International Journal of Latest Trends in Engineering and Technology
Special Issue SACAIM 2016, pp. 330-335
e-ISSN:2278-621X

A SURVEY ON DYNAMIC VM CONSOLIDATION TECHNIQUE IN CLOUD

Sreenivasa B.L[1], Mithun D Souza[2], Majed Hussain[3] and S Sathyanarayana[4]

Abstract- High energy consumption in cloud data center is growing rapidly because of data center size is becoming larger and larger. To save energy in data center Dynamic consolidation of virtual machine presents a significant opportunity. A live VM migration is one of VM consolidation approach that helps to identify under-loaded physical machines which can be switched-off or put into a low-power mode. On the other side, achieving quality of service at the desired level between cloud service providers and end user is critical. Therefore main challenges are reaching desired level Quality of Service and at same time reduce in energy consumption. In this paper, we studied the Dynamic VM consolidation techniques used by various author. We have summarized in the table, the performance metric and tool used for evaluation.
Keywords: Cloud computing, Virtual Machine Consolidation, Virtual Machine Migration.

I. INTRODUCTION

Cloud computing with its pay-as-you-go services can be classified as a new era of computing. Cloud model is composed of five essential characteristics [1]: On-demand self-service, broad network access, Resource pooling, rapid elasticity and measured service. On-demand self-service ensures that a consumer can one-sidedly provision computing capabilities automatically without requiring human interaction with each service provider. Broad network access gives access to capabilities available over the network through standard mechanisms. Resource pooling pools computing resources to serve multiple consumers. Rapid elasticity is used to elastically provision and release capabilities or resources. Measured service control and optimize resource use by leveraging a metering capability [1]. The important feature in cloud computing is virtualization. Virtualization supports storage, application, server and network devices. The benefits of virtualization are utilization of resource, portability, isolation of application, system reliability, high performance, improved manageability and fault tolerance. Computing services by using VM technology are dynamically provisioned.

The traditional CAPEX model (buy the dedicated hardware and depreciate it over a period of time) to the OPEX model (use a shared cloud infrastructure and pay as one uses it), the IT companies are moving to OPEX model for their business growth. The warehouse size

[1] *Department of Information Technology Aloysius Institute of Management and Information Technology Mangalore, Karnataka, India*
[2] *Department of Information Technology Aloysius Institute of Management and Information Technology Mangalore, Karnataka, India*
[3] *Department of Information Technology Aloysius Institute of Management and Information Technology Mangalore, Karnataka, India*
[4] *First Grade Women's College Mysore, Karnataka*

datacenters are used by the companies for providing cloud service to meet user demand, which incurs considerable amount of energy.

The remainder of the paper is organized as Motivation section, the reason is discussed. The dynamic VM consolidation techniques section, the methods are discussed. The summary on performance metric used for evaluation section, it summarizes the performance metric used in evaluating the techniques. And finally in conclusion section, we have discussed about the overall conclusion and future work.

II. MOTIVATION

Server virtualization provide an ability to run entire VM including its own operating system i.e. guest operating system on another operating system i.e. host operating system. VM can be migrated from one host to other host machine.VM migration is easier than the process migration. As process migration suffers from residual dependency. In which original host machine must remain present and network accessible, in order to service certain calls or even memory accesses on behalf of migrated process. While after successfully migrating VM the source machine is free [2].

Virtual Machine Migration methods are divided into two types [2]: Hot (live) migration and cold (non-live) migration. The status of the VM loses and user can notice the service interruption in cold migration. Virtual machine keeps running while migrating and does not lose its status. User doesn't feel any interruption in service in hot (live) migration. In live migration process, the state of a virtual machine is transferred to migrate. The state consists of its memory contents and local file system. Local file system need not be transferred. First, VM is suspended, then its state is transferred, and lastly, VM is resumed at destination host [3].

Live migration facilitates online maintenance, load balancing and energy management [3]:

A.Online maintenance:

To improve system's reliability and availability, a system must be connected with the clients. And the up gradation and maintenance of the system is also necessary task so for this all VMs are migrated away without disconnecting.

B. Load Balancing:

VMs can be migrated from heavy loaded host to light loaded host to avoid overloading of any one server.

1. Energy Management*:*

2. VMs can be consolidated to save the energy. Some of the underutilized server VM's are switched down and the consolidated servers ensure power efficient green cloud.

