Dell Validated Designs for VDI

Designs for VMware Horizon vSAN Ready Nodes

May 2023

H19568

Design Guide

Abstract

This design guide describes the architecture and design of the Dell Validated Design for integrating VMware Horizon brokering software with vSAN Ready Nodes to create virtual application and desktop environments based on the latest Dell PowerEdge servers in a VMware vSphere environment.

Dell Technologies Solutions

Dell
Validated Design

DELL Technologies

Copyright

Contents

Chapter 1 Introduction

This chapter presents the following topics:

Solution Introduction

Overview

Dell Validated Designs for virtual desktop infrastructure (VDI) in vSAN-based environments simplify and extend your VMware environment. By combining compute, storage, virtualization, and management, Dell Validated Designs for VDI are the ideal solutions for your VDI environment.

The Dell Validated Designs for VDI are built on vSAN Ready Nodes appliances. These Ready Nodes are true hyperconverged infrastructure (HCI) platforms providing performance, flexibility, and scale for VDI environments.

Dell vSAN Ready Nodes ensure that your pre-validated configuration works with vSAN technology and VMware Horizon 8 suite. Installing VMware Horizon 8 with its VDI components on vSAN Ready Nodes enables organizations to quickly deliver Microsoft Windows virtual desktops or server-based hosted shared sessions on a wide variety of endpoint devices.

Document purpose

The purpose of this document is to introduce the architecture, components, design options, best practices, and configuration details for successful VDI deployments for vSAN Ready Nodes 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 vSAN Ready Nodes.

What’s New?

Dell vSAN Ready Nodes based on 16th Generation PowerEdge servers with 4th Generation Intel® Xeon® Scalable Processors feature:

- **Improved virtual desktop density**—With increased CPU core count and support for 4800MT/s DDR5 memory, 4th Generation Intel Xeon Scalable CPUs provide higher virtual desktop density per host for virtual desktop workloads.
- **Intel Speed Select Technology (SST**)—Improvements to SST technology through Performance Profiles enables improved server utilization and reduced qualification costs by letting you reconfigure a single server to match fluctuating VDI workloads.

Design Guide Introduction

Dell Technologies offers comprehensive, flexible, and efficient VDI solutions that are designed and optimized for your organization, which makes Dell VDI solutions easy to plan, deploy, and run.

vSAN Ready Nodes are one solution that uses VMware vSAN technology to help you start or extend your data center. This solution does not include the software components that are found in the VxRail product. However, vSAN Ready Nodes offer a greater array of platforms, configurations, and additional peripheral device choices.

Dell Validated Designs for VDI offer several key benefits:

- **Predictable costs, performance, and scalability to support a growing workforce**—Deploying from a data center reduces the cost of deploying applications and desktops.
- **Rapid deployments**—Rapid automated deployment at the infrastructure layer through Dell Services.
- **Rapid scaling to serve enterprises of any size**—Scale rapidly with workload-specific configurations per platform. The solution is scalable up to 64 nodes per cluster, supporting thousands of virtual machines (VMs). Continue scaling with pod architecture and by combining multiple clusters.
- **Dell Technologies support**—Dell Validated Designs for VDI are tested and validated engineering systems for VDI and its related tools. Deployment services provide installation of this turnkey VDI appliance to ensure a rapid deployment with linear and predictable scalability.
- **User experience (UX)**—NVIDIA virtual GPU technology brings the power of NVIDIA GPUs to virtual desktops, apps, and workstations, accelerating graphics and compute to enable virtualized workspaces to perform just like physical PCs. This means that users working from home offices or anywhere can have a consistently excellent user experience.

Note: Dell Technologies offers single-company-support models for Horizon and vSAN-based solutions.

Chapter 2 Solution Architecture

This chapter presents the following topics:

Overview

This chapter provides an architecture overview and guidance for managing and scaling a VMware Horizon environment on Dell vSAN Ready Nodes.

Solution architecture

The following figure depicts the architecture of the validated solution, which includes the network, compute and graphics, management, and storage layers. This architecture aligns with the VMware Horizon pod and block design. A pod is divided into multiple blocks. Each block is made up of one or more vSphere clusters and a vCenter Server.

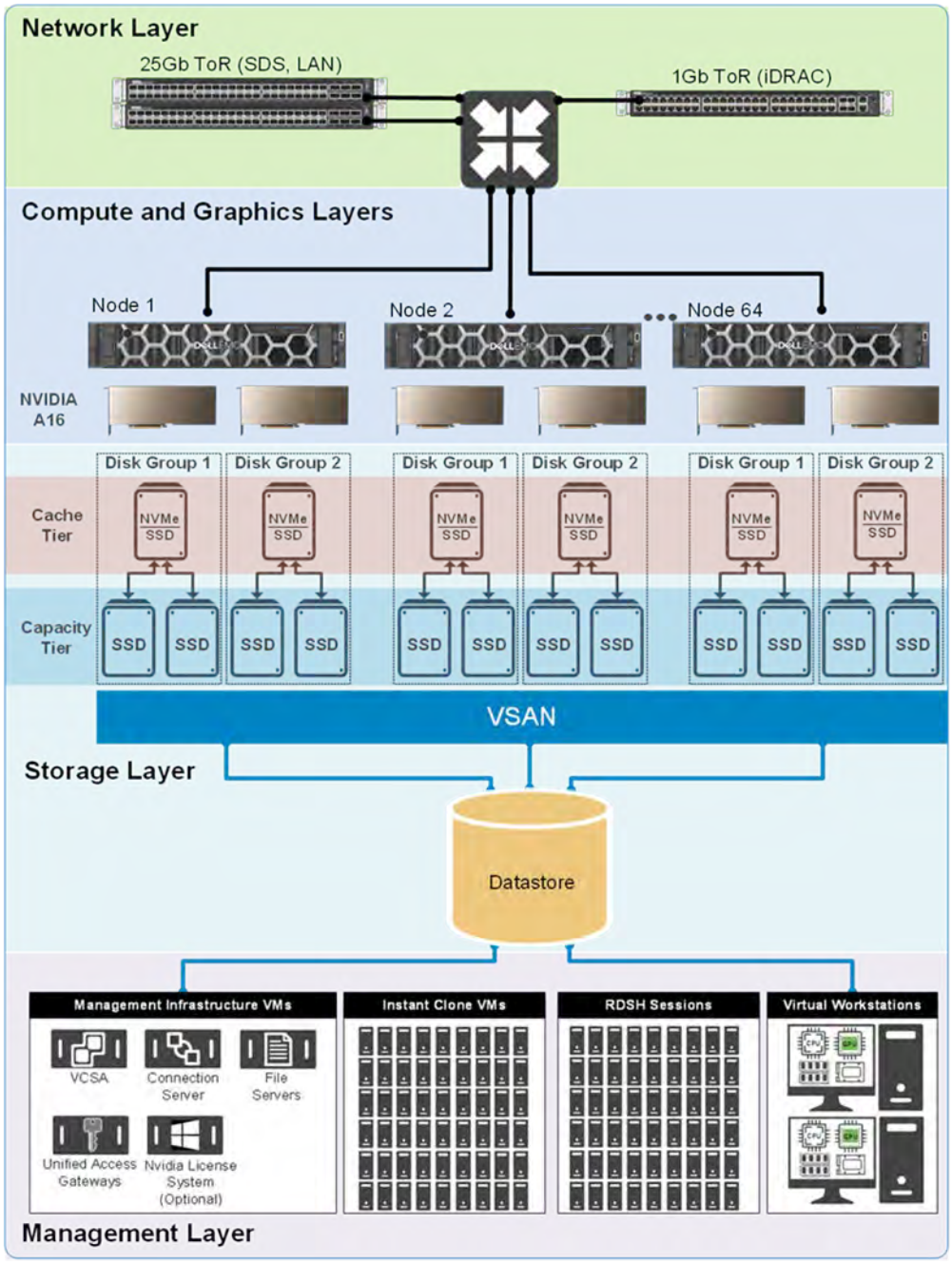

Figure 1. Solution architecture

Physical Architecture

Overview

The PowerEdge R760 vSAN Ready Node is the recommended appliance for VDI deployments as it is leveraged for both “Density Optimized” and “Virtual Workstation” configurations.

vSAN Ready Nodes

vSAN Ready Nodes are pre-validated Dell server configurations that reduce the complexity of deploying vSAN technology. For the supported (or available) vSAN Ready Node configurations, see the vSAN Ready Node compatibility guide on the VMware website. vSAN Ready Nodes provide more customized hardware and platforms to meet your data center needs.

