Cisco Solution for EMC® VSPEX™ End-User Computing

Citrix® XenDesktop™ 5.6 with VMware® vSphere™ 5 for 2000 Virtual Desktops

Enabled by Cisco Unified Computing System, Cisco Nexus Switches, Citrix XenDesktop 5.6, VMware vSphere 5 and EMC VNX5500™

Reference Architecture Guide

April 2012

Contents

Reference Architecture Overview

Document Purpose

This document describes the reference architecture of the Cisco solution for EMC® VSPEX™ end-user computing for 2000 virtual desktops. This document provides the solution layout and guidelines for building similar solutions.

Solution Purpose

VSPEX pre-validated and modular architectures are built with proven best-of-breed technologies to create complete virtualization solutions that enable you to make an informed decision in the hypervisor, compute and networking layers. VSPEX eliminates desktop virtualization planning and configuration burdens. VSPEX infrastructures accelerate your IT Transformation by enabling faster deployments, greater flexibility of choice, efficiency, and lower risk.

This reference architecture is not intended to be a comprehensive guide to every aspect of this solution. Server capacity is provided in generic terms for required minimums of CPU, memory and network interfaces; the customer is free to select the server and networking hardware of their choice that meet or exceed the stated minimums.

The Cisco solution for VSPEX features the enterprise-class Cisco Unified Computing System (UCS) Servers and Nexus switches delivering performance, versatility, and density without compromise. Cisco's portfolio of products and technologies offers a holistic approach to the design, operation, and delivery of IT services. This approach makes it easier for IT to integrate existing technology silos and:

- Respond more quickly to business demands
- Reduce capital expenditures and operating expenses
- Simplify IT operations

These platforms optimized for Virtualization, manageability, performance and scalability are ideal for:

- Consolidation and virtualization
- Private cloud computing
- Application or infrastructure-as-a-service

For more detailed information on performance and scalability testing, refer to the EMC VSPEX End-User Computing Solutions Citrix XenDesktop 5.6 with VMware vSphere 5 for 2000 Virtual Desktops Enabled by Citrix XenDesktop 5.6, VMware vSphere 5, VNX5500—Deployment Guide and associated documentation for best practices and specific usage requirements.

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 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 uses Cisco UCS B230 M2 Server, Cisco Nexus 5548UP and 1000v switches, EMC VNX5500™ and VMware vSphere 5 to provide resources for a Citrix XenDesktop 5.6 environment of Windows 7 virtual desktops provisioned by Citrix Provisioning Services (PVS) 6.0.

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 workday. 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 cost effective and predictable performance for a virtual desktop infrastructure, the infrastructure must be able to:

- Have high density of virtual desktops per server
- Scale linearly with increase in number of virtual desktops
- Rapidly provisioning a scale-out infrastructure
- Provide low latency and high bandwidth for the clustering, provisioning and storage interconnect networks
- Handle the peak I/O load from the clients while keeping response time to a minimum

Cisco UCS Blade Servers provide unprecedented virtual desktop density per server providing an effective server cost per desktop. In addition, Cisco UCS provides unified management and a single domain can manage up to 25000+ desktops.

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.

EMC next-generation backup enables protection of user data and end-user recoverability. This is accomplished by leveraging EMC Avamar® and its desktop client within the desktop image.

Solution Benefits

This VSPEX solution aids in the design and implementation stages required for the successful implementation of virtual desktops on Citrix XenDesktop. The solution balances performance requirements and cost by using Cisco Unified Computing System, Nexus Switches and VNX operating environment features such as FAST Cache.

VNX multi-protocol support enables use of either Fibre Channel SAN-connected block storage or 10-gigabit Ethernet (GbE) connected NFS for flexible, cost effective, and easily deployable storage for VMware-based desktop virtualization.

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
- Increased productivity for virtual workforces in any location
- Increased use of the latest mobile devices to drive innovation throughout the business
- Increased adaptability to business change with fast, flexible desktop delivery for setting up an offshore location, mergers and acquisitions, branch expansion, and other initiatives

Key Components

Introduction

This section briefly describes the key components of this solution.

The Hardware Resources and Software Resources sections provide more information on the components that make up the solution.

Cisco UCS B-Series Rack-Mount Servers

Cisco Unified Computing System is the first truly unified data center platform that combines industry-standard, x86-architecture blade and rack servers with networking and storage access into a single system. Key innovations in the platform include a standards-based unified network fabric, Cisco Virtualized Interface Card (VIC) support, and Cisco Extended Memory Technology. The system uses a wire- once architecture with a self-aware, self-integrating, intelligent infrastructure that eliminates the time-consuming, manual, error-prone assembly of components into systems.

