# Dell EMC Ready Architectures for VDI

## Designs for VMware Horizon 7 on VxBlock System 1000

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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 VxBlock System 1000 converged infrastructure to create virtual applications and desktops in a VMware vSphere environment.

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- Executive summary ..... 4
- Solution architecture ..... 7
- Key components ..... 13
- Design sizing and guidelines ..... 21
- Design enhancements ..... 24
- Conclusion ..... 26
- References ..... 27

# 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 EMC can assist IT teams in this journey while improving user experience with 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 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 ones.

## Technology solution

The Dell EMC Ready Architecture for VDI based on the Dell EMC VxBlock System 1000 converged infrastructure is a complete solution for your enterprise VDI workload at scale. VxBlock 1000 provides enterprises worldwide with the simplicity of a turnkey experience that enables you to focus on innovation rather than maintenance.

VxBlock 1000 combines industry-leading technologies, including Dell EMC storage and data protection options, Cisco UCS blade and rack servers, Cisco LAN and SAN networking, and VMware virtualization, in one fully integrated system.

VxBlock 1000 simplifies component integration, upgrades, and daily operations. It can be configured according to your needs, comes with comprehensive management software, and provides a simplified path to a cloud operating model.

VxBlock System 1000 converged infrastructure is designed with future needs in mind and can support next-generation technologies to provide enhanced performance and scalability.

## Key benefits

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

Dell EMC recommends using the VxBlock System 1000 converged infrastructure to run VMware Horizon 7 VDI infrastructure. VxBlock 1000 provides a highly scalable and agile platform to run your enterprise-level VDI workloads. You can also run your VDI workloads with high-value application workloads such as SAP, Oracle, Microsoft SQL, and Epic in a VxBlock 1000 system.

This Ready Architecture offers several key benefits:

- **Converged management and automation**—VxBlock Central software provides a unified interface and access point for converged infrastructure operations. It simplifies daily administration by providing enhanced system-level awareness, automation, and analytics. VxBlock Central includes Dell EMC launch points to VMware vRealize Orchestrator with workflows for automating daily operational tasks and to vRealize Operations for deep VxBlock analytics and simplified capacity management.
- **Flexible choice of components**—You can mix, share, and adapt pools of storage, data protection, and compute resources for all workloads to maximize performance and utilization.
- **Simplified life cycle management**—Ongoing life cycle management, including interoperability testing, security and patch management, and component updates, is one of the cornerstones of VxBlock systems. The platform uses the Release Certification Matrix (RCM), where interoperability is validated to ensure that the health of your system is optimized. Each RCM represents thousands of hours of testing, validation, and certification.
- **Integrated data protection**—Dell EMC Data Protection for Converged Infrastructure simplifies backup, recovery, and failover of your VxBlock 1000. Dell EMC offers advanced data deduplication, replication, and data protection technologies for achieving your recovery point objective (RPO) and recovery time objective (RTO) requirements.
- **Dell EMC support and services**—Dell EMC offers fully integrated, 24/7, single-call support. Dell EMC's portfolio of services (including deployment services, migration services, and residency services) accelerates deployment speed and integration into your IT environment. It also minimizes downtime by ensuring that your software and firmware remain current throughout the product life cycle.

## Document purpose

This document introduces the architecture, components, design options, best practices, and configuration details for successful VDI deployments for Dell EMC VxBlock System 1000 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 Architecture for VDI that delivers Microsoft Windows virtual desktops using VMware Horizon 7 VDI components on Dell EMC VxBlock System 1000.

