

EMC INFRASTRUCTURE FOR VIRTUAL DESKTOPS ENABLED BY EMC VNX, VMWARE vSPHERE 4.1, VMWARE VIEW 4.5, VMWARE VIEW COMPOSER 2.5, AND CISCO UNIFIED COMPUTING SYSTEM

Reference Architecture

EMC GLOBAL SOLUTIONS

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Reference architecture overview

Document purpose The document describes the reference architecture of the EMC Infrastructure for Virtual Desktops Enabled by EMC® VNX™, VMware® vSphere™ 4.1, VMware View™ 4.5, VMware View Composer 2.5 and Cisco Unified Computing System (CS) solution, which was tested and validated by EMC Global Solutions.

Introduction to the VNX family of unified storage platforms The EMC VNX family delivers 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.

All of this is available in a choice of systems ranging from affordable entry-level solutions to high-performance, petabyte-capacity configurations servicing the most demanding application requirements. The VNX family includes the VNXe™ series, purpose-built for the IT manager in entry-level environments, and the VNX series, designed to meet the high-performance, high-scalability requirements of midsize and large enterprises. The VNX family includes two platform series:

- The VNX series, delivering leadership performance, efficiency, and simplicity for demanding virtual application environments that includes VNX7500™, VNX5700™, VNX5500™, VNX5300™, and VNX5100™
- The VNXe (entry) series with breakthrough simplicity for small and medium businesses that includes VNXe3300™ and VNXe3100™

Feature	VNX series	VNXe series
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 and block protocols	✓	✓
Object access through Atmos™ Virtual Edition (Atmos VE)	✓	
Simplified management with EMC Unisphere™ for a single management framework for all NAS, SAN, and replication needs	✓	✓
Up to three times improvement in performance with the latest Intel multicore CPUs, optimized for Flash	✓	

Note: VNXe does not support block compression.

Software suites available

- FAST Suite—Automatically optimizes for the highest system performance and the lowest storage cost simultaneously (not available for the VNXe series or the VNX5100).
- Local Protection Suite—Practices safe data protection and repurposing (not applicable to the VNXe3100 as this functionality is provided at no additional cost as part of the base software).
- 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 (not available for the VNX5100 and VNXe series).
- Total Protection Pack—Includes local, remote, and application protection suites (not applicable to the VNXe3100).
- Total Value Pack—Includes all three protection software suites and the Security and Compliance Suite (the VNX5100 and VNXe3100 exclusively support this package).

Solution purpose

The purpose of this reference architecture is to build and demonstrate the functionality, performance, and scalability of virtual desktops enabled by the EMC VNX family, VMware vSphere 4.1, VMware View 4.5, VMware View Composer 2.5, and Cisco Unified Computing System. We built this solution on an EMC VNX5700 platform with multiprotocol support, which enables Fibre Channel (FC), block-based storage for the VMware vStorage Virtual Machine File System (VMFS) and CIFS-based storage for user data.

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

This document is not a comprehensive guide to every aspect of this solution.

The business challenge

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

The purpose of this solution is to build a replica of a common customer virtual desktop infrastructure (VDI) environment and validate the environment for performance, scalability, and functionality. Customers will realize:

- Increased control and security of their global, mobile desktop environment, which is typically their most at-risk environment
- Better end-user productivity with a more consistent environment
- Simplified management with the environment contained in the data center
- Better support of service level agreements and compliance initiatives
- Lower operational and maintenance costs

The technology solution

This solution demonstrates how to use an EMC VNX platform to provide the storage resources for a robust VMware View 4.5 environment by using Windows 7 virtual desktops.

Planning and designing the storage infrastructure for VMware View is a critical step because the shared storage must be able to absorb large bursts of input/output (I/O) that occur during the course of a day, which can lead to periods of erratic and unpredictable virtual desktop performance. Users can adapt to slow performance, but unpredictable performance will quickly frustrate them.

To provide a predictable performance to a virtual desktop infrastructure, the storage must be able to handle the peak I/O load from the clients without resulting in a lengthy response time. Designing for this workload involves deploying several disks to handle brief periods of heavy I/O, which is expensive to implement.

This solution incorporates the following components and the EMC VNX5700 platform:

- 2,000 Microsoft Windows 7 virtual desktops
- VMware View Composer 2.5-based linked clones
- Storage tiering (SAS and NL-SAS)
- EMC FAST Cache
- EMC FAST VP
- Cisco Unified Computing System (UCS)
- Sizing and layout of the 2,000-desktop VMware View 4.5 environment
- Multipathing and load balancing by EMC PowerPath®/VE
- User data on the CIFS share
- Redundant View Connection Manager

Solution architecture

Architecture diagram

This section describes the tests performed to validate the EMC Infrastructure for Virtual Desktops Enabled by EMC VNX, VMware vSphere 4.1, VMware View 4.5, and VMware View Composer 2.5 solution. It involves building a 2,000-desktop VMware View 4.5 environment on a VNX series system and integrates the new features of each of these systems to provide a compelling, cost-effective VDI platform.

Figure 1 depicts the overall physical architecture of the solution.

