

Virtuozzo Accelerates Intel® Optane™ SSD Performance for Bare-Metal, Container and VM Applications

Benchmark testing of Virtuozzo 7 with the Intel® Optane™ SSD DC P4800X Series demonstrated significant performance gains compared to previous-generation Intel® SSDs for the data center.

JUNE 2018

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Executive Summary

Virtuozzo 7 helps companies migrate to a software-defined data center (SDDC) in order to consolidate workloads and infrastructure. It relies on highly flexible, efficient software-defined storage to provide peak performance. Virtuozzo performed a series of benchmark tests to measure the performance of the new Intel® Optane™ Solid State Drive (SSD) DC P4800X Series compared to previous-generation Intel® 3D NAND SSDs, when used with both containers and virtual machines (VMs) in Virtuozzo 7. The test results showed up to 150 percent better random read and seven times better random write performance for the Intel® Optane™ SSD DC P4800X, compared to previous-generation Intel® SSDs, demonstrating that these innovative drives are ideal for modern SDDC environments.¹

The Need for an Agile Data Center Infrastructure

To stay competitive, companies must respond quickly to changing technologies and customer needs. To accomplish that goal, companies need tools and infrastructures that allow them to efficiently build apps and services they can roll out to customers and internal workers at a rapid pace. Unfortunately, older, traditional data center infrastructures cannot support that level of agility. For many businesses, it takes far too long to deploy or redeploy hardware, operating systems, VMs, and workloads to meet the needs of developers, data center and IT managers, and line-of-business (LOB) managers.

To increase agility, many businesses are looking to transition from traditional infrastructures to software-defined infrastructures (SDIs) for their data centers. Software-based hyperconverged infrastructure solutions can help speed that transition, as long as the platforms are built on fast, reliable, scalable components—including modern storage—to simplify management and avoid performance bottlenecks.

Virtuozzo 7

Virtuozzo can help businesses in their transition to SDDC environments. Its technology enables consolidation of the infrastructure stack, easier management, and a future platform for cloud-native apps and micro-services. It provides an efficient, cost-effective way to deploy and manage both containerized and VM workloads with software-defined storage and high availability, providing users with ultimate flexibility and non-disruptive services.

Virtuozzo 7 integrates system containers, virtual machines and software-defined storage in a single platform that lets businesses easily deploy and shift workloads to optimize density and performance in the data center. It also enables live migration between containers and VMs to support high availability.

To take full advantage of Virtuozzo 7, companies need an underlying infrastructure that can support the agility and manageability that Virtuozzo 7 is capable of delivering. The innovative Intel® Optane™ SSD DC P4800X, built on Intel® Optane™ technology, can accelerate the performance of Virtuozzo 7 with consistent, reliable performance.

The Intel® Optane™ SSD DC P4800X features an entirely new storage technology that accelerates applications via fast caching and storage. And because the Intel® Optane™ SSD DC P4800X Series is extremely responsive under any load, it offers highly predictable, fast, consistent performance.

Putting Intel® Optane™ Technology to the Test

To measure the performance gains from Intel® Optane™ technology, Virtuozzo performed a series of benchmark tests in its labs, comparing the Intel® Optane™ SSD DC P4800X Series to the previous-generation Intel® SSD DC P3700 Series running on Virtuozzo 7.

The test results demonstrated significant performance gains with the Intel® Optane™ SSD DC P4800X, including up to 150 percent better random read performance and seven times better random write performance compared to previous-generation drives.¹ Most importantly, Virtuozzo 7 was able to deliver up to 98 percent of that performance to virtualized applications, exceeding a half-million input/output (I/O) operations per second (IOPS).¹

Virtuozzo Benchmark Test Scenario

The Virtuozzo 7 benchmark tests compared the I/O performance of 64 GB Intel® Optane™ SSD DC P4800X drives to previous-generation 350 GB Intel SSD DC P3700 drives. Engineers ran benchmark applications in three environments: directly on the host operating system, virtualized in a container, and virtualized in a VM. The tests measured random read and write operations using an assessment designed to emulate the behavior typical for transactional databases.

The applications' performances in containers and in VMs were benchmarked on both an idle host and on a host running emulated production loads consuming both CPU and memory resources. The tests measured random read and write operations and were designed to emulate access patterns typical for transactional databases. All block sizes used were 4 KB.

Because high-performing Intel® Optane™ SSD DC P4800X Series drives are likely to be shared by multiple users, applications, or tenants, Virtuozzo ran the benchmark tests multiple times, increasing the number of parallel threads in each iteration. The test bed included a single host, container or VM, and the number of clients used in each test scaled from 1 to 4 to 8 to 16 to 32 and eventually to 64 clients running in parallel.

