DESIGN AND IMPLEMENTATION OF THE INFRASTRUCTURE OF A PRIVATE CLOUD COMPUTING MODEL.

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Abstract. *The article presents the process realized to implement a cloud computing project, using managers open as OpenStack, Eucalyptus and OpenNebula, which allow private Cloud models deploy code. For the implementation of Cloud Computing project steps core is described , as are the physical architecture of the network and its respective logical architecture of each manager , like how is dimensioned each manager to provide infrastructure as a service to different users . Finally disclosed the results of the various tests on the three platforms to the students of the Faculty of Engineering of Applied Science at the Technical University of the North.*

Keywords

Cloud computing, Software as a service, virtualization.

1. Introduction

At the "Universidad Técnica del Norte" the cloud computing project oriented model private cloud to provide infrastructure as a service to students and teachers is carried out, this initiative came from researchers Engineers, "Facultad de Ingeniería en Ciencias Aplicadas" and PhD. José Luis García Dorado.

The progress and development has formed a perspective based on a need by users to manipulate information from any application based on the concept of cloud computing from the context of the IT location.

It was decided to perform as a solution the design of a Cloud Computing infrastructure oriented using free platforms OpenStack, Eucalyptus and OpenNebula. Which provide the service of virtual machines for students of Engineering in Electronics and Communication Networks.

In this article the design and implementation of each of the free software platforms as well as performance testing that was performed to determine the performance one decade will be detailed.

2. Design and Implementation

The computer model called Cloud Computing that allows for the scalability of any virtualized resource within the network as a service.

2.1 Platforms

OpenStack

OpenStack is a virtualization management software open source, which allows users to connect different technologies and components from different vendors and expose a unified API regardless of the underlying technology. OpenStack, you can manage different types of hypervisors, network devices and services, storage components using a single API that creates a fabric data center unified, (ORACLE, 2014).

Figure 1**.** Logo of OpenStack
Reference: http://docs.openstack.org/

OpenStack is the collaboration of developers and technologists producing cloud computing platform open standard for both public and private cloud (OpenStack, 2015). [1]

Main Characteristics

This infrastructure manager in the cloud as it is OpenStack has several characteristics listed below:

• Installation is somewhat complicated, but also provides a very robust compared to other operators and thus optimal and efficient cloud platform is obtained.

• OpenStack provides a compatible-EC2 API, which lets you interact with Amazon EC2 API; this is convenient for multi-cloud environments is the common EC2 API.

• It has its own storage system called Swift, which is designed to provide fault tolerance and scalability.

• It offers flexible models to suit the needs of different user groups applications or networks. Standard models include flat networks or VLANs to separate servers and traffic.

• Through its system of identity management called Keystone performs user authentication and service.

Eucalyptus

Eucalyptus is a software architecture based on Linux that implements scalable private and hybrid clouds within the characteristics of infrastructure.

The platform allows the use of resources (hardware, storage and network) using a self-service interface depending on the needs that are required within certain activities. [1]

Figure 2. Logo of Eucalyptus
Reference: Enterprise Edition 2.0

Eucalyptus is a computing platform compatible with EC2 cloud and cloud storage compatible with S3. [2]

Main Characteristics

• Eucalyptus offers API support Amazon EC2, S3, IAM, ELB, Auto Scaling and CloudWatch services. It offers you the ability of a hybrid cloud.

• Control IP addresses allows the IP allocation to VMs dynamically, elastic and controlled manner. [3]

• It is implemented as Infrastructure Service (IaaS), where users provide processing power, storage and computing resources. [4]

• The high flexibility it has.

• In the implementation allows scalability in performance.

• Instances of Virtual Machines running through a software called hypervisor or VMM (Virtual Machine Monitor).

OpenNebula

OpenNebula is a cloud computing platform under free and open-source software for managing distributed infrastructure of a data center capable of managing virtual servers for the deployment of private, public and hybrid infrastructure as a service implementations.

Figure 3**.** Logo of OpenNebula
Reference:
https://www.udsenterprise.com/es/blog/2016/02/22/uds-enterprise-soporta-opennebula/

Main Characteristics

• OpenNebula is an open-source software that allows you to build any type of Cloud.

• It is designed to achieve integration with any network and storage, in order to adapt to existing data centers.

• OpenNebula has the ability to manage storage, networks and different virtualization technologies available today.

• Provides the ability to deploy distributed infrastructure services, combining data center resources as well as remote Clouds, according to deployment policies.

2.2 Physical Infrastructure

As an initial part of the implementation of the different cloud platforms physical infrastructure that has the Technical University Northern determining the different elements that intervene in the internal and external access to different platforms to be installed it is determined, as can be seen in the Figure 4 each server on which were implemented platforms is installed on the Datacenter Engineering Faculty of Applied Science (FICA) which are connected by the switch distribution Datacenter to the central building which provides the exit to internet and connection to other subnets university
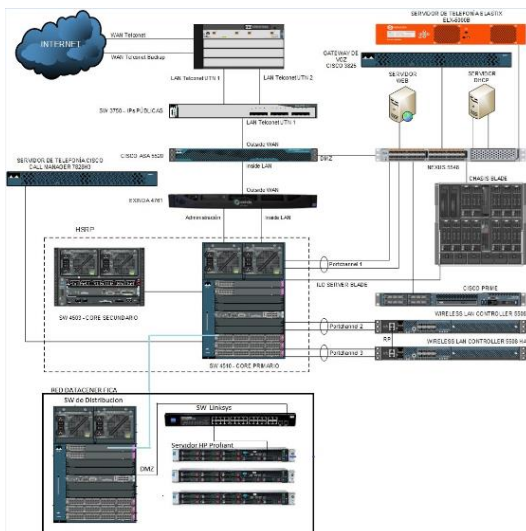

Figure 4. Physical infrastructure and their components
Referenc**e:** Elaboration Own.

