Dell EMC Ready Architectures for VDI

Designs for VMware Horizon on XC Family

August 2019

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Design Guide

Abstract

This design guide describes technical considerations and best practices for integrating VMware Horizon brokering software with Dell EMC XC Family devices to create virtual application and desktop environments in a VMware vSphere environment.

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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 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 more proactive role. 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 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 a large number of 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 and 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, 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.
- **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 ones.

Technology solution

Dell EMC Ready Architectures for VDI on XC Family devices provide a quick and easy way to simplify and extend your VDI 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 Dell EMC XC Family devices. These true hyperconverged infrastructure (HCI) platforms provide performance, flexibility, and scale for VDI environments.

Dell EMC recommends XC Family devices for customers who require a VMware Horizon broker with a Nutanix-based HCI solution. In this case, the Dell EMC XC Family devices provide a complete VDI solution. VMware Horizon 7 VDI technology is enhanced with an HCI environment that is built on Dell EMC PowerEdge servers. Dell EMC software and services further optimize the solution in the areas of deployment, recovery, management, and automation.

The XC Family includes the following choices. The hardware and software are the same. The difference is in the licensing and service providers.

- **Dell EMC XC Core systems**—Purchase Nutanix licenses through the Nutanix partner ecosystem. Nutanix provides support for Nutanix software.
- **Dell EMC XC Series appliances**—Purchase Nutanix licenses as part of the appliance purchase from Dell EMC or the Dell EMC partner ecosystem. Dell EMC is the initial support contact point for Dell EMC XC Series appliances.

Installing VMware Horizon 7 with its VDI components on XC Family devices 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.

- **XC Family life cycle management (LCM)**—Automates software and firmware updates for XC Family clusters, providing inventory and cluster-aware update capability.
- **Simplified Dell EMC networking solutions**—Offers reference architectures, deployment guides, and best practices to ensure that the networking component on an XC Family solution can support an accelerated time-to-value.
- **ProDeploy**—Provides on-site implementation, including planning, installation, and configuration.
- **Support Flexibility**—Choose Dell EMC XC Series appliances with a single point-of-contact for hardware and HCI software or select XC Core systems for hardware support from Dell EMC and software support for HCI from Nutanix.

Document purpose

This document introduces the architecture, components, design options, best practices, and configuration details for successful VDI deployments for XC Family devices 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 XC Family devices.

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 XC Family devices.

Architecture overview

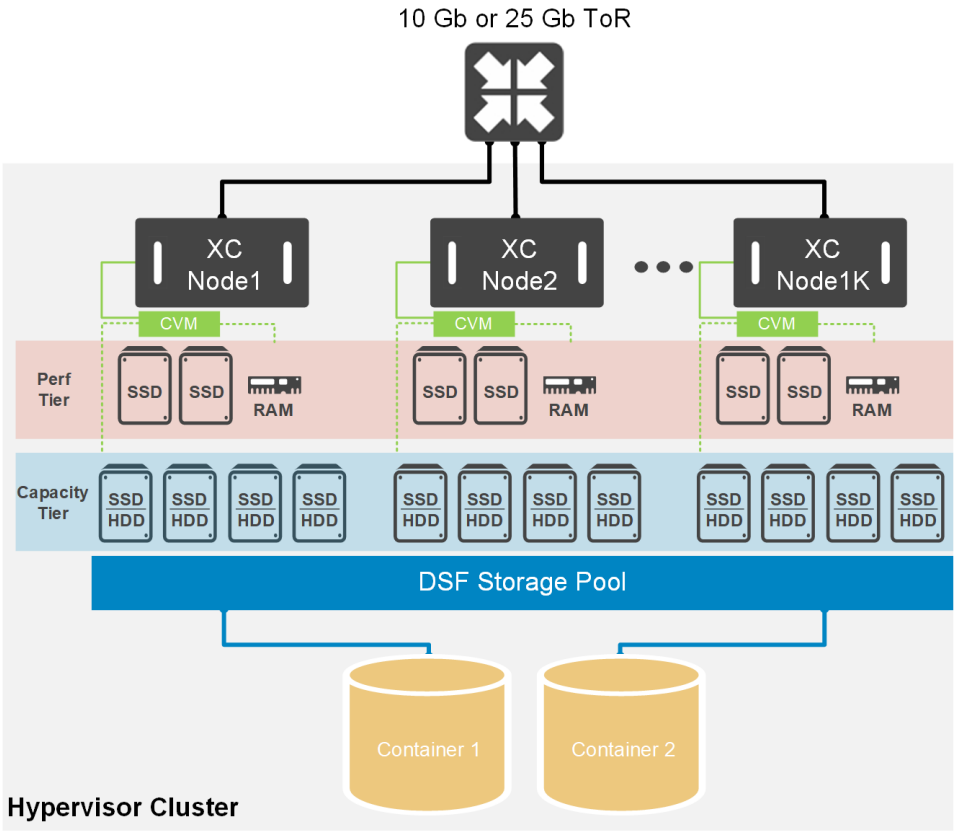
The following figure depicts the architecture of the validated solution, including the network, compute, management, and storage layers. This architecture aligns with the VMware Horizon Block/Pod design. A pod is divided into multiple blocks. Each block is made up of one or more vSphere clusters, a Virtual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