In data center for reducing power consumption two high-level approaches are considered: Dynamic server provisioning and Dynamic VM consolidation. By switching the idle or underutilized physical servers off or to low power modes, consolidation of VM has proven to be an effective technique in reducing the power. It leverages virtualization technology such as Xen and VMWare to provide significant benefits in data centers to reduce energy consumption [4][5]. But maintaining desired level of Quality of Service (QoS) between end user and cloud service provider is critical. . The QoS requirements are formalized via Service Level Agreement (SLA), which describes such characteristics as minimal throughput, maximal response time or latency delivered by the deployed system [6].

III. DYNAMIC VM CONSOLIDATION TECHNIQUES

A. Optimal Online Deterministic Algorithms and Adaptive Heuristics Technique:

To understand the implication on online nature of the problem, the Beloglazov and R. Buyya conducted competitive analysis. And proves that the competitive ratios of optimal online deterministic algorithms for the single VM migration and dynamic VM consolidation problems [7]. The Beloglazov and R. Buyya proposed novel adaptive heuristics for dynamic consolidation of VMs, based on an analysis of historical data from the resource usage by VMs. The developed randomized or adaptive algorithm improves the performance of optimal deterministic algorithms. The CloudSim tool is used as a simulation platform for the experiment. For experiment the data sets provided as a part of the CoMon project, a monitoring infrastructure for PlanetLab is used [8]. The local regression based algorithm combined with MMT VM selection policy significantly outperforms. In regard to the ESV metric, there is substantially reduced level of SLA violation and the number of VM migrations [7].

B. K-nearest Neighbor Regression Technique:

In order to meet SLA availability guarantee and efficient resources utilization, the Fahimeh Farahnakian et al., considered a resource utilization prediction method (KNN-UP) based on K-nearest neighbor regression that improves the performance of proposed consolidation algorithm. Since CPU consumes the main part of energy, the KNN-UP forecasts CPU usage in each host [9]. KNN-UP aims to forecast over-utilized and under-utilized host. The CloudSim tool is used as a simulation platform for the experiment. For experiment the data sets provided as a part of the CoMon project, a monitoring infrastructure for PlanetLab is used [8]. The KNN-UP is able to minimize energy consumption and SLA violation rate more efficiently [9].

C. LiRCUP: Linear Regression based CPU Usage Prediction Technique:

In this research Fahimeh Farahnakian et al., presents a CPU usage prediction method based on the linear regression technique. The linear regression technique approximates the short time future CPU utilization based on the history of usage in each host [10]. It is employed in the live migration process to predict over-loaded and under-loaded hosts. The CloudSim tool is used as a simulation platform for the experiment. For experiment the data sets provided as a part of the CoMon project, a monitoring infrastructure for PlanetLab is used [8]. The LiRCUP method is able to minimize energy cost and SLA violation rate more efficiently [10].

D. Reinforcement Learning Technique:

In this research, the Fahimeh Farahnakian et al., propose a Reinforcement Learning-based Dynamic Consolidation method (RL-DC) to minimize the number of active hosts. The RL-DC utilizes an agent to learn the optimal policy for determining the host power mode by using a popular reinforcement learning method. As the workload changes the agent learns from the past knowledge whether the host should be switched to the sleep or active mode and to improve itself. Therefore RL-DC to achieve online energy and performance management it dynamically adapts to the environment and it does not require any prior information. The CloudSim tool is used as a simulation platform for the experiment. The data set is provided by CoMon project, a monitoring infrastructure for PlanetLab is used [8]. The RL-DC method is able to minimize energy cost and SLA violation rate more efficiently [11].

E. Multi-agent technique:

In this research, Fahimeh Farahnakian et al., present a multi-agent based architecture for performing dynamic VM consolidation task in a large scale data center. Fahimeh Farahnakian et al., split the NP-hard dynamic VM consolidation problem into two sub-problems: Physical Machine's status detection and VM placement optimization. The architecture uses a local agent in each Physical Machine to solve the first sub problem using Q-learning, one of the most important reinforcement learning algorithm. Moreover, a global agent is proposed as a supervisor to dynamically optimize the VM placement based on the local agent's decisions. Therefore, agents cooperate together to minimize the number of active Physical Machine according to the current resource requirements. The CloudSim tool is used as a simulation platform for the experiment. For experiment the data sets provided as a part of the CoMon project, a monitoring infrastructure for PlanetLab is used [8]. The MADC method is able to minimize energy consumption and SLA violation rate more efficiently [12].

