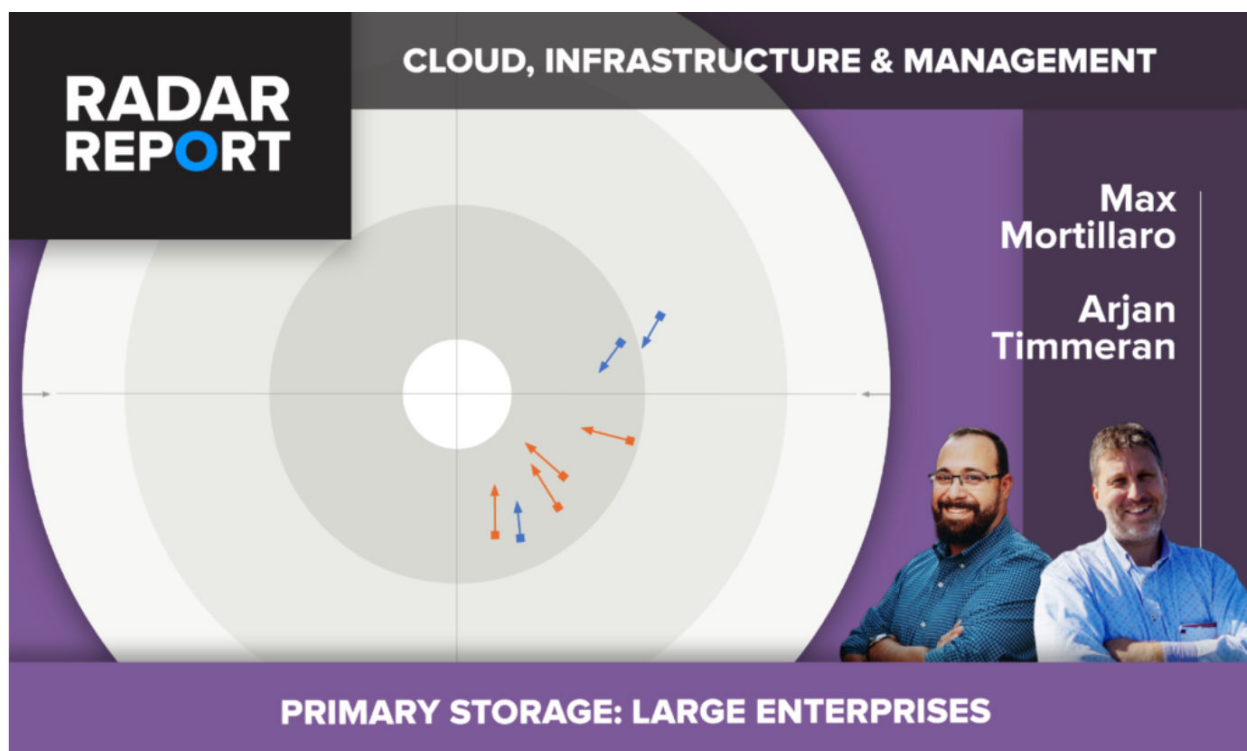




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Jan 19, 2023 -- Market Radar

GigaOm Radar for Primary Storage for Large Enterprisesv3.0

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1. Summary

Primary storage systems for large enterprises have adapted quickly to new needs and business requirements, with data now accessed from both on-premises and cloud applications. We're in a transition phase, moving from storage systems designed to be deployed in data centers to hybrid and

multicloud solutions, with similar functionalities provided on physical or virtual appliances as well as through managed services.

The concept of primary storage, data, and workloads has radically changed over the past few years. Mission- and business-critical functions in enterprise organizations were concentrated in a few monolithic applications based on traditional relational databases. In that scenario, block storage was often synonymous with primary storage, and performance, availability, and resiliency were prioritized, usually at the expense of flexibility, ease of use, and cost.

Now, after the virtualization wave and the exponential growth of microservices and container-based applications, organizations are shifting their focus to artificial intelligence (AI)-based analytics, self-driven storage, improved automation, and deeper Kubernetes integration. In addition, the prevalence of cyberthreats such as ransomware attacks require organizations to implement a multilayered defense strategy. To prevent downtime and data loss, protecting data assets at the source (in production, on primary storage systems) becomes a key aspect of any security strategy.

Still, the thirst for performance remains high, and support for new storage types—including emerging compute express link (CXL)-compatible persistent memory types—and non-volatile memory express (NVMe) transport protocols is now becoming the gold standard.

Moreover, organizations have not lost their appetite for cost optimization. Thus, when it comes to total cost of ownership (TCO) and flexibility, the emergence of storage as a service (STaaS) provides cloud consumption models that are increasingly being sought after.

When it comes to modern storage, and block storage in particular, flash memory and high-speed Ethernet networks have commoditized performance and reduced costs, allowing more liberty in system design. Fibre channel remains a core component in many storage infrastructures, for legacy reasons only. At the same time, enterprises are working to align storage with broader infrastructure strategies, which address issues such as:

- Better infrastructure agility to speed up response to business needs
- Improved data mobility and integration with the cloud
- Support for a larger number of concurrent applications and workloads on a single system
- Simplified infrastructure
- Automation and orchestration to speed up and scale operations
- Drastic reduction of TCO along with a significant increase in the capacity per sysadmin under management
- Better overall energy efficiency to achieve environmental, social, and corporate governance (ESG) objectives and reduce energy bills, especially when operating at scale

These efforts have contributed to the increasing number of solutions as startups and established vendors alike move to address these needs. Traditional high-end and midrange storage arrays have been joined by software-defined and specialized solutions, all aimed at serving similar market segments but differentiated by the focus they place on the various points described above. A one-size-fits-all solution doesn't exist. In this report, we will analyze various aspects and important features of modern storage systems to better understand how they impact the metrics for evaluating block storage systems, especially in relation to the needs of various IT organizations.

This GigaOm Radar report highlights key primary storage vendors providing solutions to large enterprises, and equips IT decision-makers with the information needed to select the best fit for their business and use case requirements. In the corresponding GigaOm report "[Key Criteria for Evaluating Primary Storage Solutions](#)," we describe in more detail the key features and metrics that are used to evaluate vendors in this market.

HOW TO READ THIS REPORT

This GigaOm report is one of a series of documents that helps IT organizations assess competing solutions in the context of well-defined features and criteria. For a fuller understanding, consider reviewing the following reports:

Key Criteria report: A detailed market sector analysis that assesses the impact that key product features and criteria have on top-line solution characteristics—such as scalability, performance, and TCO—that drive purchase decisions.

GigaOm Radar report: A forward-looking analysis that plots the relative value and progression of vendor solutions along multiple axes based on strategy and execution. The Radar report includes a breakdown of each vendor's offering in the sector.

Solution Profile: An in-depth vendor analysis that builds on the framework developed in the Key Criteria and Radar reports to assess a company's engagement within a technology sector. This analysis includes forward-looking guidance around both strategy and product.

2. Market Categories and Deployment Types

This report is designed specifically around solutions for large enterprises. For the reader's benefit, we also provide insight into how the vendor was evaluated (in terms of ability to address market segment needs) in the other companion radars for small and midsize businesses.