Distributed Storage Fabric (DSF) is the Nutanix distributed storage solution formerly known as Nutanix Distributed File System (NDFS). It contains, among other things, the following storage features:

- Backup
- Compression
- De-duplication
- Disaster Recovery
- Erasure Coding (EC-X)
- Replication

The Controller Virtual Machine (CVM) is the virtual machine running on each Nutanix node that delivers the DSF.

Figure 1 XC Family devices with VMware Horizon



You can use any of the Horizon supported cloning techniques—full, linked, and instant—to deploy this Dell EMC Ready Architecture for VDI.

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

Solutions that are based on XC Family devices 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 resources to the infrastructure, for example, SSD drives, to scale vertically.

Scaling out

Each component of the solution architecture scales independently depending on the required number of supported users. You can add XC Family nodes at any time to expand the Software-Defined Storage (SDS) pool in a modular fashion.

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)

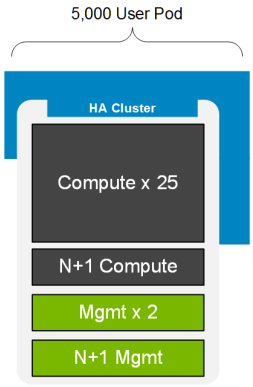
- 2,000 VMs (all clone types) if App Volumes or AppStacks are attached

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.

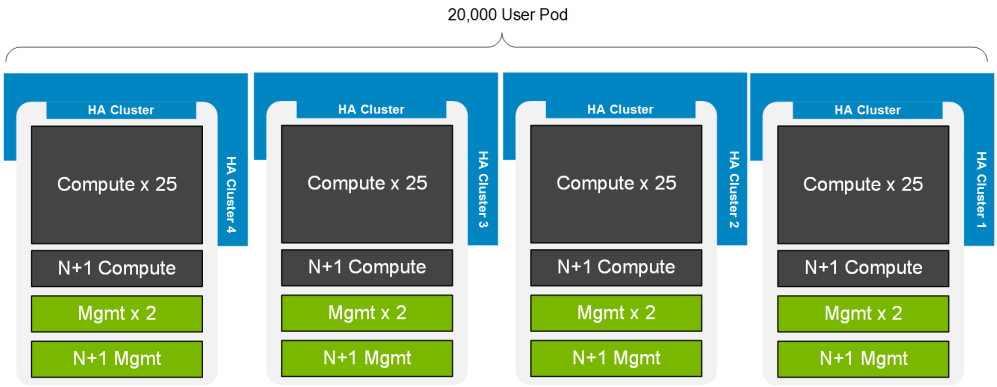
The following figure shows a 5,000-user Horizon block that is based on a 200-user per node density.

Figure 2 Single 5,000-user block



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

Figure 3 Scaleout environment 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.

Management and multisite considerations

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 multisite or disaster recovery (DR) configurations, see the Horizon 7 Enterprise Edition Multi-Site Reference Architecture.