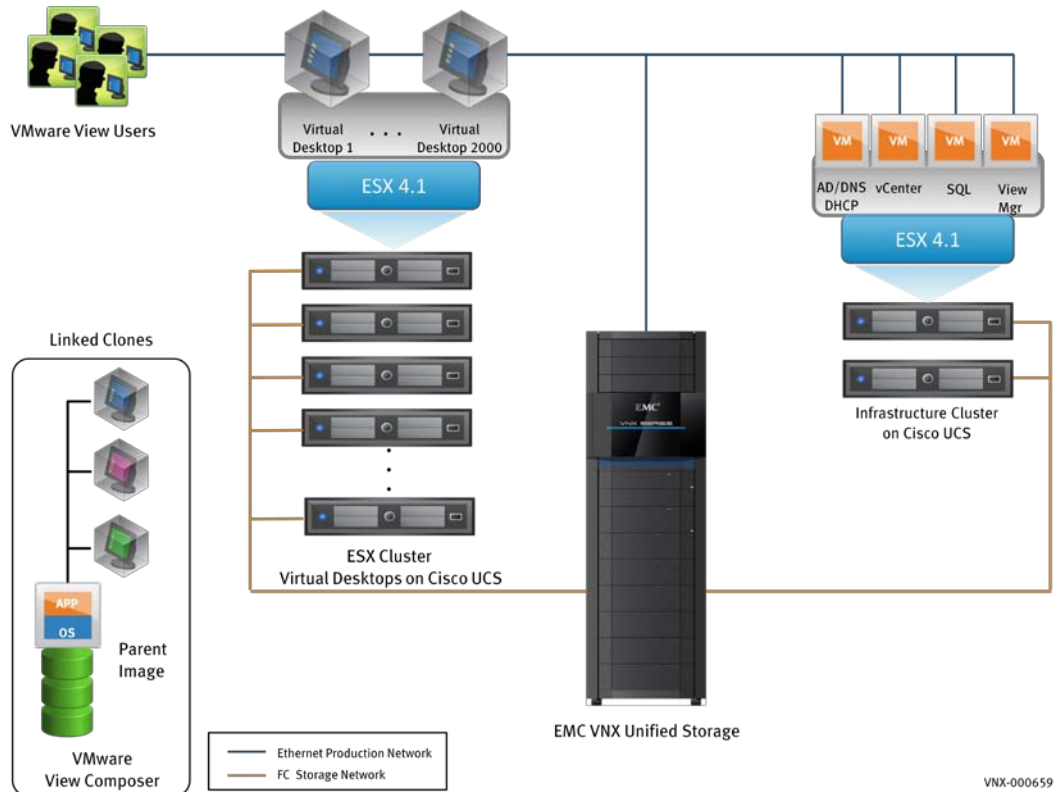


Figure 1. Solution architecture

Table 1 lists the hardware used in this solution.

Table 1. Solution hardware

Hardware	Quantity	Configuration	Notes
EMC VNX5700	1	DAEs configured with: 145 300 GB 15k rpm SAS disks 45 1 TB 7.2k near-line SAS disks 15 200 GB Flash drives	VNX shared storage providing block, file, FAST VP, and FAST Cache
Cisco UCS B200 server blade	16	Two quad-core Intel® Xeon® 5500 Family CPUs 48 GB RAM Converged network adapter	Two UCS chassis, each hosting 8 blades 8 servers per vSphere cluster. Two clusters, each hosting 500 Windows 7 virtual machines.
Cisco UCS B200 server blade	8	Two quad-core Intel Xeon 5500 Family CPUs 96 GB RAM Converged network adapter	One UCS chassis of 8 blades. For one VMware ESX® cluster hosting 1,000 Windows 7 virtual machines.
Intel server	2	Two quad-core Intel 5400 Family CPUs 32 GB RAM Gigabit quad-port Intel VT	Infrastructure virtual machines (VMware vCenter™, DNS, DHCP, Active Directory, Microsoft SQL Server, View Connection server and Replica Servers)
Cisco Nexus 7000	1	C7010 (10 slot) Chassis Intel Xeon CPU with 4 GB RAM	Infrastructure Ethernet switch
Cisco MDS 9509	2	Nine slots, Two Supervisor modules, five 4 Gbps FC modules, two 2 Gbps FC modules, dual power supply	For dual FC fabric
Cisco UCS Chassis	3	UCS 5108 2 UCS 2104XP-I/O module	For 24 server blades, 6 UCS 2104XP IOMs
Windows 7 virtual desktops	Each	1 vCPU, 1.5 GB RAM, 20 GB VMDK, 1 NIC	Virtual desktops that are created for this solution

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

Table 2. Solution software

Software	Configuration	Notes
EMC VNX5700 VNX OE for block	Release 31	Operating environment for block
EMC VNX5700 VNX operating environment (OE) for file	Release 7.0	Operating environment for file
VMware vSphere ESX	4.1 Build 260247	Server hypervisor
EMC PowerPath Virtual Edition	5.4 SP2	Multipathing and load balancing for block access.
VMware vCenter Server	4.1 build 258902	vSphere Management Server
VMware View Manager	4.5 build 277452	Software hosting virtual desktops
VMware View Composer	2.5	View component that uses linked clone technology to reduce storage size
Microsoft SQL Server	2005	Database that hosts the tables for VMware vCenter, View Composer, and View Events
Microsoft Windows 2008	R2	Operating system for the server environment
EMC Unisphere™	1.0	Management tool for EMC VNX series
Microsoft Windows 7 Enterprise	64-bit RTM	Operating system for the virtual desktops
VMware Tools	8.3.2	Enhancement tool for the virtual machine
Microsoft Office	Office 2007 SP2	Used on the virtual desktops
UCS	1.2	Firmware, management software

Logical diagrams

As part of validating this solution, we compared the test results using the following scenarios:

- FAST Cache with no dedicated replica LUN
- FAST Cache with dedicated replica LUN
- No FAST Cache with dedicated replica LUN

Each scenario is pictured in the following diagrams.

