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An Efficient Threshold-Fuzzy-Based Algorithm for VM Consolidation in Cloud Datacenter

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ABSTRACT

Cloud computing has grown exponentially in the recent years. Data growth is increasing day by day, which increases the demand for cloud storage, which leads to setting up cloud data centers. But they consume enormous amounts of power, use the resources inefficiently, and also violate service-level agreements. In this paper, an adaptive fuzzy-based VM selection algorithm (AFT_FS) is proposed to address these problems. The proposed algorithm uses four thresholds to detect overloaded host and fuzzy-based approach to select VM for migration. The algorithm is experimentally tested for real-world data, and the performance is compared with existing algorithms for various metrics. The simulation results testify to the proposed AFT_FS method is the utmost energy efficient and minimizes the SLA rate compared to other algorithms.

KEYWORDS

Adaptive Four Threshold, Cloudsim, Energy Efficiency, Fuzzy Logic, Host Classification, SLA Violation Rate, VM Consolidation, VM Selection

1. INTRODUCTION

The need for computing resources is growing day by day due to the availability of cloud-based services. The refinement of these services is pay-as-you-go modality. Ever increasing the storage demands, cloud service providers launched the warehouse-size data centers, for satisfying the customer needs. The cloud data centers provide computing services dynamically through Virtual Machine (VM) technologies. They provide favorable circumstances for consolidation and environmental isolation. Nowadays IT companies are shifting from their traditional Capital Expenditure (CapEx - buy the original hardware) to the Operating Expenditure (OpEx - use shared cloud services and pay as one uses it) (Monil & Rahman, 2015). Initially, cloud service providers only focused on the user demands and did not consider the amount of energy.

The reason behind the high energy consumption of data centers is not only the high volume of computing resources available and inefficient power usage of hardwares but also the inefficient use

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of the resources. The problem is that, a fixed range of power is given to all servers: Even idle servers consume 70% of their peak power. Another crucial issue is high energy consumption by computing resources like running servers which emit a significant amount of heat. Cooling the operational servers which consumes high amount of power. The running servers not only produce the heat energy, they also emits a significant amount of carbon-di-oxide (CO_2).

The energy inefficiency is overcome by using virtualization technology. It endorses cloud service providers to create multiple Virtual Machines (VMs) or instances in each host on the servers, that improves the utilization of the resources. The reduction in energy consumption can be achived by deputizing idle servers to sleep, or hibernation mode which evicts the idle system. The primary objective is to keep minimum hosts active in the given time. The VM consolidation will migrate VMs from overloaded host to normally loaded host which may lead to quality of service degradation, that is Service Level Agreement (SLA) Violation Rate. Hence algorithms must be designed in such a way that they not only reduce energy consumption but also serve desired QoS (like SLA). There are two types of VM consolidation. The first type is known as static VM consolidation where VM size is set up in a single deed using the peak load demand of the workload. VMs are placed in the same host during their entire lifetime. Setting the VM size for the peak load demand confirms that the VM will not be overloaded. However, since the workloads can present variable demand patterns, it can lead to the idleness of the host. The second type is known as dynamic consolidation where periodical changes in the workload demand are carried out in each VM and based on that the required configuration changes are performed.

Dynamic consolidation is performed in two necessary steps. One is to migrate VMs from underutilized hosts and put them into sleep mode to minimize the number of active hosts. Another step is migrating VMs from overloaded hosts to avoid performance degradation which may lead to SLA violation of the quality of service requirements. Furthermore, live migration is the way to achieve energy efficiency. The main advantage of live migration is the ability to transfer VM between the hosts with a near to zero downtime. In the real world, the computation demand is very dynamic, for that reason the decision depends on several criteria. This paper focuses on efficient selection of VM for migration. A fuzzy-based VM selection algorithm is proposed to achieve minimum energy consumption and maintain the SLA violation at a minimal level.

The remaining section of this paper is organized as follows: In section 2, related works have been discussed. Section 3, explains the proposed AFT method and AFT-FS based VM selection algorithm. Section 4, discusses the experimental setup, experimental results, and comparison of energy-aware algorithms. Finally, section 5 concludes the work with the possibilities of future improvements.

2. RELATED WORKS

Several algorithms have been proposed for energy efficient dynamic VM consolidation in cloud data centers. They are designed to achieve minimum energy consumption, minimum SLA violation rate, dynamic VM migration, and the minimum number of active hosts in a given time. In data centers energy consumption management are broadly classified into three categories: Dynamic performance scaling (Wu, Chang, & Chan, 2014), (Wierman, Andrew& Tang, 2009), Threshold-based heuristics, Prediction based on statistical analysis of historical data, and other techniques.

The first category is Dynamic Performance Scaling (DPS) (Wu, Chang, & Chan, 2014), (Wierman, Andrew, & Tang, A., 2009). In this method system components are adjusted dynamically to save power consumption and improve the performance of the data center. For example, the supply voltage can gradually decrease or increase and accordingly the CPU (i.e., host) clock frequency will also change. Even DPS method can save power when the resource is not fully utilized. In Dynamic Voltage and Frequency Scaling (DVFS) technique (Hanson, Keckler, Ghiasi, Rajamani, Rawson & Rubio, 2007), DPS method is used for saving power. DPS method is divided into three types. 1) Interval-based Method (Wu, Chang, & Chan, 2014), -5]: It gets the CPU utilization of hosts by varying the the hosts'

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