

Exclusive Look at AFA Solutions & Vendors

From HPE to Dell EMC and NetApp, our experts stack up the leading AFA vendors & their platforms.



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- How 6 midrange storage arrays from top vendors stack up
- All-flash and hybrid HPE Nimble Storage arrays get updates
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How 6 midrange storage arrays from top vendors stack up

Chris Evans, Contributor

The midrange storage appliance ecosystem is gradually transitioning toward all-flash and the adoption of NVMe technology. This market is growing fast, with the release of several new storage arrays in the past year. These include platforms from top storage vendors Dell EMC, Hewlett Packard Enterprise, Hitachi Vantara, IBM, NetApp and Pure Storage.

Storage array vendors continue to use a mix of commodity enclosures with a 2U form factor that support either 24 or 25 NVMe drives. These offerings typically expand using SAS rather than NVMe. This isn't surprising in a cost-conscious market. But there are still plenty of custom NVMe-based designs -- notably from HPE, Hitachi Vantara and Pure Storage.

The use of NVMe, storage class memory (SCM) and flash means most midrange array users will have way more performance than they could ever use. There's also a trend toward simplified management. This is exemplified by the newest entrant to the market -- Dell EMC PowerStore -- which doesn't offer user-configurable RAID choices.

Storage vendors have instead focused on host-based features. There's slow but increasing support for NVMe-oF and universal adoption of management through APIs and command-line interfaces. This includes support for container storage interfaces and virtual volumes for virtualization. Snapshots, replication and data reduction are all now table stakes.

Vendors are offering more purchasing options, ranging from pure consumption to capital acquisition. These programs provide midsize organizations with periodic hardware refreshes.

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The most striking observation is that the midrange is becoming the new enterprise-class. Vendor offerings now provide scalability, high performance and high reliability. In fact, all the midrange all-flash arrays we examined are suitable for all but the most mission-critical of applications.

Let's examine the architecture, features and purchasing options of these six new midrange storage arrays and see how they compare.

Compare leading midrange storage arrays						
	Dell EMC PowerStore	Hewlett Packard Enterprise Primera	Hitachi Vantara VSP E990	IBM FlashSystem 7200	NetApp EF600	Pure Storage FlashArray//X
ARCHITECTURE	Scale up, out	Scale up, out	Scale up	Scale up, out	Fixed	Scale up
MEDIA	NVMe SCM, NVMe SSD and SAS SSD	SAS SSD and HDD	NVMe SSD and SCM	NVMe SSD, SCM, SAS SSD and HDD	NVMe SSD	NVMe SSD and SCM cache
HOST SUPPORT	FC, iSCSI and NFS/SMB	FC	FC and iSCSI	FC, FC-NVMe, iSCSI, iSER and RoCE	NVMe-oF and NVMe/FC	NVMe-oF, FC and iSCSI
MAX. DRIVES AND CAPACITY	384 drives and 3,594 TB four-node	1,600 TB raw SSD only, 4,000 TB SSD and HDD	1.44 PB internal using 15 TB NVMe drives	760 per enclosure, 3,040 per system, 32 PB raw maximum	360 TB using 24x 15 TB drives	878 TB raw, 3.3 PB effective
PURCHASING PROGRAM	Dell Pay as You Grow/Flex on Demand	HPE GreenLake/Timeless Storage	Hitachi Vantara EverFlex	IBM Storage Utility Program	NetApp Keystone	Evergreen Storage

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Dell EMC PowerStore

Dell EMC in May introduced PowerStore, a scale-out and scale-up all-flash NVMe storage array. PowerStoreT appliances consist of a 2U chassis with two controller nodes and up to 25 NVMe NAND flash or Intel Optane SCM drives. Three 25-bay SAS enclosures can extend a single node up to 96 drives, providing up to three tiers of storage -- Intel Optane SCM NVMe, NAND flash NVMe and NAND flash SAS.

The PowerStore family of appliances offers five controller models: 1000, 3000, 5000, 7000 and 9000. These scale performance from 4x Intel Xeon 32-core 1.8 GHz processors with 384 GB of system memory up to 4x Intel Xeon 112 core 2.1 GHz and 2,560 GB processors. SSD capacities range from 1.92 TB to 15.36 TB. Optane drives are 375 GB or 750 GB. PowerStore systems can also scale out, with up to four federated nodes in a single cluster.

