DESIGN AND IMPLEMENTACION OF THE INFRASTRUCTURE OF A PRIVATE MODEL OF CLOUD COMPUTING

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Summary. *The article presents the process made for the implementation of a project of Cloud computing, using managing of open source like OpenStack, Eucalyptus and OpenNebula, which allow to deploy models of Cloud Private. In the implementation of the project of Cloud the process bases in function of characteristics like the physical architecture of the network, the respective logical infrastructure of each agent and the dimensioned of each one of the platforms to offer infrastructure like service to the different users. Finally it gives to know the results obtained through the different proofs made to the students of the Faculty of Engineering in Sciences Applied of the north Technical University.*

Key words

Computation in the cloud, Software as a service, virtualization.

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.*

1. Introduction

In the north Technical University carries out the project of cloud computing oriented to a model of cloud private to offer infrastructure as a service to the students and educational, this initiative is born of the engineers researchers of the Faculty of Engineering in Sciences Applied and of the PhD. José Luis García Gilded.

The advance and development has formed a perspective in base to a need by part of the users to manipulate the information from any location based in the concept of cloud computing from the context of the IT.

It posed make like solution the design of a Cloud computing oriented to infrastructure employing the free platforms Openstack, OpenNebula and Eucalyptus. Which offer the service of virtual machines for the students of the career of Engineering in electronics and Networks of Communication.

In the present article detailed the design and implementation of each one of the platforms of free software to the equal that the proofs of operation that made to determine the performance decade one of them

2. Design and Implementation

The model of computation designated Cloud Computing that allows to offer scalability of any type of resource virtualization inside the network like a service.

2.1 Platforms

OpenStack

OpenStack Is a software of management of virtualization of open source, that allows to the users connect distinct technologies and components of different providers and expose an API unified, independently of the underlying technology. OpenStack, can administer different types of hipervisores, devices of network and services, components of storage, using an only API that creates a fabric of center of data unified, (ORACLE, 2014).

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

OpenStack Is the collaboration of developers and technologist that produce the platform of standard cloud computing opened so much ploughs cloud public like private. [1](OpenStack, 2015).

Main characteristics

This agent of infrastructure in the cloud as it is it OpenStack presents several characteristics that detail to continuation:

- His installation is a so much complicated, but at the same time offers a big robustness in comparison to the other agents and like this obtains an optimum and efficient platform of cloud.
- OpenStack Provides an API compatible-EC2, which allows to interact with the API of Amazon EC2; this is convenient for surroundings multi-cloud where EC2 is the API common.
- It has with his own system of storage called Swift, which is designed to provide tolerance to failures and scalability.
- Offers models of flexible networks to adapt to the needs of the different applications or groups of users. The standard models include flat networks or VLAN for the separation of servers and the traffic.
- For Half of his system of management of the identity called Keystone makes the authentication of user and of the service.

Eucalyptus

Eucalyptus is an architecture of software based in Linux that implements private and hybrid clouds scalable inside the characteristics of infrastructure of you.

The platform permit use the resources (hardware, storage and network) using an interface of autoservicio in function of the needs, that require inside the determinate activities. [1]

It appears 2. Logo Official Eucalyptus
Reference: Enterprise Edition 2.0

Eucalyptus is a platform of computation in the compatible cloud with EC2 and storage in the compatible cloud with S3. [2]

Main characteristics

- Eucalyptus Offers compatibility with the API of Amazon EC2, S3, IAM, ELB, Car Scaling and services Cloud Watch. That it offers him the capacity of a hybrid cloud.
- The Control of directions IP allows the allocation IPs to the VMs in shape dynamic, elastic and controlled. [3]
- It is implement like Infrastructure as a Service (IaaS), where the users cater of capacity of processing, storage and computational resources.[4]
- The high flexibility that possesses.
- In the implementation allows to make scalability in his exert.
- The instances of Virtual Machines execute through a software called hypervisor or VMM (Virtual Machine Monitor).

OpenNebula

OpenNebula Is a platform of low Cloud computing free software and of open source for the management distributed of the infrastructure of a center of able data to manage virtual servers for the deployment of private implementations, public and hybrid of infrastructure like service.

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

Main characteristics

- OpenNebula is a software open-source that allows to build any type of Cloud.
- It is designed to attain an integration with any type of network and storage, for like this adapt to the centers of existent data.
- OpenNebula has the capacity to manage the storage, the networks and the different technologies of virtualization existent in the actuality.
- It provides the capacity to deploy services in infrastructures distributed, combining resources of centers of data as well as of Clouds remote, in accordance with the politics of deployment.