## 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.

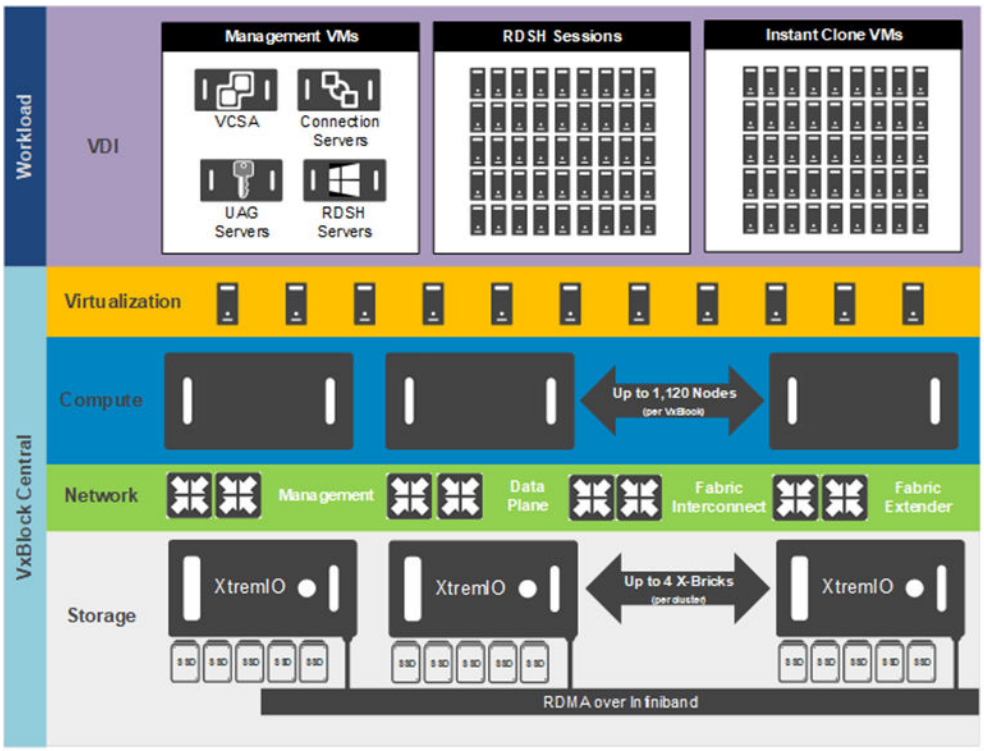
# Solution architecture

This section provides an architecture overview and guidance on managing and scaling a VMware Horizon 7 environment on Dell EMC VxBlock System 1000.

## Architecture overview

The following figure depicts the architecture of a representative, recommended VDI design based on VxBlock 1000, 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 has one or more VMware vSphere clusters, a VMware vCenter Server, and, for linked clones, a Composer server.

**Figure 1** VxBlock 1000 with VMware Horizon




Deployment of this Ready Architecture supports all VMware cloning techniques, including full, linked, and instant cloning.

A vSphere cluster can have a maximum of 64 nodes and 8,000 virtual machines (VMs) per cluster. To expand beyond these limits, you can add clusters and balance the VMs and nodes across the new clusters.

For more information about Horizon pods and blocks, see Horizon 7 Enterprise Edition Reference Architecture.

## Scaling and expanding the solution

Solutions based on VxBlock 1000 provide flexibility as you scale, reducing the initial and future cost of ownership. You can expand VxBlock 1000 by adding compute, network, and storage resources. After the initial deployment, you can add more disks and arrays for increased capacity and more servers for increased performance. Add physical and virtual servers to the server pools to scale

horizontally. Add resources to the infrastructure, for example, CPU, memory, or SSD drives, to scale vertically.

### Scaling out

Each component of the solution architecture scales independently, depending on the required number of supported users. VxBlock Advanced Management Platform (AMP) and compute domains can both be scaled out or expanded independently to accommodate their respective workloads. You can add VxBlock 1000 management, compute, networking, and storage components at any time to expand capabilities in a granular fashion.

The AMP-3S environment is scalable from 2 to 16 compute nodes while the compute environment can be scaled from 3 to 616 half-width B-Series servers or 3 to 1,120 C-Series servers with Cisco UCS fourth generation network fabrics.

When scaling the AMP-3S environment, consider both the VxBlock management components and the VDI management components. The following table outlines the AMP scaling guidance using the following assumptions:

- The VMware vCenter Server appliances are deployed in high availability (HA).
- Two VMware Horizon Connection servers are deployed for each 5,000-VM block.
- Each Horizon Connection Server has four vCPUs and 16 GB of Memory.
- A single set of Microsoft SQL Server VMs are required for the VMware Horizon event log for all user counts.

**Table 1** AMP scaling guidance

| Number of VDI users | Number of Cisco UCS C220 M5 servers for AMP-3S environment |
|---|---|
| 2,500 | 3 |
| 5,000 | 3 |
| 10,000 | 5 |
| 50,000 | 16 |

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

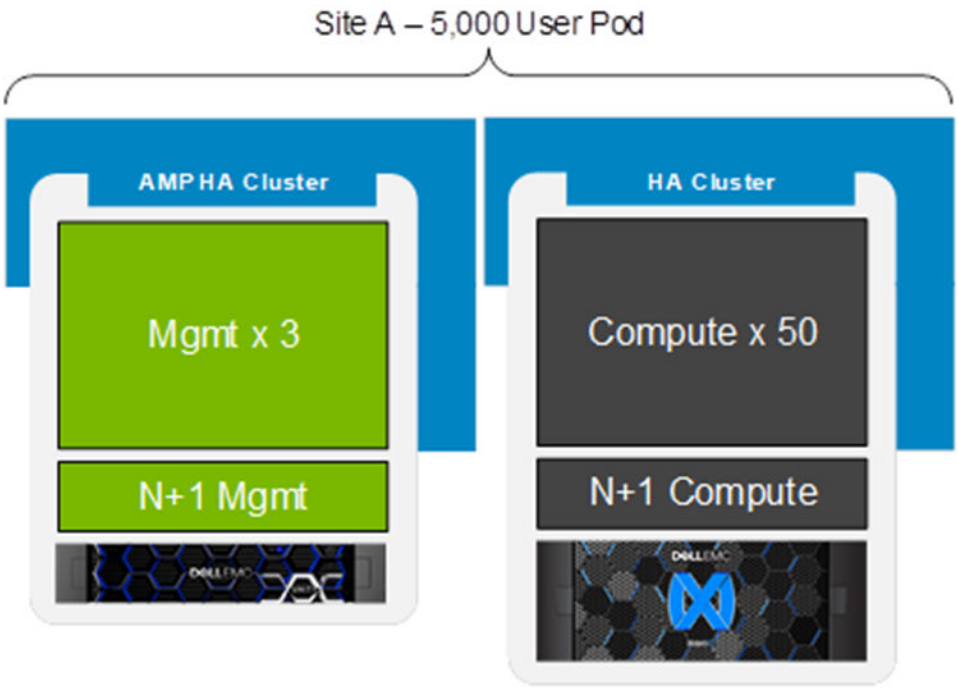
- 5,000 instant-clone VMs (without App Volumes)
- 4,000 linked-clone or full-clone VMs (without App Volumes)
- 2,000 VMs (all clone types) if App Volumes or AppStacks are attached

