

論文の内容の要旨

論文題目 A Study on Operating System Virtualization Optimized for Functional Requirements

(機能要件に最適化されたオペレーティングシステムの仮想化に関する研究)

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Virtualization technology introduces a new abstraction layer between an OS and the hardware, allowing new functionalities to be added to the OS transparently. A general-purpose hypervisor can provide richer functions, but it also requires more overhead. We can reduce virtualization overhead by specializing in a specific function.

In this thesis, we studied optimizing virtualization for functional requirements through several use cases. First, we optimized nested virtualization for hypervisor device drivers testing. Focusing on the fact that the security features required by normal virtualization are unnecessary for testing purposes, we improved virtualization performance by eliminating them. Second, we presented the efficient IOMMU virtualization method for device protection. We achieved higher performance than a regular IOMMU virtualization by only shadowing the necessary area for protection. Third, we presented a detailed performance evaluation of the NUMA-visible virtual machines on Linux. The evaluations revealed several problems with vNUMA scheduling and we fixed the incorrect paravirtualization feature that caused severe performance degradation. Finally, we proposed a method to improve the flexibility of hypervisors without compromising performance by using a secure and lightweight language virtual machine. An example of the use of the language virtual machine, we presented a source-side DDoS prevention scheme using virtualization. Through these use cases, we showed several effective ways of optimizing virtualization for functional requirements.