F. Using Ant Colony System to Consolidate VMs for Green Cloud Computing:

In this research, the Fahimeh Farahnakian et al., present distributed system architecture to perform dynamic VM consolidation to reduce energy consumption of cloud data centers while maintaining the desired QoS. Fahimeh Farahnakian et al., presented a novel dynamic Virtual Machine (VM) consolidation approach called Ant Colony System based VM Consolidation (ACS-VMC). It reduces the energy consumption of data centers by consolidating VMs into a reduced number of active Physical Machines (PMs) while preserving Quality of Service (QoS) requirements. Since the VM consolidation problem is strictly NP-hard, Fahimeh Farahnakian et al., used the Ant Colony System (ACS) to find a near-optimal solution. Fahimeh Farahnakian et al., defined a multi-objective function that considers both the number of dormant PMs and the number of migrations. . The CloudSim tool is used as a simulation platform for the experiment. For experiment the data sets provided as a part of the CoMon project, a monitoring infrastructure for PlanetLab is used [8]. The ACS-VMC not only reduced the energy consumption, but also minimized SLA violations and the number of migrations [13].

G. Migration Control in VM Selection:

In this research, Mohammad Alaul Haque Monil et al., have designed three algorithms, by doing amalgamation of heuristic method and migration control. VM selection is an important task and the energy consumption depends on the selection. Migration control could influence the VM selection mechanism as steady and resource consuming VMs not to be selected. A steady VM which is continuously consuming recourses has high probability of consuming resource in the same manner in future. So migrating such VM it will also overload the next datacenter. In this proposed model, CPU usage has been considered to identify a VM to be steady or not. The CloudSim tool is used as a simulation platform for the experiment. Migration control in Energy aware VM consolidation not only saves energy but it shows improvement in VM migration number which will reduce network traffic and also host shutdown is decreased in most of the combination which is also a positive side [14].

H. heuristics fuzzy logic and migration control:

In this research, Mohammad Alaul Haque Monil proposes the fuzzy logic and heuristic based virtual machine consolidation approach to achieve energy-QoS balance. A fuzzy VM selection method and migration control is introduced in the selection method. Fuzzy VM selection methods take intelligent decision to select VM from an overloaded host. Additionally, Migration control in Fuzzy VM selection method that will enhance the performance of the selection strategy. A new overload detection algorithm has also been proposed based on mean, median and standard deviation of utilization of VMs. The CloudSim tool is used as a simulation platform for the experiment. For experiment the data sets provided as a part of the CoMon project, a monitoring infrastructure for PlanetLab is used [8]. The heuristics fuzzy logic and migration control algorithm is able to minimize energy consumption and SLA violation rate more efficiently [15].

IV.THE SUMMARY OF PERFORMANCE METRIC USED FOR EVALUATION

Table 1 summarizes the work done by various researchers on Dynamic VM consolidation techniques in cloud. The table contains performance evaluation metrics used for evaluating the techniques for energy saving and SLA violation.

The performance evaluation metrics are as follows:
a. EC -> Energy consumption,

b. SLA violation -> Service level Agreement violation,

c. ESV -> Energy consumption and SLA violation,

d. OTF -> Overload Time fraction,

e. PDM -> Performance Degradation due to migration,

f. VMM -> Virtual machine migration.

V. CONCLUSION AND FUTURE WORK

This paper is a survey of dynamic VM consolidation techniques in cloud. . To save energy in data center Dynamic consolidation of virtual machine presents a significant opportunity. A live VM migration is one of VM consolidation approach that helps to identify under-loaded physical machines which can be switched-off or put into a low-power mode. On the other side, achieving the desired level of Quality of Service (QoS) between end user and cloud service providers is critical.we studied the Dynamic VM consolidation techniques used by various author. We have summarized in the table, the performance metric and tool used for evaluation. In future by using cloudsim tool we will compare these algorithms for the same performance metric to know the energy consumption and SLA violation.

REFERENCES:

[1]. Divya Kapil, Emmanuel S. Pilli and Ramesh C. Joshi, “Live Virtual Machine Migration Techniques: Survey and Research Challenges”, Department of Computer Science and Engineering Graphic Era Univesity Dehradum, India, 978-1-4673-4529-3/12/$31.00, 2012 IEEE.

