Cisco Solution for EMC® VSPEX™ End-User Computing

Citrix® XenDesktop™ 5.6 with VMware® vSphere™ 5 for 500 Virtual Desktops

Enabled by Cisco Unified Computing System, Cisco Nexus Switches, Citrix XenDesktop 5.6, VMware vSphere 5 and EMC VNX5300™

Reference Architecture Guide

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Contents

Reference architecture overview

Document purpose

This document describes the reference architecture of the Cisco Solution for EMC® VSPEX™ End-User Computing for 500 Virtual Desktops (the Cisco Solution for EMC VSPEX.) This document provides the solution layout and guidelines for building similar solutions.

Solution purpose

Cisco Solution for EMC 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. The Cisco Solution for EMC VSPEX eliminates desktop virtualization planning and configuration burdens. Cisco Solution for EMC 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 EMC VSPEX features the enterprise-class Cisco Unified Computing System (UCS) Servers, Nexus switches and Cisco UCS Fabric Interconnects running Cisco UCS Manager 2.1 (Fibre Channel variant only) 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 500 Virtual Desktops Enabled by Citrix XenDesktop 5.6, VMware vSphere 5, VNX5300*—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 the Cisco UCS C220 M3 Rack-Mount Server, managed by Cisco UCS Manager 2.1(1a,) Cisco Nexus 2232PP Fabric Extenders, Cisco UCS 6248UP or 6296UP Fabric Interconnects, EMC VNX5300™ and VMware vSphere 5 to provide resources for a Citrix XenDesktop 5.6 environment of Windows 7 virtual desktops provisioned by Machine Creation Services for the Fibre Channel (FC) variant. For the fully supported NFS variant, the Cisco UCS Fabric Interconnects and Nexus 2232PP Fabric Extenders are replaced by Nexus 5548UP switches. For both the NFS and FC variants, Citrix Provisioning Services (PVS) may also be used to successfully deploy this solution.

Planning and designing the server, networking and storage infrastructure for Citrix XenDesktop environment is a critical step because the server infrastructure should be sized to handle the desktop workload, both in terms of density and scale, the networking infrastructure should be provisioned to handle the burst of data traffic, and the shared storage must be able to absorb large bursts of input/output (I/O) that occur over the course of a workday.

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.
- Provide N+1 Server fault tolerance

Note: To provide N+1 server fault tolerance for a minimum of 500 desktops, we deployed five Cisco UCS C220 M3 rack servers. This configuration actually provides N+1 server fault tolerance for 600 users. As an alternative, Customers can deploy four Cisco UCS C220 M3 rack servers and efficiently support 500 desktops with all four servers in service and 450 desktops with three of the four servers on line.

Cisco UCS C-Series Rack-Mount Servers, managed by Cisco UCS Manager 2.1(1a) software, provide unprecedented virtual desktop density per server resulting in industry leading server cost per desktop.

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

The Cisco Solution for EMC VSPEX 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, including managed Cisco UCS C-Series servers and VNX operating environment features such as FAST Cache directly attached to Cisco UCS 6248UP or 6296UP Fabric Interconnects.

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 for this solution.

- Cisco UCS C-series Rack-Mount Servers
- Cisco Nexus 5000 Series Access Switches (NFS Variant)
- Cisco UCS 6248UP and 6296UP Fabric Interconnects (FC Variant)
- Cisco Nexus 2200 Series Fabric Extenders (FC Variant)
- Citrix XenDesktop 5.6
- Machine Creation Services
- VMware vSphere 5
- VNX FAST Cache
- VNX VAAI Support
- VSI for VMware vSphere
- EMC VNX Series

Hardware resources on page 13, and Software resources on page 14 provide more information on the components that make up the solution.

Cisco UCS C-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 UCS Manager Service Profile and Direct Storage Connection support. 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.