Because vSAN Ready Nodes do not offer life cycle management (LCM) and additional bundled software, Dell Technologies recommends customized deployment services and at least three years of ProSupport Plus. Add VMware Horizon Universal Subscription or Horizon Enterprise Edition (TERM) to license your Dell vSAN Ready Nodes for a full VDI deployment.

PowerEdge R760 front view

The following diagram shows the PowerEdge R760 front view with cache and capacity storage tier:

Figure 2. PowerEdge R760 front view

PowerEdge R760 rear view

The following diagram shows the PowerEdge R760 rear view with network, I/O, and GPU options:

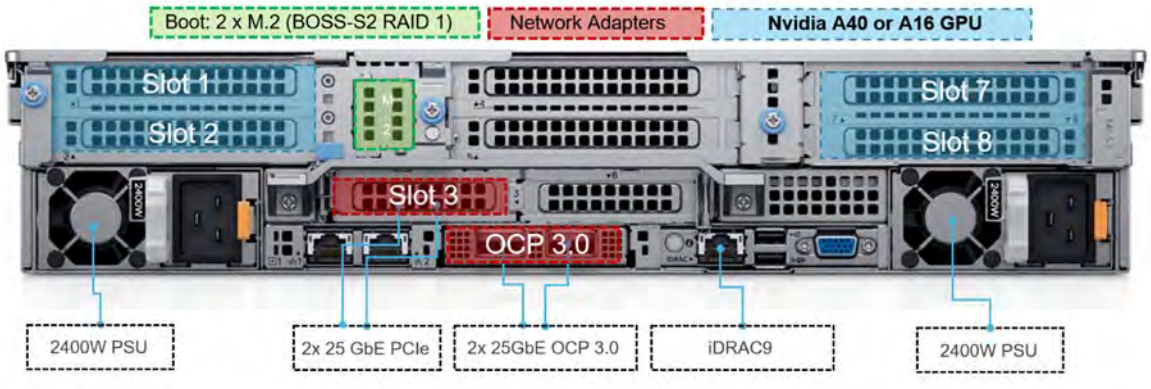

Figure 3. PowerEdge R760 rear view

VDI-optimized configurations

For graphics-intensive desktop deployments, Dell Technologies recommends the VDI-optimized 2U rack servers that support GPU hardware.

The vSAN Ready Node R760 server is configurable with or without GPUs. Dell Technologies also offers similar configurations in a 1U rack server; however, graphics configurations are limited on these platforms.

Common configurations have been designated as "Management-Optimized" and "Density-Optimized," as referenced in the following table:

Table 1. Common configurations

Configuration	CPU	RAM	Disk	GPU (optional)	Description
Management-optimized	1x Intel Xeon Gold 6430 (32-core @ 2.1 GHz)	256 GB (8 x 32 GB) @ DDR5 4800 MHz	4 TB + (capacity)	None	Offers density and value to provide a dedicated environment to deploy virtualized management infrastructure.
Density-optimized	2 x Intel Xeon Gold 6448Y (32-core @ 2.1 GHz)	1024 GB (16 x 64 GB) DDR5 @ 4800 MHz	8 TB + (capacity)	Up to 2 x full length, dual width (FLDW) Up to 6 x half length, single width (HLSW)	Offers an abundance of high-performance features and tiered capacity that maximizes user density.

NVIDIA GPUs

Dell Validated Designs for VDI are configurable using the following NVIDIA GPUs:

- **NVIDIA A40**—NVIDIA A40 GPUs provide a leap in performance and multi-capabilities for the data center, combining superior professional graphics with powerful compute and AI acceleration to meet today's design, creative, and scientific challenges. Driving the next generation of virtual workstations and server-based workloads, NVIDIA A40 brings features for ray-traced rendering, simulation, virtual production, and more.
- **NVIDIA A16**—NVIDIA A16 GPUs combined with NVIDIA Virtual PC (vPC) or NVIDIA RTX Virtual Workstations (vWS) software enables remote desktops and workstations with the power and performance to tackle any project from anywhere. Purpose-built for high-density, graphics-rich VDI and leveraging the NVIDIA Ampere architecture, NVIDIA A16 provides double the user density compared to the previous generation, while ensuring the best possible user experience.

Physical network components

Dell Validated Designs for VDI on appliances enable flexibility in networking selections. VDI validations are performed with the following hardware:

- **Dell Networking S4148F-ON (10 GbE ToR switch)**—The S4148F-ON switch optimizes your network for virtualization with a high-density, ultra-low-latency ToR switch that features 48 x 10 GbE SFP+, 2x 40 GbE QSFP+, and 4 x 100 GbE QSFP28 ports (or 72 x 10 GbE ports in breakout mode) and up to 1.76Tbps performance. The S4148F-ON switch supports ONIE for zero-touch installation of alternate network operating systems.
- **Dell Networking S5248F-ON (25 GbE ToR switch)**—The S5248F-ON 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 also supports ONIE.

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

Note: Several other hardware choices are available.

Networking

Designed for true linear scaling, vSAN Ready Nodes use a leaf-spine network architecture, which consists of two network tiers: an L2 leaf and an L3 spine that is based on 100 GbE and non-blocking switches. This architecture maintains consistent performance without any throughput reduction.

File workload

In recent years, the amount of data that is stored in file shares and user home directories across IT environments has continued to grow, resulting in an increased focus on the need to better manage this unstructured data. As a result, many organizations are deploying dedicated file workload solutions with capabilities such as cloud file tiering and single file system namespaces across their IT infrastructure. These capabilities are also useful for file workloads in a VDI environment.

Dell Technologies provides several solutions for different types of file workloads that can be leveraged for user profile management and user data.

Dell PowerStore T storage

Dell PowerStore T storage is simple, unified storage that enables flexible growth with intelligent scale-up and scale-out capabilities and public cloud integration. This storage system is ideal for general-purpose NAS or SAN mixed workload consolidation, smaller file workloads (including small to midsized VDI environments), and transactional databases.

Dell Technologies recommends that you deploy a separate PowerStore T storage system with a vSphere HA cluster or block when you are deploying PowerStore T in a VDI environment. Each PowerStore T system can scale up to four appliances per cluster. This structure provides the greatest scalability, resiliency, and flexibility for deploying and maintaining file services for the overall user pod. As unstructured data storage needs grow over time, the capacity of each PowerStore T storage system can be scaled up or out independently with minimal user impact. If you choose to deploy alternative architectures to those that are suggested in this guide, carefully consider the tradeoffs.

For guidance with selecting an appropriate PowerStore T storage solution for your file workload requirements, see Dell PowerStore on the Dell Technologies PowerStore website.

Dell PowerScale file storage

Dell PowerScale storage is a scale-out NAS solution for any file workload. The PowerScale system is ideal for a wide range of file workloads (including large-scale enterprise VDI environments requiring a single file system namespace), high-performance computing (HPC), archiving, and infrastructure consolidation.

