

EMC INFRASTRUCTURE FOR VIRTUAL DESKTOPS ENABLED BY EMC VNX SERIES (FC), VMWARE vSPHERE 4.1, AND CITRIX XENDESKTOP 5

EMC UNIFIED STORAGE SOLUTIONS

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Reference architecture overview

Document purpose EMC's commitment to consistently maintain and improve quality is led by the Total Customer Experience (TCE) program, which is driven by Six Sigma methodologies. As a result, EMC has built Customer Integration Labs in its Global Solutions Centers to reflect realworld deployments in which TCE use cases are developed and executed. These use cases provide EMC with an insight into the challenges currently facing its customers.

This document describes the reference architecture of the EMC Infrastructure for Virtual Desktops Enabled by EMC® VNX™ series, VMware® vSphere™ 4.1, and Citrix XenDesktop 5 solution, which was tested and validated by the EMC Unified Storage Solutions group.

Introduction to the new EMC VNX series for unified storage

The EMC VNX series is a collection of new unified storage platforms that unifies the capabilities of the EMC Celerra® and EMC CLARiiON® platforms into a single product family. This innovative series meets the needs of environments that require simplicity, efficiency, and performance while keeping up with the demands of data growth, pervasive virtualization, and budget pressures. Customers can benefit from VNX features such as:

- Next-generation unified storage, optimized for virtualized applications
- Automated tiering with Flash and Fully Automated Storage Tiering for Virtual Pools (FAST VP) that can be simultaneously optimized for the highest system performance and lowest storage cost
- Multiprotocol support for file, block, and object storage with object access through EMC Atmos™ Virtual Edition (Atmos VE)
- Simplified management with EMC Unisphere™ for a single management framework for all NAS, SAN, and replication needs
- Up to three times improvement in performance with the latest Intel multi-core CPUs, optimized for Flash
- 6 Gb/s SAS back end with the latest drive technologies supported:
 - 3.5-inch 100 GB and 200 GB Flash, 3.5-inch 300 GB, and 600 GB 15k or 10k rpm SAS, and 3.5-inch 2 TB 7.2k rpm NL-SAS
 - 2.5-inch 300 GB and 600 GB 10k rpm SAS
- Expanded EMC UltraFlex™ I/O connectivity: Fibre Channel (FC), Internet Small Computer System Interface (iSCSI), Common Internet File System (CIFS), Network File System (NFS) including parallel NFS (pNFS), Multipath File System (MPFS), and FC over Ethernet (FCoE) connectivity for converged networking over Ethernet

The VNX series includes five new software suites and two new software packages.

Software suites available

- VNX FAST Suite — Automatically optimizes for the highest system performance and the lowest storage cost simultaneously.
- VNX Local Protection Suite — Practices safe data protection and repurposing.
- VNX Remote Protection Suite — Protects data against localized failures, outages, and disasters.
- VNX Application Protection Suite — Automates application copies and proves compliance.
- VNX Security and Compliance Suite — Keeps data safe from changes, deletions, and malicious activity.

Software packages available

- VNX Total Protection Pack — Includes local, remote, and application protection suites.
- VNX Total Efficiency Package — Includes all five software suites (not available for the VNX5100 system).
- VNX Total Value Package — Includes all three protection software suites and the Security and Compliance Suite. The VNX5100 exclusively supports this package.

Solution purpose

The purpose of this reference architecture is to build and demonstrate the functionality, performance, and scalability of virtual desktops enabled by the EMC VNX series, VMware vSphere 4.1, and Citrix XenDesktop 5. This solution is built on Machine Creation Services (MCS) in XenDesktop 5, and a VNX5300™ platform with multiprotocol support, which enables FC block-based storage for the VMware vStorage Virtual Machine File System (VMFS), and CIFS-based storage for user data.

This document validates the performance of the solution and provides guidelines for building similar solutions.

This reference architecture is not intended to be a comprehensive guide to every aspect of this solution.

The business challenge

Customers require a scalable, tiered, and highly available infrastructure on which to deploy their virtual desktop environment. There are several new technologies available to assist them in designing a virtual desktop solution, but they need to know how to use these technologies to maximize their investment, support service-level agreements, and reduce their desktop total cost of ownership (TCO).

