Reference Architecture

EMC INFRASTRUCTURE FOR CITRIX XENDESKTOP 7

EMC VNX Series (NFS and FC), Citrix XenDesktop 7, VMware vSphere 5.1

- Simplify management and decrease TCO
- Guarantee a quality desktop experience
- Minimize the risks inherent in virtual desktop deployment

EMC Solutions Group

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EMC²

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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 real world 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 EMC® VNX® Series (NFS and FC), Citrix XenDesktop 7, and VMware vSphere® 5.1 solution, which was tested and validated by the EMC Solutions Group.

Introduction to the EMC VNX series

The VNX series delivers uncompromising scalability and flexibility for the mid-tier customer, while providing market-leading simplicity and efficiency to minimize total cost of ownership. Customers can benefit from VNX features such as:

- Next-generation unified storage, optimized for virtualized applications.
- Extended cache, using Flash drives with Fully Automated Storage Tiering for Virtual Pools (FAST VP) and FAST Cache, which can be optimized for the highest system performance and lowest storage cost on both block and file.
- Multiprotocol support for files, blocks, and objects 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 better performance with the latest Intel Xeon multicore processor technology, optimized for Flash.
- 6 Gb/s SAS back end with the latest drive technologies supported:
  - 3.5 in. 100 GB and 200 GB Flash, 3.5 in 300 GB, and 600 GB 15k or 10k rpm SAS, and 3.5 in 1 TB, 2 TB and 3 TB 7.2k rpm NL-SAS
  - 2.5 in 100 GB and 200 GB Flash, 300 GB, 600 GB and 900 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), Multi-Path File System (MPFS), and Fibre Channel over Ethernet (FCoE) connectivity for converged networking over Ethernet.

Note: VNX5100 supports FC only.

The VNX series includes five software suites and three software packs that make it easier and simpler to attain the maximum overall benefits.

The VNX software suites that are available are:

- FAST Suite—Automatically optimizes storage for the highest system performance with the lowest storage cost (FAST VP is not part of the FAST Suite for VNX5100®).

- Local Protection Suite—Practices safe data protection and repurposing.
- Remote Protection Suite—Protects data against localized failures, outages, and disasters.
- Application Protection Suite—Automates application copies and proves compliance.
- Security and Compliance Suite—Keeps data safe from changes, deletions, and malicious activity.

The VNX Software packs that are available are:

- Total Efficiency Pack—Includes all five software suites (not available for VNX5100).
- Total Protection Pack—Includes local, remote, and application protection suites.
- Total Value Pack—Includes all three protection software suites and the Security and Compliance Suite (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 EMC VNX series, Citrix XenDesktop 7, and VMware vSphere 5.1. This solution is built on an EMC VNX5300® platform with multiprotocol support, which provides NFS and FC storage for the VMware datastores, CIFS-based storage for the optional user data shares, and TFTP service for preboot execution environment (PXE) boot of PVS-based desktops.

This reference architecture validates the performance of the solution and provides guidelines to build similar solutions.

This document 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 in which to deploy their virtual desktop environment. Several new technologies are available to assist them in designing a virtual desktop solution, but they might not understand how to best apply these technologies to maximize their investment, utilize service-level agreements, and reduce their desktop total cost of ownership.

The purpose of this solution is to build a replica of a common customer end-user computing (EUC) environment and validate the environment for performance, scalability, and functionality. Customers will achieve:

- Increased control and security of their global mobile desktop environment—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 an EMC VNX platform with Windows 7 virtual desktops to provide storage resources for a robust Citrix XenDesktop 7 environment.

Planning and designing the storage infrastructure for Citrix XenDesktop is a critical step, because the shared storage must be able to absorb large bursts of input/output (I/O) that occur during some use cases—like when many desktops boot at the beginning of a workday, or when required patches are applied. These large I/O bursts can lead to periods of erratic and unpredictable virtual desktop performance. If planning does not take these use cases into account, users can quickly become frustrated by unpredictable performance.

To provide predictable performance for an end-user computing (EUC) environment, the storage must be able to handle peak I/O loads from clients while still providing fast response times. Usually, the design for this type of workload involves deploying several disks to handle brief periods of extreme I/O pressure, and this can be expensive to implement. This solution uses EMC VNX FAST Cache, allowing for a reduction in the number of disks required.

The solution benefits

This solution provides a valuable option for designing and implementing a successful deployment of virtual desktops on Citrix XenDesktop 7. The features in the VNX Operating Environment (OE), such as EMC VNX FAST Cache, provide a balance between performance requirements and cost of implementation. VNX support for NFS and FC also enables the use of VMware datastores for cost-effective and easy-to-deploy storage for the desktop virtualization platform.

Using desktop virtualization provides organizations with 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

Solution architecture

Architecture diagram

This paper provides a summary and characterization of the tests performed to validate the EMC infrastructure for EMC VNX Series (NFS and FC), Citrix XenDesktop 7, and VMware vSphere 5.1 solution. This solution involves building a 1,000-seat Citrix XenDesktop 7 environment on VNX and integrating the VNX features to provide a compelling and cost-effective EUC platform. Because both NFS and FC protocols were tested on the VNX system, the following figures illustrate the differences in connectivity between the two variants.

Figure 1 depicts the logical architecture of the NFS variant for 1,000 virtual desktops, where 10 GbE carries all network traffic for servers hosting virtual desktops and 1 GbE carries all other traffic.

