Reference Architecture

EMC INFRASTRUCTURE FOR VMWARE HORIZON VIEW 5.2

Enabled by the EMC XtremIO All-Flash Array, VMware vSphere 5.1, VMware Horizon View 5.2, and VMware Horizon View Composer 5.2

- Simplify management and decrease total cost of ownership
- Guarantee a superior desktop experience
- Ensure a successful virtual desktop deployment

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Reference architecture overview

Document purpose

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

This document describes the reference architecture of the EMC infrastructure for VMware Horizon View 5.2, enabled by the EMC XtremIO™ all-flash array, VMware vSphere 5.1, and VMware Horizon View Composer 5.2 solution, which was tested and validated by the EMC Solutions Group.

Introduction to the EMC XtremIO all-flash array

The EMC XtremIO all-flash array is custom designed for flash storage media. Furthermore, the XtremIO array scales-out by design, so additional performance and capacity are added in a building block approach, with all building blocks forming a single clustered system. The following are some of the benefits of the EMC XtremIO platform:

- **Incredibly high levels of I/O performance**

  The XtremIO storage system delivers high IOPS at low (sub-millisecond) latency, particularly for random I/O workloads that are typical in virtualized environments.

- **Enterprise array capabilities**

  The XtremIO storage system is inherently load and capacity balanced at all times and features N-way active controllers, high availability, strong data protection, and thin provisioning.

- **Standards-based enterprise storage system**

  The XtremIO system interfaces with vSphere hosts using standard 8Gb/s Fibre Channel (FC) and 10 GB iSCSI block interfaces. The system supports complete high-availability features, including support for native VMware multipath I/O, protection against failed solid state disks (SSDs), nondisruptive software and firmware upgrades, no single point of failure (SPOF), and hot-swappable components.

- **Real-time, inline data reduction**

  The XtremIO storage system deduplicates desktop images inline, allowing a massive number of virtual desktops to reside in a small and economical amount of flash capacity. Every bit of data is deduplicated before being written to flash. Data reduction on the XtremIO array does not adversely affect IOPS or latency; rather, it enhances the performance of the end-user computing environment. The more common the data, the faster XtremIO performs since inline deduplication is purely an in-memory operation of metadata instead of actual I/Os to SSDs.

- **Scale-out design**

A single X-Brick™ is the fundamental building block of a scaled-out XtremIO clustered system. You can start with a small deployment of about 1,000 virtual desktops and grow it to nearly any required scale by simply configuring a larger XtremIO cluster. As you add building blocks, the system expands capacity and performance linearly, making sizing of end-user computing (EUC) and management of future growth extremely simple.

- **VAAI integration with in-memory metadata and inline data reduction**

  The XtremIO array is fully integrated with vSphere through vStorage APIs for Array Integration (VAAI). It supports the following API primitives: ATS, Clone Blocks/Full Copy/XCOPY, Zero Blocks/Write Same, Thin Provisioning, and Block Delete. In combination with the array's inline data reduction and in-memory metadata management, XtremIO's unique VAAI implementation enables nearly instantaneous virtual machine provisioning and cloning, and enables the use of large volume sizes for unprecedented management simplicity.

- **Massive performance**

  The XtremIO array is designed to handle very high, sustained levels of small, random, blended read and write I/O as is typical in virtual desktops, and to do so with consistently low latency.

- **Ease of use**

  The XtremIO storage system requires only a few basic setup steps that can be completed in minutes and absolutely no tuning or ongoing administration to achieve and maintain high performance levels. In fact, you can take the XtremIO system from shipping box to deployment readiness in less than an hour.

- **Data center economics**

  A single X-Brick easily supports 2,500 or more full-clone desktops and 3,500 or more linked clone desktops, requiring just a few rack units of space and approximately 750 W of power

Solution purpose

The purpose of this reference architecture is to:

- Highlight the potential of a state-of-the-art EUC deployment based on XtremIO all-flash array technology
- Build a new end-user computing environment
- Validate the environment for performance, scalability, functionality, and user experience, as measured by concurrent IOPS delivered per desktop

Virtual desktop infrastructure (VDI) is an I/O intensive use case and historically has been challenging to design and deploy successfully, especially at scale. The XtremIO array makes EUC simple in a number of ways, but the three key benefits are:

- As an all-flash array, XtremIO delivers extraordinarily high levels of small random I/O, which is prevalent in EUC. This enhances the virtual desktop user experience through rapid operating system and application response times and eliminates the need to specially prepare desktop images to lower the amount of I/O they drive to the underlying storage.

- With inline data reduction, the XtremIO array is able to fit very high numbers of virtual desktops into a minimal footprint in flash, which makes an all-flash solution economically attractive and drives highly efficient data center operational metrics. This solution was tested with both linked clone and full-clone desktops, ensuring that customers can choose whichever they may need.
- The XtremIO array uses several unique capabilities simultaneously to deliver provisioning speeds that were previously impossible. Rolling out new desktops at scale can be done quickly and easily in a production environment without affecting the user experience on existing live desktops.

This reference architecture validates the performance of the solution and provides guidelines to build similar solutions. This document is not intended to be a comprehensive guide to every aspect of this solution.