For a better understanding of the market and vendor positioning (**Table 1**), we assess how well solutions for primary storage are positioned to serve specific market segments:

- **Small businesses:** In this category, we assess solutions on their ability to meet the needs of small businesses, for whom ease of use and \$/GB are important focus areas.
- **Midsize businesses:** In this category, we judge solutions on their ability to meet the needs of medium-sized companies. Also assessed are departmental use cases in large enterprises where ease of use and deployment are more important than extensive management functionality, data mobility, and feature set.
- **Large enterprises:** Here, offerings are evaluated on their ability to support large and business-critical projects. Optimal solutions in this category will have a strong focus on flexibility, performance, data services, and features to improve security and data protection. Scalability is another big differentiator, as is the ability to deploy the same service in different environments.
- **Specialized:** Optimal solutions are designed for specific workloads and use cases, such as managed service providers, big data analytics, and high-performance computing (HPC).

In addition, we recognize two deployment models for solutions in this report:

- **Hardware appliance:** These solutions are provided as a self-contained physical device with all the components necessary to deliver primary storage capabilities. The device is fully supported by the vendor, and other than managing the platform, the customer only needs to apply hotfixes or patches. This deployment model delivers simplicity at the expense of flexibility.

- **Software-defined storage (SDS):** These solutions are meant to be deployed on commodity servers on-premises or in the cloud, allowing organizations to build hybrid or multicloud storage infrastructures. This option provides more flexibility in terms of deployment, cost, and hardware choice, but it can be more complex to deploy and manage.

Table 1. Vendor Positioning

	MARKET SEGMENT				DEPLOYMENT MODEL	
	Small Businesses	Midsized Businesses	Large Enterprises	Specialized	Hardware Appliance	Software-Defined Storage
DataCore	+++	+++	++	++	—	+++
DDN	+++	+++	++	++	+++	++
Dell Technologies	+++	+++	+++	++	+++	+
iXsystems	+++	+++	++	++	++	+++
Hitachi Vantara	++	+++	+++	++	+++	++
HPE	+++	+++	+++	++	+++	++
IBM	+++	++	+++	++	+++	++
Infinidat	—	++	+++	+++	+++	—
Lightbits Labs	+	+++	++	+++	—	+++
NetApp	+++	+++	+++	+++	+++	+
Pure Storage	++	+++	+++	++	+++	+
StorONE	++	+++	+	++	++	+++
StorPool	—	++	++	+++	—	+++
Zadara	—	—	++	+++	—	+++

+++ Exceptional: Outstanding focus and execution

++ Capable: Good but with room for improvement

+ Limited: Lacking in execution and use cases

— Not applicable or absent

Source: GigaOm 2023

Readers should note that vendor positioning data in **Table 1** is a consolidated view across all three Radar reports (primary storage for small businesses, midsize businesses, and large enterprises) and provides a holistic view of primary storage solutions across market segments and deployment models.

This report covers only vendors offering primary storage for large enterprises. To review solutions for small and midsize businesses, visit the companion Radar reports.

3. Key Criteria Comparison

Building on the findings from the GigaOm report “[Key Criteria for Evaluating Primary Storage Solutions](#),” **Table 2** summarizes how each vendor included in this research performs in the areas we consider differentiating and critical in this sector. **Table 3** follows this summary with insight into each product’s evaluation metrics—the top-line characteristics that define the impact each will have on the organization.

The objective is to give the reader a snapshot of the technical capabilities of available solutions, define the perimeter of the market landscape, and gauge the potential impact on the business.

Table 2. Key Criteria Comparison

	KEY CRITERIA							
	AI-Based Analytics	New Media Types	NVMe-oF	NVMe/TCP	Cloud Integration	API & Automation Tools	Kubernetes Integration	STaaS
Dell Technologies	+++	+++	+++	+++	++	+++	+++	++
Hitachi Vantara	+++	++	++	—	++	+++	+++	+++
HPE	+++	++	++	—	+	+++	++	+++
IBM	+++	+++	++	++	++	+++	+	++
Infinidat	+++	++	+++	++	++	+++	++	+++
NetApp	+++	+++	+++	+++	+++	+++	+++	+++
Pure Storage	+++	+++	++	—	++	+++	+++	+++
Zadara	—	+++	—	—	++	+++	+	+++

+++ Exceptional: Outstanding focus and execution

++ Capable: Good but with room for improvement

+ Limited: Lacking in execution and use cases

— Not applicable or absent

Source: GigaOm 2023

Table 3. Evaluation Metrics Comparison

	EVALUATION METRICS					
	System Lifespan	Efficiency	Flexibility	Ease of Use	Cost per Transaction (\$/IOPS)	Cost of Storage (\$/GB)
Dell Technologies	+++	+++	+++	+++	+++	+++
Hitachi Vantara	+++	+++	++	++	+++	++
HPE	+++	+++	++	+++	++	+
IBM	+++	+++	++	++	++	++
Infinidat	+++	++	+++	+++	+++	+++
NetApp	+++	+++	+++	+++	+++	+++
Pure Storage	+++	+++	+++	+++	+++	+++
Zadara	+++	+++	+++	+++	++	+++

- +++ Exceptional: Outstanding focus and execution
- ++ Capable: Good but with room for improvement
- +
- Not applicable or absent

Source: GigaOm 2023

By combining the information provided in the tables above, the reader can develop a clear understanding of the technical solutions available in the market.

4. GigaOm Radar

This report synthesizes the analysis of key criteria and their impact on evaluation metrics to inform the GigaOm Radar graphic in **Figure 1**. The resulting chart is a forward-looking perspective on all the vendors in this report based on their products' technical capabilities and feature sets.

The GigaOm Radar plots vendor solutions across a series of concentric rings, with those set closer to the center judged to be of higher overall value. The chart characterizes each vendor on two axes—balancing Maturity versus Innovation and Feature Play versus Platform Play—while providing an arrow that projects each solution's evolution over the coming 12 to 18 months.

