VMware Horizon on Dell PowerStore T Scalable All-Flash Storage

Design Guide

Abstract

This design guide describes the architecture and design of the Dell Validated Design for Virtual Desktop Infrastructure (VDI) with VMware Horizon brokering software, based on Dell Technologies infrastructure, including Dell PowerStore T scalable all-flash storage.

Dell Technologies Solutions

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Validated Design

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Notes, cautions, and warnings

NOTE: A NOTE indicates important information that helps you make better use of your product.

CAUTION: A CAUTION indicates either potential damage to hardware or loss of data and tells you how to avoid the problem.

WARNING: A WARNING indicates a potential for property damage, personal injury, or death.

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Overview

The Dell Validated Designs for Virtual Desktop Infrastructure (VDI) on Dell PowerStore T scalable all-flash storage infrastructure provides a flexible, container-based architecture that ensures that features and services can be added to new or existing installations with minimal impact while providing manageability, simplicity, integration, and performance.

PowerStore provides all the benefits of an enterprise unified storage platform that combines block and file services over a variety of storage and communication protocols to support the requirements of a VDI environment. Additionally, PowerStore enables flexible growth with the intelligent scale-up and scale-out capability of appliance clusters to meet the demands of various workloads while also providing the capability to support future growth.

Installing VMware Horizon 8 with its VDI components on Dell PowerStore storage enables organizations to quickly deliver Microsoft Windows virtual desktops or server-based hosted shared sessions on a wide variety of endpoint devices.

Document purpose

This document introduces the architecture, components, design options, best practices, and configuration details for successful VDI deployments for Dell PowerStore storage with VMware Horizon 8.

Audience

This document is intended for decision-makers, managers, architects, developers, and technical administrators of IT environments who want an in-depth understanding of the value of the Dell Validated Designs for VDI that deliver Microsoft Windows virtual desktops using VMware Horizon 8 VDI components on Dell PowerStore storage.

We value your feedback

Dell Technologies and the authors of this document welcome your feedback on the solution and the solution documentation. Contact the Dell Solutions team by email.

Authors: Dell Validated Designs for VDI team

What's new?

Dell PowerStore appliances provide the following updates with the current release:

- Dell PowerStore T data storage appliance
- NVMe expansion shelves
- Embedded Module v2
- Online Mezzanine card installation

- 100 GbE I/O Modules

New in this document:

- Dell PowerStoreOS 3.0 testing and validation with Windows 10 21H2 VDI desktops
- NVMe over TCP (NVMe/TCP) block storage protocol validation

Design guide introduction

Dell Technologies offers comprehensive, flexible, and efficient VDI solutions that are designed and optimized for your organization's needs. These VDI solutions are easy to plan, deploy, and run.

PowerStore storage arrays are designed to enable growth, flexibility, and resiliency. PowerStore services are hardware and protocol independent, allowing file services to be layered without restricting block-storage flexibility.

Dell storage products are integrated into a mature monitoring and reporting suite that is designed to minimize management effort. With robust reporting and notification services, storage management can be as minimal as needed. The integrated dashboards also enable at-a-glance insight into the health and performance of the platform.

PowerStore achieves new levels of operational simplicity and agility. It uses a container-based microservices architecture, advanced storage technologies, and integrated machine-learning to unlock the power of your data. PowerStore is a versatile platform with a performance-centric design that delivers multidimensional scale, always-on data reduction, and support for next-generation media.

PowerStore brings the simplicity of public cloud to on-premises infrastructure, streamlining operations with an integrated machine-learning engine and seamless automation. It also offers predictive analytics to easily monitor, analyze, and troubleshoot the environment. PowerStore is highly adaptable, providing the flexibility to host specialized workloads directly on the appliance and modernize infrastructure without disruption. It also offers investment protection through flexible payment solutions and data-in-place upgrades.

With the addition of integrated file services, there is no requirement to purchase an external storage device for file shares. User access through NFS or Windows SMB is integrated, with the ability to share files between Microsoft Windows and UNIX or Linux users. This ability simplifies control with a single interface for data management.

PowerStore can serve data using NVMe/TCP, NVMe/FC, iSCSI, Fibre Channel, or multiple protocols simultaneously to provide seamless integration into most environments.

2

Solution Architecture

Topics:

Architecture overview

This section provides an architecture overview and guidance on managing and scaling a VMware Horizon environment with Dell PowerStore T Scalable All-Flash Storage.

Solution architecture

The following figure depicts an example of a unified storage architecture that is optimized to provide the appropriate resources for each component of the Horizon VDI solution to include Instant Clones, App Volumes, and Dynamic Environment Manager (DEM).

It shows the validated solution, including block and files resources provisioned to support the VDI desktops, application virtualization, and user profile and file data aspects of the architecture. In this example, the storage system is provisioned to support up to 8,000 users. Capacity planning and the performance requirements of the environment should be carefully considered to determine the appropriate PowerStore T storage system model and disk capacity for the environment being designed.

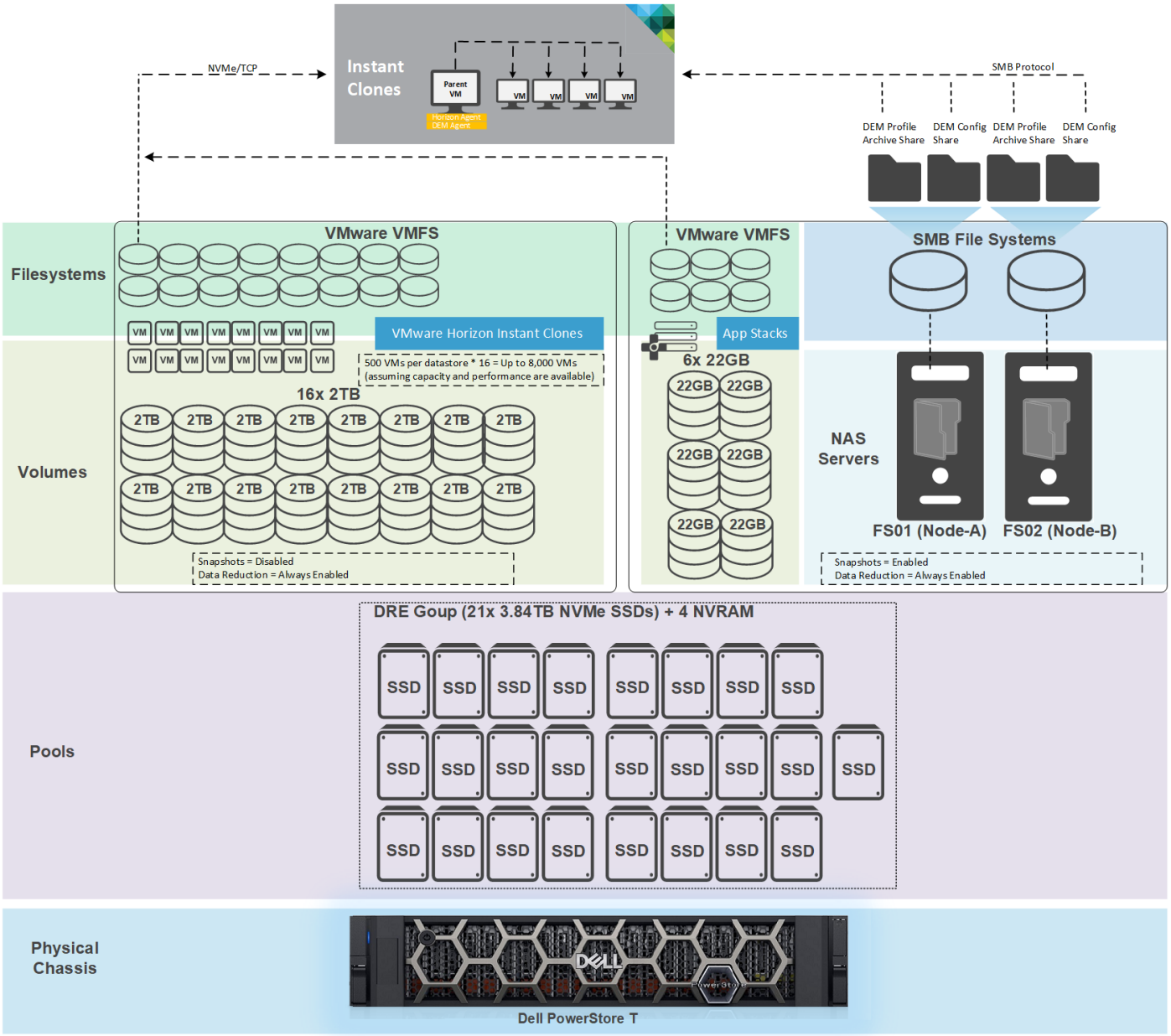

Figure 1. Solution architecture

Physical architecture

PowerStore

Dell Technologies offers several PowerStore models to support a variety of VDI deployments with various performance and capacity requirements.