Key components

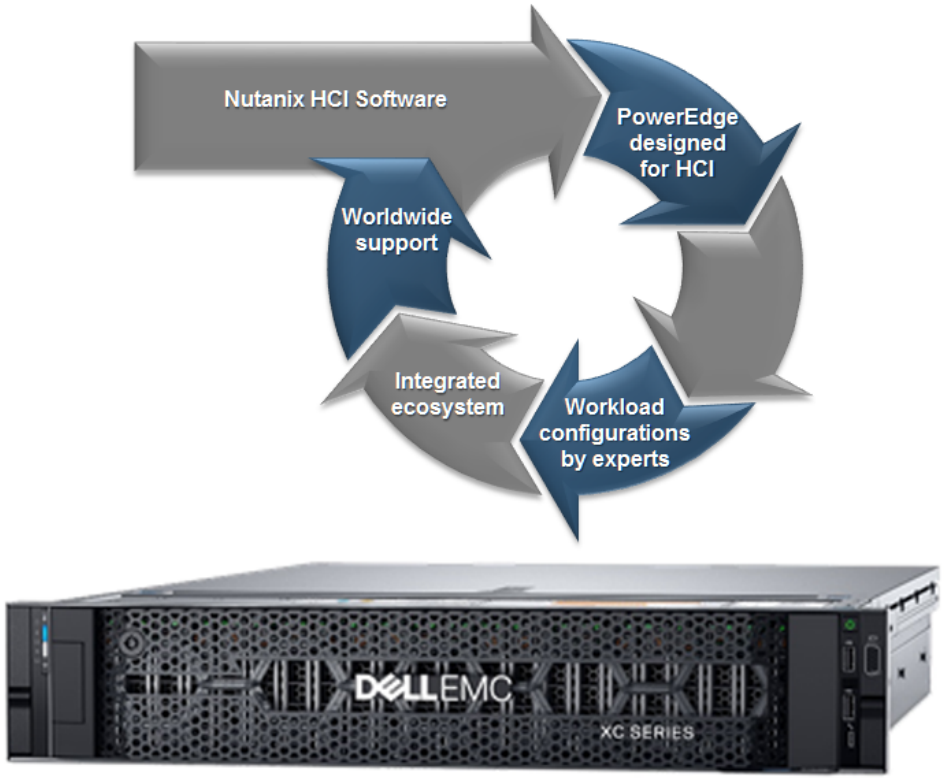
This section describes the key hardware and software components of the solution.

XC Family

The Dell EMC XC Family is a powerful HCI environment that is available in 1U or 2U environments. The XC Family is built on Nutanix software and the Dell EMC PowerEdge server platform. These devices incorporate many of the advanced software technologies that power leading web-scale and cloud infrastructures.

The following figure shows the components and benefits of XC Family devices.

Figure 4 Dell EMC XC Family device overview



For VDI-optimized configurations, you can deploy a cluster with as few as three nodes, providing an ideal environment for small deployments. To achieve full XC high availability, the recommended starting cluster size is four nodes. The XC Family 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 following XC Family devices are recommended for VDI:

- **Dell EMC XC640**—A 10-disk 1U platform with a broad range of configuration options. Each appliance comes equipped with dual CPUs, 10 to 28 cores, and up to 1.5 TB of high-performance RAM.
  For the hybrid disk configuration, a minimum of six disks is required in each host: two SSDs for the performance tier (Tier1) and four HDDs for the capacity tier (Tier2), which can be expanded up to eight HDDs as required. For the all-flash disk configuration, the chassis must be populated with a minimum of four SSDs.

The M.2-based BOSS module boots the Hypervisor and Nutanix Controller VM, while the PERC HBA330 connects the CVM to the SSDs and HDDs. 64 GB is consumed on each of the first two SSDs for the Nutanix home directory.

All HDD/SSD disks are presented to the Nutanix CVM running locally on each host, which contributes to the clustered DSF storage pool. Each platform can be outfitted with SFP+ or BaseT NICs.

- **Dell EMC XC740xd**—A 2U platform that can be configured with 24 x 2.5-inch disks or 12 x 3.5-inch disks to serve a broad range of capacity requirements. Each appliance comes equipped with dual CPUs, 10 to 28 cores, and up to 1.5 TB of high-performance RAM.
  A minimum of 12 disks is required in each host: four SSDs for the performance tier (Tier1) and eight HDDs for the capacity tier (Tier2), which can be expanded as required up to 45 TB per node raw. The M.2-based BOSS module boots the hypervisor and Nutanix Controller VM, while the PERC HBA330 connects the CVM to the SSDs and HDDs. 64 GB is consumed on each of the first two SSDs for Nutanix Home.

  All HDD and SSD disks are presented to the Nutanix CVM running locally on each host, which contributes to the clustered DSF pool. Each platform can be outfitted with SFP+ or BaseT NICs. The 24-disk XC740xd can support up to three NVIDIA P40, two M10 or six T4 GPU cards. Higher wattage power supplies (up to 2,000 W per PSU) are required when GPUs are in use.

The following table shows the full range of configurations that are available for XC640 and XC740xd devices. The next section presents more specific recommendations.