This solution builds a replica of a common customer virtual desktop infrastructure (VDI) environment and validates the environment for performance, scalability, and functionality. Customers achieve:

- Increased control and security of their global, mobile desktop environment, which is typically their most at-risk environment
- Better end-user productivity with a more consistent environment

- Simplified management with the environment contained in the data center
- Better support of service-level agreements and compliance initiatives
- Lower operational and maintenance costs

The technology solution

This solution demonstrates how to use a VNX platform to provide the storage resources for a Citrix XenDesktop 5 environment by using Windows 7 virtual desktops provisioned by Machine Creation Services (MCS).

Planning and designing the storage infrastructure for Citrix XenDesktop environment is a critical step because the shared storage must be able to absorb large bursts of input/output (I/O) that occur over the course of a work day. These bursts can lead to periods of erratic and unpredictable virtual desktop performance. Users may adapt to slow performance, but unpredictable performance will frustrate them and reduces efficiency.

To provide a predictable performance for a virtual desktop infrastructure, the storage system must be able to handle the peak I/O load from the clients while keeping response time to a minimum. Designing for this workload involves the deployment of many disks to handle brief periods of extreme I/O pressure, which is expensive to implement. This solution uses EMC VNX FAST Cache to reduce the number of disks required.

Solution benefits

This solution aids in the design and implementation stages required for the successful implementation of virtual desktops on Citrix XenDesktop 5. The solution balances performance requirements and cost by using new features in the VNX operating environment such as VNX FAST Cache.

Desktop virtualization allows organizations to exploit additional benefits such as:

- Increased security by centralizing business-critical information
- Increased compliance as information is moved from endpoints into the data center
- Simplified and centralized management of desktops
- Enable a virtual workforce to increase productivity from anywhere
- Leverage the latest mobile devices to drive innovation throughout the business
- Rapidly adapt to business change with fast, flexible desktop delivery for setting up an offshore location, mergers and acquisitions, branch expansion, and other initiatives

Solution architecture

Architecture diagram

This solution provides a summary and characterization of the tests performed to validate the EMC infrastructure for virtual desktops enabled by EMC VNX Series, VMware vSphere 4.1, and Citrix XenDesktop 5. It involves building a 1,000-seat Citrix XenDesktop 5 environment on VNX and using the new features of this platform to provide a compelling, cost-effective desktop virtualization platform.

Figure 1 depicts the overall physical architecture of the solution.

