Survey on Energy Saving Mechanisms in Cloud Computing

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***Abstract* - Energy efficiency is increasingly important for future information and communication technologies (ICT), because the increased usage of ICT, together with increasing energy costs and the need to reduce green house gas emissions call for energy-efficient technologies that decrease the overall energy consumption of computation, storage and communications. Cloud computing has recently received considerable attention, as a promising approach for delivering ICT services by improving the utilization of data centre resources. In principle, cloud computing can be an inherently energy-efficient technology for ICT provided that its potential for significant energy savings that have so far focused on hardware aspects, can be fully explored with respect to system operation and networking aspects. We can save energy by CPU Utilization and using DVFS, live migration of VM and virtualization.**

Index Terms - Cloud Computing, DVFS, Data centre, Virtualization, Green IT Live Migration.

I. INTRODUCTION

Modern resource-intensive enterprise and scientific applications create growing demand for high performance computing infrastructures. This has led to the construction of large-scale computing data centers consuming enormous amounts of electrical power. Despite of the improvements in energy efficiency of the hardware, overall energy consumption continues to grow due to increasing requirements for computing resources. For example, in 2006 the cost of energy consumption by IT infrastructures in US was estimated as 4.5 billion dollars and it is likely to double by 2011 [1]. Apart from the overwhelming an operational cost, building a data center leads to excessive establishment expenses as data centres are usually built to serve infrequent peak loads resulting in low average utilization of the resources. Moreover, there are other crucial problems that arise from high power consumption. Insufficient or malfunctioning cooling system can lead to overheating of the resources reducing system reliability and devices lifetime. In addition, high power consumption by the infrastructure leads to substantial carbon dioxide ($CO2$) emissions contributing to the greenhouse effect.

A number of practices can be applied to achieve energy efficiency, such as improvement of applications' algorithms, energy efficient hardware, Dynamic Voltage and Frequency Scaling (DVFS) [2], terminal servers and thin clients, and virtualization of computer resources [3]. Virtualization technology allows one to create several Virtual Machines (VMs) on a physical server and, therefore, reduces amount of hardware in use and improves the utilization of resources. Among the benefits of virtualization are improved fault and performance isolation between applications sharing the same 0resource (a VM is viewed as a dedicated resource to the customer); the ability to relatively easy move VMs from one physical host to another using live or off-line migration; and support for hardware and software heterogeneity.

Cloud computing naturally leads to energy-efficiency by providing the following characteristics:

- Economy of scale due to elimination of redundancies.
- Improved utilization of the resources.
- Location independence – VMs can be moved to a place where energy is cheaper.
- Scaling up and down – resource usage can be adjusted to current requirements.
- Efficient resource management by the Cloud provider

The energy consumption is not only determined by the efficiency of the physical resources, but it is also dependent on the resource management system deployed in the infrastructure and efficiency of applications running in the system. This interconnection of the energy consumption and different levels of computing systems can be seen from Figure 1.

