Reference Architecture

EMC INFRASTRUCTURE FOR CITRIX XENDESKTOP 7

EMC XtremIO, VMware vSphere 5.1, and Citrix XenDesktop 7

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

EMC Solutions

March 2014

Part Number H12439.1

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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 its own lab 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. The solution described in this reference architecture was verified with one of these use cases.

This document describes the reference architecture of the EMC infrastructure for Citrix XenDesktop 7 solution, which is enabled by EMC® XtremIO™ and VMware vSphere 5.1.

This reference architecture validates the performance of the solution with up to 2,500 virtual desktops with a single XtremIO brick. XtremIO scales out by designing a two X-Brick cluster to accommodate 5,000 demanding virtual desktops for knowledge workers. Based on the utilization statistics recorded during the test of the virtual desktops provisioned with Machine Creation Services (MCS), a two X-Brick™ XtremIO cluster is capable of scaling up to 8,000 virtual desktops, or one X-Brick can scale up to 4,000 virtual desktops. 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 end-user computing (EUC) project rollouts. Today, user expectations are increasingly being set 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 a solid-state disk (SSD).

Knowledge workers accustomed to working with an ultrabook that easily peaks at over 2,000 I/Os per second (IOPS) may experience unacceptably slow performance using a virtual desktop that delivers only between 7 and 25 IOPS (the common 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 other EUC deployment architectures cannot achieve:

- **Complete flexibility in EUC deployments**

  You can use persistent desktops or non-persistent desktops deployed as either with the vCenter clone mechanism or with the MCS provision mechanism (with or without Personal vDisks), or any combination thereof, without considering underlying I/O performance or excessive capacity consumption. The XtremIO platform gives administrators the flexibility to 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.

- **Superior EUC user experience**

  Every desktop in an XtremIO deployment gets an all-SSD experience with reliable and massive I/O potential in both sustained IOPS and the ability to burst to much higher levels as required by demanding applications such as Microsoft Outlook, desktop search, and antivirus scanning. During our scale testing every simulated application operation completed in half or less than half of the acceptable user experience boundaries. This performance was superior by a wide margin to any previously tested shared storage array.

- **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. This makes deploying virtual desktops more economical 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 all 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**

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

- **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 a posotive user experience.

- **No nights and weekends**

  Administrators no longer need to plan overnight and weekend outages for routine but I/O intensive desktop maintenance operations such as patching, scanning, or upgrading 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 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 desktops are I/O intensive, and historically have been challenging to design and deploy successfully, especially at scale. The design of the XtremIO array guarantees the success of virtual desktop deployments from pilot to large-scale production in the following aspects:

- As an all-flash array, XtremIO delivers extraordinarily high levels of random I/Os, which are prevalent in virtual desktops. This enhances the virtual desktop user experience by providing instant operating system and application response times. It also eliminates any need to specially de-feature desktop images to lower the amount of I/O they drive to the underlying storage.
- With inline data reduction, the XtremIO array can accommodate very high numbers of virtual desktops into a minimal footprint in flash, which makes an all-flash solution economically attractive and drives highly efficient datacenter operational metrics. We[1] tested this solution with both the vCenter clone mechanism provisioned and MCS-provisioned virtual desktops to demonstrate that. For the first time, you can deploy either type purely based on the business needs and not on storage constraints.
- The XtremIO array uses several unique technologies simultaneously to deliver rapid desktop rollouts at speeds that were previously impossible. Rolling out new desktops can be done quickly and easily in a production environment without affecting the user experience. Sizing, configuring, and managing XtremIO is very simple.

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.

Solution benefits

This solution aids in the design and successful deployment of virtual desktops on Citrix XenDesktop 7. It ensures the ultimate desktop performance, while at the same time delivering a highly attractive cost per desktop—not just for storage, but for the infrastructure overall.

[1] In this guide, “we” refers to the EMC Solutions engineering team that validated the solution.

Desktop virtualization also has the following additional benefits:

- Increased security by centralizing business-critical information
- Increased compliance as information is moved from endpoints into the datacenter
- Simplified and centralized management of desktops

By deploying XtremIO, you will realize:

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

Figure 1 shows the highlights of XtremIO during the XenDesktop EUC deployment.

