IDC TECHNOLOGY SPOTLIGHT

VVols Provides Powerful Application-Aware Management for vSphere Environments

August 2017

Adapted from *VMware Helps Further Expand Adoption of Hyperconvergence and Software-Defined Infrastructure with the Release of vSAN 6.6* by Eric Sheppard, IDC #US42486317

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With vSphere 6.5 and integrated Virtual Volumes (VVols) support for replication, customers can implement application-aware best practices for managing their virtual environments. Transitioning to application-aware management gives vSphere administrators the tools they have long sought to align and unify the control of data, storage and applications. Customers should understand the breadth and depth of benefits derived from their array vendors' support of VVols. Those benefits include lowering overall IT costs, increasing IT agility, improving storage resource utilization, and heightening administrative productivity. VVols integration should become a key purchase criterion for customers looking to purchase enterprise storage arrays for use in vSphere 6.5 environments starting now. This paper defines VVols, describes the benefits VVols can provide to vSphere administrators (depending upon array vendor implementation), and looks at how HPE has integrated this strategically important storage management framework in its 3PAR StoreServ and Nimble Storage product lines.

I. Introduction

Managing storage has historically involved sophisticated administration tasks that were complex, manually intensive, and time consuming. With the widespread adoption of virtual infrastructure by customers of all types and sizes, IDC has noted a distinct trend for storage management tasks to migrate away from dedicated storage administration teams toward IT generalists (most often, the virtual administrator). As IT organizations consolidated workloads onto virtual infrastructure, it became clear that the abstraction inherent in virtualization sometimes further complicated certain tasks such as storage management. Storage management challenges in virtual environments included:

- **Lack of agility.** Storage structured as silos with a logical unit number (LUN)–centric approach does not meet agility requirements in today's dynamic business environment. Adding to or repurposing LUN-centric resources is not sufficiently flexible.
- **Inefficiencies.** Virtual administrators want to manage at the application level, but arrays forced them to manage at the LUN level. A LUN will typically host many virtual machines (VMs) that have different requirements for performance. This introduces a number of inefficiencies in provisioning times, space utilization, troubleshooting, and how enterprise class-data services are applied.
- **Burdensome administration.** Common administrative operations such as VM provisioning, snapshot and replication management, and storage problem diagnosis and resolution required the virtual administrator to interact with a storage administrator, adding time and cost to routine tasks.

In 2011, VMware announced Virtual Volumes (VVols) in an attempt to simplify storage management operations in virtual environments. VVols is a new integration and management framework that replaces the existing VMFS-based approach and exposes individual VMs and their virtual disks, enabling an application-centric storage management model where applications can be easily tracked by the VMs and virtual disks they consume. VVols offers huge benefits when used with block-based arrays, but the same management paradigm that it establishes can also be applied to file-based arrays so that storage management is consistently implemented across all managed storage in a virtual environment. VVols initially shipped as part of vSphere 6.0, but it was not until the release of vSphere 6.5 and VVols 2.0 in November 2016 that it supported the core features that enterprises really needed to support mission-critical workloads.

II. Definitions

VVols is a framework, not an out-of-the-box solution, and storage vendors need to build their array integration and management solutions on top of it. An array that supports VVols can effectively apply its data services, policies, and troubleshooting tools at the more granular VM level rather than the traditional data store level, making it faster, easier, and more efficient to perform tasks that involve storage. Vendor offerings will vary based on the capabilities of their arrays and their integration implementations, so VVols offers ample opportunity for vendors to differentiate themselves while significantly simplifying storage management in vSphere environments across all platforms for end users. The bottom line is that array vendor integration with VVols will make it much easier for virtual administrators to meet more dynamic business requirements and provide faster response (e.g., for VM provisioning) while improving efficiencies and reliably managing storage in accordance with IT governance.

III. Benefits

Many benefits accrue to organizations that make the shift to VVols and application-centric storage management. This section discusses several benefits in the context of commonly performed operations in virtual environments. With these examples, the reader should be able to understand the far-reaching benefits of VVols.

While data services such as thin provisioning snapshots, encryption, and replication can be performed either by vSphere or by an array, they can be handled much faster and more efficiently by the array. APIs in vSphere such as VASA and VAAI expose available array capabilities (e.g., does the array support thin provisioning, snapshots, encryption, replication) and effectively offload the execution of these operations to the array. When array offload is used, a virtual administrator using vCenter can request a snapshot, and that command will be passed over to the array to perform (instead of vSphere performing it). Array-based snapshots can be created and deleted much faster, and deliver much better performance, than vSphere snapshots. High-performance array-based storage is also much better suited to snapshots that will be retained over longer periods of time.

Integrating at the VASA/VAAI level exposes available array-based data services via the vSphere GUI, CLI, and API. This allows virtual administrators choices in how they manage their infrastructure, all of which can be easily performed directly from vCenter. Without VVols, these types of features can be applied only at the LUN level rather than the VM level and are managed through the array vendor's GUI or a vSphere management plug-in. With VVols, virtual administrators can apply such features at the virtual disk level (i.e., application level) while still performing most operations using native vSphere storage policies.