Business challenge

Virtual desktop responsiveness is critical to successful EUC project rollouts. Today, user experience expectations are based on devices such as ultrabooks and tablets that use flash memory. For example, the rapid application response time of a modern ultrabook is due in large part to the use of an SSD.

Knowledge workers accustomed to working with an ultrabook that easily peaks over 2,000 IOPS may experience unacceptably slow performance using a virtual desktop that delivers only between 7 and 25 IOPS (the common planning assumption range in traditional EUC reference architectures). A modern EUC deployment must deliver a better-than-local desktop user experience and a better cost per desktop relative to a physical machine, and it must enable IT to continue using existing desktop management tools and applications.

EUC exacerbates the need for higher desktop IOPS by centrally serving potentially tens of thousands of virtual operating systems and applications running concurrently. EUC also introduces its own unique challenges such as boot storms and login storms, which have peak IOPS requirements that often exceed the typical operational parameters of storage arrays. All of these challenges combined with the desire to build an economical solution have led to sub-par EUC infrastructures, such as those that under-size storage and downgrade desktop functionality by disabling various software components, resulting in a user experience that is less than desirable.

Using the EMC XtremIO all-flash array as the foundation for EUC deployments provides several unique advantages that cannot be achieved with any other EUC deployment architecture:

- **Complete flexibility in EUC deployments**

  Administrators can use persistent desktops or non-persistent desktops, deployed as either full clones or linked clones, or any combination thereof, without regard to underlying I/O performance or excessive capacity consumption. The XtremIO platform allows administrators the flexibility to simply do what is right for their business because either deployment method or any combination of deployment methods presents no inherent advantage or disadvantage in performance or cost. Full clones no longer have a cost disadvantage over linked clones. More importantly, and defying conventional

wisdom, there is no longer a storage capacity penalty associated with deploying full clones over linked clones.

- Superior EUC user experience

  Every desktop in an XtremIO deployment gets an all-SSD experience with reliable and massive I/O potential both in sustained IOPS and the ability to burst to much higher levels as dictated by demanding applications such as Microsoft Outlook, desktop search, and antivirus scanning. Users can run on fully functional desktops rather than de-featured ones. During our scale testing, every simulated application operation completed in half or less of the acceptable user experience boundaries. This performance was superior by a wide margin to any previously tested shared storage array, and has led to broadening the scope of EUC to now include desktops used for engineering applications or game development.

- Lowest cost per virtual desktop

  XtremIO EUC deployments are surprisingly affordable. Because of XtremIO's inline data reduction and massive performance density, the cost per desktop is lower than with other EUC solutions, allowing virtual desktops to be deployed less expensively than their physical desktop counterparts.

- **Rapid provisioning and rollout**

  XtremIO is simple to set up and requires no tuning, any EUC deployment model can be chosen at will, and complex planning is eliminated. EUC deployments can be designed and rolled out quickly with assured success.

- **No need for third-party tools**

  XtremIO solves many I/O-related EUC deployment challenges. Additional caching or host-based deduplication schemes, or any other point solutions that increase expense and complexity, are not required.

- **No change to desktop administration**

  Any methods administrators are using to manage their existing physical desktops can be directly applied to the EUC deployment with XtremIO. No changes to software updates, operating system patching, antivirus scanning, or other procedures are needed to lighten the I/O load on shared storage. Administrators can confidently rely on XtremIO's high performance levels to deliver.

- **No change to desktop features**

  Virtual desktop best practices currently dictate dozens of changes to the desktop image to reduce the I/O load on the shared storage. XtremIO requires none of these changes, allowing the desktop to remain fully functional while providing an optimal user experience.

- **No nights and weekends**

  Administrators no longer need to plan outages over nights and weekends for routine-but-I/O-intensive desktop maintenance operations such as patching, upgrading, scanning or refreshing desktops. They can rely on XtremIO to deliver during peak regular business hours. Large numbers of desktops can

remain fully operational on XtremIO while select desktops undergo maintenance.

Solution benefits

This solution aids in the design and successful deployment of virtual desktops on VMware Horizon View 5.2. This solution ensures the ultimate desktop performance, while at the same time delivering a highly attractive cost per desktop—not just for storage, but for the overall infrastructure.

Desktop virtualization enables 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
- Increased agility when providing EUC for contractors, mergers and acquisitions, and seasonal workers
- Ability to support bring your own device (BYOD) and remote workers without reducing EUC functionality or security
- Simplified and centralized management of desktops

Customers deploying XtremIO will realize:

- A user experience that is superior to that of a physical desktop equipped with a dedicated SSD
- Increased control and security of their global, mobile desktop environment, typically their most at-risk environment
- Better end-user productivity with a more consistent environment
- Simplified management of desktop content confined to their data center
- Better support of service-level agreements and compliance initiatives
- Lower operational and maintenance costs than physical desktops

Solution architecture

Architecture diagram

This section provides a summary and characterization of the tests performed to validate the EMC infrastructure for VMware Horizon View 5.2, enabled by the EMC XtremIO all-flash array, VMware vSphere 5.1, and VMware Horizon View Composer 5.2 solution. It involves building a 2,500-seat VMware Horizon View 5.2 environment on XtremIO and integrating the features of the XtremIO all-flash array to provide a compelling and cost-effective EUC platform.