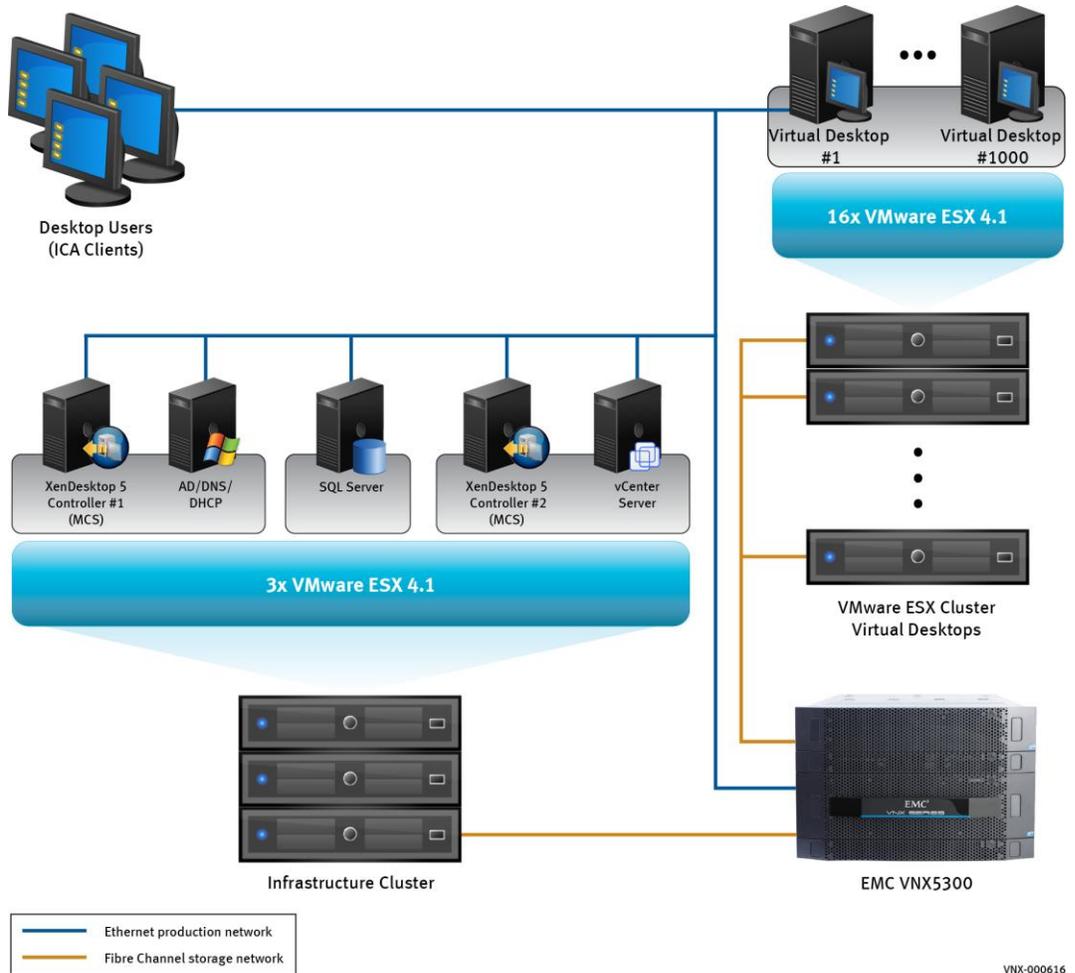


Figure 1. Solution architecture

The reference architecture consists of the following components.

EMC VNX5300 Unified Storage Platform – Provides storage by using FC connections for virtual desktops, and infrastructure virtual machines such as Citrix XenDesktop controllers, VMware vCenter™ Servers, Microsoft SQL Server databases, and other supporting services. User profiles and home directories are redirected to CIFS network shares on the VNX5300.

VMware ESX 4.1 Server – A three-node VMware ESX® 4.1 cluster is used to host infrastructure virtual machines. Two eight-node VMware ESX 4.1 clusters are used to host a total of 1,000 virtual desktops.

VMware vCenter Server 4.1 – Provides a scalable and extensible platform that forms the foundation for virtualization management for the VMware ESX 4.1 clusters.

Citrix XenDesktop 5 Controller – Two Citrix XenDesktop 5 controllers are used to provide redundant virtual desktop delivery, authenticate users, manage the assembly of users' virtual desktop environments, and broker connections between users and their virtual desktops. In this reference architecture, the controllers are installed on Windows Server 2008 R2 and hosted as virtual machines on VMware vSphere ESX 4.1 Servers.

Virtual desktops – 1000 virtual desktops running Windows 7 are provisioned using MCS, a new provisioning mechanism introduced in XenDesktop 5.

Microsoft Windows 2008 Domain Controller and DNS Server – The Windows 2008 R2 Domain Controller provides Active Directory services to manage the identities and relationships that make up the Windows environment for the virtual desktops. The domain name system (DNS) component of the Windows network infrastructure is also installed on this server. This server can be hosted as a virtual machine on a VMware ESX 4.1 Server.

Microsoft Windows 2008 DHCP Server – Centrally manages the IP address scheme for the virtual desktops. This service is hosted on the same virtual machine as the domain controller and DNS server.

Microsoft SQL 2008 Server – The Citrix XenDesktop 5 controllers and VMware vCenter Server require a database service to store configuration details. A Microsoft SQL 2008 Server is used for this purpose. This server is hosted as a virtual machine on a VMware ESX 4.1 Server.

Gigabit IP Network – The Ethernet network infrastructure provides gigabit connectivity between all the XenDesktop components, virtual desktop users, and Windows server infrastructure. The gigabit network also allows desktop users to redirect their roaming profiles and home directories to the centrally maintained CIFS shares on the VNX5300.

Table 1 lists the hardware used in this solution.

