Performance evaluation of Virtual Machines migration within a Datacenter

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Abstract

Nowadays, power consumption of data centers has significant impact on environment. Researchers are looking to find effective solutions for VM migration in data centers to reduce power consumption under given quality of service constraints.

This paper presents the performance evaluation of virtual machine migration within a Datacenter. We present an energy aware simulation setting using GreenCloud simulator. The simulator enables to capture the details of tasks load and consumed energy by data center elements such as physical machines, virtual machines, switches and links.
Performances results show that adequate VM migration strategy can result in significant saving in datacenter energy consumption.

***Keywords**: Virtual machine migration, data center, cluster, cloud computing, Energy consumption.*

1. Introduction

After a decade of progress in virtual machine technology [1], robust and efficient Virtual machine systems are extensively available and are fast becoming universal. Other benefits, these systems offer powerful mechanisms for managing shared server networks and clusters. The important VM [2] systems support live migration, checkpoint/pick up, and allocation of server resources as a measured quantity such as Xen [3] and VMware [4]. These competences create a great policy space for system organization infrastructures. Synchronized usage of basic mechanisms can make it possible to attach the potential of virtual machines for effective and efficient resource management.

The bigger challenge involves all of the steps to drive a computing service utility: configuring OS services and images, binding them to server resources, and managing and monitoring their interactions at both the system and application level [18-23].

This paper is organized as fellow. Firstly, we explain the basic support available for virtual machine migration within a Cloud Datacenter. Secondly, we carefully evaluate architectures and resources used by VMs for proper functioning that define when and where to migrate a VM. Then we present the simulation parameters and performances results. We conclude in Section 6.

2. VMs migration in cloud environment

2.1 Cloud Data Centers

The objective of cloud environment is mainly a large-scale data center, which is usually involved of a great number of physical machines (PMs). The Cloud Datacenter scheme is presented in the following figure.

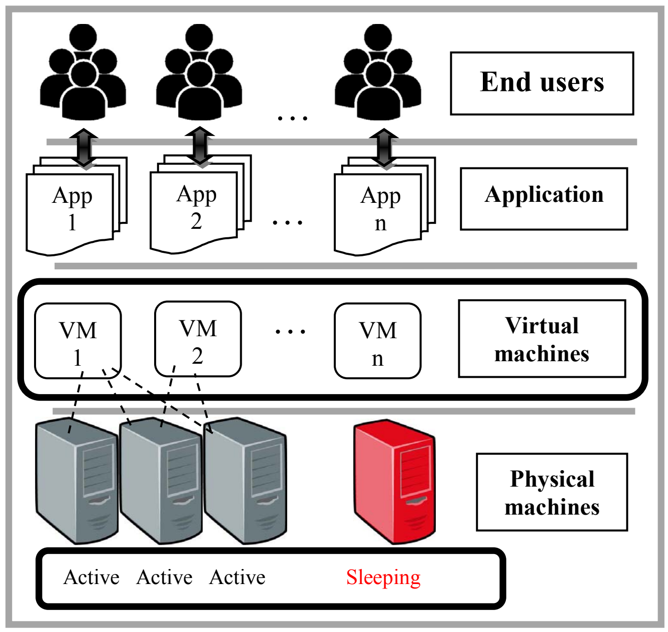

Figure 1: Cloud Datacenter architecture

Upon the physical infrastructure, virtual machines (VMs) are generally used to host several third party applications. Numerous VMs can be dynamically “started” or “stopped” on a physical machine permitting to receive workloads by sharing the resources from the same PM. These VMs can run applications based on diverse operating system environments on a single physical machine, delivering usability and flexibility for cloud end users. At the higher level, end users get services from applications installed in multiple VM that are residing on the basic physical infrastructure.

Meanwhile the internal workload differs significantly, the resource loads of each VM will differ a lot too. To merge these workloads and release some underutilized resources, Virtual machine can be dynamically migrated through different physical machines. In this way, some PM

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can be turned off or into sleep mode in order to save extra energy. In Figure.1, we set “active” and “sleeping” to define two types of node states that are represented in grey and red colors, respectively.

2.2 Virtualisation

Virtualization permits a rich deal of flexibility in the provisioning and location of servers and their associated workloads in a Cloud data center. The difficult of suppling VMs is getting a great agreement of attention [4] while placement is frequently a relatively static manual process. A virtual machine consuming only virtual resources offers a computational encapsulation that could move between physical hosts in its entirety. A feature permitted by this encapsulation is the capability to migrate a running VM from one physical host to another without a significant pause of service. This technology is presently accessible in VMware’s ESX product, Xen and it Microsoft’s Viridian product. Migration area is describe as a set of physical hosts among which a virtual machine can migrated if suitable resources are available.