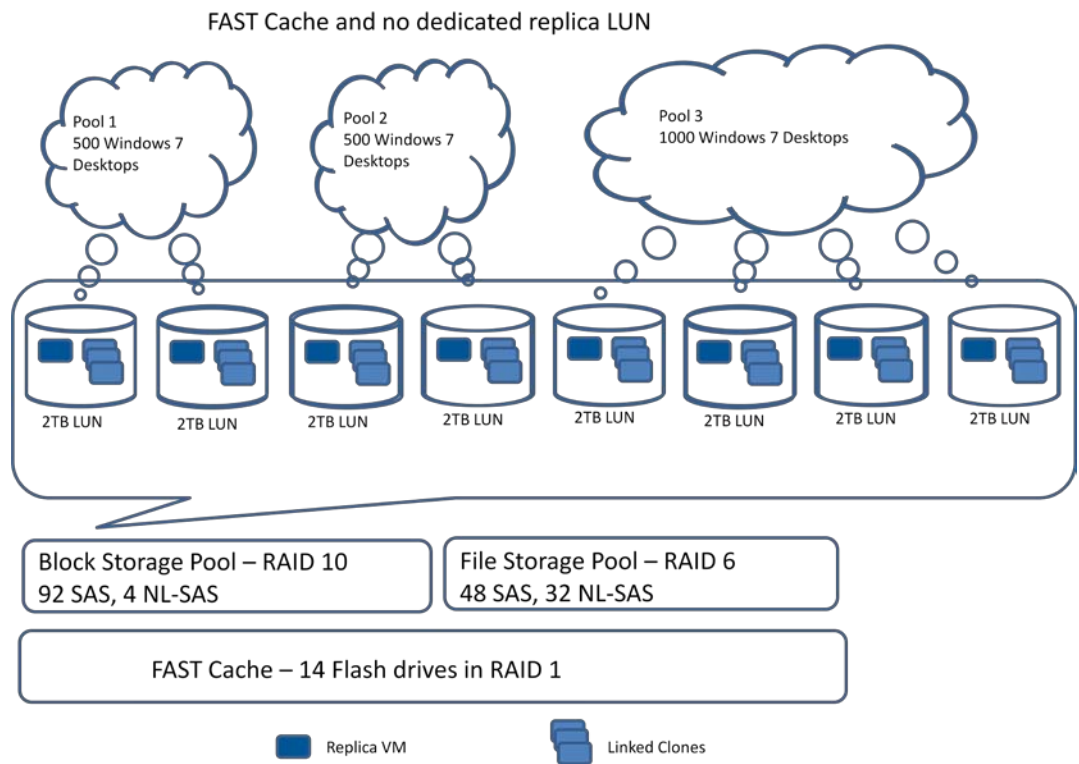


Figure 2. FAST Cache with no dedicated replica LUN

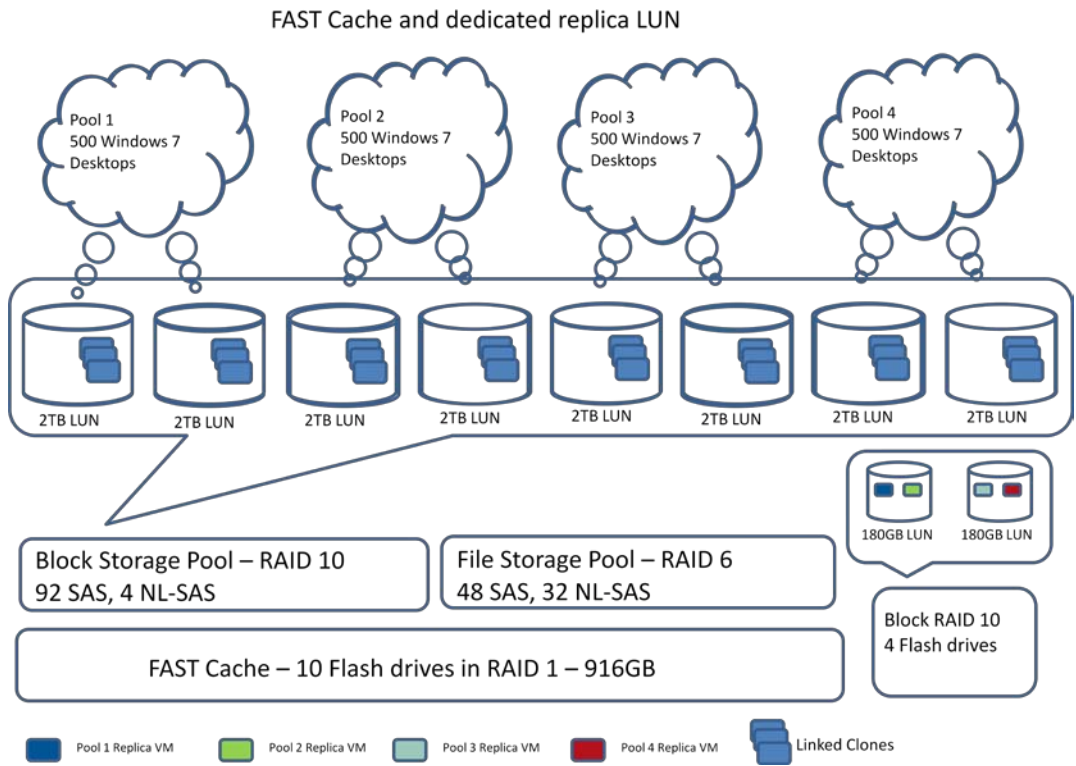


Figure 3. FAST Cache with dedicated replica LUN

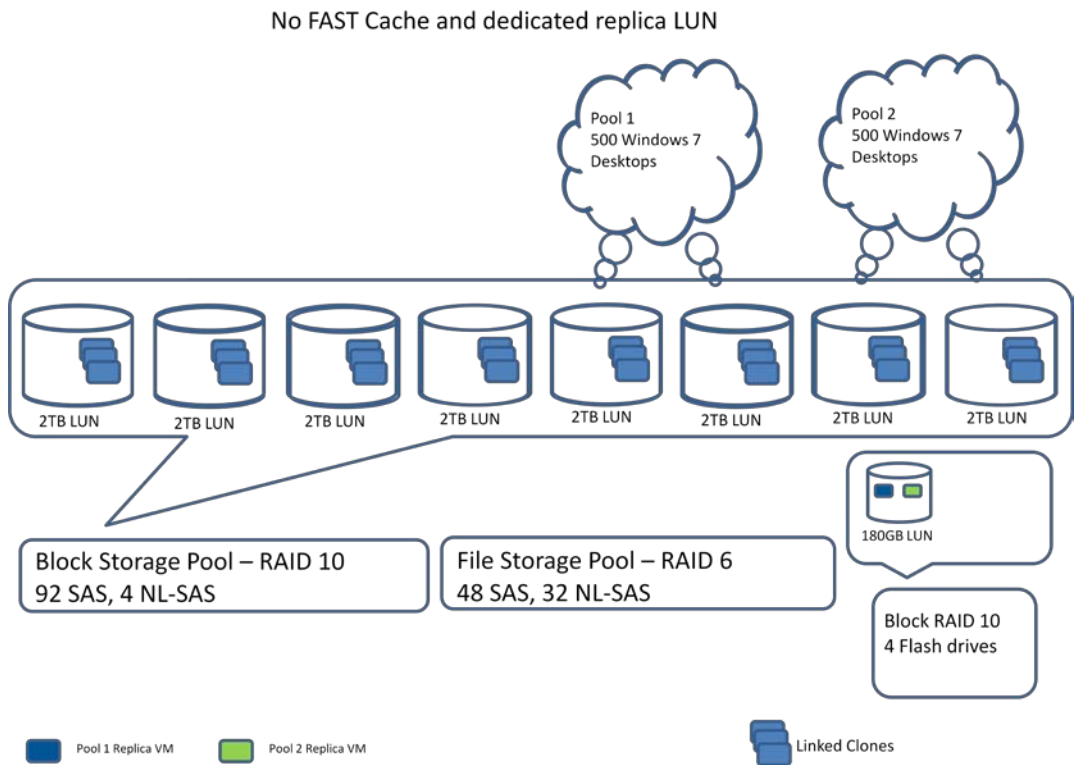


Figure 4. No FAST Cache with dedicated replica LUN

Key components

Introduction

This section briefly describes the key components used in this solution, including:

- EMC VNX platform
- VMware vSphere 4.1
- VMware View 4.5
- VMware View Composer 2.5
- Cisco Unified Computing System (UCS)

EMC VNX platform

EMC's VNX platform brings flexibility to multiprotocol environments. With EMC unified storage, you can connect to multiple storage networks using NAS, iSCSI, and Fibre Channel SAN. EMC unified storage leverages advanced technologies like EMC FAST VP and EMC FAST Cache on the VNX operating environment for block to optimize performance for the virtual desktop environment, helping support service-level agreements. EMC unified storage supports vStorage APIs for Array Integration (VAAI), which was introduced in VMware vSphere 4.1. VAAI enables quicker virtual desktop provisioning and start-up.

VMware vSphere 4.1

VMware vSphere 4.1 is the market-leading virtualization platform that is used across thousands of IT environments around the world. VMware vSphere 4.1 can transform or virtualize computer hardware resources, including CPUs, RAM, hard disks, and network controllers, to create a fully functional virtual machine that runs its own operating systems and applications just like a physical computer.

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

VMware View 4.5