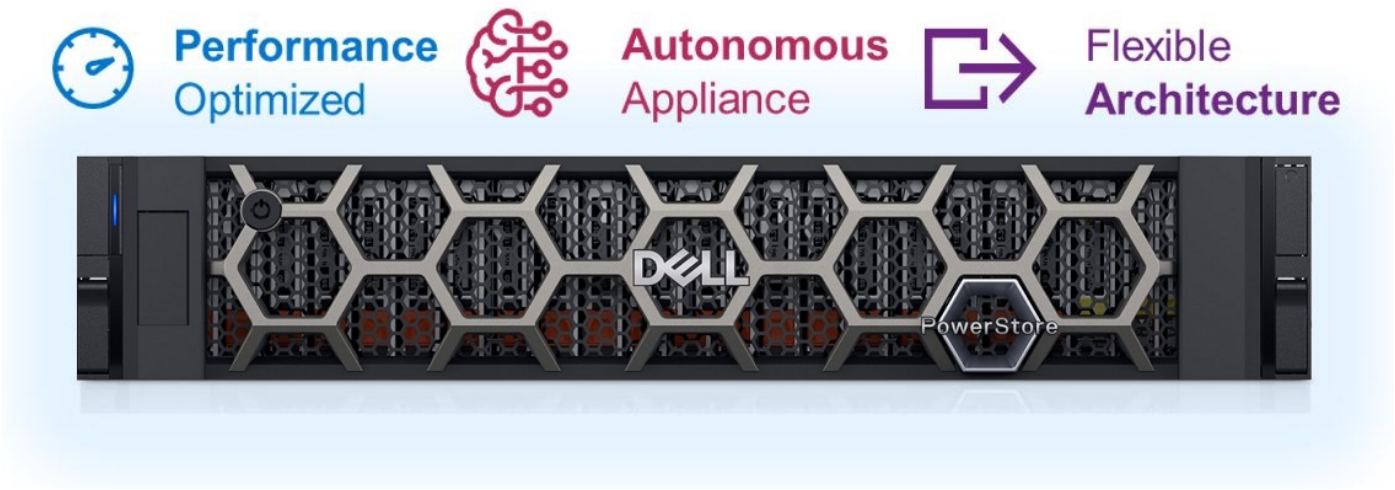

Figure 2. Dell PowerStore T

PowerStore storage systems allow you to start with as little as 6 NVMe SSD drives and scale up to 93 per appliance or 372 per cluster with up to 3 NVMe expansion shelves per appliance. PowerStorage appliances scale from 24 to 112 CPU cores, 192 GB to 2,560 GB of memory, and up to 4.52 petabytes per appliance or 18.06 petabytes effective per cluster.

With PowerStore, you can start small and scale as your storage requirements increase. Storage resources are separated from compute resources, so these aspects are managed and scaled independently as needed.

The following figure shows the PowerStore base controller front view with the NVMe SSD or SCM and NVRAM drives:

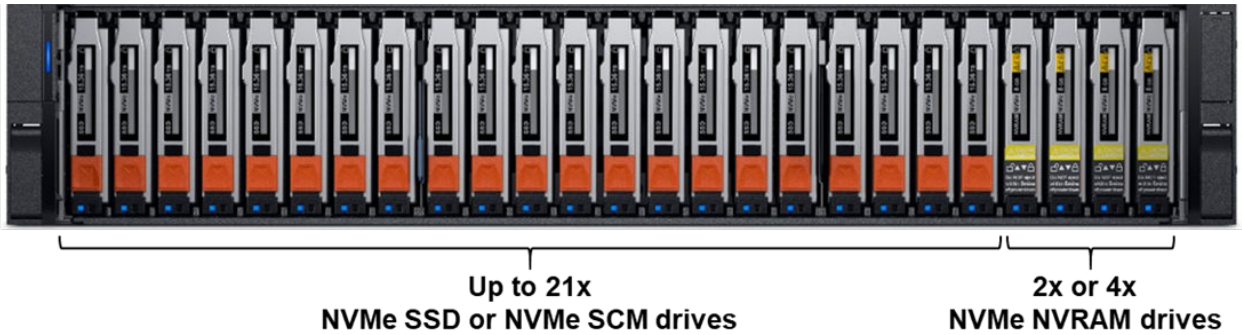

Figure 3. PowerStore base controller front view

The following figure shows the PowerStore base controller rear view with 2-port Mezzanine cards, two 100 GbE QSFP ports, and the Embedded Module v2:

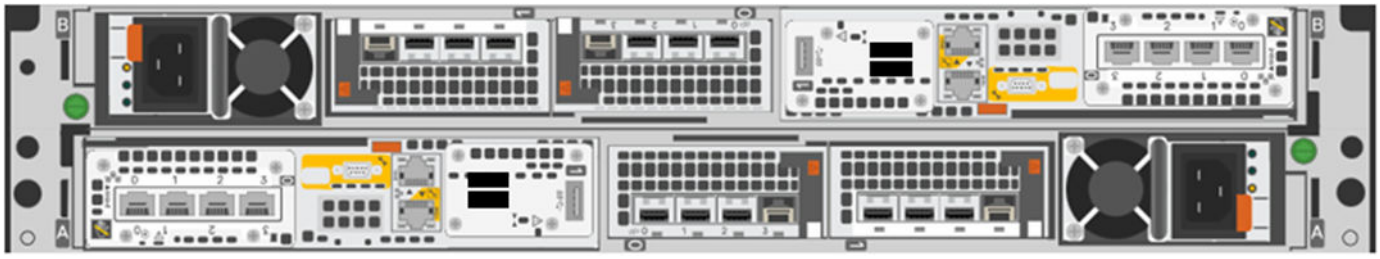

Figure 4. PowerStore base controller rear view

The following figure shows a PowerStore expansion shelf front view with NVMe SSD drives:

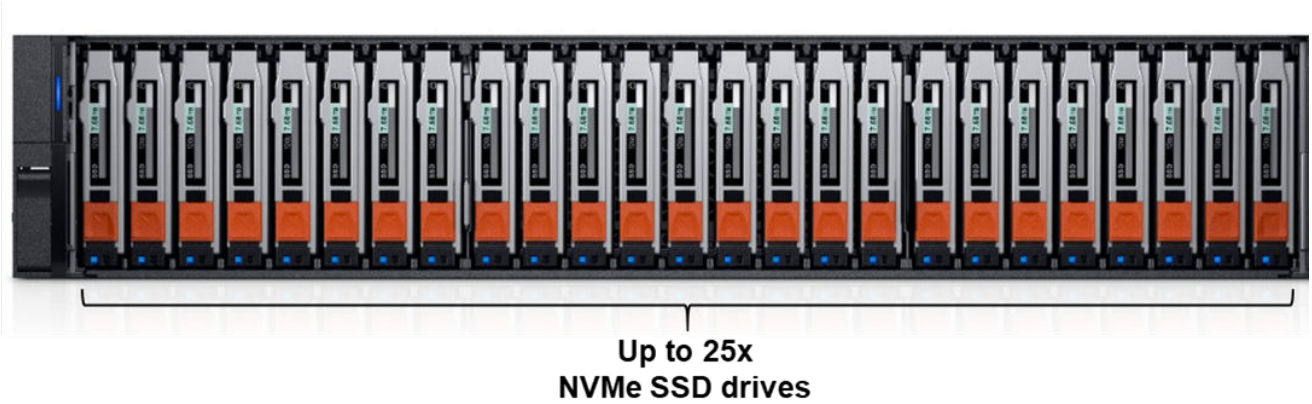

Figure 5. PowerStore expansion shelf front view

The following figure shows a PowerStore expansion shelf rear view:

Figure 6. PowerStore expansion shelf rear view

Physical network components

Dell Validated Designs for VDI enable flexibility in networking selections. VDI validations have been successfully performed with the following hardware, although several other choices are available:

- **Dell Networking S5248F-ON (25 GbE ToR switch)**—This switch provides optimum flexibility and cost-effectiveness for demanding compute and storage traffic environments. This ToR switch features 48 x 25 GbE SFP28 ports, 4 x 100 GbE QSFP28 ports, and 2 x 100 GbE QFSP28-DD ports. The S5248F-ON switch supports ONIE for zero-touch installation of network operating systems.
- **Dell Networking S4048-ON (10 GbE ToR switch)**—This switch optimizes your network for virtualization with a high-density, ultra-low-latency ToR switch that features 48 x 10 GbE SFP+ and 6 x 40 GbE ports (or 72 x 10 GbE ports in breakout mode), and up to 720 Gbps performance. The S4048-ON switch supports ONIE for zero-touch installation of alternate network operating systems.

For more information about these switches, see Dell PowerSwitch S Series 10GbE Switches and Dell PowerSwitch S Series 25/40/50/100 GbE Switches.

Client components

Users can access the virtual desktops through various client components. The following table lists the client components that Dell Technologies recommends:

Table 1. Recommended client components

Component	Description	Recommended use	More information
Latitude laptops and 2-in-1 PCs	• Biggest screens in a smaller footprint with a wide array of ports to connect peripherals and enjoy speakerphone experience • More responsive apps with Dell Optimizer and intelligent	• Mobility and space-saving devices • Allows users to be productive and stay connected with versatile, space-saving mobile solutions • Offers a modern portfolio that is built to prioritize customer	www.delltechnologies.com/Latitude

Table 1. Recommended client components (continued)

Component	Description	Recommended use	More information
	audio for a better conference experience • Better connectivity including 4G LTE, Wi-Fi 6, and eSIM • 5G design on the Latitude 9510 • Smart antenna design on select products for better connections	experience and keep employees productive wherever they work with a selection of laptops, 2-in-1s, and ecosystem products	
OptiPlex business desktops and All-in-Ones	• Intel 9th Generation core processors, providing 2 x system responsiveness with Intel Optane Memory • Flexible expansion options, including rich CPU, SSD, and PCIe NVMe • Many innovative form factors with versatile mounting options, including the industry's only zero-footprint modular desktop hidden in plain sight, and space-saving AIOs • Rich interaction with display technology, including 4k UHD AiO and matching multi-monitor support	• The ultimate modular solution • Ideal for desk-centric and remote workers in fixed environments who require varying degrees of performance and expandability	www.delltechnologies.com/OptiPlex
Precision workstations	• The most complete workstation portfolio with towers, racks, and mobile form factors • Powerful workstations for the most demanding applications, scalable storage, and RAID options • Smallest, most intelligent, and highest-performing mobile workstation portfolio • Rack workstations delivering shared or dedicated resources • Ensures peace of mind with ISV certified, reliable performance	• High-end graphics and extreme performance • Precision workstations designed to run processor- and graphic-intensive applications and activities with mission-critical reliability such as analytics, simulations, and modeling	www.delltechnologies.com/Precision

Software

This section provides a high-level overview of the components needed for creating and deploying a VDI environment. Successful deployment requires a deep understanding of the architecture when you are designing the environment.

VMware vSphere

VMware vSphere provides a flexible and secure foundation for business agility, with the following benefits for VDI applications:

- **Improved appliance management**—The vCenter Server Appliance Management Interface provides CPU and memory statistics, network and database statistics, disk space usage, and health data. This reduces reliance on a command-line interface for simple monitoring and operational tasks.
- **VMware vCenter Server native high availability**—This solution for vCenter Server Appliance consists of active, passive, and witness nodes that are cloned from the existing vCenter Server instance. You can enable, disable, or destroy the vCenter HA cluster at any time. Maintenance mode prevents planned maintenance from causing an unwanted failover.

The vCenter Server database uses native PostgreSQL synchronous replication, while key data outside the database uses separate asynchronous file system replication.

- **Backup and restore**—Native backup and restore for vCenter Server Appliance enables users to back up vCenter Server and Platform Services Controller appliances directly from the vCenter Server Appliance Management Interface or API. The backup consists of a set of files that is streamed to a selected storage device using the SCP, HTTP(S), or FTP(S) protocol. This backup fully supports vCenter Server Appliance instances with both embedded and external Platform Services Controller instances.
- **VMware vSphere HA support for NVIDIA vGPU-configured VMs**—vSphere HA protects VMs with the NVIDIA vGPU shared pass-through device. In the event of a failure, vSphere HA tries to restart the VMs on another host that has an identical NVIDIA vGPU profile. If no available healthy host meets this criterion, the VM fails to power on.
- **VMware Log Insight**—Provides log management, actionable dashboards, and refined analytics that enable deep operational visibility and faster troubleshooting.

NOTE: vSphere Enterprise Edition (or vSphere Desktop) is required to support NVIDIA graphics cards.

VMware Horizon

The architecture described here is based on VMware Horizon 8, which provides a complete end-to-end solution that delivers Microsoft Windows virtual desktops to users on a wide variety of endpoint devices. Virtual desktops are dynamically assembled on demand, providing pristine, yet personalized, desktops each time a user logs in.

VMware Horizon 8 provides a complete virtual desktop delivery system by integrating several distributed components with advanced configuration tools that simplify the creation and real-time management of the VDI.

Horizon clone technology

VMware Horizon 8 offers the following methods for cloning desktops:

- **Full clones**—These are typically used for testing purposes or to create management VMs. Full clones are not ideal for VDI because full copies have no connection to the original VM. You must update each VM with this approach.
- **Instant clones**—These are available with Horizon Universal Subscription, Horizon Standard Subscription, and Horizon Enterprise Edition (TERM) licenses. This technology provisions a VM immediately after a user requests one. This is a far easier approach to operating system updates and patch management because the VM is created when it is needed. You can use the combination of products such as VMware App Volumes and Dynamic Environment Manager to emulate persistence.

NOTE: Horizon Linked Clones and Composer were deprecated in Horizon 8 2006 and were removed in Horizon 8 2012.

VMware Dynamic Environment Manager

VMware Dynamic Environment Manager (DEM) is another piece of the overall solution that provides for dynamically assembled virtual desktops with the appearance of user persistence. DEM provides a profile and policy management solution that allows administrators to create a truly stateless virtual desktop environment while delivering a consistent and personalized experience for each user.

From the user's perspective, they receive the same profile mapping no matter where they are logged in from, so their personalized environment follows them and adapts across devices and locations. When deploying DEM, user profiles and configurations can be redirected to a NAS share. Dell PowerStore T store offers the capability to integrate with DEM by providing these NAS servers and SMB shares while also providing additional value with data reduction and protection capabilities.