When deploying a PowerScale storage system in a VDI environment, Dell Technologies recommends that you deploy a separate PowerScale system with a vSphere HA cluster or block. This structure provides the greatest scalability, resiliency, and flexibility for deploying and maintaining file services for the overall user pod. Because unstructured data-storage needs to grow over time, you can scale up the capacity of each PowerScale storage system independently with minimal user impact. In addition to scaling up each PowerScale chassis, you can also scale out a PowerScale system by using the Dell OneFS operating system. Thus, multiple PowerScale systems can provide a single volume and namespace that all user pods in a data center can access.

For guidance on selecting an appropriate PowerScale storage solution for your file workload requirements, see Dell PowerScale on the Dell Technologies PowerScale website.

Data center infrastructure

Enterprise equipment requires power to operate, racks to enable streamlined management, and cooling to maintain reliable operations.

Careful selection of the infrastructure solutions that provide these capabilities is vital to ensure uptime, scalability, energy efficiency, and ease of management. Dell Technologies provides a wide range of data center infrastructure solutions, including:

- **Dell Netshelter SX racks**—Deploy server, storage, networking equipment, and other IT hardware while optimizing power, cooling, cabling, and system management.
- **Dell Keyboard Video Mouse (KVM) and Keyboard Monitor Mouse (KMM) solutions**—Manage 8 to 1,024 local and remote servers running various operating systems across the enterprise.
- **Dell Smart-UPS**—Deliver reliable power and protect IT equipment, including servers, storage, networking, point-of-sale, and medical equipment.
- **APC Rack Power Distribution Units (PDUs)**—Provides reliable power distribution that is designed to increase manageability and efficiency in your data center.

Client components

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

Table 2. Recommended client components for virtual desktops

Component	Description	Recommended use	More information
Latitude laptops and 2-and-1s	• 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 audio for 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	• Mobility and space-saving devices • Allows users to be productive and stay connected with versatile, space-saving mobile solutions • Offers a modern portfolio built to prioritize customer experience and keep employees productive wherever they work with a selection of laptops, 2-in-1s, and ecosystem products	Latitude
OptiPlex business desktops and All-in-Ones (AIOs)	• Intel 9th Gen 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	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	• 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.	Precision

Software

Overview

Understanding the architectural components in a VDI environment is crucial to ensuring that the solution is deployed correctly. This section provides a high-level overview of the components needed for creating and deploying a VDI 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. These features reduce 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 vSAN Enterprise Edition**—Includes all-flash space-efficiency features (deduplication, compression, and erasure coding), software-defined, data-at-rest encryption, and stretched clusters for cost-efficient performance and greater hardware choice.
- **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 that this guide describes is based on VMware Horizon 8, which provides a complete end-to-end solution delivering Microsoft Windows virtual desktops to users on a wide variety of endpoint devices. Virtual desktops are dynamically assembled on demand, providing users with pristine, yet personalized, desktops each time they log 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.

For more information, see the Horizon resources page and the VMware Horizon Frequently Asked Questions.

The core Horizon components include:

- **Horizon Connection Server (HCS)**—Installed on servers in the data center, HCS brokers client connections, authenticates users, entitles users by mapping them to desktops or pools, establishes secure connections from clients to desktops, supports single sign-on, and sets and applies policies.
- **Horizon Administrator**—Provides administrator functions such as deploying and managing Horizon desktops and pools, setting and controlling user authentication, and more.
- **Horizon Agent**—Provides a means of communication with Horizon clients. The agent is installed on all VMs, physical machines, and Terminal Service servers that are used as a source for Horizon desktops. On VMs, the agent communicates with the Horizon client to provide services such as USB redirection, printer support, and more.
- **Horizon Client**—Installed on endpoints, the client creates connections to Horizon desktops that can be run from tablets, Windows, Linux, or Mac PCs or laptops, thin clients, and other devices.
- **Unified Access Gateway**—Provides a way to securely deliver connections that require a higher level of security to access, such as remote connections from the Internet.
- **Horizon Portal**—Provides access to links for downloading full Horizon clients. The portal enables the HTML access feature to run a Horizon desktop inside a supported browser.
- **vCenter Server**—Provides centralized management and configuration to the entire virtual desktop and host infrastructure. It facilitates configuration, provisioning, and management services.

Horizon clone technology

VMware Horizon 8 offers the following methods for cloning desktops:

- **Full clones**—Typically used for testing purposes or to create management VMs, this technology is not ideal for VDI because full copies have no connection to the original VM. You must update each VM with this approach.
- **Instant clones**—Available with Horizon Universal Subscription, Horizon Standard Subscription, and Horizon Enterprise Edition (TERM) licenses, this technology provisions a VM the instant a user requests one. The result is a far easier approach to operating system updates and patch management because the VM is created when it is needed. You can use a 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 completely removed in Horizon 8 (2012).

vSAN software-defined storage

vSAN is available in hybrid or all-flash configurations depending on the platform.

After vSAN is enabled on a cluster, all disk devices that are presented to the hosts are pooled to create a shared data store that is accessible by all hosts in the VMware vSAN cluster. VMs can then be created with storage policies assigned to them. The storage policy determines availability, performance, and sizing.

vSAN provides the following configuration options:

- **Hybrid configuration**—Uses flash-based devices for the cache tier and magnetic disks for the capacity tier. Hybrid configurations are ideal for clients looking for higher volume in the capacity tier. The performance of SSD and magnetic spinning disks is comparable in VDI applications.
- **All-flash configuration**—Uses flash for both the cache tier and capacity tier to deliver enterprise performance and a resilient storage platform. In this configuration, the cache tier is fully dedicated to writes, allowing all reads to come directly from the capacity tier. This model allows the cache device to protect the endurance of the capacity tier. All-flash configured solutions enable data deduplication features to extend the capacity tier.

NVIDIA vGPU

NVIDIA vGPU is the industry's most advanced technology for virtualizing true GPU hardware acceleration. The GPUs can be shared between multiple virtual desktops or aggregated to a single virtual desktop without compromising the graphics experience.

NVIDIA vGPU offers three software variants to enable graphics for different virtualization techniques:

- **NVIDIA Virtual Applications (vApps)**—Designed to deliver graphics accelerated applications using RDSH.
- **NVIDIA Virtual PC (vPC)**—Designed to provide full virtual desktops with up to dual 4K monitor support or single 5K monitor support.
- **NVIDIA RTX Virtual Workstation (vWS)**—Designed to provide workstation-grade performance in a virtual environment with support for up to four quad 4K or 5K monitors or up to two 8K monitors.

Chapter 3 Solution Validation

This chapter presents the following topics:

Validation

Overview

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

Login Enterprise performance testing

Process and monitoring

Each user load was tested against four runs: a pilot run to validate that the infrastructure was performing properly (and that valid data could be captured), and three subsequent runs to enable data correlation.

During testing, while the environment was under load, the Dell VDI Solutions team logged in to a session and completed tasks that correspond to the user workload. Although this test is subjective, it helps to provide a better understanding of the EUE in the desktop sessions, particularly under high load. This test also helps to ensure reliable data gathering.

The team monitored the following resources to ensure that the user experience was not compromised:

- **Compute host servers**—Solutions based on VMware vCenter for VMware vSphere gather key data (CPU, 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. 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 level with no bottlenecks.
- **Hardware resources**—Resource overutilization can cause poor EUE. Relevant resource utilization parameters were monitored and compared to relatively conservative thresholds. As shown in the following table, the thresholds were selected based on industry best practices and Dell VDI experience to provide an optimal trade-off between good EUE and cost-per-user, while also allowing sufficient burst capacity for seasonal or intermittent spikes in demand.