2.2 Physical infrastructure

Like initial part of the implementation of the different platforms of cloud explain the physical infrastructure that possesses the north Technical University determining the different elements that will take part in the so much internal access like external to the different platforms to install , as it can observe in **the Figure 4** each server in which they implemented the platforms this installed in the Datacenter of Faculty of Engineering in Sciences Applied (FICA) which connect by means of the switch of distribution of the Datacenter to the central building which provides the set off for internet and the connection with the other networks of the university
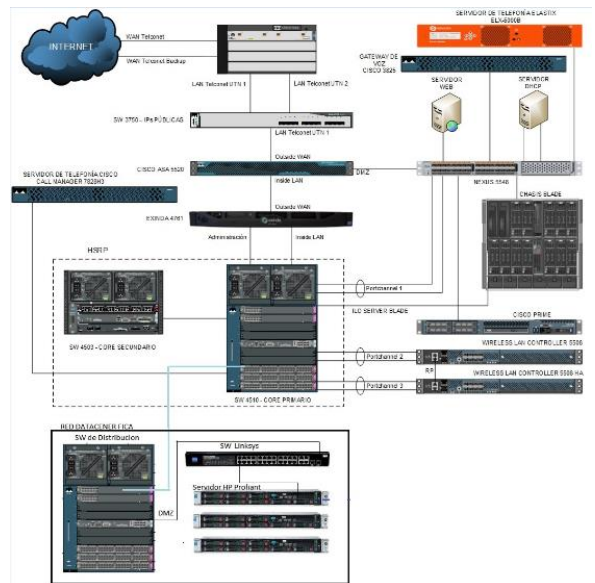

It appears 4. Physical infrastructure and his respective components

2.3 Logical architecture

OpenStack

In the Figure 3 present the systems and components with which explains OpenStack which fulfil with functionalities so different eat: the storage of volumes, the execution of virtual machines; these elements communicate between them to supply Infrastructure like service
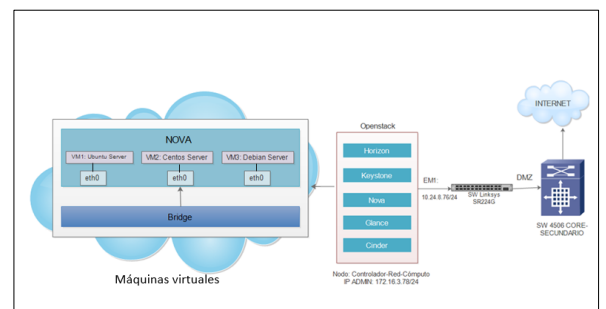
It appears 5. Logical architecture of OpenStack
Source: Own Investigation.

Node: The architecture in which it implemented the Infrastructure as a Service, consists of an alone node ("All in One"), in which they will lodge the services of the platform OpenStack eat: Horizon, Keystone, Nova, Glance and Cinder; handling to his time all the virtual machines. This node will do the function of Controller, Computation and Network.

Node Controller: Installed the components Keystone (Identification), Glance (Images of UNDER) and Horizon (Dashboard), Nova that commissions of the part of

management of the services of computation, besides the services associated to the API and the database MySQL.

Node of Computation: it finds it installed the component Nova, the attendant to do work the virtual machines, also executes the service of two hipervisores the KVM or Quemu.

Node of Network: Connect all the elements of Network, here execute several agents like the plugin-in-agent which commissions of the routing, to configure directions DHCP[1], and also caters the service of internet.

Machines virtual: they Have a virtual interface of network (eth0), the same that finds connected to the physical interface of the host host the em1 through a second logical interface known like bridge (Bridge), this communication is managed by the component Nova.

Eucalyptus

Eucalyptus Finds developed in shape modulate, giving place to the five main components that will be exposed with his high level of functionality inside the architecture of Eucalyptus, as it observes in the figure 6:

- Controller of the Cloud (CLC)
- Controller of Cluster (CC)
- Node Controller (NC)
- Storage Controller (SC)
- Walrus
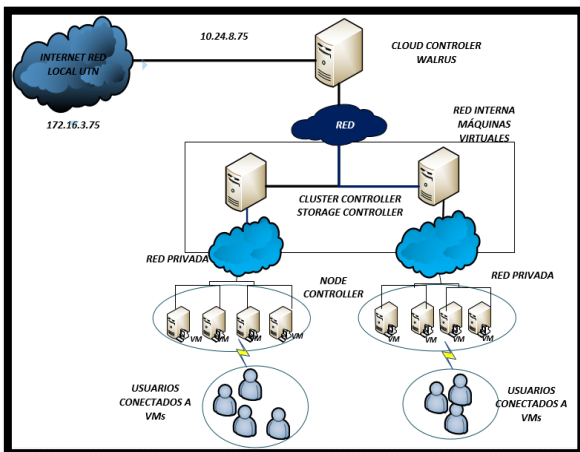
It appears 6**.** Internal architecture of Eucalyptus and his respective components
Reference: (HELION, 2013)

- **Controller of the cloud (CLC)**

The controller of the cloud fulfils his exert in the infrastructure effecting the monitory of the instances and resources of the cloud.

- Monitor the availability of resources in diverse components of the infrastructure of cloud.
- Make the monitory of the instances that are executing and resources of the cloud.

Controller of Cluster (CC)

The Controller of Cluster (CC) collect the information of the state of the nodes in the platform and effects the execution of the instances on them until the CLC.

