OCZ enterprise

Case Study

Supreme Court of Italy Improves Oracle Database Performance and I/O Access to Court Proceedings with OCZ's PCIe-based Virtualized Solution

Combination of Z-Drive R4 PCIe SSDs and VXL Cache & Virtualization Software Deliver Flash High Availability Coupled with a 60% Performance Improvement over SAN Storage

Scott Harlin

OCZ Technology Group

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1 Objectives and Results

User Objectives

- Reduce/eliminate disk I/O storage bottlenecks
- Run virtualized Oracle database applications on virtual machines (VMs)
- Improve server application performance
- Accelerate access to stored trial information and court proceedings

Achieved Benefit

- Improved Oracle database performance by 60% while providing highly available flash acceleration

2 Introduction

Corte Suprema di Cassazione. Photo taken by Blackcat from Wikipedia.

The **Supreme Court of Italy** (also known as Corte Suprema di Cassazione or the Supreme Court of Cassation) is the final jurisdiction of Italian rule. Its two essential roles are to (1) ensure that the lower courts (i.e. penal, civil, administrative and military) correctly follow legal procedure and (2) provide final decisions to the lower courts based on its interpretation of Italian law. Not only does this Supreme Court provide an assessment and ruling regarding the laws of the land, but also resolves disputes as to which lower court has the jurisdiction to hear and rule on a given case.

Regardless of the trial, all Supreme Court proceedings are digitally stored in their Oracle database for obvious security and archival purposes, but also in the age of instant information, provide a very fast means for prosecutors, defense attorneys, judges, legal administrators, and even the media to quickly access a trial's information.

As more trial proceedings were stored into Corte Suprema di Cassazione's virtualized hard drive-based storage area network (SAN), data traffic increased and disk I/O soon became a performance bottleneck. To address this challenge initially, Corte Suprema di Cassazione's IT team added more hard disk drives (HDDs) to the SAN but that only provided a temporary solution at an increase in power consumption, cooling, maintenance, IT support, and overall total cost of ownership (TCO). Though Corte Suprema di Cassazione had implemented a server virtualization model to manage and store its library of court proceedings, Oracle database performance and data I/O access needed to improve.

Corte Suprema di Cassazione is segmented into two divisions -- a penal division and a civil division, with a ruling party that includes a main president (The First President of the Court of Cassation), a deputy, a penal division president, and a civil division president. Most Supreme Court cases are heard by a panel of five judges, but for very difficult cases, it is not uncommon for nine judges to hear and rule on the case.

This case study outlines how Corte Suprema di Cassazione's IT management team addressed the storage challenges it faced by upgrading its system infrastructure with improved capabilities that deliver flash data caching into virtualized server platforms and distributes these flash resources on-demand across virtual machines (VMs) to maximize Oracle database performance. The combined hardware and software solution developed by solid-state storage leader OCZ Technology included Z-Drive R4 PCI Express (PCIe) flash-based solid-state drives (SSDs) and VXL Cache and Virtualization Software. Through this flash-based implementation, Corte Suprema di Cassazione is now achieving significant improvements in database performance and I/O access while reducing data center costs.

3 HDD Issues in the Virtualized Environment

The Corte Suprema di Cassazione enterprise configuration utilized server virtualization to expand and maximize the usefulness of its HP ProLiant DL380p Gen8, dual processor, 8-core server resource and VMware ESX software. In conjunction, five VMs were connected in the configuration which enabled multiple virtual Oracle database loads to run concurrently from a single physical host. The server virtualization model was supported by a high-performance HP P2000 G3 SAN Array that eventually grew to support 17 HDDs and over 7.5 terabytes (TBs) of storage capacity. As server virtualization provided Corte Suprema di Cassazione with better utilization of CPU and memory resources, simpler deployments and reduced maintenance, Oracle database performance and data I/O access were being taxed by hard drive limitations.

While the HP ProLiant server can handle hundreds of thousands of input/output operations per second (IOPS), each 10k rpm HDD in the SAN array can only deliver a few hundred IOPS of performance. So even if more VMs were added to Corte Suprema di Cassazione's infrastructure, the 17 HDDs within the SAN

array would still be unable to keep up with the server workload demands. As multiple Oracle workloads run concurrently in the Corte Suprema di Cassazione virtualized environment, data requests were subjected to the randomization effect known as I/O blender and therefore required a solution with strong random access capabilities to accelerate I/O.

