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Energy Efficiency in Virtualized Cloud Environment

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Abstract

Dynamic virtual machines (VMs) provide services in a cloud environment. The manner the VMs allocated to PMs influences the efficiency of cloud applications and resource competence. By using VM migration techniques, it is viable to move the VMs on from over-utilized physical machines (PMs) to under-utilized PMs ensuring the stable load on all PMs using virtualization technology. This research article illustrates the Live VM migration in the cloud system. The importance of energy efficiency in the CDC, VM Migration Process, performance metrics that are used to evaluate the efficiency of Live VM migration, and comparative analysis of VM migration techniques is also highlighted.

1. Introduction

Live VM migration is a technology for relocating VM states [1] like memory, cache from one PM to another PM. It has been under research for a couple of years, but few issues [2] still require further evaluation and explanations. Live O.S migration is a significant tool for CDC management teams by precisely isolating software and hardware [3] cogitations and data centers in a single coherent administration realm that helps with error-tolerance, resource management [3], and system maintenance. Originally in cloud computing, a strenuous effort is needed to manage long-lasting interconnection at the implementation level[4], recommended the notion of live VM migration that can transfer the entire O.S. Author [3]convey that the memory image is transferred from the host machine to another one in live VM migration [4]has also analysed the effective writable set and determined the O.S[4] migration efficiency.

2. Energy Efficiency in Cloud Computing

we can consummate servers and refrigerating systems are the most significant energy-depleting facilities in the CDCs, resulting in increased functional costs. Consequently, decreasing the energy consumption of data centers and air conditioning systems is a key issue for the sustainable development of data centers. The energy use of cloud data centers hinders the expansion of data centers due to the enormous cost of electricity and, meanwhile, the rapid development of CO_2 gasses is adversely affecting the atmosphere [5].

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The power consumption problem of the CDC has attracted the interest of both scientific and corporate enterprises. According to [6], 40 percent of the energy is exhausted in the cloud. We can deduce servers and air conditioning systems are the most crucial power-depleting physical hosts and 40 percent of the power is used to store cloud information as

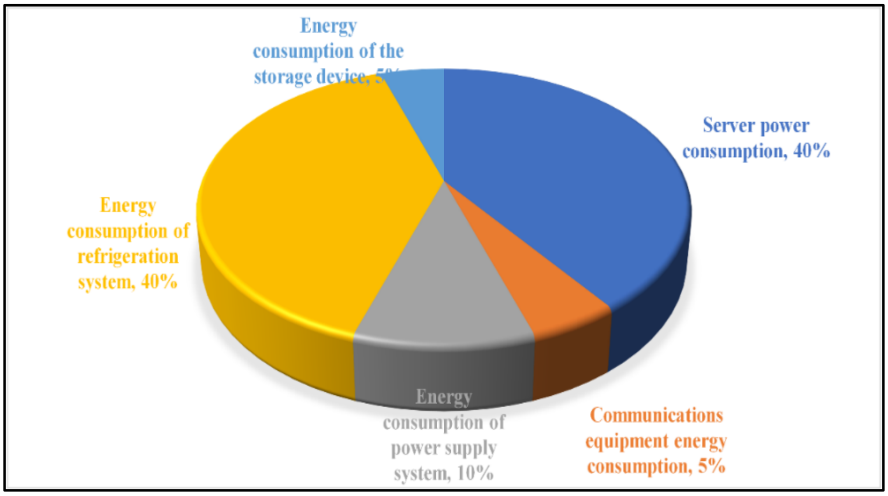

Figure 1 Energy consumption distribution of data centers

shown in Figure 1. 10% and 5% of the electricity used to supply power to servers and communication devices. And the remaining 5% of the energy is supplied to the air-conditioning system of the data centers.

3. VM Migration Process

A giant cloud infrastructure, that may encompass a variety of physical nodes, represents an infrastructure for the virtual machine migration process. The application architecture incorporates dispatchers [7], local and global managers, and Virtual Machine Monitor (VMM)[7]. Local managers evaluate the present usage of node infrastructure. Local managers help in choosing VMs which can be relocated from one PM to another PM in the following circumstances:

1. Whenever there is a threat of a breach of the SLA, the use of resources is 100 percent.
2. When One VM impoverishes the network due to immense data transfer as it interacts with some other VM delegated to another physical host.
3. When the temperature surpasses some mark - up to frigid VM nodes, they have to be transferred to another host. Data on resource usage is sent to global managers by local managers and VMs are assigned for the substantial migration process.

The virtual machine migration mechanism outlines the steps shown in figure.2 below:

1. New demand for allocation of VM.
2. Dispersing the VM requests which assist with the distribution of requests.
3. Global managers endorse information regarding the current resource management and VMs that have to be assigned to PMs.

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4. The local manager after which forwards a description of the use of resources and the VMs that are required to be moved to the corresponding global managers[7].
5. Global managers then give VMM instructions that assist to improve the current utilization.
6. Local managers inspect their hosts and grant VM resizing instructions.
7. After receiving instructions from local managers, VMM helps both VM migration and resource management.

