White Paper

IMPLEMENTING VISUALLY INTENSIVE END-USER COMPUTING

EMC Solutions

Abstract

This white paper describes the architecture, key components, and main features and functionality of a visually intensive end-user computing solution.

October 2016

EMC²

Implementing Visually Intensive End-User Computing
White Paper

Part Number H15431

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Executive summary

Business case

This solution for implementing visually intensive end-user computing (EUC) provides organizations with secure, anytime, and anywhere access to virtual desktops that support visually intensive workloads. It includes virtual desktop infrastructure (VDI), security, and professional services.

Solution overview

This EMC-tested and validated solution integrates the best of EMC, VMware, and NVIDIA products and services. It empowers IT organizations to migrate their visually intensive desktop workloads to the data center and accelerate implementation and adoption of desktop as a service (DaaS). At the same time, the solution enables customer choice for the compute and networking infrastructure within the data center. The solution caters to customers who want to further use their existing infrastructure as well as those customers who want to build out new infrastructures that are dedicated to providing DaaS. The solution can be deployed on VCE™ Vblock® converged infrastructure solutions or on the customer's own infrastructure platform.

This solution takes advantage of the strong integration among EMC storage technologies, the VMware vCloud Suite cloud infrastructure, VMware Horizon, and NVIDIA GRID enterprise graphics virtualization technology. The solution uses EMC scalable storage arrays and integrated EMC and VMware monitoring. It provides the foundation for a scalable, highly available EUC infrastructure that can deliver a superior end-user experience for visually intensive workloads.

Key benefits

The Visually Intensive End-User Computing solution enables a well-run EUC environment by bringing new functionality to IT organizations and end users. Beyond delivering virtual desktops to support visually intensive workloads, the solution, which is built on a software-defined data center (SDDC) architecture, also delivers feature-rich capabilities to deliver business-enabling virtual desktops.

The solution includes the following features and functionality:

- VMware Horizon virtual desktops that support visually intensive workloads
- Predictable scalability of the infrastructure
- Consistent performance with reduced capacity footprint
- Centralized storage of user data
- Predefined virtual desktop types

Document purpose

This document describes the architecture, key components, and main features and functionality of the Visually Intensive End-User Computing solution. The information that is provided in this paper may also be used to add visually intensive EUC functionality to an existing Horizon infrastructure.

Audience

This white paper is intended for architects, EUC administrators, cloud administrators, and others who want to deploy an EUC solution for visually intensive workloads.

We recommend that readers be familiar with storage technologies and general IT functions and requirements, and how a hybrid cloud infrastructure accommodates those technologies and requirements.

We value your feedback!

EMC and the authors of this document welcome your feedback on the solution and the solution documentation. Contact EMC.Solution.Feedback@emc.com with your comments.

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Technology overview

Graphics virtualization for Horizon virtual desktops

This solution uses NVIDIA GRID enterprise graphics virtualization technology to provide enhanced graphics capabilities for Horizon desktop customers. NVIDIA GRID graphics cards are designed specifically for the data center and have an optimized graphics processing unit (GPU) design that helps maximize user density and provide data-center-class power efficiency.

With NVIDIA GRID virtual GPU (vGPU), the graphics commands of each Horizon desktop are passed directly to the GPU, without translation by the hypervisor. This functionality enables the GPU hardware that is allocated for each user to deliver high-performance shared virtualized graphics. NVIDIA GRID cards enable you to deploy virtual desktops to a wide range of graphics applications users—from Microsoft PowerPoint presentation teams to engineers who use intensive 3D CAD software.

Applications that are certified for use with NVIDIA GRID cards include:

- Autodesk: AutoCAD, 3ds Max, Inventor, Maya
- Dassault Systèmes: CATIA, SOLIDWORKS
- ESRI: ArcGIS
- PTC: Creo View, Creo View Express
- Siemens: PLM Software NX, Syngo

Many other applications that are related to video editing, medical imaging, and manufacturing product lifecycles can also use the capabilities of NVIDIA GRID.

This solution supports the NVIDIA Kepler-processor-based K1 and K2 GRID cards as well as the Tesla-processor-based M6 and M60 GRID cards.

Predictable scalability of the infrastructure

This solution enables the infrastructure to be predictably scaled as the required number of desktops increases. This paper provides examples of VMware ESXi host hardware resource requirements for the support of 500, 3,000, 6,000, and 10,000 Horizon desktops with vGPU technology. When the number of required desktops exceeds the number of desktops that the deployed solution supports, you need only expand the resources to match the larger scale-point example.

For example, if the deployed solution supports up to 3,000 desktops but you now require 6,000 desktops, simply add the Horizon infrastructure resources that are necessary to match the requirements of the 6,000-desktop solution. Alternatively, you can also determine the specific amount of required infrastructure resources on a per-desktop basis and use that information to add only those resources. These calculations do not account for the additional resources that are necessary to accommodate outages or other events that impact infrastructure availability.

Consistent performance with reduced capacity footprint

This solution provides high performance with consistently low latency—at scale, all the time, and for all user types. It employs the EMC XtremIO all-flash array for virtual desktop storage. The array's unique content-based metadata engine, scale-out architecture, and always-on inline deduplication and compression enable you to start small and grow the solution nondisruptively. You can predictably increase both capacity and performance by adding EMC X-Brick™ building blocks to the storage array.

Centralized storage of user data

This solution supports EMC Unity™ and EMC Isilon® storage platforms to provide centralized, secure, highly available, and scalable storage of user and workload data.

Using either of these platforms, EUC administrators can provide individual users or groups of users with centrally located storage for critical data. Centralized storage eliminates the need to store the data on virtual desktops and enables administrators to easily manage and protect the data for business continuity and other purposes.

Predefined virtual desktop types

This solution includes predefined virtual desktop types that support different user types. These desktop types enable you to deploy or scale the solution to one of three predefined scale points, as outlined in this paper. This solution also supports custom scale points. Contact your EMC representative for assistance in designing a solution that meets your specific requirements. The following desktop types are offered as part of this solution:

- **Small visually intensive desktop**—For a task worker who performs duties such as reviews of existing visually intensive content and who might also use other common non-visually intensive applications.
- **Medium visually intensive desktop**—For a knowledge worker who performs reviews of existing visually intensive content and who from time to time creates or edits that content.
- **Large visually intensive desktop**—For a power user who creates or edits visually intensive content as a primary job function. This user needs sufficient resources to ensure high levels of performance when creating or editing visually intensive content.

Additional characterizations for each desktop type are described later in this document. Those characterizations are for those visually intensive workloads that are both visually and I/O intensive and, therefore, have I/O requirements that exceed the default small, medium, and large visually intensive desktop type definitions.

Solution architecture

This section describes the solution environment and supporting infrastructure. The architectures that are described in this section are designed solely to support visually intensive desktops. However, the information that is provided for the Horizon desktops can also be applied to non-visually intensive EUC solutions by enterprises that want to add visually intensive desktops. The resources that are required for the Horizon infrastructure servers are the same for both visually intensive and non-visually intensive Horizon desktops and, as such, are not discussed in this solution.

This paper provides information about how to determine the resource requirements for the vSphere host for Horizon desktops. The information applies to solutions that are specific to visually intensive Horizon desktops and to solutions that will contain a mixture of visually intensive and non-visually intensive (not GRID enabled) Horizon desktops.

Architecture overview

This solution, which integrates the Horizon desktop environment with EMC storage technologies and NVIDIA GRID enterprise graphics virtualization technologies, provides customers with a scalable platform for delivering EUC. It introduces new techniques for managing Horizon resources and offers outstanding performance, reliability, security, and manageability. It enables the delivery of a virtual desktop service with self-service capabilities and a simplified interface for performing common Horizon administrative tasks.

This solution can be deployed on a VCE converged infrastructure or on an existing infrastructure that uses a private cloud that is based on VMware vSphere.

Table 1 lists the key components of this solution.

Table 1. Visually Intensive End-User Computing solution key components

Function	Product	Notes
Virtualization	VMware vSphere	Enables the physical implementation of resources to be decoupled from the applications that use them
EUC	VMware Horizon	Manages the provisioning, allocation, maintenance, and eventual removal of the virtual desktop images that are provided to users of the system
Graphics acceleration	NVIDIA GRID	Provides vGPU technology for virtual desktops, enabling the use of visually intensive applications that traditionally required dedicated physical workstations
EUC infrastructure storage	EMC XtremIO	Provides storage for virtual desktops and the Horizon infrastructure
User data storage	EMC Unity 300™ or Unity 400™	Provides storage for user and shared data
	EMC Isilon X410	

Figure 1 shows an architectural representation of the required resources.