2.3 Logical Architecture

Openstack

In Figure 3, the systems and components that account OpenStack which meet as different functionalities as presented: storage volumes, running virtual machines; these elements communicate with each other to provide Infrastructure as a Service.
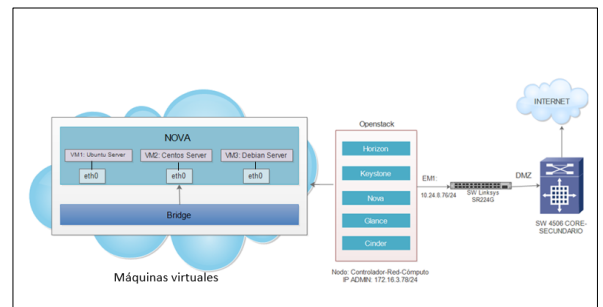

Figure 5**.** Logical architecture of Openstack
Referenc**e:** Elaboration Own.

Node: The architecture in which the Infrastructure as a Service is implemented, consists of a single node ("All in One"), in which the services of the OpenStack platform like staying: Horizon, Keystone, Nova, Glance and Cinder; turn driving all virtual machines. This node will function Controller, and Network Computing.

Node Controller: Installed Keystone (ID), Glance (OS images) and Horizon (Dashboard), Nova components responsible for the management part of computing services, plus associated services APIs and database MySQL. Computer node: the Nova component is installed, in charge of running virtual machines, the service also runs two hypervisor KVM or Quemu.

 Network Node: Connect all network elements, here several agents such as plug-in-agent which handles routing, configure DHCP addresses, and also provides internet service running.

VM: They have a virtual network interface (eth0), the same as is connected to the physical host interface host the EM1 via a second logical interface known as bridge (Bridge), this communication is managed by the component Not going.

Eucalyptus

Eucalyptus is developed in modular form, leading to the five major components that are exposed to high level of

functionality within the architecture of Eucalyptus, as shown in Figure 6:

- Cloud Controller (CLC)
- Cluster Controller (CC)
- Node Controller (NC)
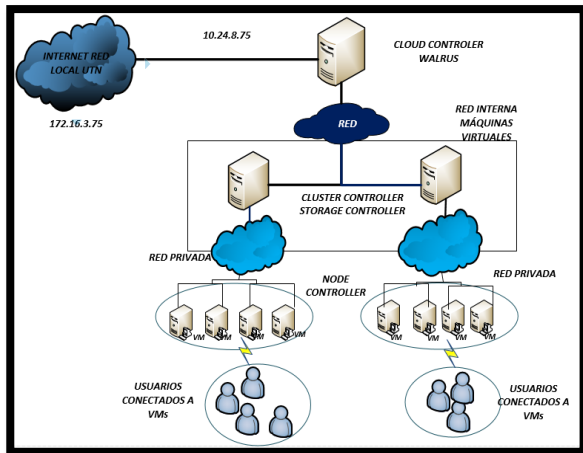- Storage Controller (SC)
- Walrus

Figure 6. Internal architecture of Eucalyptus and their respective components
Reference: (HELION, 2013)

Cloud Controller (CLC)

The controller meets the cloud infrastructure performance in carrying out monitoring instances and cloud resources.

• Monitor the availability of resources in various components of the cloud infrastructure.

• To monitor instances that are running and cloud resources.

Cluster Controller (CC)

The Cluster Controller (CC) collects status information of the nodes on the platform and performs the execution of the instances upon them to the CLC.

Node Controller (NC)

The functionality of Node Controller (NC) is based on the performance of the machines hosting the instances. The NC controls the activities of the VM, ie, their life cycle as:

- ✓ Inspection
- ✓ Completion
- ✓ Execution

• Storage Controller (SC)

The Storage Controller infrastructure to manage instances in Eucalyptus and for access to:

- ✓ Storage
- ✓ Volumes

• Walrus

It provides priority for compatibility interface S3 and EBS compatibility and stores images of the instances.

Open Nebula

In the following image the functional blocks that represent the elements corresponding to the physical structure of our platform where specified blocks are described:

- ✓ Storage
- ✓ Running virtual machines
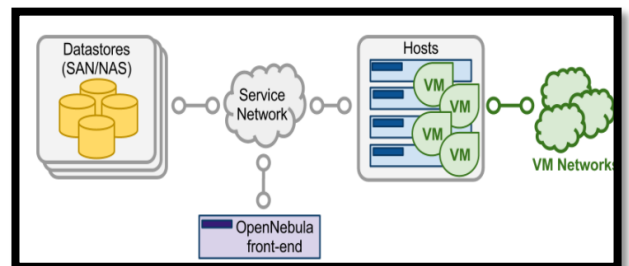- ✓ Network Infrastructure
- ✓ Frontend

Figura 7. Architecture of OpenNebula
Reference:
http://docs.opennebula.org/4.14/_images/one_high.png

- The Front-end: is the server where all services management, provisioning, monitoring, access, and management of the platform running. It is the central part of the system.

- Hosts: are the servers running virtualization functions where you instantiate and run virtual machines (VM) provided by the platform.

- The Datastores: are the servers where the images corresponding to the instances and virtual machines are stored. The datastores are capable of storing

several disc formats and configuration files, kernels, storage volumes, etc.