Figure 1 shows the overall physical architecture of the solution.

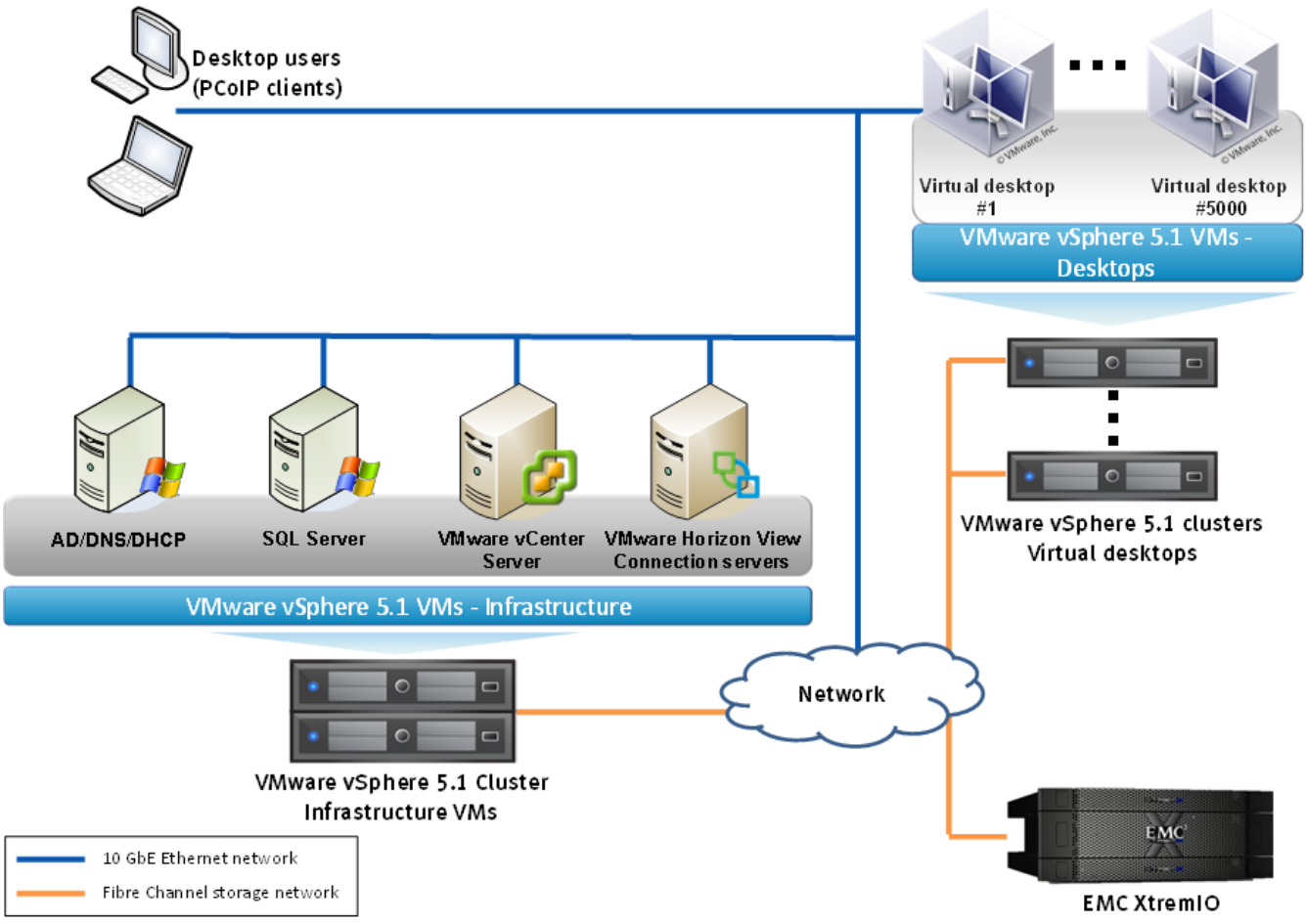

Figure 1. Physical architecture

Hardware resources

Table 1 lists the hardware used to validate the solution.

Table 1. Hardware details

Hardware	Quantity	Configuration	Notes
EMC XtremIO	1	• A single managed system of 1 X-Brick • 25 x 400 GB eMLC SSD drives per X-Brick	Shared storage for virtual desktops and infrastructure servers
Intel-based servers	20	• Memory: 144 GB of RAM • CPU: 2 x Intel Xeon E7-2870 with 2.40 GHz deca-core processors • Internal storage: 1 x 146 GB internal SAS disk • External storage: XtremIO (FC) • NIC: Dual-port 10 GbE adapter • FC HBA: Dual-port 8 Gbps adapter	• 18 servers—vSphere desktop clusters 1 and 2 • 2 servers—vSphere cluster to host infrastructure virtual machines
Cisco Nexus 5020	2	• 40 x 10 Gb ports • 2 Ethernet ports per server • 2 FC ports per server	Redundant FC and LAN A/B configuration

Software resources

Table 2 lists the software used to validate the solution.

