The development of security levels for CC may increase the constraints to the use of this technology, on the other hand the development of standard models that can easily be deployed by industries and will also reduce the existence of some limits. The use of virtualization technology in cronyism with CC may blur CC's boundaries and make it more comprehensive as well as more interesting to enterprises and operators.

On the other hand, it is mainly from the concept of distributed systems that the new concept of CC will initiate its structuring and development.

In the daily language, Cloud Computing (CC) is a set of computational resources made available to a set of users, remotely, taking these the form of services. And like any service in these days, electricity, water, gas, etc., are always available for both individual use and business use. This is possible due to the fact that in the second half of the twentieth century the technological industry adopted a set of standard models from different sources and technology platforms. CC works as a universal service, paid, but always available to users/ customers who need it, in exactly the same way as they have their electricity service.

Nevertheless, CC is a term with many meanings, therefore an effort has been carried out over the last ten years, in order to establish common denominators in these meanings, to create a more objective definition.

This effort has mainly been undertaken through the publications of the Information Technology Infrastructure Library (ITIL) [4], which is a good practices' library to be applied to infrastructures, operations and maintenance of information technology services. It was developed by the Central Computer and Telecommunications Agency (CCTA), now dependent on the Office for Government Commerce (OGC) in England.

More generally, and following the ITIL concept, a service is a relationship between a consumer and a provider, in which the provider supplies and delivers a value (service) to the consumer and in which that consumer avoids the risks and investments in providing it own value (service), currently CC is also integrated in this context. For example, the simple hosting and database management services of a commercial web store, if they are using CC, they are always available to the store owner as well as to their customers, without the said owner having to worry about those services maintenance, and also don't have to take the investment risks of buying a complex platform. If business does not go well, he simply cancels those services, not having had losses associated with the investment on technological fixed assets.

CC is a recent term, however, the concept and idea goes back to the 60s and 70s of the twentieth century, when computing was very localized and exceptionally expensive.

CC follows another concept that was called time-sharing, which implied a sharing by several entities, at different times, of the same computing equipment. However, nowadays, there are substantial differences between CC and the concept of computational time-sharing. At the time of computational time-sharing, services or machines that held them could only be used by one operator at a time, that is, they were divided by portions of time and not by portions of accommodation space; today time sharing issues do not exist, it is paid according to the service obtained or the storage that information takes, not according to the time in which the resource is being used. Nonetheless, the basic idea is very similar, is consists of providing a computer service remotely and not locally. By using simple and daily concepts by analogy, we can say that both the computational time-sharing and CC systems can be seen as a service available in the same way as electricity or water, that is, they are available when we need them , we pay for this availability and its use, for instance, if we use Office 365 [5] we pay for its usage, such as when we spend electricity, however, we can also pay for housing the documents it produces, as we pay if we want to have a power storage backup system.

Initially, in the 60's of the twentieth century, computer systems were in large rooms equipped with powerful and expensive cooling systems and with high electricity consumptions. Additionally, they could only be used locally. The next step was changing this situation through a system allowing a remote access to a central computer, and it is from here that we can speak of time-sharing.

Organizations could buy time of usage of a computer system, without the need to having them physically at their facilities, as well as without having to worry about their maintenance and administration. Microcomputers began to emerge when time-sharing concept was already popular. Microcomputers were smaller than mainframes and were exceptionally cheaper. Microcomputers quickly became more sophisticated when compared to older mainframes, but more important is that microcomputers had multitasking capabilities, allowing time-sharing.

Soon the concept of time-sharing and microcomputers led to the creation of a new concept, of distributed systems.

III. The Key Paradigm of Cloud Computing

Technologies such as cluster, grid, cloud computing and virtualization, they all have the great purpose of providing a virtual access to a wide number of computing power, through the aggregation of several resources, offering all these technologies in a unique and aggregating perspective [1].

Cloud Computing technology may terminologically name a category as well a set of "on request" services offered by a provider to a private or corporate consumer public, such as Apple, Amazon, Google or Microsoft [6].

The main principle through this technology and this model, is the delivery of computing, storage and software as a service. "The Cloud is a distributed and parallel computing system consisting of a collection of virtualized and interconnected computers presented as a set of dynamic and unified resources based on the Service Level Agreement (SLA) established between the service provider and the end customer" [7].

A report quoted by Rajkumar Buyya [8] at the University of Berkley defines the characteristics of Cloud Computing as "... an illusion of a multitude of available computing resources, the ability of the user to pay only for what he or she uses and using only the way one needs to... "[9]. On the other hand, the National Institute of Standards and Technology (NIST) has characterized Cloud Computing as "a payment model for the use of available resources, through access to specific areas of a network, these resources are configured in several areas, such as: networks, servers, hosting, applications, services. Services that may be quickly delivered with a minimal administration effort and minimal interaction with service providers "[10]. These opinions are based on the concept that CC allows users and customers to have their infrastructure information technologies in the Cloud, and not physically at their companies and facilities.

We may analyze Cloud Computing technologies evolution and even define it, by analyzing a set of technologies that support it and of which it cumulatively consists. We refer to virtualization and the use of multi-core processors, services dedicated to provide Web applications, distributed computing systems such as clusters and grid networks, as well as advanced automation and management systems, we may create a paradigm of what Cloud Computing currently is from the convergence of these technologies [6].

The evolution of cloud computing technology has always been related to the evolution of this set of different technologies. This model may bring considerable benefits, both in terms of costs and in the possibility for users of the various services to adapt model components according to their needs.