In figure.2, we display the basic organization of a virtualized system. The base virtualization layer is the software that realizes different virtual machines on VMMs (virtual machine monitors).

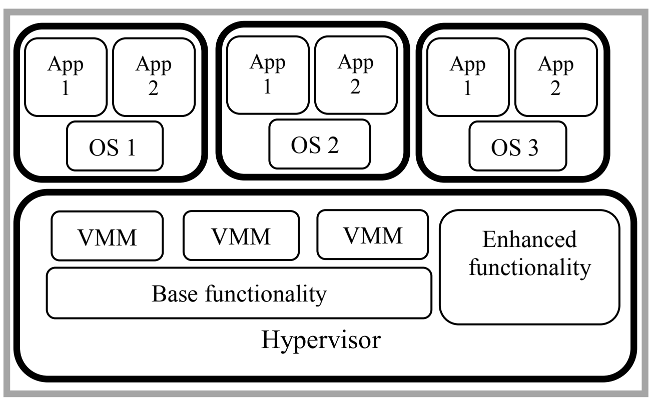

Figure 2: Basic Structure of a Virtualized System

It is the hypervisor organization in a straight line on a slate of hardware. Its functionality differs for several architectures and applications.

Every VMM running on the hypervisor has its own virtual machine generalization responsible for executing a guest OS. Its highest responsibilities are to divider and share the different resources like CPU, memory, disk and I/O procedures so that the whole system is shared by current multiplexing between diverse VMs. Live migration releases the probability of dynamically changing the mapping of virtual machines to physical hosts in a data center. This might be complete to improve the quality of service for data center users or to increase viability of providing service for data center owners.

2.3 Cloud migration

The Cloud computing structures are attractive to numerous organizations due to its scalability, affluence of management and little costs. Cloud migration makes easier the approval of flexible cloud computing. Cloud migration is the system in which we move data, application and other business related concepts from organization computers to cloud or from one cloud to another cloud [6, 18-23]. Cloud migration can displays several challenges and increase security level, but cloud computing can help to company by providing profit of data transportability, platform scalability, great accessibility, progress availability and effective resource allocation, decrease capital cost that cloud based computing deals to cloud users.

The migration of applications to cloud computing must be done in a regular means. Current enterprise applications must be methodically determine which workloads can profit most from quick migration to the cloud. While migration different parameters require to be keep into mind that are costs of migration, application reform, application performance and availability, security and privacy supplies and controlling requirements.

Such as customers fleeting their applications and data to cloud computing, it is important that the level of service provided in the cloud environment match to the service delivered by their traditional IT setting. If application botched to migrate to cloud computing eventually result in upper costs and loss of business, consequently stopping any of the potential benefits of cloud computing. This section labels series of steps that cloud users should need to know through successful migration of existing applications to cloud computing [9]:

- Evaluate your Applications and Workloads
- Construct the Business Case
- Progress the Technical Approach
- Use a Flexible Combination Model
- Discourse Security and Privacy Necessities
- Achieve the Migration

2.4 Virtual machine Migration

VM migration is the mechanism of moving VM from one physical machine to another without upsetting the rest of PMs. Migration of VM can be distributed into two classes:

a) ***Off-Line VM migration***: This migration procedure stops the VM and transfer all the positions of VM to target machine then finally restart the VM in the new host. The advantage is simple procedure however big downtime.

b) ***Live VM migration***: In this case, state of VM is relocated with minimum service failure from one host to another. The Key benefit of live VM migration is user invisible downtime with fast network [7]. Live virtual machine migration performance are:

- ***Total migration time***: Total time reserved to migrate a VM from its physical machine to the selected machine.
- ***Down time***: It present the period of time for which services are not ready for use to the machinists.
- ***Amount of migrated data***: Through the Live migration how much data is transmitted from one host to another.
- ***Migration overhead***: consists of system resource utilization.
- ***Application poverty:*** The amount with which migration slows down the applications performance within the migrating VM.

