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WHITE PAPER

Unlocking the Power of Flash with the MCx-Enabled Next-Generation VNX

Sponsored by: EMC

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EXECUTIVE SUMMARY

Continuous data growth coupled with a new generation of multi-core CPUs has placed new demands on storage systems to handle an unprecedented number of workloads. Hard disk drives (HDDs) have become ever more dense and are able to handle greater capacity, but the rotational speed of mechanical HDDs has not improved beyond 15,000rpm since 2001 and is not likely to increase, creating a bottleneck for compute performance. As organizations move toward fully (100%) virtualized datacenters, the storage systems they choose today must be able to handle hundreds, even thousands, of virtual machines (VMs) and mixed workloads and support the business not only in the present but into the future.

Flash media promises to close the compute and storage performance gap and free storage from being the I/O bottleneck within IT environments. The tectonic shift in storage I/O performance possible with flash, however, requires the processing power of multi-core CPUs. Storage system developers must re-architect their systems to unleash the power of flash media and fully utilize multi-core processors. Vendors such as EMC are leading this charge by enabling their customers to realize the full performance benefits attainable with flash. Solutions such as the next-generation VNX systems with MCx (multi-core optimization) provide multi-core–enabled software and hardware optimized to deliver more performance than ever. MCx is new VNX software that evenly distributes all VNX data services across all cores in a system. MCx ensures that cache management and back-end RAID management processes take full advantage of multi-core CPUs and allows cache and back-end processing software to scale linearly for optimal price performance.

Why should firms consider moving from HDDs to higher-performance media and adopting the MCx technology to manage the higher I/O intensity?

- **More performance.** Inherently, SSDs can achieve multiple gigabytes per second of random data throughput and offer very high IOPS performance. For example, a single SSD can provide in excess of 10,000 IOPS — a 40–200x improvement over the 50–250 IOPS performance of HDDs. MCx dramatically boosts the responsiveness of performance-critical applications, delivering up to 4x better performance, as measured by number of VMs, number of transactions, and aggregated file IOPS.
- **Greater efficiency.** IDC research found that, on average, organizations leveraging the right balance of SSDs and HDDs were able to reduce the total number of drives by up to 66% while delivering more transactions (IOPS) than a

similarly configured environment with traditional HDD-based storage media. This translates to space savings and lower facilities costs. MCx together with VNX efficiency features such as fully automated storage tiering (FAST) and fixed block deduplication reduces the need for platform overprovisioning and lowers costs by delivering optimized platform efficiency.

- **New metrics.** The historical metric of dollar per gigabyte ($/GB) is a deciding factor in many system sales; however, IDC believes that dollar-per-performance metrics — such as dollar per IOP ($/IOP) and dollar per workload ($/workload) — are more appropriate, especially for performance-sensitive environments and when firms need to tie revenue to specific applications.

IN THIS WHITE PAPER

In this white paper, IDC examines the evolution of storage controllers, from traditional HDD controllers to "hybrid array" (i.e., traditional storage arrays that can accommodate flash drives) controllers capable of optimizing flash media and multi-core CPUs. EMC provides an excellent case study since it has been at the forefront of this evolution:

- EMC is among the market leaders in flash innovation and was an early adopter of flash technologies.
- EMC was among the first vendors to deliver fully vetted and reliable flash drive options for storage systems, specifically with FAST, to help organizations optimize capacity, performance, and their overall storage investments.
- EMC saw storage vendors trying to upgrade internal hardware in the hopes of relieving the performance saturation and bottleneck issues with SSDs and realized this wasn't the right approach. The limiting factor was not the hardware; it was the software and storage controller architecture that were not optimally designed to leverage flash drives and new multi-core processors.
- EMC has now redesigned the heart of the VNX operating environment and replaced it with MCx to unlock the full power of flash and multi-core CPUs.