Benchmark Test Results: Exceptional IOPS

The results of the benchmark tests demonstrated continuously improved performance across all the test scenarios. With the Intel® Optane™ SSD DC P4800X, the Virtuozzo hypervisor was able to deliver up to 100,000 IOPS to a single VM, compared to approximately 10,000 IOPS on a platform built with the Intel SSD DC P3700 Series. In addition, Virtuozzo 7 delivered more than 500,000 IOPS to a single container.¹ The following sections describe the detailed results.

Key Findings from the Random Write Benchmark Tests

The first set of tests compared random write times for the Intel® Optane™ SSD DC P4800X and the Intel SSD DC P3700 for increasing numbers of concurrent client connections, and with apps running in containers and in VMs. The Intel® Optane™ SSD DC P4800X demonstrated higher performance than the Intel SSD DC P3700 drives for bare-metal, container, and VM apps, even under load. In addition, the performance of the Intel® Optane™ SSD DC P4800X stayed consistently high under load, even when performance dropped for the Intel SSD DC P3700 drives.¹

- **Bare-metal:** The Intel® Optane™ SSD DC P4800X delivered 131 percent better peak performance compared to the Intel SSD DC P3700 drives (541,000 IOPS versus 234,000 IOPS on 32 parallel test clients).¹
- **Containers:** The Intel® Optane™ SSD DC P4800X delivered 234 percent better peak performance compared to the Intel SSD DC P3700 drives (491,000 IOPS versus 147,000 IOPS on 64 parallel test clients).¹
- **VMs:** The Virtuozzo 7 VM provided up to 585 percent better performance on the Intel® Optane™ SSD DC P4800X compared to the Intel SSD DC P3700 (54,273 IOPS versus 7,924 IOPS on 64 parallel test clients).¹

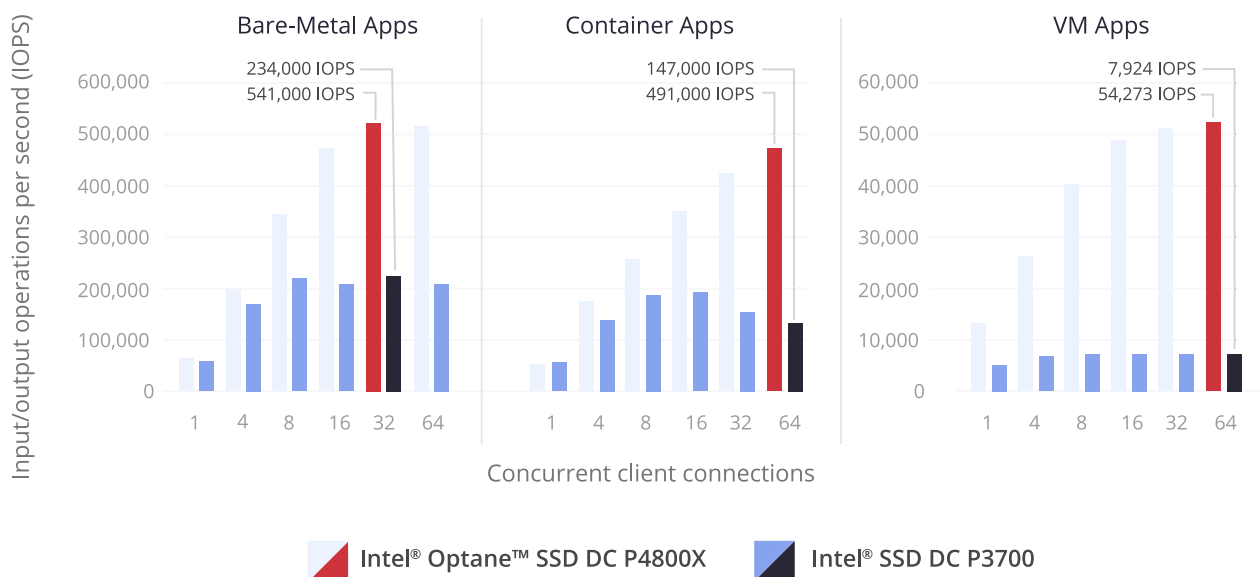


Figure 1. Random writes, 4 KB blocks (higher bars represent better results); the Intel® Optane™ SSD DC P4800X demonstrated higher performance than the Intel SSD DC P3700 for bare-metal, container, and VM apps, even under load.¹

Key Findings from the Random Read Benchmark

The second set of tests compared random read times for the Intel® Optane™ SSD DC P4800X and the Intel SSD DC P3700 for increasing numbers of concurrent client connections, with apps running in containers and in VMs. Intel® Optane™ SSDs delivered a significant random read performance increase to applications with fewer concurrent threads performing I/O operations. On a single-thread application, the performance increase was 638 percent (81,024 IOPS versus 10,974 IOPS).¹