In block-based virtual environments using VMFS data stores, LUN-level management is inefficient. Due to a number of considerations, a LUN is generally much larger in capacity than a VM and will usually host tens of VMs. Some VMs require multiple virtual disks, and those have to be carefully managed to ensure that as VMs move between LUNs for performance, workload balancing, or other reasons, those virtual disks continue to be managed as a single object. If administrators want to use array-based replication to replicate a single VM in an environment without VVols, they will have to replicate the entire LUN just to perform the operation on the single target VM. This takes up additional bandwidth in the wide area network, requires more storage capacity on the target (because the entire LUN rather than just the VM is being replicated), generates additional CPU overhead on both the source and the target, and takes additional time (more data must be moved). Administrators can try to place all VMs that have similar storage management requirements on the same LUNs, but during the course of regular datacenter operations, having to keep a certain set of VMs together on the same LUN all the time is very limiting. VVols' ability to enable array-based data services at the more granular VM level makes everything easier, faster, and more efficient. Administrators do not need to think about where a VM is placed; they just need to specify a set of storage capabilities that it requires. This general example applies to most data services — it is far more preferable to be able to apply them (resiliency, data reduction, quality of service [QoS], snapshots, encryption, replication) to a select set of VMs rather than be forced to apply them to all VMs in a LUN. Doing so makes much more efficient use of CPU, storage, and network resources; is faster; and lets data service operations be specifically associated with an application (which is how virtual administrators prefer to manage anyway).

In today's dynamic environments, new VMs are frequently provisioned and older VMs are deleted. Generally, when a new VM is provisioned, storage must be provisioned along with it. In the past, the storage administrator was needed to create the right type of storage for that particular VM. What level of storage performance is needed (define the media and QoS strategies)? What level of availability is required (define the resiliency, replication, and backup strategies)? Should the VM's data be compressed or deduplicated? Should the VM's data be encrypted? Will snapshots be associated with the VM? When VMs are deleted, additional manual intervention is required to reclaim its storage capacity and make it available for use by others. In the past, these were all reasons why a skilled storage administrator needed to participate in VM provisioning and deprovisioning operations.

To improve administrative productivity and reliability even as IT generalists are taking over more storage management responsibility, many IT organizations are emphasizing automated operations. VVols is a perfect enabler for automated operations to occur at the VM level rather than the LUN level. Skilled storage administrators can preestablish templates that deliver different service levels across a variety of areas (e.g., gold, silver and bronze templates) to correspond to different business-level requirements. When provisioning a new VM, virtual administrators just need to select the storage policy that corresponds to their required service levels (gold, silver, or bronze), and vSphere takes care of the rest. Before, if the execution of any of the needed operations was going to be offloaded to the array, they could be performed only at the LUN level rather than the VM level. With VVols, the operations can be specified to occur at the VM level. This allows application templates to be defined that can very specifically tailor the storage provisioned to the requirements of the application, all without having to involve a storage administrator. The same general paradigm holds also for any array-based policies that are used to manage storage — with VVols, these can all be efficiently applied just to the VMs that need them. A good VVols implementation will comprehensively enable automated operations of all types to occur at the application (VM) level.

IV. Trends

Because of its speed, ease of use, and efficiency benefits, application-aware management in virtual environments is the future. Fewer and fewer IT organizations will have dedicated storage administration teams; instead, IT organizations will look to virtual administrators to take on an increasing number of IT infrastructure management tasks for compute, server, and networking. Using frameworks such as that provided by VVols, vendors are collaborating to provide application-aware management as a core feature of the software-defined datacenter. Even the few vendors that had attempted to build a proprietary "application-aware management" capability into their enterprise arrays are moving to take advantage of VVols in vSphere environments. VVols will become the de facto way for enterprise arrays to support application-aware management in vSphere environments.

V. Vendor Profile

For IT organizations interested in leveraging VVols to improve IT agility, lower administrative costs, and increase efficiencies while ensuring that VM operations adhere to IT governance guidelines, HPE has a very strong story across its 3PAR StoreServ and Nimble Storage All Flash and Adaptive Flash storage platforms. 3PAR StoreServ was one of five original VVols design partners in 2011 and was selected by VMware as the Fibre Channel reference platform. 3PAR and Nimble were among the first vendors to ship VVols implementations and were the only two storage design partners for VVols 2.0 in vSphere 6.5. The level of VVols integration available on those platforms today is broader than that available from any other enterprise storage vendor. HPE's enterprise storage platforms, including both 3PAR StoreServ and Nimble, support deep vSphere integration, including VASA, VAAI, VADP, VVols, Site Recovery Manager, Metro Storage Cluster, vRealize Operations, vRealize Log Insight, and vRealize Orchestrator/Automation.

