ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 1, Issue 10, December 2013

An overview of Energy Efficiency for Data Center and Cloud Computing

Mohan Babu Choragudi[1], Dr. Gajendra Akhikari[2], Lavanya Vemulapalli [3]

Associate Professor, Lingayas Institute of Management and Technology Vijayawada, India[1]

ABSTRACT: Energy consumption cost and environmental result are dynamic task to cloud computing. Datacentres are the backbone of cloud computing. They proceed to be challenging issues to energy efficiency. Cloud computing is providing utility-oriented IT services to users worldwide. Customary on a pay-as-you-go model, it permits website hosting of pervasive purposes from customer, scientific, and business domains. Nevertheless, datacentre's web hosting Cloud functions consume huge amounts of energy, contributing to high operational cost and carbon footprints to the environment. We focus on the development of dynamic resource provisioning and allocation algorithms that that consider the synergy between various data center infrastructures (i.e., the hardware, power units, cooling and software), and holistically work to boost data core energy efficiency and performance. In detailed, this paper proposes (a) architectural standards for energy-efficient management of Clouds; (b) energy-efficient useful resource allocation policies and scheduling algorithms considering quality-of-service expectations, and contraptions energy utilization traits; and (c) a novel software technology for energy-efficient management of Clouds.

KEYWORDS: Cloud Computing, Data Center, Energy Efficiency, VM Consolidation

I. INTRODUCTION

The designers have always primarily focused on improving the performance of computing systems and hence the performance has been steadily growing driven by more efficient system design and increasing density of the components described by Moore's law. Although the performance per watt ratio has been constantly rising, the total power draw by computing systems is hardly decreasing. On the contrary, it has been increasing every year that can be illustrated by the estimated average power usage across three classes of servers. Apart from the overwhelming operating costs due to high energy consumption, another rising concern is the environmental impact in terms of carbon dioxide (CO2) emissions caused by this high energy consumption. In 2007, the total carbon footprint of the IT industry including personal computers, mobile phones, and telecom devices and data centres was 830 MtCO2e, 2% of the estimated total emissions and this figure is expected to grow in the coming years [1]. Therefore, the reduction of power and energy consumption has become a first-order objective in the design of modern computing systems.

There are two possible solutions to make IT Systems greener: 1) improve efficiency or 2) find a plentiful supply of clean, affordable energy. As the latter is still in the realms of science fiction, energy efficiency is where the main focus of research will be in the near future. IT companies are learning that cutting emissions and cutting costs naturally go together, by making systems energy efficient money may be saved automatically. Energy Aware Computing research is attempting to addresses this problem. Work in this field is tackling issues ranging from reducing the amount of energy required by a single processor chip to finding the most effective means of cooling a warehouse sized data centre. Cloud Computing has the potential to have a massive impact, positive or negative, on the future carbon footprint of the IT sector.

On the one hand, Cloud Computing datacentres are now consuming 0.5% of all the generated electricity in the world, a figure that will continue to grow as Cloud Computing becomes widespread particularly as these systems are "always-on always-available". However, the large datacentres required by clouds have the potential to provide the most efficient environments for computing. The growing popularity of cloud computing would therefore drive the cloud providers to build efficient systems in order reduce the total cost of ownership (TOC) and hence improve their green credentials. The main aim of Energy-Aware Computing is to promote awareness of energy consumption at both software and hardware levels and hence consumes lesser amount of power. The unique position of Cloud Computing allows this area to be brought into sharper focus and will go some way to improving the carbon footprint of IT now and in the future.

II. RELATED WORK

In the literature review below, a previous study investigated energy efficiency on cloud computing and focused on data center technology. Rajkumar Buyyaet al.[2], the author propose (a)architectural principles for energy-efficient management ofClouds; (b) energy-efficient resource allocation policies and scheduling algorithms considering quality-of-service expectations, and devices power usage characteristics; and(c) a novel software technology for energy-efficient management of Clouds. Anton Beloglazov et al.[3], he propose a novel technique for dynamic consolidation of VMs based on adaptive utilization thresholds, which ensuresa high level of meeting the Service Level Agreements(SLA). He validates the high efficiency of the proposedtechnique across different kinds of workloads using workload traces from more than a thousand PlanetLabservers.

Nguyen Quang Hung et al.[4], he propose two hostselection policies, named MAP (minimum of active physicalhosts) and MAP-H2L, and four algorithms solving the leasescheduling problem. Those algorithms reducing 7.24% and7.42% energy consumption than existing greedy mappingalgorithm. On their simulations show that energyconsumption decreased by 34.87% and 63.12% respectively.

Uddin et al.[5], he developed a tool to improve theperformance and energy efficiency of data centers. Hedivided data center components into different resource poolsdepending on different parameters. The frameworkhighlights the importance of implementing green metricslike power usage effectiveness (PUE) and data centereffectiveness and carbon emission calculator to measure theefficiency of data center. The framework is based onvirtualization and cloud computing. Meenakshi Sharma etal.[6], author firstly presented an analysis of differentVirtual machine(VM) load balancing , a new VM loadbalancing algorithm has been proposed and implemented inVirtual Machine environment of cloud computing in order toachieve better response time and reduce cost.

