Transforming Application Performance with Persistent Memory
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1. Executive Summary

Data is growing at 53% per year between 2011 and 2016 according to IDC. Businesses are demanding more real-time data to drive revenue. Server performance is doubling every 18 months. What does this mean? The increasing gap between server performance and storage performance is killing application (and business) performance. This is not a new issue, but its business importance has accelerated and broadened to new revenue-generating applications.

There are plenty of potential solutions to this issue, from classic tuning the existing environment to new all-flash technologies. Vendors are constantly revamping old solutions and bringing new ones to market. Every solution has tradeoffs in performance, cost, implementation time, level of disruption, etc.

This paper examines the classic solutions and presents two new ones – the Violin Memory Array and Maestro Memory Appliance. Violin Flash Memory Arrays can transform the datacenter with performance up to 20x better than traditional disk-based storage arrays. Many enterprises will find Maestro a compelling solution as it accelerates application performance on legacy storage – up to 10x and requires no changes to applications, servers, storage or software.

2. Introduction

IDC research estimates that the digital universe contained 281 Exabytes in 2007. In 2013, the amount of digital information produced in just one year is predicted to equal 3,700 Exabytes.¹

- Data Warehouses are tripling in size every two years.²
- Demand for OLTP systems (electronic banking, order processing, employee time clock systems, e-commerce, and eTrading) is relentlessly increasing.
- On-Line Analytical Processing (OLAP) is resurgent, creating new demands on data infrastructures.
- Virtualization of datacenters is rapidly growing, and increasingly constrained by I/O
- Virtual desktops (VDI) are also growing rapidly to improve costs and operational efficiency
- Handheld devices are rapidly increasing the amount and types of data that must be managed
- Unstructured data such as emails, photos, machine log data and videos are exploding

Real-time applications that drive revenue are slowing down and negatively impacting operations and revenue. Responsiveness in providing data and analysis to business units is increasingly a competitive advantage, or disadvantage. Increasingly, business moves at the speed of data.

The good news is there are more and more new alternatives available to speed up critical applications. New technology is arriving that can provide relief for I/O constraints at a cost effective price.

¹ IDC estimate (An exabyte is a billion gigabytes, while a gigabyte is a billion bytes. A byte is composed of 8 digital bits, each either a zero or a one. A byte typically encodes one letter, number, or special character in the Western alphabet or number system.)

3. What is the Application Performance Limit?

Applications hit the performance limit when they are I/O constrained. Revenue generating applications have to provide near-instant access to information in order to compete in today’s fast-paced marketplace. When customers don’t get the response or service they expect, they quickly turn to the competition to fulfill their needs to minimize lost revenue opportunities.

This is not a new problem. Companies have been dealing with it for years.

Classic Solutions:

1. **Storage Area Network (SAN) or Network Attached Storage (NAS)** – Often the first thing Enterprises do when data starts to outgrow existing architecture is install a SAN or NAS to enhance application performance by sharing data across multiple servers and/or more efficiently managing and securing the data. Many SAN and NAS arrays also provide caching functionality that provides some performance benefit for certain applications.

2. **Tuning Disk Spindles** – As data access requirements increase, the next solution is to spread the data across more disk spindles. By spreading data across more spindles and only using the outer tracks of the disks (called short-stroking of the disks), I/O performance can be increased, at the cost of wasted capacity and management.

3. **Database Tuning** – Typically, application, database and storage engineers work together to tune an application and database. Often some simple changes (such as moving index files) produce dramatic performance gains. However, once “tuning” crosses over into application re-writing, this becomes a very risky and costly strategy. And if applications change, databases need to be tuned with high cost trained personnel to achieve the best performance gains.

Enterprises should evaluate all of these solutions before going to the next level. Although sometimes expensive, they are low risk and non-disruptive to current operations.

When these classic solutions are no longer keeping up with application performance demands, Enterprises find themselves approaching the limits of their current architectures.

![Figure 1: Application Acceleration Options](image-url)
4. Maximizing Application Performance

The good news – there are new and enhanced technologies that will sustain the performance of IT systems when approaching the performance limit.

- **Enterprise Flash/SSD tier** – Most storage vendors offer enterprise SSDs as an additional media option for their current arrays. In many cases this does provide some I/O performance boost and preserves current hardware, software and processes. Manual migration of selected data to flash can slow implementation. This option leaves enterprises captive of the storage vendor but brings memory to a disk architecture. Several new storage vendors offer enterprise all-flash arrays with stunning performance. The price for these ultra-high performance arrays has been declining and now is competitive with disk based arrays when the total cost of computing is analyzed. There are two main categories of these all-flash arrays- SSD based and flash architecture based. Performance and density for the flash architecture based designs is generally superior to traditional architectures with SSDs due to the redundant controller functions and standardized hardware of the SSD approach instead of a specialized design to optimize flash performance in the flash architecture arrays. SSD architecture solutions are usually based on HDD designs, whereas flash architecture arrays are designed from the ground up to optimize the capabilities of memory technology. The leading example of the all-flash array is the Violin Flash Memory Array for superior application performance which can deliver up to 20x performance improvement over traditional disk-based storage.