Table 1. Solution hardware

Hardware	Quantity	Configuration	Notes
EMC VNX5300	1	<ul style="list-style-type: none"> Two Data Movers (active/standby) Three DAEs configured with: <ul style="list-style-type: none"> Thirty 300 GB, 15 k rpm 3.5-inch SAS disks Nine 300 GB, 15 k rpm 3.5-inch NL-SAS disks Three 100 GB, 3.5-inch flash drives 	VNX shared storage
Intel-based servers	3	<ul style="list-style-type: none"> Memory: 20 GB RAM CPU: Two Intel Xeon E5450 3.0 GHz quadcore processors Storage: One 67 GB internal disk NIC: Two Broadcom NetXtreme II BCM 1000 Base-T Adapters 	ESX cluster to host infrastructure virtual machines
Intel-based servers	16	<ul style="list-style-type: none"> Memory: 72 GB RAM CPU: Two Intel Xeon X5550 2.6 GHz quadcore processors Storage: One 67 GB internal disk NIC: Four Broadcom NetXtreme II BCM 1000 Base-T Adapters 	Two ESX clusters to host 1,000 virtual desktops
Brocade DS5100	2	Twenty-four 8 Gb ports	Redundant SAN A/B configuration
QLogic HBA	1	<ul style="list-style-type: none"> Dual-port QLE2462 Port 0 – SAN A Port 1 – SAN B 	One dual-port HBA per server connected to both fabrics

Software resources Table 2 lists the software used in this solution.

Table 2. Solution software

Software	Configuration
VNX5300 (shared storage, file systems)	
VNX OE for file	Release 7.0.12
VNX OE for block	Release 31 (05.31.000.5.006)
EMC VSI for VMware vSphere: Unified Storage Management	Version 4.1
EMC VSI for VMware vSphere: Storage Viewer	Version 4.0.1

Software	Configuration
EMC VSI for VMware vSphere: Path Management	Version 4.0.1
XenDesktop Desktop Virtualization	
Citrix XenDesktop Controller	Version 5 Platinum Edition
Operating system for XenDesktop Controller	Windows Server 2008 R2 Enterprise Edition
Microsoft SQL Server	Version 2008 Enterprise Edition (64-bit)
VMware vSphere	
ESX server	ESX 4.1.0 (Build 208167)
vCenter Server	4.1.0 (Build 208111)
Operating system for vCenter Server	Windows Server 2008 R2 Enterprise Edition
PowerPath Virtual Edition	5.4 SP2 (Build 298)
Virtual Desktops	
Note: The desktop is used to generate the test load.	
Operating system	Microsoft Windows7 Enterprise (32-bit)
Microsoft Office	Office Enterprise 2007 Version 12
Internet Explorer	8.0.7600.16385
Adobe Reader	9.1
McAfee Virus Scan	8.7.0i Enterprise
Adobe Flash Player	10
Bullzip PDF Printer	6.0.0.865
Login VSI (VDI workload generator)	2.1.2 Professional Edition

Key components

Introduction

This section briefly describes the key components of this solution.

- EMC VNX unified storage platform
- Citrix XenDesktop 5 desktop virtualization
- VMware vSphere ESX 4.1 Server

“[Hardware resources](#)” and “[Software resources](#)” on page 10 provides more information on the components that make up the solution.

The VNX Series

The VNX series is a dedicated network server optimized for file and block storage access that delivers high-end features in a scalable, easy-to-use package.

The VNX series delivers a single-box block and file solution, which offers a central management point for distributed environments. This makes it possible to dynamically grow, share, and cost-effectively manage multiprotocol file systems and provide multiprotocol block access. Administrators can take advantage of simultaneous support for NFS and CIFS protocols by allowing Windows and Linux/UNIX clients to share files by using the sophisticated file-locking mechanisms of VNX for file and VNX for block for high-bandwidth or latency-sensitive applications.

VNX FAST Cache

VNX FAST Cache, a part of the VNX FAST Suite, enables flash drives to be used as an expanded cache layer for the array. The VNX5300 is configured with two 100 GB flash drives in a RAID 1 configuration for a 93 GB read/write-capable cache. This is the minimum amount of FAST Cache. Larger configurations are supported for scaling beyond 1,000 desktops.

