



Validating Low Overhead for Virtualized OLTP Applications

HP Integrity Servers and Parallels Virtuozzo Containers 4.0

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Executive overview

Consolidation of computing hardware has historically been the first step in resource optimization projects. Parallels Virtuozzo Containers takes this a step further by consolidating OSs through a proven technology and management interface that reduces costs and complexity while enabling performance sensitive/resource intensive workloads to be addressed.

Parallels Virtuozzo offers high server density and scalability through its near-native performance architecture, making it optimal for applications like online transaction processing (OLTP). This document provides an overview of the OLTP performance benchmarks conducted by HP BCS Windows Integrity Engineering and Parallels Engineering on HP Integrity servers using OS virtualization technology—Parallels Virtuozzo Containers—to provide a proof point to validate the low overhead this virtualization approach yields.

An industry standard OLTP database performance test was chosen for the benchmark process. It uses a database schema, data population, transactions, and implementation rules that have been designed to be broadly representative of modern OLTP systems.

Benchmark Results summary

Parallels Virtuozzo Containers, the world's leading OS virtualization solution, creates isolated containers on a single physical server and OS instance. Compared to hypervisor virtualization technologies, Parallels Virtuozzo offers higher levels of density, performance, scalability, and manageability. Benchmarks of various types have repeatedly shown that Parallels Virtuozzo has the lowest overhead of any virtualization technology, ranging from 1% to 10% depending on the operating system (Linux or Windows) and the workload.

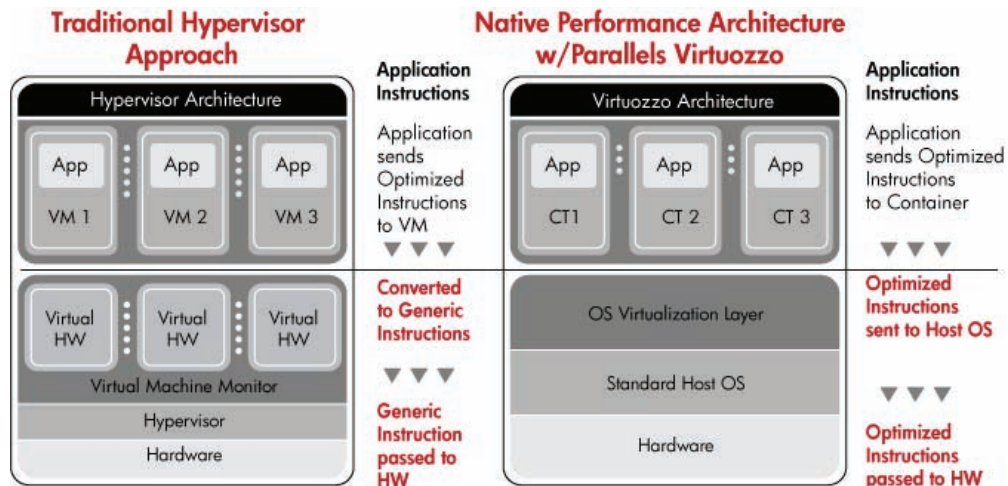
The first goal of this benchmark was to prove that this was the case for HP Integrity servers, which can scale to more CPUs and memory than any other system tested with Parallels Virtuozzo. The second goal was to prove that this low overhead could be maintained with performance sensitive / resource intensive workloads.

HP and Parallels engineers conducted the benchmark tests. These results are unaudited and therefore considered to be a generic OLTP benchmark intended only to measure virtualization overhead.

- The team first established an OLTP benchmark base line of 407 transactions per second on the test platform, an HP Integrity rx7640 server.
- With Parallels Virtuozzo installed, the team then re-ran the OLTP benchmark and obtained a result of 369 transactions per second on the test platform (spread across 8 Microsoft SQL Server 2005 instances).
- Hypervisor-based virtualization approaches can result in an overhead of up to 40% when used in these types of OLTP benchmark test environments. Parallels Virtuozzo injected a **virtualization overhead of only 9%** in an industry standard OLTP benchmark test environment.

