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Traffic-Sensitive Live Migration of Virtual Machines

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Abstract

In this paper we address the problem of network contention between the migration traffic and the Virtual Machine (VM) application traffic for the live migration of co-located Virtual Machines. When VMs are migrated with pre-copy, they run at the source host during the migration. Therefore the VM applications with predominantly outbound traffic contend with the outgoing migration traffic at the source host. Similarly, during post-copy migration, the VMs run at the destination host. Therefore the VM applications with predominantly inbound traffic contend with the incoming migration traffic at the destination host. Such contention increases the total migration time of the VMs and degrades the performance of the VM application. Here, we propose a *traffic-sensitive* live VM migration technique to reduce the contention of migration traffic with the VM application traffic. It uses a combination of pre-copy and post-copy techniques for the migration of the co-located VMs (those located on the same source host), instead of relying on any single pre-determined technique for the migration of all the VMs. We base the selection of migration techniques on the VMs' network traffic profiles so that the direction of migration traffic complements the direction of the most VM application traffic. We have implemented a prototype of traffic-sensitive migration on the KVM/QEMU platform. In the evaluation, we compare traffic-sensitive migration against the approaches that use only pre-copy or only post-copy for VM migration. We show that our approach minimizes the network contention for migration, thus reducing the total migration time and the application degradation.

Keywords: Virtual Machine, Live Migration, Traffic Sensitivity

1. Introduction

Live migration of VMs is used in datacenters for quickly eliminating the hot-spots [1, 2, 3, 4], to free up resources to save power [5, 6], or to perform system maintenance. It can also be used to defragment a datacenter or to obtain resources with specific properties, for example, specific network topology critical for HPC applications [7, 8]. Pre-copy [9, 10] and post-copy [11, 12] are commonly used live VM migration techniques. Pre-copy provides low service downtime for the migration of VMs executing read-mostly workloads. It is used as a default migration technique by Xen [13], VMware [10], and KVM [14] hypervisors. Whereas, post-copy is known for its low network overhead and allows quick consolidation [2] or eviction [15] of VMs.

Live VM migration is a network intensive activity; it requires transfer of Gigabytes of VM memory state from the source to the destination host over the network. When the migrating VMs are running network-bound applications, the applications' traffic competes with the migration traffic for the Network Interface Cards (NICs) at the source and the destination hosts. Such a contention prolongs the VM migration, thus delaying the deprovisioning of resources occupied by the VM at the source host. Furthermore, prolonged contention of network flows also degrades the performance of the network-bound VM applications. When migrating VMs are part of a group of collaborating VMs, degradation of any single VM can result in the overall degradation of the application jointly executed by these VMs.

In this paper, we address the problem of network contention between the migration and VM application traffic for the VMs executing network bound applications. The widely used 1 Gigabit NICs provide 1 Gbps bandwidth in each direction. However, when the migration traffic and the VM application traffic have the same direction, both network flows contend for the available bandwidth. Whereas when the direction of the flows is opposite, they do not compete with each other. Hence the level of contention depends on the rate of VM traffic in each direction and the direction of the migration traffic. In pre-copy migration, the VMs run at the source host during their migration; therefore the migration traffic contends with the VMs that predominantly have outbound network flow. In contrast, in post-copy, the VMs run at the destination host during their migration; therefore the migration traffic contends with the VMs that predominantly have inbound network flow.

A common approach to reduce the contention in pre-copy is by having a limit on the VM's total migration time or the amount of data transferred. Pre-copy VM migration techniques are hard coded with terminating conditions [10, 9]. When pre-copy exceeds a pre-defined limit for total migration time or transfers more than a pre-defined amount of data, its execution is suspended at the source host, and its execution state is transferred to the destination host. Even though this approach reduces the network overhead of pre-copy, premature termina-

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