

# Dell EMC Ready Architectures for VDI

## Designs for VMware Horizon on VxRail and vSAN Ready Nodes

August 2019

H17749.1

### Design Guide

#### Abstract

This design guide describes technical considerations and best practices for integrating VMware Horizon brokering software with Dell EMC VxRail appliances or vSAN Ready Nodes to create virtual application and desktop environments on the latest Dell EMC PowerEdge servers in a VMware vSphere environment.

Dell EMC Solutions

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- [Executive summary](#)..... 4
- [Solution architecture](#)..... 7
- [Key components](#)..... 10
- [Design sizing and guidelines](#)..... 17
- [Design enhancements](#)..... 21
- [Conclusion](#)..... 24
- [References](#)..... 25

# Executive summary

## Business challenge

In the past, moving from traditional PCs to a virtual desktop infrastructure (VDI) solution was challenging. A classic VDI implementation of 100 applications and 1,000 users could take 250 days or more, and the final cost was often unpredictable. Organizations today require end-to-end desktop and application virtualization infrastructure solutions that are flexible, reliable, scalable, and easy to deploy.

Desktop virtualization helps improve service delivery and competitiveness by simplifying how IT works on systems, dramatically reducing the complexity of the system and making it more flexible. The IT team can then move from being a largely reactive technical group to playing a proactive role in the strategic organization. Dell EMC can assist IT teams in this journey while improving user experience with the Dell EMC Ready Architectures for VDI.

Some challenges that organizations face today include:

- **Workforce empowerment**— Personal technology is driving newer and higher expectations. People want the same benefits at work as they have on their personal devices. They want faster, easier-to-use devices and applications that fit their specific needs. Technology itself has become a way to attract and retain the best talent. It has become a differentiator and a job perk.
- **Optimized IT resources**—Organizations that manage a large number of traditional PCs find that the task is becoming increasingly complex. With desktop virtualization, you move applications, data, and the OS (the desktop) to the data center. IT can centrally manage the virtual desktop from the data center and save time and money by troubleshooting PCs remotely instead of physically visiting each PC.
- **Improved security**—Organizations require the ability to control data, recover from disasters, apply policies, comply with regulations, and monitor risk. Maintaining data and application security, as well as compliance, are the leading IT concerns in organizations of all sizes. Mobile office trends and bring-your-own device initiatives mean that more devices and sensitive data are out of direct IT control, increasing the risk for data theft, viruses, malware, and ransomware attacks. In addition, traditional antivirus solutions cannot keep up with the amount of new malware that is created daily. Non-security IT specialists also tend to find security and compliance complex.
- **Cost management**—Organizations must monitor and optimize the total cost of ownership (TCO), achieve greater utilization from infrastructure assets, and reduce energy use.

## Technology solution

Dell EMC Ready Architectures for VDI on vSAN-based appliances provide a quick and easy way to simplify and extend your VMware environment. Since Ready Architectures for VDI combine compute, storage, virtualization, and management, these solutions are ideal for VDI.

The Ready Architectures for VDI are built on industry-leading Dell EMC VxRail appliances or vSAN Ready Nodes appliances. These true hyper-converged infrastructure (HCI) platforms provide performance, flexibility, and scale for VDI environments.

- Dell EMC recommends VxRail appliances for an enhanced VDI solution that leverages a wide range of software, tools, and resources co-developed by Dell EMC and VMware. The VMware hyper-converged software is vSphere-ready and based on vSAN Software-Defined Storage (SDS). The Dell EMC deployment and support tools integrate the software management within VxRail Manager. Data protection and replication are included and can support either hybrid or all-flash storage configurations.
- Dell EMC vSAN Ready Nodes do not include the full automation suite that is available in VxRail appliances, but they provide more flexibility in platform choices. vSAN Ready Nodes offer the confidence that your pre-validated configuration will work with vSAN technology as well as the VMware Horizon 7 suite.

Installing VMware Horizon 7 with its VDI components on VxRail appliances or 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.

## Key benefits

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

With two different vSAN-based appliance options to choose from, Dell EMC has the ideal configuration to start or extend your data center. While VxRail and vSAN Ready Nodes have the same underlying technology (VMware vSAN), each provides unique benefits. VxRail offers a turn-key solution to deploying and managing infrastructure with additional software features to assist throughout the appliance lifecycle. vSAN Ready Nodes require similar architectural design elements, but do not include the software components and elements that are found in the VxRail product. However, vSAN Ready Nodes offer a greater array of platforms and additional peripheral device choices.

Dell EMC Ready Architectures for VDI offer several key benefits:

- **VxRail Manager lifecycle management**—The integrated VxRail software lifecycle management keeps software updates and patches current. Updates are easy to install and safe to implement, because all software components are engineered, tested, and released as a bundle. Administrators are notified through the VxRail Manager when updates are available. Perform updates in your production environment with no downtime while VxRail Manager intelligently deploys important updates. VxRail Manager lifecycle management reduces complexity, makes the infrastructure more secure, and removes the risk. (VxRail Manager is available only on VxRail.)
- **Predictable costs, performance, and scalability to support a growing workforce**—The cost to deploy applications and desktops is dramatically simpler when deploying from a data center.
- **Rapid deployments**—Ready Architectures for VDI offer rapid automated deployment. (This feature is a standard offering on VxRail with optional services available for vSAN Ready Nodes.)