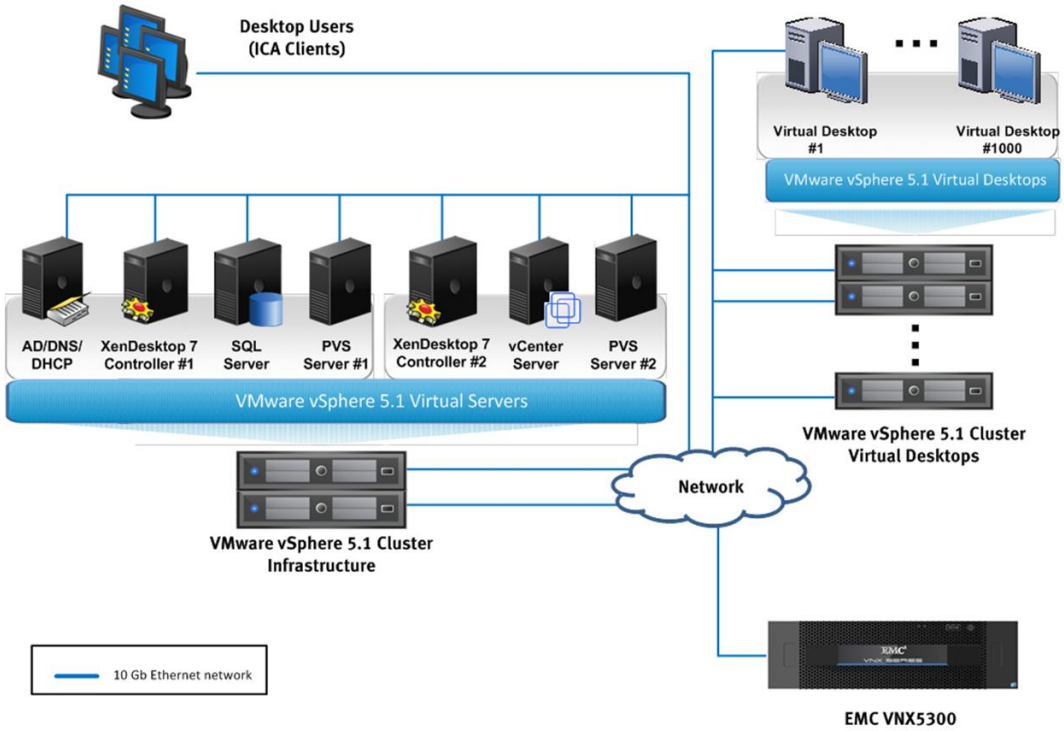

Figure 1. Logical architecture for 1,000 virtual desktops – NFS variant

Figure 2 depicts the logical architecture of the FC variant for 1,000 virtual desktops, where an FC SAN carries storage traffic and 10 GbE carries management and application traffic.

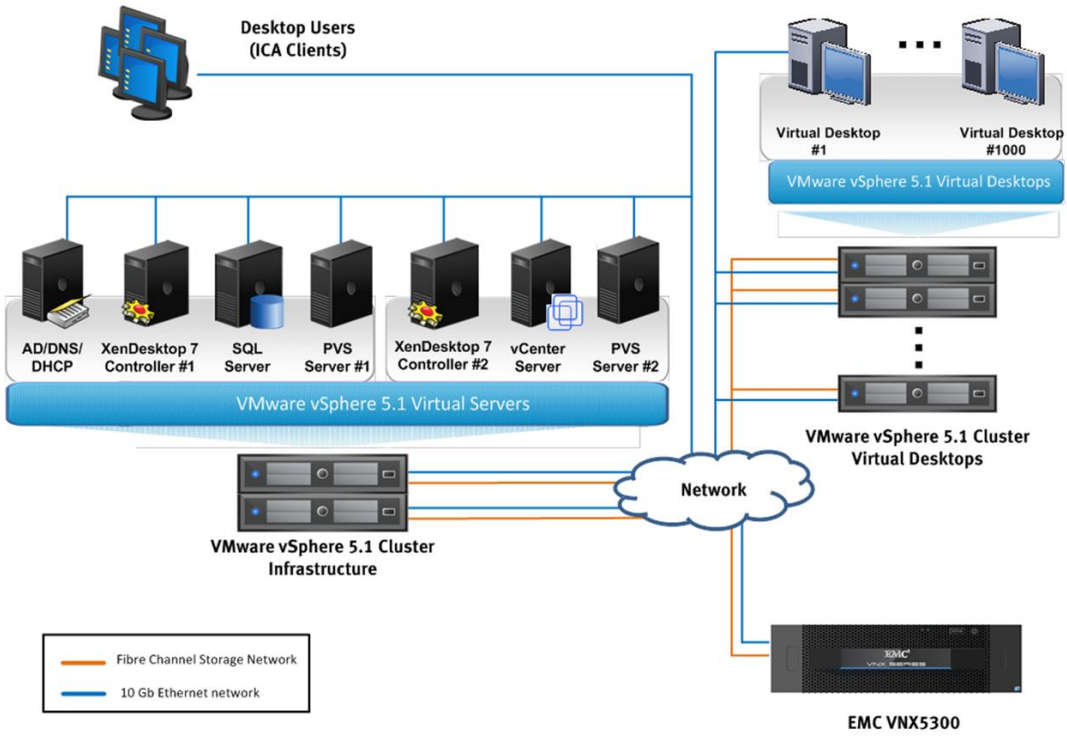

Figure 2. Logical architecture for 1,000 virtual desktops – FC variant

Reference architecture overview

The reference architecture consists of the following components:

- **EMC VNX5300 platform**—This platform provides storage using the NFS or Fibre Channel protocol for virtual desktops and infrastructure virtual machines such as Citrix Delivery Controllers, VMware vCenter™ Servers, and Microsoft SQL Server databases. Citrix Profile Management and user home directories are redirected to CIFS network shares on EMC VNX5300. The VNX platform is also responsible for hosting the TFTP boot images for PVS.
- **Citrix XenDesktop 7 Controller**—Two Citrix XenDesktop controllers provide 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 delivery controllers are installed on Windows Server 2008 R2 and hosted as virtual machines on VMware vSphere 5.1 servers.
- **Citrix Provisioning Services 6.2 server**—Two Provisioning Services 6.2 servers provide a redundant software-streaming technology, which enables virtual desktops to be provisioned and re-provisioned in real-time from a single shared-disk image. In this reference architecture, the PVS servers are installed on Windows Server 2008 R2 and hosted as virtual machines running on VMware vSphere 5.1 servers.