Managed Cisco UCS C-Series Rack-Mount Servers reduce total cost of ownership (TCO) and increase business agility by extending Cisco Unified Computing System™ innovations to a rack-mount form factor. These servers:

- Can be managed and provisioned centrally using Cisco UCS Service Profiles with Cisco UCS Manager 2.1(1a,) Cisco UCS Fabric Interconnects and Nexus 2232PP Fabric Extenders
- Offer a form-factor-agnostic entry point into the Cisco Unified Computing System, which is a single converged system with configuration automated through integrated, model-based management
- Simplify and speed deployment of applications
- Increase customer choice with unique benefits in a familiar rack package
- Offer investment protection through the capability to deploy them either as standalone servers or as part of the Cisco Unified Computing System

Note: This study highlights the use of Managed Cisco UCS C-Series Rack-Mount servers in the FC variant. The alternative NFS variant utilizes the Cisco UCS C220 M3 servers in stand-alone mode.

Cisco Nexus 5000 Series Switches (NFS Variant)

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.

Cisco UCS 6248UP and 6296UP Fabric Interconnects (FC Variant)

The Cisco UCS 6200 Series Fabric Interconnects are a core part of the Cisco Unified Computing System, providing both network connectivity and management capabilities for the system. The Cisco UCS 6200 Series offers line-rate, low-latency, lossless 10 Gigabit Ethernet, Fibre Channel over Ethernet (FCoE), and Fibre Channel functions.

Cisco UCS Fabric Interconnects create a unified network fabric throughout the Cisco Unified Computing System. They provide uniform access to both networks and storage, eliminating the barriers to deploying a fully virtualized environment based on a flexible, programmable pool of resources.

The Cisco UCS 6200 Series Fabric Interconnect offers several key features and benefits that lower the total cost of ownership (TCO), including:

- Additional bandwidth up to 1920 Gbps, increased port density up to 96 ports in two rack units (2 RU)
- Reduced port-to-port latency from 3.2 microseconds (ms) to 2 ms

- High-performance, flexible unified ports capable of line-rate, low-latency, lossless 1/10 Gigabit Ethernet, Fibre Channel over Ethernet (FCoE), and 4/2/1 and 8/4/2 Fibre Channel
- Centralized, unified management with Cisco UCS Manager software
- Efficient cooling and serviceability including front-to-back cooling, redundant front-plug fans and power supplies, and rear cabling
- Fibre Channel and 10 Gigabit Ethernet uplink connectivity are included with the Cisco UCS 6248UP and 6296UP Fabric Interconnect models

Cisco Nexus 2232PP Fabric Extenders (FC Variant)

The Cisco Nexus 2232PP 10GE Fabric Extender provides 32 10 Gb Ethernet and Fibre Channel Over Ethernet (FCoE) Small Form-Factor Pluggable Plus (SFP+) server ports and eight 10 Gb Ethernet and FCoE SFP+ uplink ports in a compact 1 rack unit (1RU) form factor.

The Nexus 2232PP in conjunction with VIC1225 converged network adapters in the Cisco UCS C220 M3 rack servers provide fault-tolerant single wire management of the rack servers through up to 8 uplink ports to Cisco Fabric Interconnects.

Reduce TCO

- The innovative Fabric Extender approach reduces data center cabling costs and footprint with optimized inter-rack cabling
- Unified fabric and FCoE at the server access layer reduce capital expenditure and operating expenses

Simplify Operation

- Cisco UCS 6248UP or 6296UP Fabric Interconnects provide a single point of management and policy enforcement
- Plug-and-play management includes auto-configuration

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.

Machine Creation Services

Machine Creation Services (MCS) is a provisioning mechanism introduced in XenDesktop 5.0. It is integrated with the 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, 600 pooled virtual desktops that are running Windows 7 32-bit operating systems were provisioned by using MCS. The desktops were deployed from one dedicated machine catalog.

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 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.

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 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.

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	✓

Software suites available

- 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.

Software packs available

- 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 solution in two storage protocol variants.

Figure 1 depicts the logical architecture of the NFS data access, wherein 10 GbE carries storage traffic for servers hosting virtual desktops

