Dell EMC Ready Solutions for VDI
Designs for VMware Horizon on VxRail and vSAN Ready Nodes
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.
Notes, cautions, and warnings

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

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

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

Business challenge

In the past, moving from traditional personal computers to a virtual desktop infrastructure (VDI) solution was challenging. A classic VDI implementation of 100 applications and 1,000 users might 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. It dramatically reduces the complexity of the system and makes it more flexible. The IT team can then move from being a largely reactive technical group to playing a more proactive role. Dell Technologies can assist IT teams in this journey while improving user experience with Dell EMC Ready Solutions for VDI.

Some challenges that organizations face today include:

- **Workforce empowerment**—Personal technology is driving newer and higher expectations. People want the same features on their work devices that they have on their personal devices. They want faster, easier-to-use devices and applications that fit their specific needs.
- **Optimized IT resources**—Organizations that manage many traditional personal computers find that the task is becoming increasingly complex. With desktop virtualization, you can move the entire desktop, including applications, data, and the operating system, to the data center. IT can centrally manage the virtual desktop from the data center. You save time and money by troubleshooting personal computers remotely instead of physically visiting each one.
- **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, is the leading IT concern 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.
- **Cost management**—Organizations must monitor and optimize the total cost of ownership (TCO), achieve greater utilization from infrastructure assets, and reduce energy use. Virtualization helps organizations achieve these goals because virtual assets are cheaper and easier to maintain than physical assets.
Technology solution

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

The Ready Solutions for VDI are built on Dell EMC VxRail appliances or vSAN Ready Nodes appliances. These true hyperconverged infrastructure (HCI) platforms provide performance, flexibility, and scale for VDI environments.

Dell Technologies recommends VxRail appliances for an enhanced VDI solution that uses a wide range of software, tools, and resources co-developed by Dell Technologies and VMware. The VMware hyperconverged software is vSphere ready and based on vSAN software-defined storage (SDS). Dell Technologies 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 prevalidated 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 Technologies offers comprehensive, flexible, and efficient VDI solutions that are designed and optimized for your organization's needs. These VDI solutions are easy to plan, deploy, and run.

To start or extend your data center, you can choose from two vSAN-based appliance options. While VxRail and vSAN Ready Nodes have the same underlying technology (VMware vSAN), each provides unique benefits. VxRail appliances provide a turnkey solution for deploying and managing infrastructure with additional software features to assist throughout the appliance life cycle. 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 Solutions for VDI offer several key benefits:

- **VxRail Manager life cycle management**—Integrated VxRail software life cycle 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 life cycle management reduces complexity, makes the infrastructure more secure, and removes the risk (VxRail Manager is available only on VxRail appliances).
- **Predictable costs, performance, and scalability to support a growing workforce**—The cost of deploying applications and desktops is reduced when deploying from a data center.
- **Rapid deployments**—Dell EMC Ready Solutions for VDI offer 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. VxRail Manager (available only with VxRail appliances) makes it easy to insert or remove nodes from your cluster to meet your business needs.
- **Dell Technologies support**—Dell EMC Ready Solutions 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.

Dell Technologies 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 Solutions for VDI that deliver Microsoft Windows virtual desktops using VMware Horizon 7 VDI components on VxRail appliances or vSAN Ready Nodes.
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 EMC Solutions team by email or provide your comments by completing our documentation survey.

Authors: Dell EMC Ready Solutions for VDI team.

NOTE: The following website provides 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 pod and block design. A pod is divided into multiple blocks. Each block is made up of one or more vSphere clusters, a vCenter Server, and, for linked clones, a composer server.

This Dell EMC Ready Solution for VDI supports all cloning techniques available from VMware: full, linked, and instant.

A vSphere cluster can have a maximum of 64 nodes and 6,400 VMs per vSAN cluster. To expand this limit, you can add clusters and balance the VMs and nodes across the new clusters.

The VMware Workspace ONE and VMware Horizon Reference Architecture provides more information about Horizon pods and blocks, as well as additional guidance about multisite configurations.
Scaling the solution

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.

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 VMs a vCenter can host depends on the type of Horizon 7 VMs being used. The recommended limit of virtual machines per vCenter is as follows:

- 12,000 full-clone or instant-clone VMs
- 4,000 linked-clone VMs

Sizing recommendations change over time as updates are released and qualifications are performed. See the VMware Horizon 7 sizing limits and recommendations (2150348) Knowledge Base article for the latest recommendations.

This Ready Solution 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 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. Scale out for 20,000 users**

Note that the management cluster sizing in the preceding diagrams are recommended minimums, and 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.