- The Network Service is the part of the network service that allows the interconnection of the Datastores Hosts and the frontend, is also communication to our private network or institutional network and provides us with an internet connection.

- Virtual Networks: the virtual network infrastructure that enables support services network between virtual machines (VM).

Dimensioning

The sizing process, to analyze the resources has to establish capacity characteristics and test equipment based on the implementation of the matters oriented applications instances.

The implementation was performed from the present physical resource, for each of the platforms that can be seen in Table 1.

NAME SERVIDOR		HP DL360 G9	HP DL360 G9	HP DL360 G9
Características	RAM	32 GB	32 GB	32 GB
	PROCESADOR	1x Intel Xeon E5-2620 V3	1x Intel Xeon E5-2620 V3	1x Intel Xeon E5-2620 V3
	DISCO DURO	3x450 GB	3x450 GB	3x450 GB
	TRAJETA DE RED	4 X 1GBE	4 X 1GBE	4 X 1GBE
	SIST. OPERATIVO	Ubuntu Server 14.04 LTS	CentOS 6.5	Ubuntu Server 14.04 LTS
FUNCIÓN		Cloud OpenStack	Cloud Eucalyptus	Cloud Open Nebula
IMAGEN				

Table 1. Characteristics of physical servers
Source: Elaboration Own.

The platforms allow compatibility with the following operating systems as shown in Table 2, such as:

SOFTWARE	LINUX	WINDOWS

Plataforma	Si existe soporte en:	Si existe soporte en :
	-Opensuse	-Windows 7
Openstack	-CentOS	-Windows 8
Eucalyptus	-Cirros	-Windows 8 server 32 bits
Open nebula	-Ubuntu	-Windows XP
	-Debian	
	-Fedora	

Table 2. Platform support with operating systems
Source: Elaboration Own.

2.4 OpenStack

Sizing for the implementation of OpenStack platform it is based on requirements of different operating systems be installed for use in applications requiring students of the Faculty of Engineering in Applied Science University; in Table 3 shows these requirements.

Sistema Operativo	Memory RAM	Disco Duro		Procesator
		Mín	Máx	
Ubuntu Server	128 MB	500 MB	1 GB	x86 – 2.4 GHz
CentOs server	512 MB	1 GB	2 GB	x86 - 1 GHz x64 - 2 GHz
Debian server	1 GB	1 GB	2 GB	x86 - 2 GHz

Table 3. Requirements Operating Systems to implement OpenStack
Source: Elaboration Own.

Once the requirements needed to install different operating systems known, we proceed to verify the main features that the physical server where the OpenStack platform will be implemented, as detailed in Table 1.

In order to gauge the exact number of virtual machines to implement OpenStack platform, you need to know how many account the physical server CPU; whereby the "lscpu" command to view the details of the processor, as shown in Figure 8.

```
Arquitectura:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Orden de bytes:        Little Endian
CPU(s):                16
On-line CPU(s) list:   0-15
Hilo(s) por núcleo:    2
Núcleo(s) por zócalo:  8
Socket(s):             1
Nodo(s) NUMA:          1
ID del vendedor:       GenuineIntel
```

Figure 8. Information on the number of cores and socktes on the physical server.
Source: Servitor Ubuntu Server 14.04 LTS

According to Figure 8, it can be seen that the server where the OpenStack platform will be staying has a socket, 8-core and 16 CPUs to be used for the implementation of different virtual machines.

Number of virtual machines

In order to calculate the number of virtual machines that can be created and run simultaneously, the formula of "OpenStack Operations Guide" (Tom y otros, 2014).

$$\#VM = \frac{\#CPUs \ x \ Vel \ de \ VM}{Vel \ Procesador} \qquad (1)$$

Where:

#VM: Number of virtual machines to work simultaneously.

#CPUs: Number of CPUs having the physical server that will host the OpenStack platform.

Vel. VM: Processor speed and virtual machine GHz.

Vel Processor: Processor speed in GHz physical server.

According to equation 1, and data in Figure 4 it provides that the maximum number of virtual machines to run simultaneously is 16.

$$\#VM = \frac{16 \ x \ 2.4 \ GHz}{2,4 \ GHz} = \mathbf{16VM}$$

Memory RAM

This calculation does agree wing amount of RAM required for each operating system to be installed on the virtual host and work properly.

$$\#VM = \frac{RAM\_T}{RAM\_SO} \qquad (2)$$

Where: #VM: Number of virtual machines can be created according to the amount of RAM.

RAM_T: Total number of physical server

RAM_SO: RAM required by the operating system of the virtual machine.

According to the detailed values in Table 3 and Equation 2, it proceeds to perform sizing the number of virtual machines that can be created in related to the consumption of RAM for each operating system.

RAM TOTAL	RAM S.O.	#VM	Sistem Operative
	1 GB	32	Ubuntu-Server
32 GB	1 GB	32	CentOs-Server
	1 GB	32	Debian-Server

Table 4. Number of VMs according to RAM
Source: Elaboration Own

The results in Table 4 indicate that you can create up to 32 virtual machines in relation to consumption of RAM that each operating system.

According to the OpenStack platform, sizing virtual machines is done in relation to the flavor that gives us when filling the template instantiation, whose value is 2 GB of RAM. Now with this value proceed to size the number of VMs that can be created through Equation 2.Los resultados obtenidos en la tabla 4, indican que se pueden crear hasta 32 máquinas virtuales en relación al consumo de memoria RAM que tiene cada sistema operativo.