IV. Grid Computation

This technology allows the aggregation of distributed resources as well as making them available in a totally transparent way. Integrated resources can be made available to certain users, with different hosting schemes as sources for these features. This system has the key advantage of quickly providing resources, through a fast and efficient location of these, along with an easy management, simulating a virtual system [6]. For instance, the integrated provision of Microsoft Outlook Online, Microsoft OneDrive and Office 365, structural tools for running a business, and that with this service do not need to be in the company´s infrastructure in order to be used.

As a rule, a wide range of tools are available to interact with Grid computing, making it easy to customize these services and make them available through the Internet.

In these environments users will add value to their work, in efficiency, satisfaction, permanent availability of services, without constraints of service quality, etc. These are scenarios in which computing services are seen as an added value, and in which shared services are seen as a marketplace, where a set of components can be purchased tailored to our needs [11]. Such as in some social networking sites and systems like Amazon.

V. Hardware Virtualization

Cloud Computing services are typically supported by sophisticated data centers housed in thousands of computers. In this context, hardware virtualization may be considered the optimal solution to reduce costs and to operationalize server's management and maintenance. The cost reduction I am referring to is directly related to the simultaneous use of CC and virtualization. And

it specifically applies to server's consolidation, a subject that will be further developed in the topic dedicated to virtualization. Hardware virtualization allows the operation of multiple operating systems on a single physical system. This is accomplished by adding a software layer called "hypervisor" (Fig. 1), in which Virtual Machines (VMs) are installed, allowing different operating systems to share the same hardware resources.

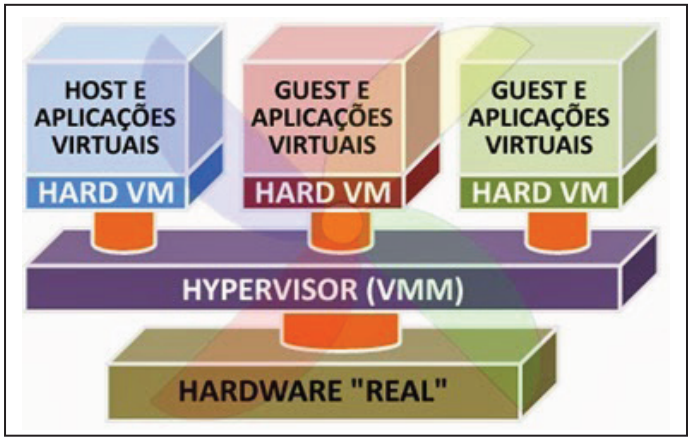

Figure 1: Hardware Virtualization (Type 1 Hypervisor)

The development of technologies such as multi-core processors and migration processes have increased the potential and demand for virtualization. This system may also allow better systems performance, a better management and administration, increased redundancy, fast disaster recovery, etc. [12].

VI. Autonomous Computing

The increasing complexity of computational systems led to the search for solutions that would allow automation mechanisms with regard to systems management and administration. Consequently, it is intended to reduce human intervention in that management.

Cloud Computing has benefited from and made use of these automation mechanisms, such as automatic monitoring, automatic administration based on scenarios, automatic optimization based on automatic monitoring. We can mention for instance the System Center Orchestrator 2012 [13]. (Fig. 3)

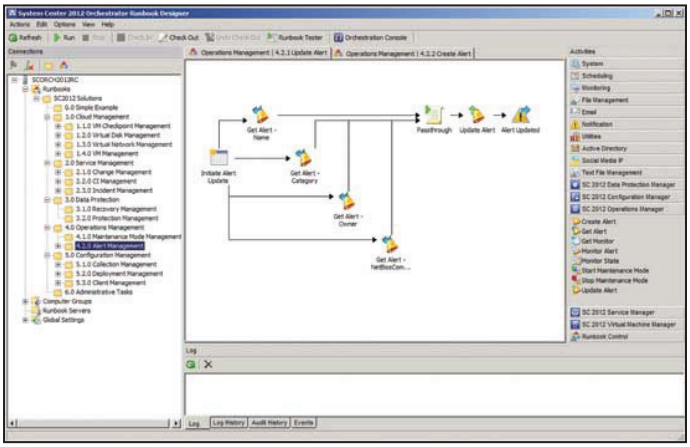

Fig. 2: Automation with 2012 System Center Orchestrator

When using CC with virtualization we can benefit from these high-level automation tools, such as Microsoft System Center Orchestrator. This is because task automation is a key element in gaining technological benefits in public and private CC. Orchestrator is a robust tool that allows you to automate repetitive standard processes as well as tasks, communicating with other systems and platforms. For instance, when a user triggers the start of an Orchestrator runbook [14] requesting the availability of a service in any helpdesk portal, this system-approved runbook will trigger an automatic provisioning through the System Center Virtual Machine Manager [14] and will deploy the required software through the Configuration Manager [15] to execute the service requested by the user who activated the runbook.

These technologies' development has led, in parallel to the development of automation-related software, such as application level management, data center capacity management, proactive disaster recovery, provisioning of virtual machines, and so on. [6].

VII. Conclusion

CC platforms are technology based on three systems complementing: virtualization, distributed computing, and automation. CC technology provides services to users, these services are paid exclusively accordingly to their use. Vendors ensure the continued availability of redundancy services and systems for information, virtual machines, software or customer services.
CC system brings back an old concept: timesharing computing and applies it to modern technologies.

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