Figure 1. Logical architecture for the NFS Variant

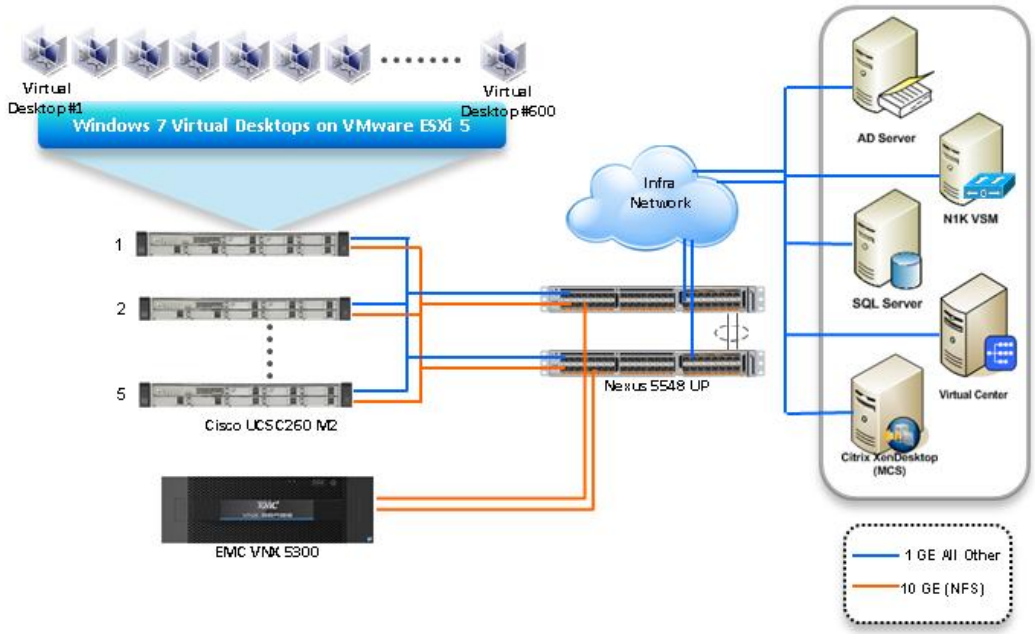
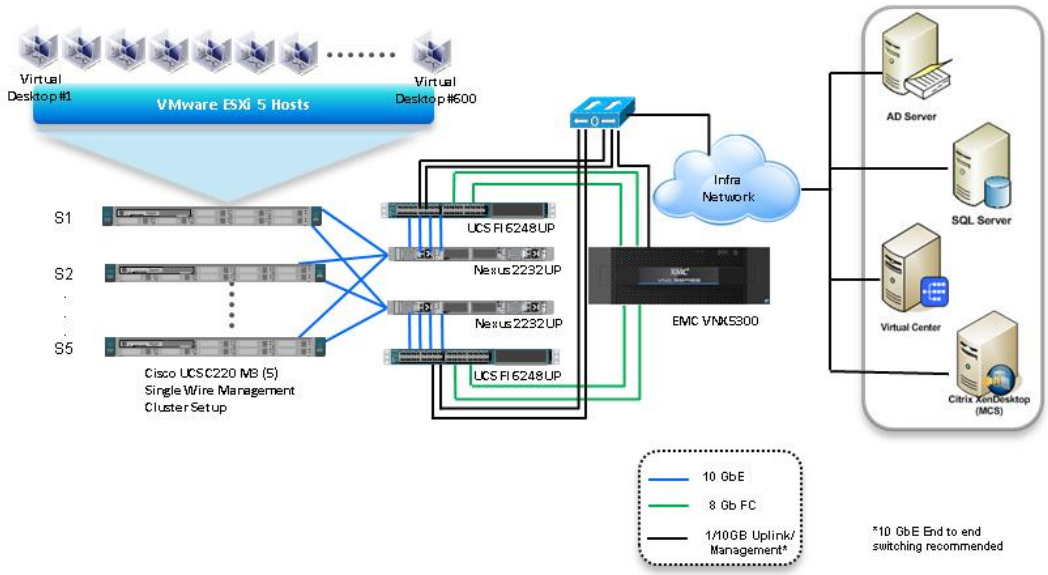


Figure 2 depicts the logical architecture of the Fibre Channel (FC) variant, wherein a FC SAN carries storage traffic and 10 GbE carries management and application traffic.

Figure 2. Logical Architecture for the FC variant



Reference architecture overview

The reference architecture consists of the following components.

Cisco UCS C220 M3 Server—Five Cisco UCS C220 M3 Rack Servers were utilized in the design to provide N+1 fault tolerance for 500 Virtual Windows 7 desktops at the server level, guaranteeing the same end-user experience if just 4 C220 M3 servers are operational. In fact, the five server architecture can comfortably support 600 desktops with N+1 server fault tolerance. For that reason, the document architecture will refer to supporting a 600 desktop capacity with five Cisco UCS C220 M3 servers.