According to the OpenStack platform, sizing virtual machines is done in relation to the flavor that gives us when filling the template instantiation, whose value is 2 GB of RAM. Now with this value proceed to size the number of VMs that can be created through Equation 2.

RAM TOTAL	RAM FLAVOR	#VM	Sistema Operativo
	2 GB	16	Ubuntu-Server
32 GB	2 GB	16	CentOs-Server
	2 GB	16	Debian-Server

Table 5. Number of VM according to the flavors of the OpenStack
Source: Elaboration Own

The results in Table 5 indicate that each virtual machine is assigned a RAM of 2 GB, while the hardware has 32 GB total, so you can size a total of 16 instances that can be of any operating system because each consumes the same resource.

Calculation of Processors

This calculation is done to determine the number of virtual CPUs needed for each operating system to implement virtual machines.

$$\#VCPU = \frac{Vel\_Procesador}{Vel\_VM} \qquad (3)$$

Where:

#VCPU: Number of CPUs per VM.

Vel_Procesador: Frequency GHz processor physical server

Vel _VM: Frequency GHz will work with the operating system on the virtual machine.

With the data in Table 3 and the execution of the equation 3 it is able to determine the number of CPUs required for each operating system for normal operation.

Velocidad Procesador	Velocidad VM	# VCPUs	Sistema Operativo
2.4 GHz	2.4 GHz	1	Ubuntu-Server
	2.0 GHz	1.2	CentOs-Server
	2.0 GHz	1.2	Debian-Server

Table 6.Number de VCPUs por VM
Source: Elaboration Own

In Table 6, it can be seen that at least one VCPUs is needed for every virtual machine regardless of operating system running on it.

Once you have calculated the number of VCPUs is needed for each operating system, it proceeds to perform sizing few virtual machines can be created.

$$\#VM = \frac{CPUs}{VCPU} \qquad (4)$$

Where: #VM: Number of virtual machines.

#VCPU: Virtual CPU allocated for each OS

#CPU: CPUs with the physical server counts.

By the results in Table 6 and equation 4, we proceed to calculate the number of virtual machines that can be created based on VCPUs.

#CPUs	#VCPUs	#VM	Sistema Operativo
	1	16	Ubuntu-Server
16	1	16	CentOs-Server
	1	16	Debian-Server

Tabla 7. Número de VM en función al número de VCPUs
Source: Elaboration Own

The results in Table 7, indicate that you can create a total of 16 virtual machines, either the operating system you need to view each consumes virtual CPUs per instance.

Then in Table 8 can be seen a small short, where the number of machines that can be created according to different points discussed above detailed.

RAM TOTAL	CPUs TOTAL	#VM por Fórmula	#VM por RAM	#VM por VCPU
32 GB	16	16	16	16

Table 8. Summary of the number of VM to create OpenStack
Source: Elaboration Own.

2.5 In Table 8, we see that the maximum number of creating virtual machines is 16, in relation to the use of formula OpenStack, RAM consumption and the number of VCPUs that is used in each instance regardless of the Linux operating system it runs.

2.6 Eucalyptus

During sizing, it requires measurements of current resource and resource consumed by the platform.

Bandwidth analysis through Exinda

Controls and manages Web access by user or host, point to point groups, individuals servers or traffic.

Through monitoring through Exinda server that owns the Technical University of the North, it brought results based on the parameters measured in real time, displayed in Table 9.

Análisy of tráfic	Taza de transferencia (Kbps)	Percentaje
Ejecution of server	1,634	7%
Ejecution of 5 instances	10,549	43%
Ejecution of 10 instances	23.969	95%

Tabla 9. Data relationship Exinda
Source: Elaboration Own

Analysis of Memory RAM

The analysis parameter RAM is to show a result server support based on the number of applications and virtual machines running on the platform called Eucalyptus cloud.

Based on the analysis performed under the consumption of RAM in the server and based on the platform, the result is shown in Table 10:

# of Instances Windows7	Use of RAM	Value Total
Inicial	9206	31985
5	14626	31985
10	31675	31985

Table 10**.** Result of consumption of RAM
Source: Elaboration Own

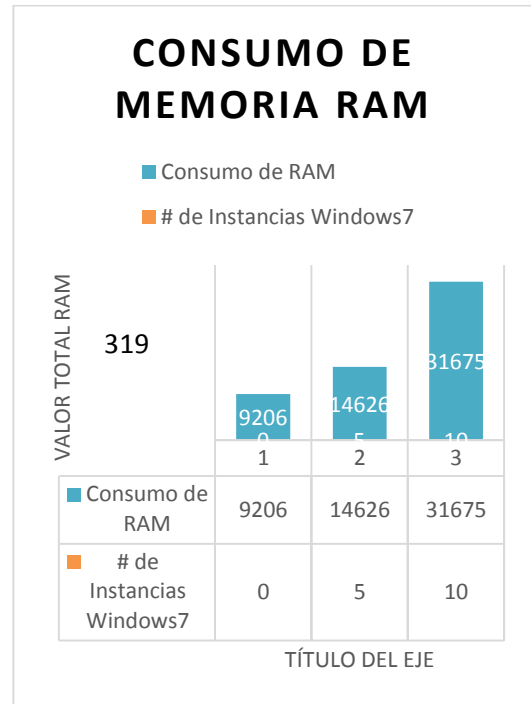The results can be seen in Figure 10, where a statistical table was established based on the results.

Figure 9. Statistical diagram RAM consumption
Source: Elaboration Own
Note: The expressed as 0, value determines the consumption based operating system based on the implementation of the platform.

Results of Memory RAM consumption in the instances.