VMware View 4.5 is the leading desktop virtualization solution that enables desktops to deliver cloud-computing services to users. VMware View 4.5 integrates effectively with vSphere 4.1 to provide:

- View Composer 2.5 performance optimization—Optimizes storage utilization and performance by reducing the footprint of virtual desktops and using tiered storage.
- Tiered storage support—View Composer 2.5 supports the use of different tiers of storage to maximize performance and reduce cost.
- Thin provisioning support—Enables efficient allocation of storage resources when virtual desktops are provisioned. This results in better use of the storage infrastructure and reduced CAPEX/OPEX.

VMware View Composer 2.5

VMware View Composer is a service that is installed on the vCenter server and provides storage savings by using linked clone technology to share the hard disk of parent virtual machines. This component is described further later in this document.

**Cisco Unified
Computing System
(UCS)**

Cisco UCS provides the computing platform purpose-built for virtualization, delivering a cohesive system that unites computing, networking, and storage access. Cisco UCS integrates a low-latency, lossless 10-Gigabit Ethernet unified network fabric with enterprise-class, x86-architecture servers that scale to the demands of virtualized desktop workloads without sacrificing performance or application responsiveness. Cisco UCS Manager enables a stateless computing model that uses Service Profile Templates to scale-up large pools of fully provisioned computing resources from “bare metal,” within a fraction of the time required by traditional server solutions.