Table 3. Login Enterprise test thresholds

Parameter	Pass/fail threshold
Physical host CPU utilization	85%
Physical host memory utilization	85%
Network throughput	85%
Disk latency	20 milliseconds
Failed sessions	2%

Note: The Dell VDI Solutions team recommends that the average CPU utilization does not exceed 85 percent in a production environment. A five percent margin of error was allocated for this validation effort. CPU utilization sometimes exceeds Dell's recommended percentage, but because of the nature of PAAC testing, these exceptions are reasonable for determining Dell's sizing guidance.

Load generation

Login Enterprise installs a standard collection of desktop application software, including Microsoft Office and Adobe Acrobat Reader, on each VDI desktop testing instance. It then uses a configurable launcher system to connect a specified number of simulated users to available desktops within the environment. When the simulated user is connected, a login script configures the user environment and starts a defined workload. Each launcher system can launch connections to several VDI desktops (target machines). A centralized management console configures and manages the launchers and the Login Enterprise environment.

The team used the following login and boot conditions:

- Users were logged in within a login timeframe of 1 hour
- All desktops were started before users were logged in

Login Enterprise workloads

The following table describes the Login Enterprise workloads that the team used in testing:

Table 4. Profile and workload

Login Enterprise workload name	Workload description
Knowledge Worker	Designed for virtual machines with 2 vCPUs, this workload includes the following activities: • Microsoft Outlook—Browse messages • Microsoft Edge—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 • Microsoft Excel—Open a large, randomized sheet • Microsoft PowerPoint—Review and edit a presentation

Software versions

The following tables summarizes the software versions that the team used to test the Login Enterprise workloads:

Table 5. Software versions

Hypervisor	Broker agent	Login Enterprise Version
7.0.3, 20328353	Horizon 2212	5.0.5

Desktop VM test configurations

The following table summarizes the desktop VM configurations that the team used to test for the Login VSI workloads:

Table 6. Desktop VM test configurations

Login Enterprise workload	vCPUs	ESXi configured memory	ESXi reserved memory	Screen resolution	Operating system
Knowledge Worker	4	8 GB	4 GB	1920 x 1080	10 Enterprise 22H2 64-bit

Results summary

The following table summarizes the host utilization metrics that the team observed for the different Login Enterprise workloads tested, as well as the user density that they derived from Login Enterprise performance testing:

Table 7. Test results summary

Server configuration	Login Enterprise workload	Operating system	User density	Average CPU	Average GPU	Average active memory	Average IOPS per user	Average network Mbps per user
Density Optimized	Knowledge Worker	Windows 10 Enterprise 22H2 64-bit	135	84%	N/A	228	19.1	1.69

The host utilization metrics in the preceding table are defined as:

- **User density**—The number of users per compute host that successfully completed the workload test within the acceptable resource limits for the host. For clusters, this number reflects the average of the density achieved for all compute hosts in the cluster.
- **Average CPU**—The average CPU usage over the steady-state period. For clusters, this number represents the combined average CPU usage of all compute hosts. On the latest Intel processors, the ESXi host CPU metrics exceed the rated 100 percent for the host if Turbo Boost is enabled, which is the default setting. An additional 35 percent of CPU is available from the Turbo Boost feature, but this additional CPU headroom is not reflected in the VMware vSphere metrics where the performance data is gathered.
- **Average active memory**—For ESXi hosts, the amount of memory that is actively used, as estimated by the VMkernel based on recently touched memory pages. For clusters, this is the average amount of physical guest memory that is actively used across all compute hosts over the steady-state period.
- **Average IOPS per user**—IOPS calculated from the average cluster disk IOPS over the steady-state period divided by the number of users.
- **Average network usage per user**—Average network usage on all hosts calculated over the steady-state period divided by the number of users.

Findings

Overview

The Dell VDI Solutions team used the Login Enterprise load-generation tool to conduct PAAC on this solution. Login Enterprise is an industry-standard tool for benchmarking VDI workloads. It uses a carefully designed, holistic methodology that monitors both hardware resource utilization parameters and EUE during load testing.

Login Enterprise Knowledge Worker

The Dell VDI Solutions team used Login Enterprise Knowledge Worker workload on a 3-node R760 vSAN Ready Node cluster to perform this test. The desktop VMs were created using VMware Horizon instant clone technology. The team also used VMware Horizon Blast Extreme display protocol and populated the compute hosts with 135 desktop VMs each.

CPU usage

The following graphs show the CPU utilization across the three hosts during the testing. CPU usage with all VMs powered on was approximately 3.65 percent before the test started.

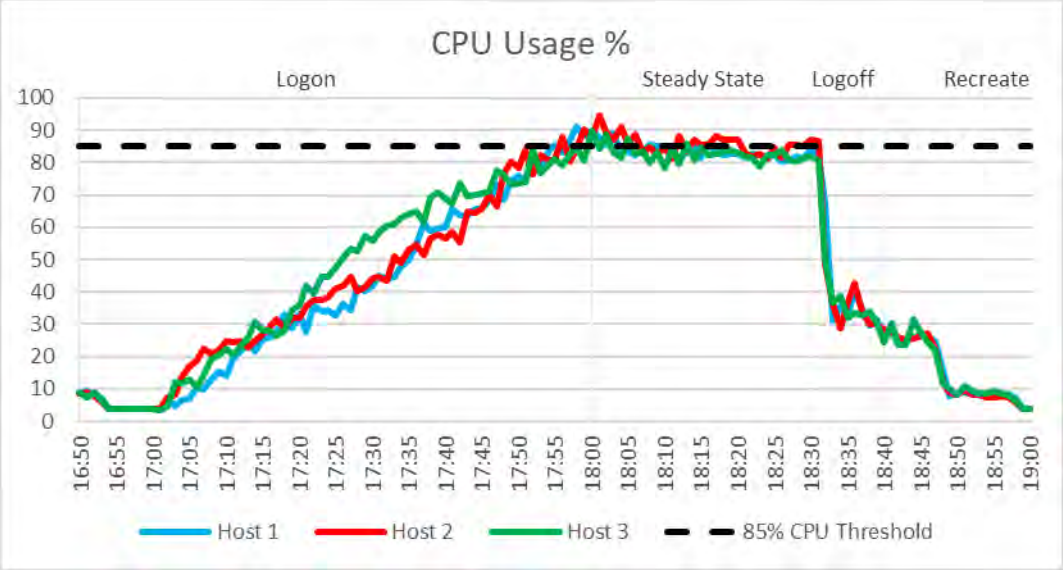

Figure 4. CPU usage percentage

During the steady-state phase, an average CPU utilization of 84 percent was recorded. This value is close to the pass/fail threshold that was set for average CPU utilization (see Table 3. To maintain good EUE, do not exceed this threshold. You can load more user sessions while exceeding this threshold for CPU, but you might experience a degradation in user experience.

As shown in the following figure, the CPU readiness was well below the 5 percent threshold that was set.