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, 50 compute nodes with 100 knowledge user VMs per node is the maximum number of VMs for the block.

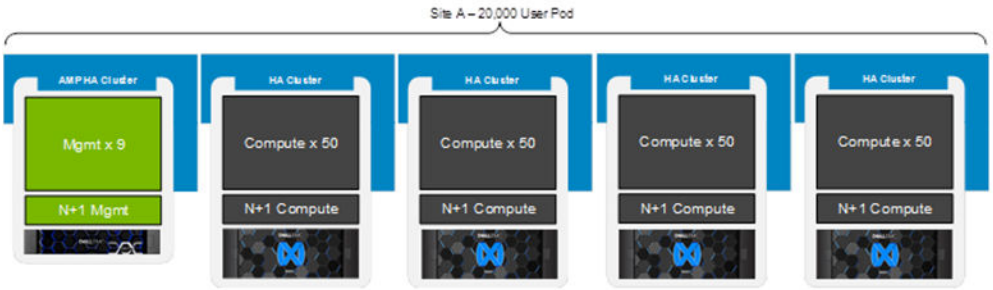
The following figure shows a 5,000-user Horizon block based on a 100-user-per-node density.

**Figure 2** Single 5,000-user block (AMP-3S)




The following figure shows a scale-out to a 20,000-user Horizon pod with 5,000 user blocks. The AMP-3S HA cluster contains the vCenter Server instances and VDI management components.

**Figure 3** Scaleout for 20,000 users




## Scaling up

Multiple aspects of the VxBlock 1000 system can be scaled up, including the compute layer's CPU, memory, and I/O; the storage layer's SSDs; and the network layer's fabric resources. When designing a VxBlock 1000 system, consider the number of users that the system will eventually support to ensure the proper selection of components such as the Cisco MDS switches. In this example, selection of a switch with higher port density provides for nondisruptive expansion for the environment in the future.

The Dell EMC XtremIO X2 array can be scaled up by adding as few as six SSDs at a time to a single X-Brick block.

The AMP-3S configuration cannot be scaled up within the context of CPU, memory, or I/O.

**Note:** The VxBlock 1000 compute layer configurations can have additional or faster processors or memory than the guidance we provide here. Maximum scalability is determined by the architecture of the selected compute model.

For more information about Horizon pod and block architecture, and scaling, see the VMware Workspace ONE and VMware Horizon 7 Reference Architecture.

# Management and multisite considerations

### Advanced Management Platform (AMP)

The AMP is an integral part of VxBlock 1000. It provides a dedicated location at which to install and support the management software that helps to install and operate components within the VxBlock 1000 system. The AMP consists of a dedicated set of hardware and software that is set up and managed independently of the computing domains within the system. The hardware has a fixed CPU and memory configuration. This guide discusses AMP-3S in detail, AMP-VX is also an option.

AMP-3S consists of the following high-level hardware components:

- 2 to 16 Cisco UCS C220 M5 servers
- Dell EMC Unity 300 Hybrid iSCSI storage

AMP-3S consists of the following software components:

- VMware vSphere ESXi Hypervisor
- Core management software
  - Dell EMC VxBlock Central
  - VMware vCenter Server Appliance
  - License Manager for Dell EMC PowerPath/VE
  - PowerPath Management Appliance
  - Cisco UCS Manager
  - Cisco UCS CIMC
  - Dell EMC XtremIO XMS
  - Dell EMC Secure Remote Services
  - Cisco Data Center Network Manager (DCNM) for SAN
  - Cisco DCNM for LAN

The AMP infrastructure is designed to be fault tolerant in terms of server, storage, and network design. The network is designed for fault isolation from the VxBlock 1000 workload domain.

The AMP infrastructure is also the appropriate location to host the VDI management components, including:

- VMware vCenter Server Appliance VMs
- Horizon Connection Server (HCS) instances
- Unified Access Gateway appliances
- Microsoft SQL Server instances to store the Horizon Event databases

For more information about these components, see the VMware Horizon section.

### Other configurations

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.

