White Paper

Answering the Requirements of Flash-Based SSDs in the Virtualized Data Center

Provide accelerated data access and an immediate performance boost of business-critical applications with caching and virtualization software

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Introduction

Flash-based solid-state drives (SSDs) are being deployed in increasing numbers throughout virtualized data centers providing the benefits of increased performance and reduced total cost of ownership (TCO). In terms of I/O access, one host-based flash SSD can deliver random input/output operations per second (IOPS) comparable to thousands of hard disk drives (HDDs) in a SAN array. When deployed with caching and virtualization software, these SSDs provide accelerated data access and an immediate performance boost of business-critical applications.

As more flash-based SSDs are deployed, IT professionals are realizing that performance is just one of many requirements for enterprise storage. In fact, many server applications rely on specific capabilities of the supported storage devices to provide critical services such as High Availability (HA), cross server network access to data volumes, and end-to-end mirroring. In some cases, these critical services are a prerequisite for running certain server applications.

If flash-based SSDs are not deployed correctly in the data center, the server application in question may gain a performance boost, but at the same time, may lose the ability to deliver key services critical to that application. Therefore, IT professionals must take into account these critical requirements when considering SSD deployments.

The purpose of this white paper is to identify key requirements that IT professionals face when deploying flash-based SSDs into an enterprise environment, and introduces an emerging hardware/software architecture that combines the power of flash acceleration with the power of storage.
virtualization. This new approach not only moves data onto host-based flash to maximize performance and efficiently utilize host resources, but also provides those critical storage services required for operating and maintaining enterprise business applications.

2 Requirements for SSDs in the Enterprise

Fast access to data is a central reason that flash-based SSDs are deployed in the data center. However, performance is just one of a set of storage requirements that IT must address, as additional key requirements, such as storage resiliency, efficient resource sharing and ubiquitous use of storage resources are no less critical to IT professionals.

As depicted in Figure 1, the key requirements that IT professionals face when deploying flash-based SSDs into an enterprise can be classified into four categories. A brief description of these requirements now follows:

Acceleration

Fast I/O access to data and low latency are reasons to deploy flash-based SSDs in an enterprise. However, the acceleration of enterprise applications requires more than just fast, low latency I/O access. In many cases, flash acceleration requires efficient performance optimization for specific applications while utilizing data caching, virtualization, or other techniques to improve data access and server application performance. In all cases, SSD implementations must be planned for and mapped out by IT using appropriate flash hardware and software to achieve the performance benefits that SSDs can provide to specific applications.

Resiliency

IT professionals must also be concerned as to whether the implemented flash-based SSDs are preventing the data center’s ability to provide uninterrupted services to its clients. End-users should not have to choose between high performance and high availability, therefore, SSD resiliency needs to be a key requirement when selecting the best flash solution fit for the enterprise.

Virtualized environments include a number of capabilities that provide users with uninterrupted service such as HA, mirroring, vMotion™ and Fault Tolerance, so let’s quickly review these key critical services:
• HA (High Availability) is designed to assure that if a host containing flash resources fails, the virtual machines (VMs) housing the data can be rebooted on a new host with full access to their data. In support of virtual machine HA capabilities, host-based flash management must assure that data written to the primary flash resource is also written to a secondary flash resource, or to underlying storage.

• Mirroring (or data mirroring) is the process of replicating data to two or more SSDs to provide backup in the event that one drive fails. Failover between mirrored flash resources should be completely transparent to the host running application VMs so that I/O access is not interrupted, even during a flash resource failure.

• vMotion is a VMware capability (part of the vSphere virtualization OS) that enables the dynamic migration of a VM’s file system from one storage system to another, with no VM downtime or service disruption to end-users. This capability can be used as a migration tool, as a load balancer or simply for taking down the SAN for maintenance. To truly support vMotion, host-based flash resources must assure no performance drops when VMs are migrated between servers.

• Fault Tolerance (FT) is one of the most demanding services of virtualized environments providing continuous non-interrupted availability of an application even during total server failures. To achieve FT, two live identical copies of a VM (mapped down to the last bit) are required so that one copy can be an immediate backup for the other copy. When deploying FT with SSD flash, a solution that supports synchronous mirroring between hosts, as well as flash high availability, is required to assure no downtime and no data loss during failures.