INTRODUCTION AND MARKET BACKGROUND

In today's market, organizations are demanding higher storage performance for their active data sets to accelerate existing applications and provide a foundation for their next-generation 3rd Platform applications (e.g., social, mobile, cloud, and big data). Traditional HDDs have provided performance and enough storage capacity up to this point; however, flash has surpassed HDD in providing an economic solution for high storage performance when $/IOP is considered.

Demands for higher performance and the economics of flash are fueling the growth of flash drives as IDC forecasts the I/O-intensive segment (SSD and flash) is growing the fastest by capacity at a 74.3% CAGR through 2017. The market demand for performance with flash, as forecast by IDC in the I/O-intensive segment, will begin to strain storage architectures designed for performance- and capacity-optimized HDDs.

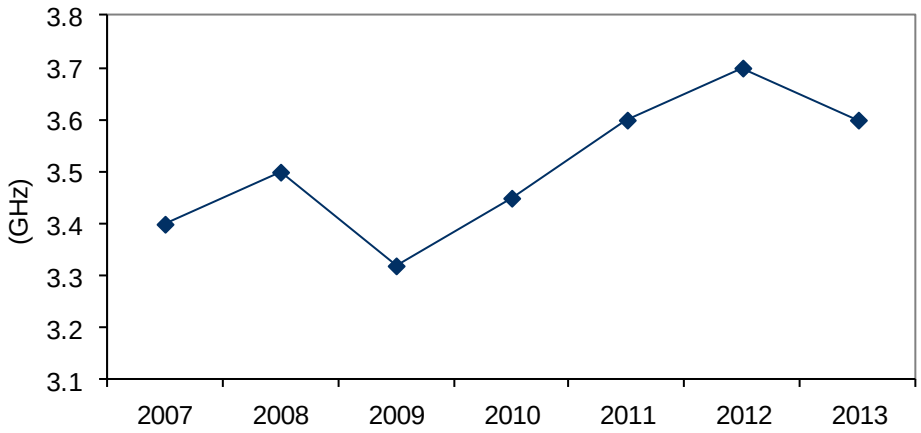
The Need for Change

HDD rotational speed has peaked at 15,000rpm and remains flat, with no revolutions-per-minute increases in sight because of the pure physical limitations of mechanical media. The VNX easily delivered performance gains over legacy arrays, not only through increased HDD spindle counts and parallel improvements in Intel CPU clock speed but also with a FLASH 1st strategy that used flash drives for both dynamic read/write cache and FAST. With FAST on VNX, the potential IOPS gains could be orders of magnitude greater (from hundreds of thousands to millions).

However, the Intel CPU clock speed has not been increasing at the same pace. Analysis of the Intel Xeon CPU clock speeds released from 2007 to 2013 reveal only a 6.9% increase in maximum speed, which peaked in 2012 (see Figure 1).

FIGURE 1

Intel CPU Speed Introduction, 2007–2013



Source: Intel, 2013

As CPU clock speed improvements have tapered off, Intel has moved from a focus on ever-faster clock speeds to delivering more processor cores on the same chip. Through extensive testing, EMC concluded that to develop a VNX system capable of delivering 1 million IOPS, it had to evolve the VNX architecture beyond CPU clock speed barriers and distribute workloads across CPUs and CPU cores, hence the next-generation VNX with MCx.