## Mixed-workload environments

In typical enterprise computing environments, VDI is not the only workload used. Many other workloads and related applications support different business units within an organization. The VxBlock infrastructure with all-flash storage provides IT organizations with a single, complete platform to simultaneously support mixed workloads and mixed applications, without requiring you to modify the application itself or use proprietary application tools to unlock performance.

IT organizations no longer need to separate workloads with different I/O patterns or different uses (such as production and test) on separate infrastructure silos. VxBlock 1000 can consolidate workloads with mixed I/O patterns onto a single infrastructure. The reduced cost of configuration, support, and maintenance lowers the overall TCO of running an enterprise data center.

Consider the following information when designing a mixed-workload environment within a single VxBlock system:

### Compute layer

Separate VDI workloads from other workloads at the compute layer. In a VDI environment, factors within the compute servers such as context switching, oversubscription, and latency can drastically affect the user experience.

Additional recommendations include:

- Isolate workloads to separate servers by using VMware vSphere clusters.
- Select the optimal compute server CPU and memory components for the workload that will run on that server.
- Consider what processors are required to provide for a good user experience. VDI workloads tend to be very dense with many VMs per host.
- Do not share GPU-equipped servers, which are likely only appropriate for VDI, with other workloads.

### Network layer

Logically separate VDI workloads from other workloads at the network layer by using either traditional VLANs and subnets or, in the case of software-defined networks, VXLANs. However, the underlying physical networking fabric can be shared.

Additional recommendations include:

- Evaluate the total bandwidth that is needed to support all workloads on the VxBlock 1000 system and select the appropriate uplink type and quantity to connect the system to the upstream network.
- Consider separating workloads into separate Cisco UCS domains for additional isolation of network resources.

### Storage layer

Ideally, separate each workload onto its own correlated physical storage arrays. Select the appropriate Cisco MDS switches to accommodate the maximum ports that are needed for the storage configuration.

Additional recommendations include:

- Selecting different storage array models and configurations for different workloads may be optimal.

- Provision the storage arrays according to the best practices for that workload.

Although not recommended, running all workloads on the same set of storage arrays is possible. When planning and designing the storage layer in such a manner, consider the following:

- The total performance in IOPS and latency for all workloads.
- The total capacity required for all workloads.
- Use Fibre Channel zoning and separate LUNs on the storage network to segregate workload I/O.
- Use different vSphere datastores to host VMs that are assigned to different workloads.
- Consider using quality of service (QoS) policies on the storage array, if they available, for the different workloads.
- Consider using vSphere Storage I/O Control.

### Management

The AMP-3S management environment is where the VDI workload hosts its own management components. It is also a good location for management components for other workloads that are not compute-intensive.

When you design the AMP, ensure that the management components that support the mixed workloads do not exceed the AMP's maximum processing or storage capabilities. If they do, the management components might have to be designed to run on the VxBlock 1000 computing environment.

# Key components

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

## Cisco UCS servers

This section describes the Cisco UCS servers that are recommended for VDI.

### Cisco UCS C-Series servers

Cisco Unified Computing System (Cisco UCS) C-Series rack servers keep pace with Intel Xeon processor innovation by offering the latest processors, with increased processor frequency and improved security and availability features. With the increased performance that is provided by Intel Xeon Scalable processors, C-Series servers offer an improved price-to-performance ratio. They also extend Cisco UCS innovations to an industry-standard rackmount form factor, including a standards-based unified network fabric, Cisco VN-Link virtualization support, and Cisco Extended Memory Technology.

Designed to operate both in stand-alone environments and as part of a Cisco UCS-managed configuration, these servers enable organizations to incrementally deploy systems use as many or as few servers as needed on a schedule that best meets the organization's timing and budget.

Many organizations prefer rackmount servers because of the wide range of I/O options that are available in the form of PCIe adapters. C-Series servers support a broad range of I/O options, including interfaces that are supported by Cisco and adapters from third parties such as NVIDIA GPUs.

For VDI-optimized configurations, you can deploy a cluster with as few as three nodes, providing an ideal environment for small deployments. This cluster can be scaled to more than 600 Cisco UCS B-Series servers or 1,000 C-Series servers per VxBlock 1000.

The following Cisco UCS C-Series servers are recommended for VDI:

- The Cisco UCS C220 M5 rack server is a high-density two-socket rack server that delivers high performance and efficiency for a wide range of workloads, including virtualization, collaboration, and bare-metal applications. This server extends the capabilities of the Cisco UCS portfolio in a 1-rack-unit (1RU) form factor.
- The Cisco UCS C240 M5 rack server is a two-socket, 2-rack-unit (2RU) rack server. It supports a wide range of storage and I/O-intensive infrastructure workloads, from Big Data and analytics to collaboration. In response to ever-increasing computing and data-intensive real-time workloads, the enterprise-class Cisco UCS C240 M5 server extends the capabilities of the Cisco UCS portfolio in a 2RU form factor. The following figure shows the UCS C240 M5 server:

**Figure 4** Cisco UCS C240 M5

Both the UCS C220 M5 and UCS C240 M5 rack servers incorporate Intel Xeon Scalable processors and support:

- Up to 20 percent more cores per socket
- Twice the memory capacity

- 20 percent greater storage density
- Five times more Non-Volatile Memory Express (NVMe) PCI Express (PCIe) solid-state disks (SSDs)

### Cisco UCS B-Series servers

The Cisco UCS B200 M5 blade server is also recommended for VDI. The B200 M5 server delivers performance, flexibility, and optimization for deployments in data centers, in the cloud, and at remote sites. This enterprise-class server offers high performance, versatility, and density for workloads, including VDI, web infrastructure, distributed databases, converged infrastructure, and enterprise applications such as Oracle and SAP HANA. It can quickly deploy stateless physical and virtual workloads through programmable, easy-to-use Cisco UCS Manager and Cisco Intersight. Cisco SingleConnect technology provides simplified server access.

## VDI-optimized configurations

The Ready Architectures for VDI team recommend the VDI-optimized 2U Cisco UCS C240 M5 rack servers that support GPU hardware for graphics-intensive desktop deployments. The C240 M5 can be configured with or without GPUs. Dell EMC also offers similar configurations in a 1U C220 M5 rack server and the B200 M5 blade server, although graphics configurations are limited on these platforms. B-Series servers also support P4 NVIDIA GPUs although only for small GPU-based workloads.

We designated these configurations as A3, B5, and C7. The following table gives further details:

**Table 2** VDI-optimized configurations

| Server configuration | CPUs | RAM | GPUs (optional) | Description |
|---|---|---|---|---|
| A3 | 2 x Intel Xeon Silver 4114 (10 core 2.2 GHz) | 192 GB (12 x 16 GB @ 2,400 MHz) | Up to 2 x full length, dual width (FLDW) | For small-scale, proof of concept (POC), or low-density, cost-conscious environments |
| B5 | 2 x Intel Xeon Gold 5120 (14 core 2.2 GHz) | 384 GB (12 x 32 GB @ 2,400 MHz) | Up to 2 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) | Up to 2 x FLDW | Offers an abundance of high-performance features and tiered capacity that maximizes user density |

## Storage components

This section describes the recommended storage components for a VDI solution on VxBlock 1000.

### XtremIO X2 X-Brick

Dell EMC XtremIO X2 is the preferred block-based storage array when designing for the VDI workload on VxBlock 1000. The XtremIO system is an enterprise-class scalable all-flash storage array that provides rich data services with high performance. It is designed to unlock flash technology's full performance potential by using the characteristics of SSDs. The XtremIO X2 array uses advanced inline data reduction methods to reduce the physical data that has to be stored on the disks.

The XtremIO storage system uses industry-standard components and proprietary intelligent software to deliver high levels of performance, achieving consistent low latency for up to millions of IOPS. It comes with a simple, easy-to-use interface for storage administrators. The system fits a wide variety of use cases for customers in need of a fast and efficient storage system for their data centers, requiring minimal setup planning before provisioning.

**Figure 5** XtremIO storage array


XtremIO all-flash technology delivers value across multiple dimensions, including:

- Performance (consistent low latency and up to millions of IOPS)
- Scalability (using a scale-out and scale-up architecture)
- Storage efficiency (using data reduction techniques such as deduplication, compression, and thin-provisioning)
- Data protection (with a proprietary flash-optimized algorithm, named XDP)
- Environment consolidation (using XtremIO Virtual Copies or VMware XCOPY)

XtremIO X2 is the new generation of Dell EMC's all-flash array storage system. It includes enhancements and added flexibility in several aspects when compared to the storage array's previous generation. The new features include scale-up for a more flexible system, write boost for a high-performing storage array, NVRAM for improved data availability, and a new web-based UI for managing the storage array and monitoring its alerts and performance stats.

The XtremIO X2 array uses a building block that is called an X-Brick. Each X-Brick block has its own compute, bandwidth, and storage resources. You can cluster X-Brick blocks together to increase performance and capacity (scale-out). You can increase the capacity a single X-Brick block by adding up to 72 SSDs.

The XtremIO architecture is based on a metadata-centric, content-aware system that helps streamline data operations efficiently. Movement of data post-write for maintenance reasons (for example, for data protection, data reduction, and so on) is not required because these tasks are all carried out inline. The system lays out the data uniformly across all SSDs in all X-Brick blocks in the system, using unique fingerprints for the incoming data, and it controls access using metadata tables. This architecture contributes to a balanced system across all X-Brick blocks in terms of compute power, storage bandwidth, and capacity.

### Isilon storage

Isilon storage is the preferred NAS solution for unstructured user data for a VDI design on VxBlock 1000. Isilon storage is a scale-out NAS solution that delivers increased performance for file-based data applications and workflows from a single file-system architecture.

**Figure 6** Isilon storage array


Isilon storage provides scale-out capacity for use as NFS and SMB CIFS shares within VMware vSphere VMs. For additional information about the Isilon storage solution as it applies to VDI, see File workload guidance.