The VMware Workspace ONE and VMware Horizon Reference Architecture provides more information about Horizon pod and 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 Technologies recommends that the VDI management infrastructure nodes be separated from the compute resources. In small environments, both management and compute can be placed in the same vSphere HA cluster. In this scenario, 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 reduction 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 multisite or disaster recovery (DR) configurations, see the VMware Workspace ONE and VMware Horizon Reference Architecture.
Key components

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

VxRail Appliance

The Dell EMC VxRail HCI appliance is available in 1U or 2U rack building blocks. It is built on VMware vSAN technology and further enabled with Dell Technologies software.

The following figure shows the components of the VxRail appliance.

![VxRail Appliance Components](image)

**Figure 4. Dell EMC VxRail appliance**

VxRail appliance platforms are equipped with 2nd Generation 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 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 supports a maximum of 40 TB raw storage with a hybrid configuration of 78 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. Dell EMC VxRail platforms**

<table>
<thead>
<tr>
<th>Platform</th>
<th>Description</th>
<th>Configurations</th>
<th>Form factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>E Series</td>
<td>Entry level</td>
<td>All-flash and hybrid</td>
<td>1U1N</td>
</tr>
<tr>
<td>V Series</td>
<td>VDI optimized</td>
<td>All-flash and hybrid</td>
<td>2U1N</td>
</tr>
<tr>
<td>P Series</td>
<td>Performance optimized</td>
<td>All-flash and hybrid</td>
<td>2U1N</td>
</tr>
<tr>
<td>S Series</td>
<td>Storage dense</td>
<td>Hybrid</td>
<td>2U1N</td>
</tr>
<tr>
<td>D Series</td>
<td>Ruggedized</td>
<td>All-flash and hybrid</td>
<td>1U1N</td>
</tr>
</tbody>
</table>

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 life cycle 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 Node 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 life cycle management and additional bundled software, Dell Technologies 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 Solutions VDI-optimized configurations

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

The VxRail V Series and vSAN Ready Node R740xd server can be configured with or without GPUs. Dell Technologies 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 Management-Optimized, Density-Optimized, and Virtual Workstation. These designations are referenced throughout the documentation.

Table 2. Common configurations

<table>
<thead>
<tr>
<th>Configuration</th>
<th>CPU</th>
<th>RAM</th>
<th>Disk</th>
<th>GPU (optional)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management-Optimized</td>
<td>2 x Intel Xeon Silver 4214 (12-core @ 2.2 GHz)</td>
<td>192 GB (12 x 16 GB @ 2,400 MHz)</td>
<td>4 TB + (capacity)</td>
<td>None</td>
<td>Offers density and value to provide a dedicated environment to deploy virtualized management infrastructure.</td>
</tr>
<tr>
<td>Density-Optimized</td>
<td>2 x Intel Xeon Gold 6248 (20-core @ 2.5 GHz)</td>
<td>768 GB (12 x 64 GB @ 2,933 MHz)</td>
<td>8 TB + (capacity)</td>
<td>Up to 3 x full length, dual width (FLDW)</td>
<td>Offers an abundance of high-performance features and tiered capacity that maximizes user density.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Up to 6 x full length, single width (FLSW)</td>
<td></td>
</tr>
<tr>
<td>Virtual Workstation</td>
<td>2 x Intel Xeon Gold 6254 (18-core @ 3.1 GHz)</td>
<td>384 GB (12 x 32 GB @ 2,933 MHz)</td>
<td>6 TB + (capacity)</td>
<td>Up to 3 x FLDW</td>
<td>Offers even higher performance at the tradeoff of user density. Typically for ISV or high-end graphics workloads.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Up to 6 x FLSW</td>
<td></td>
</tr>
</tbody>
</table>

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 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 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.

Figure 5. vGPUs in a virtualized solution

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

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

Dell EMC Ready Solutions for VDI can be configured with the following NVIDIA GPUs:

- **NVIDIA 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 Technologies recommends hosting a maximum of 32 Windows 10 users per card. While some VSAN Ready Node configurations support three cards, consider sizing with a maximum of two cards per node. Configure systems with less than 1 TB of memory when using the M10.
- **NVIDIA T4 Tensor Core**—NVIDIA’s Turing architecture is available in the T4 GPU, which is considered the universal GPU for data center workflows. The T4 GPU is flexible enough to run knowledge worker VDI or professional graphics workloads. Add up to six GPU cards into your R740xd appliance to enable up to 96 GB of graphics frame buffer. For modernized data centers, use this card in off-peak hours to perform your inferencing workloads.
- **NVIDIA RTX 6000 and 8000**—Select the Turing-based RTX 6000 or RTX 8000 for the best virtualized graphics performance for professional graphics and rendering workloads. These two GPUs have similar specifications, but the RTX 6000 has 24 GB of graphics frame buffer while the RTX 8000 has 48 GB per card. Add up to three RTX 6000 or 8000 GPU cards into your R740xd appliance to enable up to 72 GB or 144 GB respectively.

