The Insider's Guide to Evaluating All-Flash Arrays

DCIG

2018-19 ALL-FLASH ARRAY BUYER'S GUIDE

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Table of Contents

Introduction

Any organization that has yet to adopt an all-flash storage infrastructure for all active workloads is operating at a competitive disadvantage.

All-flash storage…

- helps ***organizations move faster***
- makes existing ***applications run faster*** even as data sets grow
- ***accelerates application development***
- ***enables IT departments to say, "Yes"*** to new workloads and then get those new workloads producing results in record time
- ***drives down data center operating costs***

DCIG is pleased to present this fresh snapshot of the dynamic all-flash array (AFA) marketplace. Much has changed in the all-flash array marketplace since DCIG published the *DCIG 2017-18 All-Flash Array Buyer's Guide*. Some of the more significant changes are summarized below.

Marketplace consolidation continues. As expected, some AFA providers were acquired by other storage companies. HPE acquired Nimble Storage. Western Digital acquired Tegile.

Technologies that increase performance proliferate. These performance-enhancing technologies include new multicore CPUs from Intel, faster Fibre Channel and Ethernet networking ports, and NVMe SSDs. Thus, more processing capability is being matched up with more bandwidth between application hosts and storage controllers, and between storage controllers and flash memory drives.

Dramatic increase is flash capacity. The raw capacity of the more than 100 all-flash arrays DCIG researched averaged 4.4PB, a 5x increase compared to the products in the 2017-18 edition. The highest capacity product can provide 70 petabytes (PB) of all-flash capacity, a 7x increase.

Unified storage is now the AFA norm. The first generations of all-flash arrays were nearly all block-only SAN arrays. Tegile was perhaps the only truly unified AFA provider. Today, more than 80% of the arrays in this Buyer's Guide support unified storage; as do more than half of all AFA's DCIG researched.

Most AFA's now integrate with cloud storage. More than half of the products in this Buyer's Guide can use public cloud storage as a target for cold data or for snapshots as part of a data protection mechanism. In many cases this target is actually one of the provider's own arrays running in a cloud data center or a software-defined storage instance of its storage system running in one of the true public clouds.

Predictive analytics get real. Some storage providers can document how predictive storage analytics is enabling increased availability, reliability, and performance for their products. The promise is huge. Progress varies.

Performance claims are included on most of the data sheets. In a break from our standard practice, this Buyer's Guide includes performance claims for IOPS, bandwidth and average latencies on the data sheets. These claims may hint at underlying architectural efficiencies or may have no connection with real world results. All performance claims are provided by the vendor, published by the vendor, and/or available from third parties that have tested the products. DCIG has not independently substantiated or verified these claims.

Introduction (continued)

The Value This DCIG Buyer's Guide Creates for Buyers

The *DCIG 2018-19 All-Flash Array Buyer's Guide* helps businesses accelerate the all-flash array selection process. This Buyer's Guide includes data sheets for thirty-two (32) enterprise-class all-flash arrays that achieved rankings of *Recommended* or *Excellent*. These products come from seven (7) vendors including Dell EMC, Hitachi Vantara, HPE, Huawei, NetApp, Pure Storage and Tegile.

As in the development of all prior DCIG Buyer's Guides, DCIG's analysts have already done the heavy lifting for enterprise technology buyers by:

- Identifying a common technology need with many competing solutions but with little comparative data available to technology purchasers
- Scanning the environment to identify available products in the marketplace
- Gathering normalized data about the features each product supports
- Providing an objective, third-party evaluation of those features from an end-user perspective
- Describing key product considerations and important changes in the marketplace
- Presenting DCIG's opinions and product feature data in a way that facilitates rapid feature-based comparisons

The end result is that the *DCIG 2018-19 All-Flash Array Buyer's Guide* drives time and cost out of the product selection process by enabling prospective buyers to more quickly identify a shortlist of products that meet their specific needs. Thus, prospective purchasers can focus their product evaluation energies and move more quickly to the competitive bid process.

Note that this Buyer's Guide is not intended to be a substitute for bringing individual products in-house for testing nor should readers assume that DCIG does any hands-on testing of these products. Many end user license agreements associated with these products prohibit the publishing of testing results without first getting vendor approval. In-house testing or proof-of-concept implementations should still be done, if possible, since each product will perform differently under different application workloads and data center environments. We hope you find that this Buyer's Guide meets its intended purpose in your environment.

Jerome and Ken

Executive Summary

Enterprises are accelerating their adoption of flash memory SSDs in workstations, servers and shared storage arrays. Flash memory offers significant performance benefits and operational efficiencies when compared to hard disk drives (HDDs). The continued price erosion of NAND also contributes to enterprises using flash memory in ever greater amounts. This has led IDC to forecast that worldwide SSD shipments will increase at a five-year compound annual growth rate of 15.1% though 2021.[1]

Many now recognize that while flash in its current incarnation is much faster than hard disk drives (HDDs), flash has the potential to increase performance another 10x as providers and enterprises identify and eliminate outdated disk-oriented constructs.

To deliver on this next generation of flash performance, enterprises will need to make changes up and down today's data center stack. Enterprises must:

- ***Evaluate the storage network interconnects between servers and storage arrays.*** Enterprise data centers still largely rely upon FC and iSCSI as the preferred storage protocols to connect servers and storage arrays. But as applications optimize for flash and storage arrays offer new interfaces that better deliver on the performance characteristics of flash, existing FC and iSCSI storage protocols will eventually become choke points. While the demise of these protocols is not imminent, new protocols such as NVMe-oF have already emerged while existing protocols such as InfiniBand are getting a new look.
- ***Account for ever higher capacity SSDs.*** As this Buyer's Guide goes to press, 15TB SSDs ship on some all-flash arrays, Samsung and Toshiba have announced 30TB SSDs, and we have seen previews of 50TB and even 100TB SSDs. To capitalize on the capacity these SSDs can provide, enterprises will need to verify that any all-flash array using them offers the appropriate backend connectivity such as NVMe. While NVMe technology is still in its early stages, about 20 percent of the all-flash arrays that DCIG evaluated already support NVMe as a backend connection to SSDs.
- ***Examine and optimize applications for non-volatile memory.*** Many applications include specific code to account for the latencies associated with traditional storage. Most all-flash arrays deliver latencies that are 10x lower than traditional arrays, and NVMe may enable another 10x reduction. To take full advantage of this performance potential, application owners must rewrite and remove code that accounts for the latencies of HDDs while creating new code that better leverages and optimizes for the low-latency and parallelism of NVMe-connected flash and storage-class memories such as 3D XPoint.
- ***Insist on predictive analytics capabilities.*** Enterprises are virtualizing (or containerizing) and consolidating many workloads onto high-performance application servers and all-flash arrays. It is not feasible for any human being to know how all these workloads will interact with one another or how to distribute and configure these applications to ensure the highest levels of availability, reliability, and performance at the lowest cost. Therefore, enterprises should consider predictive analytics capabilities a prerequisite for any all-flash array that will provide storage for multiple applications and workloads.

1. IDC Forecasts Strong Growth for the Solid State Drive (SSD) Industry as IT Transitions to 3D NAND Flash.", IDC Press Release, IDC, 20 Dec. 2017, www.idc.com/getdoc.jsp?containerId=prUS43390217.

Executive Summary (continued)

Through DCIG's evaluation of hundreds of features supported by each product, and comparing them to what features enterprises most need, DCIG can make recommendations as to which appliances are best positioned for enterprise use.

It is in this context that DCIG presents the *DCIG 2018-19 All-Flash Array Buyer's Guide.* As prior DCIG Buyer's Guides have done, it puts at the fingertips of enterprises a resource that can assist them in this important buying decision

The *DCIG 2018-19 All-Flash Array Buyer's Guide* accomplishes the following objectives:

- Provides an objective, third-party evaluation of products that evaluates and ranks their features from an end user's viewpoint
- Includes recommendations on how to best use this Buyer's Guide and the products contained in it
- Evaluates the features of each product based upon criteria that matter most so end users can quickly know which appliance is most appropriate for them
- Provides a standardized data sheet for each product so end users can do quick comparisons of the features supported and not supported on each product
- Gives any organization the ability to request competitive bids from different providers

How to Use this Buyer's Guide

This Buyer's Guide is intended to help users accelerate their product research and selection process—driving cost out of the research process while simultaneously increasing confidence in the results. The purpose of this Buyer's Guide is NOT intended to tell users exactly which product(s) to purchase. Rather, it is to guide them in coming up with a list of competitive products that have comparable features that meet their specific needs.

Features, as displayed on each product data sheet, represent the opinion of DCIG. DCIG encourages and strongly recommends every organization verify the functionality of the features that are of interest to them before making a buying decision. To help in that decision, this Buyer's Guide gives organizations a sense of how products compare with each other, as well as giving additional insight into what other product offerings are available on the market and the specific features they offer.

DCIG recommends that companies use this Buyer's Guide in the following seven ways:

1. ***Eliminate the painstaking research normally associated with identifying a shortlist of products that meet their needs.*** This Buyer's Guide evaluates 32 products from 7 providers. Each product is ranked *Recommended* or *Excellent* based on standard deviation ranges. More than 100 different features were evaluated, so organizations only need to look at the rankings and features to come up with a shortlist for consideration.
2. ***Do apples-to-apples comparisons of products from different vendors.*** It behooves organizations to get competitive bids from multiple vendors. But that tactic only works well when organizations know that they are receiving competitive bids on products that are roughly comparable. Using this Buyer's Guide, organizations can do a better job of accomplishing that objective.
3. ***Separate the apples from the oranges.*** Just as important as doing apples-to-apples comparisons is identifying when an orange is thrown into the mix. Sometimes it is difficult for an organization to know if it is truly getting a good deal when bids come in from vendors that include different products. Now organizations can refer to the rankings and features of each product in this Guide so they can determine if they are getting comparable products.
4. ***Gain perspective on how products from less well-known vendors compare against established and better-known brands.*** There's a built-in level of comfort when buying products from well-known vendors. There's also a built-in resistance to buying products from vendors that are perceived as unknown quantities. This Buyer's Guide helps to remove some of that apprehension about buying products from lesser known vendors. Using this Buyer's Guide, organizations can see how these products stack up.
5. ***Normalize complex terminology.*** Every industry has a proclivity to create acronyms and jargon that is specific to it. This Buyer's Guide sifts through the acronyms and jargon and then normalizes these terms, providing a foundation for meaningful comparisons. Definitions for these normalized terms are provided in the Glossary at the end of this Guide.
6. ***Take advantage of standardized data sheets to quickly compare products side-by-side.*** Product data sheets that vendors make available are rarely laid out in the same way or contain the same information. Some vendors even have data sheet formats that vary from product to product within their own portfolio. This Buyer's Guide tackles this problem by creating a standard, easy-to-read data sheet for every product. In this way, product data sheets for individual products can be referenced and the features on them quickly compared.
7. ***Help justify buying recommendations to business teams.*** An overall product ranking is included at the top of every product data sheet. This overall ranking summarizes in a single word how feature rich a product is compared to other products in the Buyer's Guide.

Disclosures

Over the last few years the general trend in the United States has been for both large and boutique analyst firms to receive some or all their revenue from vendors.

DCIG is no different in this respect as it also receives payment for some assets it produces. The services that DCIG provides include blogging, battle cards, customer validations, executive white papers, pocket analyst reports, white papers and special reports.

In the interest of transparency, some vendors included in this DCIG Buyer's Guide are or have been DCIG clients. This is not to imply that their products were given preferential treatment in the Buyer's Guide.

In that vein, there are some important facts to keep in mind when considering the information contained in this Buyer's Guide and its merit.

- No vendor paid DCIG any fee to research this topic or arrive at predetermined conclusions
- DCIG did not guarantee any vendor that its product would be included in this Buyer's Guide
- DCIG did not imply or guarantee that a specific product would receive a preferential ranking in this Buyer's Guide, before or after completion of research
- All research was based upon publicly available information, information provided by the vendor, and/or the expertise of those evaluating the information
- No negative inferences should be drawn against any vendor or product not covered in this Buyer's Guide
- It is a misuse of this Buyer's Guide to compare products included in it against products not included

Because of the number of features analyzed, there was no way for DCIG to accurately predict at the outset how individual products would end up ranking. DCIG wants to emphasize that no vendor was privy to how DCIG weighed individual features. In every case the vendor only found out the rankings of its product(s) after the analysis was complete.

Inclusion Criteria

The *DCIG 2018-19 All-flash Array Buyer's Guide* was derived from DCIG's All-flash Array Body of Research that examined more than 100 products. The following criteria were used when determining whether to include a specific product in this Buyer's Guide:

- Product is available in an all-flash configuration
- Product supports at least two controllers
- Sufficient information available to reach meaningful conclusions
- Product must be formally announced and/or generally available for purchase as of March 1, 2018
- Product achieved a ranking of *Recommended* or *Excellent*

Ultimately, it is the professional judgment of the analysts working on each DCIG Buyer's Guide whether a product meets the inclusion criteria.

The Eight-Step Process Used to Rank the Products

To rank each product included in this Buyer's Guide, DCIG went through an eight-step process to come to the most objective conclusion possible.