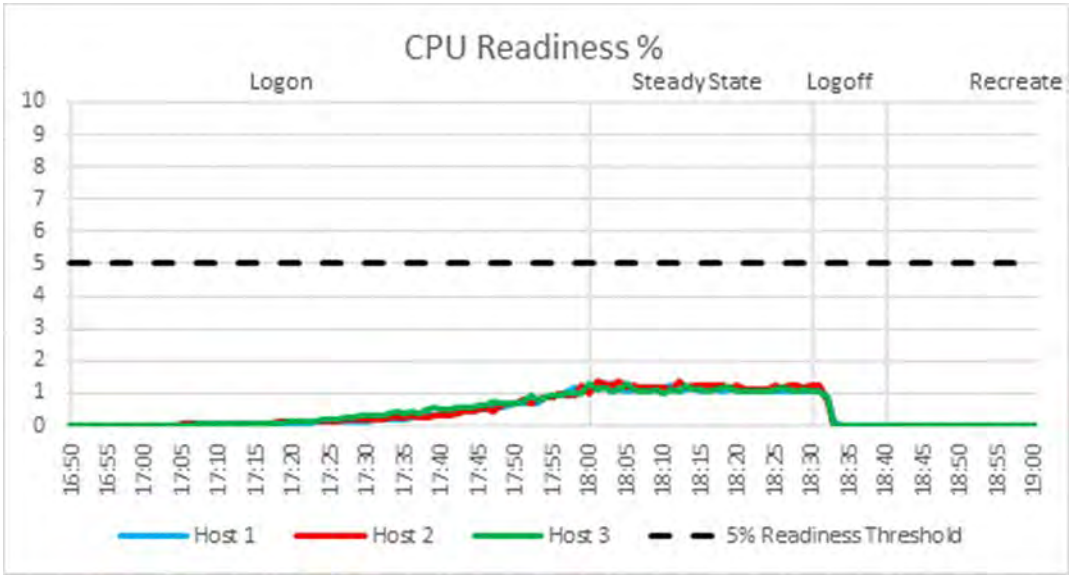

Figure 5. CPU readiness percentage

The average steady-state CPU core utilization across the three hosts was 60 percent, as shown in the following figure:

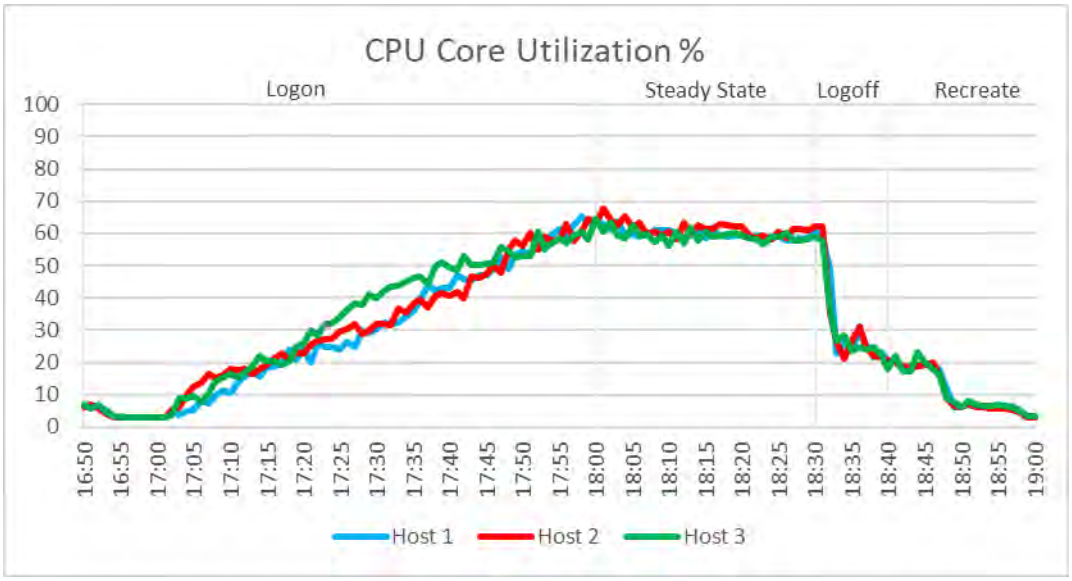

Figure 6. CPU core utilization percentage

Memory

The team observed no memory constraints during the testing on the compute hosts. Out of 768 GB of available memory per node, the compute host reached a maximum consumed memory of 734 GB and a steady-state average of 711 GB. Active memory usage reached a maximum active memory of 541 GB and recorded a steady-state average memory of 291 GB. There was no memory ballooning or swapping on the hosts.

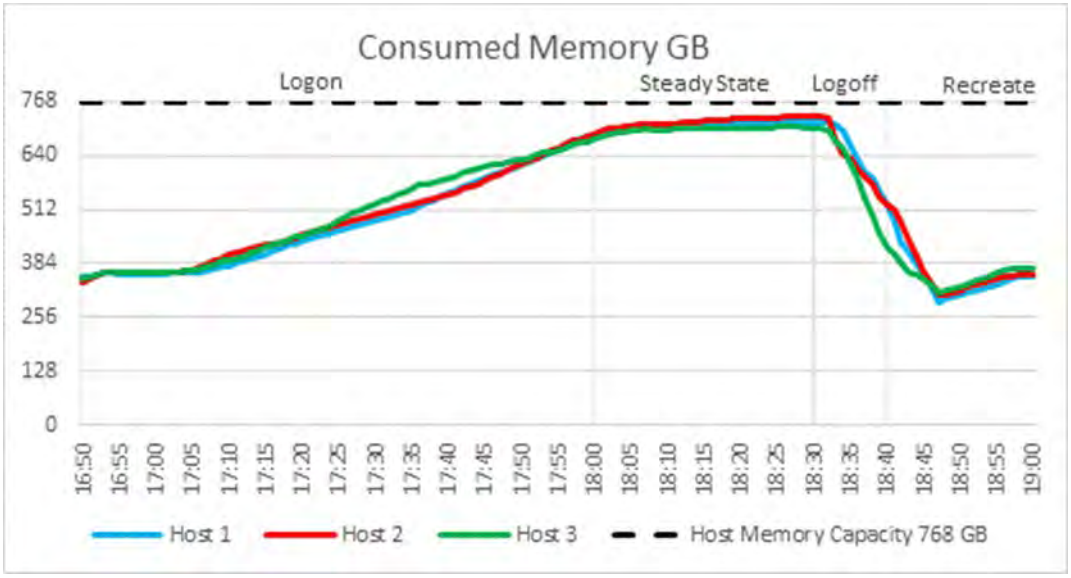

Figure 7. Consumed memory

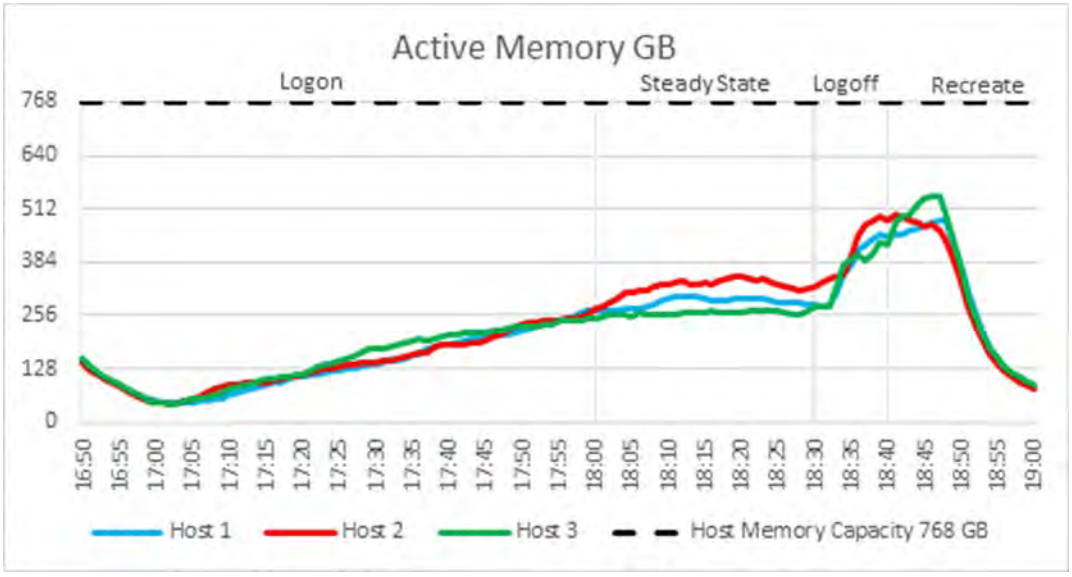

Figure 8. Active memory

Network usage

Network bandwidth was not an issue during the testing. The network usage recorded a steady state average of 686 Mbps. The busiest period for network traffic was during the re-create phase when a peak value of 2067 Mbps was recorded.