Across HPE's supported platforms, which include the 3PAR StoreServ 7000, 8000, 10000, and 20000 Series arrays and the Nimble Storage CS, AF and SF Series arrays, key data services support VVols, including resiliency, compression, deduplication, and other storage-efficiency technologies; snapshots and clones; space reclamation; storage tiering; and telemetrics. HPE is the first (and so far only) enterprise storage vendor that provides support for VVols replication, enabling array-based replication to be controlled through VMware's storage policy–based management capabilities *at the application level.* This unique feature extends the VVols framework to cover additional data mobility, data protection and disaster recovery, and distributed data use cases not supported by other vendors.

Nimble InfoSight is a cloud-based, predictive analytics platform that, with its VMVision capability, enables monitoring and troubleshooting at the VM level not just for storage but also for compute and networking resources. InfoSight is the most mature telemetrics platform of its kind in the industry and has changed customer expectations about how arrays should be monitored and managed based on data science techniques such as predictive analytics and machine learning. The introduction of InfoSight in 2010 resulted in a number of other enterprise storage vendors also eventually introducing their own versions of cloud-based predictive analytics platforms.

HPE's lead in VVols integration on enterprise-class storage arrays delivers meaningful benefits for end users:

- **Make storage management faster and more agile.** By better aligning storage management with virtual infrastructure, virtual administrators can respond to business needs such as provisioning new VMs more quickly and more reliably than in the past. Array-based data services such as thin provisioning, snapshots, encryption, and replication all operate much faster, enabling their use across workloads without concern about performance impacts. With array-based snapshots, for example, VM backups occur much faster, encouraging their broader use to improve recovery capabilities.

- **Minimize tasks that require a skilled storage administrator.** Leveraging VMware's storage policy–based management with VVols integration means that far fewer storage operations will require a skilled storage administrator. This makes both virtual administrators and specialized storage experts more productive and enables faster response to business requirements that do not require cross-functional coordination.
- **Improve the efficiencies of storage resource utilization.** By performing array-based storage operations such as data reduction, data protection, snapshots, QoS, encryption, and replication at the more granular virtual disk level, virtual administrators minimize storage resource usage and the time necessary to perform them. With VVols, storage resources such as CPU, capacity, and bandwidth are used much more efficiently. Under the older model, storage was often provisioned and then never used, space reclamation was significantly delayed because of the difficulty of doing it manually, and additional capacity and/or bandwidth was consumed in snapshotting or replicating entire LUNs when all that was wanted was a subset of the VMs hosted on those LUNs.
- **Leverage array-based replication.** By supporting VVols replication, virtual administrators can easily and efficiently apply array-based replication to address data distribution, disaster recovery, and other use cases as part of an automated workflow that operates at the application level. Competitors that do not support this require separate, manual administration through the array GUI (not the vCenter GUI) to replicate data — a slower, more costly, and less efficient approach.

Challenges

To date, VVols adoption in the real world is light, primarily because most customers are not yet running vSphere 6.5, the release that includes the functional VVols baseline necessary to support mission-critical workloads. There is still also a lack of understanding about the benefits of VVols and how and why they vary across vendor array platforms. Today, HPE has an industry-leading VVols implementation, and its early work with that framework makes its implementation more mature (not to mention more feature rich) than the implementations of many other vendors. But the onus of responsibility is on HPE to evangelize both the power of the VVols framework and the direct customer benefits that its implementations on the 3PAR StoreServ and Nimble All Flash and Adaptive Flash platforms deliver. Other vendors are working on their own implementations, looking to catch up with what HPE offers today. While these vendors may eventually offer comparable functionality, they will not be able to match the mature implementation that HPE brings to the table given its pioneering work in this area.

VI. Conclusion

VVols is the next-generation integration and management framework for vSphere that provides a new, application-centric management paradigm that is the same across both block and file protocols. It offers consistent VM-level visibility, which effectively provides application-aware storage management while allowing much higher performance and more efficient array-based data services to be seamlessly integrated into relevant workflows. Common tasks such as space reclamation are performed automatically now, making administrators more productive and capacity utilization more efficient. Any storage vendor that does not support VVols forces its customers to go outside that standardized framework, making storage management much more complex and in many cases less efficient and more expensive.

It is important for virtual administrators interested in delivering faster response times, achieving increased efficiencies, and improving productivity to understand VVols and look to use it in their VMware infrastructure. VVols will effectively replace VMFS, providing an application-aware management paradigm that is much better aligned with how virtual administrators want to manage their environments. As customers move to vSphere 6.5, they should plan to start leveraging VVols and make VVols integration a purchase criterion as they look to purchase new enterprise storage arrays.

Given HPE's industry-leading VVols integration on the 3PAR StoreServ and Nimble Storage All Flash and Adaptive Flash storage platforms, existing customers have an excellent foundation on which to base their vSphere 6.5 (or later) migration. Other IT organizations using other enterprise array platforms but planning a technology refresh would do well to compare the VVols integration capabilities of storage solutions they are considering with what HPE already offers today. Most VMware virtual environments have both block- and file-based storage under management, and VVols offers a very powerful storage management paradigm that provides a consistent framework for managing both to achieve faster response, higher efficiencies, improved productivity and, ultimately, lower cost.