Table 1 Available Dell EMC XC Family 640 and 740xd configurations

XC640-4 & -4i	XC640-10	XC740xd-24	XC740xd-12	XC740xd-12C	XC740xd-12R
• 4 x 3.5-inch drives • 64 GB - 1.5 TB • Hybrid, all flash • XC640-4: 3+ node mission critical • XC640-4i: 1 or 2 node non-mission critical	• 10 x 2.5-inch drives • 4 x 3.5-inch drives • Hybrid, all flash, NVME +SSD • NVME • 128 GB - 1.5 TB memory	• 24 x 2.5-inch drives • 64 GB - 1.5 TB memory • Hybrid, all flash, NVME +SSD • Nvidia M10, P40 and T4 GPUs	• 12 x 3.5-inch drives • 128 GB - 1.5 TB memory • Hybrid, all flash	• 12 x 3.5-inch drives • 64 GB - 768 GB memory • Hybrid, all flash	• 12 x 3.5-inch drives • 64 GB - 768 GB memory • Hybrid, all flash

Dell EMC Ready Architectures VDI-optimized configurations

The Ready Architectures for VDI team recommends the VDI-optimized 2U XC740xd devices that support GPU hardware for graphics-intensive desktop deployments.

The XC740xd can be configured with or without GPUs. Dell EMC also offers similar configurations in a 1U XC640 device, 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 document.

Table 2 Common configurations

Configuration	CPU	RAM	Disk	GPU (optional)	Description
A3	2 x Intel Xeon Silver 4114 (10 core 2.2 GHz)	192 GB (12 x 16 GB @ 2,400 MHz)	4 TB + (Performance and Capacity tiers)	Up to 3 x full length, dual width (FLDW)	For small-scale, proof of concept (POC), or low-density, cost-conscience environments
B5	2 x Intel Xeon Gold 5120 (14 core 2.2 GHz)	384 GB (12 x 32 GB @ 2,400 MHz)	6 TB + (Performance and Capacity tiers)	Up to 3 x FLDW	Geared toward larger-scale general-purpose workloads; balances performance and cost-effectiveness
C7	2 x Intel Xeon Gold 6138 (20 core 2.0 GHz)	768 GB (24 x 32 GB @ 2,667 MHz)	8 TB + (Performance and Capacity tiers)	Up to 3 x FLDW	Offers many high-performance features and tiered capacity that maximizes user density
Density-Optimized	2 x Intel Xeon Gold 6248 (20 core 2.5 GHz)	768 GB (12 x 64 GB @ 2933 MHz)	8 TB + (Performance and Capacity tiers)	Up to 3 x FLDW Up to 6 x full length single width	Offers many high-performance features and tiered capacity that maximizes user density

NVIDIA GRID vGPU

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 through 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 XC Family appliances support three cards, consider sizing with a maximum of two 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. All XC740xd-based appliances allow 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 datacenter workflows. Add up to six GPU cards into your XC740xd device to enable up 96 GB of video buffer. For modernized datacenters, use this card in off-peak hours to perform your inferencing workloads.

Physical network components

Ready Architectures for VDI for 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 S3048 (1 GbE ToR switch)**—The S3048 switch accelerates applications in high-performance environments with a low-latency top-of-rack (ToR) switch that features 48 x 1 GbE and 4 x 10 GbE ports, a dense 1U design, and up to 260 Gbps performance. The S3048-ON switch also supports Open Network Installation Environment (ONIE) for zero-touch installation of alternate network operating systems.
- **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 switch 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 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 follow the deployment and best practices that are provided in the Dell EMC XC Series Networking Deployment and Best Practices Guide.

Networking

Designed for true linear scaling, XC Family devices 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 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.

For more information, see the Horizon resources page and 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 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.

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 3 Recommended clients

Component	Description	Recommended use	More information
Dell Wyse 3040 thin client	Dell's lightest, smallest, and most power-efficient thin client.	Common tasks and basic productivity.	Wyse 3040 thin client
Dell Wyse 5070 thin client	A single thin-client platform that meets every need, the Dell Wyse 5070 has multiple operating system and	Knowledge workers who need powerful virtual desktop performance and support for unified communications	Wyse 5070 thin client

Table 3 Recommended clients (continued)

Component	Description	Recommended use	More information
	connectivity options and can be monitored, maintained, and serviced remotely.	solutions like Skype for Business.	
Dell Wyse 5070 Extended thin client	A thin client that offers an on-board graphics card for offloading and supporting up to four 4K monitors plus two 2K monitors (for a total of 6).	Knowledge workers who need powerful virtual desktop performance and support for several monitors.	Wyse 5070 Extended thin client

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 and density-optimized configurations impact more users.