XinLia etal.[7], the author proposed a virtual machine placementalgorithm EAGLE, which can balance the utilization ofmultidimensional resources, reduce the number of runningPMs, and thus lower the energy consumption. Experimentalresults show, that EAGLE can reduce energy as much as15% more energy than the first fit algorithm. Song et al.[8],he developed an adaptive and dynamic model operatingsystem-base for efficient sharing of a server by optimizingresources (CPU and memory) between virtual machines.

Bo Li, Jianxin et al.[9], he introduced an energy saving online placement model, based on a balance of workload by distributing it in virtual machine to achieve less number of node to execute that load. So the workloads are replaced, and resized. However, the migration and relocation of VMs for matching application demand can impact the QoS service requirements of the user. Abdelsalam H. Maly et al.[10], he investigated new model for a power efficient technique to increase the management of Cloud computing environments. The author formulated the resource management problem in the form of an optimization model to introduce energy consumption by the Cloud.

Huang, Li et al.[11], heintroduced dynamic resource management hardware-base. Using dynamic setting for the frequency and voltage of theprocessor during running time to set the CPU in original design power. As long as CPU works in minimum voltage,the energy consumption can directly be saved. However, the complexity of management many independent voltage/frequency islands, that make the benefits not large enough.

III.PROPOSED ALGORITHM

As deliberatedpreviously, the task results in the development of an application platform that helps energy-efficient managementand allocation of Cloud data center resources. With the intention to shrink the cost of application engineering, we will be able to commonly reusepresent Cloud middleware and related applied sciences. We will be able to leverage third occasion Cloud applied sciences and servicesofferings together with (a) VM technologies equivalent to open supply Xen and commercial one from VMWare and (b) Amazon'sElastic Computing Cloud (EC2),

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 1, Issue 10, December 2013

simple Storage provider (S3); Microsoft's Azure. We will additionally leverage our ownapplied sciences comparable to Aneka, which is Internet-based platform for building enterprise Clouds. We will be able to implement an everyday resource supervisor and plug-in application adaptors to enable interplay with exceptional Cloud administration programs similar toAneka and Amazon EC2 engine. We will enforce anenergy-aware VM supervisor that guides the reallocation of VMsin line with present useful resource necessities and states of physical nodes.

A. *ENERGY-AWARE DATA CENTRE RESOURCE ALLOCATION*

The problem of VM allocation can be divided in two: the first part is admission of new requests for VM provisioning andplacing the VMs on hosts, whereas the second part is optimization of current allocation of VMs. The first part can be seen asa bin packing problem with variable bin sizes and prices. To solve it we apply modification of the Best Fit Decreasing(BFD) algorithm that is shown to use no more than 11/9 OPT + 1 bins (where OPT is the number of bins given by theoptimal solution) [12]. In our modification (MBFD) we sort all VMs in decreasing order of current utilization and allocateeach VM to a host that provides the least increase of power consumption due to this allocation. This allows leveragingheterogeneity of the nodes by choosing the most power-efficient ones. The complexity of the allocation part of the algorithmis n.m, where n is the number of VMs that have to be allocated and m is the number of hosts.

Optimization of current allocation of VMs is carried out in two steps: at the first step we select VMs that need to bemigrated, at the second step chosen VMs are placed on hosts using MBFD algorithm. We propose four heuristics for choosing VMs to migrate. The first heuristic, Single Threshold (ST), is based on the idea of setting upper utilization threshold for hosts and placing VMs while keeping the total utilization of CPU below this threshold. The aim is to preserve free resources to prevent SLA violation due to consolidation in cases when utilization by VMs increases. At each time frameall VMs are reallocated using MBFD algorithm with additional condition of keeping the upper utilization threshold notviolated. The new placement is achieved by live migration of VMs [13].

The other three heuristics are based on the idea of setting upper and lower utilization thresholds for hosts and keeping total utilization of CPU by all VMs between these thresholds. If the utilization of CPU for a host goes below the lower threshold, all VMs have to be migrated from this host and the host has to be switched off in order to eliminate the idle power consumption. If the utilization goes over the upper threshold, some VMs have to be migrated from the host to reduce utilization in order to prevent potential SLA violation. We propose three policies for choosing VMs that have to be migrated from the host.

- Minimization of Migrations (MM) – migrating the least number of VMs to minimise migration overhead.
- Highest Potential Growth (HPG) – migrating VMs that have the lowest usage of CPU relatively to the requested in order to minimise total potential increase of the utilization and SLA violation.
- Random Choice (RC) – choosing the necessary number of VMs by picking them according to a uniformly distributed random variable.

