

Chapter 28

A Stable Matching Algorithm for VM Migration to Improve Energy Consumption and QOS in Cloud Infrastructures

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ABSTRACT

Cloud Computing is one of the fast spreading technologies for providing utility-based IT services to its users. Large-scale virtualized datacenters are established in order to provide these services. Based on a pay-as-you-go model, it enables hosting of pervasive applications from consumer, scientific, and business domains. However, datacenters hosting Cloud applications consume huge amounts of electrical energy, contributing to high operational cost for the service providers as well as for the service users. Energy consumption can be reduced by live migration of virtual machines (VM) as required and by switching off idle physical machines (PM). Therefore, we propose an approach that finds a stable matching fair to both VMs and PMs, to improve the energy consumption without affecting the quality of service, instead of favoring either side because of a deferred acceptance procedure. The approach presumes two dynamics thresholds, and prepares those virtual machines on the physical machines that the load is over one of the two presumed values to be migrated. Before migrating all those VMs, we use the Coase theorem to determine the number of VMs to migrate for optimal costs. Our approach aims to improve energy consumption of the datacenters, while delivering an expected Quality of Service.

1. INTRODUCTION

Cloud computing can be classified as a new paradigm for the dynamic provisioning of computing services supported by datacenters that usually

employ Virtual Machine (VM) technologies for consolidation and environment isolation purposes (Barham et al., 2003; Beloglazov et al., 2012). Cloud computing delivers an infrastructure, platform, and software (applications) as services

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that are made available to users in a pay-as-you-go model. These services are referred to as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) respectively. These services (Buyya et al., 2009) are not only used but also installed, deployed or replicated with the help of virtualization.

Virtualization is a technique that enables several operating systems to run simultaneously on a single physical machine. It has become a core aspect in modern servers and datacenters due to several advantages, such as flexible and efficient sharing of resources, fault tolerance, portability, and cost efficiency (Barham et al., 2003). In a virtualized environment, virtual machines (VM) acting like real physical machines can run in parallel and in isolation from each other and yet sharing the same physical resources. This ability to boot a virtual machine (VM) image on any available physical machine (PM) in a datacenter, or even across datacenters, is a key enabler for the many benefits promised by cloud computing such as resource consolidation, elastic scaling, and computation migration.

VM migration is one of the important capabilities of system virtualization, which allows applications to be transparently migrated along with their execution environments across physical machines (PMs). Live migration further allows the VM to be migrated almost without any interrupt to its application's execution. VM migration is an important means for managing applications and resources in a large virtualized system. It enables resource usage to be dynamically balanced in the entire virtualized system across physical host boundaries, and it allows applications to be dynamically relocated to improve performance and reliability (Yangyang & Zhao, 2010).

Certainly, virtualization is a very useful technology that allows simulating a variety of different platforms and managing the resources of the system. By applying the virtualization technology and VM migration technique, in accordance with the requirements of the users to configure a virtual

machine, both the computing environment and resource management problems can be solved. However, with more and more suppliers began offering cloud computing services, these services are convenient to users but consuming a lot of energy. Thus, how to save the energy of the datacenter without affecting the system performance (Quality of service) is an important issue. The problem has become more complicated and the use of the simple VM migration technique alone has become no longer enough, so, the scientific community began proposed migration strategies based on cost models, heuristics, meta-heuristics, or economic models...etc., to meet the growing needs of cloud computing users and service providers.

Aiming at the problem, this paper presents a stable matching strategy based on dynamic migration of virtual machines. The strategy seeks to improve the energy consumption, based on CPU utilization, without affecting the quality of service. Assuming that the virtual machines (VMs) are the side that wants to preserve the quality of service and physical machines (PMs) are the side that looks to optimize the energy consumption, our approach aims to find a stable matching fair to both VMs and PMs instead of favoring either side as a result of a deferred acceptance procedure. However, the resulting solutions by VMs and PMs may sometimes be different and even conflicting. This is known as the polarization of stable matching (Roth et al., 1984; Ruth et al., 2003). Some works have been proposed (Hong and Boachun, 2011) to solve this problem, but in the case of polarization, they favor one side at the expense of the other. In this work, we use an extension of the stable matching (Ruth et al., 2003) that is used in economics to find a compromise between both sides (VMs and PMs) in the case of polarization. We presume two dynamics thresholds, one for the energy consumption and the other for the quality of service, to find the appropriate moment to start migrating the VMs hosted on PMs that the load is over one of the two presumed threshold. Our approach incorporates another theorem used in

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