Table 2. Solution software

Software	Version
EMC XtremIO (FC-connected shared storage for vSphere datastores)	
Cisco Nexus	
Cisco Nexus 5020	Version 4.2(1)N1(1)
VMware vSphere servers	
vSphere	5.1.0 (1123961)
VMware vCenter Server	
OS	Windows 2008 R2 SP1
VMware Horizon View	
View Connection Server	5.2
View Composer	5.2
Microsoft Software Platforms	
Active Directory, including DNS and DHCP	Windows Server 2012
SQL Server	SQL Server 2012
System Center	System Center Operations Manager 2012
Virtual desktops **Note:** This software is used to generate the test load.	
OS	MS Windows 7 Enterprise SP1 (32-bit)
VMware Tools	9.0.5 build-1065307
Microsoft Office	Office Enterprise 2007 (Version 12.0.6562.5003)
Microsoft Internet Explorer	9.0.8112.316421
Adobe Reader	9.1.0
McAfee Virus Scan	8.7 Enterprise
Adobe Flash Player	11
Bullzip PDF Printer	6.0.0.865
Login VSI (EUC workload generator)	3.7 Professional Edition
Vdbench (I/O workload generator)	5.03

Reference architecture overview

The reference architecture consists of the following components:

- **EMC XtremIO platform**—Provides storage for Windows 7 virtual desktops by using FC connections to vSphere hosts. This solution uses a single X-Brick.
- **VMware vSphere 5.1 Server**—Servers as a two-node VMware vSphere 5.1 cluster that hosts infrastructure virtual machines. Two additional VMware vSphere 5.1 clusters are used to host 2,500 virtual desktops.
- **VMware vCenter Server 5.1**—Provides a scalable and extensible platform that forms the foundation for virtualization management for the VMware vSphere 5.1 clusters. One VMware vCenter Server was used in this solution.
- **VMware Horizon View Manager Server 5.2**—Provides virtual desktop delivery, authenticates users, manages the assembly of users' virtual desktop environments, and brokers connections between users and their virtual desktops. In this reference architecture, VMware Horizon View Manager 5.1 is installed on Windows Server 2008 R2 and hosted as a virtual machine on a VMware vSphere 5.1 server. Three VMware Horizon View Manager Servers were used in this solution.
- **VMware Horizon View Composer 5.2**—Works directly with vCenter Server to deploy, customize, and maintain the state of the virtual desktops when using linked clones.
- **Virtual desktops**—Two thousand five hundred virtual desktops running Windows 7. The solution was validated with both full-clone desktops and linked clones created using VMware Horizon View Composer 5.2.
- **Cisco Nexus 5020 switches**—Provide high port density, wire-speed performance, and extremely low latency to meet the growing demand for a 10-gigabit Ethernet network and 8-gigabit Fibre Channel network.
- **Microsoft Windows Server 2012 R2 domain controllers and DNS servers**— Two Windows Server 2012 R2 domain controllers that provide Active Directory services to manage the identities and relationships that constitute the Windows environment for the virtual desktops. The Domain Name System (DNS) component of the Windows network infrastructure is also installed on these servers. These servers are hosted as virtual machines on VMware vSphere 5.1 hosts.
- **Microsoft Windows Server 2012 R2 dynamic host configuration protocol (DHCP) server**—Centrally manages the IP address scheme for virtual desktops. This service is hosted on one of the domain controller virtual machines.
- **Microsoft SQL Server 2012**—The database service required by VMware Horizon View Manager and VMware vCenter Server to store configuration details. This SQL Server is hosted as a virtual machine on a VMware vSphere 5.1 server.
- **Ten Gigabit IP network—**The 10-gigabit network infrastructure provides multi-gigabit connectivity between all the View infrastructure components, including the virtual desktop users and Windows server infrastructure.
- **8-gigabit Fibre Channel network—**The Fibre Channel network infrastructure that provides 8-gigabit connectivity to the XtremIO storage. The 8-gigabit

infrastructure allows vSphere servers to access FC LUNs on the XtremIO cluster with high bandwidth and low latency.

XtremIO storage layout overview

The EMC XtremIO cluster is configured with the following LUNs for desktop and infrastructure storage:

- Twenty LUNs for full-clone desktop storage, with each LUN being used to store 125 desktops. For full-clone desktops, 4 TB LUNs were used, while linked-clone desktops used 375 GB LUNs. XtremIO supports the VAAI ATS primitive, thereby enhancing desktop performance.
- One 2 TB LUN was used for infrastructure server storage.

Table 3 lists the storage requirements for each of the virtual desktop types.

Table 3. Storage requirements

Item	Capacity (GB)	Number of items	Total capacity (GB)
Linked-clone virtual desktop	3 GB (average)	2,500	7.5 TB
Linked-clone replica disks (one per desktop datastore)	20 GB	20	400 GB
Full-clone virtual desktop	20 GB	2,500	50 TB

Storage network layout overview

Figure 2 shows the 8-Gbps Fibre Channel connectivity between the Cisco Nexus 5020 switches and the EMC XtremIO cluster. In this solution, we used the 8-Gbps Fibre Channel ports on Cisco Nexus 5020 switches to extend Fibre Channel connectivity to the vSphere hosts. Only one X-Brick is shown; similar storage network connections will be needed for the second X-Brick in the cluster.