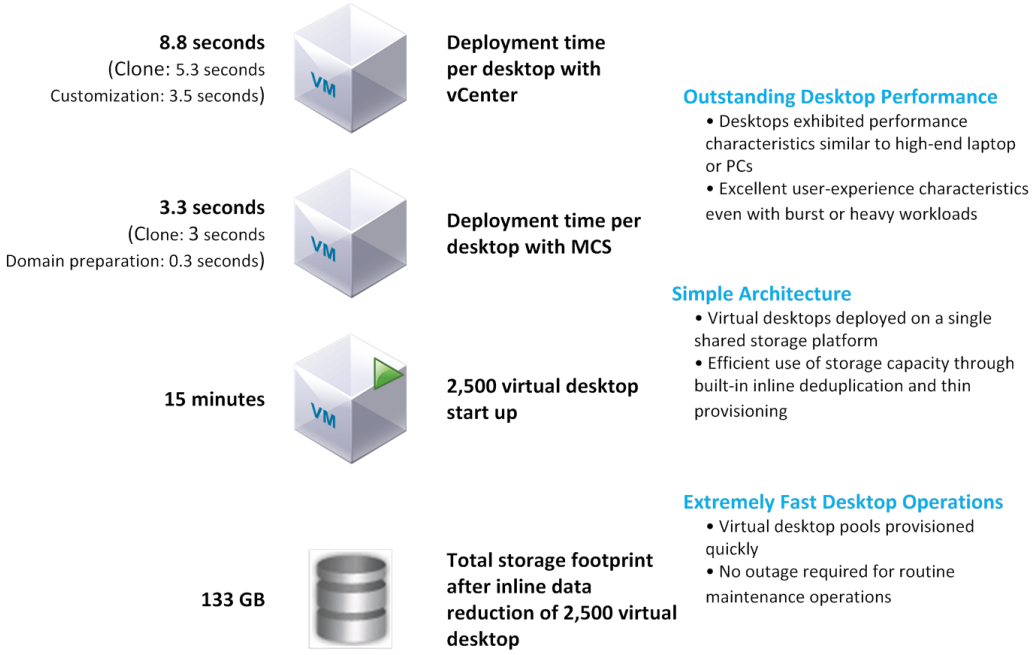

Figure 1. Highlights of XtremIO

Note: Time needed is the average that each virtual desktop takes out of 2,500 deployment. The total storage footprint is based on 2,500 virtual desktop provisioned with the vCenter clone mechanism. With 40 GB capacity, each desktop OS drive is of 14 GB data.

Solution architecture

Overview

This section provides details of the physical and virtual architecture of this solution. Figures and tables in this section are all based on a configuration with 2,500 virtual desktops.

Reference architecture diagram

This solution consists of XtremIO arrays, several servers running vSphere ESXi, 10 Gb Ethernet connectivity for non-storage workloads, and 8 Gb Fibre Channel (FC) connectivity for the storage traffic. Figure 2 shows the overall physical architecture of the solution with 2,500 virtual desktops. For 5,000 virtual desktops, similar topology applies with additional XtremIO brick and servers.