EMC technology overview

Introduction

This section identifies and briefly describes the major EMC VNX features used in this solution environment, including:

- EMC Unisphere
- EMC FAST Cache
- EMC FAST VP
- Block Data Compression

EMC Unisphere

EMC Unisphere provides a flexible, integrated experience for managing EMC CLARiiON®, EMC Celerra®, and VNX platforms from a single display. This approach to midtier storage management fosters simplicity, flexibility, and automation. Unisphere's ease of use is reflected in intuitive task-based controls, customizable dashboards, and single-click access to real-time support tools and online customer communities.

Unisphere features include:

- Task-based navigation and controls that offer an intuitive, context-based approach to configuring storage, creating replicas, monitoring the environment, managing host connections, and accessing the Unisphere support ecosystem.
- A self-service Unisphere support ecosystem, accessible with one click from Unisphere, that provides users with quick access to real-time support tools, including live chat support, software downloads, product documentation, best practices, FAQs, online communities, and a way to order spares and submit service requests.
- Customizable dashboard views and reporting capabilities that enable at-a-glance management by automatically presenting users with valuable information in terms of how they manage their storage. For example, customers can develop custom reports up to 18 times faster with EMC Unisphere than without.
- Common management provides a single sign-on and integrated experience for managing both block and file features.

Figure 5 provides an example of the Unisphere Summary page that gives administrators a wealth of detailed information on connected storage systems, from LUN pool and tiering summaries to physical capacity and RAID group information.



Figure 5. Unisphere Summary page

EMC FAST VP

With EMC FAST VP, EMC has enhanced its FAST technology to support file as well as block. This feature works at the storage pool level, below the LUN abstraction. Whereas earlier versions of FAST operated above the LUN level, FAST technology analyzes data patterns at a far more granular level. As an example, rather than move an 800 GB LUN to flash drives, FAST VP now identifies and monitors the entire storage pool in 1 GB chunks. If data becomes active, then FAST VP automatically moves only these “hot” chunks to a higher tier like flash. As data cools, FAST VP also correctly identifies which chunks to migrate to lower tiers and proactively moves them. With such granular tiering, it is now possible to reduce storage acquisition while at the same time improve performance and response time. And because FAST VP is fully automated and policy-driven, there is no manual intervention required to make this happen, so you save on operating costs as well.

EMC FAST Cache

VNX FAST Cache, a part of the VNX FAST Suite, enables you to use Flash drives as an expanded cache layer for the array. FAST Cache has array-wide features 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 that data chunk are serviced by FAST Cache. This allows immediate promotion of very active data to the Flash drives. This dramatically improves the response time for very active data and reduces the data hot spots that can occur within the LUN.

FAST Cache is an extended read/write cache that can absorb read-heavy activities such as boot storms and antivirus scans, and write-heavy workloads such as operating system patches and application updates.

Block Data Compression

EMC VNX includes Block Data Compression, which allows customers to save and reclaim space anywhere in their production environment with no restrictions. This capability makes storage even more efficient by compressing data and reclaiming valuable storage capacity. Block Data Compression works as a background task to minimize performance overhead. Block Data Compression also supports thin LUNs, and automatically migrates thick LUNs to thin during compression, freeing valuable storage capacity.

VMware technology overview

Introduction

VMware View delivers personalized virtual desktops as a managed service from a virtualization platform built to deliver the entire desktop, including the operating system, applications, and user data. VMware View 4.5 provides centralized automated management of these components with increased control and cost savings. VMware View 4.5 improves business agility while providing a flexible high-performance desktop experience for end users across a variety of network conditions.

VMware View components

To provide a virtual desktop experience, VMware View uses various components, each with its own purpose. The components that make up the View environment are:

- Hypervisor
- VMware View Connection server
- VMware vSphere vCenter Server/View Composer
- VMware View Security server
- VMware View Transfer server
- Supported database server like Microsoft SQL Server
- VMware View Agent
- VMware View Client
- VMware View Admin Console
- View PowerCLI
- ThinApp

Figure 6 shows the VMware components described in the following sections.