Organizations can run local applications with the PowerStore X family using the AppsOn feature, which virtualizes the storage controllers under an embedded ESXi hypervisor. Performance and scalability are the same as PowerStore T, with half of CPU and dynamic RAM resources dedicated to applications and half to storage. PowerStore supports iSCSI, NFS and server message block over Ethernet -- 10 or 25 (gigabit Ethernet) GbE -- or Fibre Channel (FC) -- either 16 or 32 Gb. Internal RAID protection offers either RAID-5 4+1 or RAID-5 8+1 configurations. The RAID configuration is determined by the drive count at system build time.

Dell offers a range of flexible purchase options, including Pay as You Grow and Flex on Demand metered consumption.

Hewlett Packard Enterprise Primera

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HPE launched Primera at Discover 2019. This new midrange storage platform uses intellectual property and takes its inspiration from the HPE 3PAR family of products but isn't a direct replacement or upgrade for them. Primera has three configuration options and two family groups. The A models are all-flash, and HPE describes the C models as converged, but they're essentially flash or HDD hybrids.

The Primera A630 and C630 24-drive, 2U dual node processors each have a single CPU and a system maximum of 16 host ports, which can be either 16 Gb or 32 Gb FC. There are also two built-in 10 GbE ports. The base chassis supports 24 SFF SAS 2.5-inch drives with eight drives providing NVMe and SAS dual connectivity. Organizations can add up to five additional SAS disk enclosures to the A630, or nine enclosures to the C630. The total supported drive count is either 144 SSDs or 240 HDDs.

The 650 model offers either two or four controllers, with dual processors per node. Port connectivity increases to 48 ports with 16 Gb or 32 Gb FC, while drive count increases to 384 SSDs or 576 HDDs. The A650 supports up to 14 enclosures and the C650 supports up to 22 enclosures. The 670 model increases drive scalability to 576 SSDs and 960 HDDs -- 22 enclosures for the A670 and 38 enclosures for the C670.

HPE stresses Primera's simplicity of installation with a 100% availability guarantee. RAID-6 is the only internal protection mechanism. Although the platform still uses application-specific integrated circuit technology, much of the internal code has been written with a microservices

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architecture that enables better internal scaling, resiliency and in-place upgrades. Primera doesn't support NVMe drives or NVMe-oF as a front-end protocol.

HPE offers flexible consumption models through its GreenLake and Timeless Storage programs.

Hitachi Vantara Virtual Storage Platform E990

The VSP E990 is the newest of Hitachi Vantara's Virtual Storage Platform appliances. All VSP systems use the storage virtualization operating system, which provides a unified look and feel to the management of a range of disparate hardware offerings. The E990 is an all-flash NVMe-based dual controller appliance. It scales to 1.44 PB of internal capacity using 15 TB NVMe SSDs or 287 PB of capacity using external storage virtualization.

The VSP E990 has a 4U chassis with dual controllers, supporting up to 80 FC -- 16 Gb or 32 Gb -- or 40 iSCSI 10 GbE connections. Hitachi claims the system will deliver up to 5.8 million IOPS and 30 GBps of bandwidth. Midsize enterprises can connect as many as four disk shelves to a controller enclosure, providing up to 96 NVMe drives. It's worth noting that the drives are all NVMe-connected, rather than a mix of NVMe and SAS, like some other vendors offer.

The VSP E990's internal protection options include RAID-6, RAID-5 and RAID-1, each with multiple configurations. Hitachi provides a 4:1 sight unseen data reduction guarantee, but it excludes certain data types. The Hitachi Ops Center manages all VSP products, including the E990.

Hitachi offers a range of consumption models, from as-a-service to capital acquisition through its newly announced EverFlex program.

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IBM FlashSystem 7200

The IBM FlashSystem 7200 is based on a 2U enclosure with up to 24 NVMe flash drives. The platform uses IBM Spectrum Virtualize software to drive four eight-core processors and up to 1,536 Gb of system memory per enclosure. The FlashSystem 7200 can cluster as many as four enclosures together in a single system. Base enclosures support NVMe drives, with the option to increase both SSD and HDD capacity through SAS expansion enclosures.

The FlashSystem 7200 supports a wide range of drive types and capacities. This includes IBM proprietary FlashCore modules up to 38.4 TB with hardware compression, SCM drives up to 1.6 TB, NVMe SSDs up to 15.36 GB, SAS SSDs up to 30.72 TB and SAS HDDs up to 14 TB.

Front-end host support includes 16 or 32 Gb Fibre Channel and Fibre Channel-NVMe and up to 25 GbE iSCSI, iSCSI Extensions for RDMA (iSER) and RDMA over Converged Ethernet (RoCE). IBM claims latency figures as low as 70 microseconds (μ s) with up to 2.3 million IOPS and 35 GBps throughput.