CPU

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**—2.25 users per core. For example, 36 knowledge users with dual eight-core processors.
- **Power workers**—1.62 users per core. For example, 16 power users with dual eight-core processors.

For architectures with Cascade Lake processors:

- **Knowledge workers**—3.38 users per core. For example, 54 knowledge users with dual eight-core processors.
- **Power workers**—2.65 users per core. For example, 42 power users with dual eight-core processors.

For graphics configurations:

- 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 CPU oversubscription.
- Workloads where NVIDIA Virtual PC is used tend to require less CPU and GPU resources than NVIDIA GRID Quadro Virtual workloads. Due to this difference, the trend is that there are typically more VMs per node than in the case of vDWS but they're less richly configured.

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.

GPU

Consider these options when choosing GPU cards:

- Dell EMC strongly recommends NVIDIA M10 graphics options only for Virtual PC workloads. Quadro Virtual Data Center Workstation licenses do support the M10 card, but the card performance is less aligned with the features available in that license.
- For graphically intense workloads like CAD or for desktops running mixed workloads (including both graphics and significant computation), a P40 card is the optimal choice.
- NVIDIA's Turing 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 XC740xd device to enable up 96 GB of video buffer. For modernized data centers, use this card in off-peak hours to perform your inferencing workloads.

NVIDIA GRID 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 that are 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.

Sizing considerations

General best practices for sizing your deployment include:

- **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**—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**—We recommend that you separate the management and compute layers. When creating a management cluster, consider using the XC640 platform to reduce the data center footprint.
- **Network isolation**—The network configuration for Dell EMC XC devices uses either a 10 Gb or a 25 Gb converged infrastructure model. All required VLANs traverse either two 10 Gb NICs or two 25 Gb NICs configured in an Active/Active team.

Test results and density recommendations

The recommended user densities for this testing are shown in the following table. The user densities were achieved by following Nutanix best practices with Redundancy Factor 2 and Cache deduplication enabled. 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	Profile name	Workload name	User density
Density Optimized	Knowledge worker	Login VSI Knowledge worker	135
Density Optimized	Power worker	Login VSI Power worker	106
Density Optimized + 6x NVIDIA Tesla T4	Graphics Multimedia worker (Virtual PC: T4-1B)	Login VSI Multimedia worker	48
Density Optimized + 6x NVIDIA Tesla T4	Graphics Power worker (Virtual PC: T4-1B)	Login VSI Power worker	96 [a]
Density Optimized	RDSH Task worker	Login VSI Task worker	233 (Horizon Apps RDSH/ Published Desktop)

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.

All Login VSI tests were completed successfully without reaching the Login VSI maximum, indicating that the user experience was good. Except for the Graphics Power worker profile, the metrics for all other workloads were well within the thresholds that we set. You can get better user densities by increasing the thresholds that we set—however, there might be a degradation in user experience.

For additional resources on this topic, see the VMware documentation section.

Design assessment

Before deployment, 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 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.

Dell EMC provides a number of 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. Further information on AVE is available at the Dell EMC Avamar Virtual Edition web page.

Data Domain Virtual Edition

Dell EMC Data Protection Virtual Edition (DDVE) is a data protection storage solution that runs as a virtual appliance on a customer's choice of hardware or any of multiple public cloud options (including VMware Cloud on AWS). For on-premises deployments, DDVE is deployed as a virtual appliance on the relevant hardware platform, in this case the Dell EMC XC Family. 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. Further information about DDVE is available at the Dell EMC Data Domain Virtual Edition webpage.

The process for protecting a VMware Horizon VDI environment using AVE and DDVE is outlined in the Data Protection of a VMware Horizon VDI Environment using Dell EMC Data Protection operations guide.

Other Dell EMC Data Protection Products

As well as the DDVE and AVE solutions described in the preceding sections, Dell EMC provides a number of other data protection products for specific use cases, including a range of appliances which reduce the complexity of data protection with a scalable, pre-configured solution that combines data protection storage with software, search and analytics. Further information is available at the Dell EMC Data Protection webpage.

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.

The architectures shown in Figures 5 and 6 below show VDI management and compute environments sharing a vSphere HA cluster. This architecture is universally applicable across SDS environments that require access to dedicated file storage. It is also acceptable to configure these management and compute environments in separate HA clusters (as shown in the 'Architecture Overview' section). In this scenario, each compute cluster and its associated management cluster should share a single file storage system, for example Unity, Isilon.

