

2020-21 ENTERPRISE ALL-FLASH ARRAY BUYER'S GUIDE

The Insider's Guide to Evaluating Enterprise All-Flash Arrays



The End-to-end NVMe Opportunity

First-generation all-flash arrays (AFAs) dramatically improved the performance and data density of enterprise data centers. For many enterprises, these AFAs provided a 10x performance improvement compared to legacy HDD-based storage systems.

AFAs also eliminated the data center management overhead associated with avoiding or addressing performance issues in legacy arrays.

Most of the first-generation AFAs connected to flash memory via decades-old disk-oriented SATA or SAS protocols. These protocol stacks include many features that do not apply to flash memory. Further, they do not take advantage of the parallelism and other capabilities of flash memory and other non-volatile memories.

Storage industry experts recognized the deficiencies of existing protocols. They formed the NVM (non-volatile memory) Express consortium to create the NVMe and NVMe-oF standards that would fully expose the benefits of non-volatile memory in computing environments. NVMe is designed from the ground up to deliver high bandwidth and low latency storage access for current and future NVM technologies. (Figure 1.)

In 2021, the NVMe and NVMe-oF ecosystems have become large and mature enough for vendors to incorporate these technologies into enterprise-class storage systems. Vendors do so in three primary ways:

- By using NVMe SSDs in their arrays
- With NVMe-optimized storage operating systems
- By using the NVMe over Fabrics (NVMe-oF) protocol to transfer data between storage controllers and application hosts

NVMe SSDs. The NVMe protocol supports up to 64,000 queues per PCIe-attached SSD, versus just one queue with SAS and SATA. This new parallelism means each application or CPU thread can have its own queue, eliminating the need for I/O locking.

NVMe enables arrays to deliver more IOPS and throughput. Because the NVMe protocol itself is streamlined, it can deliver double the number of IOPS per CPU core compared to SATA or SAS data transfer protocols, and do so with less latency.

NVMe-optimized storage operating systems. NVMe allows storage vendors to eliminate overhead associated with I/O locking from the data path. The process of incorporating NVMe SSDs into enterprise storage systems also revealed other opportunities to reduce CPU overhead and latency by streamlining code.

NVMe over Fabrics. NVMe-oF extends the benefits of NVMe across the data center. With NVMe-oF, application servers get more IOPS at lower latency while using fewer CPU cycles for storage-related functions.

AFAs that incorporate all three of these advances enable end-to-end NVMe in the data center, delivering another order-of-magnitude improvement in performance. Replacing legacy HDD-based arrays or first-generation all-flash arrays with an array supporting end-to-end NVMe will deliver more data center

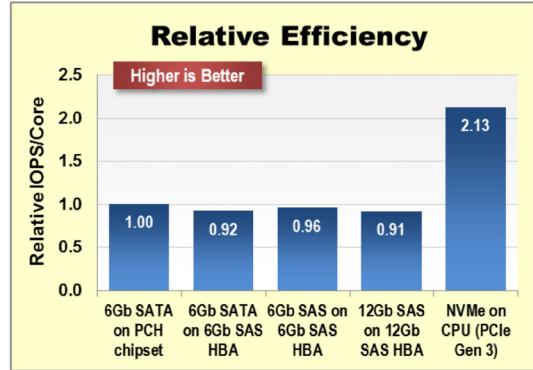


Figure 1 Source: https://www.nvmexpress.org/wp-content/uploads/NVMe_Overview.pdf

performance with fewer servers, in less space, using less power. The economic return on investment can be substantial.

Enterprise storage vendors are at different points in the NVMe journey. More than 40% of the AFAs DCIG researched for the 2020-21 Enterprise All-Flash Array Buyer's Guide incorporate NVMe SSDs into their designs. All of these have taken steps to optimize their storage operating systems. However, less than a fourth of the AFAs support NVMe-oF, and even fewer extend that support beyond the array controller to the storage expansion shelves.

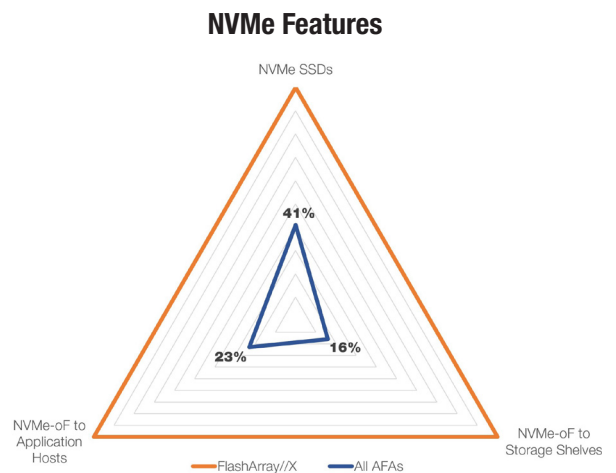


Figure 2 Source: DCIG

Pure Storage FlashArray

The Pure Storage FlashArray portfolio implements all three of the above advances to deliver the full performance and consolidation benefits of end-to-end NVMe to the data center.

Pure Storage was founded as an all-flash array company at a time when most vendors were using flash memory only as a cache or as a high-performance tier within a hybrid array. This explains why Pure Storage was an early adopter of NVMe technology, and why it goes beyond the typical approach to incorporating NVMe into its enterprise storage arrays. Its NVMe journey is depicted in the following infographic. (Figure 3.)

