Poris: A Scheduler for Parallel Soft Real-Time Applications in Virtualized Environments

With the prevalence of cloud computing and virtualization, more and more cloud services including parallel soft real-time applications (PSRT applications) are running in virtualized data centers. However, current hypervisors do not provide adequate support for them because of soft real-time constraints and synchronization problems, which result in frequent deadline misses and serious performance degradation. CPU schedulers in underlying hypervisors are central to these issues. In this paper, we identify and analyze CPU scheduling problems in hypervisors. Then, we design and implement a parallel soft real-time scheduler according to the analysis, named Poris, based on Xen. It addresses both soft real-time constraints and synchronization problems simultaneously. In our proposed method, priority promotion and dynamic time slice mechanisms are introduced to determine when to schedule virtual CPUs (VCPUs) according to the characteristics of soft real-time applications. Besides, considering that PSRT applications may run in a virtual machine (VM) or multiple VMs, we present parallel scheduling, group scheduling and communication-driven group scheduling to accelerate synchronizations of these applications and make sure that tasks are finished before their deadlines under different scenarios. Our evaluation shows Poris can significantly improve the performance of PSRT applications no matter how they run in a VM or multiple VMs. For example, compared to the Credit scheduler, Poris decreases the response time of web search benchmark by up to 91.6 percent.