- **Specialized Dedicated Data Warehouse Appliances** – These solutions have been on the market for 20+ years. If an enterprise has a Data Warehouse type application that requires a 50x performance boost and has a huge dataset, this could be a reasonable solution. These are typically tiered storage with flash and traditional hard disk drives.

- **Memory Appliances** – This new class of appliances leverage current infrastructure and procedures. They can deliver up to 10x improvement in application performance with no changes to applications, databases, servers, storage or processes. In the best example, caching algorithms are hardware based for low management effort and high performance. While a flash tier brings memory technology to a disk architecture, Memory Appliances bring flash architecture to a disk tier. Violin Memory’s Maestro Appliance brings several advantages to this class of solution, to be detailed later.

- **Server Flash/SSD** – Installing SSD drives directly in a server can often increase application performance with minimal disruption to infrastructure and applications for in-memory applications. However, this approach does not scale to large amounts of data and provides a solution only for smaller applications that do not utilize multiple servers. Similar to the issue with all-flash arrays, the architecture makes a difference. Simply putting SSDs in a server doesn’t provide the performance lift that PCIe based cards can generate. PCIe based server flash combines performance and ease of use for scale-out and in-memory applications. Violin Memory’s Velocity PCIe cards provide an outstanding server-based Memory solution.
5. Acceleration Selection Guidelines

The type of storage solution implemented should depend on the type of application requirements and infrastructure. For applications with smaller, slower-growing datasets that don’t require shared storage and without high availability requirements, server side flash may be the simplest solution. Server side flash may also be appropriate for in-memory applications where massive external storage via a SAN is not required.

For larger, high growth applications, a combination of SANs, Enterprise storage and cache tier is probably the current situation. For larger datasets and high growth datasets with high performance requirements, moving directly to an enterprise all-flash array may be an appropriate solution. Because application performance can be a competitive advantage, the all-flash array option potential has the largest benefit to the enterprise and will be the preferred option.

For some applications that have very high read-only workload without heavy interactive requirements, a Memory Appliance may be appropriate.

6. Application Acceleration with Memory Solutions

Critical applications enable the enterprise, and speed can be a competitive advantage. To deliver the best application performance and competitive advantage, think speed. Think persistent memory. The ultimate solution to application performance is the use of a persistent memory array. The all-flash storage array from Violin Memory delivers performance that makes a difference. There may be constraints on instituting a new array into the current environment such as economic depreciation concerns or the desire for a phased implementation. In these cases, the Violin Maestro Appliance can accelerate applications even as data resides on the traditional disk-based storage. Maestro can also provide migration services to move data onto new Violin Flash Memory Arrays when appropriate to get the best performance.
7. The Violin Effect

Violin Flash Memory Arrays

All roads lead to all-memory arrays to accelerate the data center to new heights. Violin Memory’s 6000 series arrays provide a selection of capacity and performance to meet a wide variety of requirements. Violin 6000 Series flash Memory Arrays are all-silicon shared storage systems built from the ground up, harnessing the power of flash memory and delivering industry-leading performance and ultra-low data access latencies. A single 3U array delivers more than 1 million IOPS with consistent, spike-free latencies in microseconds, a full order of magnitude lower than legacy storage solutions. This game-changing combination makes the 6000 Series the storage of choice for high IOPS, scale-out virtual infrastructure configurations, business-critical applications with stringent service level agreements, and real-time big data analytic environments.

6000 Series flash Memory Arrays connect natively to existing 8Gb/s Fibre Channel, 10GE iSCSI, and 40Gb/s Infiniband network infrastructures and managed by the Violin Memory Operating System, providing a simple and easy GUI management interface. Provisioning storage for an application is extremely simplified. No RAID groups, storage silos, or storage tiers get in the way. New LUNs are spread across the entire surface of the Flash Memory Fabric. Never worry about hotspots again; the raw performance capabilities of 6000 Series flash Memory Arrays eliminate storage bottlenecks and application latencies and simply make your shared storage as fast as memory.

8 Gb/s Fibre Channel array vs Violin Flash Memory array with DSS workload

Figure 3: For details see RedHat Violin Performance Brief “Removing Performance Bottlenecks in Databases with RedHat Enterprise Linux and Violin Memory Flash Storage Arrays”
Violin Flash Memory Arrays contain industry leading technology as well. The core of the 6000 is the Flash Memory Fabric. The Flash Memory Fabric is a resilient, highly available deep mesh of thousands of flash dies that work in concert to continuously optimize performance, latency, and longevity. Contrary to SSD based systems that reuse legacy disk based architectures, the Flash Memory Fabric is the result of an all silicon system approach. This approach utilizes patented flash optimization algorithms implemented in hardware, operating at line rate. All of the active components of the Flash Memory Fabric are hot-swappable for enterprise grade reliability and serviceability, just another benefit of the 6000.