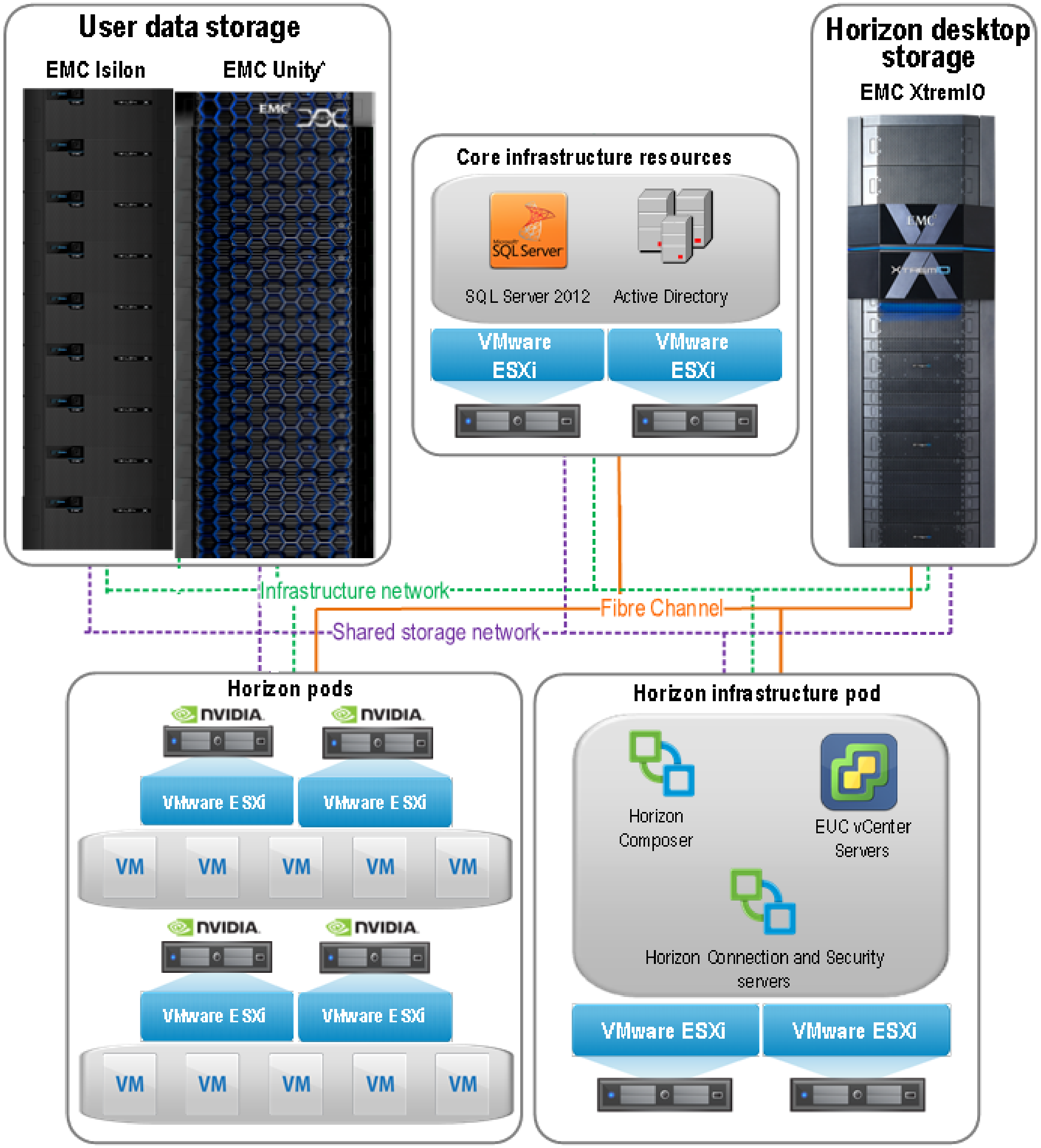

Figure 1. Visually Intensive End-User Computing solution architecture

As shown in Figure 1, the solution includes a dedicated Horizon infrastructure pod that hosts Horizon Connection Server instances, Horizon Composer, and multiple dedicated VMware vCenter Server systems. One vCenter Server system manages the Horizon infrastructure virtual servers and the vSphere clusters that host them. One or more vCenter Server systems, based on number of desktops being deployed, manage Horizon desktops and their associated vSphere clusters. The solution also uses dedicated pods to host Horizon desktops. Unity and Isilon arrays provide user data storage, and XtremIO arrays provide storage for Horizon desktops.

The components that are shown in Figure 1 apply to VCE converged infrastructure-based and stand-alone EUC deployments.

Horizon desktop type options

Table 2 lists three desktop types that we used when sizing the solution. The IOPS values in the table assume an I/O breakdown of 50 percent writes and 50 percent reads. The table provides two IOPS values for each desktop type to account for different requirements among desktops of each type.

Table 2. Solution desktop types

Desktop type	Use	vCPUs	RAM (GB)	IOPS—Standard	IOPS—High	Full-clone storage (GB)	Linked-clone storage (GB)
Small visually intensive	Task worker	2	8	50	150	75	19
Medium visually intensive	Knowledge worker	2	16	100	300	150	37
Large visually intensive	Power worker	4	24	150	600	300	50

The storage capacity requirements in Table 2 include space for the ESXi virtual machine swap (vswp) files, virtual machine (VM) log files, and other VM configuration files. The values that are provided apply to both Microsoft Windows 7 and Windows 8.1.

Due to differences in visually intensive desktop CPU use, small visually intensive desktops require one physical ESXi host processor core for every two Horizon desktop virtual CPUs (2 vCPUs:1 pCPU oversubscription). Medium and large visually intensive desktops require one physical ESXi host processor core for every one Horizon desktop virtual CPU (no oversubscription, a 1:1 ratio of vCPUs to pCPUs)[1]. Table 8 provides details about desktop ESXi host hardware requirements for multiple solution scale points. Consult your EMC representative for determining requirements that fall outside the examples that are provided.

The definition of each desktop type will likely vary from one environment to the next. However, the desktop types that are described in Predefined virtual desktop types on page 7 provide the basis of the sizing guidance for the solution.

[1] These ratios are to physical CPU cores. While Hyper-Threading must be enabled on the Horizon desktop ESXi hosts, it does not have any impact on these sizing calculations.

Hardware resources

Table 3 lists the key hardware components of this solution.

Table 3. Key solution hardware components

Category	Products
Graphics acceleration services	NVIDIA GRID K1, K2, M6, and M60 GPU cards in supported server platforms as listed in *NVIDIA GRID Certified Servers*
Storage services	• EMC XtremIO all-flash array (for Horizon desktops and/or the Horizon infrastructure) • EMC Isilon system (for user data) • EMC Unity system (for user data)
Compute services	Options include: • VCE Vblock converged infrastructure solutions • Supported hardware platforms, as listed in the *VMware Compatibility Guide*
Network services	Supported network platforms, as listed in the *VMware Compatibility Guide*, as well as those platforms that are included as part of a VCE Vblock **Note:** All ESXi hosts must use at least 10 GbE uplinks.

The resources that are required for the Horizon desktops might vary based on the final design of the solution.

Software resources

Table 4 lists the key software components of this solution.

Table 4. Key solution software components

Category	Product
EUC	VMware Horizon 7.0
Graphics acceleration services	The latest versions available of the following NVIDIA GRID software components (to be used during the deployment): • ESXi VIB module • Desktop graphics drivers • vGPU license server (for NVIDIA M-series based installations only)
Virtualization and cloud management	VMware vSphere 6.0 Update 2, including: • VMware ESXi • VMware vCenter Server

Note the following:

- EMC recommends that the EUC desktop pods run vSphere 6 to ensure compatibility with future revisions of NVIDIA GRID and VMware Horizon.
- To correlate VMware product build numbers with update levels, see VMware Knowledge Base article 1014508.

Key components

Introduction

This section describes the following key components of this solution:

- VMware Horizon Enterprise Edition

  Solution components include Horizon, Horizon Composer, VMware vSphere, and VMware vCenter Server.
- NVIDIA GRID graphics virtualization
- Compute resources, including either a VCE Vblock converged infrastructure solution or an existing infrastructure based on vSphere
- EMC storage services: XtremIO, Unity, and Isilon platforms

VMware Horizon Enterprise Edition

Horizon is a leading desktop virtualization solution that delivers desktop services from the cloud to end users.

Horizon Enterprise Edition is a bundled solution. It includes Horizon, vSphere, vCenter Server, Horizon Workspace, VMware App Volumes, VMware User Environment Manager, VMware ThinApp, VMware vRealize Operations for Horizon, and VMware Mirage.