VMware App Volumes

VMware App Volumes is a real-time application delivery system that enterprises can use to dynamically deliver and manage applications. Applications can be layered onto virtual desktops using VMware AppVolumes. This greatly improves application management and updates by removing the applications from the VDI base image and managing them independently.

Applications are packaged and delivered by attaching a standard VMDK or VHD file to a virtual machine. You can centrally manage the applications with the App Volumes Manager, a web-based interface that is integrated with Active Directory (AD) and vSphere. Administrators can assign, update, or remove applications to be delivered at the next user login without the need to modify the desktops or disrupt users while they are working.

An additional feature of App Volumes is Writable Volumes, which can contain data such as application settings, user profiles, licensing information, configuration files, and user-installed applications. This feature allows users to install applications and access their application data across sessions and devices.

VMware App Volumes and Writable Volumes require storage space which can be provided by the Dell PowerStore T storage array. It allows for high-performance access to applications for end-users as well as application and data persistence while also providing data reduction and protection capabilities.

3

Validation

Topics:

Test and performance analysis methodology

VDI test tools

Login VSI by Login Consultants is the industry-standard tool for testing VDI environments and server-based computing (RDSH environments). It installs a standard collection of desktop application software (such as Microsoft Office and Adobe Acrobat Reader) on each VDI desktop; it then uses launcher systems to connect a specified number of users to available desktops within the environment. Once the user is connected, the workload is started using a login script, which starts the test script once the user environment is configured by the login script. Each launcher system can launch connections to several target machines (for example, VDI desktops).

VDI test methodology

To ensure the optimal combination of end-user experience (EUE) and cost-per-user, performance analysis and characterization (PAAC) testing on Dell VDI solutions is carried out using a carefully designed, holistic methodology that monitors both hardware resource utilization parameters and EUE during load-testing.

For Login VSI, the launchers and Login VSI environment are configured and managed by a centralized management console. Additionally, the following login and boot paradigm is used:

- All users are logged in within a maximum timeframe of one hour. The login rate is determined by the total number of user sessions and the maximum timeframe. For example, with a maximum timeframe of 1 hour (3,600 seconds) and a user session count of 360 sessions, a new user login would be initiated every 10 seconds for the test. The formula for this is Launch Window / Sessions = Overall Logon Rate.
- All desktops are pre-booted in advance of logins commencing.
- The data collection interval for datastores is one minute.

Profiles and workloads

It is important to understand user workloads and profiles when designing a desktop virtualization solution and to understand the density numbers that the solution can support. At Dell Technologies, we use five Login VSI workload/profile levels and three NVIDIA nVector workload/profile levels, each of which is bound by specific metrics and capabilities with two targeted at graphics-intensive use cases. We present more detailed information in relation to these workloads and profiles later in the document, but first it is useful to define the terms “profile” and “workload” as they are used in this document:

- **Profile**—The configuration of the virtual desktop such as the number of vCPUs and the amount of RAM configured on the desktop that is available to the user.
- **Workload**—The set of applications that are used by PAAC testing of Dell VDI solutions (for example, Microsoft Office applications, PDF Reader, Internet Explorer, and so on).

Load-testing on each profile is carried out using an appropriate workload that is representative of the relevant use case. The following table shows the load-testing that we used:

Table 2. Login VSI workloads

Login VSI workload name	Workload description
Knowledge Worker	Designed for virtual machines with 2 vCPUs. This workload includes the following activities: ● Microsoft Outlook—Browse messages. ● Internet Explorer—Browse websites and open a YouTube-style video (480p movie trailer) three times in every loop. ● Microsoft Word—Start one instance to measure response time and another to review and edit a document. ● Doro PDF Printer and Acrobat Reader—Print a Word document and export it to PDF. ● Microsoft Excel—Open a large, randomized sheet. ● Microsoft PowerPoint—Review and edit a presentation. ● FreeMind—Run a Java-based mind mapping application. ● Other—Perform various copy and zip actions.

Resource monitoring

The following sections explain the component monitoring that is used on Dell solutions.

VMware vCenter

VMware vCenter is used for VMware vSphere-based solutions to gather key data such as CPU, GPU, memory, disk, and network usage from each of the compute hosts during each test run. This data is exported to .csv files for single hosts and then consolidated to show data from all hosts (when multiple hosts are tested). While the report does not include specific performance metrics for the Management host servers, these servers are monitored during testing to ensure that they are performing at an expected performance level with no bottlenecks.

Resource utilization

The purpose of this test was to determine the user density at a reasonable system load. Testing to system failure was out of scope. To achieve a reasonable system load, target thresholds for system resources were set as shown in the following table. These thresholds reflect a system that is well utilized, but not near failure.

Table 3. Resource utilization parameters

Parameter	Pass/fail threshold
Average CPU usage	85%
Average CPU core utilization	85%
Average CPU readiness	10%
Average memory utilization (active)	85%
Consumed memory	<100%
Memory ballooning	0
Memory swapping	0
Network throughput	85%
Cluster storage latency	20 milliseconds (ms)
Disk latency	20 ms
Spare capacity	15%

Test configuration details

The following tables list the hardware and software components of the infrastructure that was used for the PAAC test. All host machines were updated with the latest operating system and security updates.

The following table shows the hardware components:

Table 4. Hardware components

Hardware type	Component
Compute host hardware	16 x PowerEdge R750 Servers ● 2 x Intel Xeon 6348 @ 2.6 GHz, 28-core processors ● 1,024 GB Memory @ 3200 MT/s (16 x 64 GB DDR4) ● Broadcom Adv. Dual 25 Gb Ethernet 25 Gbps
Management host hardware	R730
Storage	Dell PowerStore 9200 T ● PowerStoreOS 3.0 ○ 21 x 3.84 TB NVMe SSD ○ 25 GbE NVMe/TCP
Network	S5248-ON Switch

The following table shows the software components:

Table 5. Software components

Software type	Program/version
Display protocol	BLAST Extreme H.264 + Switch Codec
Broker	VMware Horizon 8.4
Hypervisor	vSphere ESXi 7.0.3
SQL	Microsoft SQL Server 2019
Desktop operating system	Microsoft Windows 10 Enterprise 64-bit (version 21H2)
Office software	Microsoft Office 365 / 2019
Management operating system	Microsoft Windows Server 2019
Login VSI version	4.1.40.1
Antivirus software	Windows Defender

User VM configurations

The following table summarizes the standard PAAC VM configurations for Login VSI currently used for the various profiles/ workloads tested:

Table 6. Login VSI configurations

Workload	VM profiles				
	vCPUs	RAM	RAM reserved	Desktop video resolution	Operating system
Knowledge Worker	2	4 GB	2 GB	1920 x 1080	Windows 10 Enterprise 64-bit

Standard VDI test results and analysis

We performed this test with the Login VSI Knowledge Worker workload on a 16-node compute cluster (see Table 4). We created the desktop VMs using VMware Horizon instant clone technology provisioned on PowerStore storage volumes with connectivity through NVMe/TCP. The VDI desktops used the VMware Horizon Blast Extreme display protocol. We populated each of the 16 compute hosts with 225 desktop VMs for a total of 3,600.