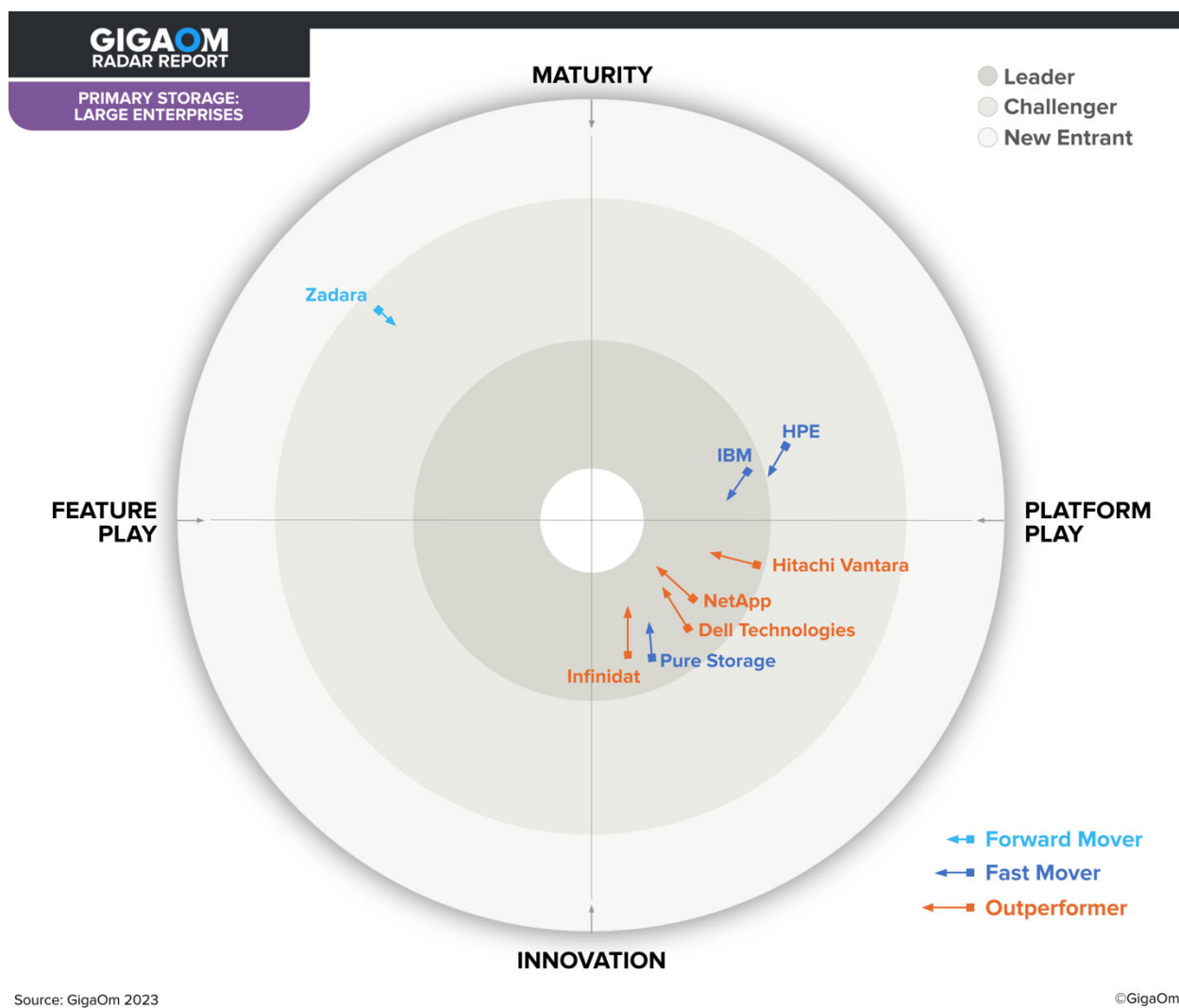


Figure 1. GigaOm Radar for Primary Storage for Large Enterprises

As you can see in the Radar chart in **Figure 1**, Zandara is the lone vendor in the Mature/Feature Play area, with the rest split into two groups, one large and one small.

The larger group, located in the lower-right area of the radar, offers platform-based solutions with an innovative approach. These consist of NetApp, Dell Technologies, Infinidat, Pure Storage, and Hitachi Vantara.

NetApp delivers outstanding capabilities for large enterprises both on-premises and in the cloud (as a first-party offering) with solutions architected around its ONTAP operating system (OS). The recently launched BlueXP service delivers thorough and yet seamless data mobility and data management capabilities, providing a best-in-class and unmatched experience. Dell Technologies offers PowerMax and PowerFlex for large enterprise use cases. The PowerMax platform combines the robustness of its predecessors with newly introduced appliances that significantly improve capacity, density, performance, and cyber resiliency. It uses a combination of onboard and AIOps-related machine learning (ML)-driven capabilities, and has the ability to consume services through a STaaS model. In contrast, PowerFlex takes a different approach that enables massive scalability.

Pure Storage delivers no-compromise all-flash storage in this segment with FlashArray//XL and FlashArray//X. The company offers compelling storage capacity and density with the FlashArray//XL. It provides best-in-class, Portworx-based Kubernetes support, a proven non-disruptive upgrade architecture, and a broad choice of flexible consumption models, including STaaS options.

Infinidat focuses on massive capacity and scalability with its InfiniBox rack-scale solution and also offers the InfiniBox SSA II all-flash architecture oriented at mission-critical workloads. The company is driving significant innovation in the AIOps, ransomware protection, and STaaS areas, and fully supports NVMe/TCP (NVMe over transmission control protocol) and NVMe-oF (NVMe over fabrics).

Hitachi Vantara now supports non-disruptive upgrades on its virtual storage portal (VSP) 5000 series appliances targeting large enterprises. The company is improving its STaaS offering (with support for multitenancy), has closed the gap on Kubernetes integration, and offers multiple management options, as well as ransomware detection and mitigation capabilities.

The smaller group consists of vendors in the Maturity/Platform Play quadrant: IBM and HPE. IBM's FlashSystem 9500 appliance is based on the modern IBM Spectrum Virtualize architecture, offering an NVMe all-flash array backed by IBM's AI-based analytics suite, which combines performance and scalability for large organizations with STaaS options and ransomware protection features. Focusing primarily on GreenLake, HPE nevertheless offers its Alletra 9000 appliance for large enterprises, a robust all-NVMe architecture that includes advanced data reduction mechanisms, the excellent InfoSight AI-based analytics platform, and a software as a service (SaaS) intent-based provisioning solution.

Zadara takes a different approach with Zadara Edge Cloud Services. It provides compute, storage, and networking resources deployed either on-premises or in the cloud and is offered through a cloud-like as-a-service consumption model. The entire stack is fully managed by Zadara and eliminates complexity and management overhead; however, organizations have to operate within the capabilities of the solution. In last year's report, Zadara was considered a platform. However, it lacks support for some of this year's updated and expanded key criteria, placing it in the Maturity/Feature Play area.

As a final comment, two vendors evaluated in the [2021 Radar for Primary Storage for Large Enterprises](#) have been removed from this year's report. Excelero was acquired by NVIDIA, and its solution is no longer available to new customers, while Pavilion Data ceased business operations in October 2022.

INSIDE THE GIGAOM RADAR

The GigaOm Radar weighs each vendor's execution, roadmap, and ability to innovate to plot solutions along two axes, each set as opposing pairs. On the Y axis, **Maturity** recognizes solution stability, strength of ecosystem, and a conservative stance, while **Innovation** highlights technical innovation and a more aggressive approach. On the X axis, **Feature Play** connotes a narrow focus on niche or cutting-edge functionality, while **Platform Play** displays a broader platform focus and commitment to a comprehensive feature set.

The closer to center a solution sits, the better its execution and value, with top performers occupying the inner Leaders circle. The centermost circle is almost always empty, reserved for highly mature and consolidated markets that lack space for further innovation.

The GigaOm Radar offers a forward-looking assessment, plotting the current and projected position of each solution over a 12- to 18-month window. Arrows indicate travel based on strategy and pace of innovation, with vendors designated as Forward Movers, Fast Movers, or Outperformers based on their rate of progression.

Note that the Radar excludes vendor market share as a metric. The focus is on forward-looking analysis that emphasizes the value of innovation and differentiation over incumbent market position.

5. Vendor Insights

Dell Technologies

Dell Technologies offers two solutions for the large enterprise market: PowerMax and PowerFlex. PowerMax consists of a modular architecture based on node pairs, in which each node pair provides storage, compute, and cache capacity to the PowerMax system, allowing the solution to scale up and scale out. The newest PowerMax systems are based on a new multiple-node NVMe scale-out architecture with NVIDIA DPU technology and are designed to deliver high throughput and ultra-low latency to performance-oriented workloads. Organizations can opt for two updated PowerMax editions: the 2500 series and the 8500 series. These updated models boast a doubled performance over the 2000/8000 series, with a 14x higher storage density, achieved by a seven-fold usable capacity increase combined with a halving of required rack space. This results in energy savings of up to 87%, according to Dell Technologies. Both models support NVMe-oF, Fibre Channel, and iSCSI protocols. PowerMax systems are powered by PowerMax OS, which includes an embedded hypervisor. The various modules execute as services on top of PowerMax OS, delivering management, data services, and other mission-critical storage capabilities. The solution also supports SmartFabric Storage Services, a software tool for automating NVMe/TCP infrastructure discovery and configuration.