Efficient Resource Sharing

Modern data centers are designed around the principal of efficient resource sharing. As application loads and data access demands shift dynamically throughout the day, SSD flash must continually be available to application loads running on different hosts. An SSD solution that is isolated in the enterprise is counter-productive to the flexibility that IT professionals require to run their data centers efficiently.

Ubiquity

In a typical data center environment, thousands of VMs may be deployed for specific applications that use different operating systems, as well as different versions of the operating system, whether it is Windows, Linux or another. In fact, providers of cloud services often do not know which operating systems will be used at any given time, as the choice is left to the end-user. When deploying an SSD solution that is isolated in the enterprise is counter-productive to the flexibility that IT professionals require to run their data centers efficiently.
Recent advances in flash-based SSD technology introduce a third flash deployment architecture that completely addresses the key enterprise requirements.

SSD Flash Deployment Options

Until recently, IT professionals were provided with two major flash-based SSD deployment architectures that address some aspects of acceleration, resiliency, resource sharing and ubiquity, but none address these enterprise requirements completely. Recent advances in flash-based SSD technology introduce a third flash deployment architecture that completely addresses the key enterprise requirements. The following is a quick synopsis of these flash-based deployment architectures and how they address key enterprise requirements.

3 SAN Array-Based Flash Deployments

Under this architecture, flash-based SSDs are added to enterprise SAN arrays that are either all flash arrays or provide a hybrid approach with HDDs. In this deployment architecture, flash-based SSDs are available to any application server that accesses the SAN array.

Flash-based SSDs reside in the SAN and connect to host-based applications as a shared network resource in a similar manner as HDDs, and address some of the ubiquity requirements in the enterprise. Any application that connects to a SAN can also connect to the flash-based SSD implemented in the SAN, enabling all of the storage services available in the SAN, such as mirroring and virtualization, to be made available to the flash-based SSD.

The downside of this deployment architecture is that it significantly reduces the ability of flash-based SSDs to accelerate the host-based applications since the flash resource is subjected to the same network and array controller bottlenecks that plague HDD-only platforms. The high speed benefits of flash become irrelevant when the SSD cannot be efficiently accessed due to the limitations of the network itself. When flash-based SSDs reside in the SAN, it is more difficult to optimize flash usage to the data access requirements of the applications themselves.

4 Host-Based Flash with Caching Software Deployments

Under this architecture, flash-based SSDs with associated caching software are placed on the application host server and are much closer to the applications...
they are servicing. The flash resource is only available to applications running on this particular server.

Placing the flash resource in the server (literally right next to the CPU running the applications), helps achieve two major goals. First, bottlenecks that limit the transmission speed between the flash-based SSD and the host CPU are all but removed. Secondly, caching decisions can be made at the host level, with close monitoring of the flash resources, the application requirements, and the specific application data access patterns.

If the flash-based SSD is not deployed with proper software, considerable limitations can be placed on the applications and servers using them, adversely affecting storage services and network availability. When critical data is taken from the SAN and moved into the server, it no longer can be accessed from other servers, and is not redundantly maintained. While benefitting from the speed advantages that flash enjoys over hard drives, the SSD loses its ability to provide a resilient, fault tolerant service that IT professionals and business users require. When the flash resource becomes physically tied to the host server, efficient resource sharing between servers becomes impossible, considerably increasing TCO in the data center.

5 Host-based Flash with Storage Acceleration and Virtualization Software Deployments

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<th>Enterprise Requirements</th>
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Table 1: SSD deployment options based on enterprise requirements in a virtualized data center

Under this architecture, flash-based SSDs are combined with software to not only accelerate server application performance, but also to transform the host-based flash resource into a highly available, resilient, network-accessible virtualized solution. Unlike the previous two options, this emerging flash deployment architecture allows the enterprise to fully benefit from flash access performance while retaining the full set of enterprise storage requirements.
Key to this architecture is intelligently combining the power of flash acceleration with the power of storage virtualization. When deploying a host-based flash SSD with acceleration and virtualization software, the data is moved onto the flash resource, along with its critical storage services. Through this approach, all of the enterprise storage requirements are maintained even when accelerated to their highest performance levels resulting in a highly efficient, fault tolerant, SAN-less enterprise flash solution. Table 1 showcases the flash architecture deployment options based on the four essential groupings of enterprise data center requirements.