For solution validation we deployed the following:

- vSphere 6.0 Update 2
- Horizon 7.0, including Horizon Connection Servers, Horizon Composer, and the Horizon Client

Horizon

Horizon delivers published desktops and applications on a single integrated VDI platform. It manages, deploys, and brokers client connections to Horizon desktops. Additionally, it integrates effectively with vSphere to provide the following:

- **Performance optimization and tiered storage support**—Horizon Composer enables the use of linked-clone-based desktops, which optimize storage utilization and performance by reducing the footprint of virtual desktops.

  This solution uses a stand-alone Horizon Composer server to minimize the impact of virtual desktop provisioning and maintenance operations on vCenter Server.

- **Thin provisioning support**—Horizon enables efficient allocation of storage resources when virtual desktops are provisioned. The efficient allocation of resources results in better use of the storage infrastructure.

For detailed information about all the new features and functionality in the versions of Horizon that are supported with this solution, see *Release Notes for VMware Horizon 7 version 7.0.1*.

vSphere

vSphere is the leading virtualization platform in the industry. It provides flexibility and cost savings by enabling the consolidation of large, inefficient server farms into nimble, reliable infrastructures. The core vSphere components are the vSphere hypervisor and vCenter Server for system management.

This solution uses vSphere Desktop, which is intended for customers who want to purchase vSphere licenses for desktop virtualization only. vSphere Desktop provides the full range of features and functionality of the vSphere Enterprise Plus edition, enabling customers to achieve scalability, high availability, and optimal performance for all their desktop workloads.

vCenter Server

vCenter Server is a centralized platform for managing vSphere environments. Accessible from multiple devices, it provides administrators with a single interface for all aspects of monitoring, managing, and maintaining the virtual infrastructure.

vCenter Server is also responsible for managing vSphere advanced features such as High Availability (HA), Distributed Resource Scheduler (DRS), vMotion, and Update Manager.

NVIDIA GRID graphics virtualization

NVIDIA GRID delivers a high-performance, interactive visually intensive experience remotely, making complex 2D and 3D content accessible anywhere, any time, on any device. With GRID cards in an ESXi host, Horizon desktop clients can access rich visual content with large datasets, in high resolution with interactive performance. Additionally, Horizon clients enjoy this access whether they are at the office, on the road, or off the clock, using a laptop, tablet, or phone.

NVIDIA GRID vGPU technology delivers visually intensive desktop-class performance that easily scales with a multitude of clients. NVIDIA GRID vGPU technology enables professional-caliber visually intensive computing to shift to data centers and clouds, to whatever degree meets the needs of the business.

Compute resources

This solution has specific compute resource requirements. Table 5 provides an aggregate of the compute resources that are required and assumes that Intel Hyper-Threading Technology is enabled on the Horizon desktop ESXi hosts. These resources were calculated based on configurations of 500, 3,000, 6,000, and 10,000 desktops, using the desktop types listed in Table 2 on page 10. The actual resource requirements will vary based on the desktop type and the total number of desktops being deployed.

Table 5. Solution compute resource requirements

Desktop type	No. of desktops	CPU cores	RAM (TB)
Small visually intensive desktop	500	500	4
	3,000	3,000	24
	6,000	6,000	48
	10,000	10,000	80
Medium visually intensive desktop	500	1,000	8
	3,000	6,000	48
	6,000	12,000	96
	10,000	20,000	160
Large visually intensive desktop	500	2,000	12
	3,000	12,000	72
	6,000	24,000	144
	10,000	40,000	240

For all custom desktop-compute-resource sizing calculations, contact your EMC representative for assistance.

VCE converged infrastructure systems

VCE converged infrastructure offers fast deployment of infrastructure, high application performance and availability, low TCO, and infrastructure lifecycle assurance. In addition, VCE offers infrastructure systems that are specifically designed and supported for VDI.

When customers deploy this solution on VCE converged infrastructure systems, they receive all the benefits of VCE converged infrastructure plus the following:

- Single-call customer support that extends to the entirety of the infrastructure layer for all systems within the VCE System
- Vastly accelerated time-to-value
- Additional administrative efficiency and reliability with VCE Vision™ Intelligent Operations, which provides single-console management for the entirety of the physical infrastructure within the VCE System

EMC storage services

This solution uses multiple EMC products to provide storage services, optimize the performance of the storage infrastructure, provide storage maintenance that is based on integration with vSphere, and enable advanced storage performance analytics and monitoring.

Table 6 outlines the type of storage in this solution for which each storage array has been validated.

Table 6. EMC storage array solution validation

Storage array	Horizon infrastructure storage	Horizon desktop storage	User data storage
EMC XtremIO	Yes	Yes	Not applicable
EMC Unity	No	No	Yes
EMC Isilon	No	No	Yes

EMC XtremIO

The XtremIO all-flash array is designed to maximize the use of flash storage media. It provides these key benefits:

- Extremely high levels of I/O performance, particularly for random I/O workloads that are typical in virtualized environments
- Consistently low (sub-millisecond) latency
- True inline data reduction that removes redundant information in the data path and writes only unique data on the storage array, thus lowering the amount of capacity required
- A full suite of enterprise array capabilities, N-way active controllers, high availability, strong data protection, and thin provisioning
- A scale-out design that adds performance and capacity in a building block approach, with all building blocks forming a single clustered system

The X-Brick building block is the fundamental component of an XtremIO clustered system. A single X-Brick supports up to 2,500 full-clone or 3,500 linked-clone desktops. With a Starter X-Brick, you can begin with a small virtual desktop deployment (up to 1,250 full-clone or 1,750 linked-clone desktops). You can then expand to nearly any scale by upgrading the Starter X-Brick to an X-Brick, and then adding more X-Brick blocks. The XtremIO system expands capacity and performance linearly as building blocks are added, greatly simplifying EUC sizing and management of future growth.

For virtual desktop environments, the XtremIO array can provide:

- Outstanding user experience for all desktop types, at enterprise scale, at all times
- Radically simple administrator experience with an easy, efficient, and cost-effective deployment model

EMC Unity storage system

In this constantly changing world of increasing complexity and scale, the need for an easy-to-use intelligent storage system is greater than ever before. Customers using new applications and solutions require dependable storage and are often tasked with the challenge of doing more with less. The Unity family addresses this challenge by packaging a powerful storage system into a cost-efficient and space-efficient profile. Unity features include:

- **Unified environment**—Unity delivers a full block and file unified environment in a single 2U enclosure. You use the same pool to provision and host LUNs, consistency groups, network-attached storage (NAS) servers, file systems, and vSphere Virtual Volumes alike. The Unisphere management interface offers a consistent look and feel, whether you are managing block resources, file resources, or both.
- **Modern, simple interface**—Unisphere, the Unity management interface, has been built with the modern-day data center administrator in mind. Using browser-native HTML5, Unisphere can be used across a variety of operating systems and web browsers without the need for additional plug-ins. The interface has been designed to mimic the practical flow of an administrator's daily life, with provisioning and management functions that are organized in easy-to-find categories and sections.
- **Flexible deployment options**—With Unity, a deployment offering exists for a range of different use cases and budgets, from the virtual offering of UnityVSA to the Unity platform. The Unity system can be configured as an all-flash system with only solid-state drives. Alternatively, it can be configured as a hybrid system with a mix of solid-state and spinning media to deliver the best on both performance and economics.
- **Optional I/O modules**—The Unity platform supports a variety of connectivity. I/O module options include 12 Gb serial-attached SCSI (SAS) (for back-end expansion), 16 Gb Fibre Channel (four ports), 10 GbE Optical (two- and four-port variants), and 10 GbE BaseT and 1 GbE BaseT (four ports). I/O modules that support iSCSI and NAS can be used for both simultaneously.
- **Expanded file system**—At its core, the UnityFS file system is a 64-bit based file system architecture that provides increased maximums to keep pace with the modern data center. You can provision file systems and VMware NFS datastores in sizes as large as 64 TB and create multiple millions of files per directory and subdirectories per directory.
- **Native data protection**—Security and availability of data are critical concerns for many customers, and Unity offers multiple solutions to address these needs. Unified Snapshots provide point-in-time copies of block and file data that can be used for backup and restoration purposes. Asynchronous replication offers an IP-based replication strategy within a system or between two systems. Synchronous block replication benefits FC environments that are close together and require a zero-data-loss schema. Data-at-rest encryption ensures that user data on the system is protected from physical theft and can stand in the place of drive disposal processes such as shredding.