- **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. The VxRail Manager (available only with VxRail appliances) makes it easy to insert or remove nodes from your cluster to meet your business needs.
- **Dell EMC support**—Dell EMC Ready Architectures for VDI are tested and validated Engineering Systems for VDI and its related tools. Deployment Services provide installation of this turn-key VDI appliance to ensure a rapid deployment with linear and predictable scalability.

Dell EMC offers single-company-support models for Horizon and vSAN-based solutions.

## Document purpose

This document introduces the architecture, components, design options, best practices, and configuration details for successful VDI deployments for VxRail appliances and vSAN Ready Nodes with VMware Horizon 7.

## Audience

This guide is for decision makers, managers, architects, developers, and technical administrators of IT environments who want an in-depth understanding of the value of the Ready Architectures for VDI that deliver Microsoft Windows virtual desktops to users using VMware Horizon 7 VDI components on VxRail appliances or vSAN Ready Nodes.

## We value your feedback

Dell EMC and the authors of this document welcome your feedback on the solution and the solution documentation. Contact the Dell EMC Solutions team by [email](#) or provide your comments by completing our [documentation survey](#).

**Authors:** Dell EMC Ready Architectures for VDI team.

 **Note:** The following page on the Dell EMC Communities website provides links to additional documentation for VDI Ready Solutions: [VDI Info Hub for Ready Solutions](#).

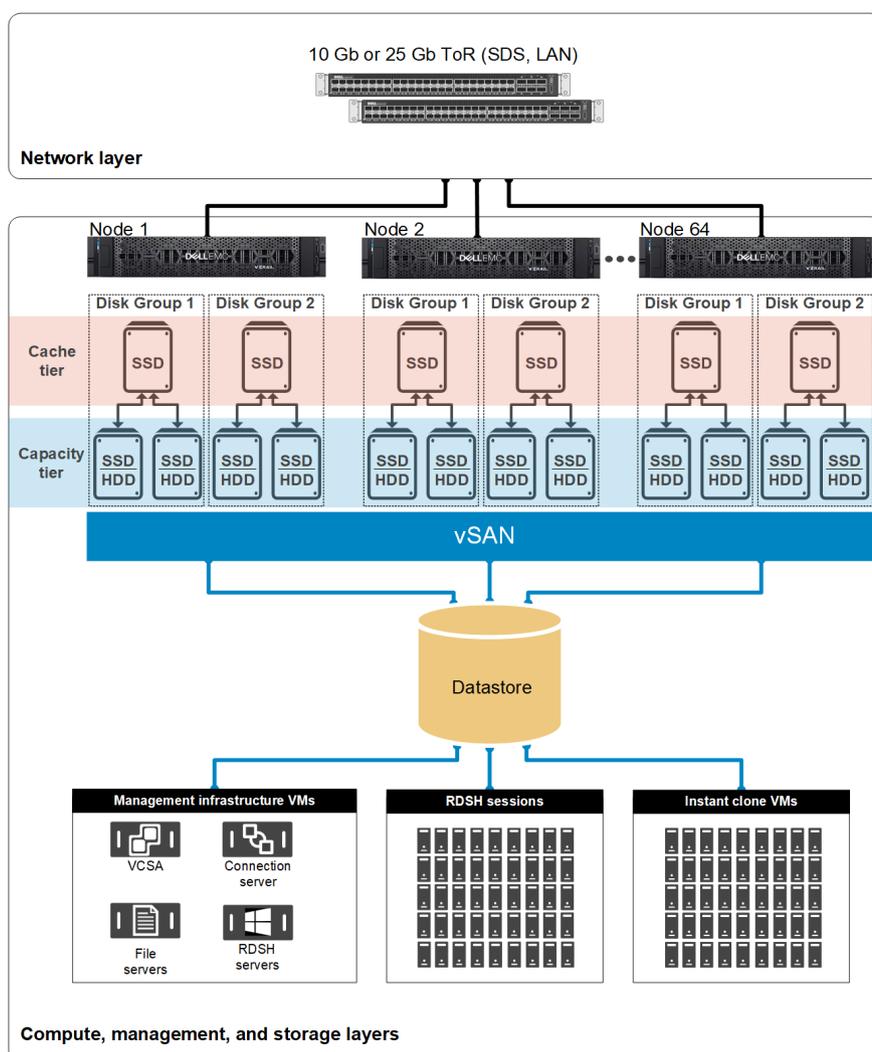
# Solution architecture

This section provides an architecture overview and guidance on managing and scaling a VMware Horizon 7 environment on Dell EMC VxRail appliances.

## Architecture overview

The following figure depicts the architecture of the validated solution, including the network, compute, management, and storage layers. This architecture aligns with the VMware Horizon Block/Pod design. A pod is divided into multiple blocks. Each block is made up of one or more vSphere clusters, a vCenter, and, for linked clones, a composer server.

**Figure 1** VxRail Appliance or vSAN Ready Nodes with VMware Horizon



The deployment option for this Dell EMC Ready Architecture for VDI supports all cloning techniques available from VMware: full, linked, and instant.

A vSphere Cluster can have a maximum of 64 nodes and 8,000 VMs per cluster. To expand from this limit, you can add clusters and balance the VMs and nodes across the new clusters.

The [Horizon 7 Enterprise Edition Reference Architecture](#) provides more information about Horizon pods and blocks.

## Scaling the solution

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

### 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 scaling limit for vSAN is restricted by the limits of the hypervisor at 64 nodes per block.