MCx: The VNX Centers Around Multi-Core Optimization

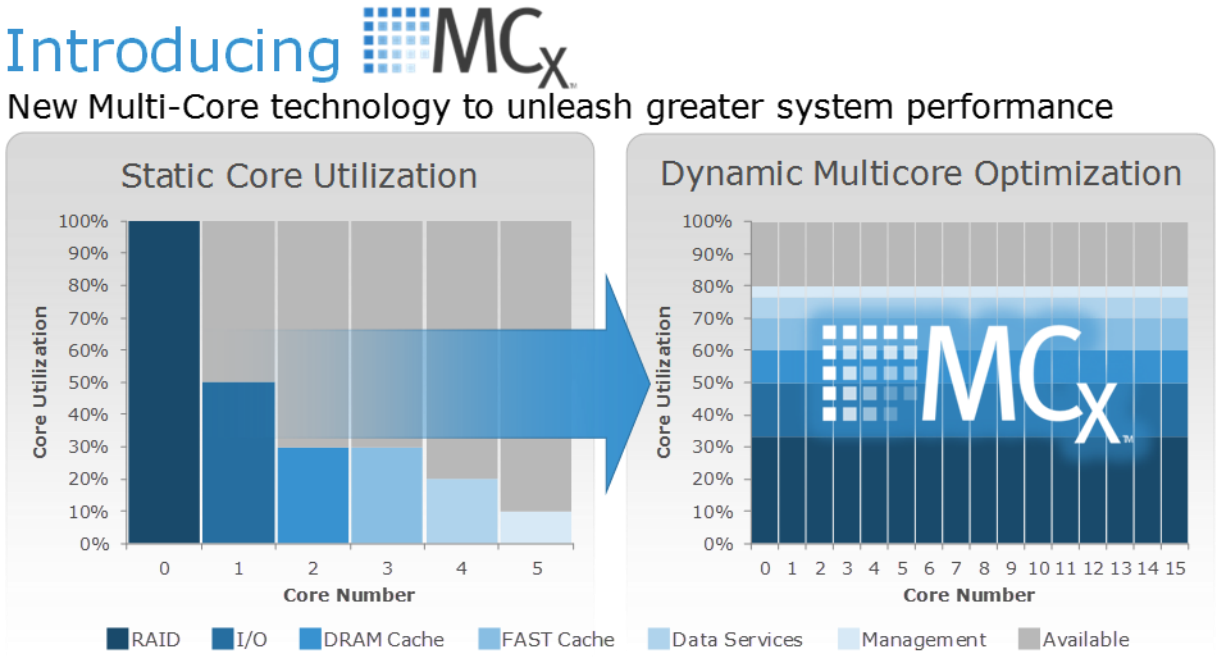
A hybrid approach is a good initial step to utilize the power of SDDs. However, a traditional storage system can add only a small number of SSDs before the high-

performance media saturates the internal storage controllers and I/O back end. Early saturation of the storage system results in a configuration that doesn't scale or leads to overbuying of SSD performance that can't be fully utilized, which leads to higher $/IOP and $/workload.

For the power of flash to be fully realized, the storage system software must be able to utilize more than one CPU or CPU core for any given service. Transitioning from a static architecture, which was CPU clock speed bound, to dynamic core utilization by spreading the work evenly among CPUs and cores required a fundamental change at the heart of the VNX operating environment (see Figure 2). The enormity of this change is synonymous with making a change to an operating system kernel, which is complex and will affect every service operating on the system.

FIGURE 2

VNX Multi-Core CPU Utilization



Source: EMC, 2013

One of the leading reasons organizations purchase EMC's VNX is for its long heritage of reliability and years of testing. Therefore, any changes to the heart of the system should not be taken lightly; this is why EMC spent years of development and testing to implement a multi-core distribution of its core data services (MCx).