- **VMware vSphere 5.1 server**—This two-node VMware vSphere 5.1 cluster hosts infrastructure virtual machines. Two additional VMware vSphere 5.1 clusters host 1,000 virtual desktops.
- **VMware vCenter Server 5.1**—This server provides a scalable and extensible platform that forms the foundation for virtualization management for the VMware vSphere 5.1 clusters. This solution uses one VMware vCenter Server.
- **Virtual desktops**—One thousand virtual desktops running Windows 7 are deployed using Citrix Provisioning Services (PVS).
- **Microsoft Windows 2008 R2 domain controllers and DNS server**—The Windows 2008 R2 domain controller provides Active Directory services to manage the identities and relationships that constitute 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 is hosted as a virtual machine on a VMware vSphere 5.1 host.
- **Microsoft Windows 2008 R2 dynamic host configuration protocol (DHCP) server**—This server centrally manages the IP address scheme for virtual desktops. This service is hosted on the same virtual machine as the domain controller and DNS server.
- **Microsoft SQL Server 2008 R2**—SQL Server is the database service used to store configuration details required by Citrix XenDesktop, Provisioning Services, and VMware vCenter Server. This SQL Server is hosted as a virtual machine on a VMware vSphere 5.1 server.
- **IP network**—The Ethernet network infrastructure provides IP connectivity between virtual desktops, VMware vSphere servers, and VNX platform. The IP network allows vSphere servers to access NFS datastores on VNX5300 and desktop streaming from PVS servers with high bandwidth and low latency. It also allows desktop users to redirect their user profiles and home directories to the centrally maintained CIFS shares on the VNX.
- **Fibre Channel network**— For the FC variant, storage traffic between all vSphere hosts and the VNX storage system is carried over an FC network. All other traffic is carried over the IP network.

Note: EMC Validation testing for this solution used 10 Gigabit IP networking. Customer implementations may have different requirements. EMC VSPEX End-User Computing: Citrix XenDesktop 5.6 and VMware vSphere 5.1 for up to 2,000 Virtual Desktops provides a complete discussion of network requirements.

Storage layout

This section describes the core and optional reference architectures for physical storage layout.

Core reference architecture

Figure 3 shows the physical storage layout of the disks in the core reference architecture. This configuration accommodates only the virtual desktops and vDisk/TFTP images. The disks are distributed among two VNX5300 storage buses to maximize array performance.

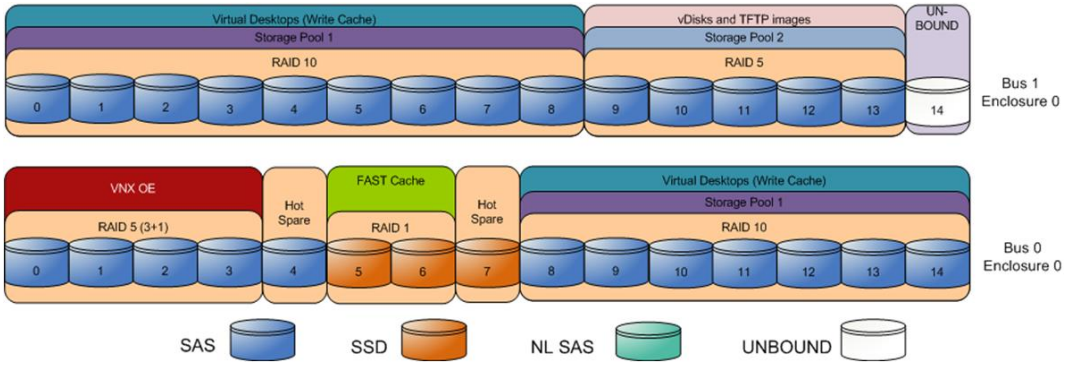

Figure 3. VNX5300 – core reference architecture physical storage layout

The following configurations are used in the core reference architecture:

- Four SAS disks (0_0_0 to 0_0_3) are used for the VNX OE.
- Disks 0_0_4 and 0_0_7 are hot spares. These disks are marked as hot spare in the storage layout diagram.
- Sixteen SAS disks (0_0_8 to 0_0_14 and 1_0_0 to 1_0_8) in the RAID 10 Storage Pool 1 are used to store virtual desktops. FAST Cache is enabled for the entire pool.
  - For the NFS variant, ten LUNs of 400 GB each are provisioned from the pool to provide the storage required to create four 1 TB NFS file systems. The file systems are presented to the vSphere servers as NFS datastores.
  - For the FC variant, four LUNs of 1 TB each are provisioned from the pool to present to the vSphere servers as VMFS datastores.
- Five SAS disks (1_0_9 to 1_0_13) in the RAID 5 Storage Pool 2 are used to store PVS vDisks and TFTP images. FAST Cache is enabled for the entire pool.
- Two Flash drives (0_0_5 to 0_0_6) are used for EMC VNX FAST Cache. There are no user-configurable LUNs on these drives.
- Disk 1_0_14 is not used for testing this solution.

Optional reference architecture

Figure 4 shows the physical storage layout of the disks that are optionally used to store the infrastructure servers, user profiles and home directories, and Personal vDisks, if pre-existing high performance file storage is not being used. The disks are distributed among two VNX5300 storage buses to maximize array performance.