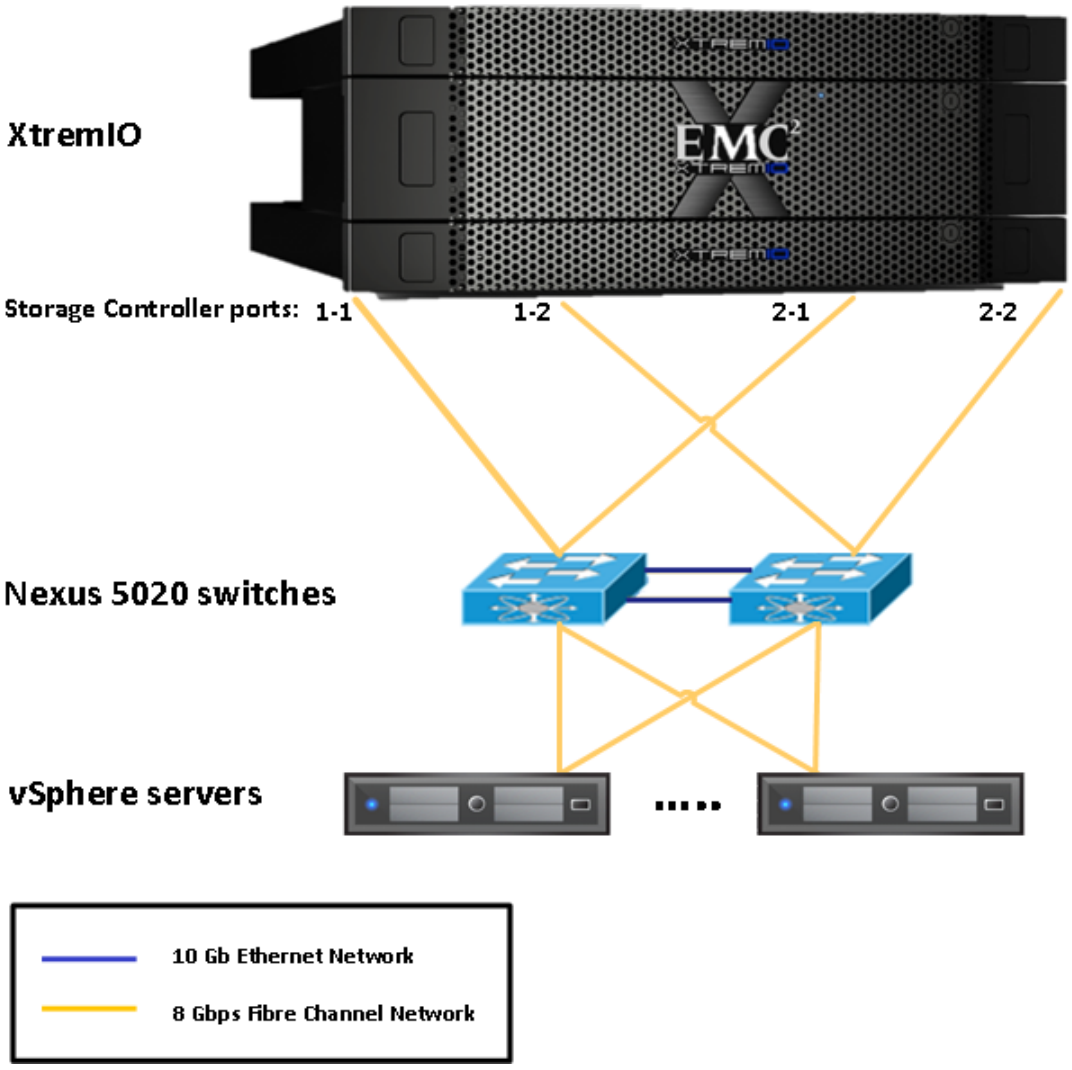

Figure 2. Network layout diagram

Host network configuration

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

Figure 3 shows the vSwitch configuration in the vCenter Server.

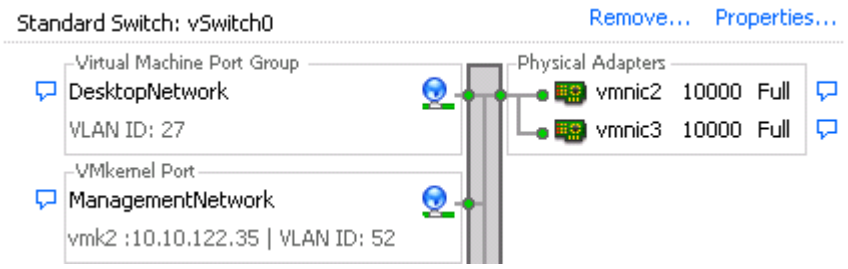

Figure 3. vSwitch configuration in vCenter Server

Virtual switch vSwitch0 uses two physical network interface cards (NICs).

Table 4 lists the port groups configured on vSwitch0.

Table 4. Port groups configured on vSwitch0 and vSwitch1

Virtual switch	Configured port groups	Used for
vSwitch0	ManagementNetwork	VMkernel port for vSphere host management
	DesktopNetwork	Network connection for virtual desktops and LAN traffic

Profile characteristics

Table 5 provides the validated environment profile.