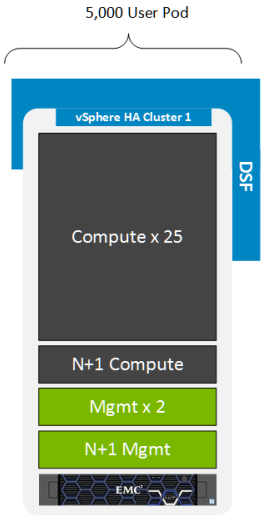
Dell EMC Unity

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 midsized 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.

For guidance about selecting an appropriate Dell EMC Unity storage solution for your file workload requirements, see Dell EMC Unity XT All-Flash Unified Storage.

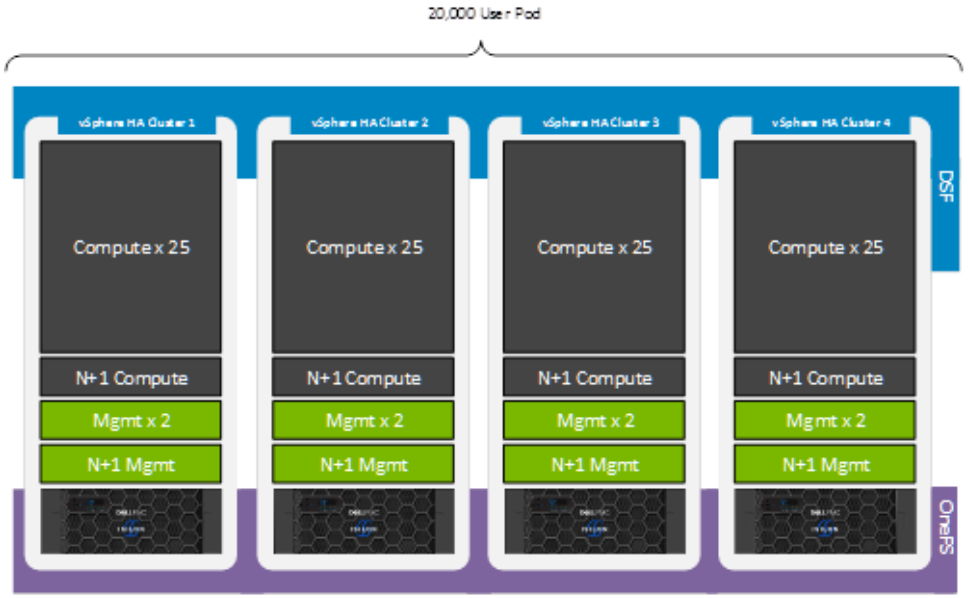
Dell EMC Isilon file storage

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 as the VDI environment grows. You can deploy alternative architectures to the one suggested here, but you should consider the tradeoffs carefully.

For guidance about selecting an appropriate Dell EMC Isilon storage solution for your file workload requirements, see Dell EMC Isilon Scale-Out Network Attached Storage.

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 XC Family devices 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 XC Family devices 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:

- **XC640**—Select this device if graphics are not required or where high computer power per unit of rack space is required.
- **XC740xd**—Select this device if graphics are required or where there are significant storage capacity and I/O requirements.

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.

For additional resources and other VDI designs to help make IT groups a strategic asset, go to https://www.dellemc.com/en-us/solutions/vdi/index-it.htm.

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 Virtual Desktop Infrastructure
- Dell EMC XC Series and XC Core Technical Resource Center

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 XC Family Design Guide
- Dell EMC Ready Architectures for VDI: Designs for VMware Horizon on XC Family Deployment Guide
- Dell EMC Ready Architectures for VDI: Designs for VMware Horizon on XC Family Validation Guide

VMware documentation

The following VMware documentation provides additional and relevant information:

- VMware vSphere documentation
- VMware Horizon 7 documentation
- VMware Compatibility Guide
- Horizon 7 Enterprise Edition Reference Architecture
- Horizon 7 Enterprise Edition Multi-Site Reference Architecture

For additional information about advanced architectural considerations (for example, NUMA-related topics):

- Best Practices for Published Applications and Desktops in VMware Horizon Apps and VMware Horizon 7

NVIDIA documentation

The following NVIDIA documentation provides additional and relevant information:

- NVIDIA Virtual GPU Software Quick Start Guide