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Power and QoS Aware Virtual Machine Consolidation in Green Cloud Data Center

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ABSTRACT: **Cloud computing is a technological way of managing large numbers of highly virtualized resources in such a way that they resemble a single large resource from management perspective. The cloud computing model—made promising by complicated automation, provisioning and virtualization technologies. Such shifts to the computational demands results in greater power consumption, increased operational costs and high carbon emissions to environment. The challenge for the Cloud Provider to deal with necessary requirement of power-performance trade-off by satisfying high Quality of Service (QoS) and Service Level Agreements (SLA) requirements while maximizing their profits. The issue of energy efficient utilization of resources is also important for Cloud entities to decide on the cloud service provider that can comply with SLA parameters. Dynamic VM consolidation includes efficient determination of overload and under-loaded hosts, so that effective decisions - like migration of VMs to other hosts, can be taken to optimize the power. In this paper, Energy-Efficient VM Consolidation Policies which meets SLAs and QoS expectations are explored and propose a novel: SLA and Energy Aware policy for Dynamic Virtual Machines Consolidation in Cloud data centers is evaluated.**

Keywords: Cloud Computing, Energy Efficiency, Qos, SLA, Virtual Machine, Consolidation, Cloudsim

I. INTRODUCTION

The technologies like Grid computing, Distributed computing, Parallel computing, Virtualization technology, utility computing and other associated technologies gave birth to Cloud Computing model. It has more significant characteristics such as large scale computation, storage, virtualization, high scalability, high reliability and low price service [1].

The challenge for the Cloud Provider to deal with necessary requirement of power-performance trade-off by satisfying high Quality of Service (QoS) and Service Level Agreements (SLA) requirements while maximizing their profits. Out of several issues, Energy consumption has attracted extensive attention in Cloud Computing as a solution to enhance the profit. Dynamic Virtual Machine (VM) Consolidation is potential approach for reducing energy consumption by dynamically adjusting the number of active machines to match resource demands, but it is one of the most important challenges in the cloud based distributed systems. The theme of this work is to propose the SLA and Energy Aware Dynamic VM Consolidation policy and provide the baseline for better performance and environment.

This work is aimed at helping cloud providers analyze several power characteristics of their own technologies as well as pre-existing IT resources to identify their favorability in the migration to the new energy efficient cloud architectures. This work can bring significant benefits to cloud providers and consumers. By conducting a performance evaluation studies a comparative analysis of proposed and various existing energy efficient VM consolidation techniques are presented. For experimentation purpose in CloudSim toolkit, real world workload traces from more than a thousand VMs are taken. The results also help in analyzing the effectiveness of existing policies.

II. RELATED WORK

Earlier work either concentrate on single type of SLAs (Service Level Agreements) or resource usage patterns of applications, such as web applications, leading to inefficient utilization of data center resources. Also, energy efficient resource management is usually addressed to wireless devices with the objective of improving battery lifetime.Some of Researches have gave their contribution in the same field that is also inspiring. Anton Beloglazov *et al.* [3] presented a survey of research in energy-efficient computing. A number of open research challenges addressed includes: The architectural principles for energy-efficient management of Clouds; energy-efficient resource allocation policies and scheduling algorithms considering QoS expectations and power usage characteristics of the devices; Both resource providers and consumers are substantially benefited. The approach is validated by conducting a performance evaluation study using the CloudSim [4-5] toolkit showing significant cost savings and demonstrates high potential for the improvement of energy efficiency under dynamic workload scenarios. Beloglazov and Buyya [6] have proposed a novel technique for dynamic consolidation of VMs based on accustomed (adaptive) utilization thresholds, which ensures a high level of meeting the Service Level Agreements (SLA). The SLA violation is less than 1% and good results achieved in number of VM migrations and energy consumption. The efficiency validation is done using various different workload traces from more than a thousand PlanetLab servers. The authors in [8] have combined and coordinated five diverse power management policies and investigated the problem of power management for a data center environment. The authors explored the problem in terms of control theory and applied a feedback control loop to coordinate the controllers' actions.

III. PROPOSED WORK

The design of proposed framework for VM Consolidation is shown in Fig. 1. The proposed framework is different at two stages in the type of algorithmic techniques used. The name given to Overload and Under-load Detection Algorithm is "Efficient Utilization" and the name given to VM selection policy is "Less Migration Time". The proposed Overload and Under-Load Detection Algorithm is named as "Efficient Utilization Algorithm" and represented as "EFU".