- **VMware integration**—With VMware Aware Integration (VAI) in Unity systems, discovery of a VMware environment has never been easier. You can use VAI to import the ESXi host and vCenter environment details into Unisphere for efficient management of your virtualization environment. Support for VMware vStorage APIs for Storage Awareness (VASA) 2.0 enables the provisioning and use of vSphere Virtual Volumes, a new virtualization storage technology delivered by ESXi 6.0. Unity supports Virtual Volumes for both block and file configurations.
- **Multiple management paths**—You can configure and manage your Unity system with any of the following methods:
  - Unisphere UI, which is a browser-based graphical view of the system and its resources
  - Unisphere CLI (UEMCLI), using Secure Shell (SSH) or over a Windows host
  - Unity REST API, which you can use to perform any function that is possible to perform with UEMCLI

The Unity storage system sets new standards for midrange storage. It provides a powerful combination of simplicity, modern design, affordable price point, and deployment flexibility that is ideal for resource-constrained IT professionals in large or small companies. Unity is well-suited for midsize deployments, remote office/branch office locations, and cost-sensitive mixed workload environments. Designed for all-flash and delivering high value, Unity systems are available in an all-flash or hybrid-flash converged deployment, and as a software-defined virtual edition. The EMC Unity website provides more information about Unity storage. Figure 2 shows the Unity family.

Figure 2. EMC Unity family

As shown, the Unity system is offered in four models for each of two different configurations—all flash or hybrid flash. The platform starts with the Unity 300 and scales up to the Unity 600. Table 7 provides a high-level comparison of the different Unity models.

Table 7. Unity model comparison

Model	Processor	Memory	Maximum no. of drives	Maximum capacity (raw)
Unity 300	Intel E5-2603 v3 6 core/1.6 GHz	24 GB/storage processor (SP)	150	1.5 PB
Unity 400	Intel E5-2630 v3 8 core/2.4 GHz	48 GB/SP	250	2.5 PB
Unity 500	Intel E5-2660 v3 10 core/2.6 GHz	64 GB/SP	350	3.5 PB
Unity 600	Intel E5-2680 v3 12 core/2.5 GHz	128 GB/SP	500	5.0 PB

The *Introduction to the Unity Platform white paper* provides detailed information about the Unity system.

EMC Isilon storage system

This solution uses the Isilon scale-out NAS storage array to provide user data storage services. The combination of Isilon scale-out NAS with other tier 1 arrays is designed to address large-scale EUC storage challenges. The XtremIO array delivers exceptional performance and the responsiveness that is required to support virtual desktops and their associated Virtual Machine Disk (VMDK) files. Isilon scale-out NAS provides highly efficient, massively scalable storage for EUC user and profile data.

Isilon scale-out NAS is a fully distributed system consisting of nodes of modular hardware that are arranged in a cluster, as illustrated in Figure 3. The distributed Isilon OneFS® operating system combines the memory, I/O, CPUs, and disk nodes in a cohesive storage unit to present a global namespace as a single file system. The cluster that is shown in the figure uses 10 GbE connectivity for both client-facing and Isilon intracluster communications. Intracluster communications may also use InfiniBand.

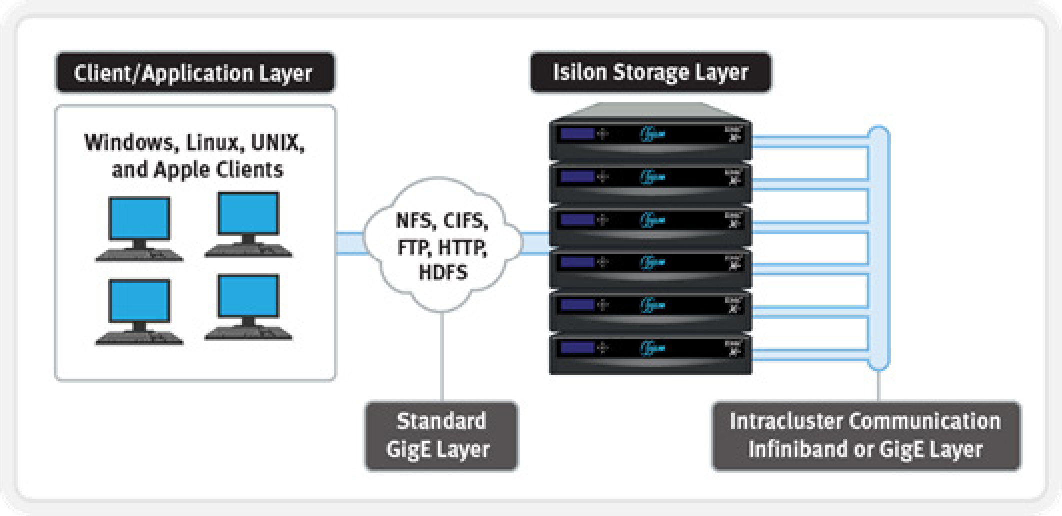

Figure 3. Components of an Isilon cluster

The nodes work together as peers in a shared-nothing hardware architecture with no single point of failure. Every node adds capacity, performance, and resiliency to the cluster. As nodes are added, the file system expands dynamically and redistributes data, eliminating the work of partitioning disks and creating volumes. The result is highly resilient, distributed, and scalable storage architecture.

The distributed OneFS operating system handles a failure by distributing the load of a failed node to the remaining nodes. The system keeps just enough redundant information to reconstruct the data from a node or disk that fails, and the amount of overhead to protect against failure decreases as nodes are added to the cluster.

Design considerations

Overview

This section describes the vSphere resources that are required to host the visually intensive Horizon desktops. The resource amounts vary, depending on the total number of desktops being deployed and the desktop types being used.

Table 8 provides an aggregate of the Horizon desktop ESXi host resources that are required for this solution for standard IOPS and high IOPS requirements. The resource amounts are based on the information that is provided in Table 2 on page 10. To determine requirements for custom sizes that are not discussed in the solution documentation, contact your EMC representative for assistance.

Consider the following when you review the Horizon desktop resource requirements:

- Assuming that each server in the Horizon desktop pod has similar specifications, the final design must include one additional ESXi host for every eight in the pod. This design ensures that sufficient capacity exists for scheduled ESXi maintenance or unscheduled interruptions.

  For example, if a Horizon desktop pod has 16 ESXi hosts with identical configurations and resource capacity as outlined in Table 8, add two ESXi hosts to ensure that availability requirements will be met.

- Specific recommendations for server physical processor socket configurations and processor core densities are not provided. However, the ratio of server CPU to RAM must remain constant to ensure that the desktops have access to the recommended CPU and RAM resources.
- The required storage includes an additional 20 percent of capacity to provide the free space that is necessary to perform SCSI UNMAP operations on block-based desktop storage.
- vSphere Distributed Resource Scheduler must be enabled in fully automated mode with a priority 2 migration threshold. This ensures automatic load balancing of the virtual desktops and supports automated ESXi host evacuation when maintenance is performed.

- Horizon infrastructure ESXi hosts, as well as all other ESXi hosts, must have redundant 10 GbE uplinks to ensure that sufficient network bandwidth is available and availability needs are met.
- An XtremIO array is the only array that is supported in this solution for visually intensive desktops.

Table 8. Horizon infrastructure resource requirements: Desktops

Desktop type	No. of desktops	ESXi host CPU cores	Server RAM (TB)	IOPS–standard (50% write/50% read)	IOPS–high (50% write/50% read)	Full-clone storage (TB)	Linked-clone storage (TB)
Small visually intensive	500	500	4	25,000	75,000	37.5	9.5
	3,000	3,000	24	150,000	450,000	225	57
	6,000	6,000	48	300,000	900,000	450	114
	10,000	10,000	80	500,000	1,500,000	750	190
Medium visually intensive	500	1,000	8	50,000	150,000	75	18.5
	3,000	6,000	48	300,000	900,000	450	111
	6,000	12,000	96	600,000	1,800,000	900	222
	10,000	20,000	160	1,000,000	3,000,000	1,500	370
Large visually intensive	500	2,000	12	75,000	300,000	150	25
	3,000	12,000	72	450,000	1,800,000	900	150
	6,000	24,000	144	900,000	3,600,000	1,800	300
	10,000	40,000	240	1,500,000	6,000,000	3,000	500

These configurations also provide the basis of the storage-array sizing guidance that is provided in this white paper.

ESXi host sizing

Table 9 provides an example of ESXi host sizing based on the information that is provided in Table 8.

Table 9. ESXi host sizing example

Item	Description/Amount	Notes
Desktop type	Small (dual vCPUs, 8 GB of RAM each)	
NVIDIA GRID card and profile	M6-0B (blade) or M60-0B (rack)	• Most rackmount servers can accommodate two NVIDIA M60 cards for a total of 64 desktops running an M60-0B vGPU profile. • Blade servers can accommodate one NVIDIA M6 card for a total of 16 desktops running an M6-0B vGPU profile. • For a detailed explanation of NVIDIA GRID vGPU profile specifications, see NVIDIA GRID vGPU display profile options on page 23.
Number of desktops	500	
Number of server CPU cores required	500 (value is obtained from Table 8 and assumes 2:1 desktop vCPU to server core consolidation ratio)	• (500 desktops * 2 vCPU) / 2 desktop vCPUs per core = 500 server cores required. • 500 desktops / 500 server cores = 1 desktop per server core.
Amount of RAM required	4 TB	500 desktops * 8 GB RAM each = 4 TB RAM.
Proposed server CPU and RAM configurations	Blade: • 2 x 10 core CPU (20 total cores) • 192 GB RAM	
	Rack: • 2 x 18 core CPU (36 total cores) • 320 GB RAM	
Sample server maximum desktop count based on the proposed server configurations	Blade: • 20 CPU cores per server * 1 desktop per server core = 20 desktops per server • 192 GB RAM per server / 8 GB RAM per desktop = 24 desktops per server • Single NVIDIA M6 card using the M6-0B display profile = 16 desktops per server	Based on the proposed configuration, a maximum of 16 desktops can be placed on each server.

