Optimizing energy consumption using Eucalyptus in the Cloud Computing environment

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Este documento tratará de analizar las funcionalidades que las infraestructuras de Cloud Computing, en este caso la que nos ofrece Eucalyptus, así como proponer un nuevo algoritmo en el sistema del controlador de la nube y el controlador Clúster; en el cual se reduce considerablemente un consumo de energía debido a las necesidades del usuario final y tenemos que considerar la carga de que el sistema del virtualizador de las máquinas tiene una vez que se conecta.

Palabras Claves: Eucalyptus, cloud computing, computación, optimización, energía.

This document will try to analyze the functionalities that the infrastructures of Cloud Computing, in this case Eucalyptus, offer, as well as propose a new algorithm within the system of the Cloud Controller and Cluster Controller; in which we will succeed to save a considerably large energy consumption due to the requirements of the final user and we have to considerer the charge that the system of the virtualizer of the machines has once it is switched on.

Keywords: Eucalyptus, cloud computing, computer, optimizing, energy.

1. Cloud Computing Technology

1.1. Introduction to Cloud Computing

Cloud Computing comes from the idea of a new computing paradigm that integrates distributed computing, multiple data centers, applications, and computational consumption and about all the term virtualization as well Operating Systems platforms and service providers according to external demand customer, through the Internet.

The idea of cloud computing was born from *Sun Microsystems*, "the network in the computer", making a substantial difference from the past Computer Science, in which it was oriented only to our personal computer.

The term "cloud computing" emerged around 2006 in conferences, blogs, articles. It has proliferated on the cloud so far around the IT that will become paradigm and possibly almost a new science, "the cloud". While the cloud is gaining popularity it highlights the importance of increasingly powerful and economic processors, more ubiquitous networks that results in the data center which become factories for computing services to industrial scale, the software is delivered as an online service and wireless networks connect more and more devices to the free and paid offer.

Cloud Computing gives us a much broader approach, because it doesn't only reflects a single computer but multiple computers interconnected by a network either an Intranet or Internet, for a specific purpose to access various information with relative ease and consistency.

1.2. Profits

The main advantages of Cloud Computing Technology are listed below:

- High Availability. - The infrastructure and architecture of a Cloud System is specially designed for high redundancy and to ensure unlimited continuity in their service.
- Economic. - To reduce maintenance costs.

It prevents capital expenditures to invest. Energy costs are significantly reduced and the working source becomes an operational expense. There are few barriers to entry, as infrastructure is provided by a third party and apart from other systems the service is purchased only once. The Cloud is growing according to the increasing user demand.

The price is set based on its use and according to the user priority.

- Multiuser. - Allows sharing both costs and resources through a multi-user, allowing:
- Independence. - There is a computational media independence and its existence, allowing users to access from various locations to public clouds using an Internet browser type network protocols *SSH* or *SFTP*, independent of geographic location, operating system and computer.

  Infrastructure is provided by a third party, and can be accessed via Internet and users can connect from anywhere.

- Scalability. - Providing instant on-demand resources, it is an individual service and in real time to increase demand.

- Its performance is monitored by means of a built architecture to use services of web type like interface system.

Nowadays there is a confusion between the concept of cloud in relation to the concept of Grid Computing. The distinctions between these technologies are not very clear because the Grids and Clouds share a similar vision, such as reducing computing costs and they can increase the flexibility and reliability of the hardware used.

The main definitions used by many authors are:

- R.Buyya [1]: A cloud is a type of parallel and distributed system consisting of a collection of interconnected and virtualized computers that are dynamically provisioned and presented to one or more unified computing resources based on service level requirements, established through negotiation between service providers and consumers.

- J.Kaplan [2] Cloud Computing captures many keywords, which attempt to cover a variety of issues ranging from implementation, load balancing, provisioning, business model and architecture. It is the next logical step of the software. For us, the most simple explanation of cloud computing is described as Centric Internet software.

- R.Bragg [3] The key concept between a web application and Cloud ... more development and more secure. We can find much cheaper as migrating a web of a Cloud to invest in our own set of servers ... is a desk for people without a computer.

- K.Sheynkman [2] Clouds put focus on making the hardware layer consume according to demand computational and storage capabilities. It is important, as a first step, but companies harness the power of the Clouds ending with the infrastructure that applications need to be easily configured, getting an escalation rate dynamic and used by a hardware virtualized environment.

- P.McFedries [4] Inside of Cloud Computing we can have our data and our software residing inside the cloud, and we can also access to all of these things not only through our computer but also access through friendly devices such as mobile phones, PDAs... megacomputer permitted by the virtualization and software is taken as a service... This utility of computer power is widely used by data centers.