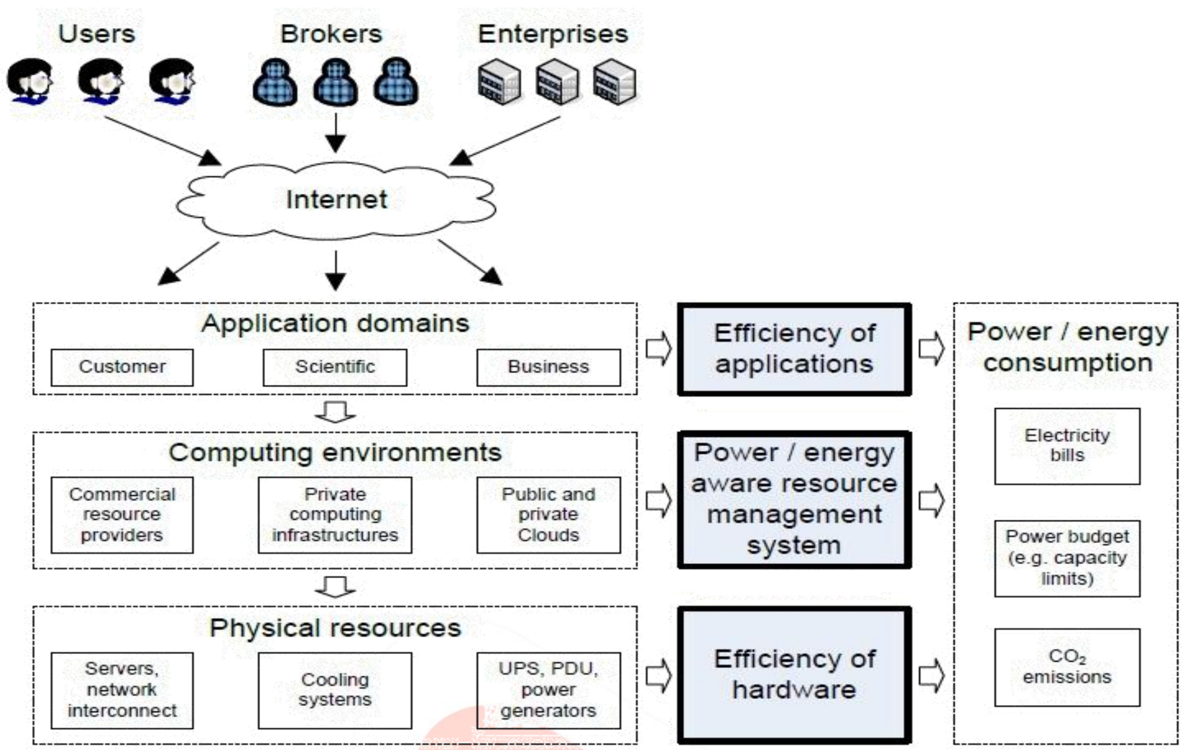

Figure 1. Energy consumption at different levels in computing systems.

II. STATIC AND DYNAMIC POWER CONSUMPTION

1. Dynamic Voltage Frequency Scaling (DVFS)

Dynamic voltage frequency scaling is a hardware technology that can dynamically adjust the voltage and frequency of the processor in execution time. By applying DVFS technology, without having to restart the power supply, system voltage and frequency can be adjusted in accordance with the specification of the original CPU design into a different working voltage. While CPU works in lower voltage, the energy consumption can effectively be saved. The power consumption of the CPU is measured by multiplying the voltage square with the system frequency (as Eq. 1.1). Where V is the voltage, F is the frequency, and C is the capacitive load of the system. The DVFS is the power saving technology by reducing the voltage supply [5]. The reduction of CPU frequency means that the voltage can also be dropped, though it will result in the degradation of th0e system performance and lead to prolong the execution time. In addition, the overhead of the voltage adjusting should also be considered. The purpose of the DVFS is to allow the degradation of the execution speed of a task by decreasing the CPU frequency and voltage to reduce the power consumption. This technology is often used in real-time systems.

$$P=V^2 * F *C \qquad (1.1)$$

As mentioned above, by applying the DVFS technology, CPU voltage can be lowered, but the execution speed of the task will be reduced. From Eq. 1.1, we can see that if only reducing the frequency, energy cannot be saved effectively. In the system, C is the capacitive load of the system, only in lowering the frequency and also reducing the voltage, the power consumption can be saved effectively.

2. Multi-core consideration

- P-State (Performance State)
  No of P-state is processor specific. Higher P- state number represents slower processor speed.
- C-State (CPU Operating State)
  Higher the c-state number the deeper the CPU sleep mode. More components are shut down to save power.
  C0 – CPU fully turned on.
  C1 – First Idle State, Stops CPU main internal clock via software.
  C2 – Stop CPU main internal Clocks via hardware.

III. VIRTUALIZATION

1. What is virtualizations?

One method to improve the utilization of resources and reduce energy consumption,which has been shown to be efficient is dynamic consolidation of Virtual Machines (VMs) enabled by the virtualization technology. Virtualization allows Cloud providers to create multiple VM instances on a single physical server, thus improving the utilization of resources and increasing the Return On Investment (ROI).

