Performance Analysis for Pareto-Optimal Green Consolidation Based on Virtual Machines Live Migration

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ABSTRACT

Huge energy requirement of cloud data centers is prime concern. Dynamic Virtual Machine (VM) consolidation based on VM live migration to switched-off or put some of the under-loaded host Physical Machines (PMs) into a low power consumption mode can significantly save energy in data centers and achieve green cloud computing. Performance overheads imposed on source and destination hosts during and after VM live migration is the main focus of research. Existing VM consolidation approaches are inefficient regarding VM live migration time, application downtime, VM pre and post-migration overheads which results in Quality of Service (QoS) degradation. So, near-optimal solution which optimizes these overheads is main challenge. This paper discusses the causes of VM live migration performance overheads and comparison of different overhead optimization techniques on the basis of parameters like accuracy and migration cost. Pareto-Optimal solution is proposed to eliminate the VM performance overheads.

KEYWORDS

Cloud Computing, Consolidation, Green Cloud Computing, Live Migration, Post-Migration Overheads, Pre-Migration Overheads, Virtual Machine, Virtualization

1. INTRODUCTION

Cloud computing is currently most a promising approach to hosting data and applications globally shared resources. Cloud computing can also provide cost effective service in areas like IoT, Big Data and Embedded Systems (Bhatt et al., 2017; Dey and Mukherjee, 2016; Dey et al., 2018). Cloud service providers use data centers to provide computational resources as per user demand. Currently day by day many small e-businesses are shifted towards cloud and this increases number of data centers day by day.

Live migration of VMs from one PM to other can balance load and reduce power consumption of data centers. Live migration also plays main role to reduce performance overheads on PMs by performing resource redistribution amongst the PMs. VM live migration can perform consolidation of VMs to decrease the energy requirements for cloud data centers after shifting under-loaded PMs to sleep or power saving stage without decrease of QoS. So, multi-objective consolidation of VMs effectively provide improved PM resource utilization to reduce overall energy consumption and achieve “green cloud computing.”

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Unfortunately, most of available approaches for VM live migration are narrow objective and selectively focusing on optimization of overheads associated with either pre or post migration phase. These types of partial optimization strategies focusing of either pre or post migration suffers from additional overheads on CPU, memory and network bandwidth availability with leads to increase in VM live migration span, application unavailability duration (downtime) and SLA violation. These narrow objectives like single aim to reduce requirement for active servers or decreasing n/w traffic for optimization strategies associated with VM live migration and consolidation makes these approaches unfit for practical implementation.

To obtain effective consolidation by using live migration multiple parameters and overheads must be considered. Any framework only focusing on few or limited objectives will result in biased solution for live migration and consolidation and will further adversely affect the VM performance in other aspects. However, live migration mostly results in some downtime for migrating VM which negatively affects services running on it and results in SLA violation. Also additional overheads are imposed on CPU, memory, network bandwidth of not only migrating VM but also source and destination PMs and their currently associated VMs, it is known as co-location interference. So, a live migration approach must be broad enough to focus on all these aspects.

### 1.1. Phases Involved During VM Live Migration

VM live migration involves following 6 phases:

- **Target selection:** VM is selected from a host for future migration.
- **Destination Selection and Resource Reservation:** A destination host is selected and required resources like CPU cores, partitioned memory and disk space are reserved on it.
- **Repetitive Data Transfer:** All the data in memory of VM is copied to destination host. Again pages which got modified during previous copy are being continuously copied to destination host.
- **Suspension and Traffic Migration:** VM on source host is suspended, all dirty pages of memory are sent finally and the notification is sent to hypervisor for migration all further incoming traffic of VM on source to corresponding destination.
- **Resource De-Acquisition:** Once notification is received from central cloud controller, all data associated with VM on source is copied to destination and all resources of VM associated with source host are released.
- **Activation:** VM on destination activated and all normal operations are started.

### 2. LITERATURE REVIEW

During live migration, the migrating VM(s) suffers from noticeable degradation in performance which is result of overheads created during process of live migration on resources like CPU, VM memory and interconnection network. Practically performance isolation can’t be achieved just by doing isolation amongst the resources shared by different VMs. So VMs located on a physical host and sharing resources like CPU, memory and networking have to face noticeable performance drop called as co-location interface. Therefore, VM migration should handle overheads not only related to migration but also interference associated with the co-locating VMs.
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