2.5 Migration policies

VM Migration policies are implemented primary by applying the overloading algorithm to examine if selected host is overloaded yet or not. The general flow of VM Migration policies is presented in Figure.3. VM overloaded detection algorithm launch when the host is overloaded, then VM collection policy used to select VMs that require to be migrated from the host. Once the list of VMs (migrated from the overloaded hosts) is determined, the VM placement algorithm is invoked to discovery a new placement for the VMs to be migrated.

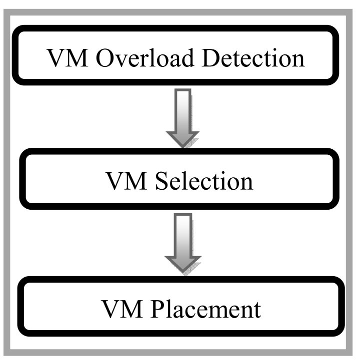

Figure 3: Flow of VM Migration

After selecting the overloaded host, the next stage is to select specific VMs to migrate from the host. After that, the host is tested again for being overloaded. If it is still considered overloaded, the policy selection VM is applied iteratively. This is stay continual until the host is not considered as overloaded. There are many VM Migration policies which can be used for identifying overloading like underestimated of migrations policy [12], Uppermost Potential Growth Policy [12], Random Choice Policy, Minimum Migration Time Policy, Maximum Association Policy, Network Aware VM migration process.

2.6 Problem of migration

The cost that virtualization can provide is producing great IT organizations to switch into virtualized data centers. Whereas this model offers a number of advantages, it becomes obligatory to manage the mapping of these VMs to the physical machines in the data center. Mapping a virtual machine suitably against a physical host requires knowing the ability of the physical hosts and the resource necessities of the virtual machines as well as an understanding of how to determinate resource activities in a way that is consistent with data center policies. In virtual Datacenters that do not process autonomic live migration, an appropriate physical host is regularly taken at the time of virtual machine creation or activation, and the virtual machine executes there till it is restarted.

Worker involvement is required to deal with unexpected events like variations in virtual machine load or unexpected downtime of physical machines. Employing an autonomic controller, it is probable to react in agreement with Datacenter policies to these events, and to present policy mechanisms that improve other factors such as power consumption or chilling loads. Because VM loads frequently modify over time, it is not sufficient to make good original placement selections. It is essential to make dynamic act alter placements if restraints are satisfied as conditions variation in the Datacenter. Since these changes happen in response to perceived conditions, such a dynamic supervisor is a feedback manager must display the same permanence and non-thrashing performances as any other feedback controller.

The problems of VM mapping starts with a configuration where the VM are previously positioned on physical hosts, and any algorithm that solves this problem must generate solutions from this initial arrangement. Such resolutions are lists of serial and parallel live migrations to be implemented to move the data center from the present state to the wanted state. As these live migrations are executed, all middle states must satisfy at least a subset of the problem constrictions, while it is possible for some constrictions to be relaxed thru this period. For example, if the virtualization software maintained oversubscribing physical memory it might be allowable to exceed a host's physical memory size through migrations even if the data center policies usually did not agree it.

Sometimes time is necessary to have a midway state that is worse than the original state for better-gotten final state. External conditions might also permit constraints to be relaxed, a fire or a midair conditioner failure in the data center might agree a degree of overload not generally allowed. VM and physical machines may be added or/and detached from the datacenter and the resource loads can change, so the quality of any VM mapping may degrade over time and will want to be revaluated once this happens.

We mention to the difficult of estimating the layout of a data center and generating a list of live migrations to recover the quality of the mapping of VM onto physical machines in that data center as the IRP (Iterative Rearrangement Problem)[7].

3. Related work

We read in a collected works a number of systems and techniques that put onward to provision and manage virtual networks resources. For virtual network providing, authors suggest greedy algorithms to efficiently allocate virtual machine to substrate resources. In [5], authors propose an implanting algorithm with admission control and online requests. This algorithm bids periodic optimization devices such as path splitting and path migration. Furthermore, in [6], authors suggest a method for mapping a virtual network in a cost-efficient method to guarantee that instantiated virtual networks are fit to switch any traffic pattern. Besides, authors in [7] propose an algorithm for virtual network with dynamic rearranging.

To manage virtual networks, many papers suggest diverse primitives and mechanisms. Authors in [8], suggest Virtual Router on the Move (VROOM), a primitive for virtual network management. It offers a free transfer of virtual resources (routers and links) from one physical machine to another to simplify physical network-management tasks. Additionally, [9] intends techniques for dynamic allocation of processing resources (CPU) to virtual machines. Additionally, in [10], authors extant an autonomic system named VIOLIN. Additional, the datacenter operators could use power regulator to match server power consumption to the accessible rack.

