

Scaling XenDesktop 7 to 5,000 users with VMware vSphere 5.1 (ESXi)

Citrix Solutions Lab Validated
Solutions Design Guide

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More and more enterprises are turning to desktop virtualization as a solution to rising IT costs, security concerns, and the user demands of BYOD and work from anywhere, at any time, from any device. But can a desktop virtualization solution support thousands of users, both local and remote? How well does a virtual desktop solution scale?

This document discusses the environment created in the Citrix Solutions Lab to successfully deploy and support 5000 virtual desktop users in a multi-branch environment.

The Solutions Lab was formed to design, architect, and test deployments of large scale Citrix virtualization solutions from end-point device to the datacenter, including multi-branch remote locations.

This document provides information about:

- **The Design** – How Citrix products and valued Citrix partner hardware were architected and configured to build a 5000 user, multi-branch solution
- **The Conclusions** – Based on test results, the conclusions the Solutions Lab team were able to draw and the lessons they learned

This document describes virtualization technology design and concepts. It covers the overall methodology for configuring and testing a real-world desktop virtualization environment to support a large number of users. This document does not provide step by step or detailed configuration instructions, but will define the architecture used in testing.

This document is intended for the IT professional with relevant experience in virtualization technologies, and provides guidance when designing large scale virtual desktop environments. In addition, IT and other business executives will gain a better understanding of what's needed to deliver virtual desktops and applications to their users.



Citrix XenDesktop 7

XenDesktop delivers Windows apps and desktops as secure mobile services from a cloud-ready platform while simplifying management, reducing costs and enhancing security.

XenDesktop 7 is a simple way to enable employees to work from any device. Delivering the best mobile experience, XenDesktop gives people the freedom to shift work to a more optimal place—on whatever device they choose, accessing both apps and desktops whenever and wherever, over any network connection.

When IT can react more quickly to the changing needs of the business and deliver both virtual apps and desktops from a single platform, it becomes a valuable asset to the business rather than just a cost. With XenDesktop 7, the business can:

- Deliver secure access to mission-critical business apps and data from mobile devices
- Empower employees by providing 24x7 self-service access to the applications they need from a simple enterprise app storefront
- Quickly add new employees, open new offices, and start offshore operations by providing a full function corporate desktop to new users in a matter of minutes
- Easily support teleworking mandates and green initiatives while reducing facility and travel expenses
- Manage applications, desktops and data centrally, making it easier to protect sensitive resources and adhere to regulatory compliance standards
- Recruit top talent from anywhere by offering flexibility and work-life balance by supporting anywhere computing on a variety of devices
- Seamlessly ensure high availability and enhance performance through integrated networking and branch optimization solutions
- Control the ever-increasing costs of annual PC refresh cycles by centrally managing and delivering virtual apps and desktops to any device, including low-cost thin clients

XenDesktop 7 is at the center of a remarkable transformation giving IT the power to mobilize the workforce while realizing lower costs, greater business agility, and virtual apps and desktops for any type of user.

Citrix solutions combine virtualization, networking, and cloud computing technologies to deliver a full portfolio of offerings that enable virtual workstyles for users and virtual datacenters for IT while putting IT at the center of this transformation.

Key benefits

- Mobilize Windows apps and desktops for any device
- Reduce costs of desktop management
- Secure remote access to business-critical data
- Unified architecture simplifies deployment



Executive Summary

This document details the design, deployment, and validation of the new Citrix Desktop Virtualization architecture available in XenDesktop 7.

Project overview

XenDesktop 7 integrates Citrix XenApp and VDI technologies into a unified architecture, providing operational and management efficiencies in regards to the design and deployment of desktop virtualization.

This project consisted of designing, building, and testing a XenDesktop environment to show how 5000 users can access services across multiple geographic locations, utilizing HP BL460c Gen8 blade servers, an EMC VNX7500 storage array, and VMware vSphere 5.1 with Citrix XenDesktop 7, NetScaler, and Branch Repeater technologies.

Project goals

This Desktop Virtualization test environment was built with the following goals in mind:

- Validate XenDesktop 7 within a 5000 user environment by leveraging the capabilities of XenDesktop 7 to deploy desktops and applications to three types of users; local, remote office, and remote access
- Create a modular design allowing for linear scalability and growth maintaining a balance of desktop types; in the test environment, 64% hosted shared desktops, 18% random VDI desktops, and 18% static VDI desktops with Personal vDisk (PvD) to allow for user customization
- Design the environment to be highly available and resilient to failure, where possible, while maintaining business continuity
- Validate that XenDesktop 7 can support different types of users in different geographic locations, such as branch office workers and remote access users, with a single pane of glass, centrally managed from the datacenter from deployment to daily operations
- Validate that the test environment would stay within the following defined guidelines, while not encountering the maximum capacity of any individual component within that environment
 - No server CPU utilization average to be over 85% while under load
 - Storage to perform within EMC guidelines of response times under 10 milliseconds per request
 - 5000 users connect, complete a test run, and logoff cleanly

LoginVSI 3.7 was used as the load generation tool for all users to verify the solution

For more information about Login VSI, see the [Login VSI](http://LoginVSI.com) website



Conclusions

- Testing validated that XenDesktop 7 delivered a resilient solution on VMware vSphere 5.1 supporting 5,000+ concurrent users deployed over a multi-branch solutions environment.
- StoreFront 2.0 successfully scales using an N+1 model.
- Provisioning Services (PVS) 7.0 successfully supported the multiple Flexcast models provided with XenDesktop 7.
- All infrastructure servers in the environment were successfully virtualized.
- The new consolidated XenDesktop 7 interface greatly simplified the deployment and management of different Flexcast models.
- Utilizing a modular design provides easy management and scalability.

This white paper provides design considerations and guidelines for a mixed FlexCast model deployment. The diagram below provides a high level view of the environment tested.

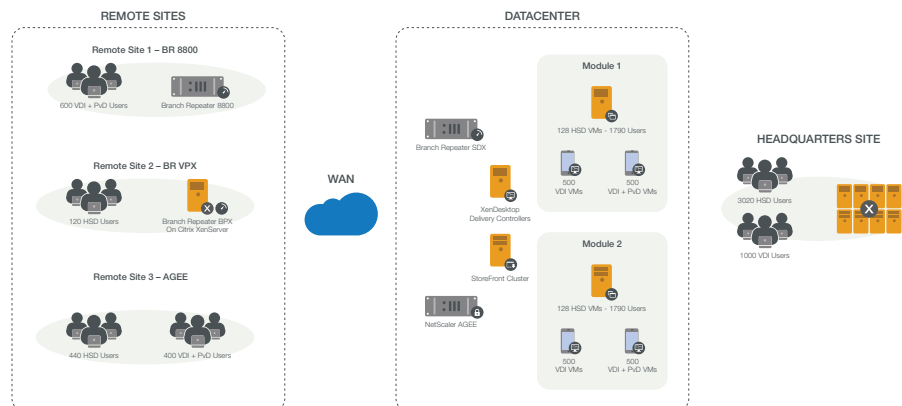


Figure 1: Overview of a XenDesktop 7 multi-site enterprise environment with 5K+ users



Abbreviations and naming conventions

The following abbreviations and naming conventions are used in this document.

AG	Access Gateway
AGEE	Access Gateway Enterprise Edition
BR	Branch Repeater
CIFS	Common Internet File System
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
HA	High Availability
HDX	High Definition eXperience
HSD	Hosted Shared Desktop
IOPS	Input/Output Operations Per Second
iSCSI	Internet Small Computer System Interface
ISL	Inter-Switch Link
NFS	Network File System
NS	NetScaler
NTP	Network Time Protocol
PvD	Personal vDisk
PVS	Provisioning Services
RAID	Redundant Array of Independent Disks
TCO	Total Cost of Ownership
VDA	Virtual Delivery Agent
VDI	Virtual Desktop Infrastructure
vDisk	Virtual Disk (Provisioning Services Streamed VM Image)
VLAN	Virtual Local Area Network
VM	Virtual Machine
VPX	Virtual Appliance
WAN	Wide Area Network
WSFC	Windows Server Failover Cluster



Hardware and software used

The following hardware and software was used in the test environment:

Software

Component	Version
Virtual Desktop Broker	Citrix XenDesktop 7
VDI Desktop Provisioning	Citrix Provisioning Services 7.0
Endpoint Client	Citrix Receiver for Windows 4.0
User Profile Management	Citrix User Profile Manager 5.0
VDI Personalization	Citrix Personal vDisk 7.0
Web Portal	Citrix StoreFront 2.0
Licensing	Citrix License Server 11.11
Workload Generator	Login VSI 3.7
Office	Microsoft Office 2010 SP1
Virtual Desktop OS (VDI Desktops)	Microsoft Windows 7 x64 SP1
Virtual Desktop OS (Hosted Shared Desktops)	Microsoft Windows Server 2012
Database Server	Microsoft SQL Server 2012
VDI Hypervisor Management	vCenter Server 5.1
VDI Hypervisor	VMware vSphere 5.1 Enterprise Plus

Hardware

Component	Version
Blade Servers	
• Infrastructure	HP ProLiant BL460c Gen8
• Virtual Desktop Hypervisors	HP ProLiant BL460c Gen8
Network Appliances	
• WAN Optimization	Citrix Branch Repeater 8800, SDX, and VPX Citrix
• Remote Access	NetScaler/Access Gateway Enterprise Edition
Network Devices	
• Backbone Switch	Cisco Nexus 7010K 8x32/10G
• Multi-layer Switches	HP H3C 5820, 580
Storage Systems	EMC® VNX® 7500

Additional detail can be found in the [Appendix](#).