Cisco UCS B-Series Blade Servers provide a comprehensive line of two and four-socket servers to deliver world-record-setting performance to a wide range of workloads. Based on Intel® Xeon® processor E7 and E5 product families, these servers are ideal for virtualized and non-virtualized applications. These servers:

- Reduce capital and operating expenses with converged network fabrics and integrated systems management
- Deliver performance, versatility, and density without compromise
- Address a broad set of workloads, from IT and web infrastructure through distributed database for both virtualized and non-virtualized environments
- Increased IT staff productivity and business agility through just-in-time provisioning and mobility support for both virtualized and non-virtualized environments

Cisco Nexus 5000 Series Switches

Cisco Nexus® 5000 Series Switches deliver an innovative architecture to simplify data center transformation by enabling a high-performance, standards-based, multi-protocol, multi-purpose, Ethernet-based fabric. They help consolidate separate LAN, SAN, and server cluster network environments into a single 10 Gigabit Ethernet fabric. This unification enables network consolidation and greater utilization of previously separate infrastructure and cabling, reducing by up to 50 percent the number of adapters and cables required and eliminating redundant switches. This infrastructure displacement also lowers power and cooling costs significantly.

Citrix XenDesktop 5.6

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.

Citrix Provisioning Services

Citrix Provisioning Services (PVS) is a very commonly deployed provisioning method for XenDesktop and XenApp environments. It is the ideal provisioning method for scale out configurations as well as configurations which have XenApp in the environment.

Provisioning Services streams a single shared disk image (vDisk) rather than copying images to individual machines, Provisioning Services enables organizations to reduce the number of disk images that they manage, even as the number of machines continues to grow, simultaneously providing the efficiencies of a centralized management with the benefits of distributed processing.

In addition, because machines are streaming disk data dynamically and in real time from a single shared image, machine image consistency is ensured, while at the same time large pools of machines can completely change their configuration, applications, and even OS in the time it takes them to reboot.

Using Provisioning Services, any vDisk can be configured in Standard Image mode. A vDisk in Standard Image mode allows many computers to boot from it simultaneously; greatly reducing the number of images that must be maintained and the amount of storage that would be required. The vDisk is in read-only format and the image can not be changed by target devices.

PVS 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.

VMware vSphere 5

VMware vSphere 5 is the market-leading virtualization platform that is used across thousands of IT environments around the world. VMware vSphere 5 transforms a computer’s physical resources by virtualizing the CPU, RAM, hard disk, and network controller. This transformation creates fully functional virtual desktop that run isolated and encapsulated operating systems and applications just like physical computers.

The high-availability features of VMware vSphere 5 are coupled with DRS and vMotion, which enables the seamless migration of virtual desktops from one vSphere server to another with minimal or no impact to the customer’s usage.

This reference architecture leverages VMware vSphere Desktop Edition for deploying desktop virtualization. It provides the full range of features and functionalities of the vSphere Enterprise Plus edition allowing customers to achieve scalability, high availability and optimal performance for all of their desktop workloads. Also, vSphere Desktop comes with unlimited vRAM entitlement. vSphere Desktop edition is intended for customers who want to purchase only vSphere licenses to deploy desktop virtualization.

Cisco Nexus 1000v Series Switch

Cisco Nexus 1000V Series Switches deliver highly secure, multitenant services by adding virtualization intelligence to the data center network. These soft-switches are integrated with VMware vCloud Director. They are built to scale for cloud networks, with support for Virtual Extensible LAN (VXLAN). This addresses the requirements for scalable LAN segmentation and helps to enable broader virtual machine mobility.

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 VNX5500 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 FAST Cache configuration. Larger configurations are supported for scaling beyond 500 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.

The 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 because the base desktop image and other active user data are so frequently accessed that the data is serviced directly from the flash drives without having to access the slower drives at the lower storage tier.

VNX VAAI Support

Hardware acceleration with VMware vStorage API for Array Integration (VAAI) is a storage enhancement in vSphere 5 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.

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 vSphere 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.
- **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.

- **Path Management (FC variant only)**–Provides a mechanism to change 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 EMC PowerPath®/VE.

Refer to the EMC VSI for VMware vSphere product guides on the EMC Online Support website for more information.

EMC VNX Series

The EMC VNX™ family is optimized for virtual applications delivering industry-leading innovation and enterprise capabilities for file, block, and object storage in a scalable, easy-to-use solution. This next-generation storage platform combines powerful and flexible hardware with advanced efficiency, management, and protection software to meet the demanding needs of today's enterprises.

The VNX series is powered by Intel Xeon processor, for intelligent storage that automatically and efficiently scales in performance, while ensuring data integrity and security. The VNX series is designed to meet the high-performance, high-scalability requirements of midsize and large enterprises.