- **Controller of Nodes (NC)**

The functionality of the Controller of Nodes (NC) bases in the execution of the machines that lodges the instances. The NC controls the activities of the VM, that is to say, his cycle of life eat:
  - ✓ Execution
  - ✓ Inspection
  - ✓ Termination

- **Storage Controller (SC)**

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

  - ✓ Storage
  - ✓ Volumes

    - **Walrus**

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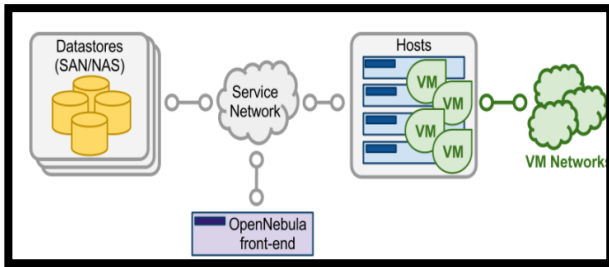
Open Nebula

In the following image describe the functional blocks that will represent the corresponding elements to the physical structure of our platform where specifies the blocks of:

- Storage

- Execution of virtual machines

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[1] DHCP: It is the Protocol of Dynamic Configuration of Host

- Infrastructure of network

- Frontend

It appears 7. Functional architecture of OpenNebula
Source:
http://docs.opennebula.org/4.14/_images/one_high.png

- **The Front-end:** it is the server where execute all the services of management, provision, monitoring, access, and administration of the platform. It is the central part of the system.
- **The Hosts**: they are the servers that execute the functions of virtualization where instance and will execute the virtual machines (VM) provided by the platform.
- **The Datastore:** they are the servers where store the corresponding images to the instances and virtual machines. The datastore are able to store several formats of disks, as well as files of configuration, kernels, volumes of storage, etc.
- **The Service Network:** it is the part of the service of network that allows the interconnection of the Hosts with the Datastore and the Frontend, besides is the communication to our private network or institutional network and provides us a connection to internet.
- **Virtual Networks:** it is the virtual infrastructure of network that allows to bear the services of network between the virtual machines (VM).
-

Dimensioning

The process of dimensioning, allows to analyze the resources that have, to establish characteristics of the capacity of the team and subject to proofs in base to the execution of applications orientates to the matters on the instances.

The implementation make it to him from the present physical resource, for each one of the platforms that can observe in the table 1.

It APPOINT SERVER		HP DL360 G9	HP DL360 G9	HP DL360 G9
Characteristics	**RAM**	32 GB	32 GB	32 GB
	PROCESSOR	1x Intel Xeon And5-2620 V3	1x Intel Xeon And5-2620 V3	1x Intel Xeon And5-2620 V3
	HARD DISK	3x450 GB	3x450 GB	3x450 GB
	TRAJETA OF NETWORK	4 X 1GBE	4 X 1GBE	4 X 1GBE
	SIST. OPERATIVE	Ubuntu Server 14.04 LTS	CentOS 6.5	Ubuntu Server 14.04 LTS
	FUNCIÓN	Cloud OpenStack	Cloud Eucalyptus	Cloud Open Nebula
	IMAGE			

Table 1. Characteristics of the physical servers
Source: Own Preparation.

The s platforms, allows the compatibility with the following operative systems s as it shows in the table 2, such as:

SOFTWARE	LINUX	WINDOWS
Platform	If it exists support in: -Opensuse	If it exists support in : -Windows 7 -Windows 8
Openstack **Eucalyptus** **Open nebula**	-CentOS -Cirros -Ubuntu -Debian -Fedora	-Windows 8 server 32 bits -Windows XP

Table 2. Support of platform with the operating systems
Source: Own Preparation.

2.4 OpenStack

The dimensioning for the implementation of the platform of OpenStack is based in requirements of the different operating systems that will be installed for the use of the applications that need the students of the Faculty of Engineering in Science Applied of the University; in the table 3 can observe said requirements.

Operating system	Memory RAM	Hard disk		Processor
		Minimum	Maximum	
Ubuntu Server	128 MB	500 MB	1 GB	x86 – 2.4 GHz
	512 MB	1 GB	2 GB	

CentOs server	1 GB	1 GB	2 GB	x86 - 1 GHz
Debian server				x64 - 2 GHz
				x86 - 2 GHz

Table 3. Requirements of the Operating systems to implement in OpenStack
Source: own Preparation.

Once that it knows the requirements that needs for the installation of the different operating systems, proceeds to verify the main characteristics that has the physical server where will implement the platform of OpenStack, as they detail in the table 1.