Solutions architecture

The diagram below illustrates the architecture of the Citrix XenDesktop test environment. Each component deployed in the test environment is discussed in detail in this section.

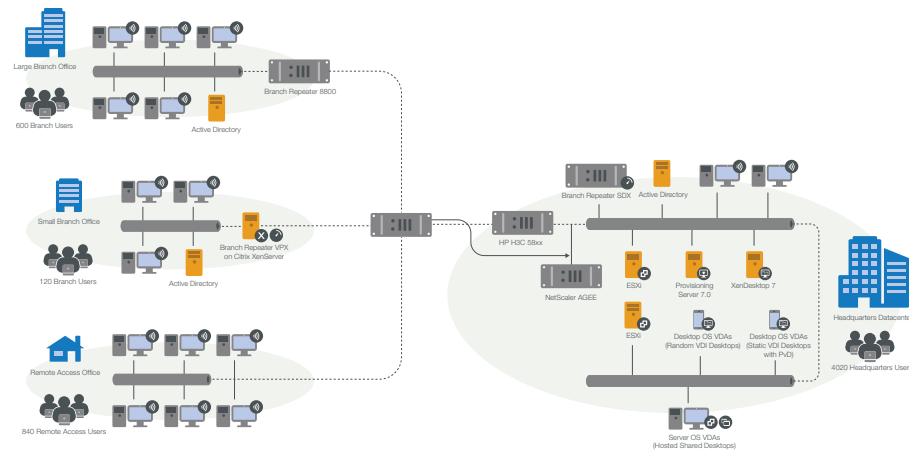


Figure 2: XenDesktop 7 multi-site enterprise environment with 5K+ users

Users and locations

Main office (4,020 users)

The main office location required virtual desktop services with centralized system and desktop image management. Users within the main office comprised primarily task workers, provided with a mix of 3020 hosted shared desktops and 1000 random VDI desktops.

Large branch office (600 users)

Users in the large branch office location needed secure and accelerated remote access to the datacenter-based virtual desktops. These users comprised primarily engineering staff, provided with static VDI desktops (with PVD).

Small branch office (120 users)

Users in the small branch office location also needed secure and accelerated remote access to datacenter-based virtual desktops. These users comprised primarily sales and administration staff, provided with hosted shared desktops.

Remote access (840 users)

Access Gateway was chosen to provide secure, remote access to remote users. These users comprised a mix of staff, provided with a mix of 400 hosted shared desktops and 440 static VDI desktops (with PVD).



User split

Site	Number of users	Percentage of users
Main office	4020	72%
Remote	1560	28%

Desktop split

Model	Number of desktops	Percentage of desktops
Hosted shared desktop	3580	64%
Random VDI desktop	1000	18%
Static VDI desktop (with PvD)	1000	18%

The desktop type split was designed based on customer input. A large majority of customers deploy a significant amount of hosted shared desktops to users, because their needs are relatively simple. More complex task workers get a random VDI desktop instead of a hosted shared desktop. High-level workers who require the ability to personalize their desktops are provided with static VDI desktops (with PvD) to allow for that personalization. Rather than working with dedicated desktops, the static VDI desktop (with PvD) construct solves the personalization requirement whilst still providing a lower TCO.

Storage infrastructure

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 generalist in smaller environments, and the VNX series, designed to meet the high-performance, high scalability, requirements of midsize and large enterprises.

The EMC VNX 7500 unified storage platform is at the top of the line of the VNX series. It is powered by Intel quad-core Xeon 5600 series processors and delivers five 9's of availability. It is designed to deliver maximum performance and scalability for enterprises, enabling them to dramatically grow, share, and cost-effectively manage multi-protocol file and block systems. It supports up to 1000 drives and eight X-Blades (also known as Data Movers) for file protocol support.

A single EMC VNX 7500 appliance was utilized to provide storage for the test environment. The solution was validated using NFS for data storage of virtual desktops, SQL databases, and infrastructure virtual machines such as delivery



controllers, vCenter Servers, and other supporting services. CIFS was configured for profile management and for PVS vDisks.

Storage architecture design

In a large scale PVS deployment, the option typically chosen for the PVS write cache destination is “Cache on device hard drive” to achieve higher scalability and allow ease of manageability and agility.

In a virtualized environment, this cache area resides in the virtual hard disks attached to the virtual machines, and is IO intensive because, while the PVS servers absorb most of the read IOPS for the virtual desktops, all writes are redirected to the write cache area.

As the write cache area is write intensive by nature, Citrix recommends designating RAID 10 storage pools on the VNX for PVS write cache to minimize the RAID penalty incurred by RAID 5 or other similar RAID types. Because EMC VNX arrays support RAID 10 pools with multiples of eight drives, Citrix recommends using that drive count unit as the building block while the number of deployed desktops continues to scale.

In the test environment, the storage pools used to store PVS write cache for both hosted shared desktops and VDI desktops were made up of 64 and 24 SAS 15K drives respectively.

Storage deployment

Four data movers (storage file heads) in a single EMC VNX 7500 were utilized, with two assigned to support virtual desktops, one assigned to infrastructure, and one configured for failover.

The following table defines the number of drives associated with each storage pool, the protocol used in accessing the pool, the RAID configuration, and whether or not EMC VNX 7500 FAST™ Cache was used in accessing the pool. EMC FAST Cache is a storage performance optimization feature that provides immediate access to frequently accessed data.

For more information see the [EMC](#) website.

	Drive count	Drive type	Protocol	RAID	FAST Cache
Infrastructure VMs	10	SAS	NFS	5	N
SQL database/quorum	5	SAS	NFS	5	N
HSD/VDI desktop vDisk	5	SAS	CIFS	5	Y
HSD Write Cache	64	SAS	NFS	10	Y
Random VDI desktop Write Cache	24	SAS	NFS	10	Y
Static VDI desktop Write Cache	24	SAS	NFS	10	Y



	Drive count	Drive type	Protocol	RAID	FAST Cache
PvD	20	SAS	NFS	5	Y
User Profiles	15	SAS	CIFS	5	N
VNX system drives	4	SAS	N/A	5	N/A
FAST Cache drives	10	SSD	N/A	1	N/A
Hot spares	6	SAS	N/A	N/A	N/A
Hot spare	1	SSD	N/A	N/A	N/A
SAS used	171				

The FAST Cache SSD drives were 200GB in size. Using EMC best practices, a maximum of 250 VMs was used for each NFS datastore in VSphere.

Network infrastructure

The next consideration for this environment was the network architecture and design. The network architecture for the test environment included, but was not limited to, the creation of IP address requirements, VLAN configurations, required IP services, and server network configurations. Considerations regarding IP allocation, IP block assignment, and WAN Routing were extremely important in ensuring that the design maintained its modularity.