Alternatively, with just four Cisco UCS C220 M3 Rack Servers, we can effectively host 500 users with all servers online or 450 Users with 3 UCS C220 M3 servers running.

Building on the success of the Cisco UCS C200 M2 rack-mount server, the enterprise-class Cisco UCS C220 M3 server further extends the capabilities of Cisco's Unified Computing System portfolio in a 1U form factor with the addition of the Intel® E5-2600 series product family CPUs that deliver significant performance and efficiency gains. In addition, the Cisco UCS C220 M3 server provides 16 DIMM slots, 8 drives and 2 x 1 GbE LOM ports delivering outstanding levels of density and performance in a compact package. Each Cisco UCS 220 M3 server utilized a Cisco VIC1225 converged network adapter. In the NFS Variant, the VIC1225 handles storage communications only. In the FC Variant, all traffic is hosted by the VIC1225.

Cisco Nexus 5548UP Switches (NFS Variant) — Two Cisco Nexus 5548UP access switches are 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.

In the NFS Variant of this architecture, neither the optional Nexus 5548UP expansion modules nor the optional L3 module were used.

Cisco UCS 6248UP or 6296UP Fabric Interconnects (FC Variant) —Two Cisco UCS 6248UP Fabric Interconnects running UCS Manager 2.1(1a) firmware provide unified network, server and storage management, including FC zoning. UCS 6296UP FIs could be used if higher port densities are required.

The optional 16-unified-port expansion module was not used in this architecture.

The Cisco UCS 6248UP or 6296UP Fabric Interconnects are uplinked at 1 or 10Gbps to the Customer's existing L2 or L3 network. Cisco recommends 10Gbps uplinks.

Cisco Nexus 2232PP 10GE Fabric Extenders (FC Variant)—Two Nexus 2232PP 10GE Fabric Extenders were deployed to provide cluster-mode single wire management to the UCS C220 M3 rack servers.

Four of eight available10Gb ulplinks from each Nexus 2232 were utilized to provide 40Gb of bandwidth between the UCS 6248UP Fabric Interconnects and the Cisco UCS C220 M3 rack servers.

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 dedicated Customer infrastructure VMware vSphere 5 Servers.

Virtual desktops—Six hundred virtual desktops running Windows 7 32-bit operating systems are provisioned using MCS, a provisioning mechanism introduced in XenDesktop 5.0.

VMware vCenter Server 5—Provides a scalable and extensible platform that forms the foundation for virtualization management for the VMware vSphere 5 cluster. The vCenter Server in this architecture was deployed on a Windows 2008 R2 SP1 virtual machine on dedicated Customer infrastructure VMware vSphere 5 hosts.

Microsoft Windows 2008 R2 Domain Controller and DNS server—Two Windows 2008 R2 Domain Controllers provide 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. These servers were hosted as a virtual machine on dedicated Customer infrastructure VMware vSphere 5 Servers.

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 dedicated Customer infrastructure VMware vSphere 5 server.

Mixed 10 and 1 Gb IP Network (NFS Variant)—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 VNX5300 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 VNX5300. The Cisco UCS C220 M3 management communications, desktop clients, XenDesktop management components, and Windows server infrastructure can reside on 1 Gb network.

10Gb IP Network (FC Variant)—All ethernet network communications from the Cisco UCS C220 M3s through the Cisco UCS Fabric Interconnects utilize cluster mode 10Gb speeds. The Cisco UCS Fabric Interconnects are utilized to uplink ethernet traffic to the Customer's existing Layer 2 or 3 switches for communications with

infrastructure services and client machines. Cisco recommends 10Gb uplinks to the existing Customer network for best performance.

Fibre Channel Network (FC Variant)—Storage traffic between all vSphere hosts and the VNX5300 is carried over an 8Gb FC network.

EMC VNX5300 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 VNX5300.