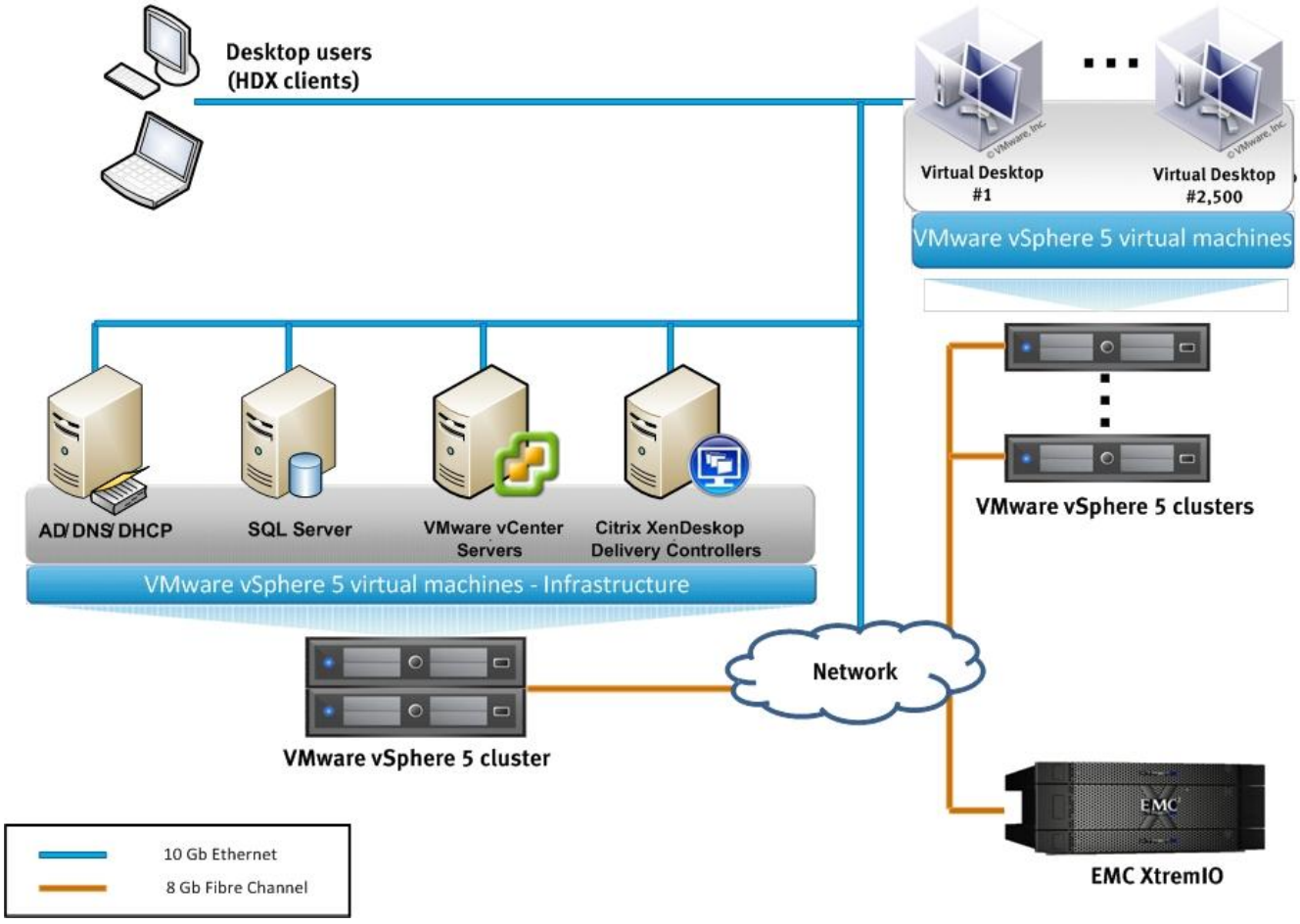

Figure 2. Physical architecture

Hardware resources

Table 1 lists the hardware used to validate the solution.

Table 1. Hardware details

Hardware	Quantity	Configuration	Notes
Storage array EMC XtremIO	1	1 x X-Brick • 25 x 400 GB eMLC SSD drives per X-Brick	Shared storage for virtual desktops and infrastructure servers
Servers	25	• Memory: 384 GB of RAM • CPU: 2 x 2.90 GHz octa-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	• 23 servers—vSphere desktop clusters 1 • 2 servers—vSphere cluster to host infrastructure virtual machines
Converged switches	2	30 x 8 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	Description
EMC Virtual Storage Integrator (VSI)	EMC Unified Storage Management	5.6
	EMC Storage Viewer	5.6
EMC PowerPath software	EMC PowerPath/VE	5.9
VMware vSphere server	VMware vSphere	5.1.0
VMware vCenter server	OS	Windows 2008 R2 SP1
Desktop broker	Citrix XenDesktop	7
Virtual desktops[2]	OS	Windows 7 Enterprise SP1 (32-bit)
	VMware tools	9.0.5

[2] This software is used to generate the test load.

Software	Version	Description
	Microsoft Office	Office Enterprise 2010 with Service Pack 2
	Internet Explorer	10
	Adobe Reader	11
	McAfee Virus Scan	8.7 Enterprise
	Adobe Flash Player	11
	Doro PDF Printer	1.8
	Login VSI (EUC workload generator)	4.0 Professional Edition

- **EMC XtremIO platform**—Storage for Microsoft Windows 7 virtual desktops by using FC connections to vSphere hosts. This solution is validated with a single X-Brick cluster.
- **VMware vSphere 5.1 Server**—A two-node VMware vSphere 5.1 cluster that hosts infrastructure virtual machines when validating 2,500 virtual desktop. An additional VMware vSphere 5.1 clusters is used to host 2,500 virtual desktops.
- **VMware vCenter Server 5.1**—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.
- **Citrix XenDesktop 7**—Software that 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, Citrix XenDesktop 7 is installed on Microsoft Windows Server 2012 and hosted as a virtual machine on a VMware vSphere 5.1 server. Two Delivery Controller Servers were used in this solution.
- **Machine Creation Services (MCS)**—A provisioning mechanism integrated with the XenDesktop management interface, Citrix Studio, to provision, manage, and decommission desktops throughout the desktop lifecycle from a centralized point of management.
- **Citrix Personal vDisk (PvD)**—Software that allows users to preserve customization settings and user-installed applications in a pooled non-persistent desktop.
- **Virtual desktops**—2,500 desktops running Windows 7.
- **Converged switches**—Switches that provide high port density, wire-speed performance, and extremely low latency to meet the growing demand for a 10-Gb Ethernet network and 8-Gb Fibre Channel network. Two Converged switches were used in this solution.
- **Microsoft Windows Server 2012 R2 domain controllers and DNS servers**—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. Two Windows Server 2012 R2 domain controllers were used in this solution.

- **Microsoft Windows Server 2012 R2 dynamic host configuration protocol (DHCP) server**—A service that 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 Citrix XenDesktop and VMware vCenter Server to store configuration details. This SQL Server is hosted as a virtual machine on a VMware vSphere 5.1 server.
- **10-gigabit IP network**—Provides multi-gigabit connectivity between all the XenDesktop 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

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

- Ten LUNs for virtual desktop storage, with each LUN used to store 250 desktops. For vCenter provisioned virtual desktops, we used 15 TB LUNs, while we used 4 TB LUNs for MCS-provisioned virtual desktops. XtremIO supports the vStorage APIs for Array Integration (VAAI) Atomic Test and Set (ATS) primitive, which enhances desktop performance.
- Two 2 TB LUNs for personal vDisk Virtual Machine Disks (VMDKs), 3 GB per virtual desktop.
- One 2 TB LUN for the 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 (TB)
MCS-provisioned virtual desktop	3(average)	2,500	8
Personal vDisk for MCS-provisioned virtual desktop	3	2,500	8
Virtual desktop provisioned with the vCenter clone mechanism	40	2,500	100

Storage network layout

Figure 3 shows the 8 Gbps FC connectivity between the converged switches and the XtremIO cluster. In this solution, the FC ports extend FC connectivity to the vSphere hosts. Only one X-Brick is shown; similar storage network connections are needed for the second X-Brick in the cluster for a total of 5,000 virtual desktops configuration.