Data services include advanced data reduction through global inline deduplication and compression backed by Dell's 4:1 data reduction guarantee. Replication is one of the strong capabilities of the PowerMax platform, thanks to the robust and long-established Symmetrix Remote Data Facility (SRDF) feature, which enables active/active synchronous and asynchronous replication modes at scale with a cybervault option. Note that SRDF/A (asynchronous) supports VMware vVols integration when used with VMware Site Recovery Manager, with SRDF/A, enabling a full-storage, policy-based management

experience. Other data services include ransomware anomaly detection and alerting, multiple-array smart provisioning, multifactor management authentication, end-to-end encryption with data reduction efficiencies, embedded NAS, PowerPath (which enables consistent application availability and performance), and SnapVX space-efficient snapshots that are immutable (secure snapshots that can't be deleted manually until a user-specified expiration time). Finally, PowerMax embeds a real-time, ML engine that analyzes host input/output (I/O) traffic and ensures optimal data placement on NVMe flash drive pools according to each workload's I/O profile.

Cloud support is available through Cloud Mobility for Dell PowerMax, a feature that runs as a virtual machine (VM) on PowerMax OS. Cloud Mobility allows seamless and transparent data movement between PowerMax systems and object storage, whether cloud-based—Amazon Web Services (AWS), Microsoft Azure—or on-premises object stores such as Dell ECS and PowerScale. This easy data flow enables archiving and long-term data retention use cases, freeing up space on PowerMax systems and leveraging low-cost, cloud-based, object storage economics. In addition, data sets present in the cloud or in on-premises object storage can be made available to other workloads, either through an AWS marketplace appliance or through a vSphere-based vApp (for ECS and PowerScale).

The system is managed through Unisphere for PowerMax, a dedicated management interface that supports multiple PowerMax systems and delivers a comprehensive overview of the managed systems with various metrics concerning health, performance, capacity, and compliance. PowerMax also integrates with CloudIQ to benefit from more advanced monitoring and alerting related to health checks, cybersecurity recommendations, performance impact/anomaly/workload contention analysis, capacity forecasting, and more. New proactive ransomware detection capabilities will be added to CloudIQ imminently. For application programming interface (API) and automation support, organizations can either rely on CloudIQ (which provides unified webhook and REST API support across products) or directly use PowerMax APIs.

Kubernetes integration is available through a vVol integration with VMware Tanzu or through Dell's Container Storage Modules (CSM). Organizations running PowerMax alongside VMware vSphere will appreciate the seamless integration between the two platforms. The other deployment model leverages CSM, a regularly updated, open-source suite of modules developed for Dell products. CSM covers storage support (through container storage interface, or CSI drivers) and other capabilities, such as authorization, resiliency, observability, snapshots, and replication. OpenShift and Docker platforms are also supported by CSM.

Dell's other storage offering is the Dell PowerFlex software-defined infrastructure platform, which now provides file services in addition to block storage, and includes simplified deployments with NVMe/TCP. The solution is software-defined and is used preconfigured on Dell-provided PowerFlex appliances or in a fully integrated rack-scale fabric that includes connectivity. However, it is now available in an SDS-only deployment model as well. Organizations can also deploy PowerFlex on AWS via a simple deployment wizard, which includes setting up availability zones. The solution runs on AWS EC2, using either EC2 Instance Store or EBS storage, and scales linearly by federating instances.

PowerFlex is engineered to streamline operations and boost agility with intelligent software-driven automation. PowerFlex Manager, a unified management toolset for PowerFlex systems, simplifies IT operations management (ITOM) and lifecycle management (LCM) tasks by providing extensive automation. It enables automated deployments and expansions with minimal hands-on time for the IT team, letting them focus on other strategic initiatives. Further, a rich out-of-the-box toolset, including PowerFlex REST API, PowerFlex Ansible modules, and Dell CSM and CSI drivers, enhances DevOps productivity and IT agility. Lastly, Dell CloudIQ intelligent insights simplify monitoring of distributed multiple-location PowerFlex deployments by providing a seamless cloud-based AIOps mechanism.

PowerFlex is built for linear scalability, resiliency, and performance, useful for several use cases, such as enterprise databases and workloads, analytics AI and ML, and modernized containerized applications. Compared to the monolithic approach of the PowerMax solution, and putting PowerMax's rack-scale

option aside, PowerFlex allows organizations to start small without compromising on performance, with the ability to massively scale to thousands of nodes.

Dell Technologies provides STaaS capabilities through its APEX offering, in which clients can order block or file services and define performance tier, base capacity, subscription length, and deployment location (on-premises or in a Dell-provided co-location site), as well as various criteria that will also define the storage platform deployed in the background. Because storage is offered as a service, though, this is less relevant.

Strengths: Dell Technologies continues to demonstrate the relevance of its PowerMax solution, thanks to a robust and innovative architecture designed to offer the best reliability to mission-critical workloads. Efficiency improvements as well as sustained development of the CloudIQ AIOps platform are laudable. The PowerFlex platform is a relevant alternative for organizations that require performance but want to scale at their own pace, enabling massive scalability and the ability to run on AWS.

Challenges: Compared to other players in the market, cloud integration capabilities remain average.

Hitachi Vantara

Hitachi Vantara traditionally focused on medium and large organizations. Its products use the same OS and expose the same feature set, enabling users to design their infrastructures with a consistent set of characteristics both at the core and at the edge. Two storage series are relevant for large enterprise businesses: the VSP 5200 and 5600.

The VSP 5000 Series is a storage solution that can scale up and out easily. It consists of a hardware appliance that offers great value for large enterprise businesses. The VSP 5200 can provide up to 23 PB of capacity, while the VSP 5600 can provide up to 69 PB. In both, the storage is available in all NVMe, all flash, or in hybrid form. These systems also scale very well in both performance and capacity. The VSP 5000 Series now allows non-disruptive upgrades to the next generation of storage. Data services include adaptive data reduction, storage virtualization, and in-system replication, as well as copy data management and non-disruptive migration capabilities. And for connectivity, VSP 5000 products support NVMe-oF, Fibre Channel, and iSCSI interfaces. The solution also offers mainframe (FICON) 16 Gb/s and 32 Gb/s interfaces.

Hitachi Vantara offers Hitachi Ops Center Suite, an ML-powered management platform aimed at simplifying and improving operations for the entire storage stack. This solution consists of several highly integrated components. Hitachi Ops Center Clear Sight provides cloud-based monitoring capabilities. Hitachi Ops Center Analyzer offers real-time observability and anomaly detection, while Hitachi Remote Ops handles the resolution of infrastructure issues with up to 90% of problems automatically resolved. In addition, a new capability branded Secure System Updates allows non-disruptive in-place updates without the need to evacuate an array. Extra components, such as Administrator and Automator, provide configuration and automation capabilities. Through Ops Center Suite, organizations can take advantage of various automation and API integration capabilities between their Hitachi Vantara storage and their automation platforms. For routine monitoring activities, the Clear Sight SaaS management portal provides easily consumable health information at a glance. The Clear Sight solution is available to all Hitachi VSP customers and included in the appliance purchase price. It's worth noting that the Hitachi management stack also provides good ransomware detection and mitigation capabilities with a combination of immutable snapshots and detection and proactive mitigation mechanisms.