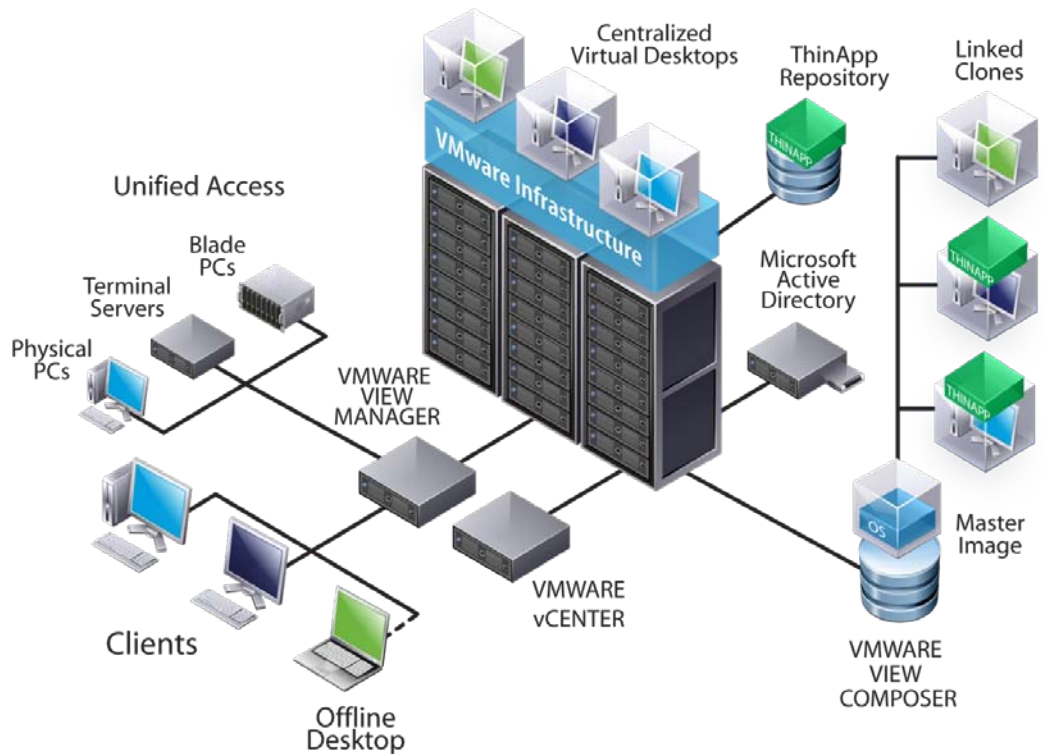


Figure 6. VMware components

Hypervisor

Hypervisor is used to host the virtual desktops. To get most of the features, we recommend that you use VMware vSphere 4. The vSphere 4 features such as vSphere API for array integration (VAAI), memory compression, and ballooning help to host more virtual desktops on a host.

VMware View Connection Server

The VMware View Connection Server hosts the LDAP directory and keeps the configuration information of the VMware View desktop pools, its associated virtual desktops, and VMware View. This data information can be replicated to other View Connection Replica servers. The View Connection Server also acts as a connection broker that maintains the desktop assignment. It supports an SSL connection to the desktop using RDP or PCoIP. It also supports RSA® SecurID® two-factor authentication and smart card authentication.

VMware vSphere vCenter/View Composer

The VMware vSphere vCenter Server helps you manage your virtual machines and vSphere ESX hosts and provides high availability (HA) and Distributed Resource Scheduling (DRS) clusters. VMware vCenter Server hosts customization specification that permits cloned virtual machines to join the Active Directory (AD) domain. The View Composer service is installed on the vCenter Server that provides storage savings by using linked clone technology to share the hard disk of the parent virtual machine as shown in Figure 7.

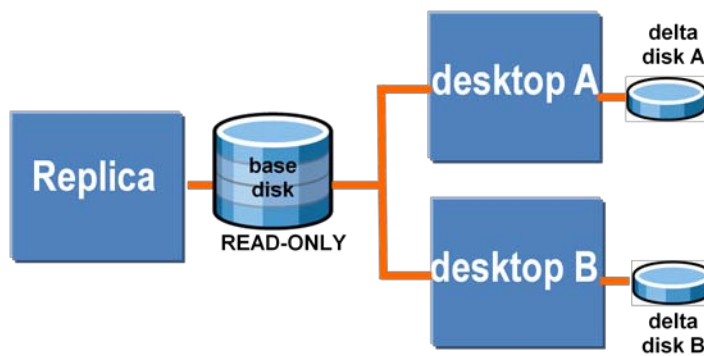


Figure 7. Linked clones

The operating system reads from the common read-only replica image and writes to the linked clone. Any unique data created by the virtual desktop is also stored in the linked clone. A logical representation of this relationship is shown in Figure 8.

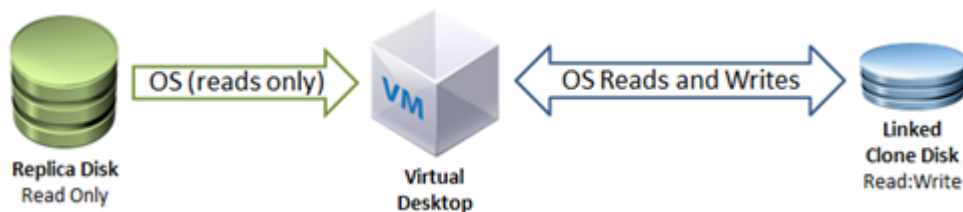


Figure 8. Linked clone virtual machines

View Security Server

The View Security Server is a different type of View Connection server. It supports two network interfaces—one to a private enterprise network and another to the public network. It is typically used in a DMZ and enables users outside the organization to securely connect to their virtual desktops.

VMware View Transfer Server

The VMware View Transfer Server is another type of View Connection Server that is required when you use the local mode feature. The Transfer Server can use the CIFS share on VNX files to store the published image. The local mode allows users to work on a virtual desktop disconnected from the network and later synchronizes the changes with the View environment.

Database Server

The VMware View supported database server is used to host the tables used by View Composer and can optionally store the VMware View events.

VMware View Agent

VMware View Agent is installed on the virtual desktop template and is deployed to all the virtual desktops. It provides communication to the View Connection Server and enables options for USB redirection, virtual printing, PCoIP server, and Smartcard over PCoIP.

VMware View Client

VMware View Client software is used to connect to the virtual desktops using the connection broker. View Client allows users to print locally from their virtual desktop, and with the proper configuration, users can access USB devices locally.

VMware View Admin Console

VMware View Admin Console is a browser-based administration tool for VMware View and is hosted on the View Connection Server.

VMware View PowerCLI

VMware View PowerCLI provides the basic management of VMware View using Windows Powershell. It allows administrators to script some basic VMware View operations and can be used along with other Powershell scripts.

VMware ThinApp

VMware ThinApp is an application virtualization product for enterprise desktop administrators and application owners. It enables rapid deployment of applications to physical and virtual desktops. ThinApp links the application, the ThinApp runtime, the virtual file system, and the virtual registry into a single package. The CIFS share on EMC VNX file can be used as a repository and to deploy the ThinApp to the virtual desktops.