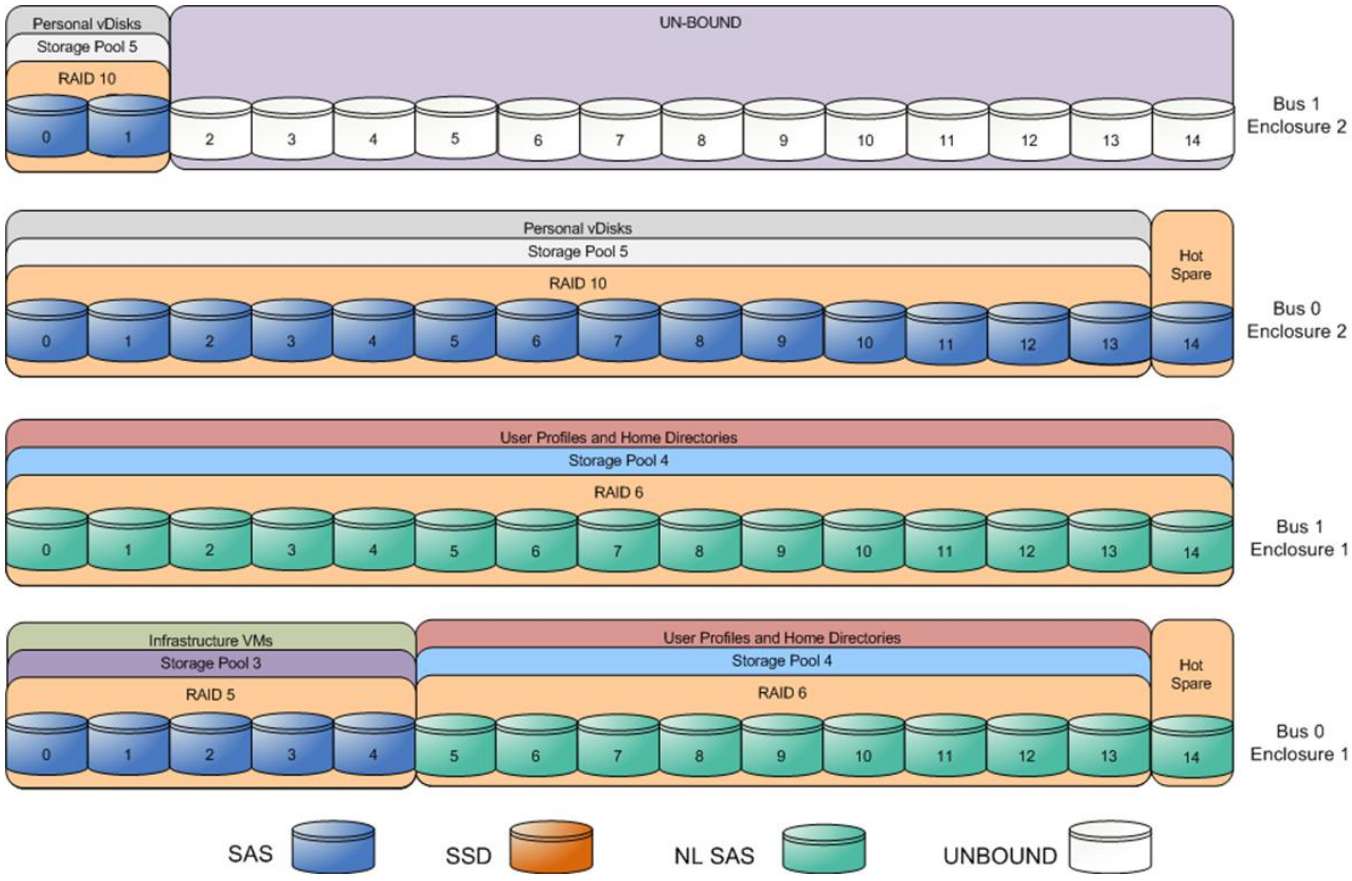

Figure 4. VNX5300 – optional reference architecture physical storage layout

The following configurations are used in the optional reference architecture:

- Disks 0_1_14 and 0_2_14 are hot spares, as marked in the storage layout diagram.
- Five SAS disks (0_1_0 to 0_1_4) in the RAID 5 Storage Pool 3 are used to store the infrastructure virtual machines.
  - For the NFS variant, ten LUNs of 200 GB each are provisioned from the pool to provide the storage required to create one 1 TB NFS file system. The file system is presented to the vSphere servers as an NFS datastore.
  - For the FC variant, one LUN of 1 TB is provisioned from the pool to present to the vSphere servers as a VMFS datastore.

- Twenty-four NL-SAS disks (0_1_5 to 0_1_13 and 1_1_0 to 1_1_14) in the RAID 6 Storage Pool 4 are used to store user profiles and home directories. FAST Cache is enabled for the entire pool.

  Ten LUNs of 32 TB each are carved out of the pool to provide the storage required to create two CIFS file systems.

- Sixteen SAS disks (0_2_0 to 0_2_13 and 1_2_0 to 1_2_1) in the RAID 10 Storage Pool 5 are used to store the Personal vDisks. FAST Cache is enabled for the entire pool.
  - For the NFS variant, ten LUNs of 400 GB each are carved out of the pool to provide the storage required to create four 1 TB NFS file systems. The file systems are presented to the vSphere servers as NFS datastores.
  - For the FC variant, four LUNs of 1 TB each are carved out of the pool to present to the vSphere servers as VMFS datastores.
- Disks 1_2_2 to 1_2_14 are unbound. They were not used for testing this solution.

VNX shared file systems

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

Network layout overview

Figure 5 shows the 10-GbE connectivity between the VMware vSphere servers and the EMC VNX storage for the NFS variant. Uplink Ethernet ports coming off the 10-Gb switches can be used to connect to a 10-Gb or a 1-Gb external LAN.