The result observed in Table 11 was obtained from the analysis based on the consumption of RAM, when subjected the platform during the execution of a number of instances.

Note: GNS3 is a high-performance tool that requires further action.

Instances Windows7	Use of RAM	Memoria RAM do not use	Value Total
Ejecución SS.OO	1,1GB	0,9GB	2GB
GNS3 y Packet Tracer	1,87GB	0,13GB	2GB

Tabla 11**.** Result of consumption of RAM instance
Source: Elaboration Own

Memory RAM consumption based on the peak value

RAM aplications= 1,87GB

RAM 1vm= 2 GB

RAM 10vm=2GB*10 =20 GB

RAM total=20 GB

Instances are created under the action of 2GB of RAM, data presented in Table 11, therefore a diagram is set based on the resource consumption of using a statistical diagram as shown in Figure 11.
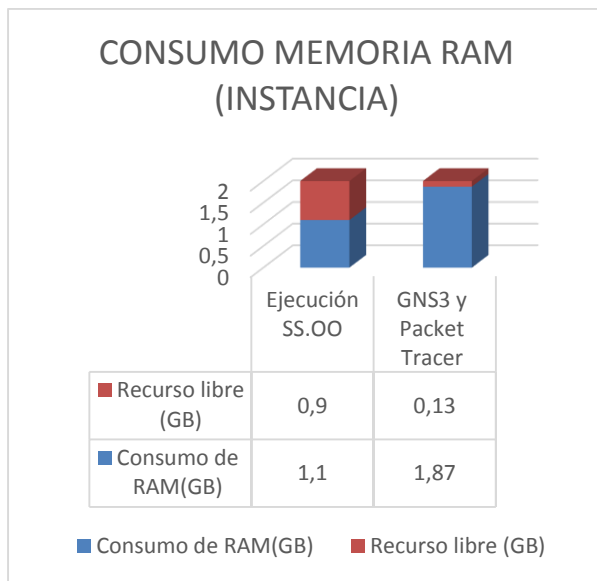

Figure 10**.** RAM consumption in instances
Source: Elaboration Own

CPU consumption

CPU consumption is an analysis of the system, by means of tools to determine CPU usage and utilization.
On average, top provides a real-time view of the system, then we proceed to obtain the data during the execution of the platform.

Load average: 0.14; 0.18; 0.18

Use of CPU: 2.3%us+0.6%sy+0.0%wa= 2.9%

Determines 2.9% of CPU usage on the server, where the platform is executed.

The execution of 5instances, used in applications designed for networking.

Load average: 1.20; 1.38; 1.04

Use of CPU: 25.2%us+6.3%sy+5.8%wa= 37.3%

Determines 37.3% of CPU usage on the server, where the platform is executed.

10 instances run also found using applications designed for networking.

Load average: 6.10; 6.16; 5.08

Use of CPU: 54.6%us+7.8%sy+0.4%wa= 62.8%

Determines 62.8% of CPU usage on the server, where the platform is executed.

Analysis of the results of CPU Consumption

Depending on the results obtained through monitoring and according to established parameters determines the CPU consumption as shown in Table 12, is connected based on running applications and functions of the instances, therefore , it is proportional to its use.

# de instances	Use of CPU (%)	Use of CPU do not use (%)
Valor inicial	2,9	97,1
5	37,8	62,2
10	62,8	37,2

Table 12**.** CPU consumption analysis according to the number of instances.
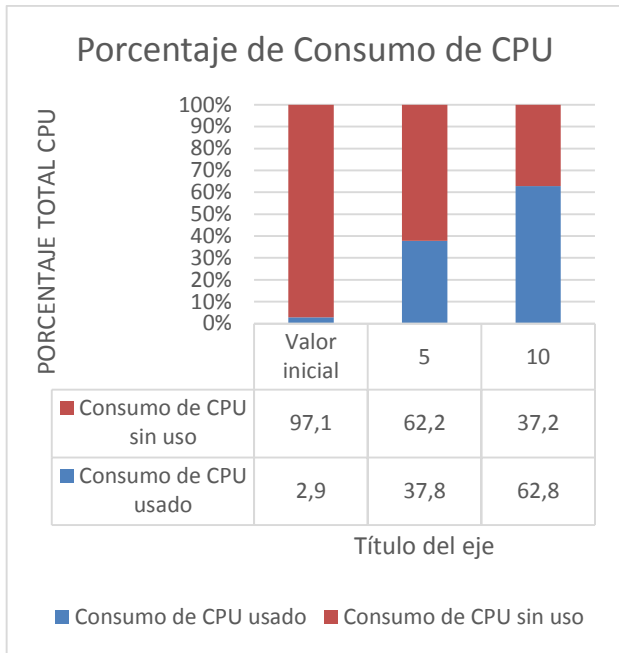**Source:** Elaboration Own

Figure 11. Percentage of CPU usage
Reference: Plataforma Eucalyptus SA.

The maximum CPU consumption value achieved was 62.8% on 100% provided. This value varies according to the use of instances by the student or user that is performing some application, as shown in Figure 12.

CPU consumption in instances

Parameter analysis measuring CPU consumption based on the resource instance and during execution of the application is made.

Instances based on CPU usage, vary according to applications or activities to which the instances are subjected, therefore, results set based on the consumption of CPU instances, as shown in Table 13.

Instances Windows7	Use of CPU (%)
Ejecución SS.OO	0-5
GNS3 y Packet Tracer	52-60

Table 13. CPU consumption of CPU of the instances.
Source: Elaboration Own

Based on the obtained values of the parameters sizing, is obtained as the final result can create a number of virtual machines that supports server capacity, which results submitted under the evidence is obtained, the calculations presented by (VMWARE Jose Luis Gomez, 2013).

