Towards A Virtual Machine Migration Algorithm Based On Multi-Objective Optimization

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ABSTRACT

In the cloud computing, the virtual machine (VM) dynamical management method needs to consider VM resource re-configuration caused by system computation resource status changing and load fluctuation. Based on migration objectives as QoS (Quality of Service), resource competition and energy consumption, the VM migration time, migration objective node selection and VM placement strategies are designed in this work. The Multi-Criteria Decision-Making (MCDM) method is also introduced for migration destination host selection. Experiment results show that the multi-objective optimization management method with TOPSIS can achieve lower service-level agreement (SLA) violation rate, less energy consumption and better balance among different objectives.

KEYWORDS

Cloud Computing, Migration, Multi-Objective Optimization, Virtual Machine

INTRODUCTION

With the popularity of cloud computing, the scale of data center is also increasing rapidly. Confront with huge cluster, it is an urgent problem to meet users’ needs to reasonably configure virtual resource in accordance with system operation status based on energy saving. As a manner to adequately utilize computing resource and optimizing performance of data center, the resource virtualization in cloud environment attracts more and more attention. In the Infrastructure as a Service (IaaS) cloud computing, one computer can be virtualized as several logical computers. The VM operates on different physical machine as stand-alone unit, which can also migrate among physical machines. Briefly pausing VM services, the VM can be transmitted from one physical machine to another. The mechanism enables dynamically adjustment of VM deployment based on system operation status, so as to adapt to service and computation changing, thus adequately utilizing computing resources in the system (Canali, & Lancellotti, 2014).

Many researches regarded dynamic VM management as an optimization problem, such as users’ QoS optimizing or energy consumption minimization (Karve et al., 2006; Hermenier et al., 2009; Jung et al., 2010; Goudarzi et al., 2012). There are also some research results based on saving migration cost and system performance. The VM placement algorithm in (Pagès et al., 2014) is based on migration benefit maximization, which is triggered in case of resource utilization exceeds the threshold. Aiming at same goal, the method in (Wood, Shenoy, Venkataramani, & Yousif, 2007). performs VM migration by targeting at reducing SLA violation and avoiding too high resource

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utilization of physical node. The method migrates VM from physical machine with the largest load to the smallest one, so as to reduce data amount generated in migration as possible. In order to satisfy SLA goal of dynamic work load, the dynamically remapping algorithm between physical machine and VM was put forwarded (Bobroff, Kochut, & Beaty, 2007). The application placement problem in the cluster among heterogeneous physical nodes considering about energy consumption and migration cost perception were studied (Goudarzi et al., 2012), where the improved first adaptation descending heuristics algorithm was used to obtain the local optimal solution. The VM placement is optimized by constraining programming mode, while striving to minimize migration cost of VM re-placement.

The point-to-point migration of VM is also an important topic in the VM dynamic management. Many systems stop service temporarily and copy status data to the destination host (Whitaker et al., 2004; Sapuntzakis et al., 2002; Kozuch, & Satyanarayanan, 2002; Osman et al., 2002). After migration completes, the VMs on the destination server will restart. However, the VMs cannot provide service within the migration period. Other methods tried to shorten downtime of VM by merely transmitting process groups (Osman et al., 2002; Nelson et al., 2005), which also result in long time of out of service. In order not to interrupt service in the migration process, the concept of pre-copy was introduced to improve the stop copy algorithm (Clark et al., 2005). It performs VM migration while providing service. On this basis, the VM migration program on WAN was also studied (Whitaker et al., 2004; Clark et al., 2005).

It can be known from above studies that most VM migration method only targets on one or two goals. In order to achieve goals of improving QoS, reducing resource competition and decreasing energy consumption, the multi-objective optimization VM dynamic management method is proposed in the work. The method mainly solves the VM re-allocate problem caused by change of system condition or dynamic application load.

The rest of the paper is organized as follows: Section 2 discusses the selection problem of VM migration. Section 3 designs the destination host selection algorithm. Section 4 performs experiment and Section 5 concludes this paper.

**SELECTION PROBLEM OF VM MIGRATION**

**Migration Time Selection**

The monitoring on physical server is to collect real-time data on physical node and determine status, so as to make-decision of VM migration time. The existing works generally set a single threshold and carry on migration when the threshold is exceeded. For example, the VM migrates when CPU utilization of physical node is higher than the pre-defined threshold. But the load of system is fluctuating with time, the resource utilization and energy utilization of data center are also dynamically changing. Therefore, the policy that performs VM migration immediately after threshold be exceeded may result in unnecessary resource allocation, and then leading to instability operation of data center.

In order to avoid this, the paper puts forward the method to perform next operation only if the pre-defined resource utilization threshold is exceeded continuously. The sliding window concept in network is introduced into the node monitoring process. In other words, the system samples resource utilization status of physical server in accordance with certain time interval and records it in the window. As the window size is fixed, it replaces data based on the FIFO principle. The value of window will change with time. To any window, the warning is triggered when times that value in it beyond the threshold scale larger than the preset one. The warning just reflects past operation status of physical node, but not the trend of resource utilization in the future, so it cannot be regarded as the basis to determine whether perform VM migration merely. Therefore, it needs to predict next sample value after warning to determine whether to perform next step operations. The AR(n) model in the time series forecasting method is used in the paper, where the value $V_{t-1}, V_{t-2}, \cdots, V_{t-n}$
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