Nathuji et al. [11] have suggested organization of a data center's resource managing system where resource management is separated into local and global policies. At the local level the system powers the guest OS's control management policies. The global manager acquires the information on the existing resource allocation from the local managers and put on its policy to resolve whether the VM placement needs to be improved. However, authors have not suggested a precise policy for automatic resource organization at the global level. Beloglazov et al. [12] suggested an experimental for determining the time to migrate VMs from a host built on exploitation thresholds. It is established on the idea of setting higher and lesser employment thresholds for hosts and protection the total utilization of the CPU by all the VMs.

Beloglazov et al. [13] suggested virtual machines selection policies such as lowest migration time policy, random choice policy and maximum association policy.

The Minimum Migration Time (MMT) policy migrates a virtual machine that entails the lowest time to complete a migration rather to the other VMs distributed to the host. The RC (Random Choice) policy selects a VM to be migrated agreeing to a regularly distributed distinct random variable.

Anton Beloglazov [12] suggested a highest probable progress policy of VMs migration that have lowest CPU utilization relative to the capacity of CPU defined by VM parameters in order to the probable increase of the host's utilization and prevent an SLA violation.

Red Hat's System Scheduler [15] and Platform's VM Orchestrator [16] afford placement policies with the objective of load balancing and the saving energy consumption. They continuously display the utilization of available hosts and, if needed, achieve a remapping using live migration [14], which promises the satisfaction of policies during runtime. The user can define priorities and other parameters for the placement; however, user cannot change the policies.

4. Structure of the simulator

GreenCloud [17] is an addition to the network simulator Ns2 [17], which we developed for the training of cloud computing environments. The GreenCloud proposals users a complete modeling of the energy consumed by the total components of the data center, such as physical machines, virtual machines, links and switches. Additionally, GreenCloud offers a specific analysis of workload distributions. In addition, a specific attention is devoted on the packet level simulations of communications in the data center infrastructure. The simulator conceived the results with fixed packet size and different traffics such us CBR (Constant Bit Rate), TFRC (TCP Friendly Rate Control) and different transport protocols. Moreover, the simulator support different architecture such us three-tier debug, three tier high-speed and three-tier heterogeneous and support various Datacenter scheduler such us Green, Round Robin, Radom, Rand DENS and Best DENS. Figure 4 presents the structure of the GreenCloud extension mapped onto data center architecture.

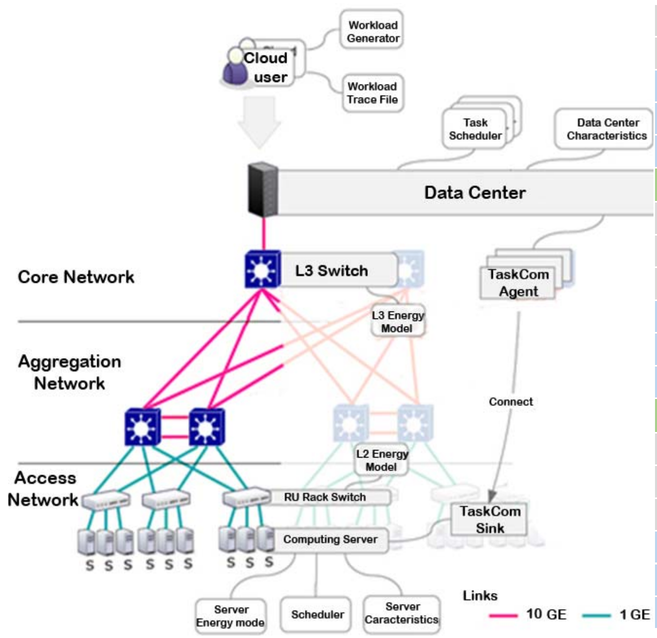

Figure 4: Architecture of the GreenCloud simulator

5. Simulation parameters and results

5.1 Experimental setup and results

We provide an example that studies simulations of an energy-aware data center and tasks load summation. The simulation parameters specifies the task that can be scheduled under VMs or physical hosts, based on the deadlines of the task. We fix the number of Core nodes, Aggregation nodes and Access node. We choose the three-tier Debug architecture and the green datacenter scheduler while the number of physical machines are varied. Table 1 summarizes the simulation setup parameters.