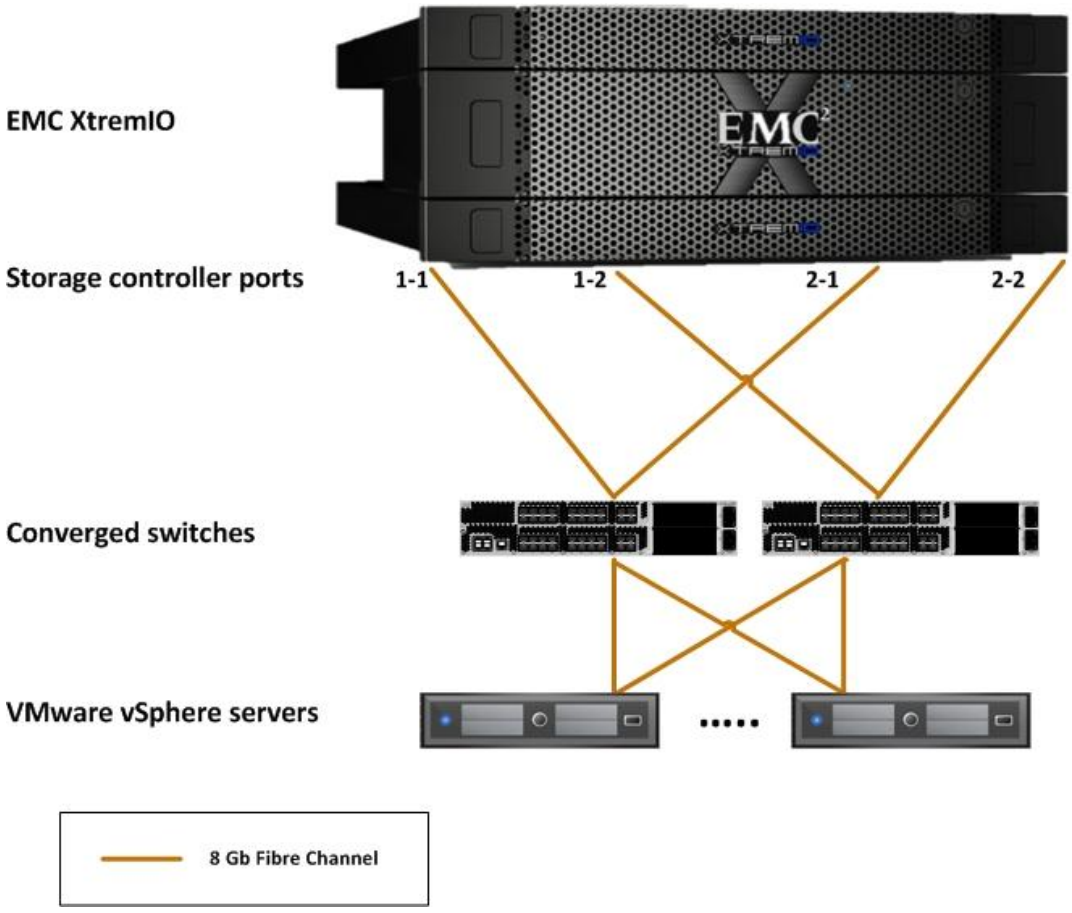

Figure 3. Network layout diagram

Host network configuration

All network interfaces on the vSphere servers in this solution use 10-Gb Ethernet connections. We assigned IP addresses to all virtual desktops by using a dynamic host configuration protocol (DHCP) server.

Figure 4 shows the virtual switch (vSwitch) configuration in the VMware vCenter server.

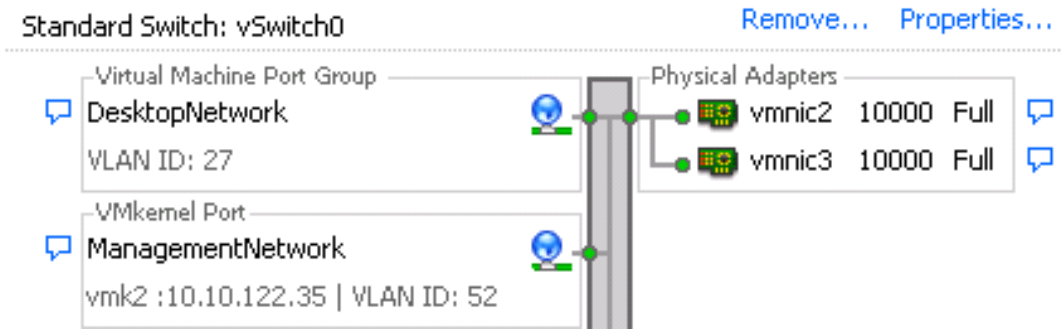

Figure 4. vSwitch configuration in the VMware vCenter server

vSwitch0 uses two physical network interface cards (NICs).