Table 1. VNX Customer Benefits

Feature	
Next-generation unified storage, optimized for virtualized applications	✓
Capacity optimization features including compression, deduplication, thin provisioning, and application-centric copies	✓
High availability, designed to deliver five 9s availability	✓
Automated tiering with FAST VP (Fully Automated Storage Tiering for Virtual Pools) and FAST Cache that can be optimized for the highest system performance and lowest storage cost simultaneously	✓
Multiprotocol support for file, block, and object with object access through Atmos™ Virtual Edition (Atmos VE)	✓
Simplified management with EMC Unisphere™ for a single management interface for all NAS, SAN, and replication needs	✓
Up to three times improvement in performance with the latest Intel Xeon multicore processor technology, optimized for Flash	✓

Available Software Suites

- **FAST Suite**—Automatically optimizes for the highest system performance and the lowest storage cost simultaneously.
- **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.

Available Software Packs

- **Total Efficiency Pack**—Includes all five software suites.
- **Total Protection Pack**—Includes local, remote, and application protection suites.

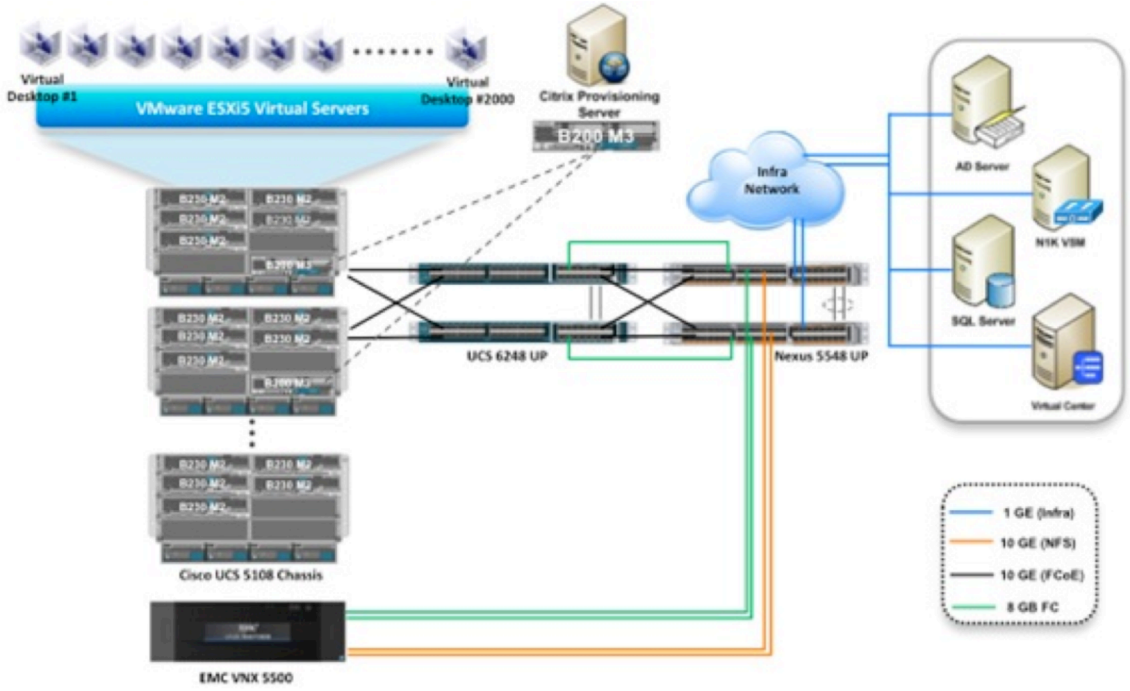
Solution Architecture

Logical Architecture Diagrams

The architecture diagrams in this section show the layout of major components comprising the solutions.

Figure 1 depicts the logical architecture for the virtual desktop deployment based on FC and NFS–FC for boot and NFS for data storage traffic.

Figure 1. Logical Architecture-NFS Variant



Reference Architecture Overview

The reference architecture consists of the following components.

- **Cisco UCS B230 M2 Server**—The Cisco® UCS B230 M2 Blade Server is one of the industry's highest-density two-socket blade server platforms. It is a critical new building block in the Cisco Unified Computing System™ portfolio, offering compact performance for enterprise-critical applications within the Cisco Unified Computing System architecture. It is an excellent choice for IT departments that are looking for ways to increase computing performance and memory capacity while getting the most value from the available space in their data centers.

Cisco continues its commitment to being a trusted x86 systems provider with a wide range of system options. The Cisco UCS B230 M2 further extends the capabilities of the Cisco Unified Computing System by delivering new levels of performance, energy efficiency, reliability and security for mission-critical applications in a virtualized environment. These servers feature Intel® Xeon® processor E7-2800 product family, for up to 20 processing cores, 32 DIMM slots, two optional solid-state drives (SSDs) and one dual-port mezzanine slot for up to 20 Gbps of redundant I/O throughput.

Cisco UCS B230 M2 blade servers are optimally design for virtual desktop workload.