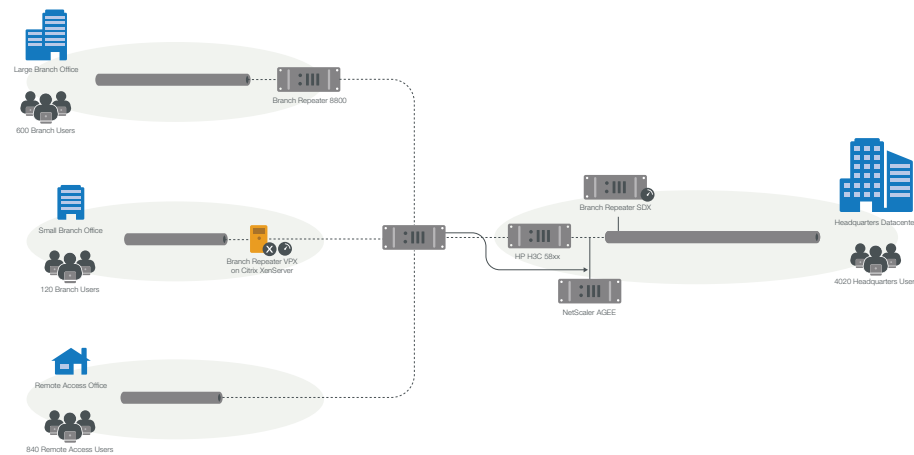


Figure 3: Network diagram for XenDesktop 7 multi-site enterprise environment with 5K+ users

Network design

When planning the network environment, it was important to determine how many nodes would be needed at the beginning of the project and how many would need to be added throughout the lifetime of the project. Once known, planning of the IP address blocks could begin.



It is desirable to employ a modular approach to network VLAN design. Traffic separation is efficient for VDI IP considerations and alleviating bandwidth traffic concerns. If possible, create a separate VLAN for certain types of traffic. For example, a Storage VLAN for storage traffic (that is iSCSI, NFS, or CIFS), DMZ's for certain external incoming traffic types, a server management VLAN (which may include Lights-Out capabilities and log gathering mechanisms), and Guest VLANs for virtual desktops. This type of design approach keeps layer 2 broadcasts to a minimum while not over-utilizing the CPU and memory resources of network devices.

Design considerations

As a design consideration, the chunks of desktop growth have an impact on how a network is designed. A /24 network allows for growth in chunks of 200 VDI desktops, while a /23 network allows for growth in chunks of 500 desktops. By planning the network design with growth and a buffer considered, blocks can be aggregated in chunks of /24's, /23's, and /22's (1024 hosts) as needed.

Datacenter and remote office LAN network architecture overview

The Cisco Systems Nexus 7010K Core Switch with eight cards and 32 10GbE ports provided the datacenter multilayer switching and routing services. This switch also provided all routing, switching, and security services for the rest of the environment. H3C/HP 5820 10GbE switches served other 10GbE service ports. Also, 1GbE ports were served by H3C/HP 5801 1GbE switches with 10GbE uplinks.

For branch office sites, workgroup switching and routing were required. The 1GbE ports required were provided by H3C/HP 5801 1GbE switches, which incorporated 10GbE uplinks to the core infrastructure. No latencies were introduced to the LAN configuration.

WAN network architecture overview

The planning for the multisite WAN test environment included planning for VLAN and other network-based services, supporting both virtualized and physical systems, and providing for WAN, DMZ, and firewall connectivity. Planning also included placing network service appliances, such as Branch Repeater and NetScaler systems, in correct, logical network locations.

The test environment WAN routing at the datacenter was provided by a single Cisco core switch, as mentioned above. To meet the requirement for providing appliance-to-appliance ICA optimization for the XenDesktop virtual desktops access in the environment, BR-SDX appliances were deployed in a HA configuration at the datacenter. Standalone BR appliances (8800-series and virtual appliances) were deployed at each of the branch office locations. Branch site Layer-3 routing and edge services were provided by H3C 58XX Series multi-layer switch router devices.

A Branch Repeater 8800-series appliance was selected for the large branch office (600 users) and a Branch Repeater virtual appliance (VPX) for the small branch office (120 users). A Branch Repeater SDX appliance Model 13505 was used to allow for a single connection point for remote Branch Repeater connections at the datacenter.



For remote access users, ICA Proxy and VPN services were required. To meet this requirement, a NetScaler appliance with an Access Gateway Enterprise Edition license was deployed in the datacenter. LACP 802.3AD was used for all ISL's between all devices.

Design considerations

Each network appliance is limited by the number of connections that they can support; most network appliances list the maximum number of TCP connections that they support. In the Citrix VDI environment, the ICA connection capacity of the Remote Access and WAN Acceleration devices needs to be considered. It is necessary to match this capacity with the site user requirements, while including a buffer for future site growth.

- To optimize storage communications in the environment, Citrix recommends using a dedicated VLAN for server to storage connections.
- Consider separating heavy network traffic in a dedicated VLAN so that it does not interfere with other traffic.
- Uplinks between all network switches at Layer 2 should employ 802.3ad LACP Ethernet aggregation for increased throughput and resiliency.
- To determine the overall bandwidth needed, it is necessary to know the bandwidth required per session. The number of possible remote site sessions is directly proportional to the bandwidth.

Common infrastructure

The common infrastructure components, those normally already in place in a datacenter environment (including, but not limited to Active Directory, DNS, DHCP, and NTP), were hosted on VMs outside of the XenDesktop environment deployed for this test.

Active Directory

A Windows 2008 R2 four-site Active Directory with a Single Forest, Single Domain structure was deployed. Two Domain Controllers were deployed in each site for redundancy and each site hosted its own AD-integrated DNS and DHCP.



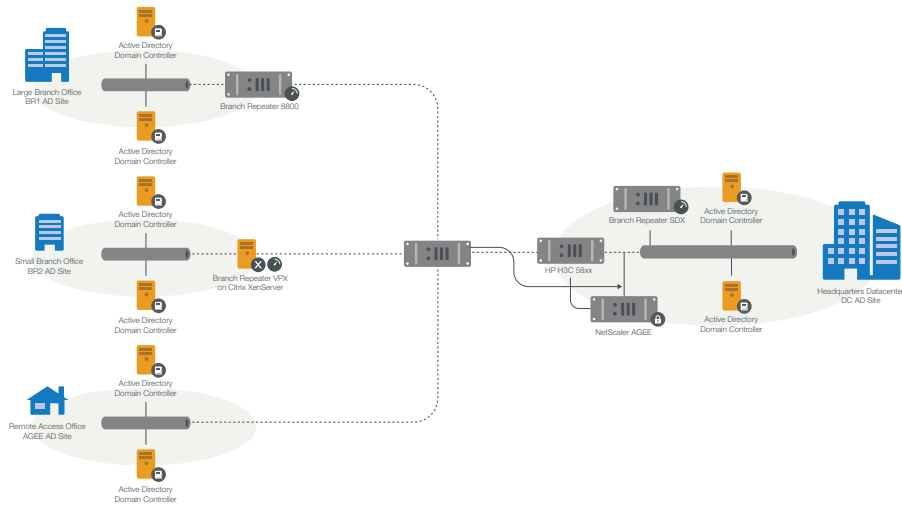


Figure 4: Active Directory multi-site structure

Client infrastructure

A significant LoginVSI client environment was required for the test environments large-scale deployment. Almost 300 VSI client launchers were deployed for over 5000 independent ICA sessions. All client launcher systems were virtualized in a completely separate XenServer environment.

VDI infrastructure modular design

With the common infrastructure in place, the next step was to design, create, and configure the infrastructure that would support the first modular block. After that first block of users was built and tested an additional modular block was deployed. This section outlines the modular VDI infrastructure that was used along with the modular block sizing and configuration of the VSphere environment, vCenter, PVS, and SQL Server.

Infrastructure deployment methodology

Similar to the common infrastructure deployment methodology, the modular infrastructure utilized HP Insight Control for the deployment of the operating system. The VDI infrastructure was hosted on HP BL460c Gen8 blade servers.

Modular block overview

One modular block (c-Block) contained one cluster for each desktop type (random VDI, static VDI (with PvD), and hosted shared) and the supporting infrastructure for them.