2. Types of Virtualization[4]:

- Full virtualization
- Para virtualization

2.1 Full Virtualization

Full virtualization is a complete installation of one machine is done on the another machine. It will result in a virtual machine which will have all the software that are present in the actual server.

Purposes [6]:

- Sharing computer system among multiple users.
- Isolating users from each other.
- Emulating hardware on another machine.

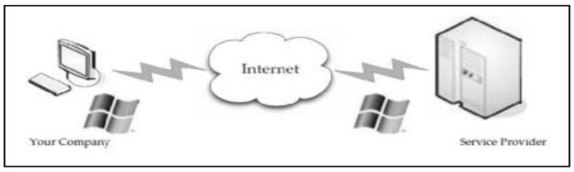

Figure 2. Full Virtualization (adopted from [6]).

2.1 Para virtualization

In this, the hardware allows multiple operating systems to run on single machine by efficient use of system resources such as memory and processor. e.g. VMware software. Here all the services are not fully available, rather the services are provided partially.

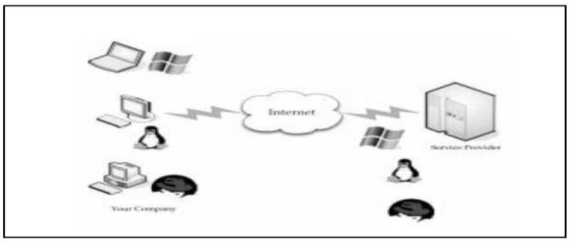

Figure 3. Para virtualization (adopted from [6]).

IV. CLOUDSIM

In this paper, CloudSim [7] is used to evaluate the performance of the energy saving mechanism. It is a cloud computing simulation software and developed by the University of Melbourne. CloudSim can support the construction of the large-scale cloud computing environment for simulation and the data center, service agent, scheduling, and resource allocation platform can also be constructed automatically. Moreover, it provides a virtualization engine that can be used to establish and manage a variety of virtualization services in the nodes of the data center.

While allocating processors for virtualization services, resources sharing in temporal and spatial can be switched flexibly. CloudSim applies mature virtualization technology, according to the requirements of users; the data center can allocate appropriate resources to each user. CloudSim provides resource management and monitoring as well as the mapping of the host and virtual machines. In addition, it provides the function for message exchange in data center and users can develop their own algorithms to be processed in CloudSim. Figure 4 shows the schematic diagram of CloudSim.

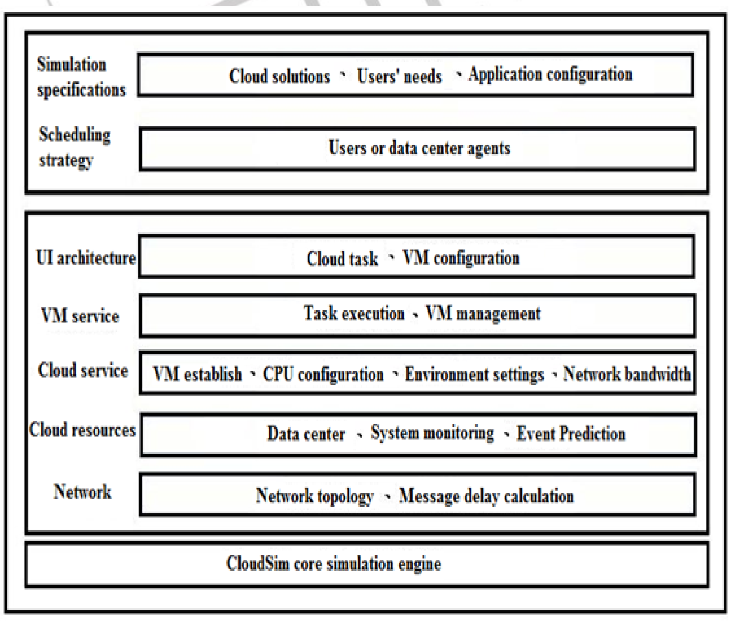

Figure 4. Schematic Diagram of CloudSim(adopted from [7]).