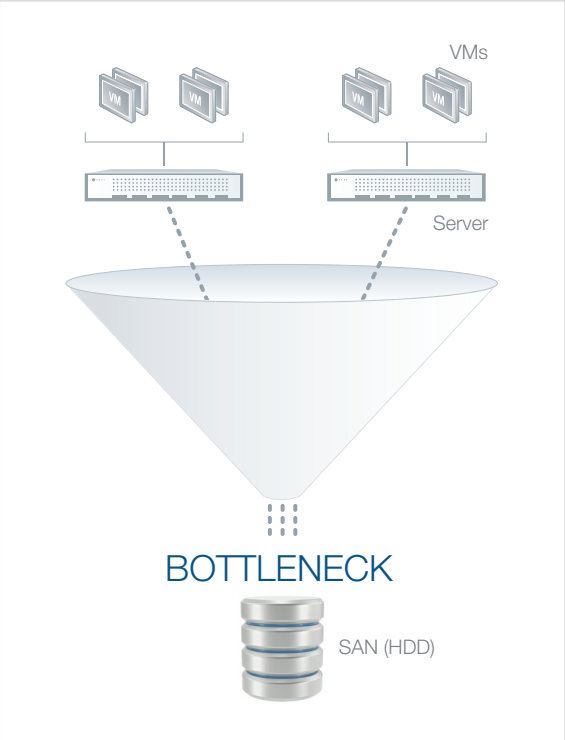


Figure 1: Concurrently running multiple virtual machines (VMs) in a virtualized environment will cause heavy randomization of data access towards the SAN

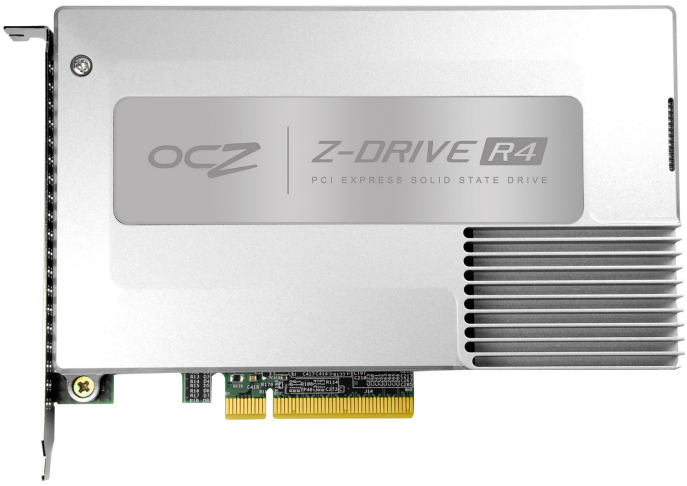
This became the major shortcoming of Corte Suprema di Cassazione's virtualized environment as HDDs require that their mechanical heads move from location to location, limiting each drive's physical ability to quickly read or write random data. As each HDD head movement takes time, read/write IOPS performance and latency are slowed until data is found and accessed. An example of Corte Suprema di Cassazione's performance bottleneck issue is depicted in Figure 1.

To monitor and assess hard drive performance every day, Corte Suprema di Cassazione's IT department ran daily continuous performance tests of its Oracle database based on benchmarks and queries they developed over time. Given this proven testing process, it was determined that a refresh of its server virtualization capabilities and storage infrastructure were necessary to improve access and retrieval of court proceedings and trial information stored in its Oracle database.

As part of this refresh, Corte Suprema di Cassazione would also evaluate solid-state drives with varying interfaces as SSDs store data using NAND flash memory, and with no moving parts, handle random data access effortlessly. As a result, SSDs are a superior enabler of virtualization capable of delivering random IOPS performance comparable to a large SAN array with hundreds of HDDs implemented.

4 The OCZ Virtualized Solution

To help them address their Oracle performance limitations, Corte Suprema di Cassazione secured the services of their local systems integrator, Asystel Italia, who developed a cluster solution based on OCZ Technology's Z-Drive R4 PCIe SSDs and VXL Cache and Virtualization Software. Though Corte Suprema di Cassazione assessed different SSD products and interfaces, they ultimately selected PCIe, not only because it provides more than 40 times faster speed than SAS or SATA interfaces, but the compact, full-height power-efficient card fits directly into the server's PCIe bus in close proximity to the central processor. This enables host CPU and memory resources to be offloaded to the Z-Drive R4 SSD card, which in turn, delivers much faster and more reliable access to



the trial information file groups and court proceeding data segments available from its Oracle database.