To be able to dimensioned the exact number of the virtual machines to implement in the platform of OpenStack, needs know with those that CPU explains the physical server; by which executes the commando *"lscpu"* to see the details of the processed, as it indicates in the 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
```

It appears 8.Information of the number of cores and sockets in the physical server.
Source: Terminal of the Server Ubuntu Server 14.04 LTS

Of agreement to the figure 8, can observe that the server where will lodge the platform OpenStack has a socket, 8 cores and 16 CPUs that will be used for the implementation of the different virtual machines.

Number of virtual machines

To make the calculation of the number of virtual machines that can create and execute simultaneously, employs the formula of the book "OpenStack Operations Guide" (Tom and others, 2014).

$$\#VM = \frac{\#CPUs \; x \; Vel \; of \; VM}{Vel \; Processor} \qquad (1)$$

Where: **#VM:** Number of virtual machines to work simultaneously.

#CPUs: Number of CPUs that has the physical server that lodged to the platform OpenStack.

Vel. Of VM: Speed of the processor and GHz of the virtual machine.

Vel Processor: Speed of the processor in GHz of the physical server.

Of agreement to the equation 1, and data obtained in the figure 4, establishes that the maximum number of virtual machines to execute simultaneously is of 16.

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

Memory RAM

This calculation does it to him of agreement to the quantity by heart RAM that needs each Operating system to be installed in the host virtual and work of suitable way.

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

: **#VM:** Number of virtual machines that can create of agreement to the quantity by heart RAM.

RAM_T: Quantity total by heart RAM of the physical server

RAM _UNDER: Memoria RAM required by the operative system of the virtual machine.

Of agreement to the values detailed in the table 3 and of the equation 2, proceeds to make the dimensioning of the number of virtual machines that can be created in relate to the consumption by heart RAM of each operating system.

TOTAL RAM	RAM S.Or.	#VM	Operating system
	1 GB	32	Ubuntu-Server
32 GB	1 GB	32	CentOs-Server
	1 GB	32	Debian-Server

Table 4. Number of VM of agreement to the memory RAM
Source: own Preparation.

The results obtained in the table 4, indicate that they can create until 32 virtual machines in relation to the consumption by heart RAM that has each operating system.

Of agreement to the platform of OpenStack, the dimensioning of the virtual machines makes it to him in relation to the flavor that provides us to the moment to fill the staff of creation of instances, whose value is 2 GB by heart RAM. Now with this value proceeds to dimensioned the number of VM that can create, by means of the equation 2.

TOTAL RAM	RAM FLAVOR	#VM	Operating system
	2 GB	16	Ubuntu-Server
32 GB	2 GB	16	CentOs-Server
	2 GB	16	Debian-Server

Table 5.Number of VM of agreement to the flavors of the OpenStack
Source: own Preparation.

The results obtained in the table 5, indicate that each virtual machine is assigned a memory RAM of 2 GB, whereas the physical team possesses 32 GB total, by which can dimensionar a total of 16 instances that can be of any operating system since each one consumes the same resource.

Calculation of Processors

This calculation makes to determine the number of CPUs virtual that needs by each operating system to implement in the virtual machines.

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

Donde: **#VCPU:** Number of CPUs by VM.

Vel_Processor: Frecuencia in GHz of the processor of the physical server

Vel _VM: Frecuencia in GHz with which will work the operating system in the virtual machine.

With the data obtained in the table 3 and the execution of the equation 3, attains determine the number of CPUs that needs each operating system for a normal operation.

Speed Processor	Speed VM	# VCPUs	System Operative
	2.4 GHz	1	Ubuntu-Server
2.4 GHz	2.0 GHz	1.2	CentOs-Server

| 2.0 GHz | 1.2 | Debian-Server |

Table 6.*Number of VCPUs by VM*
Source: Own Preparation

In the table 6, can observe that it needs at least a VCPU by each virtual machine independently of the operating system that execute in the same.