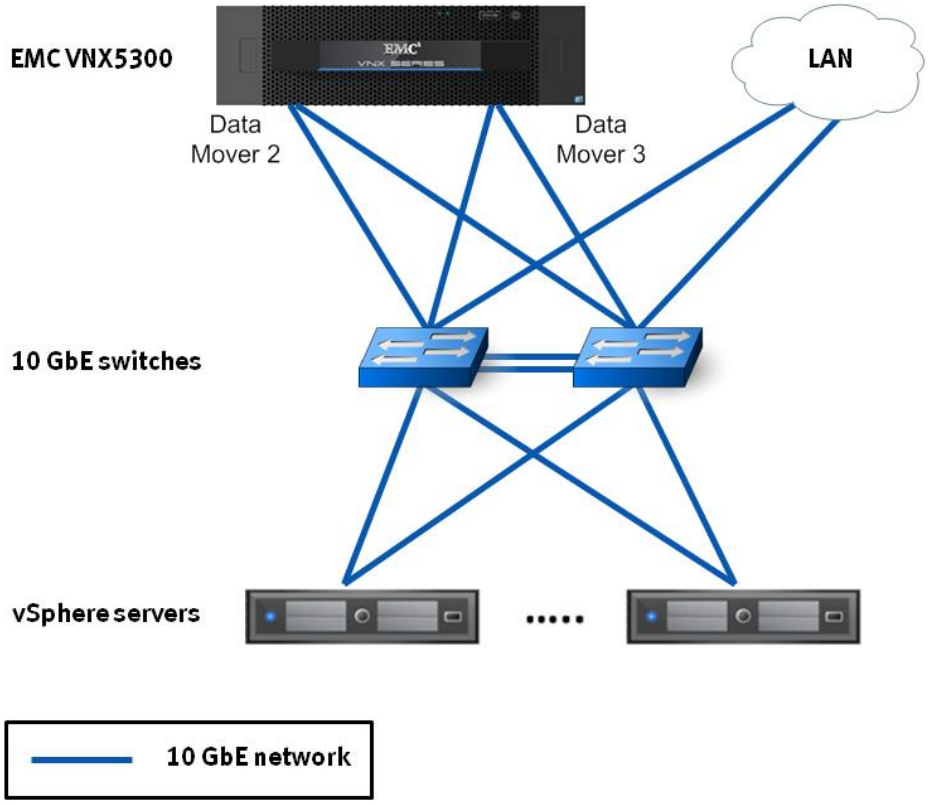

Figure 5. Network layout diagram for NFS variant

Figure 6 shows the 10-Gb Ethernet and 8-Gb Fibre Channel connectivity between the VMware vSphere servers and the EMC VNX storage for the FC variant.

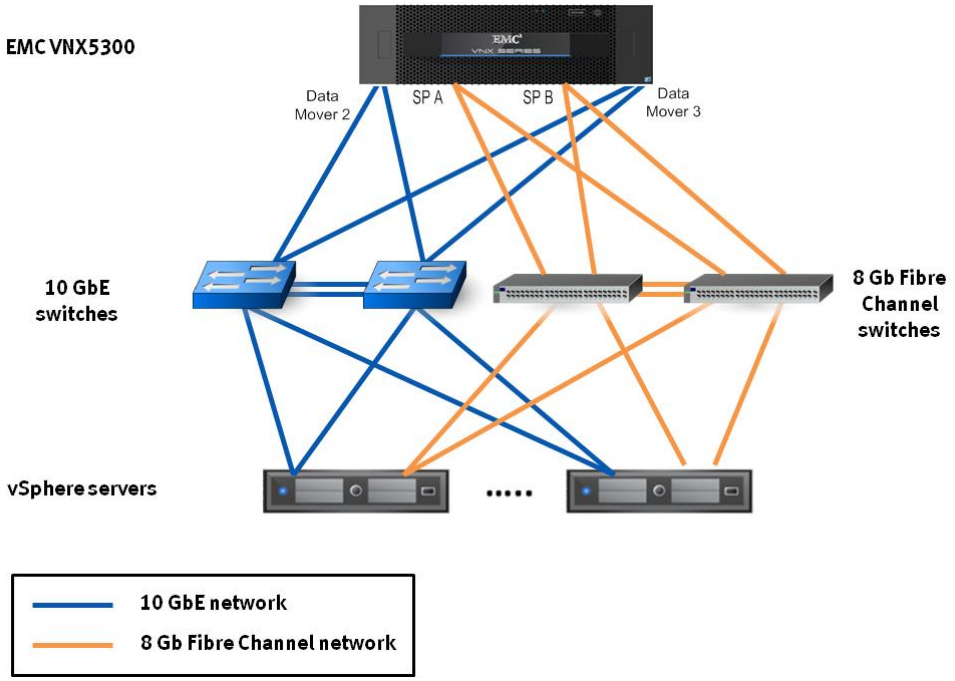

Figure 6. Network layout diagram for FC variant

Host network configuration

All network interfaces on the vSphere servers in this solution use 10-Gb Ethernet connections. All virtual desktops are assigned IP addresses by using a DHCP server. The Intel-based servers use two 10-Gb Ethernet ports for all the network connections.

Figure 7 shows the vSwitch configuration in the vCenter Server.

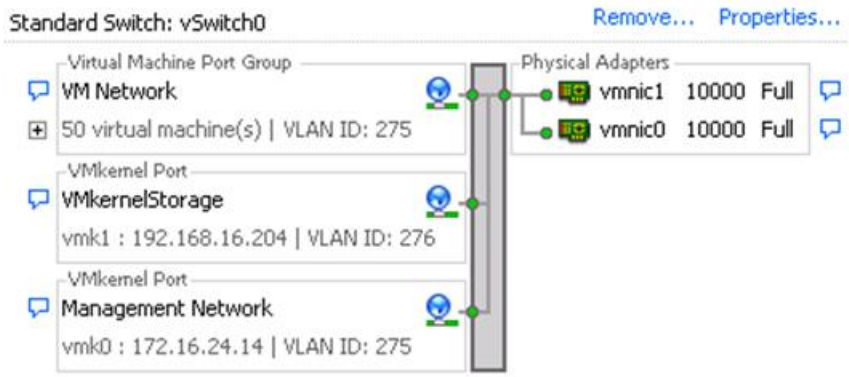

Figure 7. vSwitch configuration in vCenter Server

Virtual switch vSwitch0 uses two physical network interface cards (NICs) each. Table 1 lists the port groups configured on vSwitch0.

Table 1. Port groups configured on vSwitch0

Virtual switch	Configured port groups	Used for
vSwitch0	Management Network	VMkernel port for vSphere host management
vSwitch0	VM Network	Network connection for virtual desktops and LAN traffic
vSwitch0	VMkernelStorage	NFS datastore traffic

VNX5300 network configuration

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

The VNX5300 Data Movers are configured for two 10-Gb interfaces on a single I/O module. Link Aggregation Control Protocol (LACP) is used to configure ports fxg-1-0 and fxg-1-1 to support virtual machine traffic, home folder access, and user profiles.

Figure 8 shows the back of two VNX5300 Data Movers that include two 10-Gb fiber Ethernet (fxg) ports each in I/O expansion slot 1.