Traditionally, performance sensitive/resource intensive workloads (such as databases) have not been virtualized with hypervisor-based technologies because of the overhead incurred. Because OS virtualization does not abstract the hardware, optimized instructions can be passed through directly to the underlying operating system (see Figure 1).

Figure 1: Comparison of Hypervisor and OS Virtualization Technologies



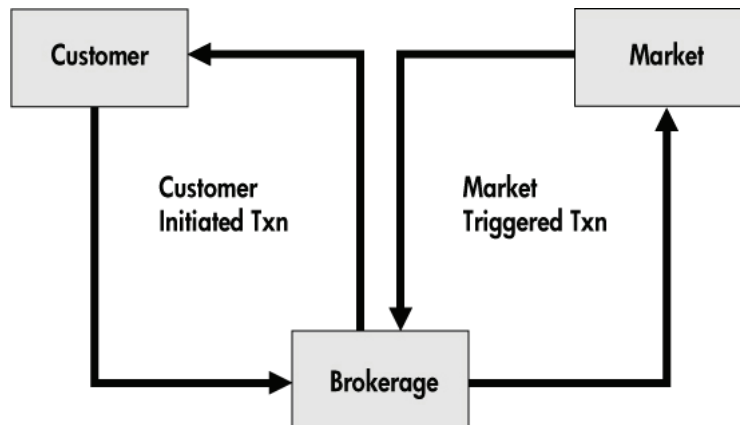
The results highlighted in this document show that by using OS virtualization, organizations are able to consolidate performance sensitive and resource intensive workloads without sacrificing performance.

OLTP Benchmarking Test overview

The OLTP benchmark used is designed to model a brokerage firm with customers who generate transactions related to trades, account inquiries, and market research. The brokerage firm in turn interacts with financial markets to execute orders on behalf of the customers and updates relevant account information.

The benchmark is “scalable,” meaning that the number of customers defined for the brokerage firm can be varied to represent the workloads of different-size businesses. The benchmark defines the required mix of transactions that the benchmark must maintain. The benchmark establishes a metric for results in transactions per second (tps). It specifically refers to the number of Trade-Result transactions the server can sustain over a period of time.

Figure 2: OLTP model—a brokerage firm



Parallels Virtuozzo Containers overview

Parallels Virtuozzo Containers unique architecture makes it the perfect solution for server consolidation and business continuity configurations.

- **Missing hardware emulation stack:** Parallels Virtuozzo does not emulate hardware. Hardware-backed system resources are applied directly to the hardware (after performing minimal security and namespace verifications). For example, disk read/write operations are converted to block access operations and are then applied directly to the physical block device. Same operations in the hypervisor solutions are additionally tunneled through SCSI command envelopes with further decoding back to file system disk read/writes.
- **Efficient memory sharing:** Parallels Virtuozzo enables applications and services running in different containers to share the hardware resources presented by the host OS. For example, the same DLL loaded from multiple applications in different containers has single mapping in the host's physical memory. This provides significant memory and disk space savings when running more than one container on the host.
- **On-demand allocation policy:** In the hypervisor solutions, a virtual instance allocates memory on startup even if no applications demand memory at that moment. In contrast, a container allocates memory only when applications demand such resources. This makes using ballooning memory drivers and other resource intensive or potentially unreliable memory reclaim techniques unnecessary.
- **System-wide caching:** With Parallels Virtuozzo, applications running in containers benefit from the host's overall file system caches, not from per-container caches. This brings significant performance advantages in shared application usage scenarios (such as database consolidation) where the same applications are often started in multiple containers.

Parallels Virtuozzo's OS virtualization architecture also offers several manageability advantages.