Item	Description/Amount	Notes
	Rack: • 36 CPU cores per server * 1 desktop per server core = 36 desktops per server • 320 GB RAM per server / 8 GB RAM per desktop = 40 desktops per server • Two NVIDIA M60 cards using the M60-0B display profile = 64 desktops per server	Based on the proposed configuration, a maximum of 36 desktops can be placed on each server.
Maximum number of desktops for each proposed server configuration	Blade: 16	Limit is due to NVIDIA GRID card vGPU limits (maximum of 16 desktops running the target display profile).
	Rack: 64	Limit is due to server CPU core count (maximum of 36 desktops based on selected server CPU configuration).

The values in Table 9 do not account for redundancy. Redundancy is achieved by adding one ESXi host for every eight present in the cluster, as described earlier in this section. Also, with the presence of these additional ESXi hosts, no one ESXi host has to run at full capacity under normal operating conditions, which helps ensure consistent levels of performance during periods of above-average load.

VMs that are powered on and using NVIDIA GRID card resources cannot be migrated between ESXi hosts using vSphere vMotion. Regardless, ensure that sufficient ESXi host capacity is available to support planned or unplanned downtime of other hosts in the cluster.

Hosting visually intensive and non-visually intensive desktops on the same ESXi host

You can use ESXi hosts for both visually intensive and non-visually intensive desktops if the infrastructure requires it, assuming sufficient CPU and RAM resources are available. You can also use ESXi hosts if you want to introduce NVIDIA GRID cards into an existing Horizon environment, which is supported if the desktop ESXi hosts are on the NVIDIA GRID Certified Servers list.

As an example, the following information would apply to an environment with both visually intensive and non-visually intensive desktops on the same ESXi host and with the blade-server configuration that is described in Table 9. This information does not include requirements to support ESXi host redundancy. Those requirements must be calculated separately, as described in the previous section.

- The blade server could host a maximum of 16 visually intensive desktops due to NVIDIA GRID card vGPU limits, which would leave 4 of the ESXi host CPU cores unused. For non-visually intensive desktops, EMC typically recommends a 5:1 ratio of desktop vCPU to ESXi host CPU cores, which means that the four available CPU cores could accommodate approximately 20 desktop vCPUs.

- Based the RAM configuration of the blade server, and assuming that the server currently hosts 16 visually intensive desktops using 8 GB of RAM each, approximately 64 GB of RAM will be unused. A typical non-visually intensive desktop requires a minimum of 2 GB of RAM, which means that the available RAM could accommodate approximately 32 desktops.
- In this example, the number of ESXi host CPU cores is the limiting factor. Therefore, for this particular blade server configuration, in addition to the 16 visually intensive desktops, you could potentially host up to 20 single vCPU or 10 dual vCPU non-visually intensive desktops.

As previously mentioned, to account for redundancy you must have in reserve sufficient unused ESXi host resources, including NVIDIA GRID resources. Having these resources also means that under normal conditions ESXi hosts do not have to operate at full capacity, which helps ensure consistent levels of performance during periods of above-average load.

NVIDIA GRID vGPU display profile options

Each NVIDIA GRID graphics card supports a varying number of vGPUs based on which display profile is used. A single graphics card can run multiple display profiles simultaneously. However, once the card limits are reached, vSphere cannot power on any additional VMs that are configured to use it. Plan carefully to ensure that sufficient NVIDIA GRID resources are available for all the guest VMs.

The desktop type being deployed and the desktop vGPU requirements influence the hardware configuration of the ESXi hosts that are used in the Horizon desktop pods. Because the maximum number of NVIDIA GRID vGPUs that a particular server platform can host is fixed, you must know your exact vGPU requirements to determine the final design.

In most cases, individual application vendors provide the information that is required to determine which profile your virtual desktops require. While most NVIDIA GRID display profiles have identical maximum display resolutions, the maximum number of supported displays and display frame buffers vary from one profile to the next. Consult your application vendor and your EMC representative to determine your display requirements, as that information is required to determine your vSphere server configuration.

Table 10 and Table 11 list the characteristics of each GRID profile type, as provided by NVIDIA, as well as the maximum number of profiles a single GRID card can accommodate. When determining vSphere server sizing, in addition to sizing for VM CPU and RAM requirements, consider the maximum number of NVIDIA grid cards and, in turn, vGPUs that a particular server can accommodate.

Note: "Intended user" in Table 10 and Table 11 is an NVIDIA term to help you determine the display profile for each visually intensive desktop user. The display profile that is selected determines the number of desktops a particular GRID card can support but does not affect the CPU, RAM, or storage requirements of the desktop itself. The "Intended user" column is for informational purposes only. Final determination of the required display profiles is often specific to the application or applications being used. Contact your EMC representative and application vendor for assistance in determining application vGPU requirements.

Table 10. NVIDIA K2 and K1 vGPU profiles

Card	Physical GPUs	Virtual GPU	Intended user	Frame buffer (MB)	Virtual display heads	Maximum resolution	Maximum vGPUs	
							Per GPU	Per card
GRID K2	2	GRID K280Q	Designer	4,096	4	2560 x 1600	1	2
		GRID K260Q	Designer	2,048	4	2560 x 1600	2	4
		GRID K240Q	Power user	1,024	2	2560 x 1600	4	8
		GRID K220Q	Power user	512	2	2560 x 1600	8	16
GRID K1	4	GRID K180Q	Power user	4,096	4	2560 x 1600	1	4
		GRID K160Q	Power user	2,048	4	2560 x 1600	2	8
		GRID K140Q	Knowledge worker	1,024	2	2560 x 1600	4	16
		GRID K120Q	Knowledge worker	512	2	2560 x 1600	8	32

Tesla M6 and M60 cards that are listed in Table 11 use the same NVIDIA Tesla processor, but the M6 cards are designed for use with blade servers. The M60 cards have two Tesla GPUs per card, whereas the M6 cards have only one. As a result, the M60 cards can accommodate twice the number of vGPUs as the M6 cards.[2]

[2] M-series vGPU profiles that end in "Q" have been customized by NVIDIA and are qualified to work with specific third-party visually intensive applications. Use these display profiles instead of those that end in "B," which are meant for more general use. Contact your EMC representative for a current list of applications that have been qualified for use with NVIDIA GRID vGPUs.

Table 11. NVIDIA M60 and M6 vGPU profiles

Card	Physical GPUs	Virtual GPU	Intended user	Frame buffer (MB)	Virtual display heads	Maximum resolution	Maximum vGPUs		GRID license edition required
							Per GPU	Per card	
Tesla M60	2	M60-8Q	Designer	8,192	4	3840 x 2160	1	2	GRID Virtual Workstation - Extended
		M60-4Q	Designer	4,096	4	3840 x 2160	2	4	
		M60-2Q	Designer	2,048	4	2560 x 1600	4	8	GRID Virtual Workstation
		M60-1Q	Power user, designer	1,024	2	2560 x 1600	8	16	
		M60-0Q	Power user, designer	512	2	2560 x 1600	16	32	
		M60-2B	Power user	2,048	2	2560 x 1600	4	8	GRID Virtual PC
		M60-1B	Power user	1,024	2	2560 x 1600	8	16	
		M60-0B	Power user	512	2	2560 x 1600	16	32	
Tesla M6	1	M6-8Q	Designer	8,192	4	3840 x 2160	1	1	GRID Virtual Workstation - Extended
		M6-4Q	Designer	4,096	4	3840 x 2160	2	2	
		M6-2Q	Designer	2,048	4	2560 x 1600	4	4	GRID Virtual Workstation
		M6-1Q	Power user, designer	1,024	2	2560 x 1600	8	8	
		M6-0Q	Power user, designer	512	2	2560 x 1600	16	16	
		M6-2B	Power user	2,048	2	2560 x 1600	4	4	GRID Virtual PC
		M6-1B	Power user	1,024	2	2560 x 1600	8	8	
		M6-0B	Power user	512	2	2560 x 1600	16	16	

The newer NVIDIA M-series Tesla-based cards are also different from the K-series Kepler-based cards in that the vGPU licenses are required for each powered-on VM. Contact your EMC representative for assistance with NVIDIA M-series vGPU licensing.