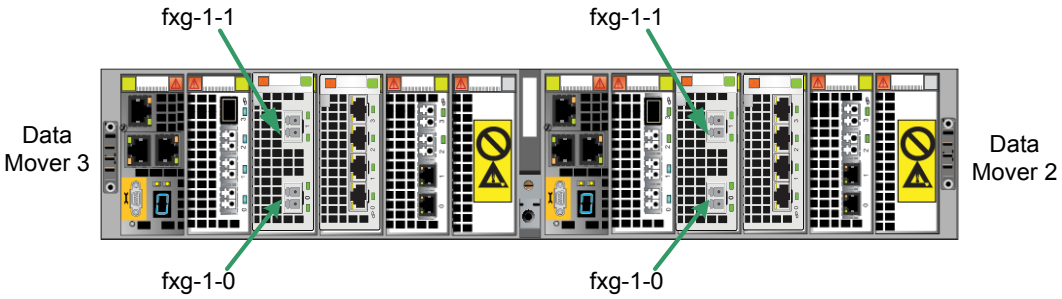

Figure 8. VNX5300 Data Movers

Key components

Introduction

This section briefly describes the key components of this solution:

- EMC VNX series
- EMC VNX FAST Cache
- VSI for VMware vSphere
- VNX VMware vStorage API for Array Integration support
- PowerPath/VE for VMware vSphere (FC variant only)
- Citrix XenDesktop
- Citrix XenDesktop Machine
- Citrix Provisioning Services 6.2
- Citrix Personal vDisk
- Citrix Profile Management
- VMware vSphere 5.1

"Hardware and software resources" provides more information on the components that make up the solution.

EMC VNX series

The EMC 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 centralized point of management 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 the simultaneous support for NFS and CIFS protocols by enabling Windows and Linux/UNIX clients to share files by using the sophisticated file-locking mechanism of VNX for File and VNX for Block for high-bandwidth or for latency-sensitive applications.

EMC VNX FAST Cache

VNX FAST Cache, a part of the VNX FAST Suite, uses Flash drives 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 92 GB read/write-capable 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 the Flash drives. The use of Flash drives dramatically improves the response times for very active data and reduces data hot spots that can occur within the LUN.

FAST Cache is an extended read/write cache that enables Citrix XenDesktop to deliver consistent performance at Flash-drive speeds by absorbing read-heavy activities,

such as login storms and antivirus scans, and write-heavy workloads such as boot storms. This extended read/write cache is an ideal caching mechanism for Citrix XenDesktop because the base replica desktop image and other active user data that are frequently accessed are serviced directly from the Flash drives without having to access the slower drives at the lower storage tier.

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 for managing EMC storage within the vSphere environment. Features can be added and removed from VSI independently, which provides flexibility to customize VSI user environments. The features are managed by using the VSI Feature Manager. VSI provides a unified user experience that allows new features to be introduced rapidly in response to changing customer requirements.

The following VSI 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 vSphere hosts and virtual machines. SV presents the underlying storage details to the virtual data center administrator, merging the data of several different storage mapping tools into a few seamless vSphere client views.
- Unified Storage Management—Simplifies storage administration of the EMC VNX platforms. It enables VMware administrators to provision new NFS and VMFS datastores and RDM volumes seamlessly within the vSphere client.

The EMC VSI for VMware vSphere product guides, available on the EMC Online Support website, provide more information.

VMware vStorage API for Array Integration support

Hardware acceleration with VMware vStorage API for Array Integration (VAAI) is a storage enhancement in vSphere 5.1 that enables vSphere to offload specific storage operations to compatible storage hardware such as the VNX series platforms. With storage hardware assistance, vSphere performs these operations faster and consumes less CPU, memory, and storage fabric bandwidth.

PowerPath/VE for VMware vSphere (FC variant only)

PowerPath/VE works with VMware vSphere as a multipathing plug-in (MPP) that provides enhanced path management capabilities to VMware vSphere hosts. Having multiple paths enables the VMware vSphere host to access a storage device even if a specific path is unavailable. Multiple paths can also share the I/O traffic to a storage device.

Citrix XenDesktop 7

Under the XenDesktop 7 architecture, management and delivery components are shared between XenDesktop and XenApp to give administrators a unified management experience. The components of the XenDesktop 7 architecture are shown in Figure 9.