The following figure shows the network usage:

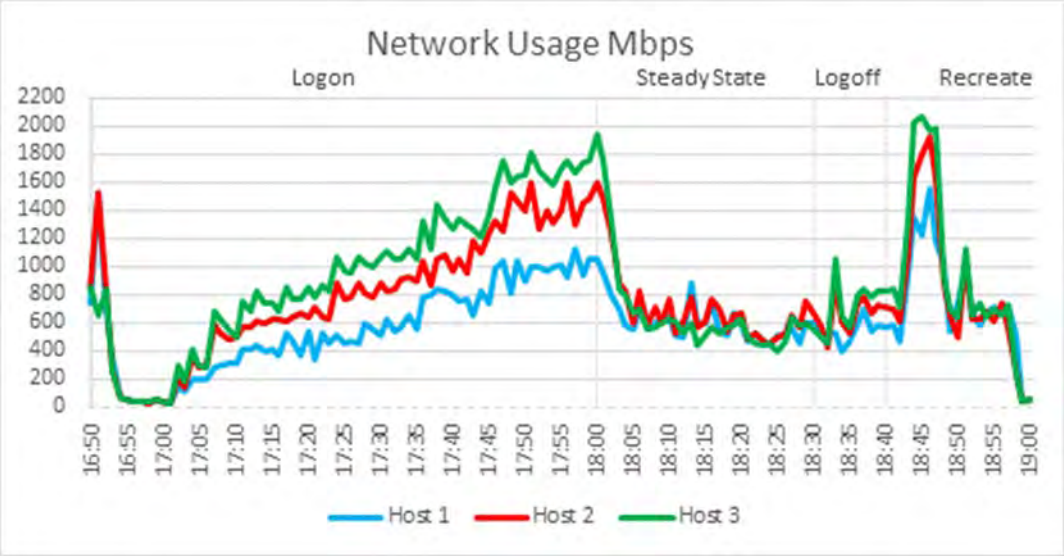

Figure 9. Network usage bandwidth

Cluster IOPs

Cluster IOPS reached a maximum value of 4745 for read IOPS and 2978 for write IOPS during the steady-state phase. The average steady-state IOPS metric was 1968.

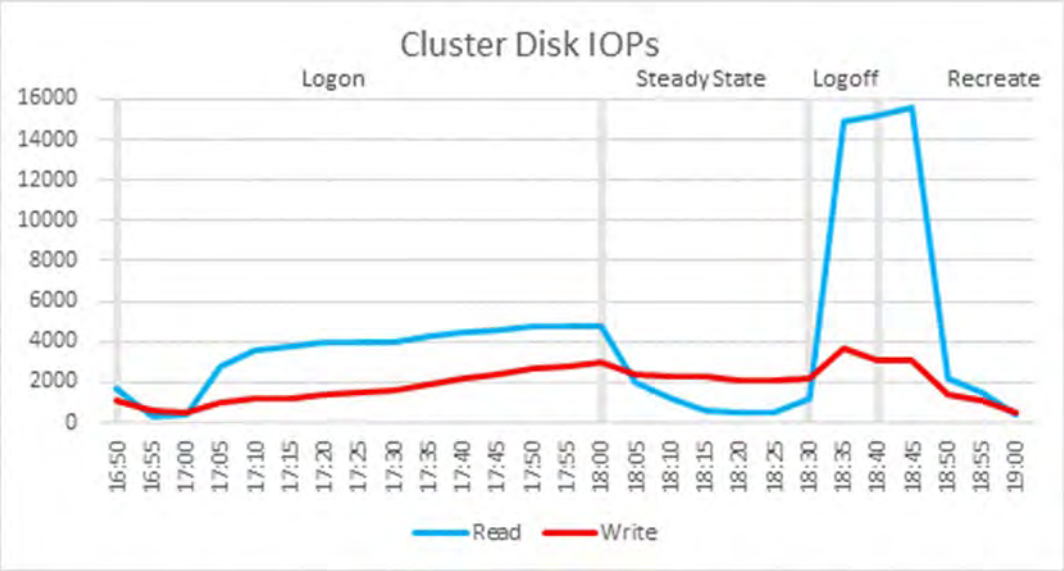

Figure 10. Cluster disk IOPs

Disk I/O latency

Cluster disk latency reached a maximum read latency of 0.356 milliseconds and a maximum write latency of 0.513 milliseconds during the steady-state phase. The average steady-state latency was 0.37 milliseconds.

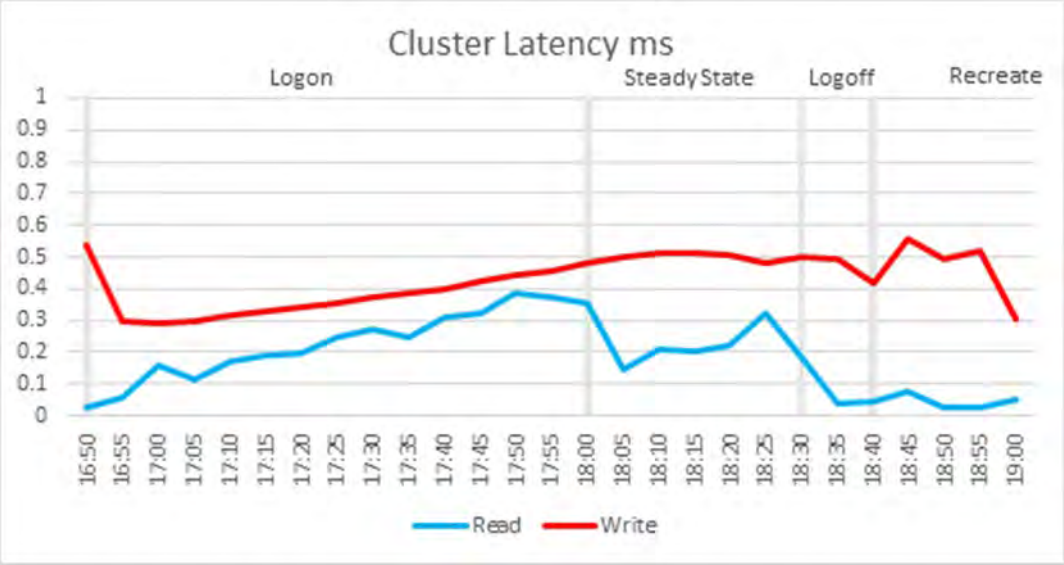

Figure 11. Cluster disk I/O latency

User experience

The Login Enterprise End User Experience (EUX) score was 8.2/10 and the VSImax was >401, which means that VSImax was not reached during this test and that it would be possible to run more sessions with this configuration. For more information about Login Enterprise EUX Scores, see this Login Enterprise EUX Score – Login VSI article.