Once that it has calculated the number of VCPUs that needs by each operating system, proceeds to make the dimensioning of those that virtual machines can create .

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

Donde: **#VM:** Number of Machines virtualis.

#VCPU: CPU Virtual assigned by each Operating system

#CPU: CPUs with which explains the physical server.

By means of the resultados obtained in the table 6 and the equation 4, proceeds to calculate the number of virtual machines that can create in function of VCPUs.

#CPUs	#VCPUs	#VM	System Operative
	1	16	Ubuntu-Server
16	1	16	CentOs-Server
	1	16	Debian-Server

Table 7. Number of VM in function to the number of VCPUs
Source: Own Preparation.

The resultados obtained in the table 7, indicate that they can create a total of 16 virtual machines, already was the operating system that need in sight that each one consumes a VCPU by instance.

To continuation, in the table 8 can observe a small summary, where details the number of machines that can create of agreement to the different points treated previously.

RAM TOTAL	CPUs TOTAL	#VM by Formula	#VM by RAM	#VM by VCPU
32 GB	16	16	16	16

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

In the table 8, looks that the maximum number of creation of virtual machines is 16, in relation to the use of formula of OpenStack, consumption by heart RAM and the number of VCPUs that employs in each instance was cual was the operating system Linux that execute .

2.5 Eucalyptus

During the process of dimensioning, requires make measurements of the current resource and of the resource consumed by the platform.

Analysis of Bandwidth through EXINDA

It controls and it manages the access Web by user or host, the traffic point ready of groups of users, servers or individuals.

Through the monitory by means of the server Exinda that possesses the north Technical University, contributed resulted in base to the parameters measured in tiempor real, exposed in the table 9.
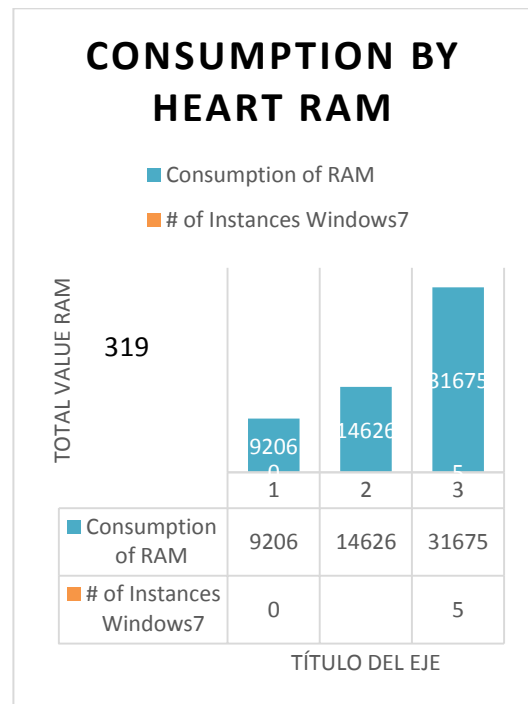
Analysis of traffic	Cup of Transfer(Kbps)	Percentage
Execution of server	1,634	7%
Execution of 5 instances	10,549	43%
Execution of 10 instances	23.969	95%

Table 9. Relation of data Exinda
Source: own Preparation.

Analysis by heart RAM

The analysis of the parameter of the memory RAM is to show a result of support of the server in base to the number of applications and virtual machines that execute on the platform of cloud designated Eucalyptus.

In base to the analysis made under the consumption by heart RAM of the server and based in the platform, observes the result in the table 10 :

# Of Instances Windows7	Consumption of RAM	Total value
Initial	9206	31985
5	14626	31985
10	31675	31985

Table 10**.** Result of the consumption of RAM

The results sand can observe in the figure 10, where established a statistical picture in function of the results.

CONSUMPTION BY HEART RAM

	Consumption of RAM	# of Instances Windows7
	1	2	3
Consumption of RAM	9206	14626	31675
# of Instances Windows7	0		5

TÍTULO DEL EJE

It appears 9. Statistical diagram of consumption of RAM
Reference: own Preparation based in analysis
Note: The value expressed in 0, determines the basic consumption of the operating system in function of the execution of the platform.

Results of consumption by heart RAM, in the instances.

The result observed in the table 11 obtained of the analysis in base to the consumption by heart RAM, when being subjected the platform during the execution of a number of instances.

Note: GNS3 is a tool of high performance that requires greater resource.

Ff

Instances Windows7	Consumption of RAM	Memory RAM without use	Total value

Execution SS.OO	1,1GB	0,9GB	2GB
GNS3 and Packet Tracer	1,87GB	0,13GB	2GB

Table 11. Result of the consumption by heart RAM of the instance

Consumption by heart RAM in function of the value hammer
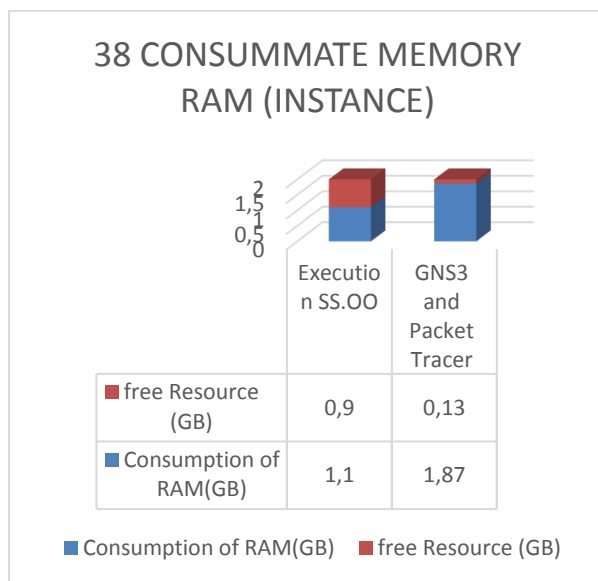
RAM applications= 1,87GB

RAM 1vm= 2 GB

RAM 10vm=2GB*10 =20 GB

Total RAM=20 GB

The instances created under the resource of 2GB by heart RAM, exposed data in the table 11, therefore it establishes a diagram in base to the consumption of the resource of the by means of a statistical diagram as it observes in the figure 11.