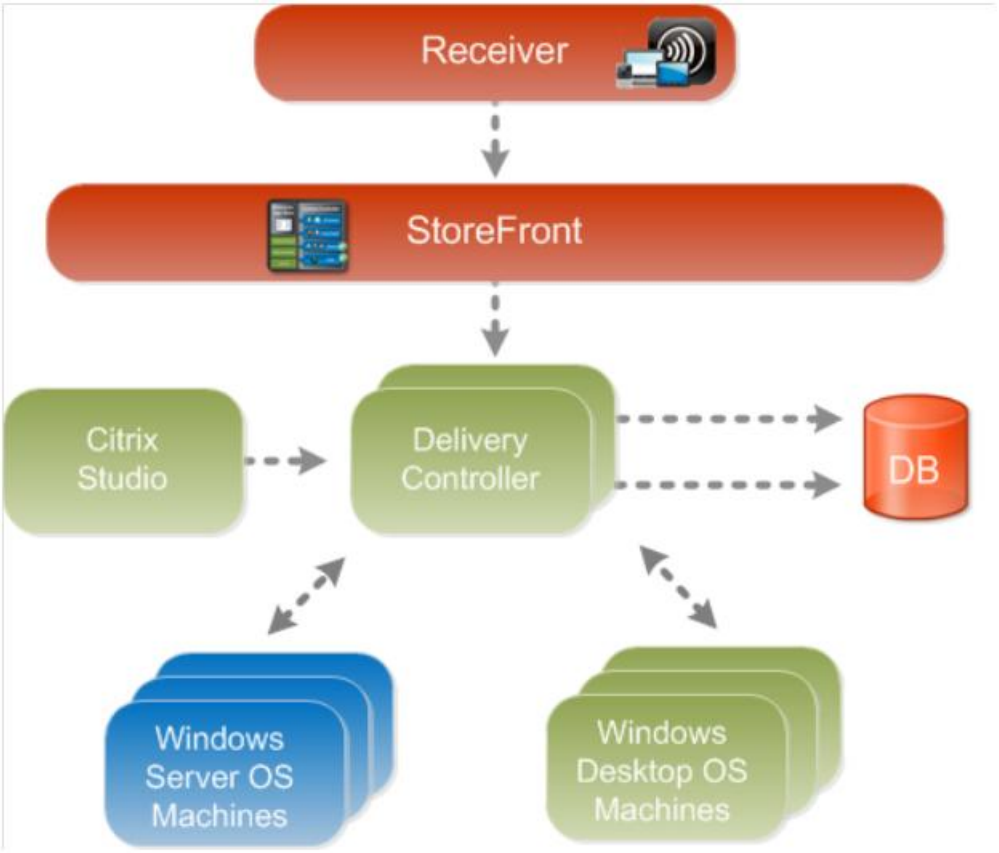

Figure 9. Citrix XenDesktop 7 architecture components

The XenDesktop 7 architecture components are described as follows:

- **Receiver**: Receiver provides users with self-service access to resources published on XenApp or XenDesktop servers. Receiver combines ease of deployment and use, and offers quick, secure access to hosted applications, desktops, and data. Receiver also provides on-demand access to Windows, Web, and software as a service (SaaS) applications.
- **StoreFront**: StoreFront authenticates users to sites hosting XenApp and XenDesktop resources and manages stores of desktops and applications that users can access.
- **Studio**: Studio is the management console that enables you to configure and manage your XenApp and XenDesktop deployment, eliminating the need for separate management consoles to manage delivery of applications and desktops. Studio provides various wizards to guide you through the process of setting up your environment, creating workloads to host applications and desktops, and assigning applications and desktops to users.
- **Delivery Controller**: The Delivery Controller distributes applications and desktops, manages user access, and optimizes connections to applications. Each site has one or more delivery controllers.

- **Server OS Machines**: Virtual machines or physical machines based on Windows Server operating system used for delivering applications or hosted shared desktops to users.
- **Desktop OS Machines**: Virtual machines or physical machines based on Windows Desktop operating system used for delivering personalized desktops to users or applications from desktop operating systems.

Citrix XenDesktop Machine Catalog

Citrix XenDesktop 7 provides several options to create a machine catalog through PVS using Desktop and Server OS:

- **Random with Desktop OS:** End users are connected to desktops randomly. When a user logs off, the desktop is available for another user to log in. Any changes made to the desktop are lost when it is restarted.
- **Static with Desktop OS:** End users are assigned to a certain desktop every time they log in. When a user logs off, only that user can log back in to that particular desktop. Any changes made to the desktop are lost when it is restarted.
- **Personal vDisk with Desktop OS:** End users are assigned to a certain desktop every time they login. When the user logs off, only that user can log back in to that particular desktop. Any changes made to the desktop are saved on the personal vDisk regardless of whether it is restarted or refreshed.
- **Hosted shared Desktops with Server OS:** End users are connected to a hosted shared desktop session on the Server OS. When a user logs off, the session is closed. Any changes made to the hosted shared desktop session are lost when the user logs off.

Citrix Provisioning Services 6.2

PVS takes a different approach from traditional desktop imaging solutions by fundamentally changing the relationship between hardware and the software that runs on it. By streaming a single shared disk image (vDisk) instead of copying images to individual machines, PVS enables organizations to reduce the number of disk images that they manage. As the number of machines continues to grow, PVS provides the efficiency of centralized management with the benefits of distributed processing.

As machines stream the disk data dynamically in real time from a single shared image, the machine image consistency is ensured. In addition, the configuration, applications, and even the operating system (OS) of large pools of machines can change completely during the restart operation.

In this solution, PVS provisions 1,000 virtual desktops running Windows 7. The desktops are deployed from a single vDisk image.

Citrix Personal vDisk

Personal vDisk allows users to preserve customization settings and user-installed applications in a pooled desktop. This capability is accomplished by redirecting the changes from the user's pooled virtual machine to a separate disk called Personal vDisk. During runtime, the content of the Personal vDisk is blended with the content from the base virtual machine to provide a unified experience to the end user. The Personal vDisk data is preserved during restart and refresh operations.

Citrix Profile Management

Citrix Profile Management preserves user profiles and dynamically synchronizes them with a remote profile repository. Citrix Profile Management ensures that personal settings are applied to desktops and applications regardless of the user's login location or client device.

The combination of Citrix Profile Management and pooled desktops provides the experience of a dedicated desktop while potentially minimizing the amount of storage required in an organization.

With Citrix Profile Management, a user's remote profile is downloaded dynamically when the user logs in to a Citrix XenDesktop. Profile Management downloads user profile information only when the user needs it.

VMware vSphere 5.1

VMware vSphere 5.1 is used to build the virtualization layer for this solution. VMware vSphere 5.1 transforms a computer's physical resources by virtualizing the CPU, memory, storage, and network. This transformation creates fully functional virtual machines that run isolated and encapsulated operating systems and applications, just like physical computers.

High-availability features of VMware vSphere 5.1 such as vMotion and Storage vMotion enable seamless transfer of virtual machines and stored files from one vSphere server to another with minimal or no performance impact. Coupled with vSphere Distributed Resource Scheduling (DRS) and Storage DRS, virtual machines have constant access to the appropriate resources through load balancing of compute and storage resources.

High availability and failover

Introduction

This solution provides a high availability end-user computing infrastructure. Each component is configured to provide a robust and scalable solution for the host layer, connectivity layer, and storage layer.

Storage layer

The VNX series is designed for five 9s availability by using redundant components in the array. All Data Movers, storage processors, and array components are capable of continued operation in case of a 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 vSphere host has multiple connections to both Ethernet networks to protect against link failures. These connections are spread across multiple blades in an Ethernet switch to protect against component failure in the switch.