FAST Cache is an array-wide feature available for both file and block storage. FAST Cache works by examining 64 KB chunks of data in FAST Cache-enabled objects on the array. Frequently accessed data is copied to the FAST Cache and subsequent accesses to the data chunk are serviced by FAST Cache. This enables immediate promotion of very active data to flash drives. This dramatically improves the response times for the active data and reduces data hot spots that can occur within the LUN.

FAST Cache is an extended read/write cache that enables XenDesktop to deliver consistent performance at flash drive speeds by absorbing read-heavy activities such as boot storms and antivirus scans, and write-heavy workloads such as operating system patches and application updates. This extended read/write cache is an ideal caching mechanism for MCS in XenDesktop 5 because the base desktop image and other active user data are accessed with sufficient frequency to service the data is directly from the flash drives without having to access slower drives at a lower storage tier.

VNX VAAI Support

Hardware acceleration with VMware vStorage API for Array Integration (VAAI) is a storage enhancement in vSphere 4.1 which enables ESX to offload specific storage operations to compatible storage hardware such as the VNX series platforms. With storage hardware assistance, ESX performs these operations faster and consumes less CPU, memory, and storage fabric bandwidth.

VSI for VMware vSphere

EMC Virtual Storage Integrator (VSI) for VMware vSphere is a plug-in to the vSphere client that provides a single management interface that is used for managing EMC storage within the vSphere environment. Features can be added and removed from VSI independently, which provides flexibility for customizing VSI user environments. Features are managed by using the VSI Feature Manager. VSI provides a unified user experience, which allows new features to be introduced rapidly in response to changing customer requirements.

The following features were used during the validation testing:

- Storage Viewer (SV) – Extends the vSphere client to facilitate the discovery and identification of EMC VNX storage devices that are allocated to VMware ESX hosts and virtual machines. SV presents the underlying storage details to the virtual datacenter administrator, merging the data of several different storage mapping tools into a few seamless vSphere client views.
- Path Management – Provides a mechanism for changing the multipath policy for groups of LUNs based on storage class and virtualization object. This feature works with devices managed by VMware Native Multipathing and PowerPath/VE.
- Unified Storage Management – Simplifies storage administration of the EMC VNX unified storage platform. It enables VMware administrators to provision new NFS and VMFS datastores, and RDM volumes seamlessly within vSphere client.

Refer to the EMC VSI for VMware vSphere product guides on Powerlink for more information.

Citrix XenDesktop 5

Citrix XenDesktop transforms Windows desktops as an on-demand service to any user, any device, anywhere. XenDesktop quickly and securely delivers any type of virtual desktop, or any type of Windows, web, or SaaS application, to all the latest PCs, Macs, tablets, smartphones, laptops and thin clients – and does so with a high-definition HDX user experience.

FlexCast delivery technology enables IT to optimize the performance, security, and cost of virtual desktops for any type of user, including task workers, mobile workers, power users, and contractors. XenDesktop helps IT rapidly adapt to business initiatives by simplifying desktop delivery and enabling user self-service. The open, scalable, and proven architecture simplifies management, support, and integration.

Machine Creation Services (MCS)

Machine Creation Services (MCS) is a new provisioning mechanism introduced in XenDesktop 5. It is integrated with the new XenDesktop management interface, Desktop Studio, to provision, manage, and decommission desktops throughout the desktop lifecycle management from a centralized point of management.

MCS allows several types of machines to be managed within a catalog in Desktop Studio, including dedicated and pooled machines. Desktop customization is persistent for dedicated machines, while a pooled machine is required if a non-persistent desktop is appropriate.

In this solution, 1,000 virtual desktops that are running Windows 7 were provisioned by using MCS. The desktops were deployed from two dedicated machine catalogs.

Desktops provisioned using MCS share a common base image within a catalog. Because of this, the base image is typically accessed with sufficient frequency to naturally leverage EMC VNX FAST Cache, where frequently accessed data is promoted to flash drives to provide optimal I/O response time with fewer physical disks.

VMware vSphere 4.1

VMware vSphere 4.1 is the market-leading virtualization platform which is used across thousands of IT environments around the world. VMware vSphere 4.1 can transform or virtualize computer hardware resources, including the CPU, RAM, hard disk, and network controller. This transformation creates fully functional virtual machines that run their own operating systems and applications just like physical computers.