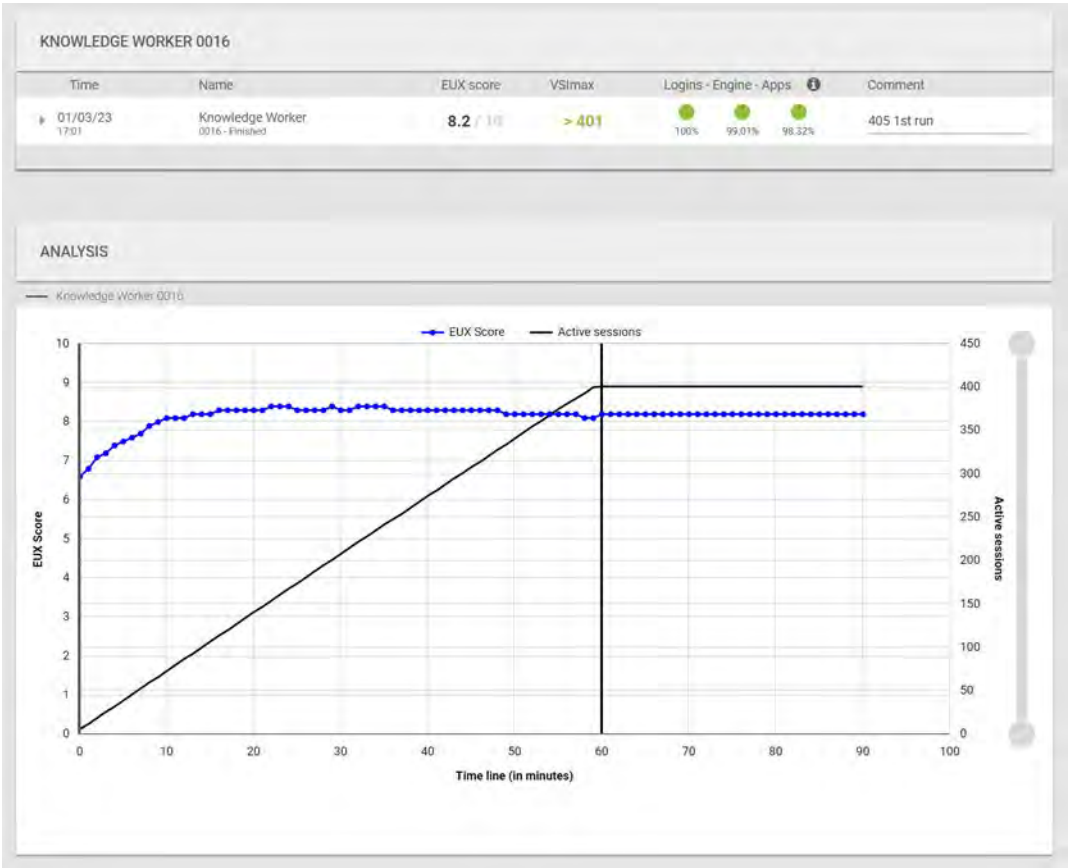

Figure 12. Login Enterprise EUX score

Summary

Overview

The Dell VDI Solutions team has provided extensive performance testing results and guidance based on the PAAC testing that they conducted with the Login Enterprise Knowledge Worker workloads. The 4th Generation Intel Xeon Scalable processors in our Density Optimized configuration provide performance, density, and agility for your VDI workloads.

The configurations for the vSAN Ready Nodes are optimized for VDI. The team selected memory and CPU configurations that provide optimal performance; however, you can change the vSAN Ready Node configurations to meet your environmental requirements. For further assistance, contact your Dell Technologies account representative.

Note: Changing the memory and CPU configurations from those that have been validated in this document will affect the user density per host.

User density recommendations

The following tables show the recommended user densities that were achieved during the performance testing on vSAN Ready Nodes. The Dell VDI Solutions team followed the VMware best practices of FTT = 1 and configured a reserved slack space of 30 percent. The team also used Microsoft Windows 10, 64-bit, and Microsoft 365 with Office Apps to test Login Enterprise Knowledge Worker.

Table 8. Recommended user densities

Server configuration	Workload	Windows version	User density
Density optimized	Login Enterprise Knowledge Worker	Windows 10 Enterprise 22H2 64-bit	135

Chapter 4 Sizing the Solution

This chapter presents the following topics:

Overview

vSAN-based solutions provide flexibility as you scale, reducing the initial and future cost of ownership. Add physical and virtual servers to the server pools to scale horizontally. Add virtual resources to the infrastructure to scale vertically.

Sizing Guidelines

Overview

This section provides various general best practices for sizing your VDI deployment.

Platform configurations

With several configurations to choose from, consider these basic differences:

- **Density Optimized—**This configuration provides a good balance of performance and scalability for various general-purpose VDI workloads.
- **Virtual Workstation**—This configuration provides the highest levels of performance for more specialized VDI workloads, which means it can be used with ISV and high-end computing workloads.

CPU

User density and graphics considerations include:

- Architectures with Sapphire Rapids processors:
  - **Knowledge workers**—2.1 users per core (for example, 33 knowledge users with dual eight-core processors)
- Graphics:
  - For high-end graphics configurations with NVIDIA vWS graphics enabled, choose higher clock speeds over higher core counts. Many applications that benefit from high-end graphics are engineered with single-threaded CPU components. Higher clock speeds benefit users more in these workloads.
  - For NVIDIA vPC configurations, use higher core counts over faster clock speeds to reduce oversubscription.

Note: Most graphics configurations do not experience high CPU oversubscription because vGPU resources are likely to be the resource constraint in the appliance.

Memory best practices

Memory allocation and configuration guidance:

- Do not overcommit memory when sizing because memory is often not the constraining resource. Overcommitting memory increases the possibility of performance degradation if contention for memory resources, such as swapping and ballooning of memory, occurs. Overcommitted memory can also affect storage performance when swap files are created.

- Populate memory in units of eight DIMMs per CPU to yield the highest performance. Dell PowerEdge servers using 4th Generation Intel Xeon Scalable processors have eight memory channels per CPU, which are controlled by four internal memory controllers, each handling two memory channels. To ensure that your environment has the optimal memory configuration, use a balanced configuration, where each CPU supports a maximum of 16 DIMMs (or 32 DIMMs for a dual-CPU server). The most effective configuration is 16 DIMMs (8 per processor) with Intel Xeon Scalable processors.

NVIDIA vGPU considerations best practice

When sizing and configuring solutions requiring graphics accelerators, consider that:

- vPC licenses support up to 2 GB of frame buffer and up to two 4K monitors, or a single 5K monitor to cover most traditional VDI users. Maximum node density for graphics-accelerated use can typically be calculated as the available frame buffer per node divided by the frame buffer size.
- The addition of GPU cards does not necessarily reduce CPU utilization. Instead, it enhances the user experience and offloads specific operations best performed by the GPU.
- Dell Technologies recommends using the BLAST protocol for vGPU enabled desktops. NVIDIA GPUs are equipped with encoders that support BLAST.
- Virtual Workstations are typically configured with at least 2 GB video buffer.

Sizing considerations

General best practices for sizing your deployment:

- **User density**—If concurrency is a concern, calculate how many users need the environment during peak utilization. For example, if only 80 percent are using the environment at any time, the environment must support only that number of users (plus a failure capacity).
- **Disaster recovery (DR)**—Dell Technologies recommends that you implement a dual or multi-site solution for DR planning. The goal is to keep the environment online and, in case of an outage, to perform an environment recovery with minimum disruption to the business.
- **Management and compute clusters**—Dell Technologies recommends that you separate the management and compute layers into separate clusters. You can use a combined management and compute cluster for small environments. Consider using the PowerEdge R660 platform to reduce data center footprint when creating a management cluster for a large-scale deployment. With larger storage and graphics capabilities, Dell Technologies recommends R760 for compute clusters.
- **Network isolation**—When designing for larger-scale deployments, consider physically separating the management and VDI traffic from the vSAN traffic for traffic isolation and to improve network performance and scalability. This design illustrates a two-NIC configuration per appliance with all the traffic separated logically using VLAN.
- **FTT**—Dell Technologies recommends sizing storage with NumberOfFailuresToTolerate (FTT) set to 1, which means that you must double the amount of total storage to accommodate the mirroring of each VMDK.

- **Slack space**—Dell Technologies recommends adding an additional 30 percent of slack space to prevent automatic rebalancing of storage, which impacts performance. Automatic balancing occurs when the storage reaches 80 percent of the full threshold. Therefore, 70 percent is recommended to reserve a 10 percent buffer.