- **Bare-metal:** The Intel® Optane™ SSD DC P4800X delivered 40 percent better top performance in random read operations than the Intel SSD DC P3700 (556,000 IOPS versus 398,000 IOPS on 64 parallel test clients).¹
- **Containers:** The Intel® Optane™ SSD DC P4800X delivered 48 percent better top performance in random read operations than the Intel SSD DC P3700 (542,000 IOPS versus 365,000 IOPS on 64 parallel test clients).¹
- **VMs:** The Virtuozzo 7 VM provided up to 912 percent better random read performance on the Intel® Optane™ SSD DC P4800X compared to the Intel SSD DC P3700 (103,000 IOPS versus 10,178 IOPS on 16 parallel test clients).¹

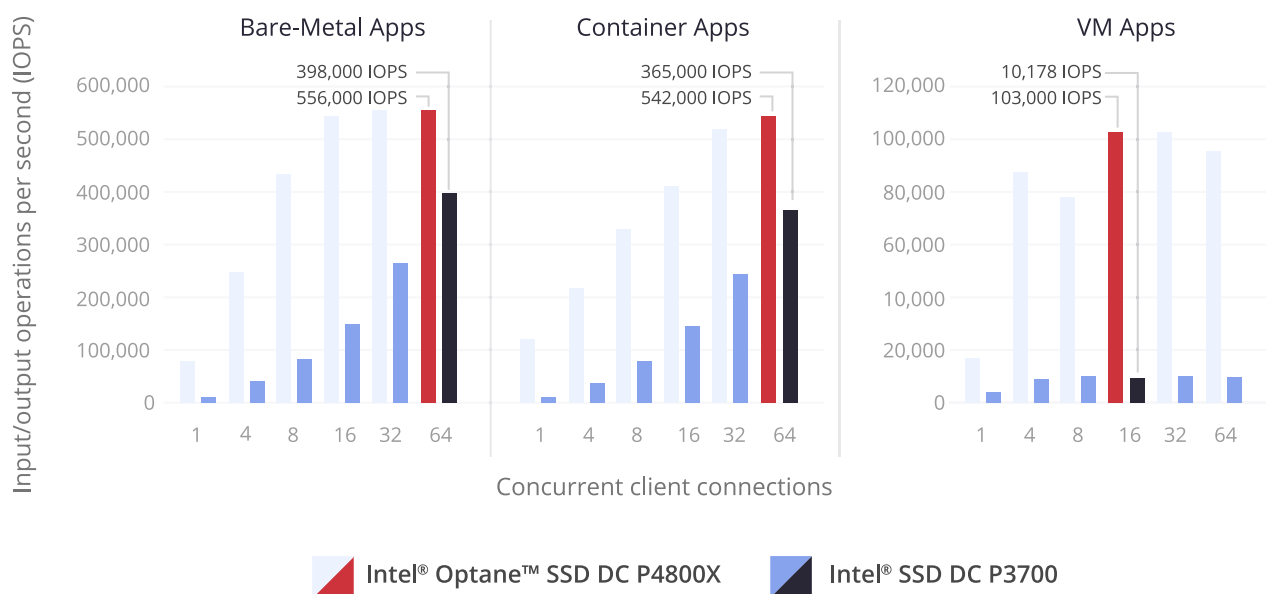


Figure 2. Random reads, 4 KB blocks (higher bars represent better results); the Intel® Optane™ SSD DC P4800X demonstrated higher performance than the Intel SSD DC P3700 for bare-metal, container, and VM apps, even under load.¹

Key Findings from the Random Write, Followed by fdatasync, Benchmark

The third set of tests compared the performance of the Intel® Optane™ SSD DC P4800X and the Intel SSD DC P3700 performing random writes, followed by the fdatasync benchmark, with each set of tests measuring increasing numbers of concurrent client connections, and with apps running in containers and in VMs.

- **Bare-metal:** The Intel® Optane™ SSD DC P4800X delivered 40 percent better top performance in random write/fdatasync operations than the Intel SSD DC P3700 (536,000 IOPS versus 383,000 IOPS on 32 parallel test clients).¹
- **Containers:** The Intel® Optane™ SSD DC P4800X delivered 45 percent better top performance in random write/fdatasync operations than the Intel SSD DC P3700 (419,000 IOPS versus 288,000 IOPS on 64 parallel test clients).¹
- **VMs:** The Virtuozzo 7 VM provided up to 10 percent better random write/fdatasync performance on the Intel® Optane™ SSD DC P4800X compared to the Intel SSD DC P3700 (43,497 IOPS versus 39,519 IOPS on 64 parallel test clients).¹