### Other storage options

While the XtremeIO X2 system is the preferred array for VDI workloads within VxBlock 1000, it might be appropriate to select one of the other storage offerings within the Dell EMC product portfolio in some instances. Examples of where this may be the case include:

- The VxBlock 1000 system hosts other workloads where one of the other storage systems might be more optimal.
- Your organization has standardized storage systems.
- The storage solution must integrate with existing disaster recovery and backup products that rely on technologies that are specific to another storage system model or type.

These other storage options are briefly detailed in the following sections.

**VMAX All Flash storage**
VMAX All Flash arrays deliver the highest possible flash density by supporting the highest capacity flash drives. These arrays enable you to expand performance and capacity to address real-world workloads. With a base capacity of 13 TBu (usable capacity in terabytes), the VMAX All Flash array can provide up to 4.42 PBe (petabytes effective) capacity through inline compression. The VMAX All Flash array can provide up to 6.7 million IOPS of performance.

**PowerMax storage**
PowerMax storage arrays are a new family of Dell EMC NVMe storage. These arrays deliver:

- The next generation of low latency, which measured in microseconds, not milliseconds
- High performance and scalability for mission-critical multicontroller storage

With a base capacity of 13 TBu, the PowerMax array can provide up to 4.42 PBe capacity through inline compression and deduplication. The PowerMax array can provide up to 6.7 million IOPS of performance.

**Dell EMC Unity storage**
Dell EMC Unity storage is simple, unified all-flash and hybrid storage with hybrid cloud capabilities. The Unity array is ideal for general-purpose NAS/SAN mixed-workload consolidation, smaller file workloads (including small to midsize VDI environments), and transactional databases.

Unity storage arrays are midrange storage solutions that support transactional workloads, such as databases, virtualized servers, and multiple workload consolidations. These arrays offer a unified solution that supports block and file environments with the flexibility to configure a system, capacity points, and Integrated Data Protection options. Unity storage arrays are optimized for virtualized applications.

Regardless of the storage protocol implemented, VxBlock System 1000 can include cabinet space, cabling, and power to support the hardware. Unity storage includes controllers that eliminate the need for separate hardware for file sharing. The controllers also facilitate moving from block storage to unified storage, thus avoiding hardware changes.

Dell EMC Unity Hybrid and Unity All-Flash storage arrays provide a scalable hardware design and advanced software capabilities using spinning and flash drives. Dell EMC Unity All-Flash arrays support high-density SSDs, including 3D NAND triple-level-cell (TLC) drives.

## NVIDIA GRID vGPU

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

GRID vGPU is 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 GPU-accelerated applications using RDSH
- **Virtual PC**—Designed to provide full virtual desktops with dual 4K monitor support
- **Quadro Virtual Data Center Workstation (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:

- **NVIDIA Tesla M10 (Maxwell)**—Recommended for Virtual Applications or Virtual PC environments. Each card is equipped with 32 GB of video buffer with 8 GB of maximum available buffer per user. Dell EMC recommends hosting a maximum of 32 Windows 10 users per card.
- **NVIDIA Tesla P40 (Pascal)**—Recommended in Quadro vDWS configurations that require large video buffers. Each P40 has 24 GB of available video buffer, which can be divided into 1, 2, 3, 4, 6, 8, 12, or 24 users, depending on your virtual workstation needs.

**Note:** All Cisco UCS C240 M5 rack servers support up to two full-height dual-width cards per node.

## Physical network components

Ready Architectures 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:

- **Cisco Nexus 31108TC-V**—These base switches are deployed in pairs for out-of-band management. Each switch provides forty-eight 100 Mb/s, 1 Gb/s, and 10 Gb/s Base-T fixed ports and six QSFP28 ports to provide 4 x 10 GbE (40 GbE each) or 100 GbE connections.
- **Cisco Nexus 9336C-FX2**—This data plane switch provides thirty-six 40/100 Gb/s QSFP28 ports. The Cisco Nexus 9336C-FX2 switch can be used for the top-of-rack (ToR) network switch and for additional switch pairs to support Isilon connectivity.
- **Cisco UCS 6454 Fabric Interconnect**—This is a core part of the Cisco UCS, providing both network connectivity and management capabilities for the system. The Cisco UCS 6454 offers line-rate, low-latency, lossless 10/25/40/100 GbE, Fibre Channel over Ethernet (FCoE), and Fibre Channel functions.
- **Cisco Nexus 2232PP Fabric Extender**—This provides thirty-two 10 GbE and FCoE small form-factor pluggable plus (SFP+) server ports and eight 10 Gb/s Ethernet and FCoE SFP+

uplink ports in a compact 1U form factor. The Cisco Nexus 2232PP Fabric Extender allows for a greater number of 10 GbE rackmount servers.

- **Cisco MDS 9396S Multilayer Fabric Switch**—These switches provide 48 to 96 line-rate ports for nonblocking, 16 Gb/s throughput.

## VMware vSphere

VMware vSphere provides a powerful, flexible, and secure foundation that enables business agility and accelerates the digital transformation to cloud computing.

vSphere provides the following benefits for VDI applications:

- **Improved appliance management**—The vCenter Server Appliance Management Interface (VAMI) 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 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 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 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 VMware Horizon License Frequently Asked Questions.