Violin Memory is uniquely positioned to deliver flash memory systems that can compete with performance disk from a cost for raw capacity perspective, even before taking into account the potential benefits of features like deduplication. This is possible because 6000 Series flash Memory Arrays are purpose built with flash components sourced through Violin Memory’s unique and strategic alliance with industry leader Toshiba. The value of Violin’s new 6000 becomes even more obvious when compared to the capital expenditures and operating costs of running complex legacy storage systems with a limited set of SSDs, storage tiering policies, and constant monitoring and tuning.

8. Memory Acceleration of Legacy Storage

Maestro Memory Appliance

The memory appliance is designed to perform real-time analysis of an application’s storage access patterns, dynamically adjust to changes in data access patterns, and be transparent to the storage network. Application memory appliances offer great value in that they can dynamically learn the I/O profiles of an application and adjust the caching function accordingly.

The Violin Memory Force Memory Appliance with Maestro Software is the trailblazing product in this new category of memory appliances. Maestro provides zero-touch acceleration of your applications at a fraction of the cost and effort associated with other options.

Violin Maestro is deployed between a server and storage, and can be configured to operate in a Storage Area Network (SAN) or in a Direct Fibre Channel-Attached Storage configuration. The Violin Force Memory Appliance with Maestro software installs and works out of the box in hours with no disruption or downtime.

The Violin Memory Appliance with Maestro software boosts application performance up to 10 times at a fraction of the cost of alternative solutions that are disruptive, expensive and power hungry. The Violin TurboCharger automatically profiles the data access behavior of applications and creates a heuristics-driven map of the data. The I/O requests from applications are instantaneously fulfilled using this real-time data map, thus boosting their performance while allowing you to fully leverage your existing storage, servers, databases, applications, processes and personnel, resulting in dramatic reductions in CAPEX and OPEX.

Violin uses custom hardware and software to automatically move data between RAM, Flash and permanent storage. Using proprietary algorithms similar to Google’s page ranking methodology, the Violin Maestro uses Set-Ranking™ to keep the most important data in flash memory.
For companies who are approaching the application performance limit, the Violin Maestro can be your answer! It dramatically decreases latency, providing better and more predictable application performance. It also provides headroom for growth. You can “future-proof” your storage environment for rapid growth while ensuring top-notch performance; you’ll also gain the ability to run additional applications on your storage infrastructure without impacting the performance of existing applications.

Violin Maestro accelerates dataset access for any application that uses block-based storage, including Oracle Databases, DB2, Sybase, MySQL, PostgreSQL, as well as filers. Maestro enables customers to truly maximize their current storage, servers, applications, processes and personnel, which translates into bottom-line cost savings.

With a Violin Memory Appliance, your performance-challenged application environments are transformed into a data-serving infrastructure that can speed past old limits! Here is what Violin Memory means to you:

- Leave Your Apps Untouched
- Accelerate any application
- No costly upgrades: utilize installed servers, databases and software that uses block-based storage: relational databases, filers with SAN storage, storage virtualization, etc.

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### Figure 4: For details see University of California Davis Accelerate Virtualized Oracle Data Warehouse by Violin Memory

<table>
<thead>
<tr>
<th>Latency</th>
<th>Bandwidth</th>
<th>IOPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Maestro</td>
<td>30</td>
<td>130</td>
</tr>
<tr>
<td>After Maestro</td>
<td>1</td>
<td>250</td>
</tr>
</tbody>
</table>
• Leave the current configuration of your applications untouched
• Use existing IT staff

Enhance Your Existing Storage
• Cut costs by maximizing your storage capacity instead of short-stroking disks for performance

Accelerate Your Business
• Dramatically boost the performance of your revenue-generating applications
• Automatically improve the performance and scalability of your applications
• Provide consistent I/O performance across diverse types of applications
• Minimize power consumption

The Violin Maestro is complementary to other solutions. If you have a SAN - great! Violin can make it faster. Migrate to Enterprise all-flash arrays with Violin Maestro. Data Warehouse appliances (and the applications that feed them) have I/O bottlenecks; Violin can accelerate them also.

9. Don’t Wait to hit the Application Performance Limit
As traditional tuning hits its limits, it’s time to consider alternatives. The world is turning to all-flash arrays to be competitive in a fast-paced world. There is more than one way to transition to this new computing model of all-flash arrays. Contact us now to see how Violin can increase the performance of your applications.

Sign up for a free, no-risk analysis. We will profile your application I/O behavior. With this information, we can gauge the efficiency of data traffic flow between your servers and storage arrays. Your Violin traffic flow report card will show you clearly how a Violin Memory solution can improve your application performance. Don’t wait for your applications to hit the performance wall. Let Violin help you today!