Table 4 lists the port groups configured on vSwitch0.

Table 4. Port groups configured on vSwitch0

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

Key components

Introduction

This section briefly describes the key components of this solution.

- EMC XtremIO
- EMC Virtual Storage Integrator for VMware vSphere
- EMC PowerPath® Virtual Edition
- VMware vSphere 5.1
- Citrix XenDesktop 7
- Machine Creation Services
- Citrix Personal vDisk

Hardware resources and Software resources provides more information on the components used in the solution.

EMC XtremIO

The EMC XtremIO all-flash array is designed for flash storage media. Furthermore, the XtremIO array scales-out by design, in which 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 a 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 all active controllers, high availability, strong data protection, and thin provisioning.

- **Standards-based enterprise storage system**

  The XtremIO system interfaces with vSphere hosts using standard 8 Gb/s Fibre Channel (FC) and 10 GbE iSCSI block interfaces. The system supports complete high-availability features, including support for native VMware multipath I/O, protection against failed SSD, 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. XtremIO deduplicates every bit of data is deduplicated upfront before it writes the data 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 because inline deduplication is purely an in-memory metadata operation; it does not involve sending 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 2,500 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 the sizing of 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 VAAI. It supports all API commands including 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 the ability to use large volume sizes for management simplicity.

- **Massive performance**

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

- **Ease of use**

  The XtremIO storage system requires only a few basic setup steps that can complete in minutes and 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.

- **Datacenter economics**

  A single X-Brick easily supports 2,500 virtual desktops[3] that are provisioned with the vCenter clone mechanism, 2,500 MCS-provisioned virtual desktops (with and without Personal vDisks), or 2,500 virtual desktops with any combination of the above, and requires just a few rack units of space and approximately 750 W of power.

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 XtremIO storage within the vSphere environment. You can add and remove features from VSI independently, which gives you the flexibility to customize VSI user environments. You can manage the features by using the VSI Feature Manager. VSI provides a unified user experience that enables you to rapidly introduce new features in response to changing customer requirements.

The following VSI features were used during the validation testing:

- **Storage Viewer**—Extends the vSphere client to facilitate the discovery and identification of XtremIO storage arrays that are allocated to vSphere hosts and virtual machines. Storage Viewer presents the underlying storage details to the

[3] Virtual desktops are created using Power CLI or VSI.

virtual datacenter administrator, by merging the data of several different storage mapping tools into a few seamless vSphere client views.

- **Unified Storage Management**—Simplifies storage administration of the XtremIO platform. It enables you to provision new Virtual Machine File System (VMFS) datastores and raw device mapping (RDM) volumes seamlessly within the vSphere client.

EMC VSI for VMware vSphere product guides, available on the EMC online support website, provide more information.

EMC PowerPath Virtual Edition

EMC PowerPath/VE is host-based software that provides automated data path management and load-balancing capabilities for heterogeneous server, network, and storage deployed in physical and virtual environments. PowerPath uses multiple I/O data paths to share the workload, and automated load balancing to ensure that data paths are used efficiently.

VMware vSphere 5.1

VMware vSphere 5.1 can transform or virtualize computer hardware resources including CPU, RAM, hard disks, and network controllers to create fully functional virtual machines that run their own operating systems and applications just like a physical computer.

The high-availability features of vSphere 5.1 along with 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 customer.

Citrix XenDesktop 7

Within the Citrix XenDesktop 7 architecture, management and delivery components are shared between XenDesktop and XenApp to give administrators a unified management experience. Figure 5 shows the XenDesktop 7 architecture components.