1. *DCIG established which features would be evaluated and which ones would not.* Prior to selecting the features which would be evaluated, DCIG quantified, then "normalized" the list of available features such that a common name for each feature was established. In cases where a feature could not be objectively defined or understood, it was excluded from consideration.
2. *The features were grouped into five (5) general categories.* The features to be evaluated were grouped into five categories: Performance Claims, Management & Software, Hardware, Virtualization, and Support.
3. *DCIG developed a survey to capture the feature data and completed a survey for each vendor's product(s). DCIG made completed survey(s) available to each vendor for verification. Each vendor was invited to review their data and respond with any corrections or edits to the DCIG-completed survey(s).* In every case, every vendor had the opportunity to review and respond to any DCIG-completed survey.
4. *DCIG identified a list of products that met the DCIG definition for an All-flash Array based on the inclusion criteria.*
5. *DCIG weighted each feature to establish a scoring rubric.* The weighting of each feature was done by DCIG analysts. The weightings were used to reflect if a feature was supported and potentially how useful and/or important the feature was to end users.
6. *Each product's features were scores based on information gathered in the surveys.* Features were marked as either *"supported"* or *"unsupported/undetermined."* Rankings were finalized after any updates from vendors had been entered and the review period had expired.
7. *Products were ranked using standard scoring techniques.* One of the goals of this Buyer's Guide is to establish clear lines of differentiation with conclusions that are arrived at objectively. To accomplish this goal, the mean score for all products was first determined

and then a standard deviation. DCIG developed an overall ranking for each product based on where that product's overall score fit into the various standard deviation ranges.

8. *Product feature data review worksheets were created and sent to the vendors for review before publication.* Each data sheet included in this published version of the Buyer's Guide is derived from a feature data review worksheet that was made available to the vendor for its review and feedback. In every case, each vendor had an opportunity to review and update the content included on its respective data sheet(s). If the vendor did not respond, the lack of response was noted on the data sheet(s) covering their products.

Due to the large number of product features that DCIG evaluated, only a subset of the collected data could be included on the data sheets. The feature data on the data sheets was selected, in part, based on the following criteria: 1) the most variability, 2) the greatest scoring weight, and 3) the greatest interest to prospective purchasers.

DCIG Thoughts and Comments on …

Compression and Deduplication

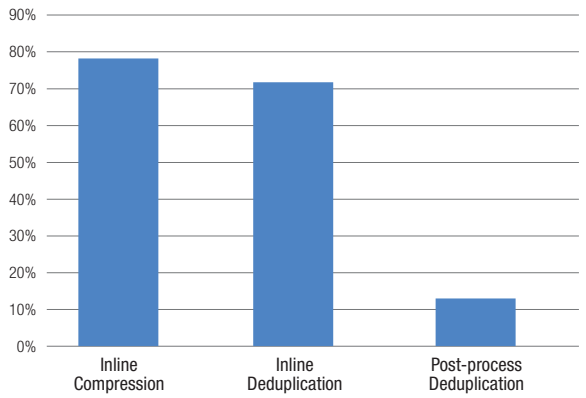
The clear majority of all-flash arrays support in-line compression and deduplication. The main points of differentiation are how the features are implemented and the options that they provide for granularity of control of these features.

In terms of feature implementation, some arrays provide separate implementations of deduplication for file and block level data. Some take this granularity even further to control when data deduplication occurs. While nearly all these arrays support in-line deduplication (deduplicating data as the array ingests the data,) some also provide options to deduplicate data ***after*** it is stored on the system. This post-process approach has merit when using the AFA for archive and/or backup use cases, though this currently represents a minority use case for AFAs.

Unless carefully architected, post-process deduplication has detrimental impacts on AFA performance and flash memory endurance because it increases the overall number of writes to the underlying flash media. This shortens the media's useful life and may slow production workloads during periods of peak activity.

Chart 1

AFA Capacity Optimization



Source: DCIG; N = 103

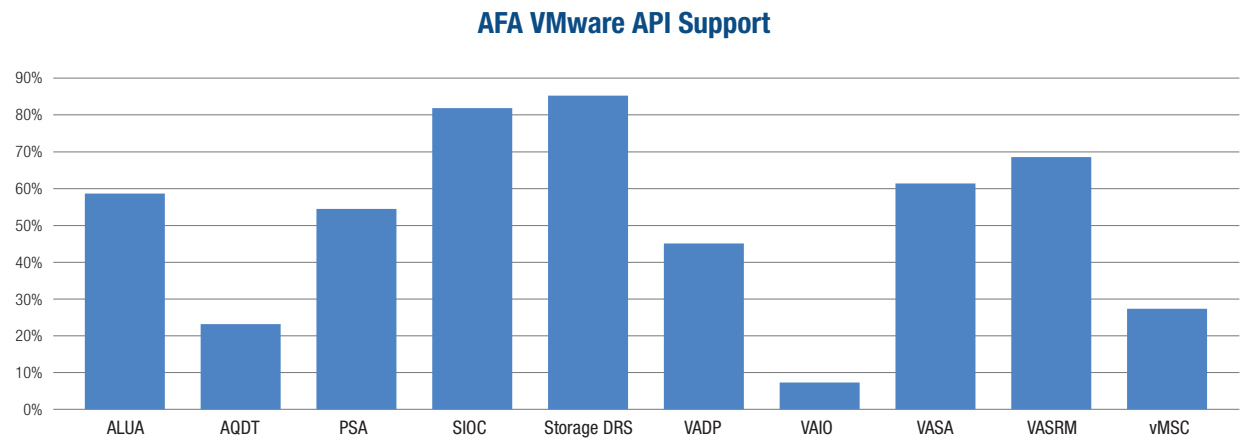
DCIG believes in-line compression and deduplication enhance the value, service life and even performance of an AFA while maximizing available storage capacity. This belief stems from the fact that most enterprises will primarily use AFAs to provide storage for shared databases, virtual servers and virtual desktops, all of which benefit greatly from the use of these in-line data efficiency technologies.

Breadth of VMware vSphere API Support

A high level of support that an all-flash array has for the VMware vSphere APIs can magnify the benefits of its native compression and deduplication features. Coupling an array's support for VMware's API with these technologies provides enterprises with the high levels of management and orchestration that they want for their virtualized environments which complement the capacity optimization features from which virtualized environments almost universally benefit.

However, as Chart 2 derived from DCIG's research into all-flash arrays illustrates, enterprises need to verify the depth of support that an all-flash array has for a specific VMware API. Among the arrays evaluated, the VMware APIs most likely to be supported were: Storage Dynamic Resource Scheduler (Storage DRS); Storage I/O Control (SIOC); vStorage APIs for Site Recovery Manager (VASRM); and, VMware's APIs for Storage Awareness (VASA). The level of support among AFAs for the other VMware APIs fell off significantly after those four.

Chart 2



Source: DCIG; N = 102

Non-volatile Memory Express Interface

Non-volatile Memory Express (NVMe) has captured the fancy of the enterprise storage world. Implementing NVMe on all-flash arrays carries with it the promise that AFAs can achieve sub-millisecond response times, drive millions of IOPS, and deliver real-time analytics and transaction processing. But differences persist between what NVMe promises for AFAs and what it can deliver in 2018.

First and foremost, NVMe is an exciting and needed breakthrough to deliver more of the performance benefits that flash and other non-volatile memories have to offer. NVMe, unlike the SCSI protocol which was designed with mechanical hard disk drives (HDDs) in mind, was designed specifically for use with non-volatile memory.

As part of speaking "flash," NVMe no longer concerns itself with the limitations of mechanical HDDs. Whether it is a read or a write, HDDs can only process one command at a time. Hence, the entire HDD is committed to completing that one command before it can start processing the next one. To help expedite command processing, commands are queued up on the SCSI interface so as soon as the HDD finishes processing a command, it can start on the next one with the maximum SCSI queue depth set at 256 commands per disk with commands sent to it on a single channel.

In contrast, the NVMe protocol is highly parallel. It can support ***64,000*** channels into the flash media and stack up to 64,000 commands in each channel. In other words, ***over 4 billion commands*** can theoretically be issued and in the queue for a single flash media at any time.

Of course, just because NVMe can support over 4 billion commands does not mean that any product or application currently comes close to doing that. Should that ever occur, and it probably will at some point in the future, advanced infrastructures will deliver tens of millions or hundreds of millions of IOPS. But as of early 2018, very few, if any, providers or enterprises are ready to support that level of performance. The NVMe protocol and ecosystem must continue to mature to support those kinds of workloads.

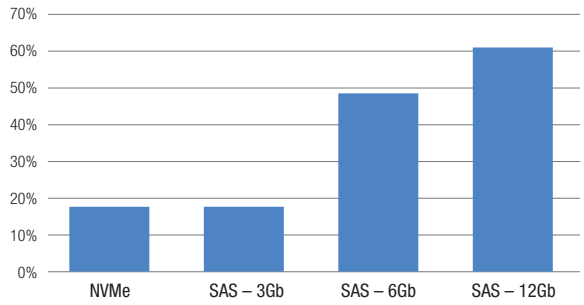
In light of these realities in 2018, here is what enterprises can realistically expect from NVMe now:

1. If you want NVMe on your all-flash array, you have a short list from which to choose. NVMe capable all-flash arrays that have a back end NVMe interfaces to all SSDs within an AFA are only available from a few vendors now with a few others offering a back end NVMe interface to some SSDs. This puts the number of all-flash arrays that currently support NVMe in the minority as Chart 3 illustrates, especially when compared to 6Gb and 12Gb SAS interfaces.

   The majority of AFAs currently use 6 or 12 Gb SAS to interface to their backend flash media for good reason: the NVMe ecosystem is immature and NVMe SSDs are not yet available in the larger capacities. Many AFA providers regard the availability of dual-ported NVMe

Chart 3

AFA Backend Flash Interface



SSDs from multiple suppliers as a pre-requisite for NVMe adoption in enterprise storage arrays. This requirement was satisfied recently, but it takes time for AFA providers to integrate NVMe into their designs and then qualify the NVMe SSDs.

2. ***Protocols used to connect application hosts and shared storage arrays will likely remain the same in 2018.*** Enterprises using NAS protocols such as CIFS or NFS or SAN protocols such as FC or iSCSI should expect to do so for 2018 and probably for the next few years. While new standards such as NVMe-oF are emerging and can deliver millions of IOPS—as some early implementations have demonstrated—most environments are not ready to use NVMe as a shared storage protocol between servers and AFA arrays. For now, NVMe remains best suited for communication between storage array controllers and their backend flash media.
3. ***NVMe should improve performance but applications may need to be modified.*** Stories about the performance improvements that NVMe offers are real and validated in the real world. However, these same users also find that some of their applications using these NVMe-based all-flash arrays are not getting the full benefit that they expected from them because, in part, their applications cannot handle the performance.

   Some users even report that they have uncovered their applications have pre-built-in wait times because the applications were designed to work with slower HDDs. Until the applications are updated to remove those preset wait times, the applications may become the new choke point that prevent enterprises from reaping the full performance benefits that NVMe has to offer.

NVMe has a bright future as an interface for flash media and other non-volatile memories. Sub-millisecond response times are certainly a realistic expectation. But in early 2018, enterprises need to set realistic expectations as to how much of a performance boost that NVMe will provide. Those expectations should be validated through a proof-of-concept implementation.

Scale-up versus Scale-out AFA Architectures

The future for AFAs with dual-controller, scale-up architectures has grown considerably brighter over the last several years. Conversely, the need for AFAs with scale-out architectures has retreated for many organizations.

On the surface, AFAs with scale-out architectures provide a distinct advantage over AFAs with dual controller, scale-up architectures for multiple reasons. Scale-out architectures embrace a "designed for failure" philosophy that provides more stable and predictable performance when one or more controllers go offline, whether for scheduled maintenance or due to a failure. This design facilitates non-disruptive hardware upgrades and software updates.

Each scale out node adds not only storage capacity but also more compute, DRAM cache and networking capacity. This allows organizations to multiply storage capacity without adding latency or introducing the complexity of managing multiple storage systems

Granted, dual-controller architectures have their own set of challenges. Taking one controller off-line for maintenance, upgrade, or due to a hardware failure has the net effect of effectively reducing available compute and memory by half. Migrating data from one dual-controller system to another has traditionally been a tricky proposition—at least in physical environments. Finally, deploying multiple dual controller, scale-up AFAs creates multiple islands of storage that enterprises must manage.

Advances in multi-core CPUs, storage networking port speeds, cache sizes, storage capacity, and the use of ASICS to accelerate in-line data services have combined to enable dual-controller arrays to handle much larger workloads. NVMe will further extend the effective processing capacity of the CPUs by eliminating a significant amount of protocol overhead.

Another dynamic that mitigates a scale-up weakness is the widespread adoption of server virtualization by enterprises of all sizes. Enterprises use technologies such as Storage vMotion to reduce the complexity and overhead associated with data migrations by automating the movement of virtual machine data stores from one AFA to another. In so doing, it mitigated one of the primary drawbacks of using AFAs with dual controller, scale-up architectures.

In trying to make a choice between AFAs with scale-out architectures and those with dual-controller, scale-up architectures and to which to give preference, those organizations that connect any physical machines to AFAs and those that are NOT using Storage vMotion or Storage DRS should give preference to AFAs with scale-out architectures. However, those enterprises that are fully virtualized and using Storage vMotion and/or Storage DRS will find that these technologies will address many of the data migration drawbacks that AFAs with dual-controller, scale-up architectures possess.

Capacity, Density, and Power Consumption

The average AFA flash density of the products in this Buyer's Guide continues to climb. Fully half of the AFAs that DCIG evaluated achieved greater than 50 TB/RU with some AFAs achieving over 200 TB/RU. The combination of all-flash performance and high storage density means that an AFA may be able to meet an organization's performance and capacity requirements in 1/10th the space of legacy HDD storage systems, creating an opportunity to realize significant data center cost reductions.