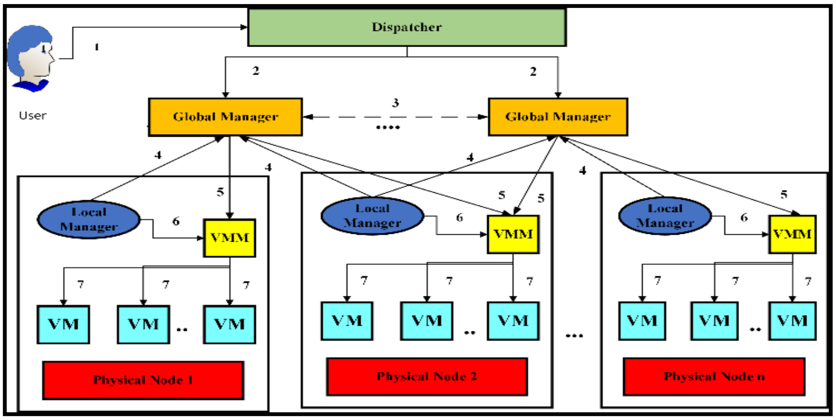

Figure 2 VM Migration Process

3.1 Performance Metric used for Live VM Migration

Research workers have recommended numerous performance parameters and these parameters are influenced when VM migration occurs. [8] demonstrates that the performance of the working applications could be downgrade when it is relocated. Thus, it is very crucial to transfer applications with nominal zero time when it is running in real-time. Author Kuno et al. [9] evaluates the efficiency of both live and non-live VM[9] migration. In live migration, VM operation retains execution and performance can deteriorate while in non-live VM[9] migration, VM suspends and no performance deteriorates. The outcome demonstrates that live migration gives enhanced performance when executing CPU comprehensive work and could be preferable for I/O exhaustive tasks if bandwidth speed is tremendous. [10] measures the performance of both the technologies XenMotion [10]and VMotion [10] and demonstrate that VMotion produces a lower amount of data being transferred than XenMotion[10] whereas XenMotion requires less overall migration time to complete its VM process than VMotion. The live migration [9] methods provide optimized performance in LAN[9] networks. The efficiency of live VM [9]migration can be evaluated with the help of the metrics mentioned below:

1. **Overall Migration Time:** This is the aggregate of the migration time of total VM migrants. Its value can alter because of the extent of data to be transferred at the time of migration. It relies on the overall amount of data transferred from origin host to target host and designated network bandwidth speed as shown in (1).
   $$Om = vm/n \qquad (1)$$
   Where, Om = overall migration time

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vm= overall VM memory
n =network bandwidth

2. **Data Transferred:** It is the amount of total data transmitted throughout VM migration and besides, it contains duplicate pages.
3. **VM Downtime:** It is the extent of time when VM is unresponsive due to the suspension of VM execution. Downtime increases as modern optimization techniques are inefficient to maintain information regarding dirty pages [11] of migrating VM. The Author [11] describes the VM downtime V_d, relies on page dirty rate *p*, page length *s*, period t_k of the previous pre-copy [11] round k, and network bandwidth n, as shown in (2):

$$Vd=\frac{p*s*t_k}{n} \tag{2}$$

4. **Performance Overhead:** Deterioration of services delivered during migration acquaint network delay, additional log data, and system running costs while applications are running on the VM.
5. **Bandwidth:** It is an important metric regarding the efficiency of the VM. The assigned network bandwidth is inversely related to VM downtime and overall migration time. The quicker transmission needs additional bandwidth thus it requires fewer overall migration.
6. **Migration Overhead:** Few additional network resources are required to accomplish the migration.

Table 1 Comparative analysis of VM Migration techniques in cloud computing

Technique	Performance Metric	Performance Gain	Simulator
[12] Cuckoo Search Algorithm	Energy utilization, SLA breach metric, VM migrations, performance deterioration due to migrations	Diminished Energy consumption, Negative effect on SLA violation.	CloudSim toolkit
[13] Modified particle swarm optimization	Energy consumption, SLA Violation and Execution time.	3-12% reduction in energy, Execution time is 27 % dwindled and 9-23% SLA violation is enhanced	CloudSim toolkit
[14] Artificial bee colony	Focus on the efficient utilization of resources and enhancing the performance	Energy consumption, execution time	CloudSim toolkit
[15] Effective energy-adept VM	Improving energy competency and saving number of PMs	Energy consumption and No. of migrations	CloudSim toolkit

migration and consolidation algorithm			
[16] Artificial Bee Colony	Power consumption and VM migrations.	Diminishes power consumption and give improved performance.	CloudSim toolkit
[17] Energy Efficiency Optimization of VM Migrations technique	CPU and memory utilization, Energy usage and Sla violation.	Improves the CPU and memory utilization 14% saving in energy. and diminishes 7% SLA	CloudSim toolkit

4. Conclusion

Cloud computing renovated the IT domain leveraging virtualization technology. It aims to achieve numerous functional values such as universal computing, fault tolerance, improved energy, service quality, etc. This research article illustrates the Live VM migration in the cloud system. The importance of energy efficiency in the CDC, VM Migration Process, performance metrics that are used to evaluate the efficiency of Live VM migration, and comparative analysis of VM migration techniques is also highlighted.

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