The high-availability features of VMware vSphere 4.1 coupled with DRS and Storage vMotion enable the seamless migration of virtual desktops from one ESX server to another with minimal or no impact to the customer's usage.

Storage architecture

Storage layout

The following storage layout diagram illustrates the layout of the disks.

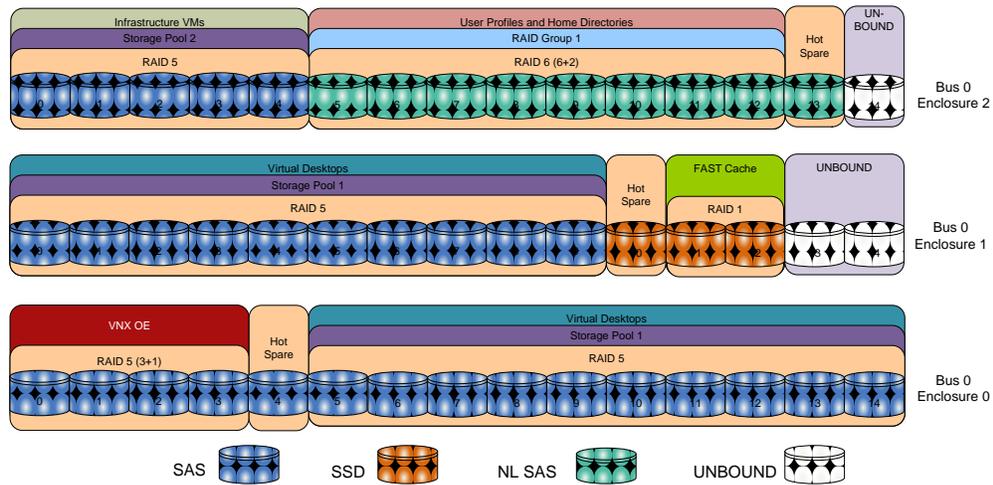


Figure 2. Storage layout

Storage layout overview

The following configuration is used in the reference architecture:

- Four SAS disks (0_0 to 0_3) are used for the VNX OE.
- Disks 0_4, 1_10, and 2_13 are hot spares. These disks are marked as hot spare in the storage layout diagram.
- Twenty SAS disks (0_5 to 0_14 and 1_0 to 1_9) on the RAID 5 storage pool 1 are used to store virtual desktops. FAST Cache is enabled for the entire pool. Eight LUNs of 500 GB each are carved out of the pool and presented to the ESX servers.
- Two flash drives (1_11 and 1_12) are used for EMC VNX FAST Cache. There are no user-configurable LUNs on these drives.
- Five SAS disks (2_0 to 2_4) on the RAID 5 storage pool 2 are used to store the infrastructure virtual machines. Two LUNs of 500 GB each are carved out of the pool and presented to the ESX servers.
- Eight NL-SAS disks (2_5 to 2_12) on the RAID 6 (6+2) group are used to store user data and roaming profiles. Two VNX file systems are created on two LUNs, a 2 TB LUN for profiles and a 4 TB LUN for user data.
- Disks 1_13, 1_14, and 2_14 are unbound. They are not used for testing this solution.

VNX shared file systems

There are two shared file systems used by the virtual desktops – one for user profiles, and the other to redirect user storage that resides in home directories. In general, redirecting users' data out of the base image of VNX for file enables centralized administration, backup, and recovery, and makes the desktops more stateless. Each file system is exported to the environment through a CIFS share.

Network configuration

Network layout overview

All network interfaces in this solution use 1 Gb Ethernet connections. All virtual desktops are assigned an IP address by a dynamic host configuration protocol (DHCP) server. All ESX servers have two onboard GbE controllers that are configured for NIC teaming to provide multipathing and network load balancing.

EMC recommends that the switches support gigabit connections, link aggregation control protocol (LACP) or EtherChannel, and the ports on the switches support copper-based media. As shown in the following diagram, the VMware virtual switches are associated with a two-port NIC teaming configuration that is physically connected to two switch ports that are configured as EtherChannel.