Table 5. Profile characteristics

Profile characteristic	Value
Number of virtual desktops	2,500
Virtual desktop OS	Windows 7 Enterprise SP1 (32-bit)
CPU per virtual desktop	1 vCPU
Number of virtual desktops per CPU core	6.9
RAM per virtual desktop	1 GB
Average storage available for each full-clone desktop	20 GB
Average storage available for each linked-clone desktop (not including the shared replica disk)	3 GB
Average storage used for each desktop (linked-clone and full-clone; used by Windows and applications)	12.74 GB
Average physical storage used for each full-clone desktop on the XtremIO array (after dedupe)	197 MB
Average physical storage used for each linked-clone desktop on the XtremIO array (after dedupe)	57 MB
Dedupe ratio of full-clone desktops (after provisioning)	81:1
Dedupe ratio of linked-clone desktops (after provisioning)	2.9:1
Average IOPS per virtual desktop at steady state (linked-clone or full-clone)	Varied based on test configuration, ranging from 5 to 33 IOPS per desktop
Peak IOPS observed per full-clone virtual desktop during boot storm	101.3
Peak IOPS observed per linked-clone virtual desktop during boot storm	89.5
Average IOPS observed per full-clone virtual desktop throughout boot storm	22.1

Profile characteristic	Value
Average IOPS observed per linked-clone virtual desktop throughout boot storm	28.9
Time required to patch each desktop using SCCM (linked-clone or full-clone)	5 minutes
Time required to complete full anti-virus scan on 2,500 desktops (linked-clone or full-clone)	2 hours 50 minutes
Time required to deploy 2,500 full-clone desktops	6 hours 45 minutes
Time required to deploy 2,500 linked-clone desktops	3 hours 20 minutes
Number of datastores used to store virtual desktops	20
Number of virtual desktops per datastore	125
Drive and RAID type for datastores	400 GB eMLC SSD drives EMC XtremIO proprietary data protection XDP that delivers RAID 6-like data protection but better than the performance of RAID 10
Number of VMware clusters used for desktops	2

Key components

Introduction

This section briefly describes the key components of this solution:

- EMC XtremIO all-flash array
- EMC VSI for VMware vSphere
- VMware vSphere 5.1
- VMware Horizon View 5.2
- VMware Horizon View Composer 5.2

Hardware resources on page 11 and Software resources on page 12 provide more information on the components that make up the solution.

EMC XtremIO all-flash array

The EMC XtremIO All-Flash Array scales-out in performance and capacity by design; that is, additional capacity and performance can be configured to meet virtually any EUC requirement. Each cluster building block is, by itself, a highly-available, high-performance, fully active/active storage system with no single point of failure (SPOF). When multiple building blocks form a cluster, XtremIO inherently stays in balance so all desktops benefit from the entire performance potential of the cluster at all times.

The XtremIO storage cluster is managed by XtremIO Operating System (XIOS), XtremIO's powerful operating system. XIOS ensures that the system remains balanced and always delivers the highest levels of performance without any administrator intervention.

- XIOS ensures that all SSDs in the system are evenly loaded, providing the highest possible performance as well as endurance that stands up to demanding workloads for the entire life of the array.
- XIOS eliminates the need to perform the complex configuration steps found on traditional arrays. There is no need to set RAID levels, determine drive group sizes, set stripe widths, set caching policies, or build aggregates.
- With XIOS, every volume is automatically and optimally configured at all times. I/O performance on existing volumes and data sets automatically increases with large cluster sizes. Every volume is capable of receiving the full performance potential of the entire XtremIO system.

EMC Virtual Storage Integrator for VMware vSphere

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

We used the following VSI features while validating and testing this solution:

- **Storage Viewer**—Extends the vSphere client to facilitate the discovery and identification of EMC XtremIO storage devices that are allocated to VMware vSphere hosts and virtual machines. Storage Viewer 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 XtremIO platform. It enables VMware administrators to provision new Virtual Machine File System (VMFS) datastores and raw device mapping (RDM) volumes seamlessly within the vSphere client.

The *EMC VSI for VMware vSphere Product Guides*, which are available on EMC Online Support, provide more information.

VMware vSphere 5.1

VMware vSphere 5.1 is the market-leading virtualization hypervisor used across thousands of IT environments around the world. VMware vSphere 5.1 can transform or virtualize computer hardware resources, including the CPUs, RAM, hard disks, and network controllers to create fully functional virtual machines. The virtual machines run their own operating systems and applications just like physical computers.

The high-availability features in VMware vSphere 5.1 along with VMware Distributed Resource Scheduler (DRS) and VMware vSphere Storage vMotion enable seamless migration of virtual desktops from one vSphere server to another with minimal or no disruption to the customers.

VMware Horizon View 5.2

VMware Horizon View delivers rich and personalized virtual desktops as a managed service from a virtualization platform built to deliver the entire desktop. With VMware Horizon View 5.2, administrators can virtualize the operating system, applications, and user data, and deliver modern desktops to end users. Horizon View 5.2 provides the following:

- Centralized, automated management of virtual desktops with increased control and cost savings
- Improved business agility as well as a flexible high-performance desktop experience for end users across a variety of network conditions

VMware Horizon View 5.2 integrates effectively with vSphere 5.1 to provide the following:

- **Performance optimization**—Optimizes storage utilization and performance using View Composer 5.2 to reduce the footprint of virtual desktops.
- **Thin provisioning support**—Enables efficient allocation of storage resources when virtual desktops are provisioned. This results in better utilization of storage infrastructure and reduced capital expenditure (CAPEX) and operating expenditure (OPEX).