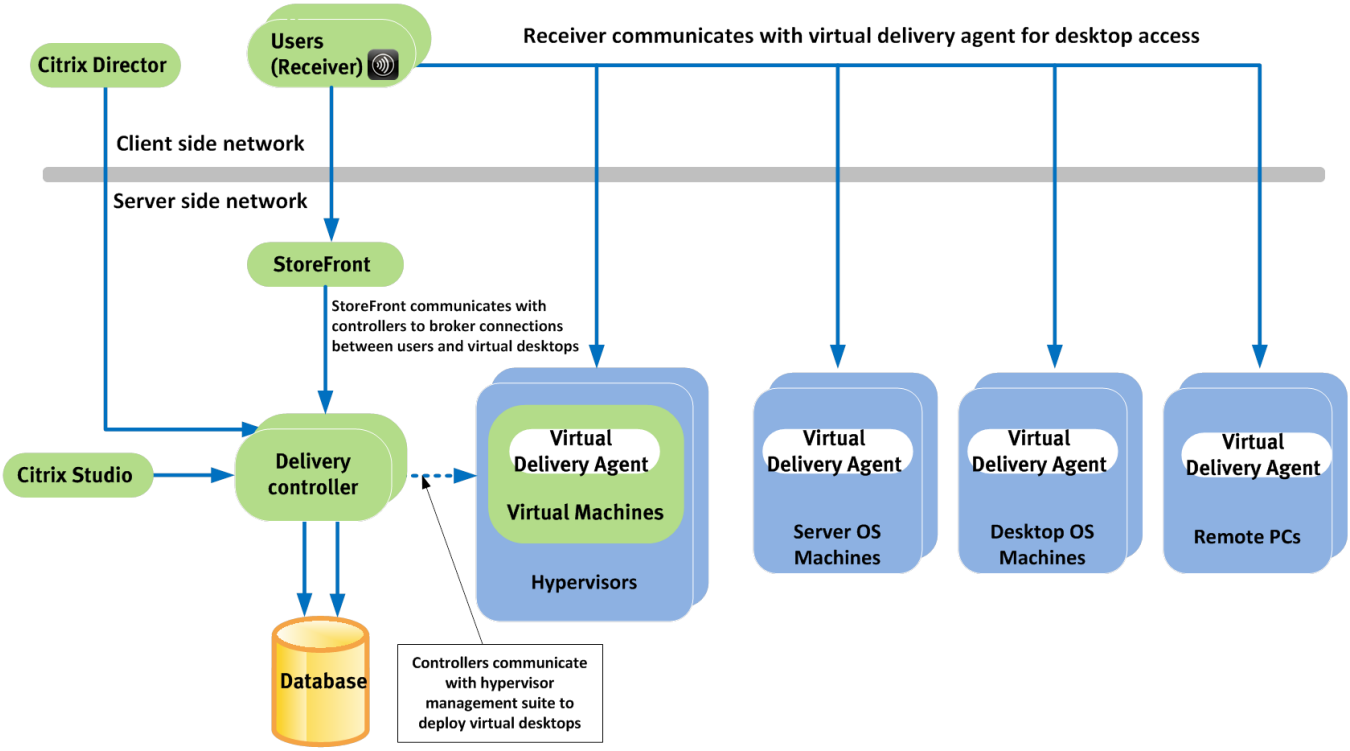

Figure 5. XenDesktop 7 architecture components

The XenDesktop 7 architecture components are:

- **Receiver**—Installed on user devices, provides you with quick, secure, self-service access to documents, applications, and desktops from any of your devices including smart phones, tablets, and personal computers (PCs). Receiver provides on-demand access to Windows, Web, and software as a service (SaaS) applications.
- **StoreFront**—StoreFront allows you to access sites that are hosting resources and manages stores of desktops and applications that users access.
- **Studio**—Studio is the management console that enables you to configure and manage your deployment, which eliminates the need for separate management consoles for managing delivery of applications and desktops. Studio provides various wizards to guide you through the process of setting up your environment, creating your workloads to host applications and desktops, and assigning applications and desktops to users.
- **Delivery Controller**—Installed on servers in the datacenter, the Delivery Controller consists of services that communicate with the hypervisor to distribute applications and desktops, authenticate and manage user access, and broker connections between users and their virtual desktops and applications. The controller manages the state of the desktops, starting and stopping them based on demand and administrative configuration. In some editions, the controller enables you to install Profile Management to manage user personalization settings in virtualized or physical Windows environments. Each site has one or more Delivery Controllers.

- **Virtual Delivery Agent**—Installed on server or workstation operating systems, the Virtual Delivery Agent (VDA) enables connections for desktops and applications. For remote PC access, you must install the VDA on the office PC.
- **Server OS machines**—Server OS machines are virtual or physical machines, based on the Windows Server operating system, that deliver applications or hosted shared desktops (HSDs) to users.
- **Desktop OS machines**—Desktop OS machines are virtual or physical machines, based on the Windows Desktop operating system, that deliver personalized desktops to users, or applications from desktop operating systems.
- **Remote PC access**—User devices are included on a whitelist and enable you to access resources on your office PCs remotely, from any device running Citrix Receiver.

Machine Creation Services

Machine Creation Services (MCS) is a provisioning mechanism that is integrated with the XenDesktop management interface, Citrix Studio, to provision, manage, and decommission desktops throughout the desktop lifecycle from a centralized point of management.

MCS enables you to manage several types of machines within a catalog in Citrix Studio. Desktop customization is persistent for machines that use Citrix Personal vDisk (PvD), while Citrix non-Personal vDisk (non-PvD) machines are appropriate if you will discard desktop changes when you log off.

This solution uses MCS to deploy 2,500 dedicated virtual desktops running Windows 7.

Citrix Personal vDisk

Citrix XenDesktop 5.6 introduced the Citrix PvD feature. With PvD, you can preserve customization settings and user-installed applications in a pooled desktop. During runtime, the content of the PvD is blended with the content from the base virtual machine to provide a unified experience to the end user. PvD data is preserved during the reboot and refresh operations.

Validated environment profile

Overview

This section provides a summary and characterization of the tests performed to validate the EMC infrastructure for Citrix XenDesktop 7.