Going forward, DCIG anticipates that AFA capacities and densities will continue to climb even they remain more power-efficient than HDDs. While the majority (~90%) of the AFAs that DCIG evaluated scaled to less than 10PB, DCIG did evaluate one AFA that when fully populated with flash media scales to more than 70 PBs of raw all-flash capacity.

Individual SSD densities also continue to increase. By way of example, as this Buyer's Guide nears publication in early 2018, the first 100TB 3.5" SSD from Nimbus Data was announced. This SSD is compatible with any storage array that uses a SATA interface to connect to its backend drives.

Using SSDs of this size, an array with SATA interfaces to just one shelf that holds 15 drives could theoretically achieve densities of 750 – 1.5 PB/RU. While the cost to implement SSDs of this size may exceed what organizations can currently justify, they do give organizations a foretaste of what capacities and densities that they can expect AFAs to deliver.

Finally, flash memory is 3x to 10x more power efficient per terabyte than traditional HDD-based storage. While the power consumption of an individual SSD is about the same as a single HDD *(a single SSD in production consumes about 10 watts versus about 9 watts for an HDD),* the amount of a capacity in a single SSD is 3x to 10x as much as in a single enterprise HDD. Many enterprises have found that they can meet their storage requirements in 1/10th the rack space, power and cooling compared to their legacy storage arrays. Some enterprises have been able to eliminate entire data centers and achieve a nearly instantaneous return on their AFA investments.

Predictive Analytics

Enterprise storage startups are pushing the storage industry forward faster and in directions it may never have gone without them. It is because of these startups that flash memory is now the preferred place to store critical enterprise data. Startups advanced the customer-friendly all-inclusive approach to software licensing, evergreen hardware refreshes, and pay-as-you-grow utility pricing. These startup-inspired changes delight customers, who are rewarding these startups with large follow-on purchases and Net Promoter Scores (NPS) previously unseen in this industry. Yet the greatest contribution startups may make to the enterprise storage industry is applying predictive analytics to storage.

The Benefits of Predictive Analytics for Enterprise Storage

The end goal of predictive analytics for the more visionary startups goes beyond eliminating downtime. Their goal is to enable data center infrastructures to autonomously optimize themselves for application availability, performance and total cost of ownership based on the customer's priorities.

The vendors that commit to this path and execute better than their competitors create value for their customers. They also enable their own organizations to scale up revenues without scaling out staff. Vendors that succeed in applying predictive analytics to storage today also position themselves to win tomorrow in the era of software-defined data centers (SDDC) built on top of composable infrastructures.

To some people this may sound like a bunch of "highfalutin mumbo jumbo," but vendors are making real progress in applying predictive analytics to enterprise storage and other

elements of the technical infrastructure. Vendors and enterprises are achieving meaningful benefits. These benefits include:

- Measurably reducing downtime
- Avoiding preventable downtime
- Optimizing application performance
- Significantly reducing operational expenses
- Improving NPS

HPE Quantifies the Benefits of Predictive Analytics

Incumbent technology vendors are responding to this pressure from startups in a variety of ways. HPE purchased Nimble Storage, the prime mover in this space, and plans to extend the benefits of Nimble's InfoSight predictive analytics to its other enterprise infrastructure products. HPE claims its Nimble Storage array customers see the following benefits from InfoSight:

- 99.9999% of measured availability across its installed base
- 86% of problems are predicted and automatically resolved before customers even realize there is an issue
- 85% less time spent managing and resolving storage-related problems
- 79% savings in operational expense (OpEx)
- 54% of issues pinpointed are not storage, identified through InfoSight cross-stack analytics
- 42 minutes: the average level three engineer time required to resolve an issue
- 100% of issues go directly to level three support engineers, no time wasted working through level one and level two engineers

The Current State of Affairs in Predictive Analytics

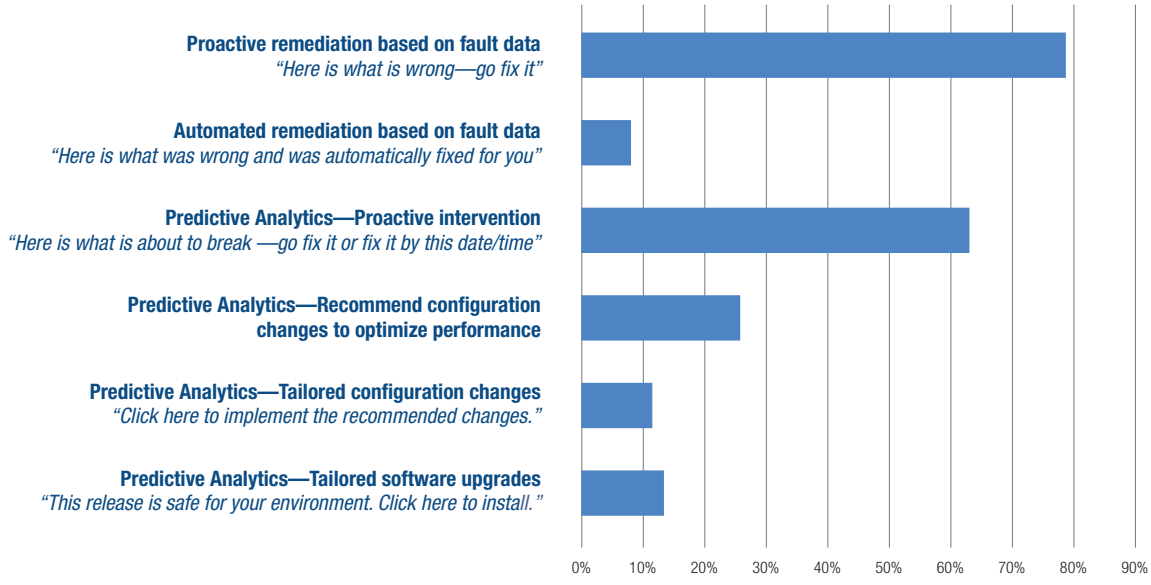
HPE is certainly not alone on this journey. In fact, vendors are claiming some use of predictive analytics for more than half of the all-flash arrays DCIG researched.

Telemetry Data is the Foundation for Predictive Analytics

Storage array vendors use telemetry data collected from the installed product base in a variety of ways. Most vendors evaluate fault data and advise customers how to resolve problems, or they remotely log in and resolve problems for their customers.

Chart 4

How All-Flash Array Vendors Currently Use Telemetry Data



Source: DCIG; N = 103

Many all-flash arrays transmit not just fault data, but extensive additional telemetry data about workloads back to the vendors. This data includes IOPS, bandwidth, and latency associated with workloads, front end ports, storage pools and more. Some vendors apply machine learning algorithms to data collected across the entire installed base to identify problem scenarios and optimization opportunities.

Predictive Analytics Features that Matter

Predictive Analytics—Proactive interventions identify something that is going to create a problem and then notify clients about the issue. Interventions may consist of providing guidance in how to avoid the problem or implementing the solution for the client. A wide range of interventions are possible including identifying the date when an array will reach full capacity or identifying a network configuration that could create a loop condition.

Predictive Analytics—Recommending configuration changes enhances application performance at a site by comparing the performance of the same application at similar sites, discovering optimal configurations, and recommending configuration changes at each site.

Predictive Analytics—Tailored configuration changes enhances application performance at a site by comparing the performance of the same application at similar sites, discovering optimal configurations, and needed configuration changes at each site. The vendor deploys the fix to other sites that run the same applications, eliminating potential problems. The vendor goes beyond recommending changes by packaging the changes into an installation script that the customer can run, or by implementing the recommended changes on the customer's behalf.

Predictive Analytics—Tailored software upgrades eliminate outages based on the predictive analytics function identifying incompatibilities between a software update and specific data center environments and then withholding that software update from affected sites. Consequently, storage administrators are shown only software updates that are believed to be safe for their environment.

Predictive Analytics is a Significant Yet Largely Untapped Opportunity

Vendors already create much value by applying predictive analytics to enterprise storage. Yet no vendor or product comes close to delivering all the value that is possible. A huge opportunity remains, especially considering the trends toward software-defined data centers and composable infrastructures. Reflecting for even a few minutes on the substantial benefits that predictive analytics already delivers should prompt every prospective all-flash array purchaser to incorporate predictive analytics capabilities into their evaluation of these products and the vendors that provide them.

Non-disruptive Upgrades (NDU)

NDU features, especially data migration and evergreen upgrades, means there is no maintenance window anymore. Since AFAs are now used to consolidate MANY workloads rather than as a point solution for high-value app acceleration, NDU features are especially important.

Performance and Pricing

Two factors that strongly influence buying decisions are performance and cost. However, DCIG does not take these two features into consideration when ranking the products found in this Buyer's Guide.

First, performance results vary according to data center environments, the data being stored, and implementation decisions. Introducing any type of performance metric would only result in the analysis in this Buyer's Guide becoming more subjective, not less.

Second, DCIG intends for this Buyer's Guide to provide a point-in-time snapshot of the all-flash array market. If DCIG had tried to test and establish performance benchmarks for all these arrays, the next generation of arrays could well be available before the testing was completed, making the information in this Buyer's Guide obsolete.

As for pricing, many factors influence final price including capacity purchased, services, extended warranties, and negotiations. These factors differ for every vendor and for every enterprise.

DCIG recognizes that price and performance are relevant and often key considerations when buying a storage array. In trying to address user interest around AFA performance, DCIG did include on product data sheets information that the respective vendor has published about its product's performance. DCIG makes no claims or warranties about the accuracy of this performance information, how the vendor arrived at these conclusions, or if an organization will achieve these performance metrics in its environment.

DCIG continues to recognize and recommend that any evaluation of AFA pricing and performance is a part of the buying process best left to end users.

Best Practices

Focus on accelerating apps. Eliminating storage performance bottlenecks may reveal bottlenecks elsewhere in the infrastructure and in applications. Getting the maximum performance benefit from an AFA may require more or faster network connections to application servers and/or the storage system, more server DRAM, adjusting cache sizes and adjusting other server and network configuration details. Some AFAs include utilities that will help identify the bottlenecks wherever they occur along the data path.

Mind the failure domain. Consolidation can yield dramatic savings, but it is prudent to consider the failure domain, and how much of an organization's infrastructure should depend on any one component—including an all-flash array.

Use quality of service (QoS) and multi-tenancy features to consolidate with confidence. Use QoS features to give critical business applications priority access to storage resources. Use multi-tenancy to limit the percentage of resources any one business unit or department can consume.

Pursue automation. Automation can dramatically reduce the amount of time spent on routine storage management and enable new levels of IT agility. This is another place where multi-tenancy and/or robust QoS capabilities add a layer of safety.

Realign roles and responsibilities. Implementing an all-flash storage strategy involves more than technology. It can, and should, reshape roles and responsibilities within the central IT department and between central IT, developers and business unit technologists. Thinking through the possible changes with the various stakeholders can reduce fear, eliminate obstacles, and uncover opportunities to create additional value for the business.

Conduct a proof of concept implementation. A good proof-of-concept can validate feature claims and uncover performance-limiting bottlenecks elsewhere in the infrastructure.

DCIG Observations

Recommended Ranking

All fifteen (15) all-flash arrays that achieved a *Recommended* ranking in this Buyer's Guide have the following features in common. This combination of features also set these products apart from other AFAs DCIG researched.

- Greater than 2.5 PB raw storage capacity (range 2.7 PB to 70 PB, mean 13.5 PB, median 8 PB)
- Provide more than twenty-four (24) 10Gb Ethernet and fifty-six (56) 16 Gb FC storage networking ports per system. Most offer at least 160 storage networking ports.
- Concurrent FC and iSCSI connectivity
- Active-Active controllers to take full advantage of available performance resources and storage networking connections
- FIPS 140-2 with AES-256 encryption for data security
- T10 PI for end-to-end data integrity
- Support for at least five multipathing solutions for continuous data access
- Management via vCenter, SCVMM, SMI-S, REST API and OpenStack Cinder
- Multi-tenancy for secure shared management of the storage system
- LDAP integration
- Support for all common operating systems and virtualization environments
- Persistent storage for containers such as Docker
- Extensive VMware integrations including VAAI block and thin primitives, ALUA, SIOC, Storage DRS, VADP, VASA, VASRM vMSC, VVols, and vRealize
- Automated uploads of telemetry data to vendor

Huawei OceanStor Dorado6000 V3, Dorado5000 V3 (NVMe), Dorado5000 V3 (SAS)

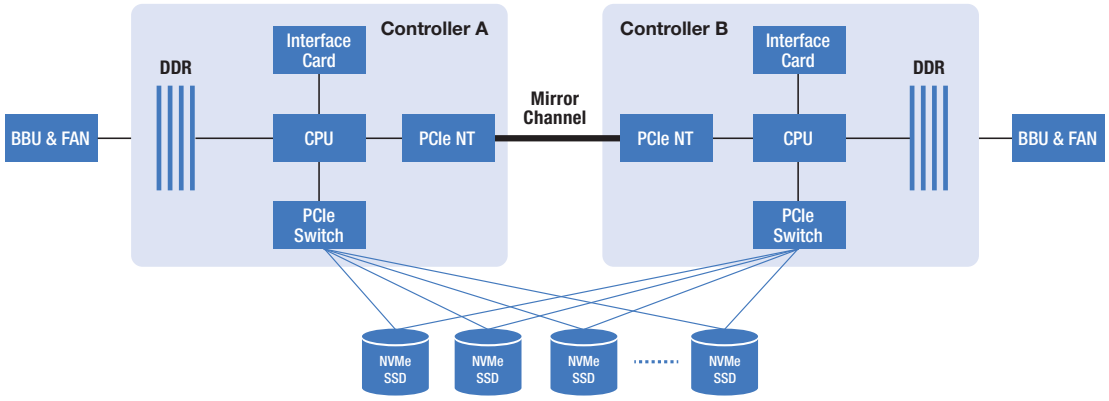
The Huawei OceanStor Dorado arrays are a designed-for-flash product line. Huawei engineered the Dorado arrays in tandem with its own SSDs to achieve high performance at consistent low latencies while extending flash life.