IBM offers a range of flexible consumption models through its Storage Utility Program.

NetApp All Flash Array EF600

The NetApp EF600 is the one of the few midrange storage arrays profiled here that offers end-to-end support for NVMe. That includes NVMe-oF for 100 or 200 Gb InfiniBand, 100 or 200 Gb RoCE and 32 Gb FC-NVMe. The platform also supports traditional 32 Gb Fibre Channel. E-series products offer a simplified experience with block support at high throughput and low latency, and the EF600 is no exception. NetApp claims sub-100 μ s response times and up to 44 GBps of throughput for sequential reads.

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A single 2U EF600 consists of two controllers with either 32 GB or 128 GB of system memory per controller. A single appliance supports up to 24 SFF NVMe drives, with capacities from 1.9 TB to 15.3 TB. Maximum raw capacity is 360 TB. Unlike most of the other platforms discussed here, the EF600 doesn't offer any shelf expansion options. Internal protection includes RAID 0, 1, 5, 6 and dynamic disk pools. Each controller supports either a Fibre Channel, InfiniBand or RoCE host interface card. Both controllers must use the same interface.

The vendor provides flexible consumption models through the NetApp Keystone program.

Pure Storage FlashArray//X

Pure Storage now offers generation three of the FlashArray//X family of appliances. Platforms range from the entry-level //X10 at 22 TB of raw capacity, up to the //X90 with 878 TB of raw capacity and 3.3 PB effective capacity after data reduction and RAID overhead.

FlashArray uses a custom hardware design based on DirectFlash modules. These hardware components provide 18.3 TB of NVMe-connected flash storage that abstracts the flash translation layer into software. A single FlashArray//X provides physical expansion of FlashArray modules with NVMe-oF-connected DirectFlash shelves.

Front-end host connectivity offers up to 40 GbE, 25 or 50 Gb NVMe or RoCE, or 16 or 32 Gb Fibre Channel. Pure Storage recently expanded its FlashArray family with DirectMemory modules. DirectMemory cache accelerates read I/O through its use of Intel Optane SCM, delivering I/O latency as low as 150 µs.

FlashArray//X is one of the most full-featured all-flash platforms examined in our analysis, with extensive data replication and host-integration options. Pure Storage offers flexible consumption and support models through its Evergreen Storage program.

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All-flash and hybrid HPE Nimble Storage arrays get updates

Carol Sliwa, Senior News Writer

Hewlett Packard Enterprise has updated its all-flash Nimble Storage arrays to enable support for NVMe and storage-class memory technologies, improve price-performance and provide a new capacity guarantee.

The All Flash (AF) series of Nimble Storage arrays has a new 6 TB entry-level model and can scale up to 800 TB of raw capacity across a four-node cluster with the high-end AF80 system. Hewlett Packard Enterprise (HPE) claims the midrange AF40 and AF60 deliver as much as a 220% performance improvement over the prior generation.

On the hybrid side, HPE is consolidating its two lines of Nimble Storage arrays equipped with SSDs and HDDs into a single Adaptive Flash portfolio. The new HF-Series of hybrid arrays features always-on inline data deduplication in all models except the "cheap-and-deep" HF20C, which targets media workloads that are unlikely to benefit from the data-reducing technology, said Dave Kresse, vice president and general manager of HPE Nimble.

HPE previously sold two separate hybrid lines to emphasize performance, with the Adaptive Flash Array CS-Series models targeting primary workloads and stress capacity in the Secondary Flash Arrays (SFA) that offered data deduplication for backup and disaster recovery, Kresse said. HPE was able to boost the performance enough to support always-on deduplication across its hybrid array product line for both primary and secondary use cases, he said. The SFA line is being discontinued.

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The raw capacity for the hybrid HF-Series starts at 11 TB for the HF20H and scales to more than 1 PB with the HF60, or about 5 PB in a four-node HF60 cluster. HPE claims the HF40 boosts performance by as much as 150% over the prior midrange hybrid model, and the maximum-capacity HF60 is 65% faster than its predecessor.

Future-proofing all-flash arrays

With its updated Nimble Storage All Flash series, HPE sought to future-proof the arrays, so customers won't have to rip and replace the systems to move to higher-performing, lower-latency nonvolatile memory express (NVMe) and storage-class memory (SCM) technologies in the future.

"We aren't yet seeing this class of media or this protocol widely used in the marketplace, given its price point today. But we do expect that to happen likely next year and certainly wanted to design this platform in a way where it could take advantage," Kresse said.