6 OCZ’s Host-Based Flash SSD with Storage Acceleration and Virtualization Software

To answer all of the flash usage requirements of the data center, OCZ Technology, a leading provider of high-performance virtualized solid-state solutions for the enterprise, has developed an integrated hardware/software solution that combines the power of flash acceleration with the power of sophisticated storage virtualization. This advanced approach not only moves data onto host-based flash to maximize performance and efficiently utilize host resources, but also provides the required storage services for operating and maintaining business-critical applications.

To achieve this optimized virtualized server environment, OCZ’s fourth generation Z-Drive R4 PCI Express (PCIe) SSD provides a compact, performance-dense, power-efficient solid-state solution that fits directly into a server’s PCIe slot to increase server application performance while delivering fast and reliable access to data without burdening host CPU and memory resources. When combined with OCZ’s VXL flash caching and virtualization software, the integrated solution enables the delivery of a complete virtual performance system for enterprise customers looking to accelerate VMs to maximize performance of key applications.

VXL software uses Z-Drive R4 PCIe cards to distribute the flash resources between VMs based on need while making sure that no VM inefficiently occupies flash when it can be better used elsewhere in the environment, and that the flash cache is optimally utilized at all times regardless of how many VMs are running concurrently. Even though the flash cache resource is located in one server, it can be shared across multiple servers making VXL the only virtualization software that can deliver this unique capability. This approach provides the highest return on investment (ROI) in a virtualized environment where many VMs share the same flash and often do not reach peak workload requirements concurrently.
In contrast to competitive solutions, VXL software does not require guest agents within the application VM, and through hypervisor connectivity, works with any operating system supported by a virtualization platform including Windows, Linux, OpenSolaris and FreeBSD. The ‘no-agents’ approach dramatically simplifies the deployment, management and maintenance of storage especially when there is an abundance of VMs in the virtualized environment.

With the Z-Drive R4 PCIe cards deployed at the host layer of virtual servers, data access is no longer a limiting factor as VXL software can run up to 10 times the number of VMs and will keep up with the random I/O requirements of all the VMs in the system. See Figure 2.

7 How OCZ Virtualization Works

OCZ treats the flash as another virtual resource and works with the hypervisor directly to dynamically distribute the flash according to need, inside and outside of the physical server. By combining storage virtualization with PCIe flash caching, and by working centrally with the hypervisor rather than with each local VM, OCZ developed a solution that takes advantage of flash performance without losing any of the benefits associated with virtualization (i.e. mirroring, High Availability, vMotion support, Fault Tolerance, etc.).

By working with the hypervisor directly, OCZ’s virtualized solution is transparent to both the VM operating system and to the hypervisor. Caching and storage virtualization is handled by VXL and designed to run in VMware ESX, Microsoft Hyper-V, or Citrix Xen virtualization platforms.

Since VXL software enables Z-Drive R4 PCIe cards to be virtualized as a highly available network resource, it enables the flash to be exposed to any VM in a virtualized cluster without negating any of the virtualization capabilities of the hypervisor layer. The ability to have flash-only level performance sets the precedence for an all-silicon, SAN-less data center that delivers all the benefits of virtualization without the need for costly back-end HDD SANs.
8 Conclusion

When flash-based SSDs are not deployed correctly in the enterprise, the server application in question may lose its ability to deliver key critical services that address resiliency, resource sharing and ubiquity. These critical services are a basic requirement for efficiently operating and maintaining the business applications that are housed in enterprise data and driven by the service levels that business users require. At this level of importance, business users should not be forced to choose between performance and High Availability.

To best address the enterprise storage requirements in a virtualized data center, OCZ has delivered an integrated hardware and software solution that combines the power of flash acceleration with the power of storage virtualization. The combination of OCZ’s Z-Drive R4 PCIe SSD with its VXL virtualization software delivers storage virtualization with PCIe flash caching, and by provides the power of flash without losing any of the benefits associated with virtualization. For the first time, IT professionals are able to provide their business users with the performance they require while maintaining the full resiliency expected from an infrastructure supporting business-critical applications.