It appears 10. Consumption by heart RAM in the instances
Reference: own Preparation based in analysis.

Consumption of CPU

The consumption of CPU consists in an analysis of the system, by means of tools that allow to determine the use of the CPU and his utilisation.

By half, of top caters a sight in time real of the system, to continuation proceeds to obtain the data during the execution of the platform.

Praise average: 0.14; 0.18; 0.18

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

It determines 2.9% of the consumption of CPU in the server, where executes the platform.

Lto execution of 5 instances, used in   the destined applications for networking.

Praise average: 1.20; 1.38; 1.04

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

It determines 37.3% of the consumption of CPU in the server, where executes the platform.

To the ejecutar 10 instances, besides that they find using the destined applications for networking.

Praise average: 6.10; 6.16; 5.08

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

It determines 62.8% of the consumption of CPU in the server, where executes the platform.

Analysis of the result of the Consumption of the CPU

In function of the results obtained, through the monitory and according to the parameters established, determines that the consumption of CPU as it observes in the table 12 , finds related in base to the execution of applications and functions of the instances, therefore, is proportional to his use.

# Of instances	Consumption of CPU (%)	Consumption of CPU without use (%)
Initial value	2,9	97,1
5	37,8	62,2
10	62,8	37,2

Table 12. Analysis of the consumption of CPU of agreement to the number of instances.
Reference: own Preparation based in analysis.
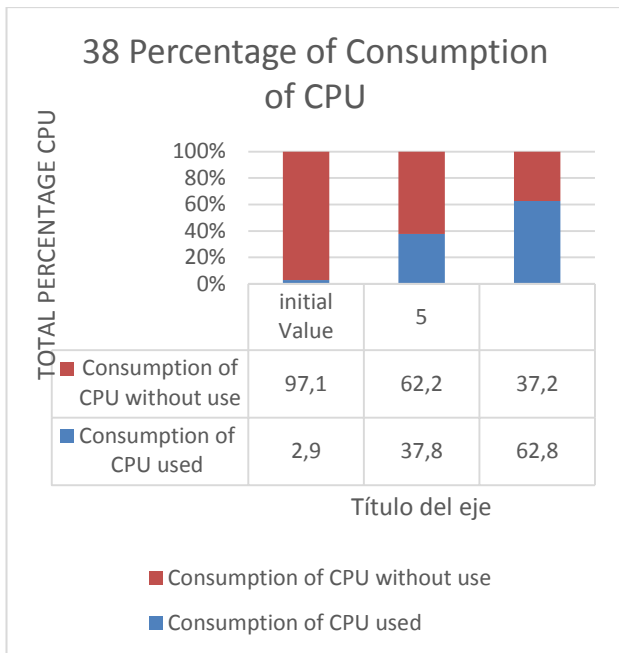
It appears 11. *Percentage of consumption of CPU*
Reference: Platform Eucalyptus SA.

The maximum value of consumption of CPU reached was of 62,8% on 100% proportionate. This value varies of agreement to the use of the instances by part of the student or user, that find exerting some type of application, as it observes in the figure 12 .

Consumption of CPU in the instances

It makes the analysis of the parameter of measurement of the consumption of CPU in base to the resource of the instance and during the execution of the applications.

The instances in base to the consumption of CPU, vary of agreement to the applications or activities to which the instances find subjected, therefore, establishes resulted in base to the consumption of CPU of the instances, as it observes in the table 13.

Instances Windows7	Consumption of CPU (%)
Execution SS.OO	0-5
GNS3 and Packet Tracer	52-60

Table 13**.** Consumption of CPU in the instance

Proofs of Operation

The instances created in base to the Platform of Eucalyptus, fundamental part of the study of cloud

computing that will be employed for the different functionalities. Appearances of applicability as it is the case to offer determinate number of instances oriented to a specific function inside the Faculty of Engineering in Science Applied of the north Technical University.

In the case of the Platform of Eucalyptus orients to offer services in base to the use of tools of Networking, providing to the academic appearance to resolve activities in function of the satisfaction of the student and educational.

2.6 OpenNebula

2.6.1 Dimensioning by heart RAM and CPU

In the following table has specified the requests of each operating system analysed, besides established the characteristics of the server and of agreement to this attained obtain the maximum number of virtual machines that can deploy in the platform, for this divides the number of cores of the server for the number of necessary cores of each system of equal way does with the memory RAM and the lower value of the 2 results corresponds to the maximum of virtual machines that can deploy of each operating system.

Operating system	Requests	
	Processing(GHz)	Memory(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. Requests of the operating systems
Reference: Own Preparation

$$N°\ Scheme\ virtual = \frac{Vel\ CPU * N°\ of\ nucleos\ of\ the\ server}{Vel\ CPU\ Operating\ system} \quad (1)$$

$$N°\ Scheme\ virtual = \frac{Memory\ RAm\ of\ the\ server}{Memory\ ram\ necessary} \quad (2)$$