In this third generation of Dorado products, Huawei moved the Dorado from high-performance all-flash block storage appliance to enterprise array in three key ways:

- Integrated many of the enterprise data services from the OceanStor enterprise array product into Dorado
- Increased scalability by bringing Huawei SmartMatrix scale-out architecture to Dorado, with announced support for up to 16 scale-out controllers

Figure 1

Device architecture of OceanStor Dorado5000 V3 with NVMe SSDs



Source: : Huawei OceanStor Dorado V3 All-Flash Storage System Technical White Paper

- Doubled or quadrupled density and capacity by offering 15.36TB SAS and NVMe SSDs for Dorado, providing up to 36.9 PB of raw flash storage in a single cluster

Dorado6000 V3 and Dorado5000 V3 are distinguished from other AFAs—including the other *Recommended* products—by their robust connectivity options. All Dorado V3 arrays support at least 128 storage networking ports of 32Gb FC or 10Gb iSCSI. All support at least 64 ports of 40Gb iSCSI or 56Gb InfiniBand. This robust connectivity is a good fit for the performance claims Huawei makes for the Dorado V3 arrays.

The Dorado5000 V3 (NVMe) is one of the first commercially available arrays to implement NVMe. The array retains traditional frontend connectivity to application hosts but uses NVMe for backend connectivity to storage media. A PCIe switch in each controller connects with up to 25 dual-ported Huawei NVMe SSDs in the same 2U enclosure as the controller.

Huawei initially offered the Dorado5000 V3 (NVMe) as a standalone 2U appliance but has announced that the array is getting the same scale-up and scale-out capabilities as the other members of the Dorado V3 family.

Based on the direction Huawei has taken Dorado V3, DCIG expects Huawei will bring additional features from the OceanStor hybrid array platform to Dorado until it becomes Huawei's primary AFA product for all workloads. Alternatively, Huawei may converge all elements of the Dorado technology into a future OceanStor array series and drop the Dorado label. Either way, customers win.

Huawei OceanStor 6800F V5, 5800F V5, 5600F V5, 5500F V5, 5300F V5

The Huawei OceanStor 6800F V5, 5800F V5, 5600F V5, 5500F V5, 5300F V5 arrays are all-flash configurations of its hybrid array line. These "midrange" arrays offer unified storage, large capacities and high densities. The mature and feature-rich OceanStor OS is certified to support a wide range of applications and data center environments.

The OceanStor 6800F V5 consists of 4 controllers in a 6U enclosure. Two controller enclosures can be linked via PCIe 3.0 to form an 8-node cluster with over 11.5PB of raw all-flash capacity.

The OceanStor 5000 Series of arrays consist of dual-controller enclosures. Up to four enclosures can be clustered to form an 8-node cluster. The cluster interconnect is 10Gb Ethernet running the iWARP RDMA protocol.

The arrays optimize resource utilization for mission critical applications through LUN-specific SmartQoS policies which ensure that the required IOPS, bandwidth or latency requirements are achieved. The OceanStor V5 arrays streamline storage infrastructure via the SmartVirtualization feature which consolidates and centralizes heterogeneous storage

systems. SmartVirtualization eliminates data silos, simplifying storage management, data migrations and disaster recovery procedures.

Hitachi Vantara Virtual Storage Platform (VSP) F1500, F800, F600, and F400

The Hitachi Vantara VSP F400, F600, F800, and F1500 all-flash arrays differ from many of the other AFA models covered in this Guide. Competitors rely either solely upon industry standard SSDs or their own flash memory modules to provide flash capacity. The Hitachi VSP models can make use of both—SSDs and the Hitachi flash module (FMD).

This flexibility on Hitachi Vantara VSP models gives enterprises more options to address application workloads specific to their environments as they can mix these two media within the VSP based upon their specific needs. For instance, they can deploy FMDs for sensitive, enterprise-grade, I/O-intensive workloads and leverage SSDs for applications that still require performance but at a lower price point. The VSP arrays then rely upon the Hitachi Storage Virtual Operating System (SVOS) to recognize these two media types and manage and prioritize the I/O traffic going to them.

Three Hitachi Vantara VSP models (the F400, F600, and F800 models) also differ from most all-flash array competitors in that they only offer dual-controller, active-active configurations whereas the other *Recommended* models can scale-out their controllers. While scale-out configurations still have decided benefits over dual-controller configurations, highly virtualized enterprises may need these benefits less as they can rely upon the storage management features found in vSphere to migrate applications and data from one storage array to another. As such, dual controller AFAs such as the F400, F600, and F800 remain viable options in these environments.

On the storage networking side, the Hitachi Vantara VSPs are the only models that support FICON connectivity. While they do support the other common storage networking protocols, FC and iSCSI, their support of FICON makes these the only *Recommended* arrays to provide connectivity to mainframe environments.

Finally, the VSP arrays distinguish themselves from others in their support for public cloud storage platforms. They support Amazon S3, Google Cloud Storage, Microsoft Azure, OpenStack and the Hitachi Cloud Platform. While every all-flash array ranked as *Recommended* provides connectivity to at least one public cloud storage provider, the VSPs are among the few that provide connectivity to multiple cloud providers.

HPE 3PAR StoreServ 20450, 9450

The HPE 3PAR StoreServ 20450 and 9450 represent the middle of the StoreServ AFA product line. They provide up to 6.6 PB of raw flash capacity with densities up to 140 TB per rack unit.

The HPE 3PAR Gen5 Thin Express ASIC (Application Specific Integrated Circuit) enables rich data services with high performance. The ASIC enhances raw capacity/density with hardware-accelerated zero block detect and in-line block-level deduplication. The ASIC also accelerates thin provisioning, thin persistence, automated space reclamation, metadata operations, and manages the PCIe cluster-interconnect.

Rich QoS features enable confident consolidation by guaranteeing the performance of critical applications through bandwidth, IOPS and latency thresholds. Management APIs and an SDK enable integration with 3rd party automation and infrastructure management frameworks; freeing IT staff to focus on other business priorities.

HPE InfoSight's cross-stack analytics tool, VMVision, helps IT teams fix problems quickly. InfoSight pinpoints the source of application performance issues whether the problem originates in storage, the network or the application host. InfoSight's recommendation engine can recommend configuration changes for things like unbalanced nodes, unbalanced storage utilization, unbalanced drive configurations, or capacity utilization.

NetApp AFF A300

NetApp has made significant strides over the past few years in developing its AFF (All-Flash FAS) product line. While the AFF product line uses the same ONTAP operating system that NetApp has used for years, its AFF arrays only support SSD drives. AFF arrays also have features such an inline compression and inline deduplication turned on by default.

The NetApp AFF A300 utilizes 15.3 TB SSD and scales to nearly 6 PB of raw all-flash capacity per dual controller pair. A fully scaled-out AFF A300 NAS cluster consists of 12 high-availability (HA) pairs with a maximum raw capacity of over 70 PB; the most of any AFA in this Buyer's Guide.

NetApp AFF arrays provide a unified storage infrastructure supporting both SAN and NAS protocols. The AFF A300 can also be clustered other with NetApp FAS (Fabric-Attached Storage) models, enabling enterprises to move workloads between high-performance all-flash tiers as well as higher capacity HDD tiers on FAS models.

NetApp continues to support more public storage clouds as part of its hybrid-cloud data fabric vision. Running the most current version of ONTAP, Clustered ONTAP 9.3, along with ONTAP Cloud, enterprises may use AWS, Google Cloud Storage, IBM Cloud Object Storage, Microsoft Azure, and/or any OpenStack Cloud Service Provider.

Excellent Ranking

All seventeen (17) products that achieved an *Excellent* ranking in this Buyer's Guide Edition have the following features in common. This combination of features also set these products apart from other AFA's DCIG researched that did not achieve an *Excellent* ranking.

- At least 80 TB raw storage capacity (80 TB to 16 PB, mean 2.5 PB, median 1.2 PB)
- All offer a total of at least twenty-four (24) storage networking ports, at least a dozen 10Gb Ethernet and a dozen 16 Gb FC storage networking ports per system.
- Support the use of User defined settings to prioritize workloads (QoS)
- Management via vCenter, SCVMM, SMI-S and OpenStack Cinder
- Automated uploads of telemetry data to vendor
- Substantial VMware integrations including VAAI block and thin primitives, Storage DRS, VASA and VASRM

Dell EMC VMAX 450FX AFA, 250FX AFA

VMAX is the current name for what was once called Symmetrix, arguably the most successful and important enterprise storage system in history. EMC used to position the VMAX as strictly a high-end enterprise array, but as midrange arrays began to encroach on traditional VMAX territory, EMC extended the VMAX range downward with smaller capacity editions of the array.

The VMAX 450FX AFA and 250 FX AFA are the current incarnations of the VMAX "low end" that nevertheless scale to 3.8 PB and 128 ports for the 450FX. The 8TB DRAM

Figure 2

VMAX All-Flash Software Bundles

F Package

HYPERMAX OS
- NDM Migration Tools, Vvols, Inline Compression, Qos

Embedded Management
- Unlsphere, DB Storage Analyzer. REST APIs

Local Replication Suite
- TimeFinder SnapVX

AppSync iCDM Starter Bundle

À la carte:
- SRDF/S SRDF/A
- SRDF/Metro
- D@RE
- eNAS
- CloudArray Enabler
- Unisphere 360
- Dell EMC Storage Analytics
- ViPR SRM & Controller
- ProtectPoint
- PowerPath Full
- RecoverPoint
- AppSync Full Suite

FX Package

Everything in F Package +
- Data at Rest Encryption
- SRDF/S/NSTAR Replication Suite
- SRDF/Metros
- ViPR Suite (SRM and Controller)
- eNAs
- Unisphere 360
- CloudArray Enabler
- PowerPath/VE (75 licenses)

À la carte:
- ProtectPoint
- RecoverPoint
- AppSync Full Suite
- Dell EMC Storage Analytics

Source: Dell EMC VMAX Family Data Sheet

cache is de-staged to NVMe flash. The arrays run the HYPERMAX OS, which has been reengineered to support multiple-core CPUs and optimized for flash memory including support for in-line compression.

Dell EMC simplified software licensing for the VMAX all-flash arrays. Although retaining some a-la-carte elements, it moved toward all-inclusive licensing by offering two base AFA bundles. DCIG evaluated the products with the extended "FX" bundle.

Dell EMC Unity 650F All-Flash, 550F All-Flash

The Dell EMC Unity All-Flash arrays replaced the VNX products. Unity arrays provide unified storage with support for 15.3 TB SSD drives that enable the Unity 650F to provide up to 384 TB in just 2U and a maximum of 16PB of storage capacity. These storage density and capacity numbers are the highest among the *Excellent* ranked arrays and compare favorably with the *Recommended* products. These numbers are further enhanced through in-line compression.

Dell EMC Unity matches robust hardware with all-inclusive licensing of a well-rounded set of software features, including support for block, file and object storage protocols with tiering to public cloud storage.

Dell EMC CloudIQ is a no-cost, SaaS cloud-based monitoring and predictive analytics application for Unity environments. CloudIQ storage analytics compares collected system data (alerts, performance, capacity and configuration) against Dell EMC best practices to determine a Proactive Health Score for each array. Issues are presented along with recommended remedial actions.

HPE Nimble Storage AF9000, AF7000, AF5000 All Flash Array

The HPE Nimble Storage AF Series of arrays continue Nimble's legacy of scale-up and scale-out capabilities, now in all-flash configurations of up to 2.2 PB. The AF series arrays differ from one another in performance and capacity. All Nimble models support scale-out clusters of up to 8 nodes, including clusters of differing models. All offer in-line data services including deduplication and compression.

Nimble's cloud-based InfoSight predictive storage analytics service raised the bar regarding proactive support for the entire storage industry. InfoSight's VMVision enables cross-stack analytics to resolve application performance issues quickly, whether the problem stems from storage, network or application host.

InfoSight's "See Once, Prevent for All" approach is evident in multiple ways. For example, InfoSight globally correlates telemetry data to identify interoperability issues, configuration issues and best practices. When HPE InfoSight engineers fix an interoperability issue for one client, a non-disruptive update is automatically provided to all other arrays that match the profile.

InfoSight also blacklists software updates with known interoperability issues for a given operating environment. Thus, InfoSight only shows software updates that are free of known problems for that specific array.

Storage administrators can use InfoSight for capacity planning. InfoSight identifies the specific date when capacity thresholds are likely to be exceeded. It can also model the impact of running specific additional applications on the array and if needed, can recommend specific upgrades required to support the application.

NetApp AFF A200

The NetApp AFF A200 possesses all the same software features as the more highly ranked AFF A300. The main differences between these two models are the hardware features found on the AFF A200. For instance, a fully scaled-out A200 NAS cluster can consist of only 4 high-availability (HA) pairs. Further, it supports a more limited number of SSDs, 576 which in turn results in a lower—but still impressive—maximum raw capacity of about 9 PB.

For those enterprises that want or need all the software features that NetApp ONTAP offers but who do not need the higher capacities, the AFF A200 provides a solution that is well-suited to many enterprise needs.