- **Fewer operating systems to manage:** The number of operating systems being managed is equal to the number of physical servers installed. Each new container creates a virtual instance of the host OS and does not require another entire instance of the operating system. This approach allows new containers and the associated applications to be typically deployed in less than 100 MBs of disk space. Hypervisors can consume up to 15 GB per virtual machine instance.
- **Improved container manageability:** Parallels Virtuozzo provides an open API and host/web-based tools to manage the virtualization services and virtualized applications directly associated with the host system and its respective containers. This significantly reduces the time and effort needed to manage the containers.
- **Ease and speed of provisioning:** Container provisioning/updating and application installation typically takes less than a minute and can be performed as completely unattended operations. Preliminary operations such as creating container images for further cloning are not required.

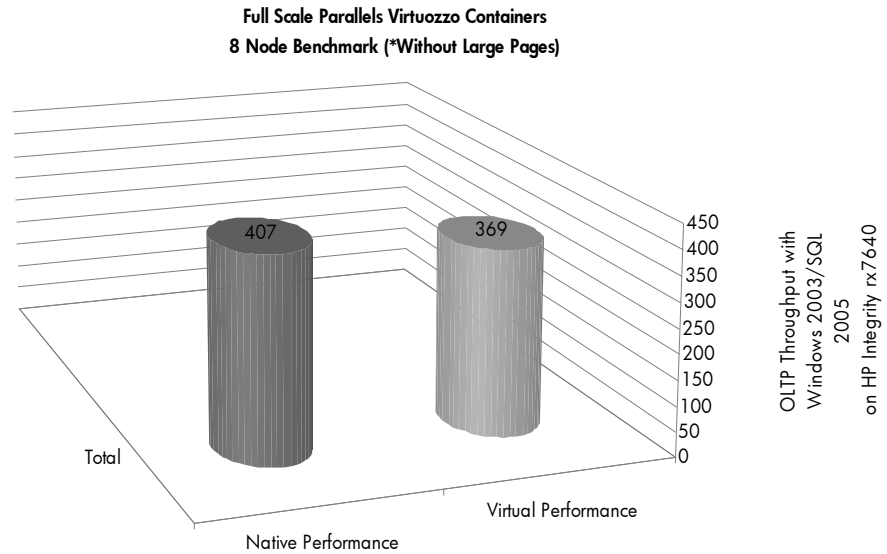
HP/Parallels Benchmark results

The following results are for aggregated performance testing of eight (8) Microsoft SQL Server 2005 instances running simultaneously. Using Parallels Virtuozzo Containers, each Microsoft SQL Server 2005 instance was run in a separate container.

Note: The number of containers is not limited to eight instances. Eight instances were used for the purpose of this testing based on the available CPUs and to provide a direct comparison to the test pass without the virtualization software installed.

Parallels Virtuozzo can support 100s of containers per physical server with a near linear overhead level (in this case 9%). Workloads that are less I/O intensive will generate overhead levels that range from 2% to 9% regardless of the number of containers deployed.