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 C220 M3 Rack Server	5 x Cisco UCS C220 M3 Rack Servers for 600 virtual desktops (600 HA) or 4 x Cisco UCS C220 M3 Rack Servers for 500 virtual desktops (450 HA) each with: • 2 x Intel Xeon E5-2690 processor • 256 GB (16 x 16GB 1600 Mhz) memory • 2 x 600 GB SAS 15k RPM hard disk • 1 x Cisco VIC1225 10 GbE Dual port PCIe CNA (for 10 GbE Network) • 2 x 1 GbE LOM (onboard Ethernet) • 1 x 10/100/1000 Mbps dedicated Management port	600 GB SAS drives used for NFS Variant Only Onboard 1 Gb LOM ports used for NFS Variant Only. Onboard 10/100 /1000 Mbps dedicated Management port used in NFS variant only
Cisco Nexus 5548UP switches **(NFS Variant)**	• 32 x fixed Unified ports (Supports 10 GbE, FCoE, FC) • 1 x 1 GbE Management port	2 x Nexus 5548UPs for redundant configuration
Cisco UCS 6248UP FI **(FC Variant)**	• 32 x fixed Unified ports (Supports 10 GbE, FCoE, FC) • 1 x 1 GbE Management port	2 x Cisco UCS 6248UP FIs for redundant configuration
Cisco Nexus 2232PP **(FC Variant)**	• 32 x fixed 10GbE • 8 x 10 GbE Uplink ports	2 x Nexus 2232PPs for cluster single wire configuration
NFS network infrastructure **(NFS Variant)**	Minimum switching capability: • Two 1 GbE ports per vSphere server for all traffic except NFS storage • Two 10 GbE ports per vSphere server for NFS storage Four 10 GbE ports for VNX Data Mover connections	Redundant LAN configuration
FC network infrastructure **(FC Variant)**	Minimum switching capability: • Two 10 Gb Unified ports per C220 M3 provided by VIC1225 CNA Provides six 10 GbE ports for management, data and vMotion and two 8Gb FC ports for storage per vSphere server • Four 8 Gb FC ports for VNX SP connections	Redundant LAN/SAN configuration

Hardware	Configuration	Notes
EMC VNX5300	• Two Data Movers (active/standby) (NFS Variant) • Two 10 GbE interfaces per Data Mover • Two 8 Gb FC ports per storage processor (FC only) • Fifteen 300 GB, 15 k rpm 3.5-inch SAS disks • Three 100 GB, 3.5-inch flash drives	VNX shared storage
	Nine 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	
Servers for Customer infrastructure	Minimum number required: • Two physical servers (minimum) • 48 GB RAM per server • Four processor cores per server • Two 1 GbE ports per server (10GB recommended)	These servers and the roles they fulfill may already exist in the customer environment

Software resources

Table 3 lists the software used in this solution.

Table 3. Solution software

Software	Configuration
VNX5300 (shared storage, file systems)	
VNX OE for file	Release 7.0.50-2
VNX OE for block	Release 31 (05.31.000.5.704)
EMC VSI for VMware vSphere: Unified Storage Management	Version 5.1
EMC VSI for VMware vSphere: Storage Viewer	Version 5.1
EMC PowerPath Viewer (FC variant only)	Version 1.0.SP2.b019
XenDesktop Desktop Virtualization	
Citrix XenDesktop Controller	Version 5.6 FP1 Platinum Edition
Operating system for XenDesktop Controller	Windows Server 2008 R2 SP1 Enterprise Edition
Microsoft SQL Server	Version 2008 R2 Standard Edition
Next-generation backup	
Avamar	6.0.0-592
VMware vSphere	
vSphere server	5.0 Update 1
vCenter Server	5.0 Update 1
Operating system for vCenter Server	Windows Server 2008 R2 SP1Enterprise Edition
vStorage API for Array Integration Plugin (VAAI) (NFS variant only)	1.0-10
PowerPath Virtual Edition (FC variant only)	5.7.0
Virtual Desktops **(Note: beyond base OS, software was used for solution validation and is not required)**	
Base operating system	Microsoft Windows 7 Enterprise (32-bit) SP1
Cisco UCS Server	

Software	Configuration
Cisco UCS C220 M3	1.4(7b)
Network	
Nexus 5548 UP (NFS Variant Only)	version 5.1(3)N1(1a)
Cisco UCS Manager	
Cisco UCS 6248UP Fabric Interconnect (FC Variant Only)	2.1.(1a)
Microsoft Office	Office Enterprise 2007 SP2
Internet Explorer	8.0.7601.17514
Adobe Reader	9.1
McAfee Virus Scan	8.7.0i Enterprise
Adobe Flash Player	11
Bullzip PDF Printer	6.0.0.865
FreeMind	0.8.1
Login VSI (VDI workload generator)	3.6 Professional Edition

Server and Network architecture

Toplogy

The architecture diagrams in this section shows the server configuration and network topology (Figure 2).