The complexity of the MM algorithm is proportional to the product of the number of over- and under-utilized hosts and the number of VMs allocated to these hosts.

Currently, resource allocation in a Cloud data center aims to provide high performance while meeting SLA, without a focus on allocating VMs to minimise energy consumption. To explore both performance and energy efficiency, three crucial issues must be addressed. First, excessive power cycling of a server could reduce its reliability. Second, turning resources off in a dynamic environment is risky from a QoS prospective. Due to the variability of the workload and aggressive consolidation, some VMs may not obtain required resources under peak load, so failing to meet the desired QoS. Third, ensuring SLA brings challenges to accurate application performance management in virtualized environments. A virtual machine cannot exactly record the timing behaviour of a physical machine. This leads to the timekeeping problems resulting in inaccurate time measurements within the virtual machine, which can lead to incorrect enforcement of SLA. All these issues require effective consolidation policies that can minimise energy consumption without compromising the used-specified QoS requirements. To achieve this goal, we will develop novel QoS-based resources selection algorithms and mechanisms that optimise VM placements with the objective of minimizing communication overhead as described below.

ISSN(Online): 2320-9801
ISSN (Print) : 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 1, Issue 10, December 2013

1) QoS-based Resource Selection and Provisioning

Data center resources may deliver different levels of performance to their clients; hence, QoS-aware resource selection plays an important role in Cloud computing. Additionally, Cloud applications can present varying workloads. It is therefore essential to carry out a study of Cloud services and their workloads in order to identify common behaviours, patterns, and explore load forecasting approaches that can potentially lead to more efficient resource provisioning and consequent energy efficiency.

2) Optimisation of Virtual Network Topologies

In virtualised data centers VMs often communicate between each other, establishing virtual network topologies. However, due to VM migrations or non-optimised allocation, the communicating VMs may end up hosted on logically distant physical nodes providing costly data transfer between each other.

IV. CONCLUSION

As a result of the examined literature review, we concluded that the previous techniques and approaches lack several features like QoS and performance against energy efficiency. Additionally, the time complexity and the reduction of the energy consumption are not highly effective. Based on our literature review we realized that the absence of and need for an integrated data center energy efficiency framework which consider the social network applications as a vital related factor in elevating energy consumption, as well as high potential for energy efficiency. Therequired integrated data center energy efficiency framework should be also applicable in different types of data centersincluding public, private and hybrid. The existence of such framework will offer a great powerful capability to deal withservice levels and resources management.

REFERENCES

[1] E. Farnworth and J.C. Castilla--□rubio, "SMART 2020: Enabling the low carbon economy in the information age," Group.
[2] Hybrid Clouds for Real-Time Systems, 2012. http://realtimecloud.com/hybrid-cloud/hybrid-clouds-for-real-timesystems/.
[3] AsgharSabbaghi, Green Information Technology andSustainability: A Conceptual Taxonomy, 2012.
[4] MueenUddin, Green Information Technology (IT) frameworkfor energy efficient data centers using virtualization, 2012.
[5] Meenakshi Sharma, Performance Evaluation of AdaptiveVirtual Machine Load Balancing Algorithm, 2012.
[6] XinLia, Energy Efficient Virtual Machine PlacementAlgorithm with Balanced and Improved Resource Utilizationin Data Center, 2013.
[7] Round-robin (RR) onWikipedia:http://en.wikipedia.org/wiki/Round-robinscheduling.
[8] Bo Li, Jianxin Li, JinpengHuai, TianyuWo, Qin Li, LiangZhong (2009),"EnaCloud: AnEnergy-saving Application LivePlacement Approach for Cloud Computing Environments", InIEEE International Conference on cloud Computing 200, 17-24.Scheduling algorithms available on website:http://en.wikipedia.org/wiki/First-come,_first-served.
[9] Abdelsalam, H., Maly, K., Mukkamala, R., Zubair, M., andKaminsky, D. 2009. Towards energy efficient changemanagement in a Cloud computing environment, Proceedingsof 3rd International Conference on AutonomousInfrastructure, Management and Security, The Netherlands.
[10] Huang, Li, An Energy Efficient Scheduling Base on DynamicVoltage and Frequency Scaling for Multi-core EmbeddedReal-Time System, 2009.
[11] Jiandun Li, JunjiePeng, Wu Zhang (2011),"A SchedulingAlgorithm for Private Clouds", Journal of ConvergenceInformation Technology, Volume 6, Number 7, 1-9.
[12] M. Yue. A simple proof of the inequality FFD (L) < 11/9 OPT (L) + 1, for all l for the FFD bin-packing algorithm. ActaMathematicaeApplicataeSinica (English Series), 7(4):321331, 1991.
[13] C. Clark, K. Fraser, S. Hand, J. G. Hansen, E. Jul, C. Limpach, I. Pratt, and A. Warfield. Live migration of virtualmachines. In Proceedings of the 2nd Symposium on Networked Systems Design and Implementation (NSDI'05).USENIX, 2005