Pure Storage FlashArray//X70, //M70, //M50, //M20, //M10

All Pure Storage FlashArray products run the designed-for-flash Purity operating environment and use the same 3U dual-controller chassis. This enables modular expansion and non-disruptive upgrades across the entire product line and across multiple hardware generations.

The FlashArray supports up to 80 CPU cores and 24 storage networking ports. The FlashArray//M20 through //X70 are among the few product families that support 40 Gb iSCSI connectivity. The FlashArray//X70 all-NVMe array supports up to 366TB of flash memory via 18.3 TB proprietary "DirectFlash" NVMe flash modules. This capacity

is enhanced by in-line compression and deduplication, with customers achieving an average data reduction rate of 5:1.

Pure Storage is one of the startups that focuses on customer-friendly innovation. It offers Evergreen Storage which provides includes upgraded controllers with each 3-year maintenance and support renewal. Pure Storage built its proactive technical support around telemetry data. They initially focused on fault data, using it to help customers avoid more than 500 Severity 1 outages.

In mid-2017 the company announced Pure1 META which applies AI and machine learning to the collected telemetry data to enable greater predictive abilities. The initial focus is on intelligent workload planning, but the larger vision is what Pure Storage calls "self-driving storage."

Tegile HD2080 Series, HD2040-Series, N5800, N5200

The Tegile IntelliFlash HD arrays pair Tegile's IntelliFlash Metadata Accelerated active-active dual-controller unified block and file storage architecture with Western Digital Corporation's SanDisk InfiniFlash dense flash enclosures to provide up to 1280 TB of raw flash capacity in 10 RU, achieving a raw density of 128 TB/RU. Tegile recently added support for up to twelve (12) 40 Gb Ethernet ports across its products, one of the few vendors currently supporting 40Gb Ethernet.

IntelliFlash arrays separate metadata from the primary data path, storing the metadata on high-performance memory devices. This separation of data optimizes functions such as in-line deduplication, in-line compression and snap-shots, while simultaneously accelerating all I/O.

The Tegile N5800 and N5200 are all-NVMe arrays offering up to 154 TB of storage in 2RU. The N5800 and N5200 use the same IntelliFlash software and offer the same front-end connectivity options as Tegile's other all-flash arrays but back-end connectivity to SSDs is via NVMe.

Tegile is one of the startups that has pushed the whole enterprise storage industry in new directions. For example, they were one of the first enterprise storage startups to offer customer-friendly all-inclusive licensing. Tegile also offers utility-based pricing, a lifetime storage refresh program, and cloud-based analytics.

Tegile is now a Western Digital brand, having been acquired by Western Digital in September 2017.

ALL-FLASH ARRAY RANKINGS

Overall Rankings

RANKING	PRODUCT
RECOMMENDED	Huawei OceanStor Dorado6000 V3
	Huawei OceanStor Dorado5000 V3 (NVMe)
	Huawei OceanStor Dorado5000 V3 (SAS)
	Huawei OceanStor 6800F V5
	Huawei OceanStor 5800F V5
	Huawei OceanStor 5600F V5
	Huawei OceanStor 5500F V5
	Huawei OceanStor 5300F V5
	Hitachi Vantara VSP F1500
	Hitachi Vantara VSP F800
	Hitachi Vantara VSP F600
	Hitachi Vantara VSP F400
	HPE 3PAR StoreServ 20450
	HPE 3PAR StoreServ 9450
	NetApp AFF A300
EXCELLENT	Dell EMC VMAX 450FX AFA
	Dell EMC VMAX 250FX AFA
	Dell EMC Unity 650F All-Flash
	Dell EMC Unity 550F All-Flash
	HPE Nimble Storage AF9000 All Flash Array

Continued on next page

Overall Rankings (continued)

RANKING	PRODUCT
EXCELLENT *(continued)*	HPE Nimble Storage AF7000 All Flash Array
	HPE Nimble Storage AF5000 All Flash Array
	NetApp AFF A200
	Pure Storage FlashArray//X70
	Pure Storage FlashArray//M70
	Pure Storage FlashArray//M50
	Pure Storage FlashArray//M20
	Pure Storage FlashArray//M10
	Tegile HD2080 Series
	Tegile HD2040 Series
	Tegile N5800
	Tegile N5200

ALL-FLASH ARRAY PRODUCTS

Dell EMC Unity 550F All-Flash

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	395K
Bandwidth per Controller / System	●
Latency ***AVERAGE, IN MICROSECONDS***	●
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✔
VM Level Snapshots using VVol	✔
Asynchronous Replication: Periodic / Continuous	✔ / ●
Synchronous Replication / Metro Cluster	✔ / ●
Zero Page Reclamation	●
Compression	✔
Deduplication: In-line / Post-process	✔ / ●
Automated Policy-based Provisioning	✔
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ● / ●
Metadata Stored Separately	●
QoS: System-defined / User-defined	● / ✔
Management Methods: IPMI / OpenStack / REST API	✔ / ✔ / ✔
Management Methods: SCVMM / SMI-S / vCenter	✔ / ✔ / ✔
Unified Management / Multi-tenancy	✔ / ✔
Native Support for Public Cloud Storage Targets	✔
File Protocols: NFSv3 / NFSv4 / pNFS	✔ / ✔ / ✔
File Protocols: CIFS / SMB3	✔ / ✔
Block Protocols: FC / iSCSI	✔ / ✔
Concurrent SAN & NAS	✔
Concurrent FC & iSCSI	✔
Authentication: LDAP / Kerberos / NIS	✔ / ✔ / ✔
Encryption: Array-based / Self-encrypting Drives	✔ / ●
T10 PI / FIPS 140-2	● / ✔
All-inclusive Feature Licensing	✔

HARDWARE

Raw Flash Capacity per System	8,000 TB
NVMe SSD / 12 Gb SAS SSD	● / ✔
Largest Capacity SSD	15TB
Raw Flash Density	192 TB/RU
DRAM Cache per Controller / System	128 / 256 GB
NVDIMM Cache per Controller / System	●
CPU Cores per Controller / System	14 / 28 Cores
Architecture: Scale-up / Scale-out	✔ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	24 / 24
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	● / 20 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✔ / ✔
Operating Temperature: Min - Max	10C/50F – 35C/95F
Operating Humidity: Min - Max	20% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✔ / ●
Hypervisors: Hyper-V / vSphere	✔ / ✔
VAAI: Block / NAS / Thin	✔ / ✔ / ✔
VADP / VASA	● / ✔
VASRM / vMSC	✔ / ●
Virtual Volumes / vRealize	✔ / ✔

SUPPORT

24x7x365 Call Center	✔
Technician Onsite with 4-hour GTD Response	✔
Proactive Remediation Based on Fault Data	✔
Predictive Analytics—Proactive Intervention	✔
Predictive Analytics—Recommend Config Changes	✔
Predictive Analytics—Tailored Software Upgrades	●

✔ SUPPORTED ● UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Dell EMC Unity 650F All-Flash

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	440K
Bandwidth per Controller / System	●
Latency ***AVERAGE, IN MICROSECONDS***	●
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✔
VM Level Snapshots using VVol	✔
Asynchronous Replication: Periodic / Continuous	✔ / ●
Synchronous Replication / Metro Cluster	✔ / ●
Zero Page Reclamation	●
Compression	✔
Deduplication: In-line / Post-process	✔ / ●
Automated Policy-based Provisioning	✔
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ● / ●
Metadata Stored Separately	●
QoS: System-defined / User-defined	● / ✔
Management Methods: IPMI / OpenStack / REST API	✔ / ✔ / ✔
Management Methods: SCVMM / SMI-S / vCenter	✔ / ✔ / ✔
Unified Management / Multi-tenancy	✔ / ✔
Native Support for Public Cloud Storage Targets	✔
File Protocols: NFSv3 / NFSv4 / pNFS	✔ / ✔ / ✔
File Protocols: CIFS / SMB3	✔ / ✔
Block Protocols: FC / iSCSI	✔ / ✔
Concurrent SAN & NAS	✔
Concurrent FC & iSCSI	✔
Authentication: LDAP / Kerberos / NIS	✔ / ✔ / ✔
Encryption: Array-based / Self-encrypting Drives	✔ / ●
T10 PI / FIPS 140-2	● / ✔
All-inclusive Feature Licensing	✔

HARDWARE

Raw Flash Capacity per System	16,000 TB
NVMe SSD / 12 Gb SAS SSD	● / ✔
Largest Capacity SSD	15TB
Raw Flash Density	192 TB/RU
DRAM Cache per Controller / System	256 / 512 GB
NVDIMM Cache per Controller / System	●
CPU Cores per Controller / System	14 / 28 Cores
Architecture: Scale-up / Scale-out	✔ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	24 / 24
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	● / 20 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✔ / ✔
Operating Temperature: Min - Max	10C/50F – 35C/95F
Operating Humidity: Min - Max	20% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✔ / ●
Hypervisors: Hyper-V / vSphere	✔ / ✔
VAAI: Block / NAS / Thin	✔ / ✔ / ✔
VADP / VASA	● / ✔
VASRM / vMSC	✔ / ●
Virtual Volumes / vRealize	✔ / ✔

SUPPORT

24x7x365 Call Center	✔
Technician Onsite with 4-hour GTD Response	✔
Proactive Remediation Based on Fault Data	✔
Predictive Analytics—Proactive Intervention	✔
Predictive Analytics—Recommend Config Changes	✔
Predictive Analytics—Tailored Software Upgrades	●

✔ SUPPORTED ● UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Dell EMC VMAX 250FX AFA

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	○
Bandwidth per Controller / System	○
Latency ***AVERAGE, IN MICROSECONDS***	○
IOPS per Watt	○

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	○ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	○ / ○
Automated Policy-based Provisioning	✓
Automated Storage Tiering	○
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	✓
QoS: System-defined / User-defined	○ / ✓
Management Methods: IPMI / OpenStack / REST API	○ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	○
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ○ / ○
Encryption: Array-based / Self-encrypting Drives	✓ / ○
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	○

HARDWARE

Raw Flash Capacity per System	1,160 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ✓
Largest Capacity SSD	1.92 TB
Raw Flash Density	26 TB/RU
DRAM Cache per Controller / System	1,024 / 4,096 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	24 / 96 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	4
Storage Networking Ports per System	**64**
Ethernet: 1 / 10 Gb	○ / 64
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	64 / 64 / ○
InfiniBand 40 / 56	○ / ○
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	○
Operating Humidity: Min - Max	○

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	○
Predictive Analytics—Tailored Software Upgrades	○

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Dell EMC VMAX 450FX AFA

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	○
Bandwidth per Controller / System	○
Latency ***AVERAGE, IN MICROSECONDS***	○
IOPS per Watt	○

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	○ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	○ / ○
Automated Policy-based Provisioning	✓
Automated Storage Tiering	○
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	✓
QoS: System-defined / User-defined	○ / ✓
Management Methods: IPMI / OpenStack / REST API	○ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	○
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ○ / ○
Encryption: Array-based / Self-encrypting Drives	✓ / ○
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	○

HARDWARE

Raw Flash Capacity per System	3,840 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ✓
Largest Capacity SSD	3.84TB
Raw Flash Density	22 TB/RU
DRAM Cache per Controller / System	1,024 / 8,192 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	16 / 128 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**128**
Ethernet: 1 / 10 Gb	○ / 96
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	96 / 96 / ○
InfiniBand 40 / 56	○ / ○
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	○
Operating Humidity: Min - Max	○

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	○
Predictive Analytics—Tailored Software Upgrades	○

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Hitachi Vantara VSP F400

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	300K / 600K
Bandwidth per Controller / System	51 / 102 GB/s
Latency *AVERAGE, IN MICROSECONDS*	800
IOPS per Watt	461

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	○
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	○ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	○ / ✓
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	○ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ○
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	2,702 TB
NVMe SSD / 12 Gb SAS SSD	○ / ✓
Largest Capacity SSD	14 TB
Raw Flash Density	75 TB/RU
DRAM Cache per Controller / System	64 / 128 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	4 / 8 Cores
Architecture: Scale-up / Scale-out	✓ / ○
Scale-out Controllers	○
Storage Networking Ports per System	**56**
Ethernet: 1 / 10 Gb	○ / 28
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	56 / 56 / 56
InfiniBand 40 / 56	○ / ○
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	16C/60F – 40C/104F
Operating Humidity: Min - Max	20% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

Hitachi Vantara VSP F600

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	400K / 800K
Bandwidth per Controller / System	102 / 204 Gb/s
Latency *AVERAGE, IN MICROSECONDS*	800
IOPS per Watt	533

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	●
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	● / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	● / ✓
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	● / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	4,053 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	14 TB
Raw Flash Density	78 TB/RU
DRAM Cache per Controller / System	128 / 256 GB
NVDIMM Cache per Controller / System	●
CPU Cores per Controller / System	8 / 16 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**56**
Ethernet: 1 / 10 Gb	● / 28
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	56 / 56 / 56
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✓ / ●
Operating Temperature: Min - Max	16C/60F – 40C/104F
Operating Humidity: Min - Max	20% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

Hitachi Vantara VSP F800

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	700K / 1.4M
Bandwidth per Controller / System	102 / 204 GB/s
Latency *AVERAGE, IN MICROSECONDS*	800
IOPS per Watt	513