- **Cisco Nexus 5548UP Switches**—The Cisco Nexus 5548UP is a 1RU 10 Gigabit Ethernet, Fibre Channel, and FCoE switch offering up to 960 Gbps of throughput and up to 48 ports. The switch has 32 unified ports and one expansion slot. The Cisco Nexus 5500 platform is equipped with expansion modules that can be used to increase the number of 10 Gigabit Ethernet and FCoE ports or to connect to Fibre Channel SANs with 8/4/2/1-Gbps Fibre Channel switch ports, or both.

The Cisco Nexus 5548UP supports one expansion module from the following offerings:

- Ethernet module that provides sixteen 1/10 Gigabit Ethernet and FCoE ports using the SFP+ interface
- Fibre Channel plus Ethernet module that provides eight 1/10 Gigabit Ethernet and FCoE ports using the SFP+ interface, and eight ports of 8/4/2/1-Gbps native Fibre Channel connectivity using the SFP+/SFP interface
- A unified port module that provides up to sixteen 1/10 Gigabit Ethernet and FCoE ports using the SFP+ interface or up to sixteen ports of 8/4/2/1-Gbps native Fibre Channel connectivity using the SFP+ and SFP interface. The use of 1/10 Gigabit Ethernet or 8/4/2/1-Gbps Fibre Channel on a port is mutually exclusive but selectable for any of the 16 physical ports per module.

In addition to these expansion modules, the Cisco Nexus 5548UP supports a Layer 3 daughter card that can be ordered with the system or as a spare (field upgradable). This daughter card provides up to 160 Gbps of Layer 3 forwarding capability (240 million packets per second [mpps]) that can be shared by all 48 ports in the chassis. Layer 3 daughter card does not take up one of the expansion slots on the rear of the chassis, but instead is installed by replacing the Layer 2 I/O module (N55-DL2) that is located on the front of the chassis.

Along with the three expansion modules, the Cisco Nexus 5596UP supports Layer 3 module, which provides up to 160 Gbps of Layer 3 forwarding capability (240 mpps) that can be shared by all the I/O ports in the chassis.

Version 2 of Layer 3 Daughter Cards and Expansion Modules have enhanced hardware capability that increases host table size from 8K to 16K or multicast routes from 4K to 8K (enabled in future software release).

- **Citrix XenDesktop 5.6 controller**—Two Citrix XenDesktop 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 5 Servers.
- **Virtual desktop**—Five hundred virtual desktops running Windows 7 are provisioned using MCS, a provisioning mechanism introduced in XenDesktop 5.0.
- **VMware vSphere 5 Server**—Sufficient vSphere 5 clusters and underlying X64 server hardware, sized per information in Table 2, host a total of 2000 virtual desktops. This architecture also shows hosts to support Active Directory, DNS, DHCP, and SQL Server, although these components can be provided by existing infrastructure.
- **VMware vCenter Server 5**—Provides a scalable and extensible platform that forms the foundation for virtualization management for the VMware vSphere 5 clusters.
- **Microsoft Windows 2008 R2 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 vSphere 5 Server.

- **Microsoft Windows 2008 R2 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 R2 server**—The Citrix XenDesktop 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 vSphere 5 server.
- **Mixed 10 and 1 Gb IP Network**—The Ethernet network infrastructure provides 10 Gb connectivity between virtual desktops, vSphere clusters, and VNX storage. For the NFS variant, the 10 Gb infrastructure allows vSphere servers to access NFS datastores on the VNX5500 with high bandwidth and low latency. It also allows desktop users to redirect their roaming profiles and home directories to the centrally maintained CIFS shares on the VNX5500. The desktop clients, XenDesktop management components, and Windows server infrastructure can reside on 1 Gb network.
- **Fibre Channel Network**—For the FC variant, storage traffic between all vSphere hosts and the VNX5500 is carried over a FC network. All other traffic is carried over 1 GbE.
- **EMC VNX5500 Series**—Provides storage by using FC (SAN) or IP (NAS) connections for virtual desktops, and infrastructure virtual machines such as Citrix XenDesktop controllers, VMware vCenter Servers, Microsoft SQL Server databases, and other supporting services. Optionally, user profiles and home directories are redirected to CIFS network shares on the VNX5500.
- **EMC Avamar Virtual Edition**—Provides the platform for protection of virtual machines. This protection strategy leverages persistent virtual desktops. It also leverages both image protection and end-user recoveries.

Hardware Resources

Table 2 lists the hardware used in this solution.