Mixed GPU deployments

As a best practice, members of a VMware vSAN-based cluster must be identical or as homogeneous as possible in terms of hardware, software, and firmware. This configuration is primarily designed to reduce operational complexity and maintenance requirements. When deploying NVIDIA vGPU and the associated NVIDIA GPUs in a VxRail or vSAN Ready Node environment, you might want or require a mixed GPU environment because:

- Usage patterns and workloads that are better matched to different physical GPU types need to be addressed.
- A newer generation of NVIDIA GPUs that adds greater value to the overall solution has been released.
- 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 information when you are 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 GPU model has its own set of NVIDIA vGPU profiles that are unique to that card model.
- Each chosen vGPU profile needs an associated VMware Horizon gold image. This requirement adds an administrative overhead because these gold images must 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 must be created and maintained for each related vGPU profile.
- VMware Horizon intelligently picks the appropriate hosts to deploy the NVIDIA vGPU pool to the correlated NVIDIA 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:
  - To enable maintenance with minimal downtime, add two or more identically configured nodes.
  - To expand by a single node, which does not provide redundancy for that vGPU type, 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 Technologies 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 Solutions for VDI on appliances enable flexibility in networking selections. VDI validations have been successfully performed with the following hardware, although several other choices are available:

- **Dell EMC Networking S4048-ON (10 GbE ToR switch)** — The S4048-ON switch optimizes your network for virtualization with a high-density, ultra-low-latency ToR switch that features 48 x 10 GbE SFP+ and 6 x 40 GbE ports (or 72 x 10 GbE ports in breakout mode) and up to 720 Gbps performance. The S4048-ON switch also supports ONIE for zero-touch installation of alternate network operating systems.
- **Dell EMC 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 zero-touch installation of network operating systems.

See Dell EMC PowerSwitch S Series 10GbE Switches and Dell EMC PowerSwitch S Series 25/40/50/100 GbE Switches for more information about these switches.

**NOTE:** Ensure that you comply with the switch requirements in the Dell EMC VxRail Network Planning Guide, which provides important information, recommendations, and best practices for VxRail appliances. 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 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. 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 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, which enable deep operational visibility and faster troubleshooting.

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

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**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 VDI.

For more information, see the Horizon 7 resources page and 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.

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**Horizon clone technology**

VMware Horizon 7 offers the following methods for cloning desktops:

- **Full clones**—These are typically used for testing purposes or to create management VMs. Full clones are not ideal for VDI because full copies have no connection to the original VM. You must update each VM with this approach.

- **Instant clones**—These are available 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 when it is needed. You can use the combination of Just-in-Time Management Platform (JMP) features such as App Volumes and User Environment Manager to emulate persistence.

- **Linked clones**—These 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 re-compose functions of the pool.

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

See the VMware Horizon 7 Instant-Clone Desktops and RDSH Servers White Paper for more information.
## Client components

Users can access the virtual desktops through various client components.

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

### Table 3. Recommended client components

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Recommended use</th>
<th>More information</th>
</tr>
</thead>
</table>
| **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 | www.delltechnologies.com/Latitude |
| **OptiPlex business desktops and All-in-Ones** | - 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 | www.delltechnologies.com/OptiPlex |
| **Precision workstations** | - The most complete workstation portfolio with towers, racks, and mobile form factors  
- Extremely powerful workstations for the most demanding applications, scalable storage, and RAID options  
- Smallest, most intelligent, and highest-performing mobile workstation portfolio  
- Rack workstations delivering shared or dedicated resources  
- Ensures peace of mind with ISV certified, reliable performance | - High-end graphics and extreme performance  
- Precision workstations designed to run processor- and graphic-intensive applications and activities with mission-critical reliability such as analytics, simulations, and modeling | www.delltechnologies.com/Precision |
| **Wyse thin clients** | - Highly secure thin client operating system with no sensitive data or personal information exposed on the local device  
- Dedicated to corporate use, prevents unauthorized software and viruses  
- Optimizes management and efficiency by delivering a controlled access to centralized data, applications, and resources | - Security and manageability  
- Optimized to access virtualized desktops and cloud applications and deliver high-quality client computing experiences and enterprise-class security, while streamlining management through centralized control | www.delltechnologies.com/wyse |
Table 3. Recommended client components (continued)