Cisco technology overview

Overview

Figure 9 displays the Cisco UCS components described in this section.

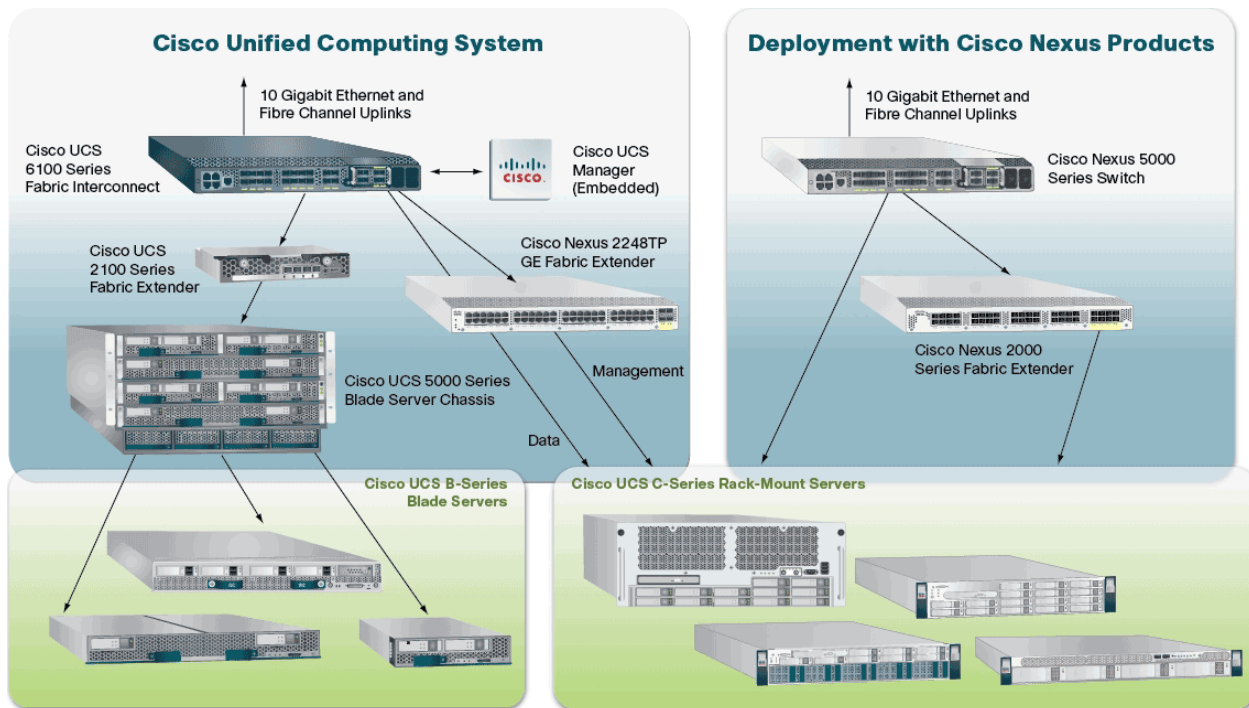


Figure 9. Cisco Unified Computing System

Cisco Unified Computing System (UCS) B-Series Blade Servers

Cisco UCS B-Series Blade Servers are designed for compatibility, performance, energy efficiency, large memory footprints, manageability, and unified I/O connectivity:

- **Compatibility:** Cisco UCS B-Series Blade Servers are designed around multicore Intel Xeon 5500, 5600, 6500 and 7500 Series processors, DDR3 memory, and an I/O bridge. Each blade server's front panel provides direct access for video, two USB, and console connections.
- **Performance:** Cisco's blade servers use the Intel Xeon next-generation server processors, which deliver intelligent performance, automated energy efficiency, and flexible virtualization. Intel Turbo Boost Technology automatically boosts processing power by using increased frequency and hyperthreading to deliver high performance when workloads demand and thermal conditions permit. Intel Virtualization Technology provides best-in-class support for virtualized environments, including hardware support for direct connections between virtual machines and physical I/O devices.
- **Energy efficiency:** Most workloads vary over time. Some workloads are bursty on a moment-by-moment basis, while others have predictable daily, weekly, or monthly cycles. Intel Intelligent Power Technology monitors the CPU utilization and automatically reduces energy consumption by putting processor cores into a low-power state based on real-time workload characteristics.
- **Large-memory-footprint support:** As each processor generation delivers even more power to applications, the demand for memory capacity to balance CPU

performance increases as well. The widespread use of virtualization increases memory demands even further due to the need to run multiple OS instances on the same server. Cisco blade servers with Cisco Extended Memory Technology can support up to 384 GB per blade.

- **Manageability:** The Cisco Unified Computing System is managed as a cohesive system. Blade servers are designed to be configured and managed by Cisco UCS Manager, which can access and update blade firmware, BIOS settings, and RAID controller settings from the parent Cisco UCS 6100 Series Fabric Interconnect. Environmental parameters are also monitored by Cisco UCS Manager, reducing the number of management points.
- **Unified I/O:** Cisco UCS B-Series Blade Servers are designed to support up to two network adapters. This design can reduce the number of adapters, cables, and access-layer switches by as much as half because it eliminates the need for multiple parallel infrastructure for both LAN and SAN at the server, chassis, and rack levels. This design results in reduced capital and operating expenses through lower administrative overhead and power and cooling requirements.