Table 2. Solution Hardware

Hardware	Configuration	Notes
Cisco UCS B230 M2 Blade Servers (for virtual desktop workload)	Per Server Configuration: • CPU: 2 x E7-2870 (2.40 GHz) 10 core processor • 256 GB memory • 2 x 100 GB SSD 3 Gb/s (optional) • 1 x Cisco UCS M81KR 10 GbE Dual port PCIe card (for 10 GbE Network)	14 x B230 M2 Blade Servers for 2000 desktops
Cisco UCS B200 M3 Blade Servers (for desktop services and other management services)	• 2 x E5-2650 (2.00 GHz) 8 core processor • 64 GB memory • 300 GB SAS 15k RPM harddisk • 1 x Cisco UCS VIC1240 40 GbE Dual port PCIe card (for 10 GbE Network)	2 x B200 M3 Blade server for up to 2000 desktops
Cisco UCS 6248 Fabric Interconnects	• 32 x fixed Unified ports (Supports 10 GbE, FCoE, FC) • 16 x Unified ports in expansion module (Supports 10 GbE, FCoE, FC) • 1 x 1 GbE Management port • 2 Cluster link port	2 x 6248 for redundant configuration
Cisco Nexus 5548 UP switches	• 32 x fixed Unified ports (Supports 10 GbE, FCoE, FC) • 16 x Unified ports in expansion module (Supports 10 GbE, FCoE, FC) • 1 x 1 GbE Management port	2 x 5548 for redundant configuration
EMC VNX5300	• Two Data Movers (active/standby) • Two 10 GbE interfaces per Data Mover • Two 8 Gb FC ports per storage processor (FC only) • Forty six 300 GB, 15 k rpm 3.5-inch SAS disks • Five 100 GB, 3.5-inch flash drives	VNX shared storage
	Thirty four 2 TB, 7,200 rpm 3.5-inch NL-SAS disks	Optional for user data
	Five 300 GB, 15 k rpm 3.5-inch SAS disks	Optional for infrastructure storage
EMC next generation backup	Avamar • One Gen4 utility node • One Gen4 3.9TB spare node • Three Gen4 3.9TB storage nodes	

Software Resources

Table 3 lists the software used in this solution.