On the hardware side, HPE had to change the backplane to support the NVMe protocol and add ports, cabling and carriers to support the new class of SCM devices that talk directly to the CPU through a PCI Express connection, according to Sakthi Chandra, senior director of product marketing at HPE Nimble. HPE also enhanced Nimble Storage's Cache-Accelerated Sequential Layout file system to support new devices and media as they become available, he said.

"For example, we can definitely take in and accommodate NVMe over Fabrics very similar to how we introduced iSCSI and Fibre Channel, because it's all completely modular. It's easy for us to add in the support for those protocols as they become mature," Chandra said.

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Nimble's move to become NVMe- and SCM-ready is part of a major industry shift to enable the adoption of NVMe technologies in IT organizations, noted Scott Sinclair, a senior analyst at Enterprise Strategy Group in Milford, Mass.

Another major all-flash array trend is supporting analytics software that can help to prevent infrastructure problems. One of the key reasons HPE acquired Nimble Storage in 2017 was to gain access to the company's InfoSight predictive analytics engine. HPE has since extended InfoSight beyond Nimble to its 3PAR storage arrays.



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HPE's Store More Guarantee

With its newly announced Store More Guarantee, HPE promises to store more data per raw terabyte in its Nimble all-flash arrays than any other vendor's all-flash arrays, or it will add more capacity to make up the difference at no charge. The pledge takes into account the array's capacity after data-reducing technologies, such as deduplication and compression.

"There are some guarantees out there, but they tend to have asterisks and all sorts of conditions under which that happens," Kresse said. "No conditions here -- very straightforward. We have high confidence in our ability to deliver on this."

To cash in on the HPE guarantee, customers could compare the effective capacity of the Nimble AF-Series to their existing all-flash storage arrays. Or, they could do a proof of concept, pitting Nimble's AF-Series against one or more all-flash arrays from other vendors.

"We believe that 90% of the time, customers will take HPE's word on the guarantee, and they don't have to really go through that," Chandra said. "For us to go through the validation that we have done internally, we had to be more than 100% confident that our arrays will stand the scrutiny if we were able to be challenged."

Eric Burgener, a research vice president for storage at IDC, said HPE is trying to drive higher customer satisfaction with its Store More Guarantee. He predicted customer satisfaction will become a stronger differentiator for all-flash array vendors now that the top 10 vendors have similar feature sets.

"Pure Storage is the leader with its Evergreen Storage, and Dell EMC announced its Future-Proof Storage Loyalty Program in December 2017. HPE's Store More Guarantee and the extension of a 'six nines' availability guarantee option on new, shipping Nimble equipment bring it much closer to Pure's Evergreen Storage," Burgener wrote in an email.

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"However, the Store More Guarantee only applies to Nimble models with inline compression, deduplication and zero block elimination enabled, not 3PAR. Pure and Dell EMC's guarantees in this area apply to their entire line of enterprise storage products -- although how they measure 'storage efficiency' may vary between vendors, so buyers need to make sure they understand how the storage efficiency guarantees are calculated when comparing offerings from different vendors," he continued.

New all-flash Nimble storage arrays

The new all-flash Nimble Storage arrays start with the 6 TB AF20Q, followed by the AF20, AF40, AF60 and AF80. HPE claims a four-node AF80 cluster could store 4 PB after data reduction and offer submillisecond latency.

Kresse credited the performance improvements to software and the engineering team's efforts to write code that can take advantage of new, off-the-shelf commodity hardware equipped with more powerful CPUs. HPE declined to share specifics on the hardware.

"Our architecture is CPU-bound, rather than spindle-bound, which essentially means that for every generation of the Intel CPUs, even if we did nothing in terms of our software, you would get the benefit of the CPU just getting better," Chandra said. "But we have definitely improved the performance side of the house, for example, to take advantage of expanded SSD and the NVDIMMs [nonvolatile dual inline memory module] in terms of how we treat our metadata and caching."

The starting list price is \$65,000 for the all-flash Nimble Storage AF-Series and \$45,000 for the hybrid HF-Series, according to HPE.

The all-flash competition for HPE Nimble Storage consists of midrange arrays, such as Dell EMC Unity; lower capacity models from Pure Storage and Kaminario; and arrays from smaller

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vendors, such as Tegile and Tintri, Burgener said. HPE is behind some vendors with its NVMe support and with its NVMe-over-Fabric roadmap not publicly disclosed, he added.

"The absolute need for NVMe performance is not really there yet for most commercial enterprise workloads, but it will clearly be growing over time," Burgener said. IDC has predicted, by 2021, NVMe-based primary storage arrays will drive more than half of primary storage revenue for external storage, overshadowing SCSI-based systems, he said.