Data center architectures						
Parameter / Tests	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**
Nbr Core nodes	1	1	1	1	1	1
Nbr Aggregation nodes	2	2	2	2	2	2
Nbr Access switch	3	3	3	3	3	3
Datacenter architecture	Three-tier Debug					
Data-Center scheduler	Green					
Nominal Disk	500 GB					
Nominal Memory	8 GB					
Commodity Processor	8 Cores					
Task size (byte)	8500 (byte)					
Simulation time (S)	65,5 seconds					
Nbr Physical Machines	10	30	50	70	90	100
Nbr of servers	30	90	150	210	270	300
Experimental Result 1	**One Cloud User**					
Used Virtual Machines	8	26	44	62	80	89
Servers energy (W*H)	29,7	86,2	142,2	202,6	258,2	286,4
Datacenter energy W*h	192,1	249,1	305,5	366,4	422,5	450,9
VM Load	7,2	23,4	39,6	55,8	72	80,1
VM memory Load	4,6	15,08	25,52	35,96	46,4	51,62
VM Tasks (Kbyte)	6,94	20,2	33,55	47,88	61,05	67,77
Experimental Result 2	**2 Cloud Users**					
Used Virtual Machines	17	53	88	125	159	177
Servers energy (W*H)	58,8	173,8	285,5	404,1	513,9	576,2
Datacenter energy W*h	221,2	336,7	448,8	567,9	678,2	740,7
VM Load	15,3	47,7	79,2	112,5	143,1	159,3
VM memory Load	9,89	30,74	51,04	72,5	92,22	102,6
VM Tasks (Kbyte)	13,8	41,06	67,64	95,86	121,8	136,8
Experimental Result 3	**3 Cloud Users**					
Used Virtual Machines	26	80	132	185	238	265
Servers energy (W*H)	87,5	257	428,5	603,6	775,1	861,1
Datacenter energy W*h	249,9	419,9	591,8	767,4	939;4	1025
VM Load	23,4	72	118,8	166,5	214,2	238,5
VM memory Load	15,08	46,4	76,56	107,3	138,4	153,7
VM Tasks (Kbyte)	20,63	60,95	101,7	143,3	184,1	204,8

Table 1: Simulation setup parameters and results

5.2 Simulation results of Virtual Machines Tasks by Using various number of Cloud users

We fixed the number of access switch, aggregation node, nominal disk and memory. We choose the three-tier Debug architecture and the green datacenter scheduler while the number of physical machines and the cloud users are varied.

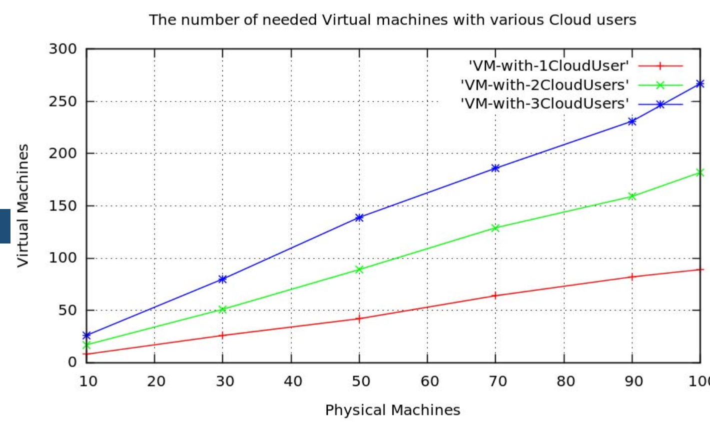

Figure 5: The number of needed Virtual machines with various Cloud users

5.3 Simulation results of energy consumption by Enabling and Disabling Virtualisation

We fixed the number of Cloud user, access switch, aggregation node, nominal disk and memory. We choose the three-tier Debug architecture and the green datacenter scheduler while the number of physical machines are varied, then we enabling and disabling the use of virtual machines.