The fourth generation Z-Drive SSD is specified to provide maximum read/write performance of up to 2800 MB/s, 410,000 random write IOPS, 275,000 random read IOPS, and the specific model selected by Corte Suprema di Cassazione supports storage capacity of 800GB.

Working in conjunction with the flash-based Z-Drive R4 PCIe SSD is the latest version of OCZ's VXL Virtualization Software (version 1.3) creating one encompassing virtualization solution. VXL Software distributes flash caching resources on-demand across VMs to maximize performance of key applications, such as Oracle databases, and distributes the flash between VMs based on need while making sure that no VM inefficiently occupies flash when it could be better used elsewhere in the environment. As a result, the flash cache is optimally utilized at all times regardless of how many VMs are running concurrently. VXL's unique caching reduces data traffic to and from the SAN by up to 90% enabling critical data to be locally available and quickly accessible in the Z-Drive card.

The Z-Drive/VXL cluster combination developed by Asystel Italia would invariably resolve Corte Suprema di Cassazione's disk I/O bottleneck issues and enable increased VM density on the physical host, as depicted in Figure 2.

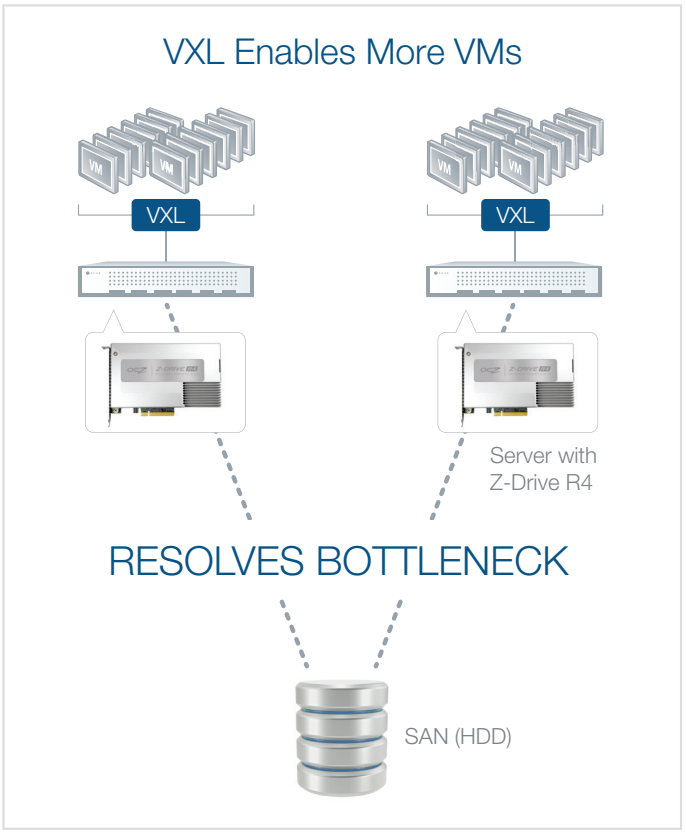


Figure 2: Asystel solved the virtualization storage bottleneck issue that Corte Suprema di Cassazione experienced using a cluster solution comprised of OCZ's VXL Software and Z-Drive R4 PCIe solid-state cards

