Performance Profiler for Virtualized Servers in Large-Scale Datacenters

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Project Description
A datacenter is a facility housing high-performance computers, storage servers, networking or other IT equipment. To meet ever-increasing demand on higher computing power, the number of servers in a datacenter has drastically increased and power consumption amounts to few tens of MW. According to recent reports of international electricity consumption estimation agencies, worldwide datacenters consume 2% of the world energy as much as the amount consumed by air traffic, and this amount is only expected to grow further in the coming years.

The reason for this significant energy consumption in datacenters is the fact that a large amount of servers provisioned to cope with the worst-case user demand. However, the reality is that a very important part of them is under-utilized because they can only execute specific types of applications due to the operating systems or hardware driver constraints. As a result, in recent years, in order to tackle the waste of excessive server provision, thereby, reducing the power consumption as well as installation cost of datacenter, most datacenter have adopted server virtualization technology, which allows a physical server to host multiple operating systems (or guests OSes) beyond the specific underlying hardware. According to the International Data Corporation (IDC), 18% of all new servers shipped in the fourth quarter of 2009 were already virtualized, and the server virtualization market is expected to grow 30% a year through 2013. The server virtualization approach is realized by including a thin software layer in the servers, called Hypervisor or Virtual Machine Monitor (VMM), which presents to the guest operating systems a virtual operating platform and manages the execution of the guest operation systems. The Citrix's XenServer and VMWare's ESXi are two most widely used hypervisors. However, the adoption of serve virtualization comes at the cost of increased system implementation and workload management complexity. In particular, virtualization causes a certain degree of performance degradation of applications due to the overhead of accessing physical resources under the supervision of the hypervisor, as well as the management of resource access conflicts among multiple operating systems running on the same server. These are examples of two management problems in virtualized server environments that have not yet been well understood due to the lack of frameworks to extract statistics about the behavior of complex IT applications and services running on large-scale virtualized server systems.

As a result, in this project, it is proposed the development of a performance profiling tool for dynamically monitoring application behaviour running on virtualized server environments. Then, by using the profiler, it will be possible to analyze the source of performance degradation of IT services on virtual servers.

Tasks of the Student
The tasks expected by the student developing this project are the following ones:

1. Study different server virtualization techniques and frameworks
2. Develop a virtualized server environment using the Xen hypervisor
3. Develop a performance profiling tool which enables to extract user-defined performance counter values of running applications on the virtualized server
4. Analyze and characterize performance degradation of server IT services and applications caused by server virtualization

Requirements
This project requires knowledge of various aspects of computer architecture, and programming knowledge. The main requirements are enumerated below:

1. Programming experience in C and/or CPP
2. Experience using Linux
3. Good knowledge of computer architecture