Figure 3. Server Configuration and Network Architecture NFS Variant

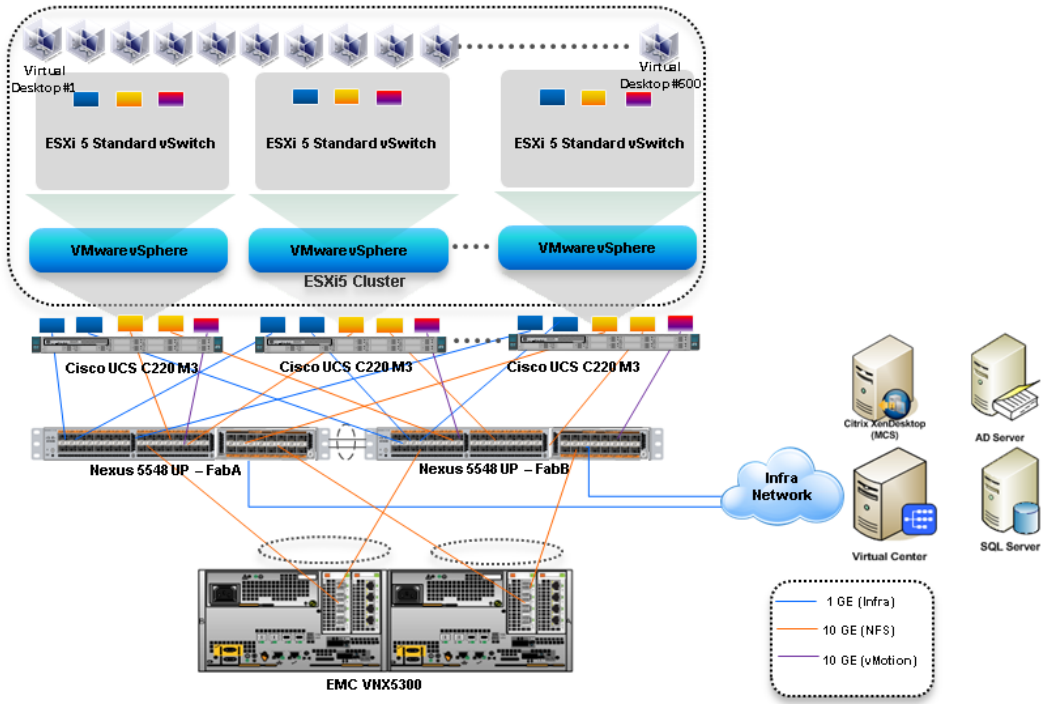
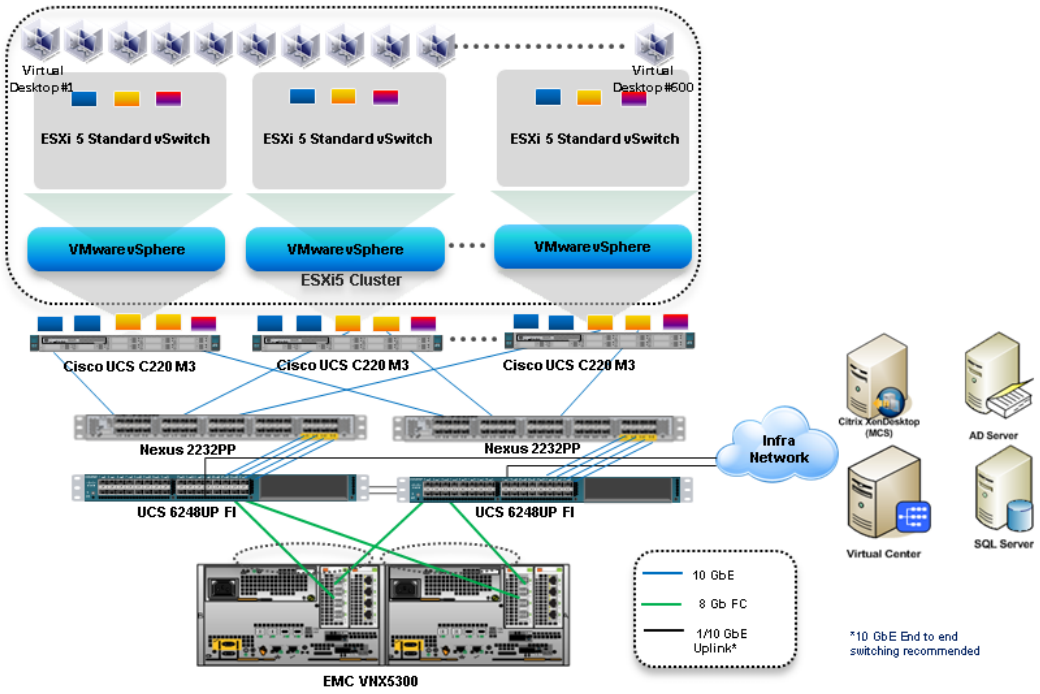