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Recommended use</th>
<th>More information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• High-quality user experiences with desktop, All-in-One, and mobile form</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>factors and a comprehensive ecosystem</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Design sizing and guidelines**

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

**Platform configurations**

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

- The Density-Optimized configuration provides a good balance of performance and scalability for various general-purpose VDI workloads.
- The Virtual Workstation 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:

- For architectures with Cascade Lake processors:
  - **Knowledge workers** — 3.125 users per core, for example, 50 knowledge users with dual eight-core processors
  - **Power workers** — 2.5 users per core, for example, 40 power users with dual eight-core processors

- For graphics considerations:
  - For high-end graphics configurations with NVIDIA Quadro Virtual Data Center Workstation 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 Virtual PC configurations, use higher core counts over faster clock speeds to reduce oversubscription.
  - Note that 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, 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 six per CPU to yield the highest performance. Dell EMC PowerEdge servers using 2nd Generation Intel Xeon Scalable 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 vGPU considerations**

Best practices for sizing and configuring solutions requiring graphics accelerators include:

- 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 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.
- When configuring NVIDIA M10 GPU cards in a solution, Dell Technologies 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

When using an external vCenter, the life cycle of the vCenter appliance is not managed by the VxRail appliance and must be managed manually. Before upgrading the VxRail clusters, ensure that the vCenter is upgraded to a supported version in accordance with the VxRail and external vCenter interoperability matrix. For additional information about the procedure to update the external vCenter appliance, see the VxRail: How to upgrade external vCenter appliance Knowledge Base article (login required).