V. VIRTUAL MACHINE MIGRATION

Virtual machine migration technique allows a virtual machine running on a physical machine to be migrated to another physical machine. Migration can be classified into two types, offline migration and real-time migration. For offline migration, the current user's state must be suspended or shut down before the migration can be performed, and users will not be able to take any action. For real-time migration, in contrast, it is not necessary to shut down the original virtual machine and the task can be migrated at the user unaware situation. The advantages of the real-time migration include load balancing, power efficiency, and convenient maintenance [7].

Migration of memory is one of the most important issues in real-time migration [8]. Virtual migration consists of the following steps: pre-migration, reservation, iterative pre-copy, stop and copy, as well as the commitment activation. Where pre-copy is the existing virtual machine migration technology. For real-time migration, by applying the pre-copy technique, all memory pages are migrated before VM migration, once the Writable Work Sequence (WWS) is small enough or the predefined iteration numbers reached, the virtual machine will start to be migrated, CPU status and memory pages are transferred to the destination machine. Although pre-copy can compromise the system downtime and total migration time, it cannot guarantee to transfer data continuously if the number of work queue limit is reached, especially when the virtual machine is running read-intensive operations.

VI. CONCLUSION

In this paper we have studied and analyzed how energy consumption is done in computing level and here we also studied DVFS technique for adjusting voltage level dynamically. Here we also describe the virtual machine migration. From this survey we analyse that using DVFS technique we can adjust dynamically frequency and voltage and we save power consumption. Also adjusting P-state and C-State u can turn on or turn off CPU as per user requirement and get maximum cpu utilization.

REFERENCES

[1] R. Brown *et al.*, “Report to congress on server and data center energy efficiency: Public law 109-431,” *Lawrence Berkeley National Laboratory*, 2008.

[2] G. Semeraro, G. Magklis, R. Balasubramonian, D. H. Albonesi, S. Dwarkadas, and M. L. Scott, “Energy-efficient processor design using multiple clock domains with dynamic voltage and frequency scaling,” in *Proceedings of the 8th International Symposium on High-Performance Computer Architecture*, 2002, pp. 29–42.

[3] P. Barham, B. Dragovic, K. Fraser, S. Hand, T. Harris, A. Ho, R. Neugebauer, I. Pratt, and A. Warfield, “Xen and the art of virtualization,” in *Proceedings of the 19th ACM symposium on Operating systems principles*, 2003, p. 177.

[4] A Taxonomy and Survey of Energy-Efficient Data Centers and Cloud Computing Systems Anton Beloglazov1, Rajkumar Buyya1, Young Choon Lee2, and Albert Zomaya2 .

[5] N. Rodrigo, Calheiros, R. Ranjan, A. Beloglazov, C. A. F. D. Rose and R. Buyya, “CloudSim: A Toolkit for Modeling and Simulation of Cloud Computing Environments and Evaluation of Resource Provisioning Algorithms”, ISSN:0038-0644, Wiley Press, New York, USA **(2011)**, pp. 23-50.

[6] Ratan Mishra1 and Anant Jaiswal,"Ant colony Optimization: A Solution of Load balancing in Cloud*",International Journal of Web & Semantic Technology (IJWesT) Vol.3, No.2, April 2012*

[7] Liang-Teh Lee, Kang-Yuan Liu, Hui-Yang Huang and Chia-Ying Tseng ,” A Dynamic Resource Management with Energy Saving Mechanism for Supporting Cloud Computing”, International Journal of Grid and Distributed Computing Vol. 6, No. 1, February, 2013

[8] G. Praveen, “Analysis of Performance in the Virtual Machines Environment”, International Journal of Advanced Science and Technology (IJAST), vol. 32, SERSC, **(2011)**, pp. 53-64.

[9] Pragati Priyadarshinee, Pragya Jain,"Load Balancing and Parallelism in Cloud Computing",International Journal of Engineering and Advanced Technology (IJEAT) Volume-1, Issue-5, June 2012