Hitachi closed the gap on Kubernetes integration with added support for Kubernetes, OpenShift, and Anthos. It also added Hitachi Cloud Connect, which allows cloud-adjacent deployments of VSP in Equinix-based co-locations. Tiering to the cloud is also supported, and the public cloud can be used for cloud bursting and for data protection and cyber resiliency use cases.

Hitachi Vantara has an interesting STaaS solution that offers pay-as-you-go and flexible consumption with guaranteed service-level agreements/service-level objectives (SLA/SLOs), a fixed rate card, and integrated analytics. The solution supports scaling up and down, with transparent pricing on a GB per month basis. It includes five storage service classes, with data availability of either 99.999% or 100%.

Recently, multitenancy was added to the STaaS offering, and three levels of managed service are available, allowing granular control between the customer and Hitachi. The company claims it can deploy the STaaS infrastructure within 14 days (both on-site or co-located, with a four-hour service activation). Currently, STaaS is managed through a separate portal (using Ops Center in the back end), but within 12 months, Hitachi will allow customers to manage the STaaS offering alongside their existing infrastructure through a single management portal.

Also worth mentioning, Hitachi offers an SDS solution called Virtual Storage Software Block (VSS Block) and provides VSS Block-ready nodes that allow organizations to quickly scale their SDS system, which also enables the data plane to be extended from the VSP solutions described above. VSS Blocks runs virtualized and integrates with an organization's core storage platform and existing hypervisor.

Strengths: Hitachi Vantara continues to provide proven storage solutions built on a robust architecture, and the company recently introduced a promising STaaS offering that allows its customers to consume infrastructure in a more flexible manner.

Challenges: Although the systems support NVMe flash, that support is only for NVMe-oF, a potential challenge that limits organizations that are heavily invested in TCP. Cloud integration remains average compared to several competitors in the market.

HPE

HPE announced a new portfolio of primary storage solutions in 2021, including, for large enterprises, the Alletra 9000 platform, an all-NVMe array built on the foundations of the HPE Primera architecture. This solution aims to satisfy the requirements of mission-critical workloads with ultra-low latency and high IOPS, boasting a no-questions-asked 100% availability guarantee. To ensure system availability, HPE leverages its InfoSight infrastructure management and AIOps platform, backed by AI and ML, to predict and prevent service disruptions, enhancing its management and analytics capabilities.

The Alletra 9000 is currently available in two models, the 9060 and the 9080, with the latter supporting more caches per node and an increased system cache ratio (3x more on the 9080 than on the 9060). As an all-NVMe architecture, Alletra 9000 supports NVMe-oF (over Fibre Channel). The solution can be extended with Alletra 2240 storage enclosures, which communicate with the Alletra 9000 through NVMe-oF (RoCE v2) connectivity. Alletra 9000 introduces non-disruptive controller upgrades, a new capability, into HPE's storage portfolio.

HPE is moving away from traditional storage management approaches. Besides InfoSight, organizations can take advantage of HPE Data Services Cloud Console. This intent-based SaaS provisioning solution enables a cloud-like experience that combines policy-based storage management and a self-service approach to workload provisioning with AI-driven workload placement. Data Services Cloud Console provides a rich and unified set of REST APIs across HPE products, allows workload movement to and from the cloud, and supports advanced security capabilities. HPE also supports cloud storage through HPE Cloud Volumes, a cloud-based platform that allows organizations to provision block volumes on either AWS or Azure. Cloud Volumes also offers a backup capability, but it doesn't support immutable snapshots yet. HPE has a good roadmap for Kubernetes integration with dedicated CSI drivers for Alletra systems.

The Alletra 9000 platform can be deployed and consumed through GreenLake, HPE's STaaS solution, which HPE touts as its primary go-to-market infrastructure delivery solution. This solution appeals to

customers with subscription options that range from traditional purchasing models to models that simplify the transition from capital expenditure (CapEx) to operating expenditure (OpEx).

Strengths: HPE occupies an interesting position with a solid all-NVMe platform, but undoubtedly most of the value it can deliver to large enterprises comes from its heavy investments in various data services platforms such as InfoSight and Data Services Cloud Console. HPE GreenLake is also a strong differentiator, providing organizations with the option to consume every HPE offering as a service. Those three elements give a clear picture of where HPE is heading: delivery of infrastructure and services through a cloud-like model.

Challenges: HPE's strategy to act as a trusted, cloud-like provider through GreenLake services unnecessarily obfuscates HPE's individual offerings, creating confusion for potential customers and making it difficult to evaluate each solution's capabilities. HPE Cloud Volumes' capabilities remain limited.

IBM

IBM offers a comprehensive storage portfolio that includes all-flash and hybrid solutions. Primary storage solutions for large enterprises are handled by the new IBM FlashSystem 9500 Series.

The FlashSystem 9500 is an NVMe all-flash array that supports 2.5-inch NVMe FlashCore Modules from IBM (with higher densities and self-compression, achieving up to 116 TB per single drive), industry standard 2.5-inch NVMe flash drives, and serial attached SCSI (SAS) solid-state drives (SSDs), with capacities of up to 30.72 TB per drive for NVMe SSDs and SAS SSDs. The system also supports storage-class memory, currently achieving up to 4.5 PB effective capacity in a 4U footprint. From a connectivity perspective, the FlashSystem 9500 architecture supports iSCSI (iSER – iWARP and RoCE) as well as Fibre Channel and NVMe-oF.

The FlashSystem 9500 is based on IBM Spectrum Virtualize, a storage OS now common to entry-level, mid-range, and high-end IBM storage systems. Supported features include automated tiering, and other resource optimization techniques, such as compression, deduplication, unmap, and automated thin provisioning, are available to improve capacity consumption and \$/GB. Several replication capabilities are included—FlashCopy, Metro Mirror (synchronous replication), policy-based asynchronous replication, three-site replication, and Global Mirror with change volumes. Additionally, a high-availability solution called HyperSwap can be implemented.

The IBM Storage Insights predictive analytics suite can monitor both IBM and several third-party systems, helping to establish a complete view of the storage infrastructure from a single interface, and automation can be achieved by taking advantage of the IBM Spectrum Virtualize REST APIs. These APIs are common to all IBM systems based on Spectrum Virtualize, allowing organizations using multiple IBM storage products based on Spectrum Virtualize to baseline their automation functions. Organizations can implement a ransomware protection strategy with FlashSystem through IBM Safeguarded Copy (SGC), a technology that provides immutable copies of data on a FlashSystem or SVC, and on IBM Copy Services Manager (CSM), an external automation and scheduling tool. The solution is branded IBM FlashSystem Cyber Vault and constitutes a framework for automating the processes required to proactively use SGC to perform data validation and recovery when a ransomware attack has occurred. IBM also offers IBM Spectrum Sentinel, an end-to-end incident recovery solution that creates immutable snapshots of critical application data, intelligently scans snapshots to verify they are free from malware and data corruption, and orchestrates restoring data to a production environment so organizations can resume normal business operations.

Integration with the cloud is achieved through cloud-tiering features embedded in the systems and virtual instances of Spectrum Virtualized deployed in the public cloud to provide a consistent user experience and set of features across different environments.