Figure 4. Server and Network Architecture FC Variant



Server details

The Cisco UCS C220 M3 servers use the following configuration:

- The Cisco UCS C220 M3s use local boot with mirrored drives for operating system (NFS Variant)
- The Cisco UCS C220 M3s use Boot from SAN for operating system (FC Variant)
- The VMs created on the server are stored in NFS shares provisioned on the VNX 5300 storage to enable vMotion. (NFS Variant)
- The VMs created on the server are stored in FC LUNs provisioned on the VNX5300 storage to enable vMotion. (FC Variant)

Network Layout

The network layout is as follows:

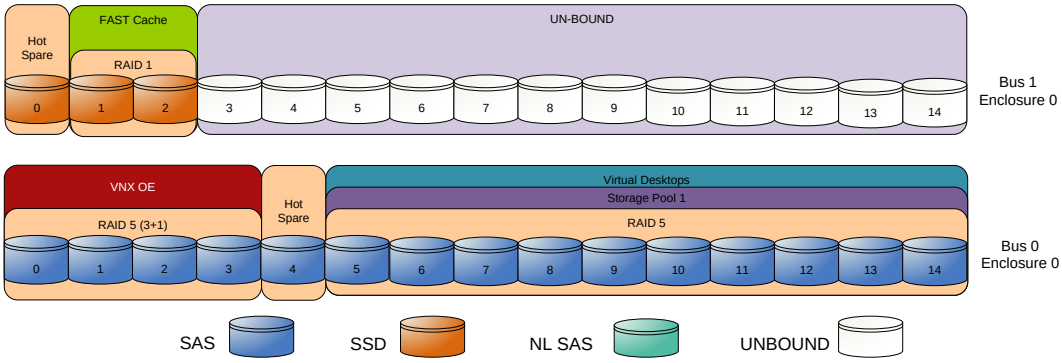
- Management, Storage, vMotion and VDI traffic are provisioned as separate VLANs using 1GE and 10GE connectivity. (NFS Variant)
- Virtual port channels are implemented on two Nexus switches for redundant loop-free topologies. (NFS Variant)
- Management, vMotion and VDI traffic are provisioned as separate VLANs using 10 GE connectivity. 8 Gb FC protocol is used for Storage. (FC Variant)

Storage architecture

Core storage layout

The following core storage diagram illustrates the layout of the disks that are required to store up to 600 desktop virtual machines. This layout does not include space for user profile data. Refer to VNX shared file systems on page 26 for more information.

Figure 5. 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 and 1_0_0 are hot spares. These disks are marked as hot spare in the storage layout diagram.
- Ten SAS disks (0_0_5 to 0_0_14) on the RAID 5 storage pool 1 are used to store virtual desktops. FAST Cache is enabled for the entire pool.

For NAS, ten LUNs of 200 GB each are carved out of the pool to provide the storage required to create four NFS file systems. The file systems are presented to the vSphere servers as four NFS datastores.