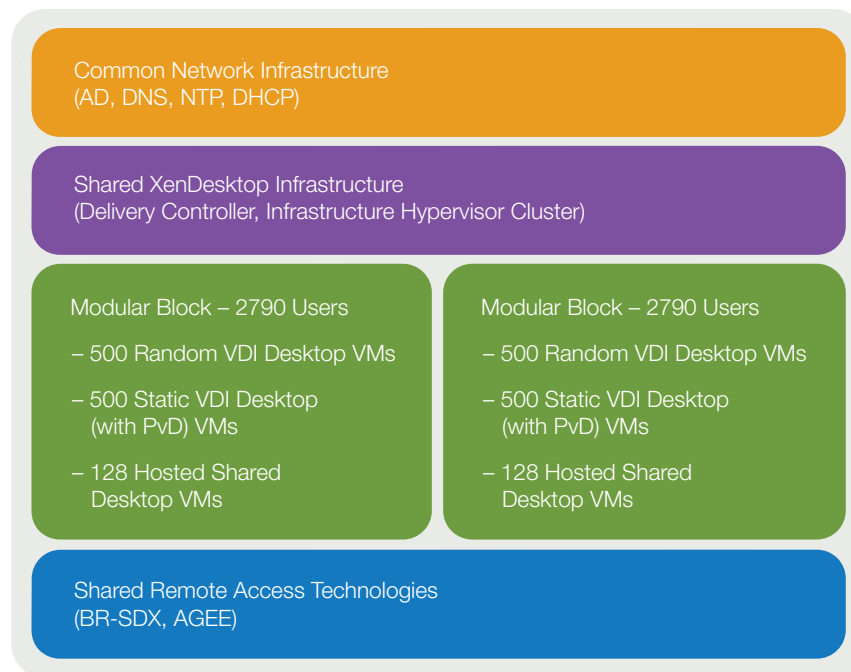


Figure 5: Modular block diagram

Modular block sizing

When scaling up a VDI environment from a single server to a modular block, it is important to understand the hardware along with its capacity and performance capabilities and limitations. This is important not only for each component, but also for the entire system working together. Finding the optimal design involves multiple cycles of testing, troubleshooting, and resolution of issues. This leads to a design where every component within the system has the ability to handle the expected load easily.

In the test environment, the first step in this process was to determine single-server VM density. Based on this information, density numbers for a single cluster of users was calculated. Because there were three different FlexCast models in the test environment, three cluster sizes were defined as follows:

- For random VDI desktops, a single cluster consisted of six servers
- For static VDI desktops (with PvD), a single cluster also consisted of six servers, but the density was reduced slightly in order to provide a level of resiliency for the PvD infrastructure
- For hosted shared desktops, a single cluster consisted of 16 servers



Following on from those calculations, the three different clusters were combined to build a “modular block” (or c-Block) of users. In the test environment, each block was built to support 2790 users. Two of these blocks were combined to build the entire environment.

With static VDI desktops (with PvD), there is sometimes a concern over availability. In other environments, if a server running a desktop with PvD fails, the process of connecting an existing PvD to a new desktop can be time-consuming, unless there is some level of resiliency allowing that desktop to boot on a different server. To alleviate that concern in the test environment, the static VDI desktop (with PvD) clusters were configured for high availability. In the six-node clusters, only five Hosts were deployed, leaving one Host for failover. Load balancing across the cluster, however, resulted in all six Hosts running at approximately 60-70% of maximum capacity to accommodate a Host failure. This resulted in the servers running at approximately 85% of maximum capacity after a single Host failure (maintaining performance at the desired level) and at approximately 100% of capacity after a double Host failure.

Each cluster was hardware specific and each module included one cluster per desktop type, as follows:

- 16-blade cluster for Windows 2012 hosted shared desktops
- 6-blade cluster for Windows 7 random VDI desktops
- 6-blade resilient cluster for Windows 7 static VDI desktops (with PvD)

Modular block infrastructure

The environment was built with two modular blocks, resulting in approximately 5500 net users.

Virtual desktop infrastructure virtualization

VDI virtualization management





Figure 6: vCenter Server and ESXi Clusters management structure

vCenter for VDI infrastructure and desktop hypervisor hosts

The ESXi 5.1 hypervisor hosts in the test environment were managed by vCenter Server 5.1, configured as follows:

- vCenter Server was configured with High Availability protection provided by vCenter Server Heartbeat 6.5.
- The primary and secondary vCenter Servers were virtualized on separate ESXi hosts.

vCenter SQL

A SQL backend database was required for vCenter. A set of virtual SQL servers was utilized in the test environment, configured as follows:

- SQL servers ran on Windows 2008 R2 ESXi VMs.
- SQL Server 2008 R2 Database Mirroring was configured using three servers:
 - Principal, mirror, and witness
- EMC VNX 7500 NFS VMDK's were used for database storage:
 - 100GB attached to both principal and mirror SQL server VMs
 - The witness server was a separate Windows 2008 R2 VM



Note: To use Windows Server Failover Clustering with SQL Server would have required Block storage (Fibre Channel or iSCSI). In the test environment, only NFS storage was available and clustering was not utilized.

VDI infrastructure hypervisors

Infrastructure components, including Delivery Controllers and Provisioning Servers, were deployed on HP BL460c Gen8 blade servers running ESXi 5.1 in an 8-node ESXi cluster, configured as follows:

- VMWare Standard Virtual Switch (vSwitch)
- Managed by the primary vCenter Server
- Shared Storage for infrastructure VMs hosted as an NFS datastore on EMC VNX 7500

VDI Infrastructure VMs

The VDI Infrastructure VMs were configured as follows:

- Windows 2008 R2 SP1 was installed
- Given a static IP address and static DNS entry in the AD-integrated DNS

RDS Licenses for Windows 2008 R2 (Infrastructure VMs) and Windows Server 2012 (hosted shared desktop VMs) were provided by a standalone Windows Server 2012 VM configured with the RD Licensing role. This VM was set up expressly to provide RDS licenses.

Citrix XenDesktop Site structure

The XenDesktop Site in the test environment was configured as a single XenDesktop 7 Site containing the following components:

- Three Delivery Controller VMs running on ESXi for HA (2 +1)
- The XenDesktop Site Database running as a SQL Server 2012 AlwaysOn High Availability Group
- Citrix Licensing Server running as a stand-alone VM



Citrix Infrastructure SQL

Three Windows 2008 R2 ESXi VMs were configured as a Windows Server Failover Cluster for the XenDesktop SQL server. SQL Server 2012 was configured as an AlwaysOn Availability Group. Storage for these VMs was provided by a dedicated NFS datastore per server to ensure high performance. A dedicated CIFS share was provided for data synchronization and backup purposes with an additional CIFS share used for the WSFC witness.