Of agreement to the equations 1 and 2 can determinesr the maximum number of virtual machines that can deploy of agreement to the requisitors of each systemoperativ or and to the resources that possesses the server.

In the table 14 details the resources that possesses the server, in this case has taken in account the basic resources for the execution of the platform OpenNebula by what for the dimensioning took 15 cores of 2,4 Ghz and 30 Gb by heart RAM, determining like this of each one of the different operating systems the maximum number of virtual machines that is possible execute at the same time.

Operating system	Current resources		MV Possible
	Cores CPU(2.4GHz)	Memory(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. I number of possible virtual Machines
Reference Own Preparation

2.6.2. Dimensioning of Bandwidth

It makes an analysis of the traffic of entrance and exit to determine the total of Bandwidth (AB) that requires an user to access to the platform and to the virtual machine and from this determine of agreement to the number of users what is the AB that has to assign to the subredes inside the north Technical University and the AB minimum that has to have in the connection to internet.

The monitory makes it to him by means of the team Exinda that finds installed in the UTN, in the figure 13 can observe that the consumo or of AB of entrance to thervidor OpenNebula is of 13 kbps and in the figure 14 shows that the traffic of exit is of 11kbps for an user by what makes an analysis that for the number of students in a classroom of classes that in average is of 40 and determines that the AB minimum is of 991 kbps to guarantee the access to the platform OpenNebula

It appears 12. Traffic of entrance in the server OpenNebula
Source: Own Preparation

It appears 13. Trafico Of Exit of the server OpenNebula
Source: Own Preparation

3. Results

3.1 Openstack

For the proofs of operation of the platform Openstack made   the measurement of the memory RAM and the

consumption of the CPU in the physical server during the simultaneous execution of 5, 10 and 15 virtual machines with Operating system Ubuntu Server.

In the Table 14, shows the result of the total consumption by heart RAM of the virtual machines   and the assigned to each one of agreement to the parameters established of each Operative Systems, can conclude that the one of agreement to the resources assigned to each instance the consumption by heart RAM and of processing is low, due to the fact that it is not working with applications that demand of greater quantity memory RAM in each virtual machine.

Operating system.	Number of virtual Machines	Memory RAM Assigned	I consummate memory RAM	
			By 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**.** Consumption by heart RAM in 5, 10 and 15 VM
Source: own Preparation

The Table 15 , shows the total consumption of processing in the host host used by the virtual machines   and the assigned to each one of the host virtual of agreement to the parameters established in each Operative Systems, can conclude that of agreement to the resources assigned to each instance the consumption of VCPUs is low, due to the fact that it is not working with applications that require of greater processing in each virtual machine.

Operating system	Number of virtual Machines	VCPU Assigned	Consumption of VCPUs	
			By VM	Total
	5	1 VCPU	1 VCPU	5 VCPUs

| Ubunt u Server | 10 | 1 VCPU | 1 VCPU | 10 VCPUs |
| | 15 | 1 VCPU | 1 VCPU | 15 VCPUs |

Table 17. Consumption of VCPU in 5, 10 and 15 VM
Source: own Preparation

3.2 Eucalyptus

Analysis of results

Result of analysis of parameters of dimensioning, as puede observe in the table 16 .

Parameters	Consumption of Team (Server)	Value to Implement by schemes
Bandwidth.	24Kbps	50 Kbps
Memory RAM	1,89GB	2GB
Consumption of CPU	62,8%	80%
Statistics of Disk	18% on 90%	-------

Table 18**.** Result of request of scheme
Source: own Preparation

In base to the proofs obtained resulted under the parameters of dimensioning, where determines, that Eucalyptus like platform of cloud private, allowed to execute applications in function of the matter of networking eat: GNS3, Packet Tracer.