The core Horizon components include:

- **Horizon Connection Server (HCS)**—HCS is installed on servers in the data center. It 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**—This installed on endpoints and creates connections to Horizon desktops that can be run from tablets, Windows, Linux, or Mac PCs or laptops, thin clients, and other devices.
- **Unified Access Gateway**—Provides a way to securely deliver connections that require a higher level of security to access, such as remote connections from the Internet.
- **Horizon Portal**—Provides access to links for downloading full Horizon clients. The portal enables the HTML access feature to run a Horizon desktop inside a supported browser.
- **vCenter Server**—Provides centralized management and configuration to the entire virtual desktop and host infrastructure. It facilitates configuration, provisioning, and management services.

### Horizon clone technology

VMware Horizon 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. Updates must be performed on 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 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 has multiple operating system and connectivity options and can be monitored, maintained, and serviced remotely. | Knowledge workers who need powerful virtual desktop performance and support for unified communications solutions such as Skype for Business | Wyse 5070 Thin Client |
| 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 configurations to choose from, consider these basic differences:

- The base B5 configuration is ideal for 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 be maintained.

**Note:** If a node outage occurs, the C7 configurations affect more users.

## CPU

User density and graphics considerations include:

- 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 for architectures with Skylake processors to achieve comparable results:
  - **Knowledge workers**—2.5 users per core; for example, 40 knowledge users with dual eight-core processors
  - **Power workers**—2.025 users per core; for example, 32 power users with dual eight-core processors
  - **RDSH Task workers**—4.325 users per core; for example, 69 RDSH (published desktop) task workers with dual eight-core processors.
- For graphics configurations, consider the following information:
  - For high-end graphics configurations with NVIDIA GRID Quadro Virtual Data Center Workstation graphics enabled, consider choosing higher clock speeds over higher core counts. Many applications that benefit from high-end graphics are engineered with single-threaded CPU components. Higher clock speeds benefit users more in these workloads.
  - For NVIDIA Virtual PC configurations, consider higher core counts over faster clock speeds to reduce oversubscription.
  - Most graphics configurations do not experience high CPU oversubscription because vGPU resources are likely to be the resource constraint in the appliance.

## Memory

Best practices for memory allocation and configuration include:

- Do not overcommit memory when sizing because memory is often not the constraining resource. Overcommitting memory increases the possibility of performance degradation if contention for memory resources, 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. VxBlock 1000 with Cisco UCS servers using Intel Skylake processors have six memory channels per CPU. The memory channels 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 DIMMs per CPU) or 24 DIMMs (12 DIMMs per CPU).

- When populating memory channels on platforms based on Intel Xeon Scalable processors (Skylake), the following balanced memory configurations provide the best performance:
  - 192 GB (24 x 8 GB)
  - 384 GB (24 x 16 GB)
  - 768 GB (24 x 32 GB)

  Additionally, the following near-balanced memory configuration provides equally acceptable performance within VDI workloads:
  - 576 GB (12 x 8 GB + 12 x 16 GB)

  Reducing the physical memory on each server node from 768 GB to 576 GB might realize cost savings when the additional memory overhead is not required by the workload. The LoginVSI Knowledge Worker testing that is described in this document provides an example. For more details, see the VMware Horizon 7 on VxBlock System 1000 Validation Guide. In this example, the total memory footprint of the workload on each node (the memory capacity of the VM multiplied by the VM density per node) fits well within 576 GB even though the system was configured with a total capacity of 768 GB.

## NVIDIA GRID considerations

Consider these best practices for sizing and configuring solutions that require graphics accelerators:

- Virtual PC licenses support up to 2 GB of video buffer and up to two 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.
- The 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 a video buffer of at least 2 GB.
- When you are 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. GPUs that are based on the Pascal architecture 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**—For DR planning, implement a dual-site or multisite 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**—Appropriately scale the management or AMP environment appropriately to accommodate the resources that are required for the VxBlock

management components as well as the VDI brokering components. Scale and create the compute clusters to accommodate the number of users in each cluster.

- **Network isolation**—Carefully design the network with both physical and logical network isolation in mind. The management or AMP environment is designed to continue operating in isolation during maintenance and firmware upgrades of the VxBlock system.

## Density recommendations

The following table lists the configurations that we tested with Microsoft Windows 10, Microsoft Windows Server 2016, and Microsoft Office 2016. The table lists the user densities that we recommend based on our testing.

**Table 4** Tested configurations and user density recommendations

| Server configuration | Profile | Workload | User density (per host) |
|---|---|---|---|
| C7 | Knowledge Worker | Login VSI Knowledge Worker | 100 |
| C7 | Power Worker | Login VSI Power Worker | 81 |
| C7 + 2x Tesla P40 | Graphics Multimedia Worker (Virtual PC: P40-1B) | Login VSI Multimedia Worker | 44 |
| C7 | RDSH Task Worker | Login VSI Task Worker | 173 (Horizon Apps RDSH/ Published Desktop) |

## 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 EMC Professional Services offers an assessment service for all VDI needs.