VMware Horizon View Composer 5.2

View Composer 5.2 works directly with vCenter Server to deploy, customize, and maintain the state of the virtual desktops when you are using linked clones. Desktops provisioned as linked clones share a common base image within a desktop pool and have a minimal storage footprint. The base image is shared among a large number of desktops.

This solution uses a standalone View Composer 5.2 server to deploy 2,500 dedicated virtual desktops running Windows 7 as linked clones. A standalone View Composer server was used to minimize the impact of virtual desktop provisioning and maintenance operations on the vCenter server.

VMware Horizon View architecture

We validated this solution using both linked-clone and full-clone virtual desktops to ensure similar performance regardless of the deployment method selected.

Full clones

VMware Horizon View 5.2 supports the use of full-clone desktops for virtual desktop deployments. View uses traditional vSphere customization specifications and the Microsoft Sysprep utility to customize each desktop after cloning it from a master desktop template.

The deduplication capabilities of the XtremIO all-flash array resulted in physical storage utilization of only 197 MB per desktop at the time of deployment.

Linked clones

VMware Horizon View with View Composer uses the concept of linked clones to quickly provision virtual desktops. With linked-clone desktops, the operating system reads all the common data from the read-only replica and the operating system or the user creates the unique data. This unique data is stored on the linked clone. Figure 4 shows a logical representation of this relationship.

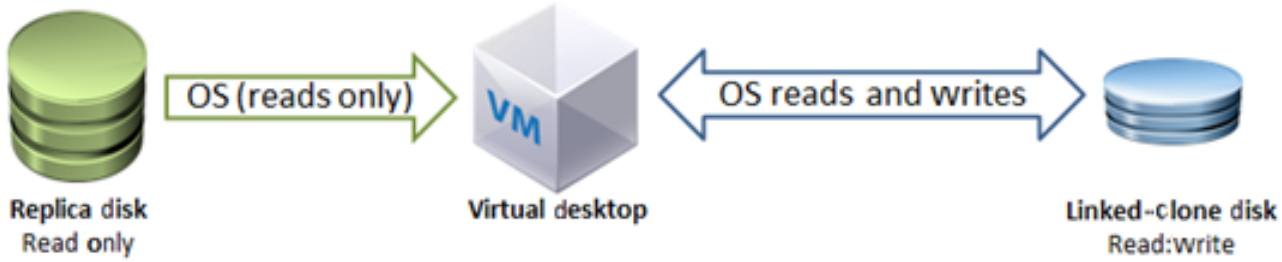

Figure 4. Logical representation of replica disk and linked clone

The deduplication capabilities of the XtremIO all-flash array, combined with the architectural advantages of a linked-clone desktop, resulted in physical storage utilization of only 57 MB per desktop at time of deployment.

Automated pool configuration

We deployed all 2,500 desktops using two automated desktop pools by using a common Windows 7 master image and used 20 datastores to store the virtual desktops; ten for each vSphere cluster.

High availability and failover

Introduction

This solution provides a highly available virtual desktop infrastructure. Each component provides a robust and scalable solution for the host layer, connectivity layer, and storage layer.

Storage layer

The EMC XtremIO array delivers the best in reliability and availability with completely redundant components and the ability to tolerate any component failure without loss of service. Fault protection includes (but is not limited to):

- Dual power supplies in controllers and drive array enclosures (DAEs) to support loss of a power supply, while keeping the controller or DAE in service
- Redundant active/active controllers to support controller failures
- Redundant SAS interconnect modules in the DAEs
- Redundant inter-controller communication links
- Multiple host connections with multipath capabilities to survive path failures
- XtremIO Data Protection (XDP) to tolerate SSD failures
- Multiple techniques to ensure initial and ongoing data integrity

Host layer

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

Conclusion

Summary

The results from the testing of this solution revealed the following conclusions:

- The EMC XtremIO array is easily capable of delivering an outstanding user experience to each virtual desktop user by servicing a high number of I/Os at sub-millisecond latency for thousands of virtual desktops per X-Brick across a wide variety of desktop workloads. These desktops can be linked clones, full clones, or even a combination of both. Based on utilization statistics recorded during testing, were more desktops needed a four X-Brick XtremIO cluster is capable of scaling up to 14,000 linked-clone desktops, or 3,500 per X-Brick, or 10,000 full-clone desktops or 2,500 per X-Brick.
- As the IOPS read/write ratio changes, the responsiveness of the XtremIO array remains virtually unchanged. The array does not require any system-level post-process garbage collection and does not exclusively lock SSDs being written to—practices that are commonly implemented in other all-flash arrays. As a result, XtremIO can provide consistent performance for any mix of read/write IOPS.
- The user experience does not degrade over time as the virtual desktops utilize additional physical storage. VMware Horizon View stakeholders (including end users, storage administrators, virtualization administrators, and desktop administrators) benefit from XtremIO's predictable, consistent performance over time. There are minimal chances of user support tickets complaining about sudden loss of desktop responsiveness.
- While 2,500 virtual desktops are running, each X-Brick can easily support additional concurrent workloads or I/O intensive routine maintenance operations because the aggregate demand from the virtual desktops is well below each X-Brick's rated capacity of 150,000 mixed (50-percent read and 50-percent write) 4K random IOPS.