Login phase

The following figure shows the performance of the Dell PowerStore storage appliance during the login phase of Login VSI:

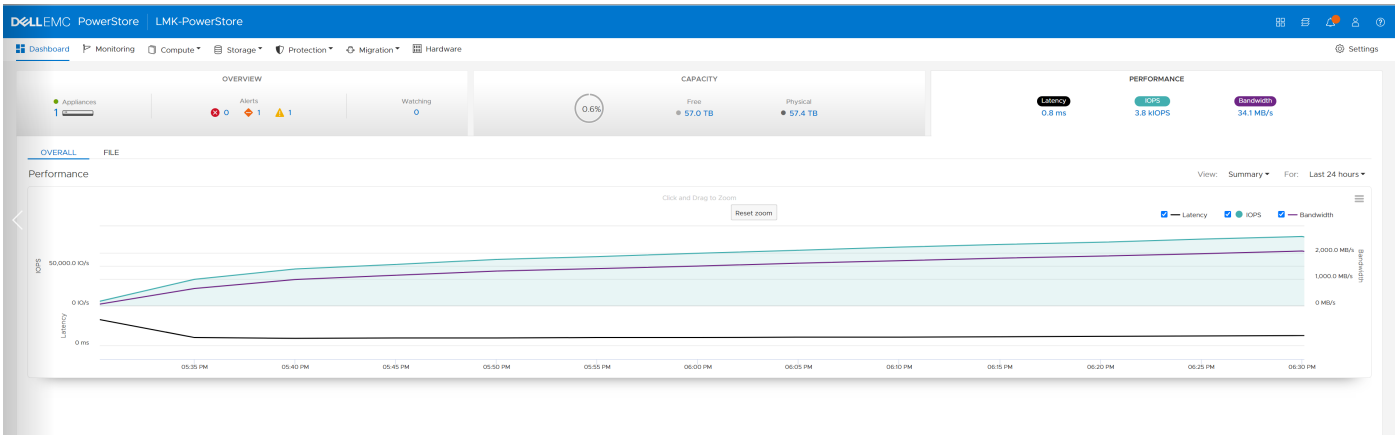

Figure 7. Login phase

Steady-state phase

Once all the simulated users logged in and were performing their daily tasks, the load was still over 56K IOPS at 0.32 ms of system latency. The following figure shows the steady-state workload:

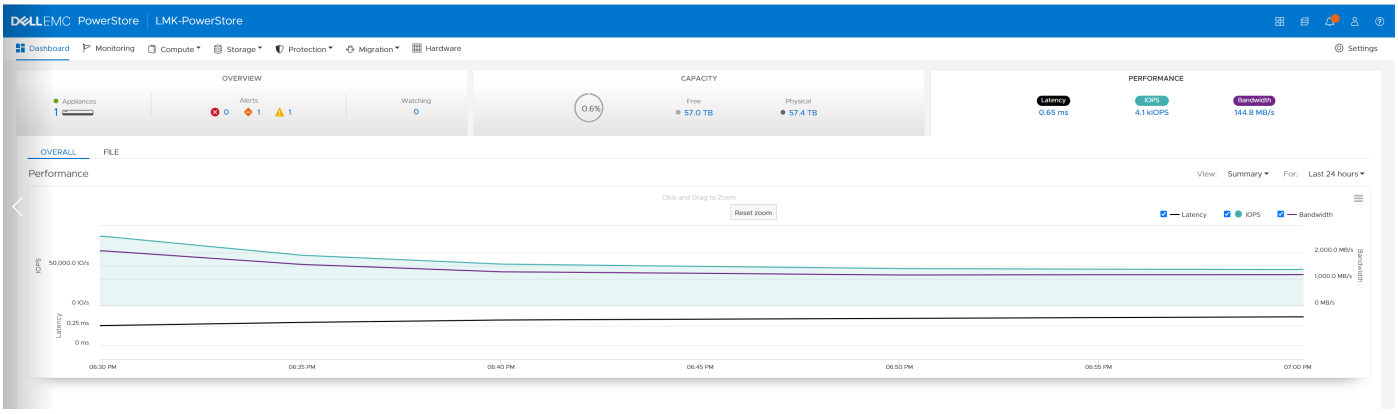

Figure 8. Steady-state phase

User experience

The baseline score for the Login VSI test was 610. This score falls in the 0 to 799 range rated as "Very Good" by Login VSI. For more information about Login VSI baseline ratings and baseline calculations, see VSImax baseline scores.

As indicated by the blue line in the following figure, the system reached a VSImax average score of 851 when 3,598 sessions were loaded. This value is well below the VSI threshold score of 1,610 set by the Login VSI tool.

During testing, VSImax was never reached, which typically indicates a stable system and a better user experience. The VSI Maximum response times increased considerably during the end of the test, indicating that there was a constraint on the computing resources. Login VSI metrics indicated that the constraint was not within the storage platform.

The Login VSImax user experience score for this test was not reached. When manually interacting with the sessions during the steady-state phase, the mouse and window movement were responsive, and video playback was good. No "stuck sessions" were reported during the testing, indicating that the system was not overloaded at any point. See Appendix A, which explains the Login VSI metrics.

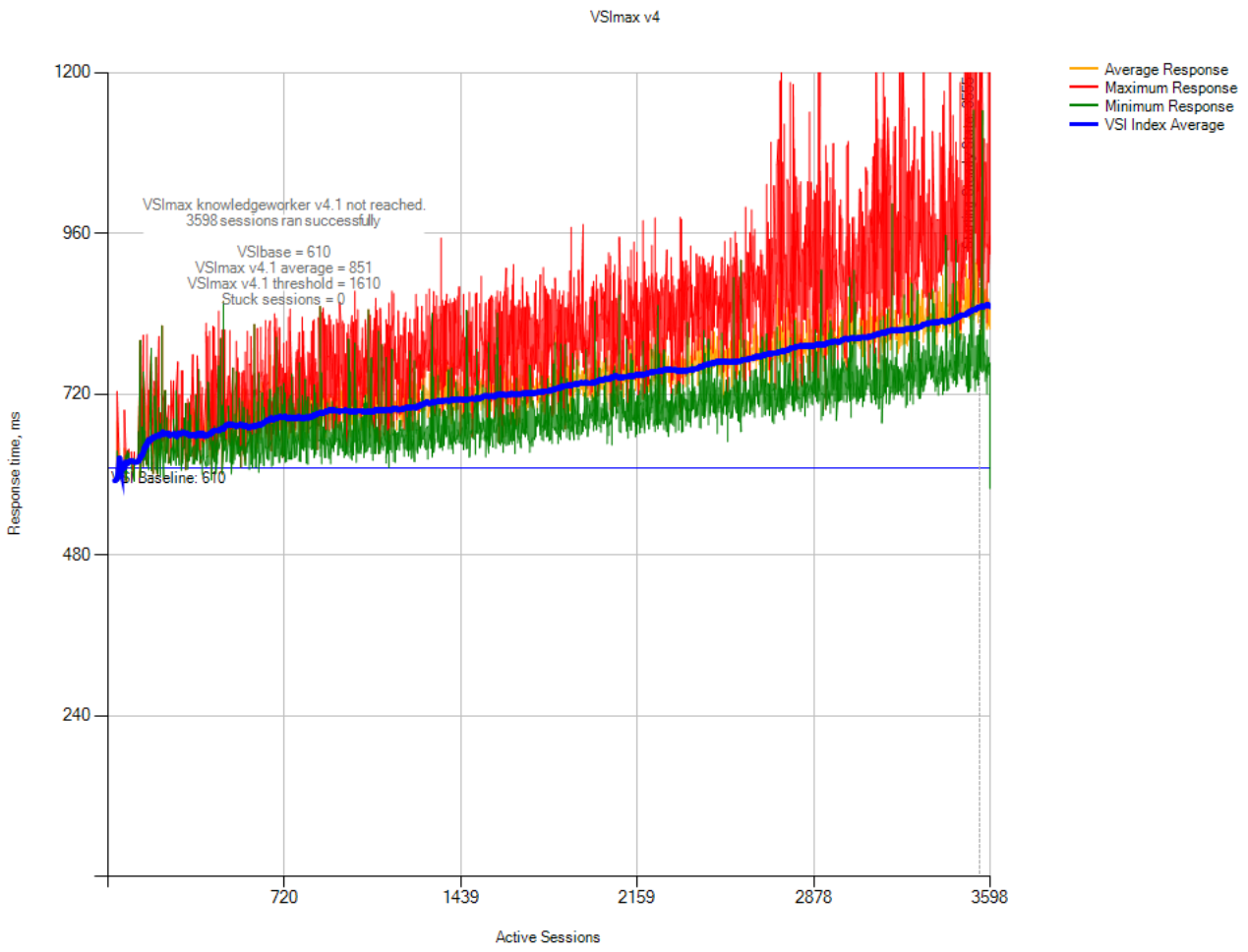

Figure 9. User experience

4

Sizing the Solution and Best Practices

Topics:

Sizing and scaling overview

VDI solutions built with Dell PowerStore T storage provide flexibility as you scale, reducing the initial and future cost of ownership. Cluster additional controllers and add SSDs and expansion shelves to the storage system to scale horizontally (scaling out). Upgrade controllers using Anytime Upgrade to scale vertically (scaling up).