Horizon desktop VM device requirements

NVIDIA GRID requires that a shared device be added to each visually intensive desktop master image. You must use the vSphere Web Client to add the device. As shown in Figure 4, set the device type to **NVIDIA GRID vCPU**, and set **GPU Profile** to whichever profile meets the application or end-user requirements.

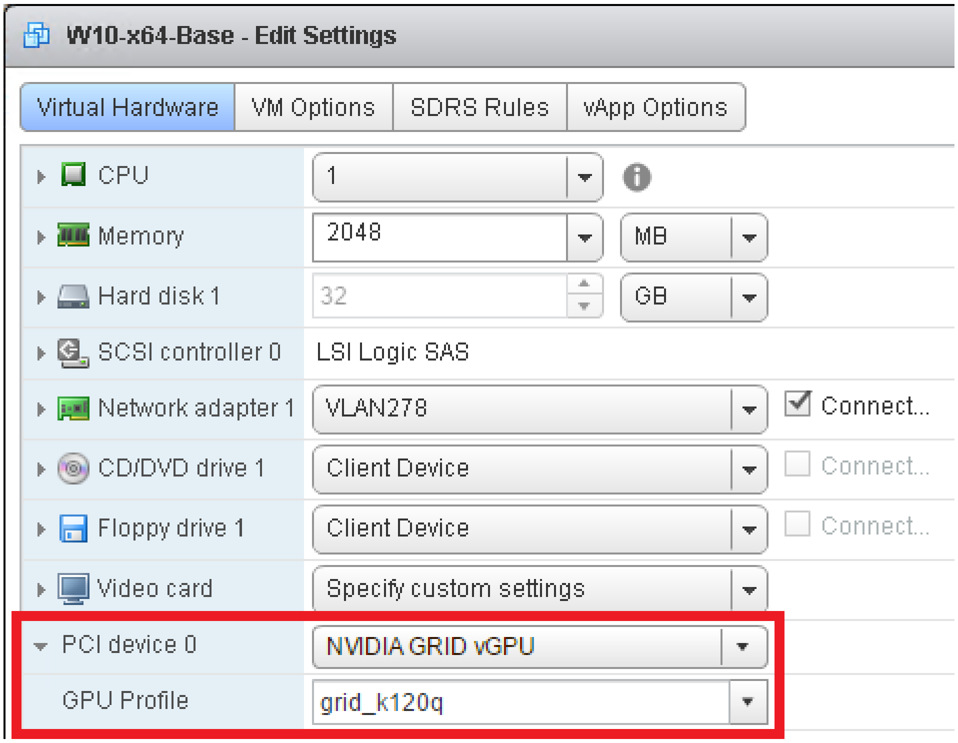

Figure 4. vSphere VM hardware settings

Horizon desktop pool requirements

To enable the use of the NVIDIA GRID vGPU, set the **Remote Display Protocol** options, as shown in Figure 5.

Starting with Horizon 7, the VMware Blast display protocol supports the NVIDIA GRID vGPUs, providing an alternative to the PCoIP selection that is shown in Figure 5.

To prevent clients from selecting Microsoft RDP as the display protocol, which NVIDIA GRID does not support, set **Allow users to choose protocol** to **No** as shown.

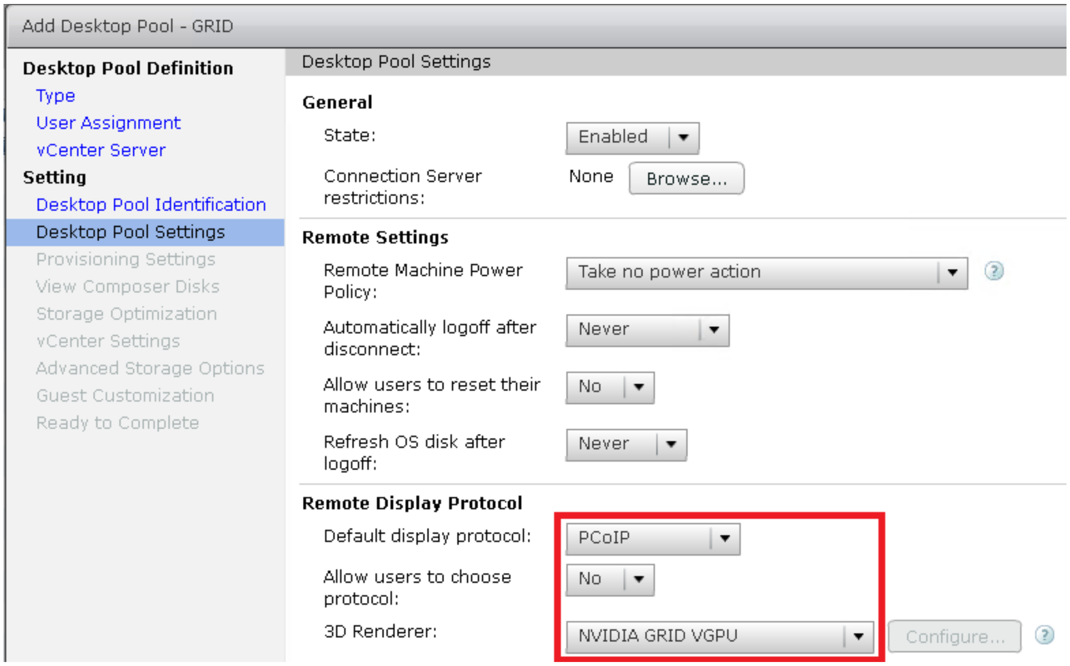

Figure 5. VMware Horizon Desktop Pool Settings menu

Desktop datastore design

Table 12 lists the number and size of datastores that are required for up to 500 desktop deployments. Due to the capacity that is required to host full-clone desktops, EMC recommends a larger number of datastores to reduce the per-datastore size. For XtremIO configurations that will support more than 500 desktops, consult your EMC representative.

Table 12. Horizon desktop datastore requirements

Desktop type		No. of datastores	Datastore size (TB)
Small Visually Intensive	Linked clone	4	2.86
	Full clone	8	5.63
Medium Visually Intensive	Linked clone	4	5.56
	Full clone	16	5.63
Large Visually Intensive	Linked clone	4	7.5
	Full clone	32	5.63

These requirements are based on the requirements that are provided in Table 8 on page 20, and they include additional space to accommodate SCSI UNMAP operations for block-based configurations. These requirements assume that each datastore will host no more than 125 desktops, as recommended by VMware for vStorage APIs for Array Integration (VAAI)-enabled datastores.

XtremIO virtual desktop storage configurations

Table 13 and Table 14 list the EMC XtremIO storage array X-Brick building-block requirements for 500-destop configurations to support standard IOPS and high IOPS requirements, respectively. Table 8 on page 20 and Table 12 describe the related infrastructure and host-server resource requirements. For XtremIO configurations that will support more than 500 desktops, consult your EMC representative.

Table 13. XtremIO 500-desktop, standard-IOPS storage configurations

Desktop type	No. of X-Brick building blocks for full-clone desktops	No. of X-Brick building blocks for linked-clone desktops
Small visually intensive	1 (10 TB X-Brick)	1 (Starter X-Brick)
Medium visually intensive	1 (20 TB X-Brick)	
Large visually intensive	2 (20 TB X-Brick)	

Table 14. XtremIO 500-desktop, high-IOPS storage configurations

Desktop type	No. of X-Brick building blocks for full-clone desktops	No. of X-Brick building blocks for linked-clone desktops
Small visually intensive	1 (10 TB X-Brick)	1 (Starter X-Brick)
Medium visually intensive	1 (20 TB X-Brick)	
Large visually intensive	2 (20 TB X-Brick)	2 (10 TB X-Brick)

The desktop type and IOPS classification are used to determine the required number and type of X-Brick building blocks. To ensure consistent performance, equally distribute the desktop datastores, which are listed in Table 12, among the X-Brick building blocks.

To enable maximum flexibility, install each X-Brick as a stand-alone cluster when you deploy multiple X-Brick building blocks. You can then move or reconfigure individual clusters, as required, instead of having to reinitialize a single cluster of multiple X-Brick building blocks.

Table 15 shows the number of datastores that must be created on each X-Brick building block for those 500-desktop configurations that have more than one X-Brick. For deployments of more than 500 desktops, consult your EMC representative. The number of datastores to be configured depends on the number of X-Brick blocks that are used in the final design.

Table 15. Virtual desktop datastores per XtremIO X-Brick building block

Desktop type	No. of desktop datastores per X-Brick	
	Full clone	Linked clone
Large visually intensive—standard IOPS	16	Not applicable (uses only one X-Brick)
Large visually intensive—high IOPS	16	2

Beyond the requirements for the number and size of the datastores, creating Horizon desktop datastores on an XtremIO array requires no specific guidance. See Table 12 on page 27 to determine datastore sizes, and create the required number of datastores on each X-Brick as instructed in Table 15.

