IOLanes: Advancing the Scalability and Performance of I/O Subsystems in Multicore Platforms

IOLANES (www.iolanes.eu) is a EU-funded research project targeted at understanding and improving the I/O performance in modern hardware that employees multicore architectures by adapting or redesigning the I/O stack and by providing system-level support that will allow future storage systems to take advantage of multicore CPUs in new ways.

With emerging storage device technologies, such as solid state disks (SSDs), systems that are capable of millions of I/O operations are expected to become commonplace. This trend shifts the bottleneck from the I/O devices to the I/O path. Recently, industry has started to also shift focus from merely using faster I/O devices, such as SSDs instead of disks, to innovations in the I/O path for achieving scale-out for big data applications.

IOLANES re-architects the systems software in the I/O path to reduce overheads from application to devices, allow I/O to scale as physical resources increase, reduce interference with multi-tenant workloads, and reduce effort for leveraging multicores when performing storage I/O. IOLANES designs I/O subsystems that will be capable of sustaining one order of magnitude more load than todays' systems, reducing the required infrastructure cost and energy to support large workloads and data sets.

Today's system software in the I/O path exhibits high overheads and poor scaling when increasing the number of cores and storage devices; shared structures, replication of functionality, synchronization requirements, and workload interference are on the way of supporting current and future I/O intensive applications that end-up consuming many times more cycles to perform each I/O operation when the number of cores increases even in low ranges, as for instance, from one to eight. By looking at the cycles used per I/O operation IOLANES is able to characterize application requirements, evaluate improvements, and project future needs. Early results show that today's I/O stack does not scale beyond 4-6 cores and that it exhibits high overheads, especially in virtualized environments.

IOLANES fundamentally re-designs the I/O path to include support for:

(a) Partitioning the I/O stack on modern multi-core servers to improve scalability and reduce interference;
(b) Reducing the impact of I/O virtualization in both in the issue and completion paths; and
(c) Embracing on-/off-loading in heterogeneous multi-core systems to support new functionality.

IOLANES evaluates these mechanisms using OLTP, OLAP, and data streaming applications and examining their impact on I/O efficiency. To better understand complex interactions IOLANES provides a single-point for performance monitoring and visualization of the I/O path from applications to devices.

Re-architecting the systems software in the I/O path and taking advantage of additional information and the potential of multicore processors, improves I/O memory utilization, reduces contention in all shared resources, avoids redundant overheads, and overall results to improved scaling by one order of magnitude while reducing virtualization cost to a few percent of bare metal performance.

The IOLANES project is supported by partners Foundation for Research and Technology – Hellas (FORTH) - Coordinator, Barcelona Supercomputing Centre (BSC), University of Madrid (UPM), INTEL Performance Labs Ireland, IBM Research Labs in Haifa, and Neurocom S.A. IOLANES is funded by the E.C. under the 7th Framework program and is part of the portfolio of the Embedded Systems Unit - G3 Directorate General Information Society.

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