Scaling out

Each component of the solution architecture scales independently, depending on the required number of supported users. You can add storage controllers, enclosures, and SSDs at any time to expand the storage pool in a modular fashion. The scaling limit for the storage cluster is restricted to four each with three expansion enclosures.

The boundary for a Horizon block is the vCenter. The number of VMs a vCenter can host depends on the type of Horizon 8 VMs in use. The recommended limit of virtual machines per vCenter is 20,000 full-clone or instant-clone VMs.

Sizing recommendations change over time as updates are released and qualifications are performed. See the VMware Configuration Maximums website for the latest recommendations. This Dell Validated Design for VDI solution uses instant clones, as shown in the following figures.

VMware recommends a limit of 5,000 instant-clone VMs per block. With these limits in mind, 25 compute nodes with 200 task-user VMs per node would reach the maximum number of VMs for the block.

The following figure shows a 5,000-user pod:

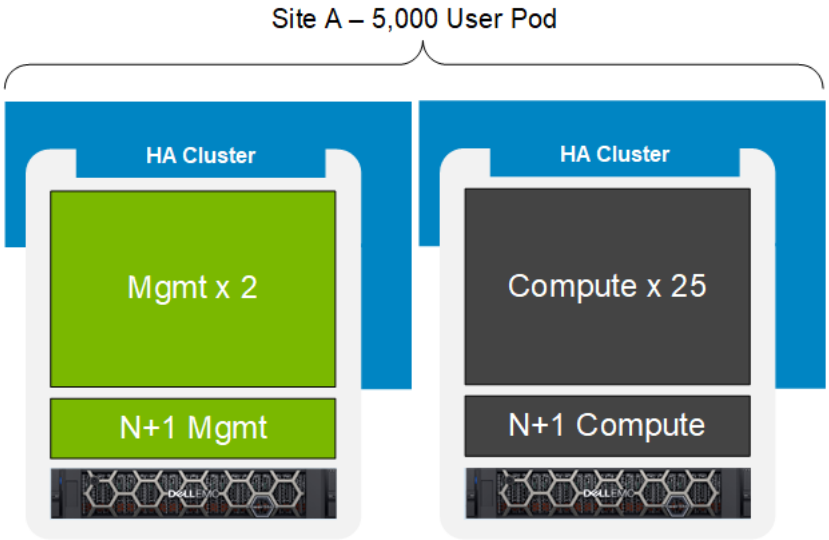

Figure 10. 5,000-user pod

The following figure shows a scale-out to a 20,000-user Horizon pod with 5,000 user blocks. Each block contains its own vCenter Server instance and VDI components, as well as a separate PowerStore T storage appliance.

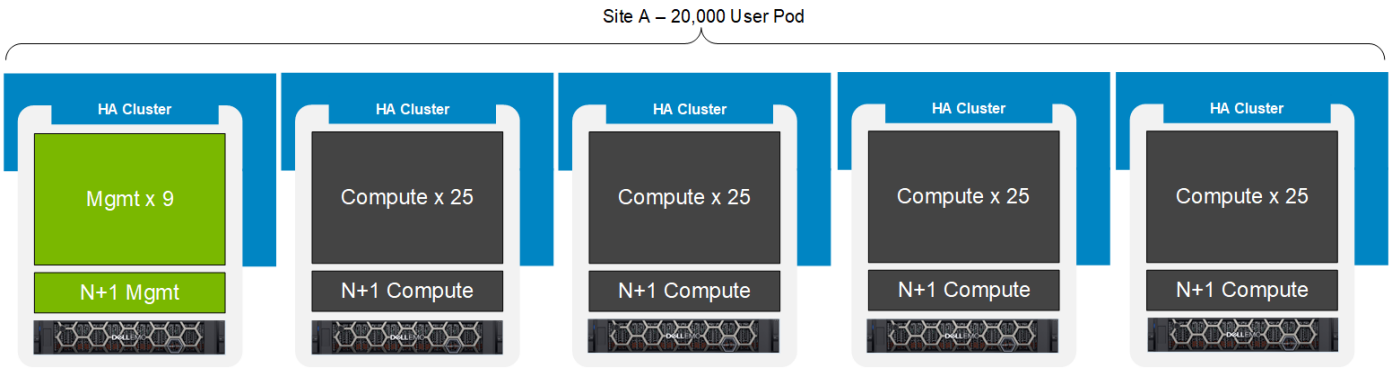

Figure 11. 20,000-user pod

Scaling up

Dell Technologies recommends selecting a PowerStore storage controller that will accommodate your workload as optimally as possible. If future growth or configuration changes require additional performance, the storage controller can be swapped through the Anytime Upgrade program.

For more information about Horizon pod and block architecture, and scaling, see the VMware Workspace ONE and VMware Horizon Reference Architecture.

Storage design

The size and type of traffic that is generated from a VDI environment is noticeably different from most business applications. The difference in the size and pattern of VDI traffic is consistent, but requires a few changes to the storage design for proper management.

VMware best practices

Most VMware best practices apply to VDI environments, but there are a few changes required due to the nature of high-density VM configurations. For VMware best practices, see Dell PowerStore: VMware vSphere Best Practices on the PowerStore Info Hub.

With most applications, storage traffic is typically 70 percent reads. There are applications that generate all reads or all writes, but the average tends to be a 70 percent read to 30 percent write ratio.

Volume count

There are several factors that determine the optimal volume count with Horizon on PowerStore. There isn't a single volume count that fits all scenarios. Performance and management overhead are typically the two most important factors. For performance reasons, a minimum of 16 volumes is recommended. This configuration ensures good queue balancing and reduces I/O bottlenecks.

Balance this volume recommendation with the goal of keeping the volume count low for minimized management. The VMware guidance for volume count should also be considered. Internal testing shows that 16 volumes can support 3,000 users from a performance perspective, but may have an impact on VM recovery from a backup. Using array-based snapshots reduces recovery time and minimizes the impact of higher user-per-volume counts.

I/O size

The average I/O size of storage traffic in a VDI environment typically ranges from 24k to 32k. This size can vary if host-based caching is enabled or allowed. Some VM configurations do not allow host-based caching.

Heavy writes

VDI environments are typically heavily biased towards writes. This bias occurs because once the VMs are booted, the I/O traffic includes mostly changes from each VM. The traffic consists of file changes, swap file writes, memory paging, and updates to user preferences. This traffic pattern makes VDI one of the more demanding applications.

The heavy write ratio of VDI requires more attention to be focused on the number of writes that are generated and the rate of change to the environment. For environments that are persistent, these factors should be accounted for when snapshots are taken. The average snapshot size is larger because of the rate of change occurring.

If persistence is maintained at the VM level and profile redirection technology is not used, the VM volumes must be larger. The snapshot growth is larger as well.

Instant clone pools

Instant clones generate a large volume of traffic during the provisioning process due to the method used to create the VMs. Since the in-memory VMFork technology creates the virtual machines quickly, the volume of traffic is significant. The I/O required to complete the creation is brief, but large.

Plan for bursts of high traffic when creating or refreshing instant clone machines. These bursts of high traffic may impact other workloads if a PowerStore appliance is not dedicated to VDI. For a large VDI implementation, a PowerStore appliance should be dedicated to VDI.

