Chapter 40
Towards Green Cloud Computing an Algorithmic Approach for Energy Minimization in Cloud Data Centers

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ABSTRACT

The article presents an efficient energy optimization framework based on dynamic resource scheduling for VM migration in cloud data centers. This increasing number of cloud data centers all over the world are consuming a vast amount of power and thus, exhaling a huge amount of CO_2 that has a strong negative impact on the environment. Therefore, implementing Green cloud computing by efficient power reduction is a momentous research area. Live Virtual Machine (VM) migration, and server consolidation technology along with appropriate resource allocation of users' tasks, is particularly useful for reducing power consumption in cloud data centers. In this article, the authors propose algorithms which mainly consider live VM migration techniques for power reduction named "Power_reduction" and "VM_migration." Moreover, the authors implement dynamic scheduling of servers based on sequential search, random search, and a maximum fairness search for convenient allocation and higher utilization of resources. The authors perform simulation work using CloudSim and the Cloudera simulator to evaluate the performance of the proposed algorithms. Results show that the proposed approaches achieve around 30% energy savings than the existing algorithms.

DOI: 10.4018/978-1-7998-5339-8.ch040

1. INTRODUCTION

Cloud computing is evolving as a new standard of comprehensive distributed computing. It has moved away the computation from home PCs and small organizations to large-scale data centers and made it advantageous for consumers and IT organizations by chunking huge amount of capital investments. Cloud is offering cost-effective solutions to almost all types of large scale computations by letting users to access scalable remote resources (e.g. servers, storage, networks, applications etc.) at any time, from anywhere, on-demand basis and also on pay-per-use basis.

This ever-proliferating demand of cloud computing has led the cloud data centers to grow rapidly. Consequently, it is now leading to a concerning issue of increasing amount of power consumption of cloud resources (Duy et al., 2010; Beik, 2012) and excess carbon footprint in the environment. It has been measured that power consumption of worldwide data centers has increased almost ten times over the past decade (Priya et al., 2013). The cost of electricity for keeping the computing resources 24/7/365 alive and continuously cooling them is thus evidently booming. Hence, there is indubitably a need of planning up for energy efficient and environment-friendly cloud architecture which is called "Green cloud computing".

Green computing could be characterized as the method of designing, composition, utilizing, and arrangement of servers, computers and correlated subsystems proficiently and effectively with no or negligible impact on the environment (Buyya et al., 2010; Caydar et al., 2010). Green computing can be accomplished by virtualization and server consolidation technology (Buyya et al., 2010; Jain et al., 2013; Siddiqui, 2013; Wadhwa & Verma, 2014; John, 2014; Tiwari, 2011, Kumar & Kiruthiga, 2014; Wadhwa & Verma, 2014; Gowri & Harikrishnan, 2014), balancing load appropriately among resources (Caydar & Alagoz, 2012; Green Grid Industry Consortium, 2007; Rassmussen, 2007; Jain et al., 2013; Siddiqui, 2013; Wadhwa & Verma, 2014; John, 2014), energy management of storage (Rassmussen, 2007; Kumar et al., 2014),managing the CPU's power consumption (Siddiqui, 2013; Wadhwa & Verma, 2014; John, 2014; Tiwari, 2011; Kumar et al., 2014; Wadhwa & Verma, 2014), power management of networking resources (Arthi & ShahuHamead, 2015; Atrey et al., 2013), etc.

Virtualization is a technique where many Operating Systems (OSs) and software applications can be easily run on just one physical server or "host" by the help of hypervisor (Garg & Buyya, 2012; Caydar & Alagoz, 2012; Green Grid Industry Consortium, 2007; Rassmussen, 2007; Jain et al., 2013; Kumar & Kiruthiga, 2014; Richariya & Motwani, 2014). Live Virtual Machine Migration (VM) facilitated by virtualization can aid in balancing load, allowing extreme responsiveness and evading hot-spots in data centers thus decreasing power ingestion (Caydar & Alagoz, 2012; Siddiqui, 2013; Mastelic et al., 2015). Server Consolidation increases resource exploitation by consolidating several VMs located on various under-utilized servers onto a single server; so, it turns off unused servers and reduces energy consumption (Green Grid Industry Consortium, 2007; Wadhwa & Verma, 2014; Tiwari, 2011). Power consumption can also be reduced by following proper resource allocation and utilization techniques (Wadhwa & Verma, 2014; Hameed et al., 2016). This paper concentrates on using these three technologies for reducing power consumption of resources in cloud data centers that can lead to green IT (Asadi & Dahlan, 2017).

According to the Cisco Global Cloud Index the traffic of global data center might touch 15.3 ZB by the year of 2020, with 92% of all workloads being performed in the cloud (Cisco Global Cloud Index, 2016). It has also projected that, at the end of 2015, the number of hyper-scale data centers would face a growth by 226% from 259%, so facing a huge increase to 485% by the year 2020 (Cisco Global Cloud Index, 2016). In the nick of time, this concerning issue has already caught hold of the consideration of