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	○
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	○ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	○ / ✓
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	○ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ○
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	8,106 TB
NVMe SSD / 12 Gb SAS SSD	○ / ✓
Largest Capacity SSD	14 TB
Raw Flash Density	81 TB/RU
DRAM Cache per Controller / System	256 / 512 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	16 / 32 Cores
Architecture: Scale-up / Scale-out	✓ / ○
Scale-out Controllers	○
Storage Networking Ports per System	**64**
Ethernet: 1 / 10 Gb	○ / 32
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	64 / 64 / 64
InfiniBand 40 / 56	○ / ○
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	16C/60F – 40C/104F
Operating Humidity: Min - Max	20% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

Hitachi Vantara VSP F1500

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	2.4M / 4.8M
Bandwidth per Controller / System	416 / 832 GB/s
Latency *AVERAGE, IN MICROSECONDS*	500
IOPS per Watt	800

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	○
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	○ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	○ / ✓
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	○ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ○
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	8,106 TB
NVMe SSD / 12 Gb SAS SSD	○ / ○
Largest Capacity SSD	14 TB
Raw Flash Density	70 TB/RU
DRAM Cache per Controller / System	1,024 / 2,048 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	64 / 128 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	4
Storage Networking Ports per System	**176**
Ethernet: 1 / 10 Gb	○ / 88
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	176 / 176 / ○
InfiniBand 40 / 56	○ / ○
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	16C/60F – 40C/104F
Operating Humidity: Min - Max	20% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

HPE 3PAR StoreServ 9450

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	500K / 2M
Bandwidth per Controller / System	8.5 / 34 GB/s
Latency *AVERAGE, IN MICROSECONDS*	500
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ● / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ●
Encryption: Array-based / Self-encrypting Drives	● / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	6,597 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	15.36 TB
Raw Flash Density	140 TB/RU
DRAM Cache per Controller / System	240 / 960 GB
NVDIMM Cache per Controller / System	● / ●
CPU Cores per Controller / System	20 / 80 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	4
Storage Networking Ports per System	**80**
Ethernet: 1 / 10 Gb	● / 40
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	● / 80 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✓ / ●
Operating Temperature: Min - Max	5C/41F – 35C/95F
Operating Humidity: Min - Max	10% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

HPE 3PAR StoreServ 20450

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	450K / 1.8M
Bandwidth per Controller / System	8.5 / 34 GB/s
Latency *AVERAGE, IN MICROSECONDS*	500
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ● / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ●
Encryption: Array-based / Self-encrypting Drives	● / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	4,317 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	15.36 TB
Raw Flash Density	105 TB/RU
DRAM Cache per Controller / System	481 / 1,924 GB
NVDIMM Cache per Controller / System	● / ●
CPU Cores per Controller / System	16 / 64 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	4
Storage Networking Ports per System	**80**
Ethernet: 1 / 10 Gb	● / 40
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	● / 80 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✓ / ●
Operating Temperature: Min - Max	5C/41F – 35C/95F
Operating Humidity: Min - Max	10% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

DCIG

HPE Nimble Storage AF5000 All Flash Array

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	70K / 560K
Bandwidth per Controller / System	●
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ●
Synchronous Replication / Metro Cluster	● / ●
Zero Page Reclamation	●
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ✓ / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	● / ✓ / ●
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	● / ● / ●
File Protocols: CIFS / SMB3	● / ●
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	●
Concurrent FC & iSCSI	●
Authentication: LDAP / Kerberos / NIS	● / ● / ●
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	736 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	3.84 TB
Raw Flash Density	23 TB/RU
DRAM Cache per Controller / System	128 / 1,024 GB
NVDIMM Cache per Controller / System	4 / 32 GB
CPU Cores per Controller / System	16 / 128 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**112**
Ethernet: 1 / 10 Gb	112 / 112
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	● / 96 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	● / ✓
Operating Temperature: Min - Max	10C/50F – 35C/95F
Operating Humidity: Min - Max	8% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	● / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	✓ / ●

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

HPE Nimble Storage AF7000 All Flash Array

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	135K / 1M
Bandwidth per Controller / System	●
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ●
Synchronous Replication / Metro Cluster	● / ●
Zero Page Reclamation	●
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ✓ / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	● / ✓ / ●
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	● / ● / ●
File Protocols: CIFS / SMB3	● / ●
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	●
Concurrent FC & iSCSI	●
Authentication: LDAP / Kerberos / NIS	● / ● / ●
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	1,292 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	3.84 TB
Raw Flash Density	26.9 TB/RU
DRAM Cache per Controller / System	64 / 512 GB
NVDIMM Cache per Controller / System	4 / 32 GB
CPU Cores per Controller / System	24 / 192 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**112**
Ethernet: 1 / 10 Gb	112 / 112
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	● / 96 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	● / ✓
Operating Temperature: Min - Max	10C/50F – 35C/95F
Operating Humidity: Min - Max	8% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	● / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	✓ / ●

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

HPE Nimble Storage AF9000 All Flash Array

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	175K / 1.4M
Bandwidth per Controller / System	●
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ●
Synchronous Replication / Metro Cluster	● / ●
Zero Page Reclamation	●
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ✓ / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	● / ✓ / ●
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	● / ● / ●
File Protocols: CIFS / SMB3	● / ●
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	●
Concurrent FC & iSCSI	●
Authentication: LDAP / Kerberos / NIS	● / ● / ●
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	2,212 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	3.84 TB
Raw Flash Density	46 TB/RU
DRAM Cache per Controller / System	128 / 1,024 GB
NVDIMM Cache per Controller / System	4 / 32 GB
CPU Cores per Controller / System	40 / 320 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**112**
Ethernet: 1 / 10 Gb	112 / 112
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	● / 96 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	● / ✓
Operating Temperature: Min - Max	10C/50F – 35C/95F
Operating Humidity: Min - Max	8% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	● / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	✓ / ●

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

Huawei OceanStor 5300F V5

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	125K / 1M
Bandwidth per Controller / System	5 / 40 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	604

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ○
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	○
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	○
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	○

HARDWARE

Raw Flash Capacity per System	3,840 TB
NVMe SSD / 12 Gb SAS SSD	○ / ✓
Largest Capacity SSD	7.68 TB
Raw Flash Density	96 TB/RU
DRAM Cache per Controller / System	64 / 512 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	8 / 64 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**160**
Ethernet: 1 / 10 Gb	64 / 96
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	160 / 160 / ○
InfiniBand 40 / 56	○ / 32
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	5C/41F – 40C/104F
Operating Humidity: Min - Max	5% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	○

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

DCIG

Huawei OceanStor 5500F V5

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	162.5K / 1.3M
Bandwidth per Controller / System	5 / 40 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	698.9

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ○
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	○
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	○
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	○

HARDWARE

Raw Flash Capacity per System	3,840 TB
NVMe SSD / 12 Gb SAS SSD	○ / ✓
Largest Capacity SSD	7.68 TB
Raw Flash Density	96 TB/RU
DRAM Cache per Controller / System	128 / 1,024 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	14 / 112 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**160**
Ethernet: 1 / 10 Gb	64 / 96
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	160 / 160 / ○
InfiniBand 40 / 56	○ / 32
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	5C/41F – 40C/104F
Operating Humidity: Min - Max	5% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	○

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

Huawei OceanStor 5600F V5

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	225K / 1.8M
Bandwidth per Controller / System	7.5 / 60 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	447.3

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ○
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	○
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	○
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	○

HARDWARE

Raw Flash Capacity per System	7,680 TB
NVMe SSD / 12 Gb SAS SSD	○ / ✓
Largest Capacity SSD	7.68 TB
Raw Flash Density	93 TB/RU
DRAM Cache per Controller / System	256 / 2,048 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	28 / 224 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**288**
Ethernet: 1 / 10 Gb	224 / 224
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	288 / 224 / ○
InfiniBand 40 / 56	○ / 112
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	5C/41F – 40C/104F
Operating Humidity: Min - Max	5% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	○

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

DCIG

Huawei OceanStor 5800F V5

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	300K / 2.4M
Bandwidth per Controller / System	7.5 / 60 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	483.8

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ○
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	○
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	○
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ○
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	○

HARDWARE

Raw Flash Capacity per System	9,216 TB
NVMe SSD / 12 Gb SAS SSD	○ / ✓
Largest Capacity SSD	7.68 TB
Raw Flash Density	93 TB/RU
DRAM Cache per Controller / System	512 / 4,096 GB
NVDIMM Cache per Controller / System	○
CPU Cores per Controller / System	40 / 320 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**288**
Ethernet: 1 / 10 Gb	224 / 224
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	288 / 224 / ○
InfiniBand 40 / 56	○ / 112
NDU: Data Migrations / Evergreen Hardware	✓ / ○
Operating Temperature: Min - Max	5C/41F – 40C/104F
Operating Humidity: Min - Max	5% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	○

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

Huawei OceanStor 6800F V5

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	375K / 3M
Bandwidth per Controller / System	7.5 / 60 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ●
Metadata Stored Separately	●
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	●
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	●

HARDWARE

Raw Flash Capacity per System	11,520 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	7.68 TB
Raw Flash Density	91 TB/RU
DRAM Cache per Controller / System	1,024 / 8,192 GB
NVDIMM Cache per Controller / System	●
CPU Cores per Controller / System	28 / 224 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**244**
Ethernet: 1 / 10 Gb	160 / 160
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	224 / 160 / ●
InfiniBand 40 / 56	● / 80
NDU: Data Migrations / Evergreen Hardware	✓ / ●
Operating Temperature: Min - Max	5C/41F – 40C/104F
Operating Humidity: Min - Max	10% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	●

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

Huawei OceanStor Dorado5000 V3 (NVMe)

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	200K / 3.2M
Bandwidth per Controller / System	5 / 80 GB/s
Latency *AVERAGE, IN MICROSECONDS*	500
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	●
File Protocols: NFSv3 / NFSv4 / pNFS	● / ● / ●
File Protocols: CIFS / SMB3	● / ●
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	●
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ● / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	3,072 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ●
Largest Capacity SSD	15.36 TB
Raw Flash Density	192 TB/RU
DRAM Cache per Controller / System	256 / 4,096 GB
NVDIMM Cache per Controller / System	●
CPU Cores per Controller / System	14 / 224 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	16
Storage Networking Ports per System	**128**
Ethernet: 1 / 10 Gb	● / 128
Ethernet: 25 / 40 Gb	128 / 64
FC: 8 / 16 / 32 Gb	128 / 128 / 128
InfiniBand 40 / 56	● / 64
NDU: Data Migrations / Evergreen Hardware	✓ / ●
Operating Temperature: Min - Max	5C/41F – 40C/104F
Operating Humidity: Min - Max	10% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	●

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

Huawei OceanStor Dorado5000 V3 (SAS)

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	150K / 2.4M
Bandwidth per Controller / System	5 / 80 GB/s
Latency ***AVERAGE, IN MICROSECONDS***	500
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	●
File Protocols: NFSv3 / NFSv4 / pNFS	● / ● / ●
File Protocols: CIFS / SMB3	● / ●
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	●
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ● / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	24,576 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	15.36 TB
Raw Flash Density	192 TB/RU
DRAM Cache per Controller / System	256 / 4,096 GB
NVDIMM Cache per Controller / System	●
CPU Cores per Controller / System	14 / 224 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	16
Storage Networking Ports per System	**128**
Ethernet: 1 / 10 Gb	● / 128
Ethernet: 25 / 40 Gb	128 / 64
FC: 8 / 16 / 32 Gb	128 / 128 / 128
InfiniBand 40 / 56	● / 64
NDU: Data Migrations / Evergreen Hardware	✓ / ●
Operating Temperature: Min - Max	5C/41F – 40C/104F
Operating Humidity: Min - Max	10% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	●

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

Huawei OceanStor Dorado6000 V3

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	250K / 4M
Bandwidth per Controller / System	7.5 / 120 GB/s
Latency ***AVERAGE, IN MICROSECONDS***	500
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ●
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	●
File Protocols: NFSv3 / NFSv4 / pNFS	● / ● / ●
File Protocols: CIFS / SMB3	● / ●
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	●
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ● / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	36,864 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	15.36 TB
Raw Flash Density	77 TB/RU
DRAM Cache per Controller / System	1,024 / 16,384 GB
NVDIMM Cache per Controller / System	●
CPU Cores per Controller / System	14 / 224 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	16
Storage Networking Ports per System	**448**
Ethernet: 1 / 10 Gb	● / 448
Ethernet: 25 / 40 Gb	448 / 224
FC: 8 / 16 / 32 Gb	448 / 448 / 448
InfiniBand 40 / 56	● / 224
NDU: Data Migrations / Evergreen Hardware	✓ / ●
Operating Temperature: Min - Max	5C/41F – 40C/104F
Operating Humidity: Min - Max	10% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	●

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

NetApp AFF A200

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	○
Bandwidth per Controller / System	○
Latency *AVERAGE, IN MICROSECONDS*	○
IOPS per Watt	○

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ○
Zero Page Reclamation	○
Compression	✓
Deduplication: In-line / Post-process	✓ / ✓
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	○ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ✓
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	○

HARDWARE

Raw Flash Capacity per System	8,812 TB
NVMe SSD / 12 Gb SAS SSD	○ / ✓
Largest Capacity SSD	15 TB
Raw Flash Density	184 TB/RU
DRAM Cache per Controller / System	128 / 1,024 GB
NVDIMM Cache per Controller / System	4 / 32 GB
CPU Cores per Controller / System	6 / 48 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	8
Storage Networking Ports per System	**32**
Ethernet: 1 / 10 Gb	○ / 32
Ethernet: 25 / 40 Gb	○ / ○
FC: 8 / 16 / 32 Gb	32 / 32 / ○
InfiniBand 40 / 56	○ / ○
NDU: Data Migrations / Evergreen Hardware	○ / ○
Operating Temperature: Min - Max	5C/41F – 45C/113F
Operating Humidity: Min - Max	8% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	○
Predictive Analytics—Recommend Config Changes	○
Predictive Analytics—Tailored Software Upgrades	○