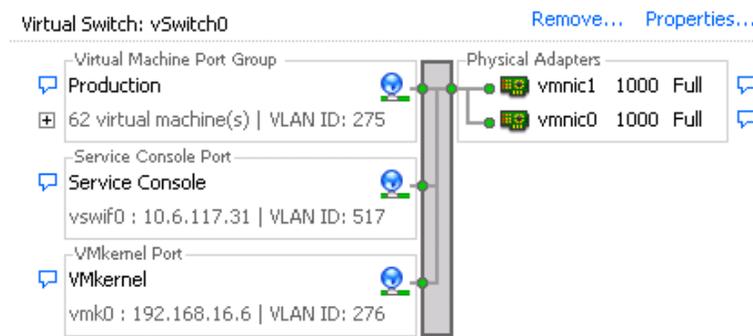


Figure 3. Network layout

VNX5300 network configuration

The VNX5300 consists of two Data Movers. The Data Movers can be configured in an active/active or active/passive configuration. In the active/passive configuration, the passive Data Mover serves as a failover device for the active Data Mover. In this solution, the Data Movers operate in the active/passive mode.

The VNX5300 Data Mover is configured for four 1-gigabit interfaces on a single I/O module. LACP is used to configure ports cge-2-0 and cge-2-1 to support virtual machine traffic, home folder access, and external access for roaming profiles. Ports cge-2-2 and cge-2-3 are left free for future expansion.

The following figure shows the rear view of two VNX5300 Data Movers that include four copper gigabit ethernet (cge) ports each in I/O expansion slot 2.

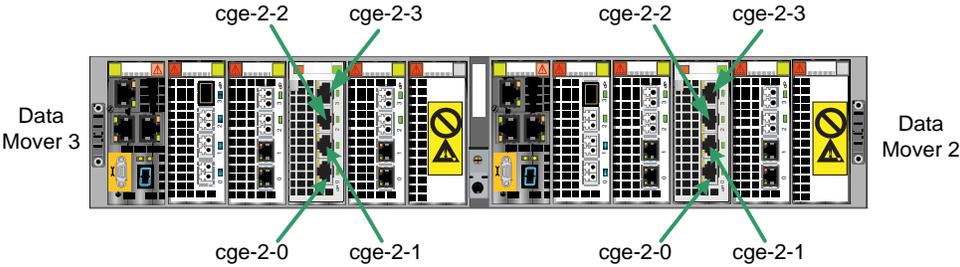


Figure 4. VNX5300 network configuration

High availability and failover

Introduction

This solution provides a highly available virtual desktop infrastructure. Each component is configured to provide a scalable, robust solution for the host, connectivity, and storage layers.

Storage layer

The VNX series is designed for five 9s availability by using redundant components throughout the array. All Data Movers, storage processors, and array components are capable of continued operation in case of hardware failure. The RAID disk configuration on the VNX back end provides protection against data loss due to hard disk failures. The available hot spare drives can be dynamically allocated to replace a failing disk.

Connectivity layer

The advanced networking features of VNX series, such as Fail-Safe Network (FSN) and link aggregation, provide protection against network connection failures at the array. Each ESX host has multiple connections to both Ethernet networks to guard against link failures. These connections are spread across multiple blades in an Ethernet switch to guard against component failure in the switch.

For FC connectivity, each host has a connection to two independent fabrics in a SAN A/B configuration. This allows complete failure of one of the SANs while still maintaining connectivity to the array.

Host layer

The application hosts have redundant power supplies and network connections to reduce the impact of component failures in the ESX servers. VMware High Availability (HA) is configured on the cluster to help recover virtual desktops quickly in case of a complete host failure.

Additionally, EMC PowerPath® Virtual Edition is configured on each ESX host, which allows dynamic load balancing of I/O requests from the server through the fabric to the array. This configuration guards against host bus adapter (HBA), path, or port failures, and also enables automated failback after the paths are restored.

Validated environment profile

Profile characteristics

The solution was validated with the following environment profile.

