Using SSDs to Reduce Storage Bottlenecks in Virtualized Environments

Tom DiGiurco, Product Marketing Manager

Introduction

Businesses are increasingly forced to do more with less—while maintaining quality and service levels. Budget, physical space, and staffing constraints keep a business' infrastructure from growing at the same pace as its customer base. The traditional approach of adding both physical servers to support growth and system administrators to maintain them can quickly fill server rooms, offices, and data centers to capacity—or even worse—require a business to build out its current space or expand to larger, costlier facilities.

In a virtualized server environment, virtual versions of servers, applications, and desktops maximize the investment in shared hardware resources while minimizing the power, space, and support staff required to maintain them—helping businesses achieve the goal of doing more with less. However, a number of challenges can adversely impact server virtualization and virtual desktop infrastructure (VDI) implementation. For example, storage system stress can result in boot storms and the “I/O blender effect”—both of which hamper virtual machine (VM) scalability and end-user satisfaction. These challenges can be addressed using Micron’s enterprise-class solid state drives (SSDs), which accelerate how quickly data is retrieved in virtualized environments.

Slowing Server Sprawl With Server Virtualization

Conventional data center designs run a single application on each server to avoid one mission-critical application from crashing and taking down other applications on the same server. For companies that have hundreds or even thousands of applications, maintaining this more conventional design while keeping up with rapidly growing demands can lead to server sprawl—which not only increases power consumption, space, and maintenance costs, but results in CPU underutilization because smaller, less frequently-used applications only use a fraction of the CPU’s processing power.

A more cost-effective solution is to use hypervisor software to create and manage multiple virtual servers—each running an operating system and an application from a single server or cluster of servers. These virtual servers (or VMs) share the host server’s CPU, RAM, local storage, and network I/O. The VMs appear as a physical server to the application and end users accessing it. Because the VMs are not chained to physical hardware that must be shut down for maintenance, they can be easily created, backed-up, cloned, migrated, and mirrored without impacting end users.

High Availability and Reliability in VDI Environments

Until recently, most office environments relied on costly, high-performance desktop PCs with local operating systems—which required numerous software licenses. In these environments, hardware and software maintenance and user errors could leave an employee’s PC idle while tying up on-site IT resources—and worse, irreplaceable files and data stored locally could be lost forever in the event of an error or system crash, and critical systems could be affected by the introduction of malware.

In a VDI, desktop hardware and applications are virtualized on servers set up with high levels of redundancy—which enables high availability. The hardware and applications are secured in managed data centers, and user data is stored on backend storage, which is backed up and can be restored in the event of a catastrophic failure. Data and applications are available 24/7 in a VDI, and an employee can access networks and applications anywhere, anytime, from any Internet-connected device, including low-cost or aging PC workstations, inexpensive thin clients, and their own devices.
Virtualization Enables Easier, Less Expensive Application Clustering

IT groups have used clustering techniques to improve application reliability for many years; however, clustering is a costly solution in traditional data center designs. When running a single instance of an application on each physical server, the total expense to build an “n-way” cluster is “n” times the expense of a single instance—reserving clustering for only the most essential business needs.

Virtualization enables several applications to be deployed on a single physical server, and that same server can host several instances of different clustered applications. Only two physical systems are needed to build a two-way cluster; the number of two-way clustered applications that can be built depends on the resources of the physical systems (one virtual instance of each application is placed on each physical system and they are clustered at the application level). By extension, “m-way” clusters are just as economical because only “m” physical systems are needed to build them.

Virtualization Creates New IT Challenges

While virtualization can minimize rising IT infrastructure costs and maximize shared hardware resources, it presents a new set of challenges for storage systems using magnetic media like hard disk drives (HDDs)—most related to the high IOPS and low latency required in virtualized environments.