The common and simplest algorithms to detect the non-overload and overload states of the host are based on setting up of CPU utilization threshold. Due to unknown and dynamic workloads, static threshold heuristics are unsuitable because it do not adapt to workload changes and do not capture the time-averaged behavior. Here we adapted a dynamic heuristic of maximum utilization, as performance of system also based on maximum demand by workloads.

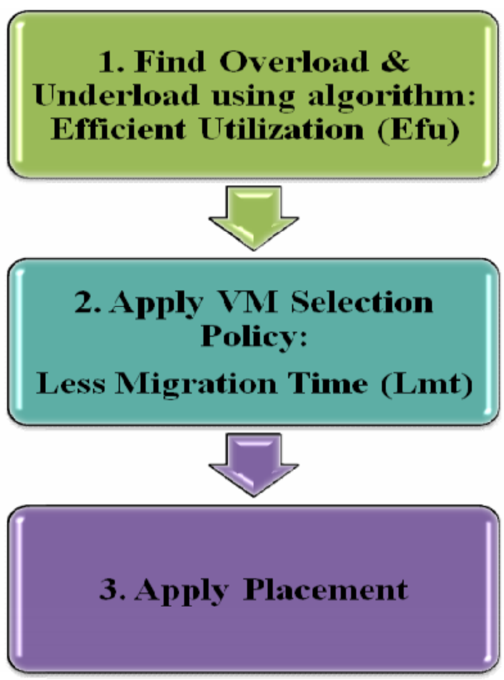

Fig. 1. Design of Proposed VM Consolidation Framework.

When the process of detecting overload or under-load detection is invoked, it compares the current CPU utilization with dynamic heuristic of the host, with the defined threshold. Based on this dynamic heuristic of maximum utilization threshold, the algorithm detects a host overload or under-load. At the next step particular VMs are selected to migrate from that host. VM selection algorithm will be iteratively applied until the host is considered as not being overloaded. Here, the proposed policy for VM selection is named as “Less Migration Time” and represented as “LMT”.

IV. EXPERIMENTAL SETUP & RESULTS

The experimental setup description includes simulation scenario and all the parameters taken. For our simulations, CloudSim uses Sun's Java version 1.7. and Apache Ant version 1.8.2 is used to compile CloudSim. A data center that is considered for simulation comprise of 800 heterogeneous physical nodes of two types. Each node is represented to have two CPU core with performance equivalent to 1860 Million Instructions per Second (MIPS) each core in Type-1 and 2660 (MIPS) each in Type-2, 4 GB of RAM, 1 GB/s network bandwidth and 1 GB of storage. This work utilizes real data on power consumption provided by the results of the SPECpower benchmark available at [11], [12], instead of using an analytical model of power consumption by a server. The general parameters and their chosen values for our simulation are mentioned in Table 1.

Table 1: General Simulation Parameters.

Variables	Value	Remark
NUMBER_OF_HOSTS	800	
No. of VMs	1052	
VM Allocation Policy	Efficient Utilization (efu)	vary as per policy we call”
VM Selection Policy	Less Migration Time (lmt)	vary as per policy we call
RAM utilization threshold	0.90	
CPU utilization threshold	0.90	
SCHEDULING_INTERVAL	900 s	15 min.
SIMULATION_LIMIT	24 * 60 * 60;	24 hrs.

Table 2: Comparison of Dvfs, IqrMmt, MadMmt, ThrMmt and EfuLmt.

Parameters	Dvfs	IqrMmt	MadMmt	ThrMmt	Proposed EfuLmt
Energy Consumption (kWh)	817.60	213.31	212.30	225.28	210.05
No. of VM migrations	0	10778	10937	11436	10442
Overall SLA violation (%)	0	0.02	0.03	0.03	0.02
Average SLA violation (%)	0	10.08	10.19	10.11	10.16
No. of Host shutdowns	440	2530	2509	2630	2434

Here in this work comparative study of following combinations of over and under-utilized host determination method, and VM selection is done with benchmark policy Dynamic Voltage and Frequency Scaling (DVFS). Also, we compared all the combinations with proposed policy.

(i) ThrMmt [Minimum Migration Time + Threshold Algorithm]
(ii) IqrMmt [Minimum Migration Time + Interquartile Range]
(iii) MadMmt [Minimum Migration Time + Median Absolute Deviation]

(iv) ThrMu [Minimum Utilization+ Threshold Algorithm]
(v) IqrMu [Minimum Utilization + Interquartile Range]
(vi) MadMu [Minimum Utilization + Median Absolute Deviation]
The comparison between Dvfs, ThrMmt, MadMmt and IqrMmt on basis of five parameters is shown in Table 2.