Cisco UCS 6100 Series Fabric Interconnects

A core part of the Cisco Unified Computing System, the Cisco UCS 6100 Series Fabric Interconnects provide both network connectivity and management capabilities to all attached blades and chassis. The Cisco UCS 6100 Series offers line-rate, low-latency, lossless 10-Gigabit Ethernet and Fibre Channel over Ethernet (FCoE) functions. The interconnects provide the management and communication backbone for the Cisco UCS B-Series Blades and UCS 5100 Series Blade Server Chassis.

Cisco Nexus 7000 Series switches

The Cisco Nexus 7000 Series offers an end-to-end solution for data center core, aggregation, and high-density end-of-row and top-of-rack server connectivity in a single platform. The Cisco Nexus 7000 Series platform is run by Cisco NX-OS software. It was specifically designed for the most mission-critical place in the network, the data center.

Cisco Nexus 1000V Series Switches, Cisco VN-Link technology

Cisco Nexus 1000V Series switches are virtual machine access switches that are an intelligent software switch implementation based on the IEEE 802.1Q standard for VMware vSphere environments running the Cisco NX-OS Software operating system. Operating inside the VMware ESX Hypervisor, the Cisco Nexus 1000V Series supports Cisco VN-Link server virtualization technology to provide:

- Policy-based virtual machine connectivity
- Mobile virtual machine security and network policy
- Non-disruptive operational model for server virtualization and networking teams

Cisco MDS 9500 Series Multilayer Directors

The Cisco MDS 9500 Series Multilayer Director layers a broad set of intelligent features onto a high-performance, open-protocol switch fabric. By addressing the stringent requirements of large data center storage environments, it provides high availability, security, scalability, ease of management, and transparent integration of new technologies.

Conclusion

VMware View 4.5 virtualization technology meets user and IT needs, providing compelling advantages compared to traditional physical desktops and terminal services.

EMC VNX5700 brings flexibility to multiprotocol environments. With EMC unified storage, you can connect to multiple storage networks using NAS, iSCSI, and Fibre Channel SAN. EMC unified storage leverages advanced technologies like EMC FAST VP and EMC FAST Cache to optimize performance for the virtual desktop environment. EMC unified storage supports vStorage APIs for array integration (VAAI), which were introduced in VMware vSphere 4.1. VAAI enables hosts to support more virtual machines per LUN and allows quicker virtual desktop provisioning.

The zero page recognition and transparent page sharing vSphere 4.1 features help you save memory and allow you to host more virtual desktops per host. Cisco UCS delivers the large memory and processing capability to achieve higher densities of virtual desktops per server, providing perfect scaling, without sacrificing performance.

Our team found the following key results during the testing of this solution:

- By using FAST Cache and VAAI, the time to concurrently boot all 2,000 desktops to a usable start was significantly reduced by 25 percent.
- By using a VAAI-enabled storage platform, we were able to store up to 512 virtual machines compared to 64 virtual machines per LUN.
- With VMware transparent page sharing, we observed memory savings up to 92 GB on a host with 96 GB of RAM, and with less than 2 percent of it swapping to a FAST Cache-enabled LUN.
- Using Flash as FAST Cache for the read and write I/O operations reduced the number of spindles needed to support the required IOPS.
- Using Cisco UCS, the user did not experience any system performance degradation as the workload on the environment increased.

References

EMC documentation

The following documents, located on EMC Powerlink®, provide additional and relevant information. Access to these documents depends on your login credentials. If you do not have access to a document, contact your EMC representative:

- *EMC Infrastructure for Virtual Desktops Enabled by EMC VNX Series, VMware vSphere 4.1, VMware View 4.5 and VMware View Composer 2.5—Proven Solution Guide*
- *EMC Infrastructure for Virtual Desktops Enabled by EMC VNX, VMware vSphere 4.1, VMware View 4.5, and VMware View Composer 2.5—An Architectural Overview*
- *EMC Performance Optimization for Microsoft Windows XP for the Virtual Desktop Infrastructure—Applied Best Practices*
- *Deploying Microsoft Windows 7 Virtual Desktops with VMware View—Applied Best Practices Guide*
- *EMC Infrastructure for Deploying VMware View in the Enterprise EMC Celerra Unified Storage Platforms—Solutions Guide*

VMware documentation

The following VMware documents, located on the VMware website, also provide useful information:

- *Introduction to VMware View Manager*
- *VMware View Manager Administrator Guide*
- *VMware View Architecture Planning Guide*
- *VMware View Installation Guide*
- *VMware View Integration Guide*
- *VMware View Reference Architecture*
- *Storage Deployment Guide for VMware View*
- *VMware View Windows XP Deployment Guide*
- *VMware View Guide to Profile Virtualization*

The following Cisco documents, located on the Cisco website, also provide useful information:

- *Solve the Desktop Crisis with Cisco Desktop Virtualization* (a solution with VMware View and Cisco Desktop Virtualization whitepaper)
http://www.cisco.com/en/US/solutions/collateral/ns340/ns517/ns224/ns836/ns978/solution_overview_c22-632364.pdf
- *Desktop Virtualization with View 4.5 and EMC Storage* (Cisco validated the design for desktop virtualization with VMware View and EMC storage)
http://www.cisco.com/en/US/solutions/ns340/ns414/ns742/ns743/ns993/landing_dcVirt-VM_EMC.html
- Cisco Desktop Virtualization Solutions Website: www.cisco.com/go/vdi
- Cisco Virtualization Experience Infrastructure Website: www.cisco.com/go/vxi