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

NetApp AFF A300

OVERALL RANK **RECOMMENDED**

PERFORMANCE CLAIMS

IOPS per Controller / System	○
Bandwidth per Controller / System	○
Latency ***AVERAGE, IN MICROSECONDS***	○
IOPS per Watt	○

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	✓ / ○
Zero Page Reclamation	○
Compression	✓
Deduplication: In-line / Post-process	✓ / ✓
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ○
Metadata Stored Separately	✓
QoS: System-defined / User-defined	✓ / ✓
Management Methods: IPMI / OpenStack / REST API	○ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ✓
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ✓
Encryption: Array-based / Self-encrypting Drives	✓ / ✓
T10 PI / FIPS 140-2	✓ / ✓
All-inclusive Feature Licensing	○

HARDWARE

Raw Flash Capacity per System	70,502 TB
NVMe SSD / 12 Gb SAS SSD	○ / ✓
Largest Capacity SSD	15 TB
Raw Flash Density	184 TB/RU
DRAM Cache per Controller / System	128 / 3,072 GB
NVDIMM Cache per Controller / System	8 / 192 GB
CPU Cores per Controller / System	16 / 384 Cores
Architecture: Scale-up / Scale-out	✓ / ✓
Scale-out Controllers	24
Storage Networking Ports per System	**336**
Ethernet: 1 / 10 Gb	○ / 336
Ethernet: 25 / 40 Gb	○ / 96
FC: 8 / 16 / 32 Gb	192 / 288 / 96
InfiniBand 40 / 56	○ / ○
NDU: Data Migrations / Evergreen Hardware	○ / ○
Operating Temperature: Min - Max	5C/41F – 45C/113F
Operating Humidity: Min - Max	8% – 90%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	○
Predictive Analytics—Recommend Config Changes	○
Predictive Analytics—Tailored Software Upgrades	○

✓ SUPPORTED ○ UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Pure Storage FlashArray//M10

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	50K / 100K
Bandwidth per Controller / System	1.5 / 3 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ●
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ● / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	● / ●
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	● / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ● / ●
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	10 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ✓
Largest Capacity SSD	18 TB
Raw Flash Density	3 TB/RU
DRAM Cache per Controller / System	512 / 1,024 GB
NVDIMM Cache per Controller / System	8 / 16 GB
CPU Cores per Controller / System	40 / 80 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**8**
Ethernet: 1 / 10 Gb	● / 4
Ethernet: 25 / 40 Gb	● / ●
FC: 8 / 16 / 32 Gb	● / 4 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	● / ✓
Operating Temperature: Min - Max	5C/41F – 35C/95F
Operating Humidity: Min - Max	10% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ✓
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Pure Storage FlashArray//M20

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	100K / 200K
Bandwidth per Controller / System	3 / 6 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ●
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ● / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	● / ●
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	● / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ● / ●
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	80 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ✓
Largest Capacity SSD	18 TB
Raw Flash Density	26 TB/RU
DRAM Cache per Controller / System	512 / 1,024 GB
NVDIMM Cache per Controller / System	8 / 16 GB
CPU Cores per Controller / System	24 / 48 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	● / 12
Ethernet: 25 / 40 Gb	● / 12
FC: 8 / 16 / 32 Gb	● / 20 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	● / ✓
Operating Temperature: Min - Max	5C/41F – 35C/95F
Operating Humidity: Min - Max	10% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Pure Storage FlashArray//M50

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	135K / 270K
Bandwidth per Controller / System	4.5 / 9 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ●
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ● / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	● / ●
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	● / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ● / ●
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	176 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ✓
Largest Capacity SSD	18 TB
Raw Flash Density	25 TB/RU
DRAM Cache per Controller / System	512 / 1,024 GB
NVDIMM Cache per Controller / System	8 / 16 GB
CPU Cores per Controller / System	40 / 80 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	● / 12
Ethernet: 25 / 40 Gb	● / 12
FC: 8 / 16 / 32 Gb	● / 20 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	● / ✓
Operating Temperature: Min - Max	5C/41F – 35C/95F
Operating Humidity: Min - Max	10% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Pure Storage FlashArray//M70

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	150K / 300K
Bandwidth per Controller / System	4.5 / 9 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ●
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ● / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	● / ●
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	● / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ● / ●
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	512 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ✓
Largest Capacity SSD	18 TB
Raw Flash Density	73 TB/RU
DRAM Cache per Controller / System	1,024 / 2,048 GB
NVDIMM Cache per Controller / System	16 / 32 GB
CPU Cores per Controller / System	40 / 80 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	● / 12
Ethernet: 25 / 40 Gb	● / 12
FC: 8 / 16 / 32 Gb	● / 20 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	● / ✓
Operating Temperature: Min - Max	5C/41F – 35C/95F
Operating Humidity: Min - Max	10% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Pure Storage FlashArray//X70

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	150K / 300K
Bandwidth per Controller / System	4.5 / 9 GB/s
Latency *AVERAGE, IN MICROSECONDS*	< 1,000
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	✓
Asynchronous Replication: Periodic / Continuous	✓ / ●
Synchronous Replication / Metro Cluster	✓ / ✓
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	●
Persistent Caching: Read / Write / Journaling	● / ● / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	● / ●
Native Support for Public Cloud Storage Targets	✓
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	● / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ● / ●
Encryption: Array-based / Self-encrypting Drives	✓ / ●
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	366 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ●
Largest Capacity SSD	18 TB
Raw Flash Density	122 TB/RU
DRAM Cache per Controller / System	1,024 / 2,048 GB
NVDIMM Cache per Controller / System	16 / 32 GB
CPU Cores per Controller / System	40 / 80 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	● / 12
Ethernet: 25 / 40 Gb	● / 12
FC: 8 / 16 / 32 Gb	● / 20 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	● / ✓
Operating Temperature: Min - Max	5C/41F – 35C/95F
Operating Humidity: Min - Max	10% – 80%

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ● / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	✓ / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	✓

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

NO FEEDBACK WAS RECEIVED FROM THE PROVIDER. ALL INFORMATION WAS SOLELY SOURCED BY DCIG.

Tegile HD2040 Series

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	●
Bandwidth per Controller / System	●
Latency ***AVERAGE, IN MICROSECONDS***	●
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	●
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	● / ●
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	●
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ●
Encryption: Array-based / Self-encrypting Drives	● / ✓
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	1,198 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	7.68 TB
Raw Flash Density	120 TB/RU
DRAM Cache per Controller / System	232 / 464 GB
NVDIMM Cache per Controller / System	8 / 16 GB
CPU Cores per Controller / System	24 / 48 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	24 / 24
Ethernet: 25 / 40 Gb	● / 12
FC: 8 / 16 / 32 Gb	12 / 12 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✓ / ✓
Operating Temperature: Min - Max	●
Operating Humidity: Min - Max	●

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	● / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	●

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

Tegile HD2080 Series

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	●
Bandwidth per Controller / System	●
Latency ***AVERAGE, IN MICROSECONDS***	●
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	●
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	● / ●
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	●
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ●
Encryption: Array-based / Self-encrypting Drives	● / ✓
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	1,290 TB
NVMe SSD / 12 Gb SAS SSD	● / ✓
Largest Capacity SSD	7.68 TB
Raw Flash Density	129 TB/RU
DRAM Cache per Controller / System	232 / 464 GB
NVDIMM Cache per Controller / System	8 / 16 GB
CPU Cores per Controller / System	24 / 48 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	24 / 24
Ethernet: 25 / 40 Gb	● / 12
FC: 8 / 16 / 32 Gb	12 / 12 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✓ / ✓
Operating Temperature: Min - Max	●
Operating Humidity: Min - Max	●

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	● / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	●

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

Tegile N5200

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	1.5M / 3M
Bandwidth per Controller / System	●
Latency ***AVERAGE, IN MICROSECONDS***	200
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	●
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	● / ●
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	●
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ●
Encryption: Array-based / Self-encrypting Drives	● / ✓
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	184 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ●
Largest Capacity SSD	7.68 TB
Raw Flash Density	92 TB/RU
DRAM Cache per Controller / System	232 / 464 GB
NVDIMM Cache per Controller / System	8 / 16 GB
CPU Cores per Controller / System	24 / 48 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	24 / 24
Ethernet: 25 / 40 Gb	● / 12
FC: 8 / 16 / 32 Gb	12 / 12 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✓ / ✓
Operating Temperature: Min - Max	●
Operating Humidity: Min - Max	●

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	● / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	●

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

Tegile N5800

OVERALL RANK **EXCELLENT**

PERFORMANCE CLAIMS

IOPS per Controller / System	1.5M / 3M
Bandwidth per Controller / System	●
Latency ***AVERAGE, IN MICROSECONDS***	200
IOPS per Watt	●

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots	✓
VM Level Snapshots using VVol	●
Asynchronous Replication: Periodic / Continuous	✓ / ✓
Synchronous Replication / Metro Cluster	● / ●
Zero Page Reclamation	✓
Compression	✓
Deduplication: In-line / Post-process	✓ / ●
Automated Policy-based Provisioning	✓
Automated Storage Tiering	✓
Persistent Caching: Read / Write / Journaling	✓ / ✓ / ✓
Metadata Stored Separately	✓
QoS: System-defined / User-defined	● / ✓
Management Methods: IPMI / OpenStack / REST API	✓ / ✓ / ✓
Management Methods: SCVMM / SMI-S / vCenter	✓ / ✓ / ✓
Unified Management / Multi-tenancy	✓ / ✓
Native Support for Public Cloud Storage Targets	●
File Protocols: NFSv3 / NFSv4 / pNFS	✓ / ✓ / ●
File Protocols: CIFS / SMB3	✓ / ✓
Block Protocols: FC / iSCSI	✓ / ✓
Concurrent SAN & NAS	✓
Concurrent FC & iSCSI	✓
Authentication: LDAP / Kerberos / NIS	✓ / ✓ / ●
Encryption: Array-based / Self-encrypting Drives	● / ✓
T10 PI / FIPS 140-2	● / ✓
All-inclusive Feature Licensing	✓

HARDWARE

Raw Flash Capacity per System	154 TB
NVMe SSD / 12 Gb SAS SSD	✓ / ●
Largest Capacity SSD	7.68 TB
Raw Flash Density	77 TB/RU
DRAM Cache per Controller / System	496 / 992 GB
NVDIMM Cache per Controller / System	8 / 16 GB
CPU Cores per Controller / System	24 / 48 Cores
Architecture: Scale-up / Scale-out	✓ / ●
Scale-out Controllers	●
Storage Networking Ports per System	**24**
Ethernet: 1 / 10 Gb	24 / 24
Ethernet: 25 / 40 Gb	● / 12
FC: 8 / 16 / 32 Gb	12 / 12 / ●
InfiniBand 40 / 56	● / ●
NDU: Data Migrations / Evergreen Hardware	✓ / ✓
Operating Temperature: Min - Max	●
Operating Humidity: Min - Max	●

VIRTUALIZATION

Hypervisors: XenServer / RHEV	✓ / ✓
Hypervisors: Hyper-V / vSphere	✓ / ✓
VAAI: Block / NAS / Thin	✓ / ✓ / ✓
VADP / VASA	✓ / ✓
VASRM / vMSC	✓ / ●
Virtual Volumes / vRealize	● / ✓

SUPPORT

24x7x365 Call Center	✓
Technician Onsite with 4-hour GTD Response	✓
Proactive Remediation Based on Fault Data	✓
Predictive Analytics—Proactive Intervention	✓
Predictive Analytics—Recommend Config Changes	✓
Predictive Analytics—Tailored Software Upgrades	●

✓ SUPPORTED ● UNDETERMINED / UNSUPPORTED

APPENDICES

Definitions, Explanations and Terminology

This section contains brief definitions and/or explanations of the terms used and assumptions made when developing the data sheets found in the *DCIG 2018-19 All-Flash Array Buyer's Guide.* These terms are in the same order as they appear on the individual data sheets.

PERFORMANCE CLAIMS

IOPS per Controller / System

Indicates the claimed number of input/output operations per second achievable by each controller and by a fully scaled-up and/or scaled-out storage system comprised of this product model. This claimed IOPS benchmark is provided by the vendor, published by the vendor, and/or available from third parties that have tested this product. DCIG has not independently substantiated or verified this benchmark.

Bandwidth per Controller / System

Indicates the claimed bandwidth each controller can provide to applications, and of a fully scaled-up and/or scaled-out storage system comprised of this model of the product. This claimed bandwidth benchmark is provided by the vendor, published by the vendor, and/or available from third parties that have tested this product. DCIG has not independently substantiated or verified this benchmark.

Latency *AVERAGE, IN MICROSECONDS*

Indicates the claimed average latency the product can achieve, expressed in microseconds. These metrics are based on whatever mix of reads and writes the vendor chooses to use as the basis of their claims. This claimed latency benchmark is provided by the vendor, published by the vendor, and/or available from third parties that have tested this product. DCIG has not independently substantiated or verified this benchmark.

IOPS per Watt

Indicates the claimed number of input/output operations the product can deliver for each watt of electricity used. These metrics are based on whatever mix of reads and writes the vendor chooses to use as the basis of their claims. This claimed IOPS per Watt benchmark is provided by the vendor, published by the vendor, and/or available from third parties that have tested this product. DCIG has not independently substantiated or verified this benchmark.