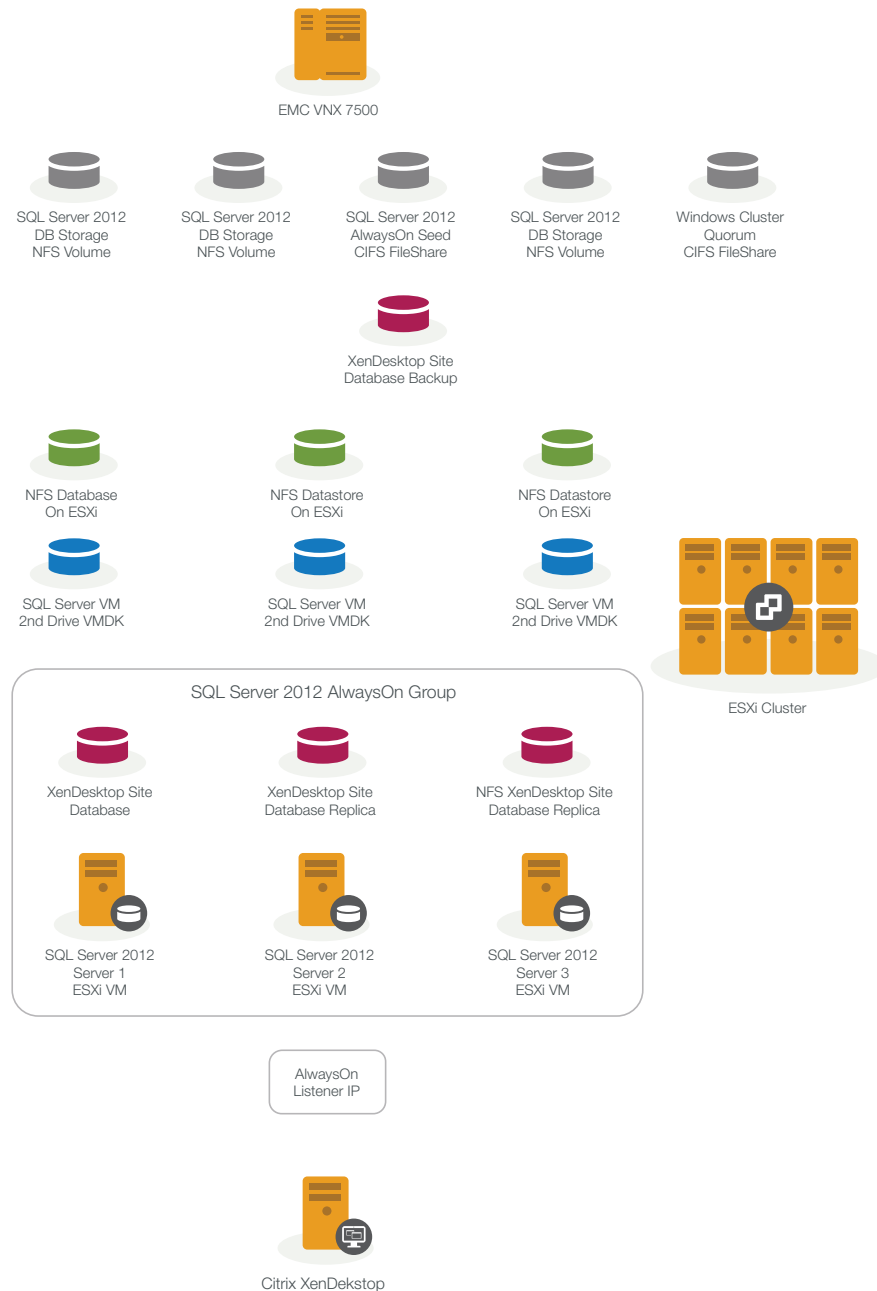


Figure 8: SQL Server 2012 structure



Web Portal – StoreFront

Web Portal services were delivered by three StoreFront 2.0 VMs deployed in the Infrastructure cluster. A dedicated active-passive pair of NetScaler VPX virtual appliances (with a single Virtual IP) was used to load-balance the StoreFront VMs. An additional stand-alone StoreFront VM was configured to allow for AGEE integration due to the limitations of the test harness.

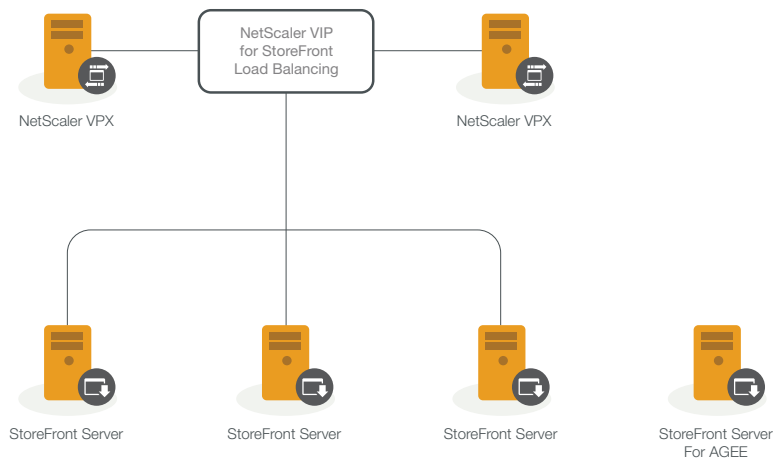


Figure 9: StoreFront deployment

Profile management

Profile management was provided by Citrix Profile Management 5.0.

Three Profile management policies were created, one per desktop type, with the following settings:

Policy	Static VDI desktops with PvD	Random VDI desktops	Hosted shared desktops
Delete locally cached profiles on logoff	Disabled	Enabled	Enabled
Profile streaming	Enabled	Enabled	Enabled
Always cache	Disabled	Disabled	Disabled
Active write back	Enabled	Enabled	Enabled
Process logons of local administrators	Enabled	Enabled	Disabled

Desktop virtualization

Desktop hypervisors

All virtual desktops were hosted on HP BL460c Gen8 blade servers running ESXi 5.1, configured with the following system settings:



- PXE NIC #1 as the first boot device in Boot Order
- HP Power Regulator P-state set to Pmax
- Jumbo Frames for storage connection to EMC
- Four networks configured:
 - Management
 - Storage
 - vMotion
 - Guest

Note: The Guest network was configured to provide one VLAN for each desktop cluster, as detailed below.

Desktop hypervisor clusters

The networking for the hypervisor clusters utilized a VMware Distributed Switch (VDS), configured as follows:

- Management VLAN
- Storage VLAN
- vMotion VLAN
- Guest 1 VLAN (hosted shared desktops)
- Guest 2 VLAN (hosted shared desktops)
- Guest 3 VLAN (VDI desktops)

Note: Guest VLAN for VDI desktops is the same across all clusters.

Desktop deployment

VDI desktops

VDI desktops were configured with 1000 in total, 500 per cluster for both random VDI desktops and static VDI desktops (with PvD). Each desktop was configured as follows:

- Windows 7 x64 OS
- 1.5GB / 1 vCPU
- VMXNet3 NIC
- 40GB HDD (Master/vDisk)
- 3GB Windows Page File
- 4GB Write Cache
- Cache on Device HDD
- 10GB Personal vDisk (Static VDI desktops only)



PVS for VDI desktops

PVS 7.0 was virtualized in the VDI infrastructure cluster as a single PVS farm, containing:

- 4 servers
- 1 site
- 1 vDisk store
- 2 vDisks (One each for static VDI desktops (with PvD) and random VDI desktops)
- A single server thread per streamed virtual desktop VM

Hosted shared desktops

Hosted shared desktops were configured with 256 in total, 128 per cluster, allowing for 1790 sessions per chassis, 3580 sessions total. Each Host was configured as follows:

- Windows Server 2012
- 12GB / 4 vCPU
- VMXNet3 NIC
- 60GB HDD (Master/vDisk)
- 18GB Windows Page File
- 25GB Write Cache
- Cache on Device HDD

PVS for hosted shared desktops

PVS 7.0 was virtualized in the VDI infrastructure cluster as a single PVS farm, containing:

- 4 servers
- 2 x 2 sites (PVS site per VLAN = ESXi hosted shared desktop chassis)
- 2 vDisk stores (One per cluster)
- 1 vDisk per store

Notes

- For hosted shared desktops, the Windows Page file was based on 1.5x RAM; for VDI desktops it was based on 2x RAM.
- For both hosted shared and VDI desktops, Write Cache was based on 2x RAM + 1.
- Memory Ballooning was disabled for all desktop VMs as per best practices.

VAMT for desktops

Microsoft VAMT 3.0 was deployed to allow for both Windows and Microsoft Office activation verification.



Test methodology

All validation testing was performed on-site at the Citrix Solutions Lab.

The focus of testing was on capturing boot-up, user logon, user logoff, and steady state metrics during the entire process of the virtual desktop lifecycle.

Test metrics were gathered for all components under test such as the hypervisor, virtual desktop, and storage and from the workload generation system, Login VSI, to determine the overall success of a test run. Each test run would need to be within the threshold of the success criteria as defined below to consider it a passing run. A test procedure is followed to provide consistency between runs.

Test overview

The following test procedure was used for each test run to ensure consistent results:

- Before each test, all desktop VMs and clients were cleanly started.
- All desktop VMs and client launchers were Idled for an hour for consistent results.
- Boot Phase – All desktop VMs needed to power on and register within one hour.
- Logon Phase – All user sessions were launched and active in Login VSI within one hour.
- Test Phase – At least two Login VSI loops were executed in each active session.
- Logoff – All users logged off after VSI completion.
- Test run reports and data were generated.
- All desktop VMs and clients were shut down.

Success criteria

Performance metrics were used to ensure the systems were not overloaded during the different tests. The main success criteria for the 5000 user, multi-branch test was to have 5000 active desktop sessions, to have a successful in-session workload execution from start to finish, and to ensure no single component in the deployment became overloaded.

Test tools

Test orchestration and workload generation

The primary test tool used in the environment was Login VSI 3.7, consisting of the VSI Client Launcher, VSI Workload, VSI Console, and VSI Analyzer applications.

Login VSI 3.7 was used as the test orchestration and workload generation system to create the load of multiple users accessing the XenDesktop 7 environment and executing a typical user workflow within a session.

After all users had logged on, the test was configured to simulate each user executing two Login VSI loops before logging off, with each loop 12-15 minutes long.



Login VSI Console and Analyzer were used to orchestrate the test launch and analyze test results for all executed test runs.

Performance data capture

Windows Performance Monitor was used to collect data for all major systems during each test run. This provided close to real-time performance monitoring during the test and in-depth historical data analysis after test completion. All desired data including systems metrics was collected and stored.

Citrix Command Center was used to collect data for Branch Repeater and NetScaler appliances.