[2] C. Clark, K. Fraser, S. Hand, J.Hansen, E.Jul, C. Limpach, I. Pratt, A. Warfield " Live Migration of Virtual Machins", 2005.

[3] Divya Kapil, Emmanuel S. Pilli and Ramesh C. Joshi, "Live Virtual Machine Migration Techniques: Survey and Research Challenges", Department of Computer Science and Engineering Graphic Era Univesity Dehradum, India, 978-1-4673-4529-3/12/$31.00, 2012 IEEE.

[4] P. Barham, B. Dragovic, K. Fraser, S. H, T. Harris, A. Ho, R. Neugebauer, I. Pratt, and A. Warfield, "Xen and the art of virtualization," in *Proceedings of the ninteenth acm Symposium on Operating Systems Principles(SOSP)*, 2003, pp. 164–177.

[5] V. Inc., "How vmware virtualization right-sizes it infrastructure to reduce power consumption," 2009.

[6] Fahimeh Farahnakian, Tapio Pahikkala, Pasi Liljeberg, Juha Plosila, Hannu Tenhunen, "Multi-Agent based Architecture for Dynamic VM Consolidtion in cloud data centers", Department of Information Technology, University of Turku, Turku, Finland, (2014) 40th Euromicro Conference on Software Engineering and Advanced Applications.

[7] Beloglazov and R. Buyya, "Optimal Online Deterministic Algorithms nd Adaptive Heuristics for Energy and Performance Efficient Dynamic Consolidation of Virtual Machines in Cloud Data Centers", Concurrency and Computation: Practice and Experience (CCPE), Vol.24, pp.1397-1420, 2012.

[8] Park KS, Pai VS. CoMon: a mostly-scalable monitoring system for PlanetLab. ACM SIGOPS Operating Systems Review 2006; 40(1):74.

[8] Park KS, Pai VS. CoMon: a mostly-scalable monitoring system for PlanetLab. ACM SIGOPS Operating Systems Review 2006; 40(1):74.

[9] Fahimeh Farahnakian, Tapio Pahikkala, Pasi Liljeberg, and Juha Plosila, "Energy Aware Consolidation Algorithm based on K-nearest Neighbor Regression for Cloud Centers", Department of Information Technology, University of Turku, Turku, Finland, (2013) IEEE/ACM 6th International Conference on Utility and Cloud Computing.

[10] F. Farahnakian, P. Liljeberg, and J. Plosila, "LiRCUP: Linear Regression based CPU Usage Prediction Algorithm for Live Migration of Virtual Machines in Data Centers", Proceedings of the 39th Euromicro Conference on Software Engineering and Advanced Applications(SEAA), pp.358-364, 2013.

[11] F. Farahnakian, P. Liljeberg, and J. Plosila, "Energy-efficient virtual machines consolidation in cloud data centers using reinforcement learning," in *22nd Euromicro International Conference on Parallel, Distributed and Network-based Processing (PDP)*, 2014, pp. 500–507.

[12] Fahimeh Farahnakian, Tapio Pahikkala, Pasi Liljeberg, Juha Plosila, Hannu Tenhunen, "Multi-Agent based Architecture for Dynamic VM Consolidtion in cloud data centers", Department of Information Technology, University of Turku, Turku, Finland, (2014) 40th Euromicro Conference on Software Engineering and Advanced Applications.

[13] Fahimeh Farahnakian, Adnan Ashraf, Tapio Pahikkala, Pasi Liljeberg, Juha Plosila,Ivan Porres, and Hannu Tenhunen," Using Ant Colony System to Consolidate VMs for Green Cloud Computing", IEEE papers: © IEEE. ACM papers: © ACM. Springer papers: © Springer.

[14] Mohammad Alaul Haque Monil, Romasa Qasim, Rashedur M Rahman," Incorporating Migration Control in VM Selection Strategies to Enhance Perfor-mance", International Journal of Information Web Applications Volume 6 Number 4 December 2014

[15] Mohammad Alaul Haque Monil,"VM consolidation approach based on heuristics fuzzy logic, and migration control", Journal of cloud computing advances, systems and applications (2016) 5:8 DOI 10.1186/s13677-016-0059-7, springerOpen.