As a result of this testing exercise, we can conclude that XtremIO storage will no longer be the bottleneck in VDI deployments. While deployments may still encounter bottlenecks and sub-par user experience, that would now more likely be a result of under sizing either the CPU or memory resources.

Figure 5 shows the average vSphere datastore latency observed during the steady state portion of the EUC workload simulation. We used Login VSI to perform the simulation, and the vdbench I/O generation utility to generate supplemental I/O within each desktop session. We used vdbench to stress the performance of the XtremIO all-flash array at much higher per-desktop IOPS levels than are possible with Login VSI alone, a practice that would have required significant changes to the disk layout of traditional spinning disk arrays.

The test results show that even as the per-desktop IOPS was increased, while also maintaining 2:1 write-to-read ratio, the XtremIO array continued to provide sub-millisecond latency to the vSphere datastores that host the virtual desktops.

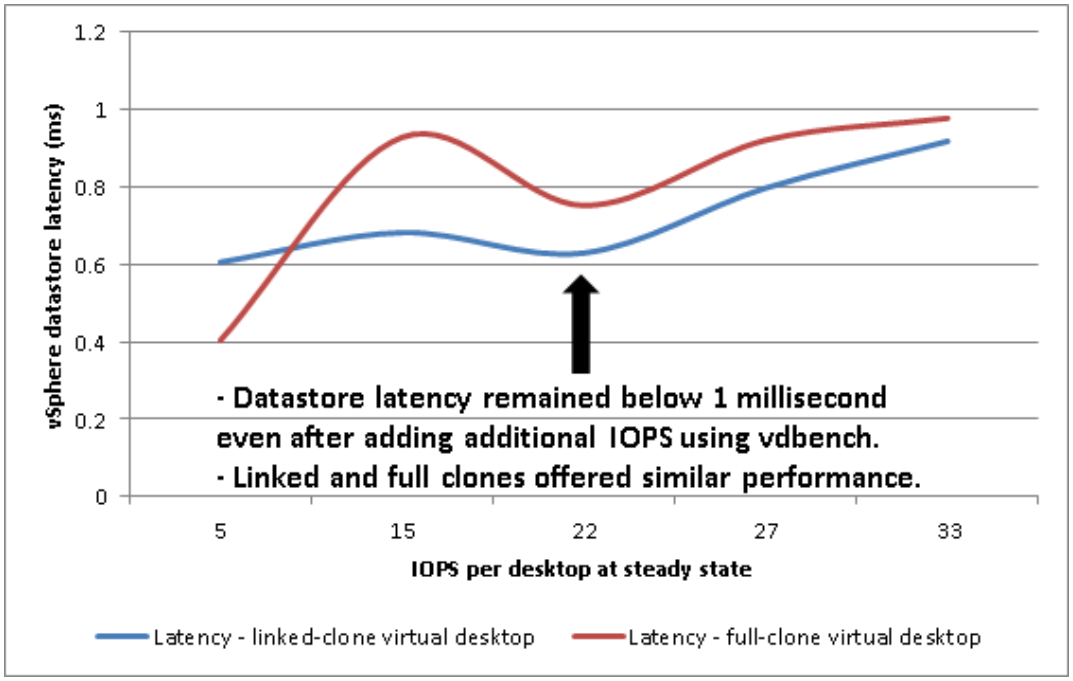

Figure 5. vSphere datastore latency

This reference architecture provides a blueprint for a validated VMware Horizon View 5.2 virtualization solution enabled by EMC XtremIO storage and the VMware vSphere 5.1 virtualization platform. The solution is able to support and scale to thousands of virtual desktops.

EMC can help you to accelerate assessment, design, implementation, and management while lowering the implementation risks for an EMC infrastructure for virtual desktops enabled by EMC XtremIO all-flash array, VMware vSphere 5.1, VMware Horizon View 5.2, and VMware Horizon View Composer 5.2.

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

References

EMC documentation

The following documents, located on EMC Online Support, 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:

- *Deploying Microsoft Windows 7 Virtual Desktops with VMware Horizon View—Applied Best Practices Guide*
- *EMC Infrastructure for VMware View 5.2, Enabled by the EMC XtremIO All-Flash Array, VMware vSphere 5.1, VMware Horizon View 5.2, and VMware Horizon View Composer 5.2—Proven Solution Guide*

VMware documentation

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

- *Anti-Virus Practices for VMware Horizon View*
- *View 5.2 Administration Guide*
- *View 5.2 Architecture and Planning Guide*
- *View 5.2 Installation Guide*
- *View 5.2 Integration Guide*
- *View 5.2 Profile Migration Guide*
- *View 5.2 Security Guide*
- *View 5.2 Upgrades Guide*
- *VMware Horizon View Optimization Guide for Windows 7*
- *vSphere Installation and Setup Guide*