Performance Outcomes

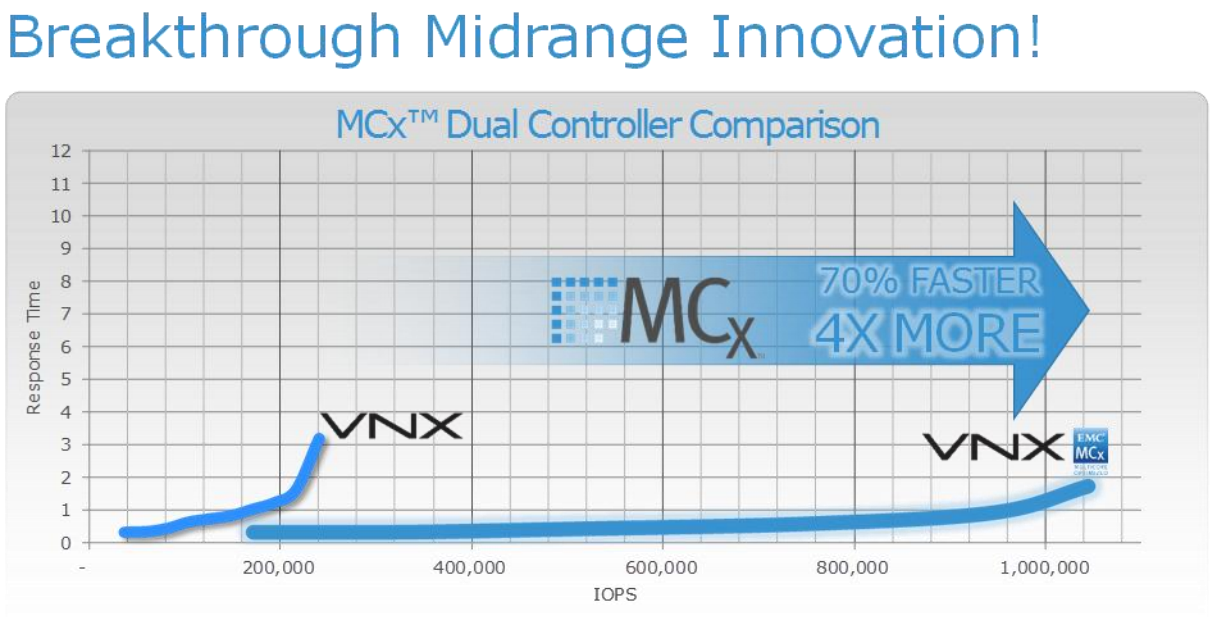
The next-generation VNX with MCx means that EMC can deliver a midrange series with the performance of an all-flash array and the efficiency of tiering:

- The modular scalability of the VNX models can address the growing customer adoption of virtualized infrastructures and cloud computing environments.
- The redesign of the VNX family makes it possible to take better advantage of the low latency of flash and deliver highly optimized data services.
- This redesign also enables more efficient capacity management with tiered SSD and HDD storage for a superior customer experience.

The performance improvement of the new VNX compared with the previous-generation VNX demonstrates the advantages of a multi-core optimized design: maximum IOPS storage performance increased by 400% and response times improved by 70% (see Figure 3).