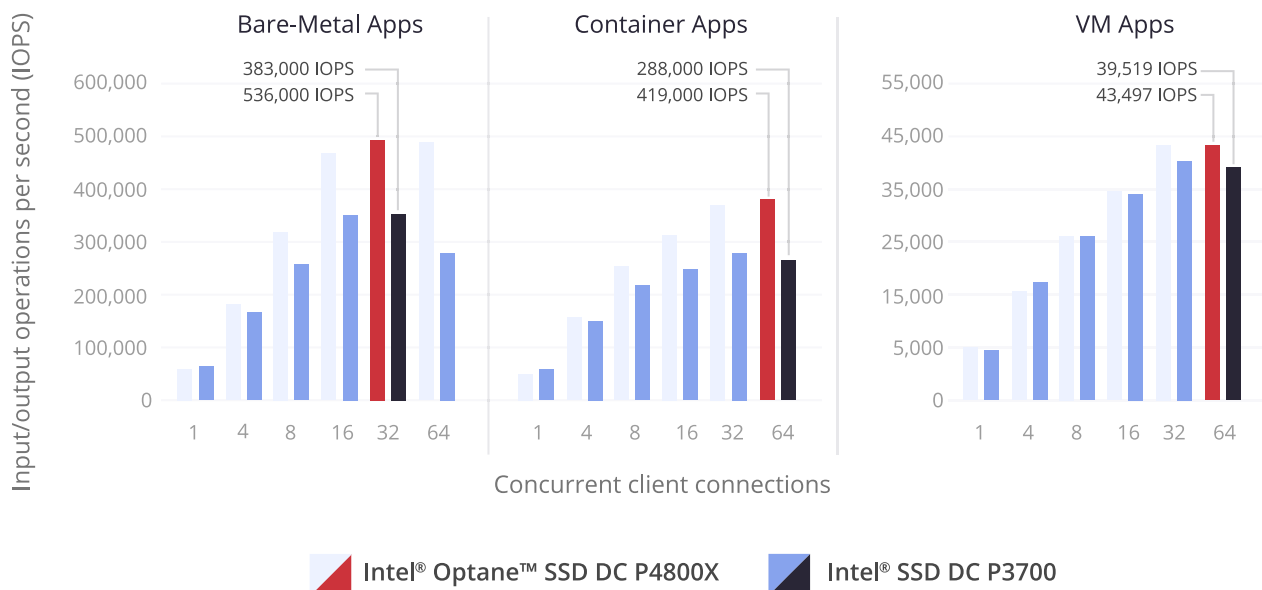


Figure 3. Random writes followed by fdatasync benchmark test, 4 KB blocks (higher bars represent better results); this benchmark best represents the access patterns of a transactional database performing massive updates.

Benchmark Test Conclusions

In almost all tested scenarios, the Intel® Optane™ SSD DC P4800X delivered a significant performance increase compared to the previous-generation Intel SSD DC P3700. The tests demonstrate the Intel® Optane™ SSD DC P4800X helps prevent storage from being a bottleneck in a hyperconverged infrastructure deployment.

The tests also showed that the combination of Intel and Virtuozzo technologies can significantly improve application performance and scalability in both containerized and VM-based SDDC environments. Businesses that deploy Virtuozzo 7 with the Intel® Optane™ SSD DC P4800X can achieve a flexible, highly available SDDC with optimized storage. Virtuozzo 7 with the Intel® Optane™ SSD DC P4800X also allows modern businesses to achieve the increased agility they need to support modern apps and services that require high performance and availability.

The Intel® Optane™ SSDs for the Data Center

The Intel® Optane™ SSD DC P4800X helps eliminate data center storage bottlenecks and allows bigger, more affordable data sets. The Intel® Optane™ SSD DC P4800X for the data center can accelerate applications, reduce transaction costs for latency-sensitive workloads, and improve overall total cost of ownership (TCO).

About Virtuozzo

Virtuozzo provides integrated container, virtual machine, and software-defined storage technology that leads to better cost efficiency, scalability and security in data centers around the world. It was the first company to monetize container workloads almost 20 years ago and has over five million containers in production today. It has also been a thought leader and active contributor to many influential open source projects, including Linux kernel, OpenVZ, CRIU, KVM, Docker, OpenStack, CNCF and OCI.

Learn More

To learn more about Virtuozzo, visit <https://www.virtuozzo.com>

- 1 Testing conducted by Virtuozzo in 2017. Configurations: Virtuozzo 7, built on Lenovo System x3650 M5* servers, powered by the Intel® Xeon® processor E5-2690 v4, 3.50 GHz, 128 GB. Storage media for baseline configuration: 350 GB Intel® SSD DC P3700 Series. Storage media for newer configuration: 64 GB Intel® Optane™ SSD DC P4800X Series.

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