SHARE RESOURCES	**Collaboration between them**	**CLOUD**
HETEROGENEOUS RESOURCES	Aggregation of heterogeneous resources	Assigned resources unshared
VIRTUALIZATION	Virtualized data and computing resources	Hardware and software platforms
SECURITY	Through credentials	Using access keys of the virtual machines
ARCHITECTURE	Service Oriented	Users choose the architecture
SOFTWARE DEPENDENCIES	Domain dependent of software application	Domain independent of software application
SOFTWARE WORKLOAD	Applications require to know the workload of the service	Workload is not essential for most applications
SCALABILITY	Nodes Scalability	Nodes and Hardware scalability
METHOD OF PAYMENT	Fixed	Flexible
USER ACCESS	Transparency in access for end users	Transparency in access for end users
Usabilidad	Unfriendly	Friendly for the users
QoS GUARANTEE	Limited support, often the best effort	Limited support, centralized by availability

2. Cloud Eucalyptus infrastructure

2.1. Definition

Eucalyptus [8] is a framework of open source software that allows implementation of a technology, such as cloud computing like a cluster.

2.2. Eucalyptus Diagrammer

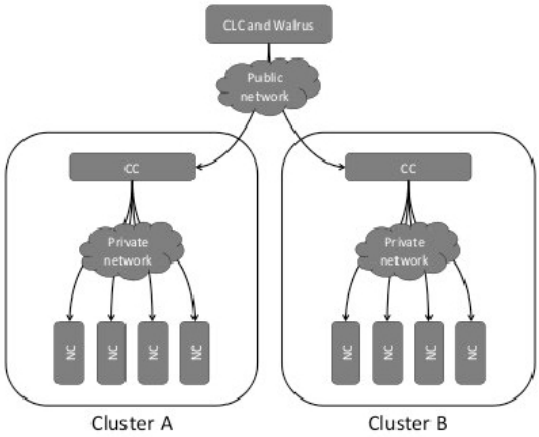

Figura 1. *Topología de Eucalyptus*

2.3. Eucalyptus Structure

- **Cloud Controller** Cloud Controller is the gateway of a cloud or front-end for both users and administrators. Making calls to the nodes to receive information about these resources, making the planning of the decisions to high standards and implementing decisions through the cluster controllers.
  The cloud controller is divided or grouped into three categories:
  - Service Interface. - Is the interface visible to the user, which is responsible for handling the authentication.
  - Data Service. - It is governed by the user, is responsible for hosting the data, and it provides the user with a configurable environment to formulate the allocation of resources.
  - Resource Service. - It is responsible for making all system entire the arbitration for the allocation of resources, allowing to the users to interact with virtual machines, networks and managing both system components as virtual resources.
- **Cluster Controller** manages information about jobs running on virtual machines, specifically in the nodes controlling the instances of the virtual network created.
- **Node Controller** is responsible for controlling all the executions, such as inspection and ending states of virtual machines on a particular host when it is running.
- textbfStorage Controller, better known as Walrus, comes to be implemented storage service for Amazon's S3 interface, which provides a mechanism for storing, accessing virtual images and user datas.

3. CPU FREQ [6]

3.1. Definition

It is a Linux kernel subsystem that provides a standard interface to modify the frequency and voltage of each processor of the system while It is operating.
It has the following states:

- Performance. - Increased frequency of the CPU.
- Powersave. - Low CPU frequency.
- Userspace. - Frequency of manual mode.
- Ondemand. - Frequency based on processor usage.
- Conservative. - Higher degree of conservation in demand of the processor.

3.2. Diagrama de CpuFreq[7]

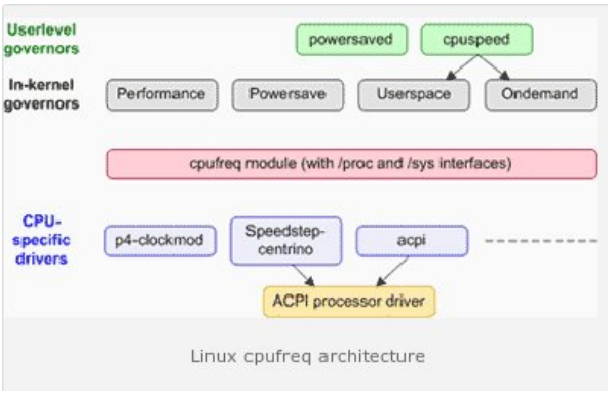

Figura 2. *Arquitectura del CpuFreq*

4. Extensions to the handler EUCALYPTUS CLOUD

4.1. Cloud Wide Voltage Information(CWVI)

It is a new module proposed that stores information from the Cloud Wide Voltage Control (CCWV), so the user will know the system load of virtual machines and the frequency of the CPU for each host that has been assigned by the CCWV.