MANAGEMENT & SOFTWARE

Redirect on Write (RoW) Snapshots

A snapshot method in which the product "freezes" a block of data that was previously written and writes new data elsewhere. This method reduces the number of read/write operations required to write a block of data by eliminating the three-step "read, rewrite, and write" process associated with the copy-on-write approach.

VM Level Snapshots using VVol

The snapshot taken on the storage array is still performed by the array using whatever snapshot techniques it natively offers. However, the initiation of the snapshot is performed using out of band communications between vSphere and the storage array and requires the use of vCenter Server.

Asynchronous Replication: Periodic / Continuous

Indicates if the array can asynchronously replicate data to another storage array from the same storage provider. Asynchronous replication writes data first to a primary storage array, and then copies the data to replication targets. This process may be continuous or periodic.

Periodic: A snapshot of one or more volumes is taken periodically on a preset schedule. The delta of changes between each snapshot are then replicated to a secondary array.

Continuous: Every write I/O is written on the local array first and the application is notified when that local write completes. The write is then replicated as soon as possible to a secondary array.

Synchronous Replication / Metro Cluster

Synchronous: Indicates if the array can synchronously replicate data to another array from the same storage provider. Write I/Os are received at the primary or source array and then copied and written to the secondary, or target array, with the write confirmed as complete on both arrays before application processing can continue.

Metro Cluster: Provides synchronous replication/data mirroring between two or more arrays at metro distances with the additional ability to initiate a failover if an entire site becomes unavailable.

Zero Page Reclamation

A thin provisioning optimization method used primarily in virtualized environments where volume resources are pre-allocated on the disk, and the space is then filled with zeros. This is done to indicate that the space is unused and may be

Appendix A—Definitions, Explanations and Terminology (continued)

reclaimed. It is also a method to overwrite data on storage space that was previously used by another virtual machine.

Compression

Compression is a feature that compresses data by removing zeros and/or spaces as the data is written to the storage system. Compression may be in-line or post-process.

Deduplication: In-line / Post-process

Data deduplication saves disk space by storing only one copy of data when identical data is already stored on the array.

In-line: Data is deduplicated before it is stored to disk.

Post-process: Data is first stored to disk in its native or raw format and subsequently deduplicated, generally during off-peak hours.

Automated Policy-based Provisioning

Provision storage using pre-defined policies that are carried out automatically without requiring manual intervention.

Automated Storage Tiering

Places data on the appropriate tier of storage based upon policies that are either built into the storage array, set by the storage administrator, or some combination of both. Moving data between tiers may occur at pre-scheduled times or dynamically.

Persistent Caching: Read / Write / Journaling

Indicates the ways in which flash memory or storage class memory is used to persist cache data through a system restart or crash.

Read: The persistent cache is used for Read I/O operations.

Write: The persistent cache is used for Write I/O operations.

Journaling: The persistent cache is used for Journaling operations.

Metadata Stored Separately

Indicates if metadata can be stored separately from the data on the target media. Storing metadata separately can enhance the overall performance of the product.

QoS: System-defined / User-defined

The QoS (Quality of Service) Workload Prioritization Options box indicates the workload prioritization methods supported by the array.

System-defined: Indicates if the product has predefined QoS rules that determine the minimum and maximum performance of a LUN/VM/Volume.

User-defined: Indicates if the product supports user-defined QoS rules that determine the minimum and maximum performance of a LUN/VM/Volume.

Management Methods: IPMI / OpenStack / REST API

IPMI / OpenStack / REST API: Indicates if the array supports an Intelligent Platform Management Interface, OpenStack Cinder and/or REST API to manage storage resources.

Management Methods: SCVMM / SMI-S / vCenter

Indicates if the product supports management via Microsoft System Center Virtual Machine Manager (SCVMM), Storage Management Initiative Specification (SMI-S), and/or VMware vCenter Server for the management of storage resources.

Unified Management / Multi-tenancy

Unified Management: Indicates if similar or like products from the same vendor within the same logical environment can be managed from a single interface

Multi-tenancy: Indicates if the array has the capability to provide discrete storage capacity and management to multiple user-groups (tenants).

Native Support for Public Cloud Storage Targets

Indicates if the product natively *(without the use of separate appliances or third-party software)* can directly interface with public cloud storage targets such as Amazon S3, Google Cloud Storage, Microsoft Azure, or other public cloud storage providers.

File Protocols: NFSv3 / NFSv4 / pNFS

Indicates if the product natively *(without the use of separate appliances or third-party software)* supports the use of Network File System version 3 (NFSV3), Network File System version 4 (NFSv4), or Parallel Network File System (pNFS).

File Protocols: CIFS / SMB3

Indicates if the product natively *(without the use of separate appliances or third-party software)* supports the use of the Common Internet File System (CIFS) or Server Message Block (SMB).

Appendix A—Definitions, Explanations and Terminology (continued)

Block Protocols: FC / iSCSI

Indicates if the product natively *(without the use of separate appliances or third-party software)* supports the use of the Fibre Channel (FC) or the Internet Small Computer System Interface (iSCSI).

Concurrent SAN & NAS

Indicates if the product can support both block (SAN) and file (NAS) protocols at the same time without the use of a separate appliance or third-party software.

Concurrent FC & iSCSI

Indicates if the product can support both FC and iSCSI protocols at the same time without the use of a separate appliance or third-party software.

Authentication: LDAP / Kerberos / NIS

Indicates which mechanisms the product can use to authenticate users accessing the product to either manage and/or use is. Indicates if the product supports Lightweight Directory Access Protocol (LDAP), Kerberos, and/or Network Information System (NIS).

Encryption: Array-based / Self-Encrypting Drives

Indicate if the product supports data encryption, and whether encryption is array-based encryption and/or through the use of self-encrypting drives.

T10 PI / FIPS 140-2

T10 PI: Indicates if the product uses the T10 Protection Information (PI) feature to validate and detect errors on data written to and read from a drive.

FIPS 140-2: Indicates if the product complies with the Federal Information Processing Standard (FIPS) publication 140-2 security standard.

All-inclusive Feature Licensing

Indicates if the product includes all features in the base software license.

HARDWARE

Raw Flash Capacity per System

The number indicates the maximum amount of raw flash memory storage capacity in terabytes (TBs) that the product can provide when fully configured. This number only includes the product's footprint and does not include the storage capacity of other systems it may have virtualized.

NVMe SSD / 12 Gb SAS SSD

NVMe SSD: Indicates if the product uses NVMe as the internal SSD interface

12Gb SAS SSD: Indicates if the product uses 12Gb SAS as the internal SSD interface

Largest Capacity SSD

The number indicates the largest capacity SSD supported by the product.

Raw Flash Density

The number indicates the maximum amount of raw flash memory that this product can provide per standard US Energy Information Administration (EIA) rack unit (RU) measurements. This measure of storage density is presented in terms of TB/RU.

DRAM Cache per Controller / System

These two numbers indicate the maximum number of gigabytes (GBs) of dynamic random-access memory (DRAM) cache that a product can support in (a) a single controller; and, (b) when the product is in its largest supported configuration.

NVDIMM Cache per Controller / System

These two numbers indicate the maximum number of gigabytes (GBs) of non-volatile dual in-line memory module (NVDIMM) cache that a product can support in (a) a single controller; and, (b) when the product is in its largest supported configuration.

CPU Cores per Controller / System

These two numbers indicate the maximum number of CPU cores that a product can support in (a) a single controller; and, (b) when the product is in its largest supported configuration.

Architecture: Scale-up / Scale-out

Scale-up: Indicates if the product supports a dual-controller configuration where storage capacity can be expanded by adding storage shelves.

Scale-out: Indicates if the product supports a scale-out configuration where storage capacity can be expanded by adding controller nodes to a cluster. These nodes add storage plus DRAM, CPU cores and storage networking ports to the configuration.

Appendix A—Definitions, Explanations and Terminology

Scale-out Controllers

The number indicates the maximum number of controllers that the product can support in a scale-out configuration, if the product supports a scale-out configuration. A controller appliance may contain 1, 2, or more controllers.

Storage Networking Ports per System

Indicates the maximum number of storage networking ports that the product supports when fully configured. This number includes any mix of FC, Ethernet, and/or Infiniband ports listed below in an optimal configuration.

Ethernet: 1 / 10 Gb

Indicates the maximum number of 1Gb and 10Gb Ethernet ports the product supports.

Ethernet: 25 / 40 Gb

Indicates the maximum number of 25Gb and 40Gb Ethernet ports the product supports.

FC: 8 / 16 / 32 Gb

Indicates the maximum number of 8Gb, 16Gb, and 32Gb Fibre Channel ports the product supports.

InfiniBand 40 / 56

Indicates the maximum number of 40Gb and 56Gb InfiniBand ports the product supports.

NDU: Data Migrations / Evergreen Hardware

Data Migrations: Indicates if the product natively supports the non-disruptive, uninterrupted (NDU) migration of data from a current model to a like or newer product model without the use of third-party hardware or software.

Evergreen Hardware: Indicates if more powerful and/or new generations of controllers and storage media can be integrated into the storage system non-disruptively.

Operating Temperature: Min - Max

These numbers indicate the minimum and maximum operating temperatures for this product.

Operating Humidity: Min - Max

These numbers indicate the minimum and maximum operating humidity for this product.

VIRTUALIZATION

Hypervisors: XenServer / RHEV

Indicate if this product provides support for the Citrix XenServer and RedHat Enterprise Virtualization (RHEV) hypervisor platforms

Hypervisors: Hyper-V / vSphere

Indicate if this product provides support for the Microsoft Hyper-V and VMware vSphere hypervisor platforms

VAAI: Block / NAS / Thin

Indicates if the product supports specific VMware vStorage API for Array Integration (VAAI) APIs to include.

Block: Indicates if the product supports one or more of the VAAI block primitives, such as Atomic Test and Set, XCOPY, or Write Same.

NAS: Indicates if the product supports one or more of the VAAI NAS primitives, such as Full File Clone, Fast File Clone, Extended Statistics, or Reserve Space.

Thin: Indicates if the product supports one or more of the VAAI Thin provisioning primitives, such as Stun, Threshold Warning, or Dead Space Reclamation.

VADP / VASA

VADP: Indicates if the product supports the vStorage APIs for Data Protection, a data protection framework which enables centralized, off-host LAN free backup of vSphere virtual machines, reduces ESX host resources to do backup processing, and enables flexible backup windows.

VASA: Indicates if the product supports the vStorage APIs for Storage Awareness. VASA collects configuration, capability and storage health information from storage products, allowing the administrator to build storage profiles based on capabilities.

VASRM / vMSC

VASRM: Indicates if the product supports the vStorage APIs for Site Recovery Manager integrates with underlying replication technology to provide policy-based management, non-disruptive testing, and automated orchestration of recovery plans.

vMSC: Indicates if the product supports VMware Metro Storage Cluster.

Appendix A—Definitions, Explanations and Terminology

Virtual Volumes / vRealize

Virtual Volumes: Indicates if the product supports the export of VMDK granular storage entities through Protocol Endpoints to enable and offload certain virtual machine operations to the storage system. Virtual Volumes enables policy-driven automation of VMware environments.

vRealize: Indicates if the product supports any component of the vRealize Suite, to include vRealize Automation, vRealize Operations, vRealize Log Insight, and/or vRealize Business for Cloud.

SUPPORT

24x7x365 Call Center

Indicates if the product's provider offers 24x7x365 response—either included with its warranty or for an additional service charge.

Technician Onsite with 4-hour GTD Response

Indicates if the product's provider offers 4-hour guaranteed on-site response times—either as part of support included with its product or for an additional fee.

Proactive Remediation Based on Fault Data

Indicates is the product's provider offers proactive resolution of problems discovered through remote monitoring and/or fault data that is automatically uploaded to the vendor.

Predictive Analytics—Proactive Intervention

Indicates if the predictive analytics function identifies something that is likely to create a problem and then notifies the affected client(s) about the issue. Interventions may range from providing guidance to implementing the solution. A wide range of interventions are possible; for example, identifying the date when an array will reach full capacity, or identifying a network configuration that could create a loop condition.

Predictive Analytics—Recommend Config Changes

Indicates if the predictive analytics function enhances application performance by comparing the performance of the same application at similar sites, discovering optimal configurations, and recommending configuration changes at each site.

Predictive Analytics—Tailored Software Upgrades

Indicates if the predictive analytics function eliminates outages based on it identifying incompatibilities between a software update and specific data center environments and then withholding that software update from affected sites. Consequently, storage administrators are shown only software updates that are believed to be safe for their environment.

Appendix B—Vendor Contact Information

Vendor Contact Information

Dell EMC
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Hopkinton, MA 01748
+1.866.438.3622
www.dellemc.com

Hewlett-Packard Enterprise (HPE)
3000 Hanover Street
Palo Alto, CA 94304
+1.866.625.0242
www.hpe.com

Hitachi Vantara
2845 Lafayette Street
Santa Clara, California 95050
+1.408.457.0155
www.hitachivantara.com

Huawei Enterprise USA, Inc.
20400 Stevens Creek Blvd., Suite 200
Cupertino, CA 95014
+1.855.464.8293
http://e.huawei.com/us/

NetApp
1395 Crossman Ave
Sunnyvale, CA 94089
+1.877.263.8277
www.netapp.com

Pure Storage
650 Castro Street, Suite #260
Mountain View, CA 94041
+1.800.379.7873
www.purestorage.com

Tegile Systems, Inc.
7999 Gateway Blvd., #120
Newark, CA 94560
+1.510.791.7900
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Appendix C—DCIG Contact Information

DCIG Contact Information

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