For details on how to create datastores on an XtremIO array, see the *EMC XtremIO Storage Array User Guide*.

Desktop ESXi host network requirements

Table 3 on page 11 describes the requirements for redundant 10 GbE uplinks for the desktop ESXi hosts. A Horizon client accessing a visually intensive desktop uses approximately 1 Mb/s to 2 Mb/s of bandwidth. Thus, due to GRID card vGPU limitations, a pair of 10 GbE ESXi uplinks can support far more Horizon client connections than the ESXi host can support visually intensive desktops. A pair of 10 GbE ESXi uplinks can usually support several thousand Horizon client connections. The ESXi host, on the other hand, can support 64 visually intensive desktops (assuming that the host has two GRID cards and uses the smallest available vGPU profile).

Horizon clients accessing non-visually intensive desktops use approximately 500 Kb/s to 750 Kb/s of bandwidth. In environments where the desktop ESXi host servers host both visually intensive and non-visually intensive desktops, the use of even 25 percent of the available bandwidth is still very unlikely. Consult your EMC representative if you require assistance to determine if the proposed infrastructure can host a combination of visually intensive and non-visually intensive desktops.

In most cases, assuming that these recommendations are followed, the primary limiting factor will be the Internet connection used by remote Horizon clients, including the connection at the source and at the Horizon data center destination. Determine how many concurrent Horizon clients your Internet connection can support and, if required, change the Horizon client settings to control bandwidth utilization or increase the Internet connection bandwidth.

User and shared data storage configurations

EMC recommends the Unity and Isilon arrays to provide the required capacity for user and shared data storage. Capacity planning requires designing a storage configuration that meets performance objectives and can be adjusted to new capacity and performance requirements as the end-user population grows or as workload profiles change.

The workload profiles comprise the following:

- Shared workload files including images and streaming media, which tend to be high volume and shared among the multiple users
- Personal user files including data files, documents, spreadsheets, presentations, and so on

Determining capacity requirements for shared workload files

Accurately estimating the amount of disk capacity that is necessary for shared workload storage on a Unity array or Isilon storage cluster requires an understanding of the following sizing factors:

- Number of applications with data directories on the cluster
- Expected disk capacity allocation per application

  An accurate assessment of this number might require consideration of additional factors. These factors include snapshot settings (the size of each snapshot operation and the rate of change to the application dataset) as well as capacity, archive and retention policies, and quota enforcement settings.

- Requirements to accommodate hardware failures or similar events that impact availability
  - For Unity arrays: Sufficient hot spare drives
  - For Isilon storage clusters: SmartPools® protection overhead for /ifs/home (or whatever top-level directory contains the application directories)—for example, N+2:1, N+1 (protection against two drive failures or one node failure and one drive or node failure, respectively)
- Expected rate of growth for the application datasets

  This growth rate can result from adding more applications, increasing the per-application disk capacity allocation, or changing snapshot policies to require more space.

- Expected performance requirement for the application datasets as determined by examining the application performance characteristics

Once you have this information, contact your EMC representative for assistance in determining storage requirements and configurations. Your EMC representative will help determine the storage space that is required for your workload file share configuration. Your EMC representative will also help determine the Unity configuration or Isilon node type and configuration that are necessary to satisfy the capacity requirement.

Use the same techniques that are commonly used with Windows-based file servers to implement folder-level permissions on Unity and Isilon arrays. For guidance on configuring folder-level permissions, see the Microsoft TechNet article *Managing Permissions for Shared Folders*.

Determining capacity requirements for personal user files

Determining the overall disk capacity requirements for personal user data files is a relatively straightforward process. The user-data size guideline in this solution assumes that each user consumes approximately 20 GB of storage space, not including any space that will be used for shared workload files for groups of users.

Validated Unity configurations for user data storage

Table 16 shows the required drive configuration for the Unity 400 array, which supports 3,500 concurrent users per individual array, excluding the hot spares that are required by default.

Table 16. Unity 400 user-data building block

Drive type	No. of drives	Minimum capacity per drive
Solid-state drive (SSD) (for EMC FAST® Cache)	4	200 GB
Near-line Serial Attached SCSI (NL-SAS)	48	2 TB

Configure each Unity 400 building block with the storage pool design that is outlined in Table 17. Create two Unity storage pools and add half of the NL-SAS drives to each storage pool to use the storage processors A and B evenly.

Table 17. Storage pool design for Unity 400 building blocks

Pool	Storage processor	RAID level	No. of NL-SAS drives
1	A	RAID 6 (6+2 configuration)	24
2	B	RAID 6 (6+2 configuration)	24

Note: If the design requires multiple Unity 400 arrays for storing user data, equally distribute the users among the arrays—up to 3,500 users per Unity 400 array for the medium and large infrastructures.

Determine the number of file systems that are required based on the specific needs of the organization. This solution requires a minimum of two file systems for storing user data, which includes user persona data that is managed by User Environment Manager or other persona management solutions. Additional Unity file systems might be required for shared storage locations or other functions.

For the medium and large infrastructures, this solution requires additional Unity 400 building blocks, as listed in Table 18.

Table 18. Unity 400 configurations for medium and large infrastructures

Infrastructure size (number of desktops)	No. of Unity 400 building blocks	Average available space per user (2 TB drives)
Medium (6,000)	2	20 GB
Large (10,000)	3	18 GB

As with the arrays that will be used to host Horizon desktops, evenly spread the user home directories among the available storage arrays.

Validated Isilon configurations for user data storage

The architecture of EUC deployments that use Isilon systems for user data storage is different than the architecture for deployments using Unity arrays. While the concept of a building block still applies, the Isilon scale-out architecture requires a different approach to determine the final size.

The configuration of an Isilon building block specifies the physical attributes of each Isilon node. Table 19 shows an example of a validated baseline one-node configuration that provides a flexible solution for sizing Isilon for user data storage.

Table 19. Isilon user-data building block

Node type	7.2k rpm SATA drive size	No. of 7.2k rpm SATA drives	SSD drive size	No. of SSD drives
Isilon X410	1 TB	34	800 GB	2

To ensure high availability, a base Isilon configuration comprises three Isilon nodes and is suitable for the starter infrastructure. The small, medium, and large infrastructures require an even greater number of nodes, as outlined in Table 20. The building block that is used in this solution for a user home directory repository is a single Isilon X410 node that is equipped with 36 drives. You can use the total number of required reference virtual desktops to select how many building blocks are adequate for hosting the user home directories. Table 20 shows how many X410 Isilon nodes are required to provide user data storage for each of the defined infrastructure sizes in this solution.

Table 20. Isilon nodes per number of virtual desktops

Infrastructure size (no. of desktops)	No. of Isilon X410 nodes	Average available space per user (1 TB drives)
Small (3,000)	4	
Medium (6,000)	6	20 GB
Large (10,000)	10	

This solution has validated an Isilon configuration of up to 10 nodes to support up to 10,000 users. Although you can add nodes to increase the capacity or performance capabilities of the Isilon cluster, the number of SSDs and SATA drives available in each node is fixed. The *EMC VSPEX with Isilon Scale-out NAS Proven Infrastructure Guide* and VSPEX Sizing Tool provide detailed information about the Isilon system.

Personal user data sizing summary

EMC considers the previously described requirements to be the minimum resources that are required to handle the home directory workloads based on the stated definition of a reference virtual desktop. In any customer implementation, the system load will vary over time as users interact with the system.

For accurate workload-sizing assistance that uses the deep product and testing insight of the Unity and Isilon product teams, contact your EMC representative. For this white paper, we have provided designs for many common workloads. Future releases of this solution will include additional workloads and recommendations to further assist with sizing different and complex I/O streams.

NVIDIA GRID deployment

The following NVIDIA documents outline the process for deploying and configuring NVIDIA GRID enterprise graphics virtualization in a new or existing Horizon infrastructure:

- *NVIDIA GRID Enterprise Software Quick Start Guide*
- *NVIDIA GRID vGPU Deployment Guide*

The high-level steps are as follows:

1. Obtain the NVIDIA GRID software from the NVIDIA licensing portal. If you are deploying M-series GRID cards, also obtain the GRID license file.
2. Deploy ESXi hosts with preinstalled NVIDIA GRID cards, or install GRID cards in existing GRID certified servers as listed on the NVIDIA GRID Partners page.
3. If you are deploying M-series GRID cards, run the NVIDIA Mode Change Utility, also known as GPUMODESWITCH, if it is required to enable graphics mode.
4. If you are deploying M-series GRID cards, deploy a NVIDIA GRID licensing server and install the GRID license file.
5. Deploy the NVIDIA GRID ESXi VIB on all ESXi Horizon desktop hosts that have GRID cards installed.
6. Using the vSphere Web Client, add the NVIDIA GRID virtualized graphics adapter to the Horizon desktop master image, as shown in Figure 6.