Storage Stress Slows Systems

Virtualization puts extreme stress on storage system performance when a large number of users and/or applications (e.g., hundreds or thousands) simultaneously vie for storage resources. In a VDI, the most common cause of I/O spikes results from boot storms that occur when a large number of users log in within a short period of time—such as at shift change when several workers arrive at the office. Similar I/O demand spikes can also occur when several users simultaneously access documents or web sites, when virus definitions are being updated, and when the IT team recomposes virtual desktop images. In a call center, boot storms are common when call volume is high during service outages or at the beginning of a billing cycle.

Because local storage is no longer associated with a single application in a VDI, the I/O traffic that once originated from a single user is now greatly multiplied when I/O streams are simultaneously sent for processing. During these boot storms when I/O traffic is at its peak, the I/O processes that would otherwise be sequential now become highly random, resulting in the “I/O blender effect”—where the VMs “blend” the I/O requests. And the heavier the workload, the more random the I/O requests become.

The I/O blender effect can adversely impact critical workloads because storage system bottlenecks reduce the speed at which data can be accessed by everyone. For example, downloading a company update sent to several employees can take minutes instead of seconds to load or mission-critical applications can time out.

I/O demands also have a dramatic impact on clustered applications in a virtualized environment. This higher degree of virtualization—with dissimilar applications running as guests in the same hypervisor—generates a storage I/O pattern that is very difficult for conventional storage to manage because the small, random I/O of these virtualized servers is extremely taxing on rotational media.
Virtual Environments Still Need to Scale
By nature, virtualization is a highly scalable technology because virtual servers and desktops are added in software rather than physically adding racks of new servers. However, even virtualized environments have a saturation point where the I/O demands of heavy workloads limit the number of virtual servers and desktops that a single physical server can handle.

Traditionally, this has required larger storage pools to be added or critical applications to be moved onto faster 15,000 RPM HDDs. But, adding racks of storage to spread out the I/O load reintroduces the issues that virtualization attempts to solve.

System Performance Impacts Application Efficiency and End-User Experience
In VDI environments, storage and server system slowdowns impact all users on the network, and the end-user experience is primarily determined by how fast data can be accessed. It is common for today’s workers to have fast PCs, laptops, and tablets at home, so they expect comparable performance at the office. Minutes spent waiting to be logged in, for e-mail to load, or documents to download adds up quickly and turns into missed deadlines and lost hours, days, weeks, or more when multiplied over the course of a year and across a company’s entire workforce.

For example, internal testing shows that HDD-based storage in a VDI environment can result in average wait times of 18 minutes, 27 seconds for systems to boot each day. For one user who earns $20.00 per hour, this equates to $6.15 per day, $30.75 per week, or $1604.45 per year. In a VDI implementation of 100 users, this results in $160,445.81 worth of unproductive user time.

The effects of lost time are multiplied when stalled systems lead to trips to the water cooler or other time-consuming work breaks. Waiting for data to be served may also be perceived as a system crash, leading to help desk calls that unnecessarily tie up support staff.

System slowdowns have an even greater impact on mission-critical applications running on virtual servers. For companies using big data analytics to analyze user interaction and deliver targeted content for their customers, waiting for data to be served can result in lost revenue (competitors can deliver content more quickly). For search engines, these slowdowns can result in incomplete and inaccurate search results and content being omitted from paid advertisers.

Micron SSDs for Virtualized Environments
Micron has an SSD portfolio of low-latency, high-IOPS, enterprise-class SATA, SAS, and PCIe SSDs that deliver the performance, capacity, durability, and power advantages essential to highly virtualized environments. Micron’s enterprise SSD solutions are designed for server storage and caching, purpose-built storage appliances, network-based caching, mid- to large-scale storage systems, and as tier-one primary storage or cache behind DRAM memory in enterprise storage arrays.

Reducing the IT Footprint
Instead of scaling out racks of HDDs to reach the required I/O performance in a virtualized environment, a small number of Micron’s SSDs can help eliminate storage I/O bottlenecks—minimizing racks of hardware, data center real estate, power, and support staff.