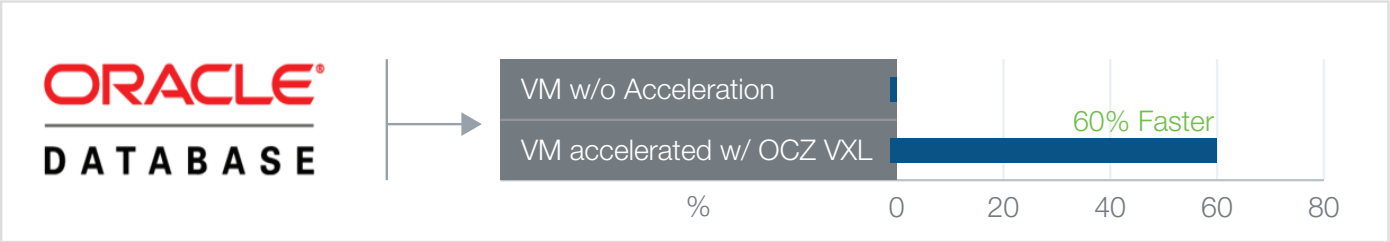
The combination of Z-Drive R4 PCIe SSDs and VXL Software brings the power of flash to virtualized environments so that all of the benefits of virtualization in reduced CAPEX and OPEX are only enhanced whenever flash is used by a VM. To accomplish this, OCZ treats the flash as another virtual resource and creates a central virtual appliance that works with VMware's ESXi hypervisor to dynamically distribute the flash according to need, inside and outside of the physical server. VXL Software does not require guest agents within Oracle VM applications dramatically simplifying the deployment, management and maintenance of database storage.

5 Testing and Implementation

The Z-Drive/VXL cluster combination developed by Asystel Italia would invariably resolve Corte Suprema di Cassazione's disk I/O bottleneck issues and enable increased VM density on the physical host.

After systems integrator Asystel Italia installed the Z-Drive R4 PCIe card and VXL Software in the HP ProLiant server on a test basis, Corte Suprema di Cassazione ran daily continuous performance tests of its Oracle database based on benchmarks and queries they developed over time and compared these test results to the non-accelerated HDD SAN environment with 17 HDDs connected. This included two 50GB databases as well as reading and writing between 10GB and 20GB each day which represented a typical usage scenario of its Oracle database.

The test results yielded a 60% improvement in performance over a non-accelerated HDD SAN while still utilizing the SAN for lower tiered storage. From this preliminary evaluation, Corte Suprema di Cassazione ran several tests over a few months using VXL accelerated volumes and experienced similar results providing them with the confidence that the OCZ virtualization solution would enable their host-based Oracle application to be run off of the SAN while increasing database performance and access to stored data. OCZ's virtualized solution was successfully implemented into Corte Suprema di Cassazione's enterprise in August 2013.



6 High Availability

For Corte Suprema di Cassazione, High Availability (HA) was just as important a capability as performance. To this end, they utilize two main data centers located approximately 6km distance from each other and needed to guarantee data availability and integrity, even during unplanned downtime or power outages.

To deliver HA capabilities in Corte Suprema di Cassazione's Oracle environment, flash data is synchronously replicated by VXL Software between two Z-Drive cards residing on two redundant cluster servers assuring that host-based Z-Drive flash is treated as a continuously available storage resource across VMware clusters yielding no data loss or VM downtime during system or server failures.

Providing Z-Drive/VXL installations at both data center locations has not only resulted in a 60% improvement in Oracle database performance but applying a WAN mirror between the two sites.

A primary and secondary configuration of the database was implemented (as depicted in Figure 3) to maintain two live identical copies of data down to the last command. Data was then synchronously replicated (or mirrored) from the primary Oracle database to a secondary Oracle database, and by placing one Z-Drive R4 PCIe card in a primary HP ProLiant server, and one in a secondary HP ProLiant server, data from the primary Oracle database was inserted into the secondary Z-Drive's flash cache through an application policy utilizing 'Cache on Write' functionality.

The result is that the secondary Z-Drive card has a live replicated copy of the Oracle database data in flash cache as well as a live replicated copy of write log data in its flash volume. This assures that if either HP ProLiant server containing Z-Drive flash resources fails, the Oracle VMs with stored data can be rebooted on a new server with full access and processing of data from its stopping point retaining all of its data as if no downtime had occurred. Providing Z-Drive/VXL installations at both data center locations has not only resulted in a 60% improvement in Oracle database performance but applying a WAN mirror between the two sites provided a 'No Single Point of Failure' (NSPOF) solution with a huge cost savings as alternative solution architectures require far costlier infrastructures.