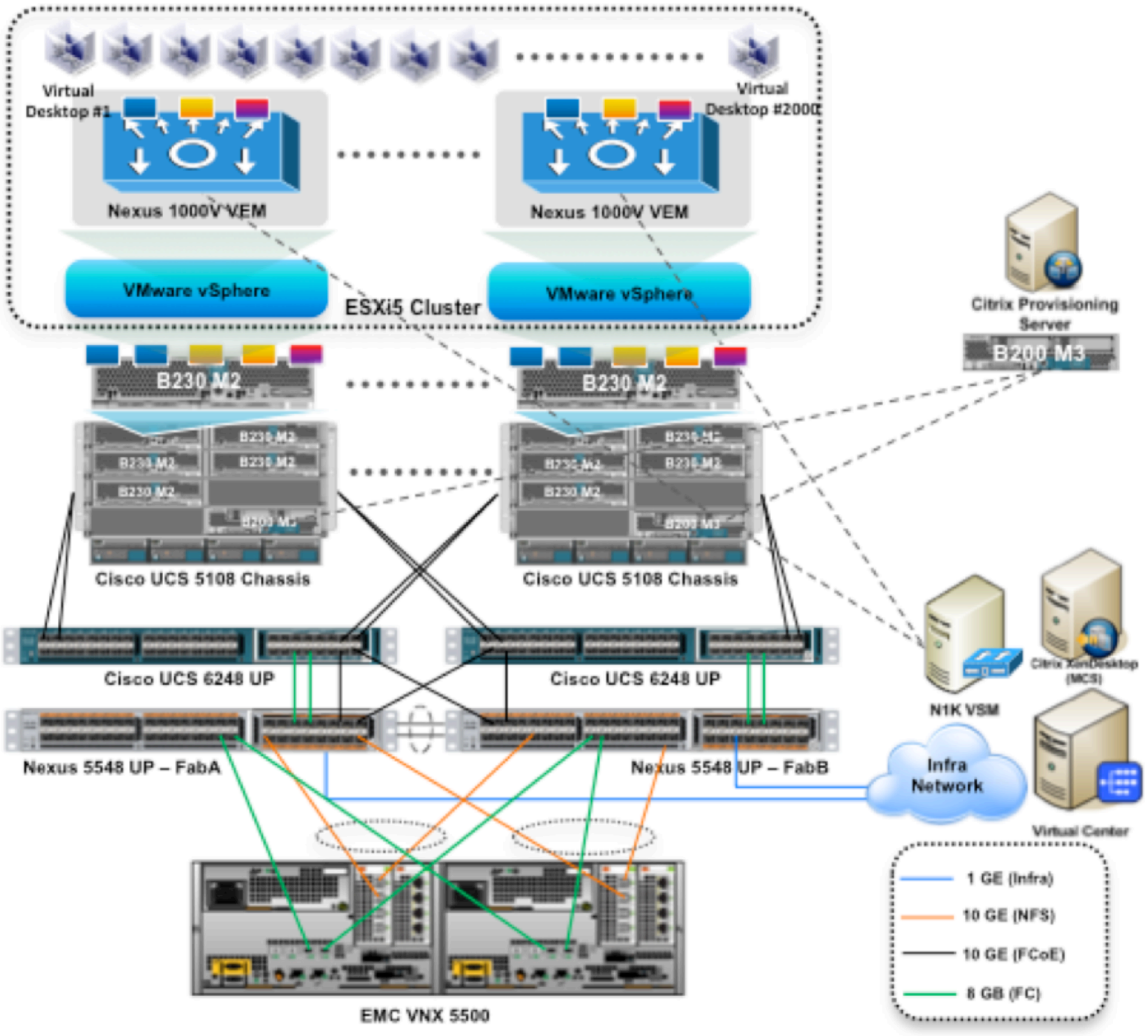
Table 3. Solution Software

Server and Network Architecture

Topology

The architecture diagram in this section shows the server configuration and network topology, Figure 2.

Figure 2. Core Storage Layout



Server Details

The Server uses the following configuration:

- Cisco Unified Computing System for managing servers, storage and networking components within single management domain
- The server uses local boot with mirrored drives for operating system
- The VMs created on the server are stored in NFS shares provisioned on the VNX 5500 storage to enable vMotion
- Network adapters are teamed for fault tolerance and throughput

Network Layout

The network layout is as follows:

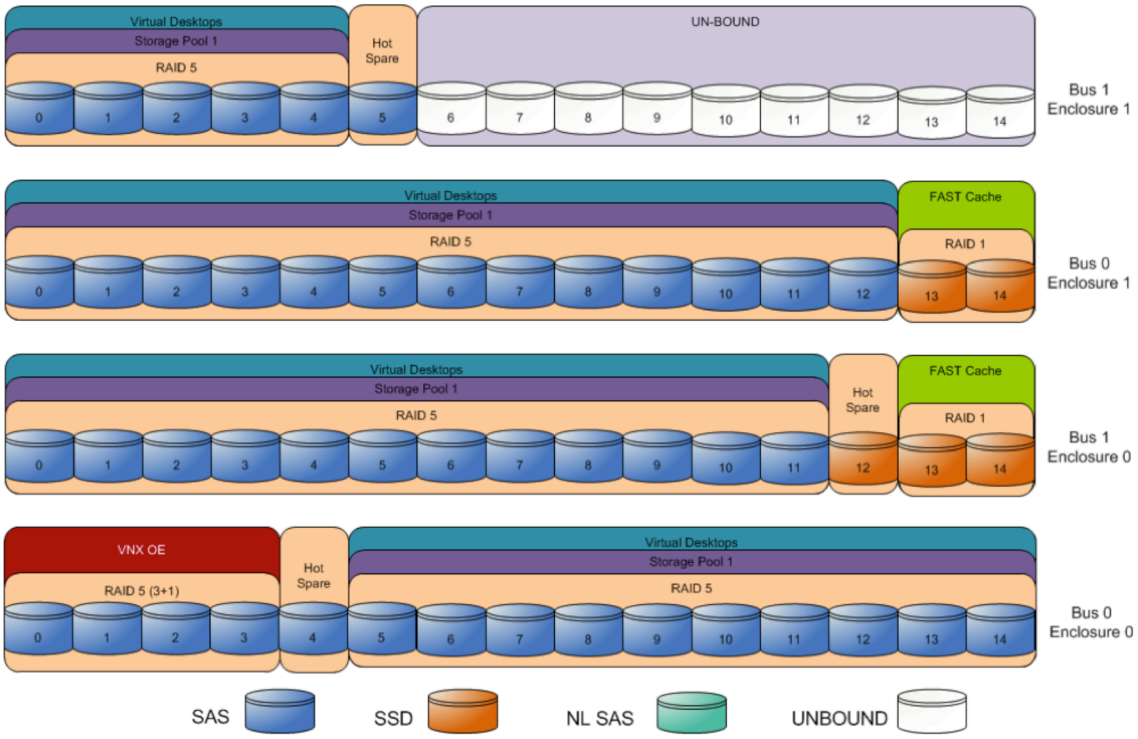
- Management, Storage, vMotion and Production traffic are provisioned as separate VLANs using 10GE connectivity
- Virtual port channels are implemented on two Nexus switches for redundant loop-free topologies.
- Virtual switch for this environment is provisioned using Cisco Nexus 1000v

Storage Architecture

Core Storage Layout

The following core storage diagram illustrates the layout of the disks that are required to store 1000 desktop virtual machines. This layout does not include space for user profile data. Refer to VNX shared file systems for more information.