V. CONCLUSION & FUTURE SCOPE

VM Consolidation is key activity to realize resource allocation in a Cloud data center and power cutback. Also, to meet SLAs while maintaining power-efficient deployment is essential at data center. The problem of host overload and under-load detection is examined as a part of dynamic VM consolidation. The problem is generally dependent on statistical and historical data analysis. This problem directly influences energy efficiency and QoS delivered by Cloud Provider. A dynamic heuristic is adapted as maximum utilization and performance of system is also based on maximum demand by workloads. So this work compares the current CPU utilization with dynamic heuristic of the host with the defined threshold. Energy efficiency; QoS perspective; SLA assurance are dealt with in proposed work. As per experimental results, the proposed approach proved power-performance trade-off and offered required Quality of Service negotiated by SLA. The proposed policies can be further combined with other energy efficient techniques and tested for performance. The proposed framework would be further implemented and tested with real cloud environment, having small number of hosts and VMs.

REFERENCES

[1] Wentao Liu, "Research on Cloud Computing Security Problem and Strategy", 978-1-4577-1415-3/12, IEEE 2012.

[2] Belady C. "In the data center, power and cooling costs more than the it equipment it supports" 2007. URL: http://www.electronics-cooling.com/articles/2007/feb/a3/.

[3] Buyya R, Beloglazov A, Abawajy J. Energy-efficient management of data center resources for cloud computing: a vision, architectural elements, and open challenges" in *Proceedings of the 2010 International Conference on Parallel and Distributed Processing Techniques and Applications (PDPTA 2010).* Las Vegas, USA, July 2010.

[4] Buyya, R.; Ranjan, R.; Calheiros, R.N., "Modeling and simulation of scalable Cloud computing environments and the CloudSim toolkit: Challenges and opportunities," High Performance Computing & Simulation, 2009. HPCS '09. *International Conference on , vol., no., pp.**1**,11, 21-24 June 2009*.

[5] Rodrigo N. Calheiros, Rajiv Ranjan, Anton Beloglazov, Cesar A. F. De Rose, and Rajkumar Buyya, "CloudSim: A Toolkit for Modeling and Simulation of Cloud Computing Environments and Evaluation of Resource Provisioning Algorithms," Software: Practice and Experience (SPE), Vol. **41**, Number 1, Pages: 23-50, ISSN: 0038-0644, Wiley Press, New York, USA, January, 2011.

[6] Anton Beloglazov and Rajkumar Buyya, "Adaptive Threshold-Based Approach for Energy-Efficient Consolidation of Virtual Machines in Cloud Data Centers", MGC '2010, 29 November - 3 December 2010, Bangalore, India. Copyright 2010 ACM 978-1-4503-0453-5/10/11.

[7] Truong Vinh Truong Duy, Yukinori Sato, and Yasushi Inoguchi, "Performance Evaluation of a Green Scheduling Algorithm for Energy Savings in Cloud Computing," in *IEEE International Symposium on Digital Object Identifier, 2010*, pp. 1-8.

[8] R. Raghavendra, P. Ranganathan, V. Talwar, Z. Wang, X. Zhu, No ''power'' struggles: coordinated multi-level power management for the data center, *SIGARCH Computer Architecture News,* **36**(1) (2008) 48–59.

[9] Anton Beloglazov, Rajkumar Buyya, "Optimal online deterministic algorithms and adaptive heuris-tics for energy and performance efficient dynamic consolidation of virtual machines in cloud data centers", Wiley InterScience, *Concurr. Comput. : Pract. Exper.*, **24**(13):1397-1420, September 2012.

[10] D. Orgizovie, B. Svilicic, E. Tijan. — "Open Source Science Clouds". *In proc of MIPRO 2010, Opatija, May 24-28, 2010.*

[11] http://www.spec.org/power_ssj2008/results/res2011q1/power_ssj2008-20110124- 00338.html

[12] http://www.spec.org/power_ssj2008/results/res2011q1/power_ssj2008-20110124-00339.html

[13] K.S. Park and V.S. Pai, "CoMon: a mostly-scalable monitoring system for Planet-Lab," *ACM SIGOPS Operating Systems Review,* vol. **40**, no. 1, pp. 65–74, 2006.