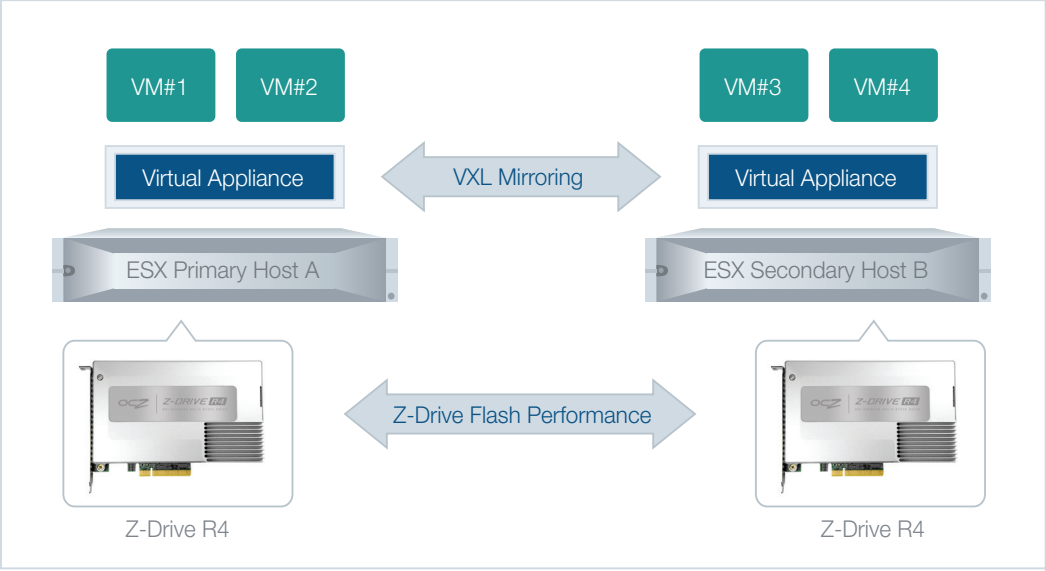


Figure 3 represents a VMware H/A environment configured with OCZ Z-Drive R4 PCIe SSDs and VXL Software

9 Conclusion

The combination of OCZ's Z-Drive R4 PCIe SSD with VXL Software transformed Corte Suprema di Cassazione's virtualized Oracle database applications by providing these key benefits:

1. **Increased Server Utilization** – By eliminating HDD storage bottlenecks, Corte Suprema di Cassazione greatly increased utilization of its HP ProLiant resources while providing higher quality of service (QoS) to users requiring trial documents or court proceedings. In fact, OCZ's combined hardware/software virtualization solution allowed the data center to grow without excessive CAPEX or OPEX while enabling more VMs to run on the central HP ProLiant host.

OCZ's combined hardware/ software virtualization solution allowed the data center to grow without excessive CAPEX or OPEX while enabling more VMs to run on the central HP ProLiant host.

2. **Reduced SAN Costs** – VXL Software provides the required storage virtualization services at the host layer (rather than at the SAN), including synchronous replication and HA, while the Z-Drive R4 PCIe card generates the IOPS requested by each VM, eliminating the need for Corte Suprema di Cassazione to deploy costly, high-end SANs with heavy virtualization services at the SAN layer. In its place, cost-efficient HDDs continued to be used for lower priority capacity storage and I/O performance was no longer generated by concurrently running spindles as power and cooling requirements associated with the SAN array was reduced as well as an overall reduction in TCO.

3. **Highly Efficient Flash Utilization** – With the implementation of flash-based virtualization in Corte Suprema di Cassazione's data center, Oracle application data was efficiently distributed between all VMs in the Z-Drive/VXL Software cluster based on need while making sure that no VM inefficiently occupies flash when it could be better used elsewhere in the environment. As a result, the flash cache provided through OCZ's virtualized solution was optimally utilized regardless of how many VMs were running concurrently.

"Once we implemented the OCZ Z-Drive and VXL Software into our HP ProLiant server platform we ran our performance tests and experienced immediate performance improvements when accessing stored trial data from our Oracle database. This ability to deliver flash data caching into virtualized server platforms and distribute these flash resources on-demand across VMs are key reasons why we have experienced 60% improvements in Oracle database performance."

- Antonio De Blasiis

Head of Engineering/IT, Corte Suprema di Cassazione

Contact us for more information

OCZ Technology Group, Inc.
6373 San Ignacio Avenue
San Jose, CA 95119 USA

P 408.733.8400
E sales@oczenterprise.com
W ocz.com/enterprise

EMAIL SALES TEAM >

VISIT OCZ ENTERPRISE >

Scott Harlin is the Director of Marketing Communications of Enterprise Solutions for OCZ Technology, a leading provider of high-performance solid-state storage solutions for enterprise and personal computing applications.