The boundary for a Horizon block is the vCenter. The number of virtual machines a vCenter (and therefore a block) can host depends on the type of Horizon 7 VMs being used. The recommendation limits for a Horizon block are as follows:

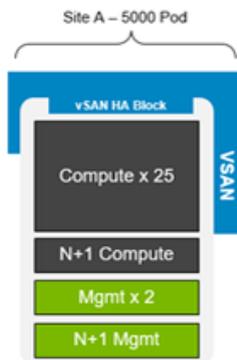
- 5,000 instant-clone VMs (without App Volumes)
- 4,000 linked-clone or full-clone VMs (without App Volumes)
- 2,000 VMs (all clone types) if App Volumes or AppStacks are attached

This Ready Architecture 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, 25 compute nodes with 200 Task-User VMs per Node would reach the maximum number of VMs for the block.

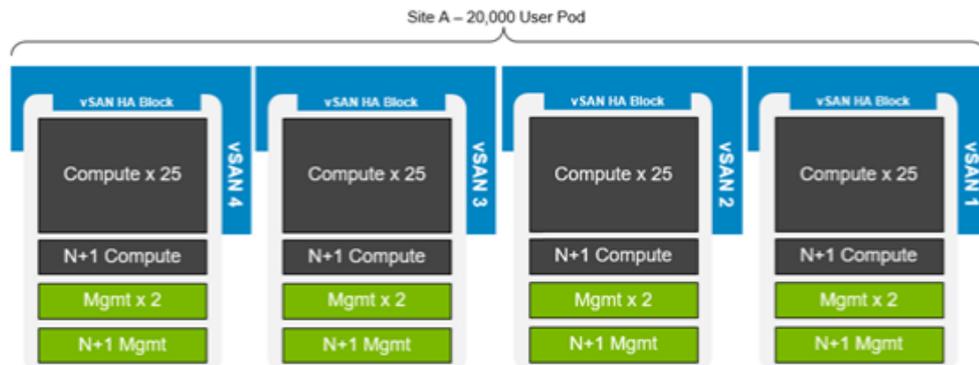
The following figure shows a 5,000-user Horizon block.

**Figure 2** Single 5,000-user 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 3** Scaleout for 20,000 users



### Scaling up

Dell EMC 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.

The [VMware Workspace ONE and VMware Horizon 7 Enterprise Edition On-premises Reference Architecture](#) provides more information about Horizon pod/block architecture and scaling.

## Enterprise solution pods

The compute, management, and storage layers are converged into a single VxRail Appliance or vSAN Ready Nodes block, hosting VMware vSphere. The number of nodes that are supported for vSphere 6.7, which is 64, determines the recommended boundaries of an individual vSphere cluster.

Dell EMC recommends that the VDI management infrastructure nodes be separated from the compute resources. Because our test environment was small, both management and compute are in the same vSphere HA cluster. Optionally, the management node can also be used for VDI VMs with an expected reduction of 30 percent of host resources for these nodes only. The 30 percent accounts for management VM resource reservations and should be factored in when sizing.

Compute hosts can be used interchangeably for Horizon Apps hosted applications and desktops, as required.

This design guide describes a single-site or single data center design. For multi-site or disaster recovery (DR) configurations, refer to the [Horizon 7 Enterprise Edition Multi-Site Reference Architecture](#).

# Key components

This section describes the key hardware and software components of the solution.

## VxRail Appliance

The Dell EMC VxRail is a powerful Hyper-converged Infrastructure Appliance (HCIA) that is available in 1U or 2U rack building blocks. It is built on VMware vSAN technology and further enabled with Dell EMC software.

The following figure shows the components of the VxRail appliance.

**Figure 4** Dell EMC VxRail appliance



VxRail appliance platforms are equipped with Intel Xeon Scalable Processors. You can deploy a cluster with as few as three nodes, providing an ideal environment for small deployments. To achieve full vSAN high availability (HA), the recommended starting block is four nodes. The VxRail Appliance can support storage-heavy workloads with storage-dense nodes, graphics-heavy VDI workloads with GPU hardware, and entry-level nodes for remote and branch office environments.

The VxRail appliance enables you to start small and scale as your requirements increase. Single-node scaling and low-cost entry point options give you the freedom to buy just the right amount of storage and compute resources to start, and then add capacity to support growth. A single-node VxRail V Series appliance can be configured with 16 to 56 CPU cores per node and support a maximum of 40 TB raw storage with a hybrid configuration of 76 TB with the all-flash option. A 64-node all-flash cluster delivers a maximum of 3,584 cores and 4,864 TB of raw storage. The following table shows the available platforms.

**Table 1** Available Dell EMC VxRail platforms

| Platform | Description           | Configurations       | Form Factor |
|----------|-----------------------|----------------------|-------------|
| E Series | Entry level           | All-flash and hybrid | 1U1N        |
| V Series | VDI optimized         | All-flash and hybrid | 2U1N        |
| P Series | Performance optimized | All-flash and hybrid | 2U1N        |
| S Series | Storage dense         | Hybrid               | 2U1N        |

## VxRail Manager

VxRail Manager, which is available on VxRail appliances only, is the primary deployment and element manager interface of the appliance. VxRail Manager simplifies the entire lifecycle from

deployment through management, scaling, and maintenance. It also enables single-click upgrades and dashboard monitoring for health, events, and physical views.