Figure 3: Aggregate Results for 8 Microsoft SQL 2005 instances

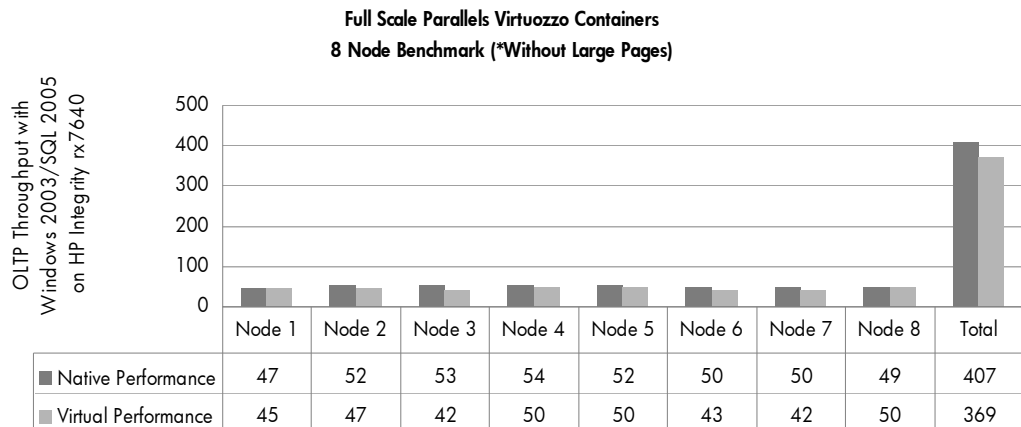


Understanding the results

With the eight instances of Microsoft SQL Server 2005 instances, each running in its own container, Parallels Virtuozzo demonstrated only **9%** virtualization overhead (compared to native Windows performance).

The measured metric was the total TPS throughput from all eight Microsoft SQL Server 2005 instances that were running concurrently. This simulated a real-world situation in which virtualization is used to consolidate the workloads tested. The overall OLTP score is a sum of the individual workload scores shown in Figure 4.

Figure 4: Individual Results for each MS SQL instance



The results from container to container are not identical because the underlying Windows system scheduler allocates different functions (NIC interrupts, HBA interrupts, and more) to the various CPUs supporting the containers. So, these functions have a varying impact, some containers show near-native performance, while other containers show a slightly increased overhead.

Thus the aggregate number is what should be focused on and how the team derived the overall Parallels Virtuozzo overhead for this performance intensive workload.

Specifications of the hardware and software used for these tests along with detailed test parameters are provided in the Appendix.

Appendix

HP BCS Windows Integrity Engineering Lab test-bed

Hardware

- Server for tests: HP rx7640, 8x1.6 GHz Intel Itanium 2 processors with 16 Cores, 64 GB RAM, separate 500 GB SAN partition for each database, 9x1 Gbit dual network adapters
- Clients (8): Intel Xeon 2xDual Core 3.6 GHz Xeon, 1 Gb RAM, 1 Gbit network card

Software

- Parallels Virtuozzo Containers for Windows 4.0 (vzupd6), Windows 2003 for Itanium, EE SP2
- Microsoft SQL Server 2005 SP2

Test configuration

The team created eight MS SQL instances. They first tested on the native Windows operating system, and then tested with eight containers. Each container was allocated 8 GB RAM and 1 CPU (2 Cores).

Size of target DB	40000 customers
Connect rate	15 users/minute
Start rate	15 users/minute

Summary of test configuration:

SQL Instance №	Average Response Time		Throughput Tps	
	PVC 4.0 for Windows	Native	PVC 4.0 for Windows	Native
1	0,09	0,10	45	47
2	0,09	0,08	47	52
3	0,11	0,07	42	53
4	0,11	0,09	50	54
5	0,08	0,09	50	52
6	0,12	0,10	43	50
7	0,13	0,08	42	50
8	0,10	0,09	50	49
Total	-	-	369	407

The results of the two runs are: $369/407 = 9\%$.

Hypervisor-based virtualization approaches can result in an overhead of up to 40% when used in this type of OLTP benchmark test environment. This is typically due to the intensive use of memory or IO that the workloads generate. Such workloads are not handled as efficiently by hypervisor-based technologies because optimized instructions are converted to generic instructions by the Virtual Machine Monitor (VMM) before being passed to the underlying hardware. However, Parallels Virtuozzo passes optimized instructions directly to the host operating system for processing. This is the key advantage of OS virtualization and why performance sensitive/resource intensive can be easily and effectively consolidated with this approach.

Call to action

The Parallels Virtuozzo Container webpage contains detail information on operating environments supported, customer case studies, product trial downloads, and more. To request a Parallels Virtuozzo Containers demo, please go to www.parallels.com/virtuozzo/demo. To request more detailed information about Parallels Virtuozzo Containers on HP Integrity servers, please e-mail at vzsales@parallels.com

For more information

www.hp.com/go/integrity/windows

www.parallels.com/virtuozzo

www.parallels.com/solutions/virtualization/itanium

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