Kubernetes clusters can provision block storage dynamically through IBM's block storage CSI driver, but functions remain limited.

IBM's StaaS solution allows organizations to consume capacity on demand. For primary storage, the solution is branded IBM Block Storage as a Service and is based on the FlashSystem storage. Organizations select a base capacity and performance tier, then IBM delivers the required hardware with an additional 50% capacity to cover growth or burst consumption. When a 75% usage threshold is reached, additional capacity is delivered and installed automatically to shorten procurement cycles. Data resiliency options can be added through IBM FlashSystem SGC to create immutable data copies in the cloud.

Strengths: Besides being based on a robust and proven architecture, one of the highlights of the FlashSystem series is the AI-based IBM Storage Insights platform that provides predictive analytics and proactive support capabilities. In contrast with the previous generation, the new FlashSystem 9500 allows organizations to combine various media types in a single chassis.

Challenges: For file services support, other IBM storage offerings or third-party file services are required.

Infinidat

Infinidat boasts a modern, AI-based, hybrid storage (InfiniBox) and solid state (InfiniBox SSA II) architecture that delivers a great feature set with compelling \$/GB and \$/IOPS figures. To achieve this goal, the InfiniBox and InfiniBox SSA II take advantage of a data path designed around a combination of DRAM, flash memory, and hard disk drives associated with sophisticated AI-based caching technology to optimize data placement. These features enable Infinidat customers to consolidate several workloads and more data per storage system to reduce the overall TCO of the infrastructure.

Infinidat has an easy-to-use, AI-driven management system to support and simplify day-to-day operations and provide proactive support. Both solutions support NVMe/TCP as well as NVMe-oF. Infinidat systems currently do not provide support for new media types such as quad-level cell (QLC) 3D NAND or storage-class memory. Infinidat claims that those media types must be thoroughly tested and currently do not bring significant advantages to its platform. However, Infinidat utilizes an SDS technology (InfuzeOS) that is media independent and will be able to support other commodity-based media types in the future without sacrificing performance.

InfiniVerse is a component of Infinidat's InfiniOps technologies providing extensive and innovative AIOps and DevOps capabilities within and surrounding the InfiniBox platforms. It is delivered as a secure, cloud-based service and—as with all InfiniOps technologies—is included at no additional cost. InfiniVerse provides users with infrastructure-wide predictive analytics, monitoring, and reporting on capacity and performance so they can address potential issues before they become a problem. InfiniVerse collects millions of data points across Infinidat's global install base, analyzed in real-time, and provides customers with the insights to optimize operational efficiency and availability. This solution integrates with data center AIOps solutions such as Splunk, Dynatrace, ServiceNow, and others.

Infinidat delivers essential cyber resilience (including ransomware protection and recovery) for storage with InfiniSafe. The solution is available on the OS and built on four capabilities: immutable snapshots (with expiration lock and protected snapshot policies), logical air-gap (both local and remote, with bidirectional replication), near-instantaneous recovery, and a fenced forensic environment for testing, validation, and recovery. The solution also includes guaranteed SLAs for immutability and snapshot recovery on InfiniBox and InfiniGuard systems, providing fast recovery capabilities even at scale. InfiniSafe can be combined with InfiniGuard to meet enterprise needs for modern data protection, disaster recovery, and business continuity. InfiniSafe is available at no additional charge on primary storage systems (InfiniBox/InfiniBox SSA) and secondary storage (InfiniGuard).

InfiniBox offers a clever implementation of the CSI plug-in for Kubernetes, which allows users to copy and migrate data to remote systems or the public cloud for backup, disaster recovery, or development activities. Infinidat offers a complete range of integrations for major OS and virtualization platforms.

Infinidat offers two STaaS models. The Elastic Pricing model is a mix of CapEx storage upfront and cloud-like operating expansions or bursts month to month, as needed. The FLX model is OpEx-based, with cloud-like pay-as-you-go consumption, whether you go up or down in storage capacity.

Strengths: Infinidat offers large enterprise features and a balanced AI-based architecture that enables users to consolidate a wide range of workloads in a single system and deliver a consistent performance experience. It also provides noteworthy cyber resiliency capabilities through InfiniSafe.

Challenges: If not addressed in the future, the lack of support for QLC 3D NAND might become a challenge.

NetApp

NetApp offers primary storage capabilities across a broad range of solutions for organizations of all sizes. Its most popular primary storage solutions for midsize businesses have been the FAS platform, which provides hybrid storage capabilities, and the AFF platform, which offers all-flash storage. The vendor continues to deliver a seamless experience across on-premises and public cloud environments with BlueXP, a unified control plane that comprises multiple storage and data services delivered via a single SaaS-delivered multicloud control plane.

All entry, mid-range, and high-end systems, including NVMe-based and hybrid models, can count on a number of integrations at the high level common to all storage systems (such as with SnapMirror for data replication), as well as a unified platform for monitoring and analytics (ActiveIQ). NetApp's AFF A-series products support end-to-end NVMe, meaning both the back-end NVMe SSDs and front-end NVMe-oF connectivity to the host. NetApp provides both NVMe/FC and NVMe/TCP support, and the solutions help customers modernize their infrastructure with higher performance, lower latency, and simpler deployment.

NetApp uses AIOps to drive down administration costs for its customers through Active IQ, a digital advisor that simplifies the proactive care and optimization of NetApp storage. It uses AIOps to uncover opportunities to improve the overall health of the storage environment and provide the prescriptive guidance and automated actions to make it happen. The BlueXP platform provides advanced security measures against ransomware and suspicious user or file activities when combined with the native security features of ONTAP storage. A new feature is the Ransomware Protection dashboard, available in BlueXP, which monitors security and user behavior to help identify risks and threats and instruct on how to improve an organization's security posture and remediate attacks.

Cloud integration is best in class, thanks to a long-term cloud-focused strategy that finds its realization in BlueXP, the latest evolution of NetApp's cloud management capabilities. ONTAP technology ensures seamless operations across locations and clouds, simplifies management, and enables data-centric operations. Among services offered in NetApp BlueXP, customers can find not only Cloud Volumes ONTAP (CVO), based on NetApp's ONTAP technology, but also first-party services on hyperscalers such as AWS (Amazon FSx for NetApp ONTAP), Azure (Azure NetApp Files), and NetApp Cloud Volume Services for Google Cloud. BlueXP also supports a host of other data services, such as observability, governance, data mobility, tiering, backup and recovery, edge caching, and operational health monitoring. It also supports ONTAP 9.10 (and beyond) deployments in all public clouds, in addition to on-premises deployments. (We covered the cloud-based offerings in the [GigaOm Radar for Cloud File Systems](#).)

The company offers Kubernetes support on primary storage through its open-source Astra Trident CSI-compliant dynamic storage orchestrator, which allows ONTAP to provide persistent storage for Kubernetes workloads, as well as the ROSA compliance certification. Moreover, NetApp's Astra Control

service enables advanced data protection, disaster recovery, portability, and migration for Kubernetes workloads using the Cloud Volumes platform as a storage provider both within and across public clouds and for ONTAP on-premises.

NetApp also offers a broad set of STaaS consumption options through NetApp Keystone, providing multiple service levels for unified file and block, block only, and object storage. Each service level has defined IOPS and latency performance SLOs/SLAs. In addition to subscribing to performance service levels, the customer subscribes to a committed capacity with the ability to burst up to 20% on demand. NetApp guarantees 99.999% uptime. Storage efficiencies are integrated into the service and are reflected in a lower service price per capacity than if no efficiencies are used. Finally, the STaaS infrastructure can be deployed either in a customer-operated data center or in an Equinix IBX data center.