Table 3. Validated environment profile

Profile characteristic	Value
Number of virtual desktops	1,000
Virtual desktop OS	Windows 7 Enterprise (32-bit)
CPU per virtual desktop	1 vCPU
Number of virtual desktops per CPU core	7.8125
RAM per virtual desktop	1 GB
Desktop provisioning method	Machine Creation Services (MCS)
Average storage available for each virtual desktop	4 GB (vmdk and vswap)
Average IOPS per virtual desktop at steady state	6 IOPS
Average peak IOPS per virtual desktop during boot storm	84 IOPS
Number of datastores to store virtual desktops	8
Number of virtual desktops per datastore	125
Disk and RAID type for datastores	RAID 5, 300 GB, 15k rpm, 3.5-inch SAS disks
Disk and RAID type for CIFS shares to host roaming user profiles and home directories	RAID 6, 2 TB, 7,200 rpm, 3.5-inch NL-SAS disks
Number of VMware clusters	2
Number of ESX servers per cluster	8
Number of VMs per cluster	500

Conclusion

The features in VNX operating environment enable EMC VNX series arrays to drive higher storage consolidation ratios at a lower cost than previously possible. This reduces the capital expenditure on equipment, and lowers the operational costs required to support the placement, power, and cooling of the storage arrays.

Feature	Benefits
EMC VNX unified storage	Provides a robust, reliable, high-performance, common storage platform for thousands of virtual desktops. A single storage platform that is efficient, powerful, and built for the most demanding virtual environments.
VMware vSphere 4.1	Provides a well established virtualization platform for virtual desktops. vSphere 4.1 adds new storage features to an already rich set of capabilities to help increase and scale virtualized environments.
Citrix XenDesktop 5	Citrix XenDesktop transforms Windows desktops as an on-demand service to any user, any device, anywhere. XenDesktop quickly and securely delivers any type of virtual desktop, or any type of Windows, web, or SaaS application, to all the latest PCs, Macs, tablets, smartphones, laptops and thin clients – and does so with a high-definition HDX user experience.

This reference architecture provides a blueprint of a validated Citrix XenDesktop 5 virtualization solution enabled by EMC VNX unified storage and the VMware vSphere 4.1 virtualization platform. The solution is able to support, and scale to thousands of virtual desktops.

References

EMC documentation

The following documents, located on EMC Powerlink®, provide 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:

- *EMC Infrastructure for Virtual Desktops Enabled by EMC VNX Series, VMware vSphere 4.1, and Citrix XenDesktop 5 – Proven Solution Guide*
- *EMC Infrastructure for Virtual Desktops Enabled by EMC Celerra Unified Storage (NFS), VMware vSphere 4, and Citrix XenDesktop 4— Reference Architecture*
- *EMC Infrastructure for Virtual Desktops Enabled by EMC Celerra Unified Storage (NFS), VMware vSphere 4, and Citrix XenDesktop 4 – Proven Solution Guide*
- *EMC Infrastructure for Virtual Desktops Enabled by EMC Unified Storage (FC), Microsoft Windows Server 2008 R2 Hyper-V, and Citrix XenDesktop 4 – Reference Architecture*
- *EMC Infrastructure for Virtual Desktops Enabled by EMC Unified Storage (FC), Microsoft Windows Server 2008 R2 Hyper-V, and Citrix XenDesktop 4 – Proven Solution Guide*
- *EMC Performance Optimization for Microsoft Windows XP for the Virtual Desktop Infrastructure – Applied Best Practices*
- *Deploying Microsoft Windows 7 Virtual Desktops with VMware View – Applied Best Practices Guide*
- *EMC Infrastructure for Deploying VMware View in the Enterprise: EMC Celerra NS-120 – Reference Architecture*
- *EMC Infrastructure for Deploying VMware View in the Enterprise: EMC Celerra NS-120 – Validation Test Report*
- *EMC Infrastructure for Virtual Desktops Enabled by EMC VNX Series, VMware vSphere 4.1, VMware View 4.5 and VMware View Composer 2.5 – Reference Architecture*
- *EMC Infrastructure for Virtual Desktops Enabled by EMC VNX Series, VMware vSphere 4.1, VMware View 4.5 and VMware View Composer 2.5 – Proven Solution Guide*
- *EMC VSI for VMware vSphere: Storage Viewer -- Product Guide*
- *EMC VSI for VMware vSphere: Unified Storage Management-- Product Guide*
- *EMC VSI for VMware vSphere: Path Management -- Product Guide*