Eliminating Storage System Bottlenecks
Using solid state storage instead of physically spinning disks (HDDs) delivers random I/O performance that is orders of magnitude better—at a lower cost per IOPS. For example, Micron’s M500DC SATA SSD delivers steady-state random read performance of 65,000 IOPS at 4KB and steady-state random write performance at 36,000 IOPS at 4KB. The P420m PCIe SSD delivers 750,000/95,000 IOPS of random read/write performance while the P320h delivers 785,000/205 IOPS random read/write and steady-state performance. These SSDs have the storage performance needed to remove the storage bottlenecks that slow systems down and leave workers idle.

Ideal for Clustered Applications
The random read/write IOPS performance of Micron’s enterprise SSDs is also a natural fit for clustered applications in virtualized environments because they are able to manage the random, small-transfer I/O workload much easier than conventional storage.

Caching Solutions for Virtualized Environments
Using Micron’s SSDs with software caching solutions can also dramatically reduce the storage latency in virtualized environments. While using Micron’s SSDs for read and write caching not only improves VM application performance (particularly for active applications), it also

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Securely Erasing Micron SATA SSDs
reduces the load on other storage systems because only requests for I/O not in cache are sent to slower spinning media or SAN. As the cache fills up, the number of cache misses that send I/O requests to slower storage is reduced, improving performance over time.

Micron’s SSDs can be used in purpose-built caching storage solutions or through partner software caching solutions that use a combination of software and Micron’s SSDs to dramatically increase VM density by eliminating I/O bottlenecks with adaptive caching. In addition, CPUs that were once idle become fully available to support additional business applications for end users.

VMware’s Virtual SAN™ (VSAN) and Virtual Flash Read Cache™ (vFRC)

VSAN is not strictly a caching solution, but it creates a virtual shared data store without a SAN and can use SSDs as cache for frequently accessed data. VMware’s cache-specific software, vFRC, leverages enterprise-grade SSDs for high-performance read caching, which minimizes storage latency by accelerating read/write disk I/O traffic with built-in caching on server-side SSDs. Both solutions provide a performance boost that is achieved by accessing data directly from storage connected to servers in a cluster, thus alleviating additional delays caused by the network. Micron’s 2.5-inch and HHHL P320h and P420m PCIe SSDs are VSAN-certified. See VMware’s VSAN and vFRC compatibility guides for a list of Micron’s approved products.

Conclusion

Virtualized environments reduce the cost, maintenance, and management of data center and client computing infrastructure. However, virtualization can put great stress on storage systems during I/O peaks that occur when large numbers of users vie for data, which can fundamentally change the nature of I/O—morphing typically sequential storage access into a completely random I/O stream. When users and applications are impacted by slow access to data, it can result in wasted time, lost business, and potentially incorrect or partial data being returned. Micron’s portfolio of high-IOPS, low-latency SSDs can be used to dramatically reduce the impact of heavy I/O loads on these virtualized systems. Micron’s SSDs help eliminate storage bottlenecks to serve critical data more quickly to users and applications.

Benefits of Micron SSDs for Virtualization

- Remove storage I/O bottlenecks that can occur during boot storms.
- Provide shortest boot and fastest latency times.
- Enable 10X faster initial boot and 4X faster complete boot than HDD.
- Increase VM density and performance.
- Maximize application uptime, enabling more productive staff.
- Optimize CPU and storage performance to process more business applications for end users.
- Improve the efficiency and performance of virtualized servers.
- Take advantage of VMware VSAN’s software-defined storage tier and high-performance read/write caching, which requires an SSD in each server.

Learn More

See the resources below and visit micron.com to learn more about how Micron’s SSDs tame boot storms and reduce storage bottlenecks in virtualized environments.

- Micron Virtualization Solutions
- P420m PCIe SSD Boot Storm Testing in Virtualized Environments
- P320h PCIe SSD Boot Storm Testing in Virtualized Environments
- Accelerating VMware® Virtual SAN™ With Micron SSDs

micron.com

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