Figure 3. Core Storage Layout



Core Storage Layout Overview

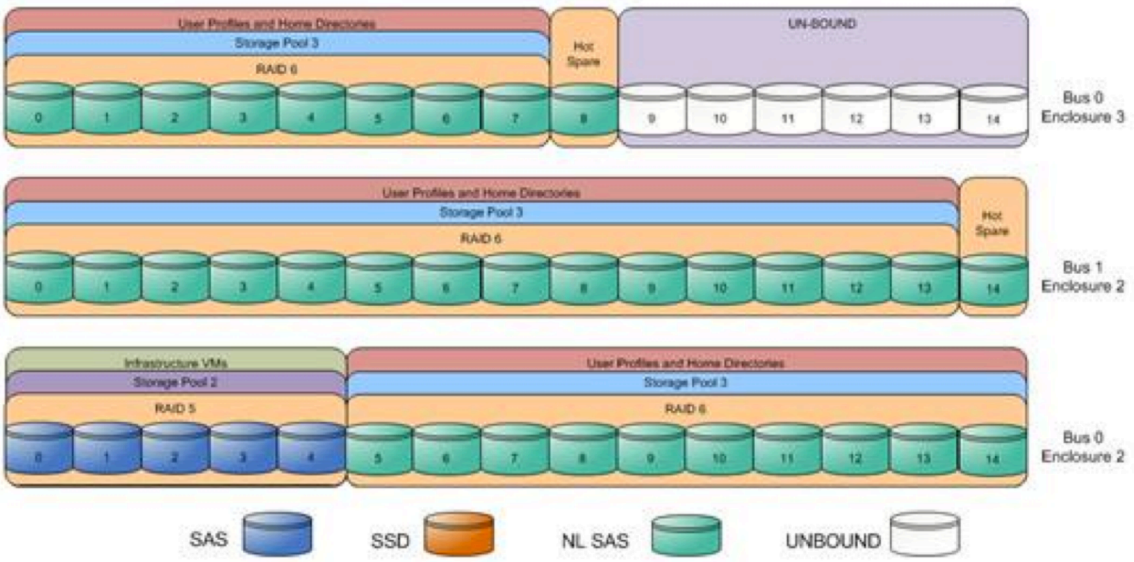
The following core configuration is used in the reference architecture:

- Four SAS disks (0_0_0 to 0_0_3) are used for the VNX OE.
- Disks 0_0_4, 1_0_12, and 1_1_5 are hot spares. These disks are marked as hot spare in the storage layout diagram.
- Forty SAS disks (0_0_5 to 0_0_14, 1_0_0 to 1_0_11, 0_1_0 to 0_1_12, and 1_1_0 to 1_1_4) in the RAID 5 storage pool 1 are used to store virtual desktops. FAST Cache is enabled for the entire pool.
- For NAS, forty LUNs of 200 GB each are carved out of the pool to provide the storage required to createsixteen NFS file systems. The file systems are presented to the vSphere servers as sixteen NFS datastores.
- For FC, sixteen LUNs of 500 GB each are carved out of the pool to present to the vSphere servers as sixteen VMFS datastores.
- Four Flash drives (1_0_13 to 1_0_14 and 0_1_13 to 0_1_14) are used for EMC VNX FAST Cache. There are no user-configurable LUNs on these drives.
- Disks 1_1_6 to 1_1_14 are unbound. They were not used for testing this solution

Optional User Data Storage Layout

In solution validation testing, storage space for user data was allocated on the VNX array, Figure 4. This storage is in addition to the core storage shown above. If storage for user data exists elsewhere in the production environment, this storage is not required.

Figure 4. Optional Storage Layout



Optional Storage Layout Overview

The following optional configuration is used in the reference architecture:

- Disks 1_2_14 and 0_3_8 are hot spares. These disks are marked as hot spare in the storage layout diagram.
- Five SAS disks (0_2_0 to 0_2_4) in the RAID 5 storage pool 2 are used to store the infrastructure virtual machines. A 1 TB LUN or NFS file system is carved out of the pool to present to the vSphere servers as a VMFS or NFS datastore.
- Thirty two NL-SAS disks (0_2_5 to 0_2_14, 1_2_0 to 1_2_13, and 0_3_0 to 0_3_7) in the RAID 6 storage pool 3 are used to store user data and roaming profiles. FAST Cache is enabled for the entire pool. Thirty LUNs of 1 TB each are carved out of the pool to provide the storage required to create four CIFS file systems.
- Disks 0_3_9 to 0_3_14 are unbound. They were not used for testing this solution.

VNX Shared File Systems

The virtual desktops use two shared filed systems – 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.

High Availability and Failover

Introduction

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

Storage Layers

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 vSphere 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 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 vSphere servers. VMware vSphere High Availability (HA) is configured on the cluster to help recover virtual desktops quickly in case of a complete host failure.

For the FC variant, EMC PowerPath Virtual Edition is configured on each ESX host that 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 Environmental Profile

Profile Characteristics

The solution was validated with the following environment profile, Figure 5.