Instant-clone machines reset on logout. As users log off, their virtual desktops refresh automatically. This action occurs throughout the workday and should be considered in the design. Virtual desktop refreshes cause a brief spike in I/O that is proportional to the number of desktops refreshing at any given time. If many desktops refresh simultaneously, the I/O demand will spike as they refresh.

Capacity

The density of data on VDI tends to be high because many Horizon VDI environments use data-reduced clones. With profile-redirection technology like VMware Dynamic Environment Manager (DEM), clone pools appear as persistent to users. DEM enables users to personalize their desktop, but pools can still employ the benefits of non-persistent VMs. Keeping the VMs small and clean improves performance and recovery time.

The advantages of small virtual desktops include faster boot times, reduced capacity requirements, reduced pool creation time, and fewer updates required. With instant clones, the administrative overhead is reduced even further with the automatic refresh of virtual desktops on logout. Any misconfiguration in a VM is cleared when the user logs out and the machine is re-cloned.

Drive counts for block-only VDI are a function of IOP requirements rather than capacity. Since the VMs generate many IOPs per TB of storage that is consumed, performance is more of a concern than capacity. In a unified-file-storage product, capacity may increase drive counts beyond performance requirements. To see the NAS limits of the PowerStore platform, see Dell PowerStore: VMware vSphere Best Practices on the PowerStore Info Hub.

The number and size of the file shares or exports determine the capacity that must be added, based on performance guidance on Dell.com/Support.

Guests

VMware Horizon supports two guest operating systems for desktop pools. Not all features are available with both operating systems because of the architecture of the individual operating systems. While only one image can be used per pool, multiple pools can be created, one for each VM role.

Windows

The behavior of Windows desktops in a VDI environment can vary greatly. Because of the number of services and process in Windows, the host load can vary based on customizations that are applied to the guest operating system.

One of the best ways to reduce CPU and disk load from a Windows VM is to use the VMware OS Optimization Tool (login required). This tool is a consolidated interface that can be used to change the behavior of VMs to reduce their hardware requirements. Be careful if choosing the most-restrictive configurations, which can cause applications or even Windows features to stop working. This tool is designed to reduce the effort of optimizing Windows, but it requires testing of the configuration for all user applications.

Another tool that was mentioned previously in this paper is VMware DEM. This tool redirects user data to one or more file shares based on certain conditions. This capability allows directing different types of data to different locations. User-profile data and documents can be pointed to home directories that are replicated. Application temporary data that does not need

protection is placed on volumes with no data protection enabled. This approach reduces replication traffic and the overall storage load.

Linux

Horizon supports virtual desktops on Linux with some caveats and restrictions on versions and distributions. For details, see the VMware product documentation about the System Requirements for Horizon for Linux. The storage requirements are determined more by the applications that are supported than the base operating system. This document does not address the variations in Linux configurations.

Networking

PowerStore has options to support diverse network designs and protocols. The abstraction between the storage and front-end connectivity enables great flexibility in design.

Management

PowerStore is managed through the first two ports on the integrated four-port card, as shown in Figure 4. These ports are automatically bonded for availability.

These ports provide connectivity through several protocols and storage methods such as web interface (HTTP), REST API, and PowerStore CLI (PSTCLI).

An integrated web-based interface is included for most management needs, as shown in the following figure. The interface addresses all day-to-day management tasks and storage alerting. Automated notification can be configured for remote alerting as well.

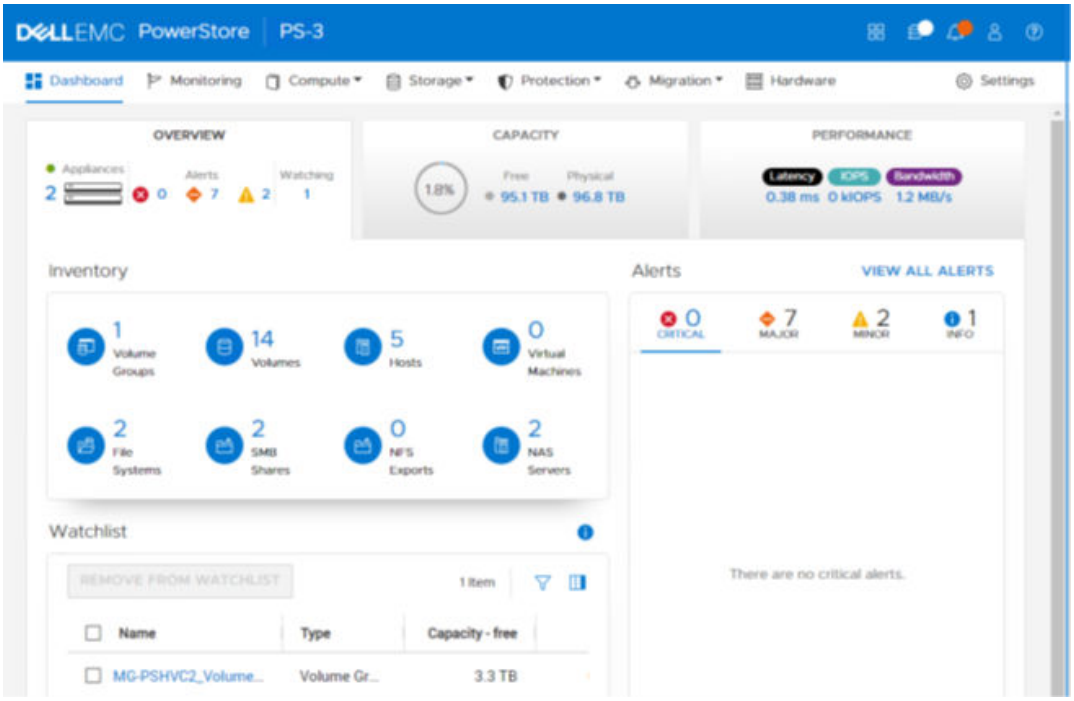

Figure 12. PowerStore interface

DRE and storage containers

PowerStore uses a dynamic resiliency engine (DRE) to automatically manage the underlying storage for maximum performance and capacity. DRE eliminates the need for administrators to configure protection settings for the storage pool. Manually setting or configuring these options is unnecessary in PowerStore. The underlying configuration and drive management are automatic.

Changing capacity needs

Planning for the future is simple with PowerStore. Dynamically scaling as drives are added is as simple as adding drives or enclosures of disks. When new drives are detected, they are automatically added to the available capacity.

Adding capacity to an existing file system is easy. Choose the new size, and the file system expands instantly. No downtime is required and there is no user impact.

Reducing the size of a file system is also simplified. If excess space is allocated to a file system, it can be reduced in size if sufficient capacity remains for existing data. With thin provisioning, no space is wasted, and file systems do not need to be reduced unless hard growth boundaries must be set.

Quotas are supported as well for growth management. This feature can prevent user directories or shared file structures from growing beyond the capacity of the system.

Horizon configuration

Horizon does not require any special configuration to work with PowerStore. The storage is presented as block storage volumes discoverable through VMware vCenter. When the pool is created, the volumes are visible as usable disks.

Volumes that are presented through PowerStore can grow dynamically. If the original volumes must grow as the VM requirements change, they can be expanded using the standard management methods. This expansion is done using a PowerCLI script (RESTAPI) that also expands the datastores. PowerStore Manager is used to expand a single volume.

Replication

The nature of VDI environments is to create pools of VMs that are not necessarily tied to a specific user. This ability reduces the administration of the environment and also reduces the need for backups, disaster recovery, and data-loss mitigation.

This design also reduces the need for replication. Since data is typically not stored in the user VMs, the VMs do not need to be copied offsite. A VM pool can quickly be created offsite if the infrastructure is available, including the template VMs.