Strengths: NetApp offers a comprehensive set of enterprise-grade capabilities that retain consistency regardless of the deployment model. Its BlueXP offering provides next-level management and orchestration capabilities complemented by a host of SaaS-based data services, simplifying data storage and data management at scale regardless of the chosen deployment model.

Challenges: Although not necessarily a challenge, NetApp's offering and ecosystem are very rich and comprehensive. Without proper guidance, some organizations might feel intimidated.

Pure Storage

Pure Storage has architected its solutions around all-flash technology. The FlashArray product line serves primary storage use cases with four products built around the same OS: the FlashArray//X, ideal for business-critical applications and performance-oriented workloads; the FlashArray//C, which targets capacity-oriented workloads with an optimized \$/GB price; the FlashArray//XL, purpose-built to meet the needs of large enterprises; and Cloud Block Store, which brings primary storage and enterprise data services to the cloud.

FlashArray//XL delivers performance and capacity in a dense form factor with two models: the //XL130 and the //XL170. The //XL systems offer up to 40 drives in a 5U package, versus 20 drives in a 3U package for //X systems. FlashArray//XL can be expanded with up to two DirectFlash shelves for a total of 96 additional drives. Besides significantly increasing capacity and workload density, these new systems also dramatically reduce the amount of rack space required. Moreover, the //XL backplane was redesigned to support greater throughput, provide more I/O capabilities and stronger resiliency, and support future expansions. All of the major activities, such as capacity expansions, controller upgrades, hardware replacement, and software upgrades, can be performed without incurring downtime or service interruption. This seamlessness is made possible by a highly available architecture in which all modules are hot-swappable, controllers are stateless, and all components are configured either in mirrored mode or in active-active high-availability configuration.

In addition, Pure Storage systems embed proprietary DirectFlash NVMe modules that optimize data placement and erasure operations, increasing available capacity and improving media endurance, even with QLC flash. The //XL model also introduces distributed NVRAM, which allows bandwidth and capacity to scale with the number of modules, lifting the limit on write throughput.

All FlashArray models use the same Purity OS. FlashArray //C, //X, and //XL systems are unified file and block storage systems that benefit from a common set of data services. Among these, data efficiency mechanisms such as always-on inline deduplication, compression, and pattern removal can significantly improve storage density and efficiency. In addition to these, deep reduction algorithms can be applied to data at rest to further improve the data consolidation ratios provided by inline deduplication. Other data services include snapshots and clones (including SafeMode read-only snapshots) and advanced data replication to cloud object storage between Pure Storage platforms. Various active cluster replication topologies are also supported, now also with ActiveCluster, which allows up to five arrays to participate in

pairing for data mobility. The entire FlashArray product family supports Fibre Channel, NVMe-oF (ROCE and FC), SMB, and NFS; NVMe/TCP is planned to be released before the end of January 2023.

Pure1 combines AI-based analytics with AIOps and self-driving storage capabilities to manage all Pure Storage products, platforms, and services. In addition to proactive monitoring and AI-driven recommendations, the solution has been recently enhanced to provide a tighter integration between the cloud-based SaaS platform and the on-premises arrays through Pure Edge Services, a new framework for secure communication that effectively extends on-premises infrastructure to the cloud management plane. Additional capabilities were also introduced: Self-Service Upgrade, which provides automated testing of array upgrade readiness, and Pure SafeGuard, a security self-service umbrella of solutions that helps organizations assess their security posture, including ransomware protection readiness across the managed array fleet.

Pure1 also provides a unified set of REST APIs and a digital marketplace where organizations can consume Pure Storage products and services directly, including STaaS with the Evergreen//One solution.

Evergreen//One (formerly known as Pure-as-a-Service) is a subscription service for hybrid cloud storage where organizations can consume foundational block, file, and object storage services using a pay-as-you-go model. These services can be consumed on-premises in an organization's private data center, in edge/hosted co-location facilities, and/or in the public cloud with Cloud Block Store. There is no hardware to purchase or required large-capacity storage commitment upfront. Instead, customers can reserve as little as 50 TiB of storage, committed at a discounted rate, with access to unlimited on-demand consumption thereafter. Evergreen//One keeps storage infrastructure fresh with an evergreen architecture that scales and stays modern non-disruptively.

With several services, performance tiers, and use cases offered, Evergreen//One maintains 25% headroom above actual customer usage, making sure there's always elastic and available capacity when needed. There is no cost to the customer if this headroom is not used. Evergreen//One subscriptions are managed by Pure1, so the solution reaps all of the Pure1 capabilities presented earlier.

Kubernetes support is another highlight area for Pure Storage, thanks to the deep integration of Portworx into the FlashArray product line. It is available through a FlashArray-specific version of Portworx Essentials for which the node count limit of the Essentials version has been lifted. Organizations can start their cloud-native journey with Portworx Essentials directly on top of FlashArray without having to plan for additional investments, and they can upgrade seamlessly later to Portworx Enterprise as they need to scale Kubernetes services.

Strengths: The FlashArray//XL systems allow Pure Storage to compete head-to-head with rack-scale solutions, providing equivalent usable capacity and performance through an efficient and compact form factor. Pure Storage also offers a comprehensive set of advanced data services, including AI-based analytics, AIOps, and Kubernetes support, as well as a compelling STaaS offering.

Challenges: Putting cloud snapshot features aside, cloud integration capabilities remain limited, with only Cloud Block Store available in the portfolio.

Zadara

Zadara's primary storage offering, zStorage, is part of Zadara Edge Cloud Services, a solution focused on partners such as regional cloud providers and managed service providers (MSPs), currently over 300 providers on six continents. Enterprise customers can choose to deploy Zadara's solution on-premises as well.

The Zadara Edge Cloud Services architecture consists of a full infrastructure stack providing compute, networking, and storage. zStorage is the storage layer of the solution and consists of one or more Virtual Private Storage Arrays (VSPAs) that can be deployed on NVMe SSD, SSD, hybrid, and hard-disk drive (HDD) media types. A VSPA is able to provide block (iSCSI, FC, iSER protocols), file (server message block, or SMB, and network file system, or NFS), and object storage (S3, Swift) services. These services can in turn be consumed on-premises, across clouds, or using a hybrid model. Various VSPAs can be created, each with its own engine type (which dictates performance) and its own dedicated set of drives, including spares, providing a strong multitenant solution. Currently, there is no support for NVMe-oF and NVMe/TCP, although the way the solution is deployed and provided to customers (primarily through MSPs) greatly reduces the need to care about connectivity protocols.

The solution offers thinly provisioned snapshots as well as cloning capabilities, which can be local or remote. The snapshot-based, asynchronous, remote mirroring feature makes possible replication to a different pool within the same VSPA, to a different local or remote VSPA, or even to a different cloud provider. The replicated data is encrypted and compressed before being transferred to the destination. The solution also allows for many-to-many relationships, which enables cross-VSPA replication in active-active replication scenarios. Cloning capabilities are also available remotely and can be used for rapid migration of volumes between VSPAs because the data can be made available instantly (although dependency on the source data remains until all of the data has been copied in the background).