Sizing considerations

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

- **User density**—If concurrency is a concern, calculate how many users will use 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**—For DR planning, Dell Technologies recommends implementing a dual/multi-site solution. 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**—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 using 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 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 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 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>
<thead>
<tr>
<th>VM size</th>
<th>FTM</th>
<th>FTT</th>
<th>Overhead</th>
<th>Configuration</th>
<th>Capacity required</th>
<th>Hosts required</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 GB</td>
<td>RAID-1 (Mirrored)</td>
<td>1</td>
<td>2 x</td>
<td>Hybrid</td>
<td>100 GB</td>
<td>3</td>
</tr>
<tr>
<td>50 GB</td>
<td>RAID-5 (3+1) (Erasure coding)</td>
<td>1</td>
<td>1.33 x</td>
<td>All-flash</td>
<td>66.5 GB</td>
<td>4</td>
</tr>
<tr>
<td>50 GB</td>
<td>RAID-1 (Mirrored)</td>
<td>2</td>
<td>3 x</td>
<td>Hybrid</td>
<td>150 GB</td>
<td>4</td>
</tr>
<tr>
<td>50 GB</td>
<td>RAID-6 (4+2)(Erasure coding)</td>
<td>2</td>
<td>1.5 x</td>
<td>All-flash</td>
<td>75 GB</td>
<td>6</td>
</tr>
</tbody>
</table>
```

- **NOTE:** The VMware Workspace ONE and VMware Horizon Reference Architecture provides more details about multi-site design considerations for Horizon.

Test results and density recommendations

The recommended user densities in the following table were achieved during the performance testing on VxRail appliances. We followed the VMware best practices of FTT = 1 and configured a reserved slack space of 30 percent. All configurations were tested with Microsoft Windows 10, 64-bit, and Microsoft Office 2019. 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 5. User density recommendations for VMware vSphere ESXi 6.7 with VMware Horizon 7.10

<table>
<thead>
<tr>
<th>Server configuration</th>
<th>Workload</th>
<th>Windows version</th>
<th>User density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density Optimized</td>
<td>Login VSI Knowledge Worker</td>
<td>Windows 10, 1803</td>
<td>130</td>
</tr>
<tr>
<td>Density Optimized</td>
<td>Login VSI Knowledge Worker</td>
<td>Windows 10, 1909</td>
<td>125</td>
</tr>
<tr>
<td>Density Optimized</td>
<td>Login VSI Power Worker</td>
<td>Windows 10, 1909</td>
<td>100</td>
</tr>
<tr>
<td>Density Optimized + 6 x T4</td>
<td>Login VSI Multimedia (Virtual PC: T4-2B)</td>
<td>Windows 10, 1909</td>
<td>48</td>
</tr>
<tr>
<td>Density Optimized + 6 x T4</td>
<td>nVector Knowledge Worker (Virtual PC: T4-2B)</td>
<td>Windows 10, 1909</td>
<td>48</td>
</tr>
<tr>
<td>Density Optimized</td>
<td>nVector Knowledge Worker</td>
<td>Windows 10, 1909</td>
<td>48</td>
</tr>
</tbody>
</table>

**Design assessment**

Before deploying the solution, assess 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 Technologies Professional Services offers an assessment service for all VDI needs.
Design enhancements

Data protection guidance

The growth of VDI adoption 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 Technologies provides several data protection solutions for different data protection requirements.

Dell EMC Avamar Virtual Edition

Dell EMC 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 additional information, see Dell EMC Avamar Virtual Edition Data Protection Software.

PowerProtect DD Virtual Edition

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


Other Dell Technologies data protection products

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

File workload guidance

The increased growth in the amount of data that is stored in file shares and user home directories across 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 deploying 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 Technologies provides a number of solutions for different types of file workloads.

Dell EMC PowerStore storage

Dell EMC PowerStore T storage is simple, unified storage that enables flexible growth with intelligent scale-up and scale-out capabilities and public cloud integration.

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

The following figure shows an example of a 5,000-user VDI deployment using Dell EMC PowerStore T storage for file shares:
When you are deploying Dell EMC PowerStore T in a VDI environment, Dell Technologies recommends that you deploy a separate PowerStore T storage system with a vSphere HA cluster or block. Each PowerStore T system can scale up to four appliances per cluster. 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 PowerStore T storage system can be scaled up or out 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.

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

**Dell EMC PowerScale file storage**

Dell EMC 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.

The following figure shows an example of a 20,000-user VDI deployment using PowerScale scale-out storage with a single namespace:

When you are deploying an 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. As unstructured data-storage needs 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 EMC OneFS operating system. Thus, multiple PowerScale systems can provide a single volume and namespace that all user pods in a data center can access.
As shown in the previous figure, you can scale out the system as the VDI environment grows. You can deploy alternative architectures to the one suggested here, but first carefully consider the tradeoffs.

For guidance about selecting an appropriate PowerScale storage solution for your file workload requirements, see the Dell EMC 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:

- **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)**—Provides reliable power distribution that is designed to increase manageability and efficiency in your data center.
Conclusion

Summary
This design guide describes the integration of vSAN-based appliances from Dell Technologies 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 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 EMC Ready Solutions for VDI offer several key benefits to clients:

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

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

- VxRail E560 or E560F (E Series)—This appliance is for small deployments where energy concerns exist or space is limited. Up to two NVIDIA T4 GPUs are supported per node.
- VxRail V570 or V570F (V Series)—This appliance configuration is VDI-optimized and offers the highest processor speeds and graphics capability. Up to six NVIDIA T4 GPUs, two NVIDIA M10 GPUs, or three NVIDIA Quadro RTX GPUs are supported per node.
- vSAN Ready Node R640—This device is a prevalidated configuration in a dense rack platform. Occupying only 1U in the rack, this powerful server supports Density-Optimized configurations for VDI. It supports up to three NVIDIA T4 GPUs per node.

To explore more about this solution, its design, and testing, see the VMware Horizon on VxRail and vSAN Ready Nodes Validation Guide. Your Dell Technologies solutions representative can assist with further information and resources.

For additional resources and other VDI designs, see the VDI Info Hub for Ready Solutions.
References
The documentation in this section provides additional information.

Previous versions
Previous versions of the documentation for this solution can be found here:
- VDI Info Hub Archive

Dell Technologies documentation
The following links provide additional information from Dell Technologies. Access to these documents depends on your login credentials. If you do not have access to a document, contact your Dell Technologies representative. Also see the VDI Info Hub for a complete list of VDI resources.
- Dell Technologies Virtual Desktop Infrastructure
- Dell EMC VxRail Hyperconverged Infrastructure
- Dell EMC vSAN Ready Nodes

VMware documentation
The following links provide additional information from VMware:
- VMware vSphere documentation
- VMware Horizon 7 documentation
- VMware Compatibility Guide
- Best Practices for Published Applications and Desktops in VMware Horizon Apps and VMware Horizon 7
- VMware Workspace ONE and VMware Horizon Reference Architecture

NVIDIA documentation
The following NVIDIA documentation provides additional and relevant information:
- NVIDIA Virtual GPU Software Quick Start Guide