In-session workload simulation

Login VSI is a publicly available tool from Login VSI B.V. that provides an in session workload representative of a typical user. A predefined “medium workload” that simulates “knowledge user working” was used for this test. Flash redirection was not enabled.

The predefined workload was used to simulate user activities during the test and to find the maximum number of active sessions that the environment was able to handle. The workload script was running on the server-side desktop and the generated traffic stream was almost purely downstream.

For more information about Login VSI, see the [Login VSI](#) website.



Conclusions

The primary objective of testing was to show that XenDesktop 7 could support 5000 users in a multi-branch configuration, using multiple FlexCast models and a modular hardware approach for scaling. As stated earlier, hosted shared desktops, random VDI desktops, and static VDI desktops (with PvD) were deployed in the datacenter and combinations of the three were deployed in the remote site locations. The defined success criteria were:

- No server CPU utilization average to be over 85% while under load
- Storage to perform within EMC guidelines
- 5000 users connect, complete a test run, and disconnect cleanly

The testing was executed as planned, the success criteria were met, and it was shown that XenDesktop 7 did meet the initial objective.

Detailed performance data for storage and ESXi Hosts is available in Appendix B.



Notes and lessons learned

All infrastructure servers in the test environment were virtualized, reducing the number of physical servers required.

Eight physical servers were used to support the required infrastructure VMs, including Delivery Controllers, PVS servers, and SQL Servers.

27 Infrastructure VMs were created to support testing:

- XenDesktop
 - 3 Delivery Controller VMs
 - 3 SQL Server VMs with AlwaysOn features configured
- PVS (Virtual)
 - 4 VMs in a VDI desktop farm
 - 4 VMs in a hosted shared desktop farm
- Storefront
 - 3 VMs in a cluster for both the datacenter and two remote sites
 - 1 VM for AGEE
- vCenter
 - 2 vCenter VMs
 - 2 vCenter SQL Server VMs
 - 1 Command Center VM
 - 1 SQL Server VM for Command Center
- NetScaler
 - 2 NS VPX VMs
- License Server VM

All XenDesktop 7 server components and the infrastructure required to support those components were virtualized.

The environment was oversized to prevent limitations in trying to achieve the 5000 user goal. The appendices provide performance data and guidelines as to where the test environment could have been sized more appropriately.

Virtualizing SQL Server 2012, including the AlwaysOn features, removed the SQL Server quorum requirement in some instances.

XenDesktop 7 includes a new environment test service. This service checks and validates certain aspects of an environment, such as network and server access,



during the installation process. This offers customers increased confidence that XenDesktop will deploy successfully. During deployment of the test environment, all checks were passed and all components were deployed successfully.

By default, XenDesktop 7 provides users with an optimized graphic experience. During testing, all desktops were configured to provide default optimized graphics experience with Desktop Composition enabled. No flash remoting was utilized.

The test environment was designed using a modular architecture. Each module supported 2500 users. This modular approach allowed testing to begin at a small scale, using only a single module, before adding another module, configured in the same way, to obtain the desired 5000 user count. Following this process would have allowed the environment to scale past 5000 users easily. Citrix recommends designing a deployment using a modular architecture to enable customers to simplify scaling and management.

During testing, over 5500 sessions connected and executed successfully. Less than 1% of sessions failed to connect out of 5580 sessions started. The connection failures analyzed were commonly due to either networking or test tool timing issues.

Changes to workflow and version capabilities in Provisioning Services 7.0 improved both vDisk image management and VM deployment. vDisk versioning allows image files to be updated simply and quickly. Changes to the PVS Target Device Service enable the creation and formatting of the write cache drive automatically during VM deployment. Previous versions required the administrator to create the write cache drive manually as part of a template.

The default write cache vDisk model provisioned for ESXi in the XenDesktop Setup wizard is a “thin provisioned” vDisk.

For information about overriding the default types of write cache disks created by provisioning deployments on ESXi and the defaults for other hypervisors, see the Provisioning Services 7.0 content in [eDocs](#).

Three StoreFront servers were configured in a cluster for the datacenter and remote branch sites. When evaluating the performance of the Storefront cluster it was concluded that two servers in a cluster would have been sufficient for the entire workload, allowing for both High Availability and a single StoreFront server failure.

A separate StoreFront server was created for Access Gateway users, because of the requirements of the test tool to use Python for certain user access. To prevent conflicts between Python and SFConnect, traffic was filtered through separate StoreFront servers.

From a hardware perspective, each Host was configured with 192GB of memory and each virtual desktop VM with 1.5GB of memory. This limited the maximum number of sessions per Host to 128, not allowing any memory for the Host itself. A conservative 10GB of memory was allowed for ESXi, ensuring 120 VMs could comfortably fit into the remaining memory. Hosts were configured in this way to avoid paging and swapping at either VM or Host level.



Appendix A: System inventory

Physical systems

HP BL 460c Gen8 with ESXi 5.1 x 56

- 32 for Hosted Shared Desktops (2 x 16)
- 24 for XenDesktop Virtual Desktops (2 x 2 x 6)
- 8 for Infrastructure

Function	Citrix Infrastructure Virtualization	Static VDI Desktops (with PvD)	Random VDI Desktops	Hosted Shared Desktops
Hardware Model	HP BL460c Gen8	HP BL460c Gen8	HP BL460c Gen8	HP BL460c Gen8
Member Host Count	8	6	6	16
Number of Network Cards	8 in total; 4 utilized	8 in total; 4 utilized	8 in total; 4 utilized	8 in total; 4 utilized
VLAN Configuration	<ul style="list-style-type: none"> • Management • Storage • Guest • vMotion 	<ul style="list-style-type: none"> • Management • Storage • Guest • vMotion 	<ul style="list-style-type: none"> • Management • Storage • Guest • vMotion 	<ul style="list-style-type: none"> • Management • Storage • Guest • vMotion
Shared Storage Protocol	NFS v3	NFS v3	NFS v3	NFS v3
Shared Storage Type	EMC VNX 7500	EMC VNX 7500	EMC VNX 7500	EMC VNX 7500
Operating System	VMWare ESXi 5.1	VMWare ESXi 5.1	VMWare ESXi 5.1	VMWare ESXi 5.1
HA/Resiliency Configuration	No HA	High Availability enabled	No HA	No HA



Network appliances

Datacenter

Branch Repeater SDX (x2)

Device	Model	Role	Version
Branch Repeater SDX	SDX-13505	Datacenter Branch Repeater	<ul style="list-style-type: none"> NetScaler 9.3, Build 58.5009 Branch Repeater VPX 6.2.0, Build 112.308159 XenServer 5.6.100-47011p

NetScaler AGE (x2)

Device	Model	Role	Version
NetScaler	MPX-10500	Datacenter Access Gateway	NetScaler 9.3, Build 60.3

NetScaler VPX

Device	Model	Role	Version
NetScaler	VPX for ESXi	StoreFront Load Balancing	NetScaler 10, Build 74.4

Large branch office

Physical Branch Repeater 8800

Device	Model	Role	Version
Branch Repeater	Repeater 8820 SM88 Series 3	Remote Site Branch Repeater	Branch Repeater VPX 6.2.0, Build 112.308159

Small branch office

Virtual Branch Repeater

Device	Model	Role	Version
Branch Repeater	VPX on XenServer 5.6	Remote Site Virtual Branch Repeater	Branch Repeater VPX 6.2.0, Build 112.308159



Virtualized systems

XenDesktop infrastructure

Function	Citrix XenDesktop Delivery Controller	Citrix Provisioning Server	Citrix License Server	Citrix StoreFront Server (Main and Branch Office connections through Branch Repeater)	Citrix StoreFront Server (Remote connections through AGEE)
Hardware Model	ESXi VM	ESXi VM	ESXi VM	ESXi VM	ESXi VM
Number of vCPUs	4	4	4	2	8
Number of Cores	1	1	1	1	1
Memory	8GB	16GB	4GB	2GB	8GB
Network Configuration	1 Network Card	2 Network Cards: • 1 Management • 1 Streaming Network	2 Network Cards: • 1 Management • 1 Streaming Network	1 Network Card	1 Network Card
Hard Drive	60GB	60GB	60GB	60GB	60GB
Operating System	Windows 2008 R2	Windows 2008 R2	Windows 2008 R2	Windows 2008 R2	Windows 2008 R2
Software	Citrix XenDesktop 7	Citrix Provisioning Server 7.0	Citrix Licensing Server 11.11	Citrix StoreFront 2.0	Citrix StoreFront 2.0