For FC, four LUNs of 500 GB each are carved out of the pool to present to the vSphere servers as four VMFS datastores.

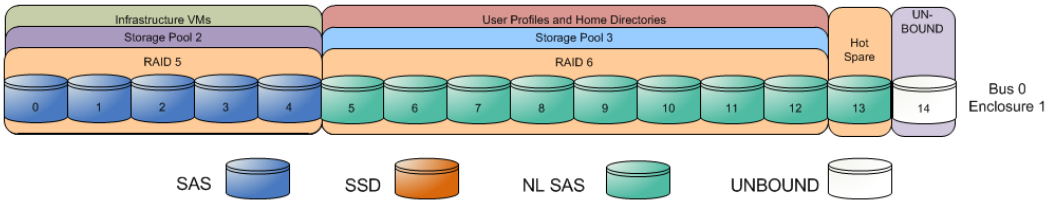
- Two Flash drives (1_0_1 and 1_0_2) are used for EMC VNX FAST Cache. There are no user-configurable LUNs on these drives.
- Disks 1_0_3 to 1_0_14 are unbound. They were not used for testing this solution.

Note: This layout was validated to support 600 virtual desktops on FC and NFS.

Optional user data storage layout

In solution validation testing, storage space for user data was allocated on the VNX array as shown below. 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 6. Optional storage layout



Optional storage layout overview

The following optional configuration is used in the reference architecture:

- Disk 0_1_13 is hot spare. This disk is marked as hot spare in the storage layout diagram.
- Five SAS disks (0_1_0 to 0_1_4) on 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 an NFS datastore.
- Eight NL-SAS disks (0_1_5 to 0_1_12) on the RAID 6 storage pool 3 are used to store user data and roaming profiles. FAST Cache is enabled for the entire pool. Ten LUNs of 1 TB each are carved out of the pool to provide the storage required to create two CIFS file systems.
- Disk 0_1_14 is unbound. It was 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 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 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.

Two Cisco UCS 6248UP Fabric Interconnects and two Nexus 2232PP Fabric Extenders, with five Cisco UCS C220 M3 rack servers attached in single wire cluster mode insure that a single component failure will not reduce system connectivity.

Host layer

The Cisco UCS C220 M3 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.

Four of the five Cisco UCS C220 M3 servers in the architecture could host all 600 virtual desktops in the event of a total failure of one rack server. This N+1 fault tolerance at the Cisco UCS C220 M3 physical level completes the circle of end-to-end high availability and fault tolerance and insures full system capacity.

Validated environment profile

Profile characteristics

The solution was validated with the following environment profile.

Table 4. Validated environment profile

Profile characteristic	Value
Number of virtual desktops	600
Virtual desktop OS	Windows 7 Enterprise (32-bit) SP1
CPU per virtual desktop	1 vCPU
Host CPU in MHz per Virtual Desktop (4 Servers)	285
RAM per virtual desktop	1.5 GB
Desktop provisioning method	Machine Creation Services (MCS)
Average storage available for each virtual desktop	4.3 GB (VMDK and VSwap)
Average IOPS per virtual desktop at steady state	8-10 IOPS
Average peak IOPS per virtual desktop during boot storm	65 IOPS (NFS variant) 84 IOPS (FC variant)
Number of datastores to store virtual desktops	4
Number of virtual desktops per datastore	150
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 (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 UCS and Cisco Nexus Switching	Provides: • high density of virtual desktops per server • linear system scale with increase in number of virtual desktops • Rapid provisioning a scale out infrastructure • low latency and high bandwidth for the clustering, provisioning and storage interconnect networks • the ability to handle the peak I/O load from the clients while keeping response time to a minimum • per virtual desktop-level networking visibility for control and manageability
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 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.
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 Hypervisor	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 powered by Cisco UCS and Nexus Switching.

References

Cisco documentation

For documentation on

- Cisco Unified Computing System, please refer to the website http://www.cisco.com/go/unifiedcomputing
- Cisco UCS C-Series Server Integration with Cisco UCS Manager 2.1 http://www.cisco.com/en/US/partner/docs/unified_computing/ucs/c-series_integration/ucsm2.1/b_UCSM2-1_C-Integration_chapter_010.html
- 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, VNX5300*—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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