As the solution is cloud-based already, cloud integrations consist of native backup and restore capabilities that leverage object storage integration with AWS S3, Google Cloud Storage, Zadara VSPA Object Storage, and other S3-compatible object stores. Object storage also can be used by Zadara for audit and data retention purposes. Zadara supports AWS Direct Connect as well as Azure ExpressRoute, both of which allow a single volume to be made available to workloads residing in multiple public clouds, enabling the use of a single dataset across multiple locations or clouds. Auto-tiering is supported on flash deployments; hot data is identified by the system and promoted to the flash/high-performance tier, while less frequently accessed data is moved to lower-cost hard disks or S3-compatible object storage.

Although Zadara implements detailed analytics and visualization capabilities combined with proactive support and integration with ITSM/ticketing systems, those capabilities are not yet augmented by AI/ML. However, all of the VSPA management functions are available via RESTful APIs, enabling automation of provisioning activities. In addition, a Python library covering the same VSPA management functions is available to automation developers. Although no native ransomware protection capabilities exist, Zadara partners with Veeam to provide such protection through Veeam's Scale-Out Backup Repository immutability features.

Kubernetes integration is possible through Zadara's CSI driver and a Kubernetes operator, both of which can deliver block and file storage services to containerized workloads.

The solution is provided as a fully integrated infrastructure stack delivered via a SaaS consumption model, which constitutes the essence of Zadara's business model. An organization consuming storage services through Zadara, therefore, gets all of the flexibility benefits of STaaS.

Zadara's Federated Edge Program allows MSPs to rapidly deploy Zadara at the edge, enabling MSPs to provision a turnkey infrastructure closer to their customers while adhering to the Zadara Cloud operating model. Zadara provides the necessary hardware and software, and revenues are shared between Zadara and Federated Edge partners.

Finally, Zadara is working on several improvements. One of them should enhance its monitoring through the use of an ML-based engine that analyzes and parses alert patterns before informing the administrators. Another planned improvement will bring cost analysis and cost optimization recommendation to its File Lifecycle feature.

Strengths: Zadara combines a simple and straightforward consumption model with a rich ecosystem of storage services and capabilities, complemented by multiple cloud integrations. The solution's deployment model as a full-stack SaaS offering eliminates the complexity and overhead associated with deployment, management, and CapEx costs.

Challenges: Even if large enterprises consume Zadara as a SaaS solution (therefore not managing the back-end infrastructure), the absence of AI-based management and analytics is a gap area compared to general market trends.

6. Analysts' Take

The primary storage market remains a very mature space. Large enterprises still consider architecture and reliability to be the primary decision factors, and many solutions in this report owe their success to their robust architecture and ability to support mission-critical applications reliably.

For this reason, organizations are now seeking added value from adjacent capabilities such as cloud integration. With more data moving to the cloud, and with new application deployment models, solutions that integrate hybrid-cloud options are gaining more attention.

Among other key differentiators, large enterprises are seeking comprehensive management capabilities that take advantage of AI and ML. Those solutions should not only provide predictive analytics capabilities and proactive remediation, but storage should be self-driven to increase the storage capacity manageable by a single administrator. Combined with other data services, such as immutable snapshots and policy-based automation, AI-based analytics can also help customers build a first line of defense against threats, such as ransomware attacks. Organizations also are seeking to replicate the cloud experience with self-service capabilities and policy-based data placement; automation and API integrations play a key role in helping them deliver a seamless experience to their user base.

Another emerging trend is STaaS, and some vendors have already built very compelling offerings that have the potential to transform the way storage will be consumed. Large organizations are considering STaaS with great interest. It delivers cloud-based, flexible consumption options and offloads the burden of management to the vendors. STaaS was built with large organizations in mind, so a broad majority of the vendors presented here offer this consumption model. Some are more advanced, while others are still transitioning away from their traditional CapEx sales model and still adapting to this tectonic shift.

Among broader industry movements, 2022 marked a setback for solutions that were leveraging Intel Optane for performance improvements in specific configurations to serve the most demanding use cases. Concerns expressed by some vendors last year about the availability of a single solution in storage-class memory manifested this year with the discontinuation of Intel's Optane business. New architectures based on CXL will emerge, but it may take time to test and qualify those technologies for optimal use with scale-out file systems. Another concern sometimes heard involves QLC NAND's low durability, although the real challenge lies in re-architecting solutions to find efficient methods to write to QLC drives while avoiding media wear.

Just like the entire technology industry, the primary storage sector is impacted by a volatile global situation amid multiple crises. In addition to the tight supply chain issues caused by the pandemic, global geopolitical tensions post-pandemic are impacting the availability of materials and forcing governments to reevaluate the strategic nature of the technology industry, resulting sometimes in abrupt policies where a given vendor or supplier may be banned in a specific market. This is particularly true for the semiconductor industry; national approaches are now being considered but may take years to have a tangible impact on supply chains and underlying storage and compute architectures.

In some regions of the world, the steep increase in energy costs and the impact of climate change are driving organizations to reevaluate the efficiency of their primary storage solutions from an energy consumption and carbon footprint perspective, either through voluntary ESG policies or because of skyrocketing utility bills. Ultimately, energy efficiency and sustainability criteria must be balanced against performance requirements and SLAs while also looking at long-term sustainability and system lifespan.

7. About Max Mortillaro

[Max Mortillaro](#)

Max Mortillaro is an independent industry analyst with a focus on storage, multi-cloud & hybrid cloud, data management, and data protection.

Max carries over 20 years of experience in the IT industry, having worked for organizations across various verticals such as the French Ministry of Foreign Affairs, HSBC, Dimension Data, and Novartis to cite the most prominent ones. Max remains a technology practitioner at heart and currently provides technological advice and management support, driving the qualification and release to production of new IT infrastructure initiatives in the heavily regulated pharmaceutical sector.

Besides publishing content/research on the TECHunplugged.io blog, Gestalt IT, Amazic World, and other outlets, Max is also regularly participating in podcasts or discussion panels. He has been a long-time Tech Field Day Alumni, former VMUG leader, and active member of the IT infrastructure community. He has also continuously been running his own technology blog kamshin.com since 2008, where his passion for content creation started.

Max is an advocate for online security, privacy, encryption, and digital rights. When not working on projects or creating content, Max loves to spend time with his wife and two sons, either busy cooking delicious meals or trekking/mountain biking.

8. About Arjan Timmerman

[Arjan Timmerman](#)

Arjan Timmerman is an independent industry analyst and consultant with a focus on helping enterprises on their road to the cloud (multi/hybrid and on-prem), data management, storage, data protection, network, and security. Arjan has over 23 years of experience in the IT industry and worked for organizations across various verticals such as the Shared Service Center for the Dutch Government, ASML, NXP, Euroclear, and the European Patent Office to just name a few.

Growing up as an engineer and utilizing that knowledge, Arjan currently provides both technical and business architectural insight and management advice by creating High-Level and Low-Level Architecture advice and documentation. As a blogger and analyst at TECHunplugged.io blog, Gestalt IT, Amazic World, and other outlets, Arjan is also from time to time participating in podcasts, discussion panels, webinars, and videos. Starting at Storage Field Day 1 Arjan is a long-time Tech Field Day Alumni, former NLVMUG leader, and active member of multiple communities such as Tech Field Day and vExpert.

Arjan is a tech geek and even more important he loves to spend time with his wife Willy, his daughters Rhodé and Loïs and his son Thomas sharing precious memories on this amazing planet.

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