Medium processing system CPU (MHz)
Specifies how value MHz CPU is used in each system and then take the mean as shown in equation 5.

[(8 CPUs x 2400 MHz) + (4 x 2400 MHz CPUs)] / 12 = 2400 MHz CPU / CPU **(5)**

Average number of VMs per system Cores for (core)

Detailing how many cores has every VMs used in each system and then take the average. The average is 1.6 core / server system as set forth in **equation 6.**

[(8 x 2 core VMs) + (4 x 1-core VMs)] / 12 = 1.6 servers cores / server **(6)**

Average CPU on maximum use

It refers to the CPU consumption medium having the system maximum performance schedule, ie, in the case of systems with 2.4 GHz CPU with maximum utilization GNS3 while using an average of 63%; and between the other virtual machines Linux systems 2.4GHz CPU have an average of 42%. The average total usage is 56% by **equation 7** system according.

[(8 x 63% consumption VMs) + (4 x 42% consumption VMs)] / 12 = 55.86% consumption servers / server **(7)**

Average capacity per system RAM (MB)

The calculation of RAM that is installed on each VM. Where VMs with CPU 2.4 GHz for Linux have 2 GB of RAM, and CPU servers with 2.4 GHz for Windows feature 2GB of RAM. Where the average is 2048 MB RAM per system according to **equation 8.**

[(8 servers x 2048 MB) + (4 servers x 2048 MB)] / 12 servers = 2048 MB / server **(8)**

Calculation of Virtual Infrastructure

The calculation is performed based on the results of the above equations.

CPU

The calculation of the CPU for virtual infrastructure is 3840 MHz / server as is done through **equation 9.**

processing means CPU VMs (MHz) x Average number of CPUs per system (core) = average normalized per server CPU (MHz) **(9)**

2400 MHz x 1.6 = 3840 MHz cores / server

Media standardized CPU utilization on peak usage (MHz)

Calculating the normalized average CPU utilization for maximum use virtual infrastructure is 2150 MHz / server as is done by **equation 10.**

Average CPU on maximum use by system (percentage) x normalized Average per server CPU (MHz) = average normalized CPU utilization on peak usage (MHz) **(10)**

56% x 3840 MHz / server = 2150.4 MHz / server

Total management CPU peak usage (MHz)

Concurrent number of VMs x Media standard CPU utilization at peak (MHz) = Total Management CPU peak usage (MHz) **(11)**

12 x 2350.4 MHz VMs / server = 28204.8 MHz

According to the calculation result is obtained as 28204,8MHz / server via **equation 11.**

RAM

Media normalized maximum RAM usage in use (MB)

The normalized average peak usage RAM exposed RAM depending resulting 1146,88MB / server according to the results according to **equation 12.**

Average capacity of system RAM (MB) x average maximum use of RAM in use by system (percentage) = average normalized using maximum use RAM (MB) **(12)**

2048 MB x 56% = 1146.88 MB server / server

Total maximum RAM usage (MB)

Concurrent number of VMs x Media standard RAM utilization at peak (MB) = total maximum RAM usage (MB) **(13)**

12 VMs x 1146.88 MB = 13764 MB

The result of all RAM usage maximum use is exposed depending on the RAM 13 764 MB resulting according to the results according to **Equation 13.**

Hardware

Finally the calculation is performed in the hardware required for the number of instances to handle the load twelve virtual machines.
It is recommended as good practice not to use more than 80% of server resources, so you'll end resources per server is 30720 MHz and 25600 MB.

(#total Of server cores x medium processing system CPU (MHz)) x estimated value of server resource consumption percentage = Net Resources **(14)**

(16 cores x 2400 MHz) x 80% = 30720 MHz / server
* 32 000 MB x 80% = 25600 MB / server

* Note: The value obtained is the result of total RAM for maximum resource consumption percentage.

Requires calculating how many servers is performed, therefore, the resources required to support the fourteen divided between resources services offered by each server.

Total CPU utilization on peak usage (MHz) / net per server CPU = Number of servers based CPU **(15)**

28204.8 MHz / 30720 MHz = 0.92 ≈1 server

Being the calculation of the RAM very close to 1 servers obtained from the calculation of the **equation 15,** it supports the work of the 12 VMs based on resources obtained from dimensioning, if appropriate administrator proposes to increase the resource which will depend on if the supplier owns the resource and needs to comply fully service.

2.7 OpenNebula

Dimensioning of RAM and CPU

The following table is specified requirements for each operating system analyzed, plus server features and accordingly it was possible to get the maximum number of virtual machines that can be deployed on the platform was established for this number is divided core server for the number of cores required for each system in the same way it is done with RAM and the smallest value of 2 results corresponds to the maximum of virtual machines that can be deployed for each operating system**.**

System Operative	Requeriments	
	Procesamiento(GHz)	Memoria(GB)
Ubuntu	1	1
Centos	2	1
LinuxMint	1	1
OpenSuse	1	512MB
Fedora	2	2
Windows XP	0.6	512MB
Windows 7	1.2	2
Windows server	2.4	2

Table 14. System requirements
Source: Elaboration Own

$$N° \; maquinas \; virtuales = \frac{Vel \; CPU * N° \; de \; nucleos \; del \; servidor}{Vel \; CPU \; Sistema \; Operativo} \quad (1)$$

$$N° \; maquinas \; virtuales = \frac{Memoria \; RAm \; del \; servidor}{Memoria \; ram \; necesario} \quad (2)$$

According to equations 1 and 2 can determine the maximum number of virtual machines that can be deployed according to the requirements of each operating system and the resources that owns the server.