SCM will happen later for everyone, Burgener said, mainly because the technology is having trouble maturing. He noted that Intel's Optane is the best known option, but it still isn't shipping in volume.



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All-flash array adoption rises for NetApp, HPE

Dave Raffo, Executive News Director

Despite all the talk from storage vendors about hybrid cloud, services and software, their all-flash storage array adoption is still rising.

NetApp and HPE reported quarterly earnings Tuesday, and both said their all-flash sales rose significantly. NetApp outperformed the three other major storage vendors that reported earnings over the past week, on the strength of its flash AFA systems.

NetApp said its AFA platform revenue increased 15% from last year -- an impressive number in an economy still recovering from a pandemic-caused recession. NetApp's overall revenue of \$1.42 billion increased 3% since last year, while Dell storage declined 7% to \$3.86 billion, Pure Storage dropped 4% to \$411 million and HPE storage slipped 3% to \$1.2 billion. However, HPE's drop would have been greater if not for a 29% year-over-year increase in all-flash storage.

In October, NetApp focused on cloud and its Keystone services program during its virtual NetApp Insight 2020. All the while, it was picking up share on its rivals with flash storage. NetApp's all-flash revenue for last quarter hit \$632 million. NetApp CEO George Kurian said all-flash arrays make up 26% of its systems sold. He expects that number to rise steadily as emerging technologies including QLC solid-state drives (SSDs) expand flash's advantages over hard disk drives.

"We are still in the early innings of the technology curve in the all-flash array market," Kurian said on NetApp's earnings call. "There are more technologies coming online over the next 18

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to 24 months that will move more and more of the disk-based market to the all-flash market. We don't think that all of the disk-based market moves to all-flash. But a substantial percentage of the total storage market -- let's say 70% to 80% -- will be an all-flash array portfolio."

Kurian said he remains optimistic about hybrid cloud storage and services. NetApp is working closely with AWS, Microsoft Azure and Google to enable customers to access NetApp technologies in public clouds. And it sees Keystone as a highly competitive alternative to HPE GreenLake and other major infrastructure vendors' emerging services programs.

HPE CEO Antonio Neri said his company's storage portfolio is a big part of its GreenLake strategy. He added that HPE's storage business is "stabilizing" after five straight quarters of declines.

"In storage, we have been on a multiyear journey to create an intelligent data platform from edge-to-cloud and pivot to software-as-a-service data storage," Neri said on HPE's earnings call.

He cited HPE's Primera all-flash array and Nimble Storage dHCI converged system as storage growth areas.

Will QLC drive more workloads to flash?

Kurian predicted flash storage will continue to increase as the price of SSDs come down. For example, lower-cost, lower-performing QLC SSDs will enable companies to move less critical workloads to flash. SSDs have largely replaced the highest speed HDDs, and Kurian expects QLC to replace more of the capacity drives now in use. NetApp does not yet sell QLC drives in its systems, although rivals Pure Storage and startup Vast Data do.

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"Today there are customers buying all-flash arrays when [SSDs] are roughly three times the cost of a hard drive," he said. "With QLC, that number gets a lot closer to one and a half to two times. We think that more workloads will come on to all-flash."

Rivals take advantage of Dell PowerStore ramp

NetApp and HPE likely benefited from soft sales of Dell EMC's new PowerStore flagship all-flash midrange storage array. PowerStore is a prime competitor to HPE Primera and NetApp AFA arrays, but Dell delayed PowerStore's launch several times before it hit the market in March. Dell COO Jeff Clarke said last week that PowerStore has not yet met expectations, but the vendor remains committed to advancing the platform.

Kurian called PowerStore "an incomplete product," adding "it is hard to build a new midrange system. And so it's going to be some time before they can mature that and make that a real system."

COVID-19 caution colors forecasts

Like other storage vendors, NetApp and HPE issued cautious forecasts because of the COVID-19 impact. The midrange of NetApp's guidance revenue is \$1.41 billion, roughly the same as last year.

"We're pleased with the news about the COVID-19 vaccines," Kurian said. "We think that the economy has mostly stabilized and it should get better from here. But we are in the midst of a nationwide lockdown. We have lockdowns in many other parts of the world. We are in for a tough few months here between November and January."

HPE did not give a revenue forecast, but CFO Tarek Robbiati said he expects a slight drop from this quarter, which would put it about the same as HPE's \$6.9 billion last year.

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"We continue to see gradual improvement, but we want to remain somewhat cautious due to the uncertain pace of recovery from the COVID-19 pandemic," he said.