Host layer

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

Validated environment profile

Profile characteristics

Table 2 provides the environment profile that was used to validate the solution.

Table 2. Profile characteristics

Profile characteristic	Value
Number of virtual desktops	1,000
Virtual desktop OS	Windows 7 Enterprise SP1 (32-bit)
CPU per virtual desktop	1 vCPU
Number of virtual desktops per CPU core	6.25
Dynamic memory per virtual desktop (maximum)	2 GB
Desktop provisioning method	Provisioning Services (PVS)
Average storage available for each virtual desktop	4 GB
Number of datastores used to store virtual desktops	4
Number of virtual desktops per datastore	250
Disk and RAID type for datastores	RAID 10, 600 GB, 15k rpm, 3.5 in. SAS disks
Disk and RAID type for CIFS shares to host the Citrix Profile Management profiles and home directories	RAID 6, 2 TB, 7,200 rpm, 3.5 in. NL-SAS disks
Number of VMware clusters for virtual desktops	2
Number of vSphere servers in each cluster	10
Number of virtual desktops in each cluster	500

Hardware and software resources

Hardware resources

Table 3 lists the hardware required to implement this solution.

Table 3. Hardware details

Hardware	Configuration	Notes
EMC VNX5300	Two Data Movers (1 active and 1 standby) Twenty-six 600 GB, 15k-rpm 3.5 in. SAS disks Three 100 GB, 3.5 in. Flash drives	VNX shared storage for core solution
	Twenty-five 2 TB, 7,200 rpm 3.5 in. NL-SAS disks	**Optional**: for user data
	Five 600 GB, 15k rpm 3.5 in. SAS disks	**Optional**: for infrastructure storage
	Sixteen 600 GB, 15k rpm 3.5 in. SAS disks	**Optional**: for Personal vDisks
Intel-based servers	Homogeneous servers providing: • 80 CPU cores: Intel Xeon 2.53 GHz or better • 1440 GB total RAM • Local boot device for each server • Two 10 GbE network ports per server • Two 8 Gb FC ports per server for Fibre Channel variant	Virtual desktop vSphere clusters. Implemented as two equal clusters for validation testing.
	Homogeneous servers providing: • 16 CPU cores: Intel Xeon 2.53 GHz or better • 96 GB total RAM • Local boot device for each server • Two 10 GbE network ports per server • Two 8 Gb FC ports per server for Fibre Channel variant	**Optional**: vSphere cluster to host infrastructure virtual machines
Ethernet network switches	At least two physical switches for redundancy. Sufficient 10 GbE network ports for: • Two connections to each cluster node • Two connections to each Data Mover	Redundant LAN A/B configuration
Fibre Channel switches	At least two physical switches for redundancy. Sufficient 8 Gb FC network ports for: • Two connections to each cluster node • Two connections to each Data Mover	Redundant SAN A/B configuration for FC variant

Software resources Table 4 lists the software used in the solution.

Table 4. Solution software

Software	Configuration
VNX5300 (shared storage, file systems)	
VNX OE for File	Release 7.1.65-8
VNX OE for Block	Release 32 (05.32.000.5.201)
VSI for VMware vSphere: Unified Storage Management	Version 5.4
VSI for VMware vSphere: Storage Viewer	Version 5.4
VMware vSphere	
vSphere Server	5.1
vCenter Server	5.1
Operating system for vCenter Server	Windows Server 2008 R2 Standard Edition
Microsoft SQL Server	Version 2008 R2 Standard Edition
vStorage API for Array Integration plug-in (VAAI) (NFS variant only)	1.0-10
PowerPath Virtual Edition (FC variant only)	5.8
Citrix XenDesktop virtualization	
Citrix XenDesktop Delivery Controller	Version 7
Provisioning services (PVS) server	Version 6.2
Operating system for Delivery Controller	Windows Server 2008 R2 Standard Edition
Microsoft SQL Server	Version 2008 R2 Standard Edition
Virtual desktops **Note:** Except for the base OS, the following software was used for solution validation and is not required.	
OS	MS Windows 7 Enterprise SP1 (32-bit)
VMware tools	9.0.0 build-782409
Microsoft Office	Office Enterprise 2007 (Version 12.0.6562.5003)
Internet Explorer	8.0.7601.17514
Adobe Reader	9.1.0
Adobe Flash Player	11.4.402.287
Bullzip PDF Printer	9.1.1454
FreeMind	0.8.1
Login VSI (EUC workload generator)	3.7 Professional Edition

Conclusion

Summary

The features of the VNX operating environment enable EMC VNX series arrays to drive higher storage consolidation ratios at a lower cost than was 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.

This reference architecture provides a blueprint for a validated Citrix XenDesktop 7 virtualization solution enabled by EMC VNX storage and the VMware vSphere 5.1 virtualization platform. The solution is able to support and scale to thousands of virtual desktops.

Next steps

EMC can help accelerate assessment, design, implementation, and management, while lowering the implementation risks for an EMC infrastructure for virtual desktops enabled by EMC VNX series (NFS and FC), Citrix XenDesktop 7, and VMware vSphere 5.1.

To learn more about this and other solutions, contact an EMC representative.

References

EMC documentation

The following documents, located on the EMC Online Support website, 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 Proven End User Computing Solution Enabled by EMC VMAX, Citrix XenDesktop with Provisioning Services for 5000 Desktops*
- *EMC Infrastructure for Citrix XenDesktop 5.6, EMC VNX Series (NFS), VMware vSphere 5.0, Citrix XenDesktop 5.6, and Citrix Profile Manager 4.1*—Reference Architecture
- *EMC Infrastructure for Citrix XenDesktop 5.6, EMC VNX Series (NFS), VMware vSphere 5.0, Citrix XenDesktop 5.6, and Citrix Profile Manager 4.1*—Proven Solutions Guide
- *Sizing EMC VNX Series for VDI Workload*—White Paper
- Deploying Microsoft Windows 7 Virtual Desktops with VMware View—Applied Best Practices Guide

Citrix documentation

For Citrix documentation, go to the Citrix website at www.Citrix.com.