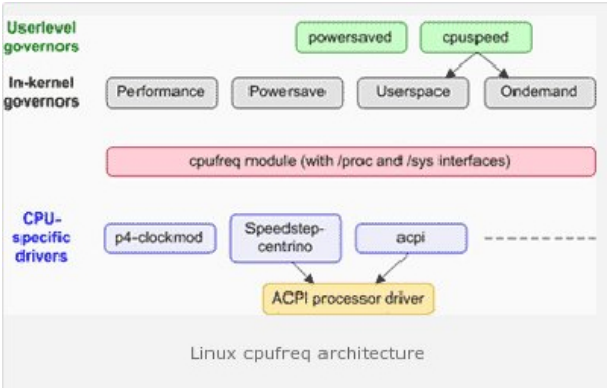

Figura 3. *Estructura del Cloud Controller*

4.2. Control Cloud Wide Voltage(CCWV)

Is a module implemented in Java inside the Cluster Controller which will be responsible for managing and regulating the voltage supplied to each host. This CCWV is the system that is hosting the virtual machines.
By using an algorithm and the instances describeResources and describeInstances will make a call to the Node Controller (NC) in order to know the status of the hypervisor, the Emulator and the resources of the NC.
Wide Cloud Control Voltage (CCWV) will send a command through of the instances runInstances according to the state of execution of the virtual machines, to determine whether it increases or decreases the frequency of the CPU of the host that contains the information.

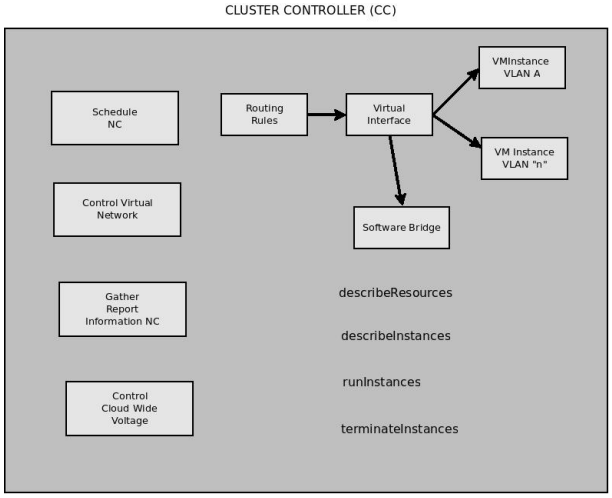

Figura 4. *Estructura del Clúster Controller*

4.3. Implementation of CpuFreq daemon

It is proposed to implement the cpufreq daemon voltage inside the Node Controller, due to receipt of an order from the Cluster Controller. The daemon by our status userspace, will be responsible for changing the CPU frequency according to the order from the Cloud Control Wide Voltage.

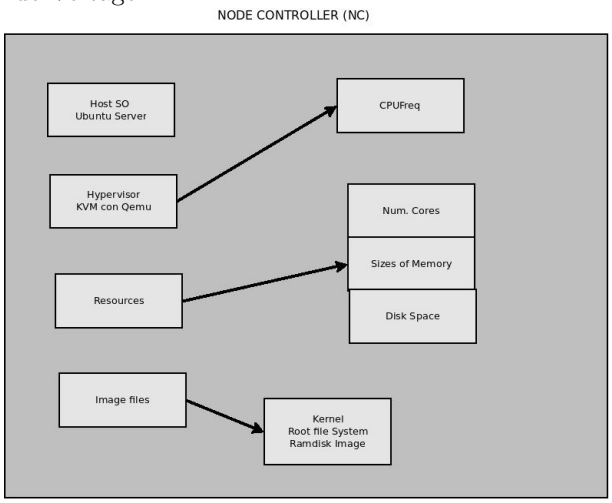

Figura 5. *Estructura del Node Controller*

5. Conclusions

In developing these new modules within Eucalyptus Cloud Infrastructure we could discusses various scenarios of a Cloud Computing environment trying to find the efficiency in the energy consumption [9], achieving:

- Reduce electricity costs.
- Improving the efficiency of a Cloud environment.
- Reduction in the rate of carbon emissions.
- To provide better service to clients.

In the future, the Clouds will be designed to reduce energy consumption, but for this will be required to analyze a greater number of delay and reduction techniques of the consumption energy. Virtualized environments are expected to be consolidated with the integration between applications and the hardware used.

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