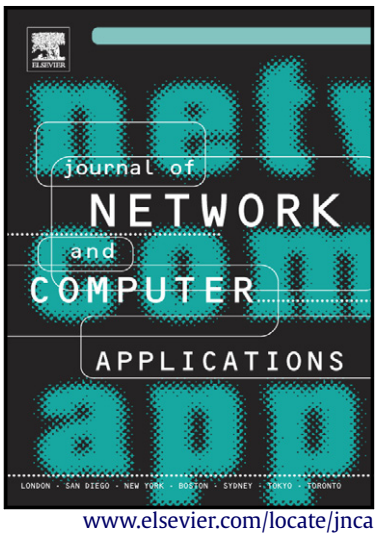

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Mingfu Li, Jingping Bi, Zhongcheng Li

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Improving Consolidation of Virtual Machine Based on Virtual Switching Overhead Estimation

Mingfu Li, Jingping Bi, Zhongcheng Li

Institute of Computing Technology, Chinese Academy of Sciences, Beijing, China

Abstract

In virtualized data centers, live virtual machine (VM) migration can increase energy efficiency by consolidating VMs on fewer servers. This problem is usually considered a Bin Packing Problem with server capacity constraints, such as CPU, memory and network bandwidth. In order to minimize the communication traffic within the data center network, existing research works used correlation-based strategy to consolidate VMs onto servers, which means that VMs with inter-traffic are consolidated as closely as possible, e.g. within a server or a rack. However, this strategy increases the traffic load of virtual switches on servers, and it causes a certain number of CPU cycles of servers to move traffic through virtual switches. A lack of consideration for the virtual switching overhead may increase the risk that VMs are not allocated enough resources, and consequently reduce VMs' performance. In this work, we conduct experiments to estimate the virtual switching overhead on server CPU resource, and based on the experiment results, we propose a virtual-switching-aware VM consolidation algorithm to address this problem. Experiments on representative data center workloads show that the overhead can occupy 10% to 30% of server's CPU resources. Additionally, our algorithm shows a much lower server capacity violation probability as compared with the baseline algorithm.

Keywords: virtual machine consolidation, virtual switching overhead, server capacity violation probability

1. Introduction

Virtualization technologies enhance cloud computing service through efficient resource sharing, instance security and system reliability (e.g. Xen is powering Amazon Web Service and Rackspace Public Cloud). Virtual machine (VM) migration, the basic function of virtualization, is the ability to move a VM from one physical server to another. This ability has been increasingly utilized in virtualized enterprise data centers to support server consolidation, load balancing and fault tolerance. Among these benefits, server consolidation is the most critical one because it increases energy efficiency of data centers. Energy efficiency of data centers seems to be a global challenge. A recent survey by Hwang et al. [1] reports that an average of one-sixth of the full-time servers in a company are left powered on without being actively used. This indicates that 4.7 million servers among the 44 million servers in the world are wasting resources daily. Even an idle server draws 45% of the power of a loaded server[1]. Fortunately, by consolidating VMs onto fewer servers, we can turn off inefficient servers, potentially reducing hardware and operating costs by as much as 50% and energy costs by 80%, saving more than $3,000 per year for every virtualized server[2]. Fewer servers can mean less space and fewer racks, fewer software licenses, smaller electricity bills, less heat and less expenses on server maintenance, all contributing to the goal of achieving green data centers.

Apart from servers, the network side is also a contributor to the energy cost of data centers. According to research work from Microsoft [2], the amortized cost of network is about 15% of the total energy cost of data centers. It leads to a network-aware (or traffic-aware) VM consolidation problem, which tries to minimize both the traffic load on network links and the number of servers used to run VMs. Considering that most data center networks are tree-topology-based with high bandwidth oversubscription, the network cost is low if data is transmitted within nearby servers. For example, in a hierarchical data center network with 20 servers per rack and 1:20 oversubscription at the first level switch, it takes 11 times longer to transmit the same amount of data from each server not in the rack to each server within the rack [3]. In order to minimize the traffic across network devices in data center networks, and consequently reduce the energy cost of networking, existing research works proposed correlation-aware VM consolidation algorithms. The basic idea of these algorithms is that VMs with high inter-traffic will be consolidated as closely as possible. For example, consolidating traffic-correlated VMs within a physical server may reduce the traffic load of switches on the access layer, while consolidating them within a server rack may reduce the traffic load of switches on the aggregation layer. We use the term **traffic-correlated VMs** to describe VMs with inter-traffic in this paper.

Due to the dynamic resource consumption of VMs and servers, the VM consolidation problem can be modeled as a

Email addresses: limingfu@ict.ac.cn (Mingfu Li), bjp@ict.ac.cn (Jingping Bi), zcli@ict.ac.cn (Zhongcheng Li)

[1] http://lonesysadmin.net/2010/05/13/power-consumption-of-a-dell-poweredge-r10

[2] http://www.vmware.com/solutions/consolidation/consolidate.html