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Energy efficiency optimization in cloud computing through virtual machine migration using the EEOM algorithm

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***Abstract*—as cloud-based business applications become more common, cloud computing has gotten much attention from the industrial and academic cycles. These applications address user needs while also initiating the problem of high data center energy consumption. This paper proposes a novel algorithm known as EEOM (Energy Efficiency Optimization of VM Migrations) to cope with this problem. Three key steps are optimized for the EEOM algorithm, including the start time, virtual machine (VM) selection, and host location, considering CPU and memory factors. The EEOM algorithm utilizes virtualization technology to transfer certain VMs from a lightly- or heavily-loaded host to other hosts. To save energy, idle hosts are switched to the low-power mode or turned off. The results demonstrate that the EEOM algorithm saves 7% energy and lowers the SLA violation rate by 13% when compared to the double-threshold (DT) algorithm.**

Keywords: Cloud Computing, Energy Consumption Management, Virtual Machine Migration, Virtual Machine Selection.

I. INTRODUCTION

The problem of high energy consumption is becoming increasingly significant as large-scale data centers develop quickly [1-3]. According to recent studies, the annual data center power consumption worldwide has increased by more than 15% [4,5]. According to a statistical report released by the Ministry of Information and National Industry, our country's yearly power consumption for computing and data centers is around 50 billion kW and is expected to exceed 100 billion kW [6,7]. The high energy consumption by data centers is extremely harmful as this may lead to energy loss, system instability, lower return on investment, and increased greenhouse gas emissions. Thus, there is a pressing need to effectively reduce energy consumption and enhance energy efficiency in data centers. The problem of high energy consumption in data centers can be overcome by transforming physical data center facilities and effectively enhancing resource utilization rates in terms of resource management [8]. Virtual machine (VM) migration is an excellent approach to improve data center resource utilization. To exchange VMs, it is not only essential to consider its nature proportionate to the workload in the cloud, but it also periodically allocates VMs to minimize the number of physical servers based on their current resource requirements. The inactive server shifts to the low energy consumption mode to reduce the static power consumption of the server, lowering the overall power consumption of data centers. However, several key considerations must be made before VM migration: (1) the VM migration time (i.e., start time), (2) VM selection, and (3) which host should be selected to match the VM designated for the exchange (i.e., host location).

Domestic and foreign researchers are now carrying out some studies on energy consumption in data centers and have made some advances. Lu et al. [9] focused on energy consumption in cloud data centers. They presented a high-accuracy energy consumption model for predicting the amount of energy consumed by a single server. They argued that: "the energy efficiency optimization mechanism is realized mainly by adopting the 'load accumulation' strategy." Berl and de Meer [10] analyzed the energy efficiency indicators in an interactive cloud environment as well as the performance of the load accumulation strategy. Their most important experimental result demonstrates that the energy efficiency optimization of the load accumulation mechanism has had a poor performance. In Vasquez et al.'s work [11], Nimbus