## vSAN Ready Nodes

vSAN Ready Nodes are pre-validated Dell EMC Server configurations that reduce the complexity of deploying vSAN technology. vSAN Ready Nodes configurations are listed in 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 lifecycle management and additional bundled software, Dell EMC recommends customized deployment services and at least three years of ProSupport Plus. Add VMware Horizon 7 Advanced or Enterprise to license your Dell EMC vSAN Ready Nodes for a full VDI deployment.

## Dell EMC Ready Architectures VDI-optimized configurations

For graphics-intensive desktop deployments, we recommend the VDI-optimized 2U/1 Node appliances that support GPU hardware.

The VxRail V Series and vSAN Ready Nodes R740XD can be configured with or without GPUs. Dell EMC also offers similar configurations in a 1U/1 Node appliance, although graphics configurations are not available on these platforms.

We have designated common configurations as *A3*, *B5*, *C7*, and *Density-Optimized*. These designations are referenced throughout the documentation.

| Configuration            | CPU   | RAM                           | Disk              | GPU (optional)   | Description   |
|--------------------------|---|-------------------------------|-------------------|--|---|
| <b>A3</b>                | 2x Intel Xeon Silver 4114 (10 core 2.2 GHz) | 192 GB (12x 16 GB @ 2400 MHz) | 4 TB + (Capacity) | Up to 3x full length, dual width (FLDW)<br>Up to 6x full length single width | For small-scale, POC, or low-density, cost-conscious environments                                 |
| <b>B5</b>                | 2 x Intel Xeon Gold 5120 (14 core 2.2 GHz)  | 384 GB (12x 32 GB @ 2400 MHz) | 6 TB + (Capacity) | Up to 3x FLDW<br>Up to 6x full length single width                           | Geared toward larger-scale general-purpose workloads; balances performance and cost-effectiveness |
| <b>C7</b>                | 2 x Intel Xeon Gold 6138 (20 core 2.0 GHz)  | 768 GB (24x 32 GB @ 2400 MHz) | 8 TB + (Capacity) | Up to 3x FLDW<br>Up to 6x full length single width                           | Offers an abundance of high-performance features and tiered capacity that maximizes user density  |
| <b>Density-Optimized</b> | 2 x Intel Xeon Gold 6248 (20 core 2.5 GHz)  | 768 GB (12x 64 GB @ 2933 MHz) | 8 TB + (Capacity) | Up to 3x FLDW<br>Up to 6x full length single width                           | Offers an abundance of high-performance features and tiered capacity that maximizes user density  |

## vSAN software-defined storage

vSAN is available in hybrid or all-flash configurations.

After vSAN is enabled on a cluster, all disk devices presented to the hosts are pooled together 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 dictates 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 GRID vGPU

Learn about GPU options.

NVIDIA GRID vGPU brings the full benefit of NVIDIA hardware-accelerated graphics to virtualized solutions. This technology provides exceptional graphics performance for virtual desktops equivalent to local PCs when sharing a GPU among multiple users.

GRID vGPU is the industry's most advanced technology for sharing true GPU hardware acceleration between multiple virtual desktops without compromising the graphics experience. NVIDIA GRID offers three software variants to enable graphics for different virtualization techniques:

- **Virtual Applications**—Designed to deliver graphics accelerated applications using RDSH.
- **Virtual PC**—Designed to provide full virtual desktop with dual 4K monitor support.
- **Quadro Virtual vDWS**—Designed to provide workstation grade performance in a virtual environment with support for quad 4K monitors.

Dell EMC Ready Architectures for VDI can be configured with the following NVIDIA Tesla GPUs for best in class user experience that is hosted from your data center:

- **NVIDIA Tesla M10 (Maxwell)**—Recommended for Virtual Applications or Virtual PC environments Each card is equipped with 32 GB of video buffer with the maximum available buffer per user at 8 GB. Dell EMC recommends hosting a maximum of 32 Windows 10 users per card. While some configurations of VSAN Ready Nodes support 3 cards, consider sizing with a maximum of 2 cards per node.
- **NVIDIA Tesla P40 (Pascal)**—Recommended in Quadro Virtual Data Center Workstation configurations that require large video buffers. Each P40 has 24 GB of available video buffer, which can be divided into 1, 2, 3, 4, 6, 8, 12, or 24 users, depending on your virtual workstation needs.  
 **Note:** All R740xd based appliances enable up to three P40 cards per node.
- **NVIDIA Tesla T4 (Turing)**—NVIDIA's newest architecture is available in the T4 GPU, which is considered the universal GPU for data center workflows. Add up to six GPU cards into your R740xd appliance to enable up 96 GB of video buffer. For modernized data centers, use this card in off-peak hours to perform your inferencing workloads.

### Mixed GPU deployments

As a best practice, members of a VMware vSAN-based cluster should be identical or as homogeneous as possible in terms of hardware, software, and firmware. This is primarily to reduce operational complexity and maintenance requirements. When deploying NVIDIA GRID vGPU and the associated NVIDIA Tesla GPUs in a VxRail or vSAN Ready Node environment, a mixed GPU environment can be necessary or desirable for several reasons, including:

- Usage patterns and workloads need to be addressed that are better matched to different physical GPU types.
- A newer generation of NVIDIA Tesla GPUs has been released that adds greater value to the overall solution.
- A previously deployed cluster has GPUs that have reached their end-of-life and the cluster needs to be expanded to accommodate a growth in the user base.