User data from file shares can be replicated in several ways. PowerStore uses protection policies to take snapshots and replicate data, as shown in the following figure.

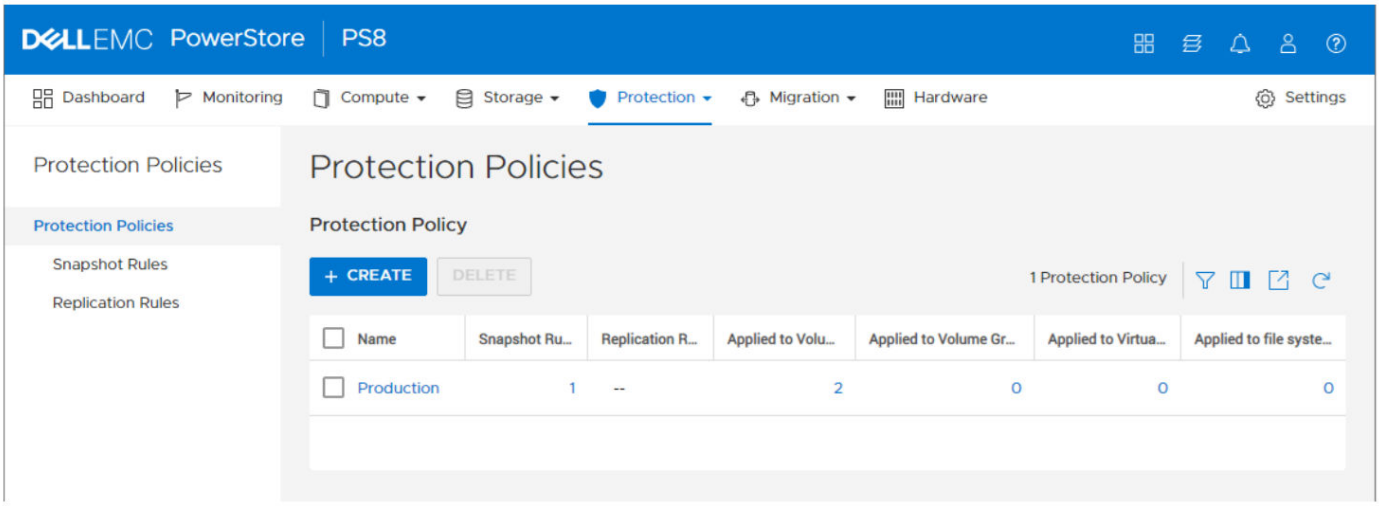

Figure 13. PowerStore protection policies

Secondary pools

One simple way to help users quickly return to work is to keep additional VMs ready in a recovery pool. This pool can be assigned to end-users if the primary systems are down. This pool may not have the same performance characteristics, but can aid in business continuity.

5

Backup and Restore

The growth of VDI adoption has elevated the strategic importance of organizational VDI environments. Users who are critical to business success are increasingly using VDI for their day-to-day productivity tasks. Consequently, the importance of protecting the VDI environment and the business value of its data has also grown as customers seek to ensure their VDI environments meet corporate availability, recovery time objective (RTO), and recovery point objective (RPO) requirements.

For information about data protection of a VMware Horizon environment, see the Data Protection for a VMware Horizon VDI Environment using Dell Data Protection Suite Operations Guide. Dell Technologies provides several data protection solutions for different data protection requirements.

Dell Avamar Virtual Edition

Dell Avamar Virtual Edition is a data protection solution that delivers software-only data protection for virtualized environments and is ideal for the VDI use case. Avamar Virtual Edition is a fully featured data protection solution that is deployed as a virtual appliance. It supports advanced functionality such as cloud-based backup, including VMware Cloud on AWS, change block tracking for fast backup and recovery, and integration with multiple VMware interfaces, such as the vRealize Automation Data Protection Extension. For more information, see Dell Avamar Data Protection Software.

Dell PowerProtect DD Virtual Edition

Dell PowerProtect DD Virtual Edition is a data protection storage solution that runs as a virtual appliance on a customer's choice of hardware or on a variety of public cloud options, including VMware Cloud on AWS. For on-premises deployments, PowerProtect DD Virtual Edition is deployed as a virtual appliance on the relevant hardware platform. PowerProtect DD Virtual Edition has a single point of management with Dell Data Domain Management Center and scales up to 96 TB per instance. One of the key features of the PowerProtect DD storage protection solution is DD Boost, which provides advanced integration with data protection applications such as Avamar Virtual Edition to enable client-side deduplication, thus accelerating backup. For more information, see Dell PowerProtect DD Virtual Edition.

Other Dell Technologies data protection products

Dell Technologies provides other data protection products for specific use cases. Products include a range of appliances that reduce data protection complexity. These scalable, preconfigured solutions combine data protection storage with software, search, and analytics. For more information, see Dell Technologies Data Protection and Backup Solutions.

6

Summary

Topics:

Overview

This design guide describes the integration of Dell PowerStore T scalable all-flash storage from Dell Technologies and VMware Horizon 8 brokering software to create virtual application and desktop environments. This architecture provides exceptional scalability and an excellent user experience, and empowers IT teams to play a proactive strategic role in the organization.

Dell Technologies offers comprehensive, flexible, and efficient VDI solutions that are designed and optimized for the organization's needs. These VDI solutions are easy to plan, deploy, and run.

Dell Validated Designs for VDI offer several key benefits to clients:

- Predictable costs, performance, and scalability to support a growing workforce
- Rapid deployments
- Rapid scaling, ready to serve enterprises of any size
- Dell Technologies support

With VDI solutions from Dell Technologies, you can streamline the design and implementation process, and be assured that you have a solution that is optimized for performance, density, and cost-effectiveness.

Next steps

Dell Technologies has configurations to fit the needs of any size organization. With PowerStore storage, there are a variety of models and configurations to choose from to meet the demands of your workload. With PowerStore Anytime Upgrade, you can perform data-in-place, non-disruptive upgrades with easy controller swaps that keep the original chassis, drives, and expansion enclosure while keeping the same support.

To explore more of our Validated Designs for VDI, contact your Dell Technologies account representative. For additional resources and other VDI designs, see the Dell Technologies Solutions Info Hub for VDI.

7

References

Dell Technologies documentation

The following Dell Technologies documentation provides additional information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your Dell Technologies representative.

- Dell Technologies Virtual Desktop Infrastructure
- Dell Technologies Solutions Info Hub for VDI
- PowerStore Info Hub
- PowerStore Product Documentation & Videos

VMware documentation

The following VMware documentation provides additional information:

- VMware vSphere documentation
- VMware Horizon documentation
- VMware Compatibility Guide
- Best Practices for Published Applications and Desktops in VMware Horizon and VMware Horizon Apps
- VMware Workspace ONE and VMware Horizon Reference Architecture

A

Appendix A: Definition of performance metrics

The following table explains the performance metrics used during our testing:

Table 7. Definition of performance metrics

Metric	Definition
CPU usage	The average CPU percentage usage over the steady-state period.
CPU core utilization	The CPU utilization percentage of the corresponding core. A core is utilized if one or both of its logical CPUs are used. This figure is averaged across all cores.
CPU readiness	The percentage of time that the virtual machine was ready but could not get a scheduled run on the physical CPU.
Consumed memory	The amount of host physical memory consumed by a virtual machine, host, or cluster.
Active memory	The amount of memory that is actively used, as estimated by the VM kernel based on recently touched memory pages.
Network usage	Network usage per user is the average over the steady-state period divided by the number of users on a host in megabits per second.
Cluster disk IOPS	Read and write Input/Outputs Operations Per Second (IOPS) consumed by all vSAN clients in the cluster, such as virtual machines, stats objects, and so on.
Disk I/O (or cluster) latency	Average read and write latency of I/Os generated by all vSAN clients in the cluster, such as virtual machines, stats objects, and so on.