- All-Flash compared with hybrid:

  - Hybrid and all-flash configurations have similar performance results. Because hybrid uses spinning drives, consider the durability of the disks.
  - Only all-flash configurations offer deduplication and compression for vSAN. Dell Technologies recommends all-flash configurations for simplified data management.
  - All-flash configurations need considerably less storage capacity than hybrid configurations to produce similar FTT, as shown in the following table.

Table 9. FTT comparisons

VM size	FTM	FTT	Overhead	Configuration	Capacity required	Number of hosts required
50 GB	RAID 1 (Mirrored)	1	2 x	Hybrid	100 GB	3
50 GB	RAID 5 (3+1) (Erasure coding)	1	1.33 x	All-flash	66.5 GB	4
50 GB	RAID 1 (Mirrored)	2	3 x	Hybrid	150 GB	4
50 GB	RAID 6 (4+2) (Erasure coding)	2	1.5 x	All-flash	75 GB	6

Note: For more information about multi-site design considerations for Horizon, see VMware Workspace ONE and Horizon Reference Architecture on the VMware Digital Workspace Tech Zone.

Scaling Guidelines

Overview

vSAN-based solutions provide flexibility as you scale, reducing the initial and future cost of ownership.

Scaling out

Each component of the solution architecture scales independently, depending on the required number of supported users. You can add appliance nodes at any time to expand the vSAN SDS pool in a modular fashion. The limits of the hypervisor at 64 nodes per block restricts the scaling limit for vSAN.

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 being used. 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 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, 20 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 Horizon block:

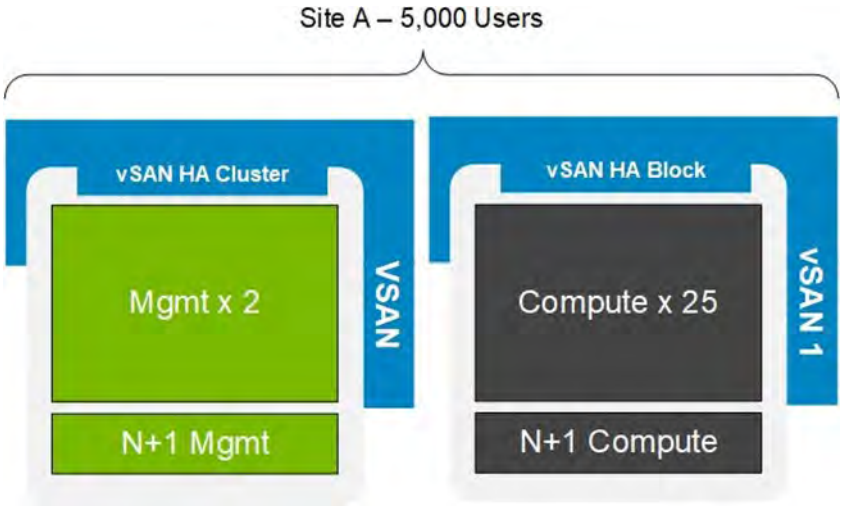

Figure 13. 5,000-user Horizon block

The following figure shows a scale-out to a 20,000-user Horizon vSAN pod with 5,000 user blocks. Each block contains its own vCenter Server instance and VDI components:

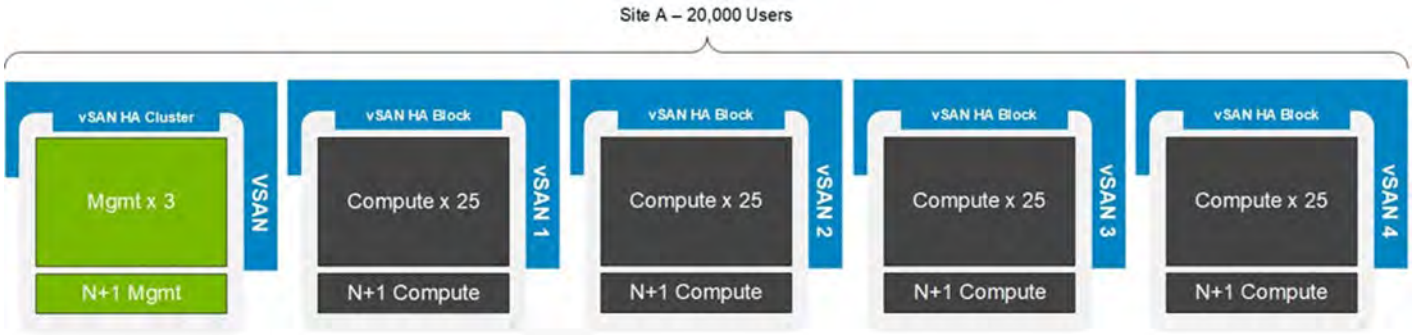

Figure 14. 20,000-user Horizon vSAN pod with 5,000 user blocks

Note: The management cluster sizing numbers in the preceding diagrams are recommended minimums; sizing must be carefully considered as part of any deployment.

Scaling up

Dell Technologies recommends a validated disk configuration for general-purpose VDI. These configurations leave drive slots available for future vertical expansion and ensure that you protect your investment as new technology transforms your organization.

Note: These configurations can accept additional or faster processors, or memory than the guidance provided here.

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

Chapter 5 Backup and Restore

This chapter presents the following topics:

Overview

VDI adoption growth has increased 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 that their VDI environments meet corporate availability, recovery time objective (RTO), and recovery point objective (RPO) requirements.

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

Dell Avamar Virtual Edition

Dell Avamar Virtual Edition is a data protection solution that delivers software-only data protection for virtualized environments and is, therefore, ideal for the VDI use case. Avamar Virtual Edition is a fully featured data protection solution that is deployed as a virtual appliance and supports advanced functionality such as backup in the cloud (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 Virtual Edition Data Protection Software.

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 various 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 PowerProtect DD 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, accelerating backup.

For more information about protecting a VMware Horizon VDI environment using Avamar Virtual Edition and PowerProtect DD Virtual Edition, see the Dell PowerProtect DD Virtual Edition and the Data Protection for a VMware Horizon VDI Environment using Dell EMC Data Protection Suite Operations Guide.

Other Dell Technologies data protection products

Dell Technologies provides other data protection products for specific use cases, including 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 Management.

Chapter 6 Summary

This chapter presents the following topics:

Summary

Overview

This design guide describes the integration of vSAN-based appliances from Dell Technologies and VMware Horizon 8 brokering software to create virtual application and desktop environments. This architecture provides exceptional scalability, an excellent user experience, and empowers IT teams to play a proactive and 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:

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

All the Dell Validated Designs for VDI are configured to produce similar results. You can be sure that the vSAN-based appliances you choose have been designed and optimized for your organization's needs.

Next steps

Dell Technologies vSAN Ready Node R760 is a flexible solution for organizations of any size. It is a prevalidated configuration in a dense rack platform and only requires 2U of rack space. Additionally, this powerful server supports Density Optimized configurations for VDI and up to two NVIDIA A16 GPUs per node.

For additional resources and other VDI designs, see the VDI Info Hub for Dell Validated Designs. Your Dell Technologies solutions representative can also assist with further information and resources.

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 Technologies Solutions team by email.

Authors: Dell VDI solutions team

Chapter 7 References

This chapter presents the following topics:

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 vSAN Ready Nodes

VMware documentation

For a complete list of VDI resources, see the VDI Info Hub. For previous versions of the documentation for this solution, see the VDI Info Hub Archive.

VMware documentation

The following VMware documentation provides more 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

NVIDIA documentation

The following NVIDIA documentation provides more information:

- NVIDIA Virtual GPU Software Quick Start Guide