Virtual desktops

Function	Streamed Static Personalized Desktop (with PvD)	Streamed Random Personalized Desktop	Streamed Hosted Shared Desktop
Hardware Model	ESXi VM	ESXi VM	ESXi VM
Number of vCPUs	1	1	4
Number of Cores	1	1	1
Memory	1.5GB	1.5GB	12GB
Network Configuration	<ul style="list-style-type: none"> • 1 Network Card 	<ul style="list-style-type: none"> • 1 Network Card 	<ul style="list-style-type: none"> • 1 Network Card
Hard Drive	<ul style="list-style-type: none"> • 40GB Master • 4GB Write Cache 	<ul style="list-style-type: none"> • 40GB Master • 4GB Write Cache 	<ul style="list-style-type: none"> • 60GB Master • 25GB Write Cache
Operating System	Windows 7 x64	Windows 7 x64	Windows Server 2012
Software	<ul style="list-style-type: none"> • Citrix Virtual Delivery Agent 7.0 • Citrix Provisioning Services 7.0 Target Device Software • Login VSI 3.7 • Microsoft Office 2010 	<ul style="list-style-type: none"> • Citrix Virtual Delivery Agent 7.0 • Citrix Provisioning Services 7.0 Target Device Software • Login VSI 3.7 • Microsoft Office 2010 	<ul style="list-style-type: none"> • Citrix Virtual Delivery Agent 7.0 • Citrix Provisioning Services 7.0 Target Device Software • Login VSI 3.7 • Microsoft Office 2010



Other infrastructure

Function	SQL 2012 Server	VMWare vCenter 5.1	SQL 2008 R2 for vCenter	Citrix Command Center	SQL 2008 R2 for Command Center
Hardware Model	ESXi VM	ESXi VM	ESXi VM	ESXi VM	ESXi VM
Number of vCPUs	4	4	4	4	4
Number of Cores	1	1	1	1	1
Memory	16GB	16GB	32GB	16GB	16GB
Network Configuration	1 Network Card	2 Network Cards: <ul style="list-style-type: none"> • 1 Management • 1 Streaming Network 	1 Network Card	1 Network Card	2 Network Cards: <ul style="list-style-type: none"> • 1 Management • 1 Streaming Network
Hard Drive	<ul style="list-style-type: none"> • 60GB for OS and Applications • 120GB for Database Storage 	60GB	<ul style="list-style-type: none"> • 60GB for OS and Applications • 200GB for vCenter Database 	60GB	60GB
Operating System	Windows 2008 R2	Windows 2008 R2	Windows 2008 R2	Windows 2008 R2	Windows 2008 R2
Software	Microsoft SQL 2012	<ul style="list-style-type: none"> • VMWare vCenter 5.1 • VMware Heart Beat 6.5 Server 7.0 	Microsoft SQL 2008 R2 x64, Cluster Node	Citrix Command Center 5.1	Microsoft SQL 2008 R2 x64



Appendix B: Performance results

Storage performance

The EMC VNX 7500 provided the storage for the test environment. The VNX 7500 consisted of three Data Movers, labeled SRV_2, SRV_3, and SRV_4, supporting NFS volumes and CIFS shares. The FAST Cache capability of the VNX 7500 was leveraged to improve IOPS performance. SRV_2 and SRV_3 supported hosted shared desktops, VDI desktops, and the XenDesktop 7 infrastructure. SRV_4 supported the common infrastructure and clients.

EMC Server	Boot NFS total	Boot NFS read	Boot NFS write	Boot CIFS total	Boot CIFS read	Boot CIFS write
SRV_2	20690	4991	17469	1742	1731	29
SRV_3	26009	5179	21928	144	140	0
SRV_4	371	11	371	7	0	0
Total	47070	10181	39768	1893	1871	29

Figure 11: Table showing boot storm IOPs peak load values during testing

EMC Server	Test NFS total	Test NFS read	Test NFS write	Test CIFS total	Test CIFS read	Test CIFS write
SRV_2	19592	666	19002	1494	1199	95
SRV_3	18943	589	18452	832	47	63
SRV_4	591	5	590	7	0	0
Total	39126	1260	38044	2333	1246	158

Figure 12: Table showing max peak load during the 5,580 user test run

EMC Server	Login VSI test		Boot storm test	
	Average NFS read response time (ms)	Average NFS write response time (ms)	Average NFS read response time (ms)	Average NFS write response time (ms)
SRV_2	5.10917	6.23959	3.54133	2.53581
SRV_3	5.47006	7.29185	8.19353	6.18747

Figure 13: Table showing NFS read and write response time in milliseconds

When looking at read and write times for NFS, single digit response times are optimal. In the above table both read and write averages are in the single digit range, even during the boot process. Peaks during the boot and test runs did exceed the single digit recommendation, but overall performance was within acceptable boundaries.



EMC recommends keeping the number of VMs per data mover under 2000 VMs. The XenDesktop environment had around 2250 VMs total. Taking into account this information, SRV_4 workload could have been supported by SRV_2 and SRV_3, eliminating the need for one of the data movers.

For more information about EMC FAST Cache and VNX 7500, [visit www.emc.com](http://www.emc.com)

ESXi Server CPU performance

One of the success criteria for the test was to keep the CPU utilization across the physical servers under an 85% average utilization. The physical servers were broken out into roles, with clusters of ESXi servers assigned to each set of roles. For the hosted shared desktop, random VDI desktop, and static VDI desktop (with PvD) roles two clusters of servers were created. A single cluster was created for the VDI Infrastructure physical servers.

The following table shows the physical servers defined by roles, clusters, Average CPU Utilization across the clusters, and the CPU Utilization of each physical server within the role.

Generic role	Clusters	Test phase processor % (average)
Random VDI Desktop	VDINPVDCLS1 (ESXi)	69.69
	VDINPVDCLS2 (ESXi)	68.65
	Random VDI Desktop Per Server Averages	
		
Static VDI Desktop (with PvD)	VDIPVDCLS1 (ESXi)	74.72
	VDIPVDCLS2 (ESXi)	73.93
	Static VDI Desktop (with PvD) Per Server Averages	
		



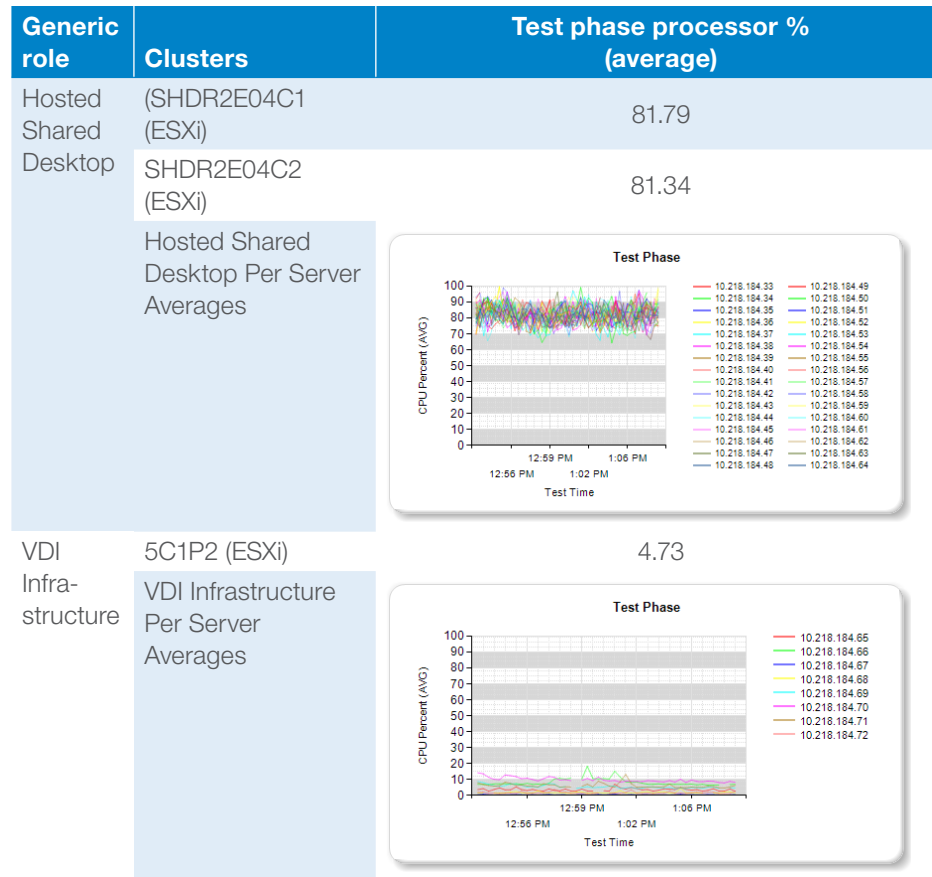


Figure 14: ESXi host performance data

When looking at each role individually, the random VDI desktop servers were well below the 85% average and the individual physical servers showed room for growth. Although further testing would be required to verify, the data shows that either the number of physical servers could have been reduced by as many as two or each server could have supported additional users.