Table 14 shows the resources that owns the server, in this case is taken into account the basic resources for the implementation of the platform OpenNebula so for sizing 2.4 Ghz cores 15 and 30 Gb is take detailed RAM, thus determining each of the different operating systems the maximum number of virtual machines that can run at the same time.

System Operative	Resources Actualy		MVs
	Núcleos CPU(2.4GHz)	Memoy(GB)	
Ubuntu	15	30	30
Centos	15	30	18
LinuxMint	15	30	30
OpenSuse	15	30	30
Fedora	15	30	15
Windows XP	15	30	60
Windows 7	15	30	15
Windows server	15	30	15

Table 15. Number of possible virtual machines
Source: Elaboration Own

Bandwidth Dimensioning

an analysis of traffic in and out is performed to determine the total bandwidth (AB) that requires a user to access the platform and the virtual machine and from this determined according to the number of users as is the AB you must be assigned to subnets within the Technical University Northern AB and the minimum that should be the internet connection.

The monitoring is performed by Exinda equipment is installed on the UTN, Figure 13 shows that consumption or AB input to the OpenNebula server is 13 kbps and Figure 14 shows that traffic output is 11kbps for a user so that an

analysis is made that the number of students in a classroom that on average is 40 and it is determined that the minimum AB is 991 kbps to ensure access to the platform OpenNebula.

Inbound Conversations				
External IP (User)	Internal IP (User)	Application	Transfer Rate (kbps)	Packet Rate (pps)
Total			13.642	25
FICA-WIRELESS: Auto Catch-all				
172.16.3.74	172.17.42.12	WebSocket[cloudfica.utn.edu.ec:29876]	7.682	14
172.16.3.74	172.17.42.12	Yahoo	5.960	10

Figure 12. Incoming traffic on the server OpenNebula
Source: Elaboration Own

Outbound Conversations				
External IP (User)	Internal IP (User)	Application	Transfer Rate (kbps)	Packet Rate (pps)
Total			11.143	16
FICA-WIRELESS: Auto Catch-all				
172.16.3.74	172.17.42.12	WebSocket[cloudfica.utn.edu.ec:29876]	7.385	10
172.16.3.74	172.17.42.12	Yahoo	3.758	5

Figure 13. Output traffic server OpenNebula
Source: Elaboration Own

3. Results

3.1 Openstack

The performance testing platform OpenStack measuring RAM and CPU consumption was realized in the physical server for simultaneous execution of 5, 10 and 15 virtual machines with Ubuntu Server Operating System.

In Table 14, the result of the total consumption of RAM for virtual machines and assigned shown each according to the parameters of each operating systems, it can be concluded that according to the resources allocated to each instance RAM consumption and processing is low, because it is not working with applications requiring higher amount RAM on each virtual machine.

System SS.OO	Number VMs	Memory RAM	Use of RAM	
			Por VM	Total
	5	2 GB	1.4 GB	7 GB
Ubuntu Server	10	2GB	1.7 GB	17 GB
	15	2GB	1.7 GB	26 GB

Table 16 shows the total consumption of processing on the host host used by the virtual machines and assigned to each virtual host according to the parameters set in each operating systems, it can be concluded that according to the resources allocated each instance VCPUs consumption is low, because it is not working with applications that require more processing on each virtual machine.

SS.OO	Number of VMs	VCPU asignados	Use of VCPUs	
			Por VM	Total
	5	1 VCPU	1 VCPU	5 VCPUs
Ubuntu Server	10	1 VCPU	1 VCPU	10 VCPUs
	15	1 VCPU	1 VCPU	15 VCPUs

Table 17. Use of VCPU in 5, 10 y 15 VM
Source: Elaboration Own

3.2 Eucalyptus

Analysis of results

Analysis result sizing parameters, as can be seen in Table 18.

Parameters	Use de Equipo (Servidor)	Value a Implementar por maquina
Ancho de Banda	24Kbps	-----
Memoria RAM	1,89GB	2GB
Consumo de CPU	62,8%	80% en función del consumo
Estadística de Disco	18% sobre 90%	60% sobre %90
Velocidad de Pocesador	2,4GHz	2,4GHz
#máquinas windows		8 VMs
#máquinas linux		4 VMs

Table 18**.** Result machines requirement
Source: Elaboration Own

Based on test results it was obtained under the parameters of sizing, where it determines that Eucalyptus private cloud as a platform, allowed to run applications based on the subject of networking as GNS3, Packet Tracer.

In addition to specifying resources that meet the requirements of the instances, by appropriate tests to improve execution capabilities, physical equipment when subjected it gives us the ability to create 8 machines based on windows7 with the characteristics shown in table 17, capable of meeting the performance parameters aimed at networking applications, based on resources.

Parámetros	SS.OO	# instancias
Numero de maquinas	Windows	8
	Linux	4

Tabla 17. Resultado de requerimiento de maquinas
Source: Elaboration Own

3.3 OpenNebula

Performance tests for the execution of 5, 10, 15 virtual machines both Linux and Windows operating system determining the CPU and memory consumption is performed when the machines are at rest and when they are being used.