Nbr Physical Machines	10	30	50	70	90	100

The results by Enabling Virtualisation						
Servers energy (W*H)	29,7	86,2	142,2	202,6	258,2	286,4
Datacenter energy W*h	192,1	239,1	305,5	366,4	402,5	430,9
The results by Disabling Virtualisation						
Servers energy (W*H)	31,2	89,9	148,4	207,7	265,2	289,9
Datacenter energy W*h	193,6	252,8	311,7	371,5	439,5	454,4

Table 2: Results from enabling and disabling VM

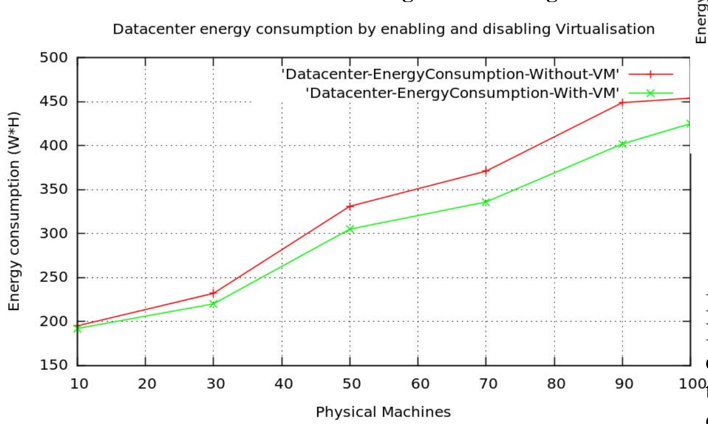

Figure 6: Datacenter energy consumption with and without VM

Figure 6 presents the variation of energy consumption of Datacenter by enabling and disabling virtualisation. The average results of datacenter energy consumption with virtualisation is (320 W*H), and energy without VM is (345 W*H), so we mark a proportion of 7,3 % between the results. This result improve the importance of virtualisation within datacenter environment.

5.4 Simulation Results of energy consumption by using Various Datacenter Schedulers

We fixed the number of Cloud user, access switch, aggregation node, nominal disk, task size and memory. We choose the three-tier Debug architecture while the number of physical machines and the datacenter schedulers are varied.

Nbr Physical Machines	10	30	50	70	90
Green Datacenter scheduler results					
Servers energy (W*H)	29,7	86,2	142,2	202,6	258,2
Datacenter energy (W*h)	192,1	249,1	305,5	366,4	422,5
Round Robin Datacenter scheduler results					
Servers energy (W*H)	68,6	205,6	342,3	479,4	615,8
Datacenter energy (W*h)	231	368,5	505,6	643,2	780,1
HEROS Datacenter scheduler results					
Servers energy (W*H)	31,8	93,9	155,0	216,5	276,8
Datacenter energy (W*h)	194,2	256,8	318,3	380,3	441,1

Table 3: Results by using various Datacenter Schedulers

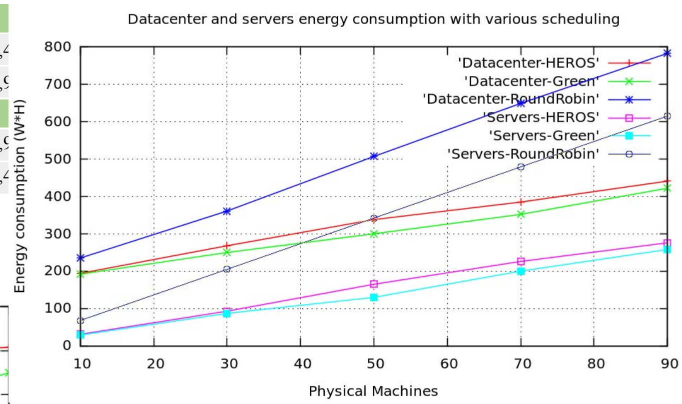

Figure 7: Datacenter and Servers energy consumption with various scheduling

Figure 7 presents variance of energy consumption of Datacenter with various scheduling. As it shown, with HEROS and Green algorithms we got less energy consumption. One cloud user and 90 PMs were set to perform the simulations. Green algorithm is very less ensuing in less energy consumption. HEROS algorithm can be used in both homogeneous and heterogeneous data centers to provide energy-efficient load balancing. Round robin scheduling is simple, easy to implement, and starvation-free but beside HEROS and Green algorithms, it does not present great performance within datacenter environment.

6. Conclusion and future work

In this paper, we present the performance evaluation of virtual machine migration within cloud environment. We presented the simulation environment for energy-aware cloud computing data centers.

Green Cloud agreements realized by decreasing the energy consumed by data centers, by designing power-aware load balancing and by resource- allocation algorithms.

In the future, there are still a number of research activities that we plan which could improve the performance of ordonnance algorithms within VM migration.

Moreover, our future work includes the VM autonomic migration through Green Cloud covering SLA constraints.

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