Profile characteristics

Table 5 provides the environment profile used to validate the solution.

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	6.79 (as tested)
RAM per virtual desktop	2 GB
Personal vDisk	3 GB
Virtual desktop base image	40 GB
Storage used in the virtual desktop master image (used by Windows and applications)	14 GB
Average physical storage used for each MCS-provisioned virtual desktop	6.3 MB
Average physical storage used for each vCenter-provisioned virtual desktop	54.5 MB
Deduplication ratio of desktops	vCenter provisioned: 241:1 MCS provisioned: 9.7:1
Average IOPS per virtual desktop at a steady state	5
Average deployment time per virtual desktop	vCenter provisioned: 8.8 seconds MCS provisioned: 3.3 seconds
Number of datastores used to store virtual desktops	10
Number of virtual desktops per datastore	250
Disk 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	1
Number of VMware vSphere servers in each cluster	23
Number of virtual desktops in each cluster	2,500

Desktop provisioning mechanism

Overview

This solution was validated using virtual desktops provisioned with the vCenter clone mechanism and MCS (with or without Personal vDisk) to ensure that similar performance can be obtained regardless of the deployment method used.

vCenter provisioned desktop

This solution uses traditional vSphere customization specifications and the Microsoft Sysprep utility to customize each desktop after it is cloned from a master desktop template, through PowerCLI script, and then adds virtual desktops to XenDesktop.

The deduplication capabilities of XtremIO resulted in physical storage utilization of only 54.5 MB per desktop during the deployment. Figure 6 shows detail storage usage and efficiency information captured from the XtremIO management GUI after the deployment of 2,500 virtual desktops. The deduplication ratio is high for freshly cloned desktops. However, in a steady state, the deduplication ratio is around 10:1.

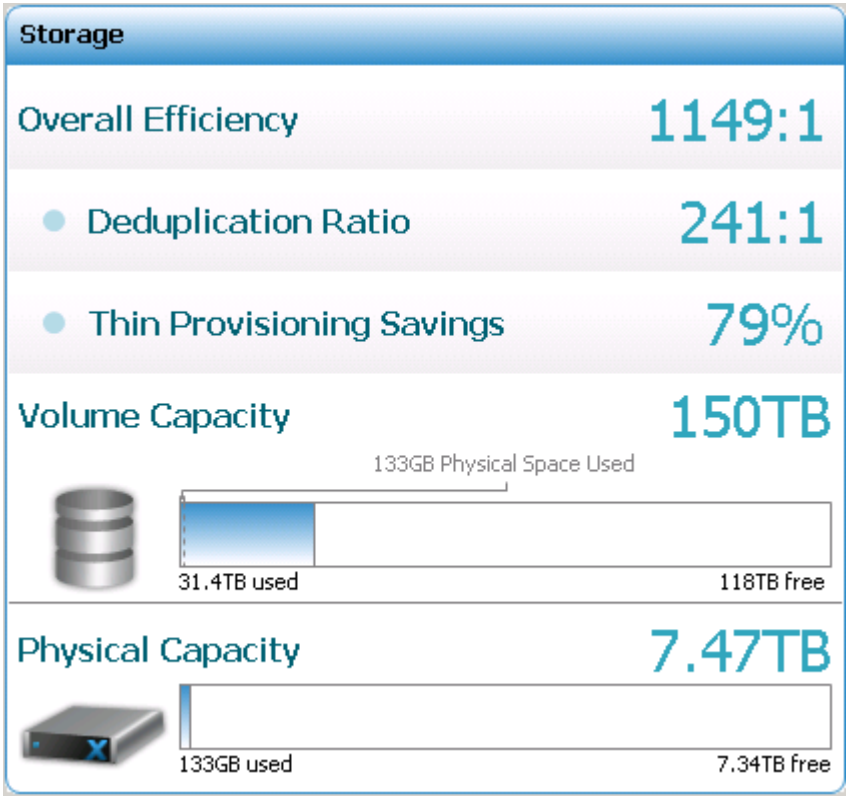

Figure 6. Storage capacity

MCS-provisioned desktop

Citrix XenDesktop 7 with MCS supports the use of base image to quickly provision virtual desktops.

With the MCS provisioning method, the operating system reads all the common data from the read-only base image, and creates the unique data on the differential disk. Figure 7 shows a logical representation of this relationship.

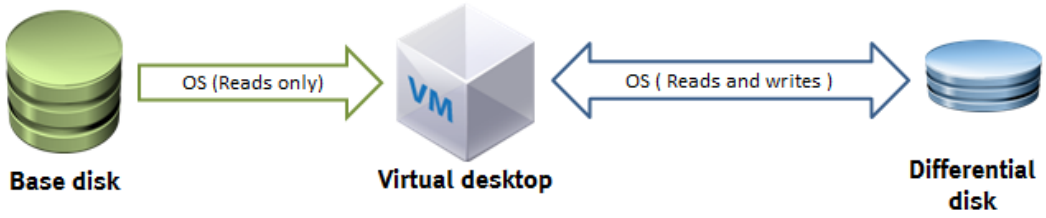

Figure 7. Logical representation of base disk and differential disk

The deduplication capabilities of XtremIO, combined with the architectural advantages of MCS-provisioned desktop, result in physical storage utilization of only 6.3 MB per desktop at the time of deployment.