Linux system

In Figure 15 shows the use of a Linux which rest gender minimum consumption of 1% of the server running operating system consumption rose but equally not exceeded the allocated resources remaining in normal operation.
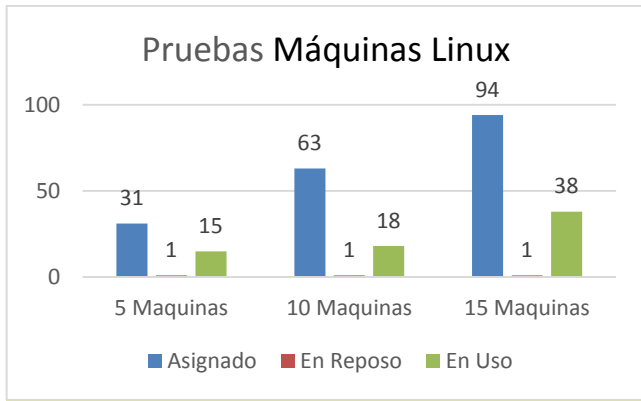
Pruebas Máquinas Linux

Figure 14. Use of CPU in Sistem Linux
Source: Elaboration Own

In Figure 16 the consumption of RAM on the server to be each virtual machine at rest and running is displayed and the proper functioning of each system was determined as consumption of RAM has not exceeded the allocated resources remained at a normal level.
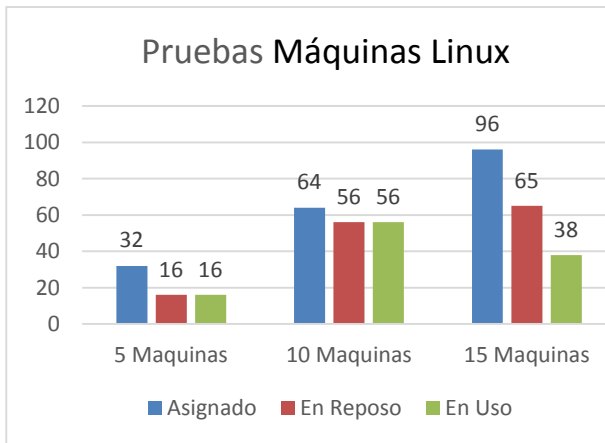
Pruebas Máquinas Linux

Figure 15. Use of Memory RAM in Linux
Source: Elaboration Own

Windows operating system

In Figure 17 you can see the consumption of 5, 10, 15 virtual machines with Windows system running at the same time, which shows that while in idle CPU consumption is minimal while when already in use their consumption increases but not exceeding the values assigned maintained in proper operation.
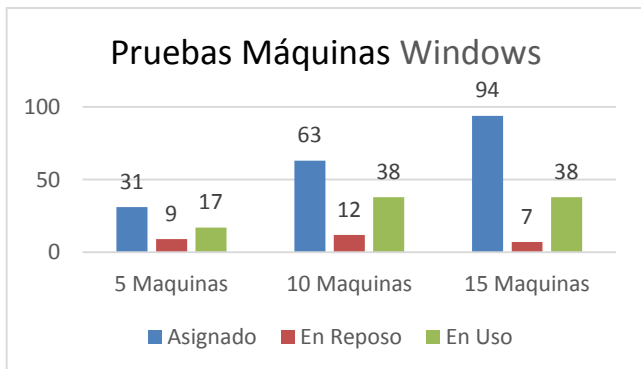
Pruebas Máquinas Windows

Figura 16. Consumo de CPU en sistemas Windows
Source: Elaboration Own

In Figure 18 the consumption of RAM that will be the server to run 5, 10, 15 virtual machines with Windows system where it can be seen that even at rest the system consumes a large amount of RAM in some cases shown overtaking the resources allocated.
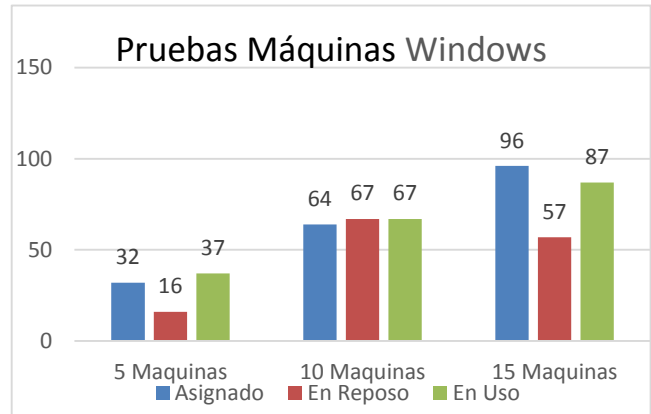
Pruebas Máquinas Windows

Figure 18. Windows
Source: Elaboration Own

4.   Conclusions

• The infrastructure private cloud under platforms OpenStack, Eucalyptus and Open Nebula within the "Facultad de Ingenieria en Ciencias Aplicadas"Faculty of Engineering of Applied Science from the "Universidad Técnica del Norte" was designed to provide services to students and teachers in the use of virtual hardware intended for different activities of different subjects, within the framework of cloud computing.

• The dimensioning was made based on the requirements of computing resources used by each operating system, working with free software their demands are lower and therefore resource consumption is lower, unlike Windows which it requires more available resources for implementation.

• The implementation of this project cloud computing, can provide a new service to the university community, emphasizing to students and teachers, that allows for academic activities from anywhere with internet access to satisfy the different needs depending on the resources obtained under sizing.

• Performance tests determining the performance of virtual machines when they are at rest and when in use and concluded that each system is run in a proper way without overloading the server where it was performed the platform stays.

• The OpenNebula platform provides a monitoring system that is integrated in the view admin web interface with which the administrator may have information about the performance of CPU resources and memory allocated to virtual machines and actual values they are being consumed helping the administrator to the dimensioning of the platform and to better manage it.

Gratitude

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