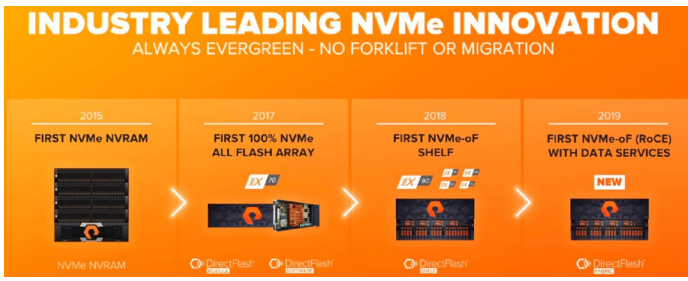


Figure 3 Source: FlashArray Architecture Deep Dive Highlights <https://www.youtube.com/watch?v=hckjiWXnICk&t=603s>

Pure Storage delivers its NVMe-enabled innovations through what it calls DirectFlash technologies. The impact of each DirectFlash technology on the data path is depicted in the following infographic. (Figure 4.)

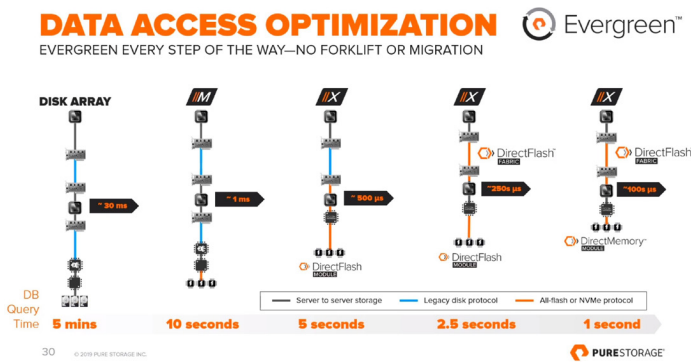


Figure 4 Source: FlashArray Architecture Deep Dive Highlights <https://www.youtube.com/watch?v=hckjiWXnICk&t=603s>

DirectFlash Software manages the flash memory globally rather than delegating flash management decisions to each solid state disk (SSD). This enables the FlashArray to provide more consistent low latency.

Pure Storage DirectFlash Modules are NVMe-attached like standard SSDs. Unlike standard SSDs, DirectFlash Modules consist primarily of raw flash memory. Since the array manages the flash globally, the modules do not require dedicated processors and DRAM for flash memory management.

Pure’s **DirectFlash Shelf** puts the FlashArray in a very small group of products that connect storage expansion shelves via NVMe. The other 84% of AFAs connect expansion shelves via traditional SAS protocols, which are slower.

Pure’s **DirectFlash Fabric** completes the picture by providing NVMe-oF connectivity to application hosts, over both Fibre Channel and RoCEv2.

Pure’s **DirectMemory Cache** module incorporates up to 6 TB of NVMe-attached Intel Optane storage-class memory (SCM) into the top-end

FlashArray models as a read cache. For extremely demanding workloads, the DirectMemory Cache can reduce read latency and increase throughput.

Pure Storage Company and Product Background

Pure Storage was founded in 2009 by a management team with extensive executive and technical leadership experience at technology companies from A-to-Z, including Akamai, NetApp, Quantum, Veritas, Xiotech, and Zimbra. The PureStorage team has expertise in flash memory, file systems, data structures, I/O optimization, and in building successful products and companies.

Pure Storage remains true to its founding focus on transforming the enterprise storage ownership experience. This focus has taken Pure Storage well beyond NVMe-enabled storage performance:

- FlashArray’s chassis-based design enables non-disruptive expansion and upgrades.
- Pure’s proactive support based on storage analytics reduces management overhead and increases system availability and performance.
- Pure’s Evergreen Storage “subscription to innovation” allows customers to non-disruptively adopt the latest technology advancements resulting in performance and scale improvements.

Pure as-a-Service further simplifies the ownership experience by delivering on-premises storage-as-a-service (STaaS) based on a pay-per-use per used GB with a minimum contract term of just twelve months.

DCIG View of the AFA Marketplace and Pure Storage

Any organization that has yet to adopt an all-flash storage infrastructure for all active workloads is operating at a competitive disadvantage. Deploying a current generation enterprise all-flash array:

- Increases operational agility
- Can improve existing application performance even as data sets grow
- Accelerates application development
- Enables IT departments to say, “Yes” to new workloads and quickly get those new workloads into production
- Increases the performance density of data centers
- Drives down data center operating costs

The Pure Storage FlashArray portfolio exemplifies these attributes and enables all of these benefits. Beyond the technology, Pure’s proactive support, plus its flexible acquisition and deployment options, demonstrates that the company continues to listen to their enterprise customers and then deliver solutions that meet their changing needs.

Note: The data for “All AFAs” is based on DCIG’s independent research into enterprise storage arrays and includes the 99 arrays that satisfy DCIG’s criteria for Enterprise All-Flash Arrays. ■

About DCIG

DCIG, the Data Center Intelligence Group, empowers the information technology industry with actionable analysis. DCIG provides informed third-party analysis of various cloud, data protection, and data storage technologies. Learn more at www.dci.com.



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