   To perform this operation, the master image must be hosted on an ESXi host with a GRID card installed.

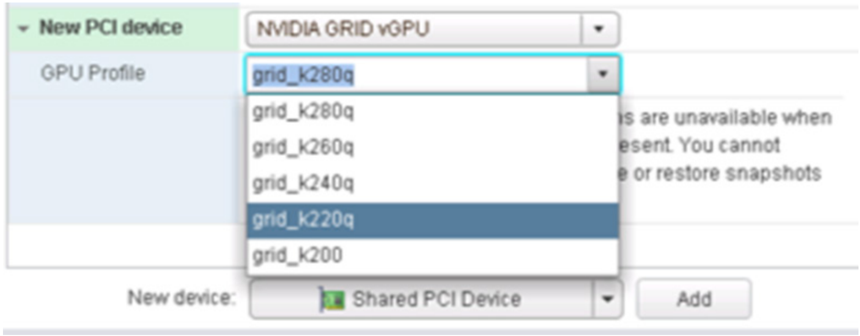

Figure 6. Adding a NVIDIA GRID virtual PCI device to a Horizon desktop VM

7. Install and configure the NVIDIA GRID drivers in the Horizon desktop master image. If using M-series cards, configure the license server information.

8. Deploy a VMware Horizon desktop pool using the master image that has the GRID hardware and software installed. On the **Desktop Pool Settings** page of the Horizon pool deployment wizard, select **NVIDIA GRID VGPU**, as shown in Figure 7.

   If the **NVIDIA GRID VGPU** option is not available when you create the Horizon desktop pool, some aspect of the installation process was not completed successfully and troubleshooting is required.

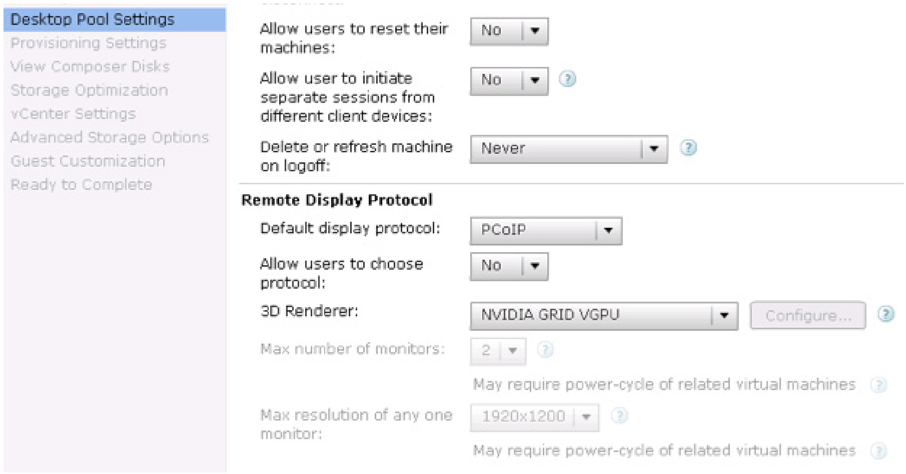

Figure 7. Horizon Desktop Pool Settings

Backup and recovery for EUC

The *EMC Backup and Recovery for End-User Computing white paper* outlines the techniques that can be used to back up an EUC infrastructure that is based on VMware Horizon. The information in that paper applies to both visually intensive and non-visually intensive desktops.

The *EMC Backup and Recovery for End-User Computing white paper* provides information on the following topics:

- Overview of EMC Avamar® and Data Domain® systems
- Sizing an Avamar or Data Domain system for an EUC environment
- EUC backup and recovery best practices
- Backup recommendations for the Horizon Connection, vCenter, database, and key Microsoft infrastructure servers
- Backup recommendations and recovery options for the various Horizon pool types
- Backup recommendations for user persona data and files

The only item that is not referenced in the paper is the NVIDIA GRID license server. If you have deployed an NVIDIA GRID license server, back it up using the same methods as for the other servers that you deployed as part of the EUC infrastructure. The procedure for recovering the license server is outlined in the NVIDIA GRID product documentation.

Conclusion

Summary

This white paper describes how to build an enterprise-class, scalable, EUC platform that incorporates the following:

- Support for visually intensive workloads
- Predefined virtual desktop types
- Centralized storage of user data
- Consistently high performance
- Predictable scalability of the infrastructure

This solution enables IT organizations to move visually intensive desktop workloads to the data center. The solution can be deployed on VCE Vblock converged infrastructure or on the organization's own infrastructure platform.

References

This section provides a detailed list of references that might be required to implement the solution that is described in this white paper.

EMC documentation

The following documentation on EMC Online Support or EMC.com 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 EMC representative.

- *Archive Solutions with EMC Isilon Scale-out NAS white paper*
- *Best Practices for Data Replication with EMC Isilon SyncIQ white paper*
- *Best Practices for Deploying a Backup Solution Using IBM Tivoli Storage Manager with EMC Isilon*
- *Deploying Microsoft Windows 7 Virtual Desktops with VMware View—Applied Best Practices*
- *Deploying Microsoft Windows 7 Virtual Desktops with Windows Server 2008 R2 Hyper-V—Applied Best Practices*
- *Deploying Microsoft Windows 8 Virtual Desktops—Applied Best Practices Guide*
- *EMC Backup and Recovery for End-User Computing white paper*
- *EMC Desktop as a Service: VMware Horizon DaaS with EMC XtremIO All-Flash Array Reference Architecture Guide*
- *EMC Isilon Home Directory Storage Solutions for NFS and SMB Environments white paper*
- *EMC Isilon InsightIQ Installation Guide*
- *EMC Isilon InsightIQ User Guide*
- *EMC Isilon OneFS Web Administration Guide*
- *EMC Isilon Scale-Out NAS for Media and Entertainment*
- *EMC Isilon SmartConnect: Optimize Scale-Out Storage Performance and Availability white paper*
- *EMC Isilon Solutions for Corporate IT: Large-Scale Home Directories and File Shares — Solution Overview*
- *EMC Isilon X410 Installation Guide*
- *EMC PowerPath/VE for VMware vSphere Installation and Administration Guide*
- *EMC PowerPath Viewer Installation and Administration Guide*
- *EMC Unity Best Practices Guide*
- *EMC Unity Family: Configuring Pools*
- *EMC Unity Family: Unisphere Command Line Interface User Guide*
- *EMC Unity Family: Unisphere Management REST API Programmer's Guide*
- *EMC Unity Quick Start*
- *EMC VSI for VMware vSphere Web Client Product Guide*
- *EMC XtremIO Storage Array Operations Guide*
- *EMC XtremIO Storage Array Security Configuration Guide*

- *EMC XtremIO Storage Array User Guide*
- *Enterprise File Archiving with EMC Isilon & OpenText Archive All-In-One Solution Overview*
- *File Archival Using Symantec Enterprise Vault with EMC Isilon*
- *Flash Implications in Enterprise Storage Array Designs white paper*
- *High Availability and Data Protection with EMC Isilon Scale-out NAS white paper*
- *Managing SMB Shares and User Home Directories in EMC Isilon OneFS 6.5 and Later*
- *Optimizing Microsoft Windows Virtual Desktops – EMC Deployment Best Practices*
- *SMB File Migration To EMC Isilon white paper*
- *The Bridge from PACS to VNA: Scale-Out Storage white paper*

VMware documentation

The following VMware documentation sites provide additional information:

- VMware Horizon documentation
- VMware vSphere 6 documentation

NVIDIA documentation

The following NVIDIA documentation provides additional and relevant information:

- *Application Deployment Guide: Autodesk AutoCAD with NVIDIA GRID vGPU on VMware Horizon*
- *Application Deployment Guide: Autodesk Revit 2015 with NVIDIA GRID vGPU on VMware Horizon*
- *Application Deployment Guide: Esri ArcGIS Pro with NVIDIA GRID vGPU on VMware Horizon*
- *GRID vGPU for VMware vSphere* (see documents under “Additional Information”)
- *NVIDIA GRID 2.0 Enterprise Software: Quick Start Guide*
- *NVIDIA GRID: Accelerated Virtual Desktops Data Sheet*
- *NVIDIA GRID: Certified Applications*
- *NVIDIA GRID K1 and K2: Enterprise Graphics Virtualization Data Sheet*
- *NVIDIA GRID vGPU and VMware Horizon: Enterprise Graphics Virtualization Solution Overview*
- *NVIDIA GRID vGPU Deployment Guide for VMware Horizon 6.1*
- *VMware Horizon with NVIDIA GRID vGPU Solution Overview*