If a mixed GPU configuration is unavoidable, consider the following points when planning and designing within a VMware Horizon VDI environment:

- Mixed physical GPUs are not supported within a single node. A single compute node can only contain a single physical GPU type.
- Each NVIDIA Tesla GPU model has its own set of NVIDIA GRID vGPU profiles that are unique to that card model.
- Each chosen vGPU profile needs an associated VMware Horizon gold image. This adds an administrative overhead because these gold images need to be either maintained separately or copied from a single parent gold image and the vGPU configurations that are applied to each subsequent related vGPU-enabled gold image.
- Separate VMware Horizon desktop pools need to be created and maintained for each related vGPU profile.
- VMware Horizon intelligently picks the appropriate hosts to deploy the NVIDIA GRID vGPU pool to the correlated NVIDIA GRID graphics cards within a vSphere cluster.
- Consider implementing VMware Horizon Cloud Pod Architecture and using global entitlements to obfuscate the separate desktop pools that are required to support the mixed GPU configuration.
- Consider redundancy and failover when expanding an existing VxRail or vSAN Ready Node cluster with a new GPU type. Your considerations should include:
  - Ideally, two or more new identically configured nodes should be added to enable maintenance with minimal downtime.
  - Expanding by a single node provides no redundancy for that vGPU type. If you are considering doing this, use VMware Horizon Cloud Pod Architecture and VMware Horizon Just-in-Time Management Platform (JMP) to reduce the impact of an outage.
- If four or more nodes are required, deploy them as a new cluster.

Consult your Dell EMC account representatives to discuss a long-term hardware life cycle plan that gets the best value out of your investment and solution.

## Physical network components

Ready Architectures for VDI for appliances allow for flexibility in networking selections. VDI validations have been successfully performed with the following hardware, although several other choices are available.

- **Dell EMC Networking S4048 (10 GbE ToR switch)**—The S4048 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 also supports ONIE for zero-touch installation of alternate network operating systems.
- **Dell EMC Networking S5248F (25 GbE ToR switch)**—The S5248F 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 also supports Open Network Install Environment (ONIE) for zero-touch installation of network operating systems.

[Dell EMC Networking S-Series 10GbE switches](#) and [Dell EMC Networking S-Series 25GbE switches](#) on the Dell EMC website provides more information about these switches.

**Note:** Ensure that you comply with the switch requirements in the [VxRail Networking Guide](#), which provides important information, recommendations, and best practices for VxRail. Consider the same recommendations for vSAN Ready Nodes.

## Networking

Designed for true linear scaling, VxRail appliances use a leaf-spine network architecture, which consists of two network tiers: an L2 Leaf and an L3 Spine that is based on 40 GbE and non-blocking switches. This architecture maintains consistent performance without any throughput reduction.

## VMware vSphere

VMware vSphere provides a powerful, flexible, and secure foundation for business agility that accelerates the digital transformation to cloud computing and promotes success in the digital economy.

vSphere provides 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. The vCenter HA cluster can be enabled, disabled, or destroyed 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 a separate asynchronous file system replication.
- **Backup and Restore**—Native backup and restore for the vCenter Server Appliance enables users to back up vCenter Server and Platform Services Controller appliances directly from the VAMI or API. The backup consists of a set of files that is streamed to a selected storage device using SCP, HTTP(S), or FTP(S) protocols. This backup fully supports VCSA instances with both embedded and external Platform Services Controller instances.
- **VMware vSphere HA Support for NVIDIA GRID vGPU-configured VMs**—vSphere HA protects VMs with the NVIDIA GRID 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 GRID 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, which 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 7, 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 7 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 virtual desktop infrastructure.

The [Horizon resources page](#) on the VMware product resources website provides more information. Also see the [Horizon License FAQ](#).

The core Horizon components include:

- **Horizon Connection Server (HCS)**— Installed on servers in the data center. The Horizon Connection Server brokers client connections, authenticates users, entitles users by mapping them to desktops and/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 deployment and management of Horizon desktops and pools, setting and controlling user authentication, and more.
- **Horizon Agent**—Installed on all VMs, physical machines, and Terminal Service servers that are used as a source for Horizon desktops. On VMs, the agent is used to communicate with the Horizon client to provide services such as USB redirection, printer support, and more.
- **Horizon Client**—Installed on endpoints for creating 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. Enable 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. It is installed on a Windows Server host, which can be a VM.

## Horizon clone technology

VMware Horizon 7 offers the following methods for cloning desktops:

- **Full clones**—Full clones 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. Updates must be performed on each VM with this approach.
- **Instant clones**—Instant clones are available only with Horizon 7 Enterprise 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 near to the time of login. You can use the combination of JMP features such as App Volumes and User Environment Manager to emulate persistence.
- **Linked clones**—Linked clones require fewer storage resources than full clones. This technology is appropriate for many VDI use cases. Differences between the master VM and the clone are maintained in a delta file. While updates can be rolled out effectively, multiple VM rebuilds are required to correctly deploy a patch at the operating system level. Operating System updates are rolled out to the master images, and then the Desktop pool is pointed to the new snapshot with the updates. A Horizon Composer instance is required with Linked Clones to manage the recompose functions of the pool.

 **Note:** Horizon Composer must be installed on a VM running Windows Server operating system.

The [VMware Horizon 7 Instant-clone Desktops and RDSH Servers White Paper](#) provides more information.

## Client components

End users can use a variety of client components to access the virtual desktops.