# Design enhancements

This section provides guidance on data protection and file workloads.

## Data protection guidance

The growing adoption of VDI 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 organizations want to ensure that their VDI environments meet their corporate availability, recovery time objective (RTO), and recovery point objective (RPO) requirements.

Dell EMC Data Protection for Converged Infrastructure simplifies backup, recovery, and failover of the VxBlock System 1000. Dell EMC offers advanced data deduplication, replication, and data protection technologies for achieving your RPO and RTO requirements. For a detailed listing of the data protection products that are available for VxBlock 1000, see the VxBlock 1000 Converged Infrastructure Data Sheet and Specifications.

For information about data protection of a VMware Horizon environment, see the Data Protection for a VMware Horizon VDI Environment using Dell EMC Data Protection Suite Operations Guide. Dell EMC provides 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, which makes it ideal for the VDI use case. AVE is a fully featured data protection solution that is deployed as a virtual appliance. It supports advanced functionality such as backup in the cloud (including VMware Cloud on AWS), change block tracking for fast backup and recovery, and integration with multiple VMware interfaces such as the vRealize Automation Data Protection Extension. For additional information, see Dell EMC Avamar Virtual Edition Data Protection Software.

### Data Domain Virtual Edition

Dell EMC Data Domain Virtual Edition (DDVE) is a data protection storage solution that runs as a virtual appliance on your choice of on-premises hardware or on a variety of public cloud options, including VMware Cloud on AWS. 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 DDVE storage protection solution is DD Boost, which provides advanced integration with data protection applications such as AVE to enable client-side deduplication, thus accelerating backup. For additional information, see Dell EMC Data Domain Virtual Edition Data Protection Software.

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

### Other Dell EMC data protection products

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

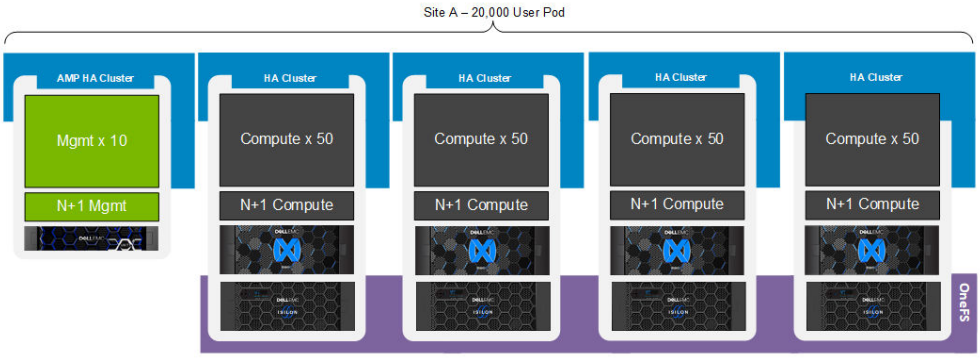
## Dell EMC Isilon file storage

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 7** 20,000-user pod on Isilon




When deploying Isilon in a VDI environment, Dell EMC recommends that you deploy a separate Isilon storage 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 Isilon storage system 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 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 consider the tradeoffs carefully.

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

# Conclusion

## Summary

A virtual application and desktop environment that is based on Dell EMC VxBlock System 1000 converged infrastructure and VMware Horizon 7 brokering software provides operational simplicity and an excellent user experience.

The VxBlock 1000 provides the latest storage arrays from Dell EMC together with compute and networking equipment from Cisco Systems and AMP management infrastructure. The compute layer includes both Cisco UCS B-Series and C-Series servers. The storage layer includes multiarray support from Dell EMC VMAX All Flash, Unity, PowerMax, XtremIO, and Isilon storage to fulfill both block and file storage needs. VxBlock 1000 comes with Cisco UCS third and fourth generation - LAN and SAN networking options.

You can easily expand the VxBlock 1000 system by separately adding additional compute, network, or storage resources. It is designed for large enterprises running VDI workloads and can run a multiworkload environment, which includes VDI and other high-value workloads such as data analytics.

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

Dell EMC Ready Architectures for VDI offer several key benefits:

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

All Dell EMC Ready Architectures for VDI are configured to produce similar results. Regardless of which VxBlock 1000 devices you choose, you can be sure that they are designed and optimized for your organization's needs.

## Next steps

To learn more about this solution, its design, and testing, see the Dell EMC Ready Architectures for VDI: Designs for VMware Horizon 7 on VxBlock System 1000 Validation Guide.

For additional information, see Virtual Desktop Infrastructure.

# 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 VDI Info Hub for Ready Solutions for a complete list of VDI resources.

- Dell EMC Virtual Desktop Infrastructure

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

- Dell EMC Ready Architectures for VDI: Designs for VMware Horizon 7 on VxBlock System 1000 Validation Guide
- Dell EMC Ready Architectures for VDI Designs for VMware Horizon 7 on VxBlock System 1000 Design 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