FIGURE 3

VNX Performance Comparison



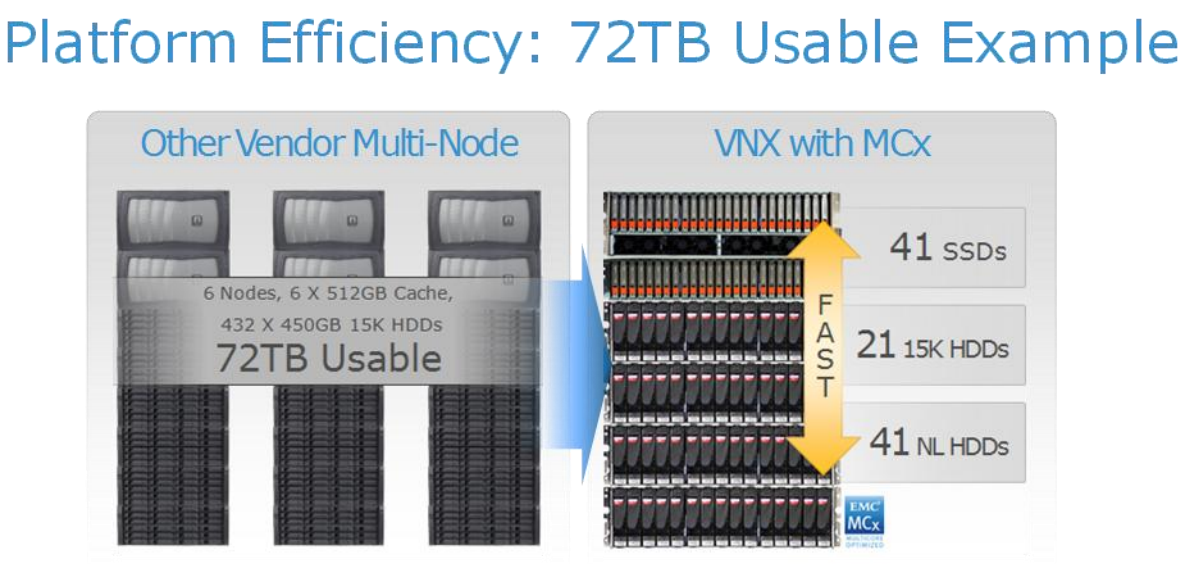
Source: EMC, 2013

EMC designed MCx specifically to take advantage of multi-core CPUs, and this enables the next-generation VNX systems to provide superior return on investment (ROI) advantages. In the example shown (see Figure 4), an array that is not

optimized for multi-core processing and does not have the efficiency features of VNX with auto-tiering would require 3x the floor space and 4x the drive count to achieve the same usable capacity.

FIGURE 4

VNX with MCx Configuration Comparison



Source: EMC, 2013

Generally, the next-generation VNX series with MCx can be expected to deliver significantly greater performance than previous VNX systems when configured for similar capacity and costs. In EMC's own performance benchmarking, a fully configured system has been demonstrated to deliver over 1 million IOPS and to accommodate up to 8,000 virtual servers. This level of performance/capacity/cost flexibility, combined with formidable scalability, makes the new VNX series worthy of consideration by firms of all sizes and in all industries.

FUTURE OUTLOOK

Optimizing the VNX for unlocking flash performance and providing the platform for future technology expansion was critical for EMC. The ability of VNX with MCx to evenly distribute internal service workloads across storage controller CPUs and cores provides access to previously stranded processing cycles for services that require more than the power of a single CPU. With access to potentially more compute cycles within the VNX, IT organizations will potentially have the ability in the future to run more applications directly on the VNX itself.

IDC is observing trends where IT organizations want to bring storage and compute closer within enterprise datacenters. EMC's next-generation VNX with MCx should be able to provide the platform for the future convergence of compute and storage.

CHALLENGES AND OPPORTUNITIES FOR EMC

One of the biggest challenges for EMC will be to show organizations how MCx can provide the promised performance gains and, at the same time, the system stability that organizations have grown accustomed to with the original VNX.

Such a major change to the heart of the architecture may concern some organizations. However, this level of planned and controlled change is inevitable since architectural evolutions are required to fully exploit new performance-related technologies such as flash drives and multi-core processors. This creates a unique opportunity for VNX customers that need higher performance to support growing IT infrastructures with larger amounts of data, more virtual machines, and demanding applications.

IDC believes that EMC is in a strong position to convince organizations of the necessity to re-architect the heart of VNX software to MCx because of the significantly greater performance outcomes.

CONCLUSION AND ESSENTIAL GUIDANCE

There are definitive and valuable benefits to choosing a storage solution that delivers longer-term strategic and revolutionary advantages versus a solution that provides shorter-term tactical or evolutionary differences.

When evaluating a storage solution supporting flash, organizations should ask the following questions:

- Can the platform give me the performance I require today and also meet my needs in five years?
- Does the system allow me to use high-performance flash for my business-critical data and optimize $/GB where performance is not a requirement?
- Does the vendor have a track record for successfully vetting and introducing new technologies?
- How much flash or SSD can be added to the present system before the storage controllers are performance saturated or the results begin to deliver diminishing returns?

Flash is the technology that promises to close the growing performance gap between storage and compute. EMC has a history of leading the market with strategic vision and successfully executing the introduction new technologies, and it has demonstrated with MCx the need to take the necessary steps to optimize storage

systems for flash and multi-core CPUs, even if doing so means re-architecting the heart of the system. The key capabilities and benefits of MCx are very convincing:

- Supports no-compromise scaling of performance and capacity
- Delivers more efficient utilization of all available VNX storage processor CPUs and cores
- Provides the software architecture and platform to incorporate emerging and future storage-related technologies