The following table lists the client components that Dell EMC recommends.

**Table 2** Recommended clients

| Component                           | Description   | Recommended use  | More information  |
|-------------------------------------|---|--|---|
| Dell Wyse 3040 thin client          | Dell's lightest, smallest, and most power-efficient thin client   | Task and basic productivity  | <a href="http://www.dell.com/us/business/p/wyse-3040-thin-client/pd">http://www.dell.com/us/business/p/wyse-3040-thin-client/pd</a> |
| Dell Wyse 5070 thin client          | A single thin client platform that meets every need, the Dell Wyse 5070 has multiple OS and connectivity options and can be monitored, maintained, and serviced remotely. | Knowledge workers who need powerful virtual desktop performance and support for unified communications solutions like Skype for Business | <a href="https://thinclientbenefits.com/products/wyse-5070">https://thinclientbenefits.com/products/wyse-5070</a>                   |
| Dell Wyse 5070 Extended thin client | Offers an on-board graphics card for offloading and supporting up to four 4K monitors plus two 2K monitors (total of 6)   | Knowledge workers who need powerful virtual desktop performance and support for several monitors   | <a href="https://thinclientbenefits.com/products/wyse-5070">https://thinclientbenefits.com/products/wyse-5070</a>                   |

# Design sizing and guidelines

This section provides recommendations and guidelines for designing your VDI environment.

## Platform configurations

With several options to choose from, consider these basic differences.

- Select the base B5 configuration when designing smaller deployments to meet minimum node requirements. B5 configurations scale well and can also effectively serve the maximum number of VMs for a block.
- C7 configurations are denser configurations that are intended for a higher scale and to reduce the number of nodes to maintain.
- The new Density-Optimized configurations provide the best performance and value for configurations with 400 or more users.

 **Note:** In the event of a node outage, the C7 configurations impact more users.

## CPU

User density and graphics considerations:

- Dell EMC Ready Architectures for VDI validation test results suggest that you can use CPU oversubscription to effectively size VDI user density. To use a CPU configuration other than those that have been validated, consider the following guidance to achieve comparable results:  
For architectures with Skylake processors:
  - **Knowledge workers**—3.75 users per core. For example, 60 knowledge users with dual eight-core processors.
  - **Power workers**—2.75 users per core. For example, 44 power users with dual eight-core processors.  
For architectures with Cascade Lake processors:
  - **Knowledge workers**—4 users per core. For example, 64 knowledge users with dual eight-core processors
  - **Power workers**—3 users per core. For example, 48 power users with dual eight-core processors
- For graphics configurations consider the following:
  - For high-end graphics configurations with NVIDIA GRID Quadro Virtual Data Center Workstation graphics enabled, consider choosing 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 Virtual PC configurations, consider higher core counts over faster clock speeds to reduce oversubscription.
  - 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 for memory allocation and configuration include:

- 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 occurs (for example, swapping and ballooning of memory). Overcommitted memory can also impact storage performance when swap-files are created.

- Populate memory in units of six per CPU to yield the highest performance. Dell EMC PowerEdge servers using Intel Xeon scalable Cascade Lake processors have six memory channels per CPU, which are controlled by two internal memory controllers, each handling three memory channels. To ensure that your environment has the optimal memory configuration, use a balanced configuration, where each CPU supports a maximum of 12 DIMMs (or 24 DIMMs for a dual-CPU server). The most effective configuration is 12 DIMMS (6 per processor) with Intel Xeon scalable processors.

## NVIDIA GRID considerations

Best practices for sizing and configuring solutions requiring graphics accelerators:

- Virtual PC licenses support up to 2 GB of video buffer and up to 2 x 4K monitors to cover most traditional VDI users. Maximum node density for graphics accelerated use can typically be calculated as the available video buffer per node divided by the video buffer size.
- Addition of GPU cards will not necessarily reduce CPU utilization. Instead, it enhances the user experience and offloads specific operations best performed by the GPU.
- Dell EMC recommends using the BLAST protocol for vGPU enabled desktops. NVIDIA Tesla GPUs are equipped with encoders that support BLAST.
- Virtual Workstations are typically configured with at least 2 GB video buffer.
- When configuring NVIDIA M10 GPU cards in a solution, Dell EMC recommends a maximum memory capacity of 768 GB, due to limitations in the Maxwell architecture. Pascal and Turing architectures do not have the same limitation

## External vCenter considerations

The VxRail Manager can upgrade appliances that are contained inside the cluster. Using an external vCenter instance disables the upgrade features available with the VxRail one-click upgrade process, and each appliance requires a separate upgrade.

## Sizing considerations

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

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

- **User density**—If concurrency is a concern, be sure to calculate how many users will be using the environment at the peak of 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**—When planning for DR, Dell EMC recommends implementing a dual/multi-site solution. The goal is to keep the customer's environment online and, in case of an outage, to perform an environment recovery with minimum disruption to the business.
- **Management and compute clusters**—For our small test environment, we used a combined management and compute cluster. For environments deployed at a larger scale, we recommend that you separate the management and compute layers. When creating a management cluster for a large scale deployment, consider using the E-Series VxRail or the R640 platform to reduce the data center footprint. With a more easily configured platform, the V-Series VxRail or R740XD platforms are preferred for compute clusters.
- **Network isolation**—This design illustrates a two-NIC configuration per appliance with all the traffic separated logically via VLAN. 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.