In addition to specifying resources that satisfy the requirements of the instances, by means of the pertinent proofs that improve the capacities of execution, to the physical team when being subjected, us proporciona the capacity to create 8 machines in function of windows7 with the characteristics that show in the table 17 , that allow to fulfil the parameters of execution of applications headed to networking, in base to the resources.

| Parameters	SS.OO	# Instances
I number of you scheme	Windows	10
	Linux	4

Table 17 . Result of request of scheme
Source: own Preparation

3.3 OpenNebula

For the proofs of performance makes the execution of 5, 10, 15 virtual machines so much of the operating system Linux as of Windows determining the consumption of CPU and memory when the machines are in rest and when they find being used.

3.3.1. System Linux

In the figure 13 can observe the consumption of an operating system Linux which in rest gender a minimum consumption of 1% of the total of the server, in execution the consumption went up but of equal way no rebaso the resources assigned keeping in a normal operation.
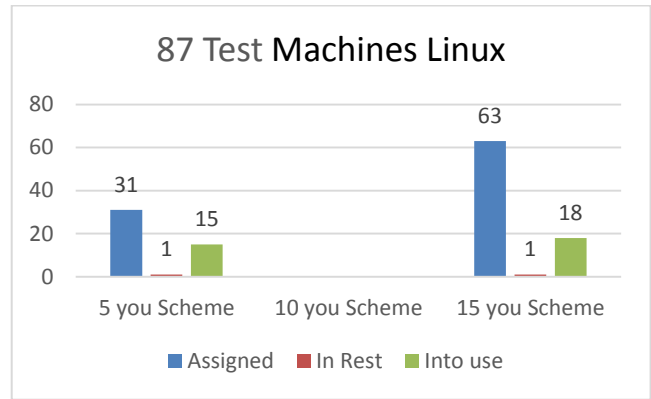
It appears 14. Consumption of CPU in systems Linux
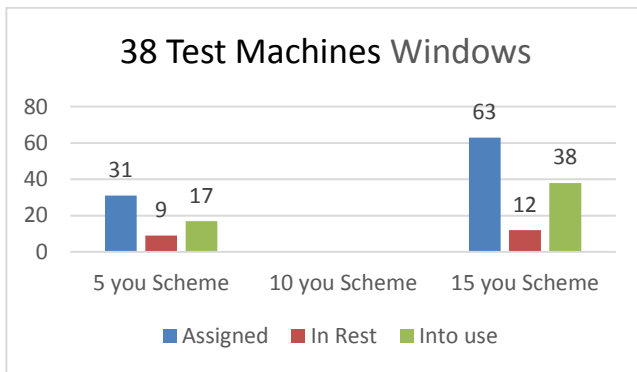Source: Own Preparation

In the figure 14 shows the consumption by heart RAM of the server when being each virtual machine in rest and in execution and determined   the correct operation of each system since the consumption by heart RAM has not exceeded the resources assigned keeping in a normal level.
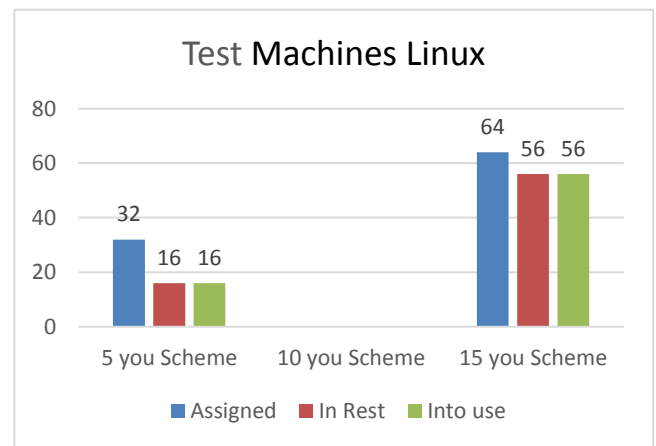
It appears 15. Consumption by heart RAM in Systems Linux
Reference: own Preparation

3.3.2. Operating system Windows

In the figure 17 can observe the consumption of 5, 10, 15 virtual machines with system Windows executing at the same time, in where it observes that while they find in rest the consumption of CPU is minimum whereas when already they find into use his consumption increases but without rebasar the values assigned keeping in a correct operation.

38 Test Machines Windows

It appears 16. Consumption of CPU in systems Windows
Source: Own Preparation

In the figure 18 shows the consumption by heart RAM that will have the server when executing 5, 10, 15 virtual machines with system Windows in where it can observe that even being in rest the system consumes a big quantity by heart RAM in some cases rebasando the resources assigned,

You test Machines Windows
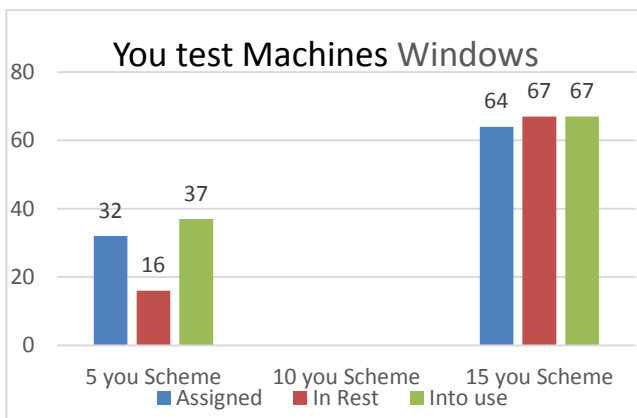
4.   Conclusions

- It designed   the infrastructures of cloud private under the platforms of Openstack, Eucalyptus and Open Nebula inside the Faculty of Engineering in Sciences Applied of the north Technical University to offer services to the students and educational in the use of virtual hardware allocated for different activities of distinct matters, inside the frame of cloud computing.

- The dimensioning made it to him in base to the requests of resources of computation employed by each operating system, when working with free software his requirements are lower and therefore the consumption of resources is lower, unlike

Windows that requires of greater disposal of resources for his implementation.

- The implementation of this project of cloud computing, allows to offer a new service to the university community, doing emphasis to the students and educational, that allow to make academic activities from cualquier place with access to internet for the satisfaction to the different needs in function of the resources obtained under the dimensioning.

- It made the proofs of operation determining the performance of the virtual machines when they find in rest and when it finds into use and arrived to the conclusion that each system executes of a correct way without overloading to the server in where it lodges the platform.

- The platform OpenNebula caters a system of monitory that comes integrated in the sight of administrator in the interface web, with which the administrator will be able to have information about the performance of the resources of CPU and memory assigned to the virtual machines and the real values that are consuming   helping to the administrator to the dimensioning of the platform and to the best handle of the same.

Gratitudes

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