Static pools configuration

We deployed all 2,500 desktops with a single virtual desktop pool by using a common Microsoft Windows 7 master image. We used ten datastores to store the virtual desktops.

High availability and failover

Overview

This solution provides a virtual desktop infrastructure with high availability. Each component is configured to provide a robust and scalable solution for the host, connectivity, and storage layers.

Host layer

The application hosts have redundant power supplies and network connections to reduce the impact of component failures in the vSphere servers. VMware high availability (HA) is configured on the cluster to help recover virtual desktops quickly in case of a complete host failure, as shown in Figure 8.

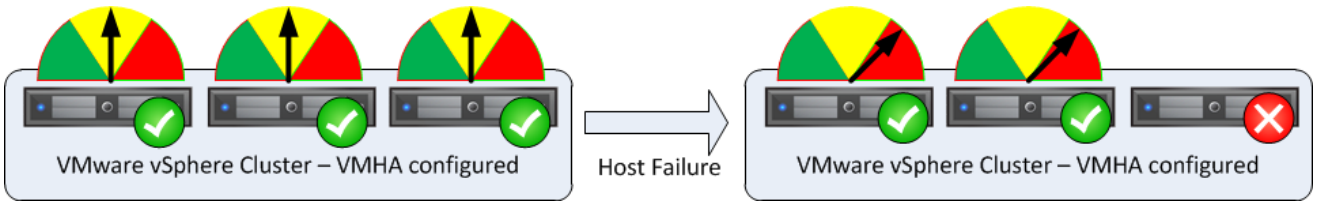

Figure 8. High-availability host layer

Connectivity layer

This reference architecture network requires redundant Ethernet and Fibre Channel links for each vSphere host, the storage array, the switch interconnect ports, and the switch uplink ports. This configuration provides both redundancy and adequate bandwidth. This configuration is also required regardless of whether the connectivity infrastructure for the solution already exists or is being deployed alongside other components of the solution.

Storage layer

XtremIO is reliable and available with completely redundant components and can tolerate any component failure without a service downgrade. Fault protection includes (but is not limited to):

- Dual power supplies in controllers and disk-array enclosures (DAEs) to support the loss of a power supply, while keeping the controller/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

Conclusion

EMC XtremIO is capable of delivering an outstanding user experience to each virtual desktop user by servicing I/O at sub-millisecond latency with high I/O levels for 2,500 desktops across a wide variety of desktop workloads with a single XtremIO X-Brick, and scaling out to 5,000 virtual desktops with two XtremIO X-Bricks. These desktops can be provisioned with the vCenter clone mechanism, MCS, and MCS with PvD, or even a combination of them. Each X-Brick can easily accommodate 2,500 virtual desktops. The number of virtual desktops that each X-Brick can support in actual deployments can be much higher depending on the types of virtual desktops configured and the workloads.

For the first time, virtual desktops that are provisioned with the vCenter clone mechanism can be deployed on XtremIO without any cost disadvantage compared with MCS-provisioned virtual desktops because of the large inline data reduction that is always on XtremIO.

As the IOPS read/write ratio changes, the responsiveness of XtremIO is virtually unchanged. XtremIO does not need "garbage collection" at the system level or exclusively lock SSDs that is being written to—both commonly implemented in other all-flash arrays. As a result, XtremIO can provide consistent performance for any mix of read/write IOPS.

No degradation in the user experience occurs over time since the virtual desktops constantly overwrite existing capacity in the array. Citrix XenDesktop stakeholders (including end users, storage administrators, virtualization administrators, and desktop administrators) benefit from the predictable and consistent performance of XtremIO over time.

This reference architecture provides a blueprint for a validated Citrix XenDesktop 7 solution enabled by XtremIO and VMware vSphere 5.1on a virtualized platform. The solution can support and scale to thousands of virtual desktops.

Refer to the *EMC Infrastructure for Citrix XenDesktop 7 Proven Solution Guide* for more details about the solution and to review the test results.

References

EMC documentation

The following documents, located on the EMC website, provide additional and relevant information:

- *EMC Infrastructure for Citrix XenDesktop 7 Proven Solution Guide*
- *Flash Implications in Enterprise Storage Array Designs*
- *EMC Infrastructure for Citrix XenDesktop 7.0. EMC VNX Series (NFS and FC), Citrix XenDesktop 7, and VMware vSphere 5.1. Reference Architecture*

Citrix documentation

The following Citrix documents, located on the Citrix website, provide relevant information:

- *XenDesktop Design & Deployment Handbook*
- *Scaling XenDesktop 7 to 5,000 users with VMware vSphere 5.1 (ESXi)*

VMware documentation

The following VMware document, located on the VMware website, provides relevant information:

- *vSphere Installation and Setup Guide*