- **FTT**—Dell EMC 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 EMC also 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 EMC 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 3** FTT comparisons

| VM size | FTM                              | FTT | Overhead | Configuration | Capacity required | Hosts required |
|---------|----------------------------------|-----|----------|---------------|-------------------|----------------|
| 50 GB   | RAID-1 (Mirrored)                | 1   | 2 x      | Hybrid        | 100 GB            | 3              |
| 50 GB   | RAID-5 (3+1)<br>(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)<br>(Erasure coding) | 2   | 1.5 x    | All-flash     | 75 GB             | 6              |

**Note:** The [VMware Workspace ONE and VMware Horizon 7 Enterprise Edition On-premises Reference Architecture](#) provides more details about multi-site design considerations for Horizon.

## Test results and density recommendations

Test results provided recommended user densities.

The user densities in the following table were achieved by following the VMware best practices of FTT = 1 and a reserved slack space of 30 percent. All configurations were tested with Microsoft Windows 10 and Microsoft Office 2016. We implemented all mitigations to patch the Spectre, Meltdown and L1TF vulnerabilities at the hardware, firmware, and software levels to ensure an improved performance impact, which is reflected in the achieved user densities.

**Table 4** User density recommendations for VMware vSphere ESXi 6.7 with VMware Horizon

| Server configuration       | Workload                                | User density    |
|----------------------------|---|-----------------|
| Density Optimized          | Knowledge worker                        | 160             |
| Density Optimized          | Power worker                            | 120             |
| Density Optimized + 6 x T4 | Multimedia (Virtual Workstation: T4-2Q) | 48              |
| Density Optimized + 6 x T4 | Power worker (Virtual PC: T4-1B)        | 96 <sup>a</sup> |

**Table 4** User density recommendations for VMware vSphere ESXi 6.7 with VMware Horizon (continued)

- a. The user density of 96 users was achieved at 95% CPU utilization. The CPU utilization threshold of 85% is relaxed when testing with graphics cards. This test represents maximum utilization of the graphical resources available to the system as well as full user concurrency. Ideally, in a production environment, you would decrease the user density slightly or use higher bin processors to bring the CPU utilization closer to the 85% threshold. All LoginVSI tests completed successfully without reaching VSI maximum, indicating that user experience was good.

## Design assessment

Before deployment, be sure to perform an assessment of your environment to validate design considerations and ensure that you are designing your architecture to meet or exceed the performance of your current environment. Dell EMC Professional Services offers an assessment service for all VDI needs.

# Design enhancements

## Data protection guidance

As the adoption of VDI has grown, this has resulted in an elevation of 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.

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 EMC provides several data protection solutions for different data protection requirements.

### Dell EMC Avamar Virtual Edition

Dell EMC Avamar Virtual Edition (AVE) is a data protection solution that delivers software-only data protection for virtualized environments and is therefore ideal for the VDI use case. AVE 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 additional information, see [Dell EMC Avamar Virtual Edition Data Protection Software](#).

### Data Domain Virtual Edition

Dell EMC Data Domain Virtual Edition (DDVE) 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, DDVE is deployed as a virtual appliance on the relevant hardware platform. DDVE has a single point of management with Dell EMC Data Domain Management Center and scales up to 96 TB per instance. One of the key features of the DD storage protection solution is DD Boost, which provides advanced integration with data protection applications such as AVE to enable client-side deduplication, thus accelerating backup. For additional information, see [Dell EMC Data Domain Virtual Edition](#).

The process for protecting a VMware Horizon VDI environment using AVE and DDVE is outlined in the [Data Protection for a VMware Horizon VDI Environment using Dell EMC Data Protection Suite Operations Guide](#).

### Other Dell EMC data protection products

Dell EMC provides few 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 additional information, see [Dell EMC Data Protection](#).

## File workload guidance

The increased growth in the amount of data that is stored in file shares and user home directories across corporate IT environments in recent years has resulted in an increased focus on the need to better manage this unstructured data. As a result, many organizations are choosing to deploy dedicated file workload solutions with capabilities such as cloud file tiering and single file system namespaces across their IT infrastructure, including for file workloads in a VDI environment.

Dell EMC provides a number of file workload solutions for different types of file workloads.

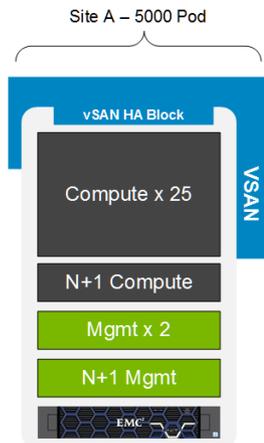
## Dell EMC Unity

Dell EMC Unity storage is simple, unified all-flash and hybrid storage with hybrid cloud capabilities.

Dell EMC Unity is ideal for general purpose NAS/SAN mixed workload consolidation, smaller file workloads (including small to mid-sized VDI environments), and transactional databases.

The following figure shows an example of a 5,000-user VDI deployment using Dell EMC Unity storage for file shares.

**Figure 5** 5,000-user pod on Dell EMC Unity



When deploying Dell EMC Unity in a VDI environment, Dell EMC recommends that you deploy a separate Dell EMC Unity storage system with a vSphere HA cluster or Block. This structure provides the greatest scalability, resiliency, and flexibility when deploying and maintaining file services for the overall user pod. As unstructured data storage needs grow over time, the capacity of each Dell EMC Unity storage system can be scaled up independently with minimal user impact. You have the choice to deploy alternative architectures to the one suggested here, but you should carefully consider the tradeoffs.