Table 4. Validated Environment Profile

Profile characteristic	Value
Number of virtual desktops	2000
Virtual desktop OS	Windows 7 Enterprise (32-bit) SP1
CPU per virtual desktop	1 vCPU
Number of virtual desktops per CPU core	8
RAM per virtual desktop	2 GB
Desktop provisioning method	Citrix Provisioning Services (PVS)
Average storage available for each virtual desktop	4 GB (VMDK and VSwap)
Average IOPS per virtual desktop at steady state	8 IOPS
Average peak IOPS per virtual desktop during boot storm	65 IOPS (NFS variant) 84 IOPS (FC variant)

Profile characteristic	Value
Number of datastores to store virtual desktops	16
Number of virtual desktops per datastore	125
Disk and RAID type for datastores	RAID 5, 300 GB, 15k rpm, 3.5-inch SAS disks, FAST Cache enabled
Disk and RAID type for CIFS shares to host roaming user profiles and home directories (optional for user data)	RAID 6, 2 TB, 7,200 rpm, 3.5-inch NL-SAS disks

Conclusion

Cisco VSPEX solution has been engineered to enable a simple, quick and reliable deployment of a broad range of shared storage workloads. This solution in conjunction with the Cisco Unified Computing System and Nexus switches, Citrix XenDesktop, VMware vSphere, and VNX provides a proven and economical path to end-user computing virtualization. EMC next-generation backup enables protection of this dynamic environment and allows for growth and flexibility.

Table 5. Solution Benefits

Feature	Benefits
Cisco Unified Computing System	First truly unified platform that combines industry-standard, x86-architecture blade and rack servers with networking and storage access into a single system. The system uses a wire- once architecture with a self-aware, self-integrating, intelligent infrastructure delivering dramatic improvement in TCO.
Cisco Nexus series Switches	Designed for a broad range of physical, virtual, storage access, and high-performance computing environments, thus giving customers the flexibility to meet and scale their IT requirements in a gradual manner and at a pace that aligns with their business objectives.
Citrix XenDesktop 5.6	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.
EMC VNX Series	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.
EMC next-generation backup	Unifies the backup process with industry leading deduplication backup software and system, and achieves the highest levels of performance and efficiency.
VMware vSphere 5 Desktop	Provides a proven, industry leading virtualization platform for virtual desktops. vSphere 5 adds new storage features to an already rich set of capabilities to help increase and scale virtualized environments.

This reference architecture provides a blueprint of a validated Citrix XenDesktop virtualization solution enabled by EMC VNX series, EMC next-generation backup, and the VMware vSphere 5 virtualization platform.

References

Cisco Documentation

For documentation, see the following:

- Cisco Unified Computing System, please refer to the website http://www.cisco.com/go/unifiedcomputing
- Cisco Nexus series Switches, please refer to the website http://www.cisco.com/go/nexus
- Cisco Validated Designs, please refer to the website http://www.cisco.com/go/dcdesignzone
- Cisco VDI Solutions, please refer to the website http://www.cisco.com/go/vdi

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 VSPEX End-User Computing Solutions Citrix XenDesktop 5.6 with VMware vSphere 5 for 500 Virtual Desktops Enabled by Citrix XenDesktop 5.6, VMware vSphere 5, VNX5500—Deployment Guide
- EMC VSPEX End-User Computing Solution Citrix XenDesktop 5.6 with VMware vSphere 5—Sizing Guide
- EMC Infrastructure for Virtual Desktops Enabled by EMC VNX Series (FC), VMware vSphere 4.1, and Citrix XenDesktop 5 — Reference Architecture
- EMC Infrastructure for Virtual Desktops Enabled by EMC VNX Series (FC), VMware vSphere 4.1, and Citrix XenDesktop 5 — Proven Solution Guide
- EMC Infrastructure for Virtual Desktops Enabled by EMC VNX Series (NFS), VMware vSphere 4.1, and Citrix XenDesktop 5 — Reference Architecture
- EMC Infrastructure for Virtual Desktops Enabled by EMC VNX Series (NFS), VMware vSphere 4.1, and Citrix XenDesktop 5 — 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 VMware View 5.0, EMC VNX Series (NFS),VMware vSphere 5.0, VMware View 5.0, and VMware View Composer 2.7— Proven Solutions Guide
- EMC Infrastructure for VMware View 5.0, EMC VNX Series (NFS),VMware vSphere 5.0, VMware View 5.0, and VMware View Composer 2.7— Reference Architecture
- EMC VSI for VMware vSphere: Storage Viewer — Product Guide
- EMC VSI for VMware vSphere: Unified Storage Management— Product Guide

Other Documentation

For Citrix or VMware documentation, please refer to the Citrix and VMware websites at www.Citrix.com and www.VMware.com.

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