The [Dell EMC Unity All-Flash Unified Storage](#) web page provides guidance about selecting an appropriate Dell EMC Unity storage solution for your file workload requirements.

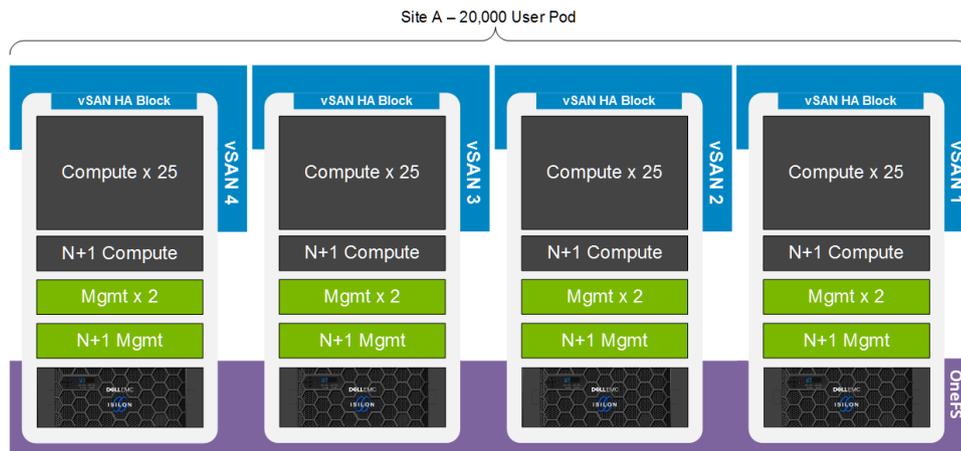
## Dell EMC Isilon file storage

Dell EMC Isilon storage is the industry's number one scale-out NAS solution for any file workload.

Isilon 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.

The following figure shows an example of a 20,000-user VDI deployment using Dell EMC Isilon scale-out storage with a single namespace.

**Figure 6** 20,000-user pod on Isilon



When deploying Dell EMC Isilon in a VDI environment, Dell EMC recommends that you deploy a separate Dell EMC Isilon storage system with a vSphere HA cluster or Block. This structure provides the greatest scalability, resiliency, and flexibility when deploying and maintaining file services for the overall user pod. As unstructured data-storage needs grow over time, the capacity of each Dell EMC Isilon storage system can be scaled up independently with minimal user impact. In addition to scaling up each Isilon chassis, Isilon can also be scaled out using the OneFS operating system. This ability means that additional Isilon systems can be added to provide a single volume and namespace that all user pods in a datacenter can access.

As shown in the previous figure, Isilon OneFS can be scaled out in unison with vSAN HA blocks as the VDI environment grows. You can choose to deploy alternative architectures to the one suggested here, but you should carefully consider the tradeoffs.

The [Dell EMC Isilon](#) web page provides guidance about selecting an appropriate Dell EMC Isilon storage solution for your file workload requirements.

## 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 EMC provides a wide range of Data Center Infrastructure solutions:

- **Dell EMC Netshelter SX racks**—Deploy server, storage, and networking equipment and other IT hardware while optimizing power, cooling, cabling, and systems management.
- **Dell EMC 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 EMC 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)**—Reliable power distribution designed to increase manageability and efficiency in your data center

# Conclusion

## Summary

This design guide has described the integration of vSAN-based appliances from Dell EMC and VMware Horizon 7 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 EMC 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 EMC Ready Architectures 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 EMC support

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

## Next steps

Dell EMC has a configuration to fit the needs of any size organization:

- VxRail E560 or E560F(E Series)—Select this device if graphics are not required or for small deployments where energy concerns exist or space is limited.
- VxRail V570 or V570F (V Series)—This configuration is VDI-optimized and offers the highest processor speeds and graphics capability.
- vSAN Ready Nodes R640—This device is a powerful pre-validated configuration in a dense rack platform. Occupying only 1U in the rack, this powerful server supports A3, B5, C7, or Density-Optimized non-graphics configurations for VDI.

To explore more about this solution, its design, and testing, see the Validation Guide for this architecture. Your Dell EMC solutions representative can assist with further information and resources.

The [Virtual Desktop Infrastructure](#) page on the Dell EMC website provides additional resources and other VDI designs to help make IT groups a strategic asset.

# References

The documentation in this section provides additional information.

## Dell EMC documentation

The following Dell EMC documentation provides additional and relevant information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your Dell EMC representative. Also see the [Dell EMC VDI Information Hub](#) for a complete list of VDI resources.

- [Dell EMC VxRail Appliance documentation](#)
- [Dell EMC Virtual Desktop Infrastructure](#)

This document is part of the documentation set for this architecture, which includes the following:

- [Dell EMC Ready Architectures for VDI: Designs for VMware Horizon on VxRail and vSAN Ready Nodes Design Guide](#)
- [Dell EMC Ready Architectures for VDI: Designs for VMware Horizon on VxRail and vSAN Ready Nodes Validation Guide](#)
- [Dell EMC Ready Architectures for VDI: Designs for VMware Horizon on VxRail and vSAN Ready Nodes Deployment Guide](#)

## NVIDIA documentation

The following NVIDIA documentation provides additional and relevant information:

- [NVIDIA Virtual GPU Software Quick Start Guide](#)