For the static VDI desktop (with PvD) servers, CPU utilization was higher due to PvD (as expected), but still under the desired guidelines. As with the random VDI desktop servers, more testing would be required but the data shows that either one physical server, at least, could be removed or the number of users per physical server could be increased.

It should be noted that Microsoft now recommends 2 GB of memory for Windows 7 64-Bit VMs. The test environment used 1.5GB. The physical servers had 192GB of memory, so going to 2 GB as recommended by Microsoft would limit the VDI servers to 96 VDI sessions as a maximum. A better number would be 90-92 to allow for operating system memory and prevent memory overcommit.



For the hosted shared desktop servers, CPU Utilization was within the desired guidelines.

Eight physical servers were allocated as VDI Infrastructure servers, to prevent the infrastructure from becoming a bottleneck. Evaluating the CPU data here and the VM performance data later in the appendix and with more testing to verify, the number of physical servers could have been reduced by as much as half.

XenDesktop infrastructure VM performance

As stated previously, the XenDesktop infrastructure (StoreFront, PVS, Delivery Controllers, and vCenter Server) VMs were oversized to eliminate possible bottlenecks in performance while trying to achieve the 5000-user workload. The multiple VMS were load-balanced within each group. The following charts show the performance of individual VMs from each group; performance across other VMs in the groups was almost identical to those listed below.

Testing focused on two main areas, the boot storm, and the actual stress test run. During each test run CPU, memory, and networking performance were monitored.

Boot storms

Boot storms put a high stress level on the VMs involved. Through power management and planning most boot storms were avoided. In normal day-to-day operations boot time would be spread over several hours to prevent system overload. The StoreFront VM was not utilized during the boot storm. CPU, memory, and network utilization was close to zero for the StoreFront VM during the test.

CPU utilization

The following graphs show CPU utilization for XenDesktop infrastructure VMs during the boot storm.

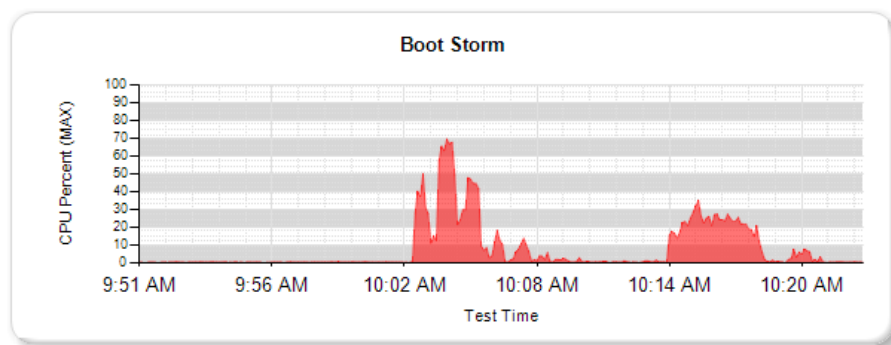


Figure 15: CPU utilization for PVS VM (Hosted Shared Desktops) during boot storm



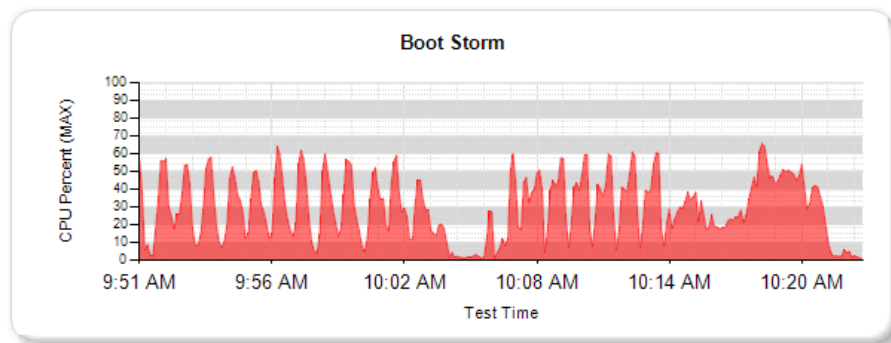


Figure 16: CPU utilization for PVS VM (VDI Desktops) during boot storm

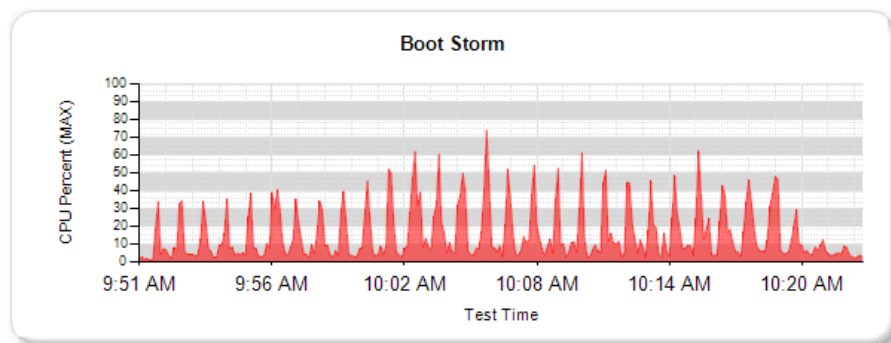


Figure 17: CPU utilization for vCenter Server VM during boot storm

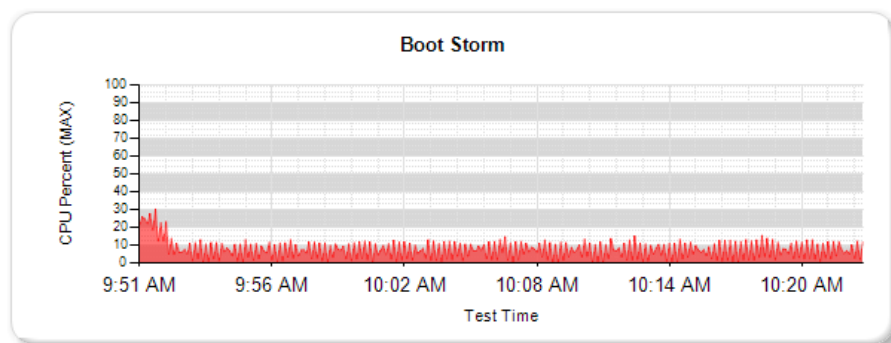


Figure 18: CPU utilization for Delivery Controller VM during boot storm



Memory

PVS VM servers were configured with 16GB of memory with less than 15% of that memory utilized during the boot storms. The vCenter Server VM was configured with 16GB of RAM with less than 50% memory utilized during the boot storm. The Delivery Controller VM was configured with 8GB of memory and utilized an average of 55% during the boot storms.

Networking

The following table details the performance of the PVS NIC handling PXE traffic during the boot storm.

PVS VM	NIC	Bytes Received/ sec	Bytes Sent/ sec	Bytes Total/ sec
Hosted Shared Desktops	vmxnet3 Ethernet Adapter	7,696,759	374,775,734	377,569,552
VDI Desktops	vmxnet3 Ethernet Adapter	5,317,918	359,490,570	361,074,115

For each PVS VM, the NIC was connected to a 3Gbps network, and utilized about 93% of the available bandwidth (377,569,552 Bytes = 2.8Gb/3Gb).

Networking for the vCenter Server VM was less than 400Mbps. For the Delivery Controller VM the network traffic was under 10Mbps.

For the boot storm process, the only concern raised was around memory utilization for the vCenter Server and Delivery Controller VMs.

Steady state test

During the steady state test, performance across both the login phase and the steady state test itself was monitored. All users were logged in over a 60 minute period. The graphs show that there was an immediate peak in CPU utilization followed by a drop to a more steady state during user login to the PVS VM running hosted shared desktops, while there was a heavier overall load during user login to the PVS VM running VDI desktops.

Logon phase

The following graphs show CPU utilization for XenDesktop infrastructure VMs during the login phase of the stress test.



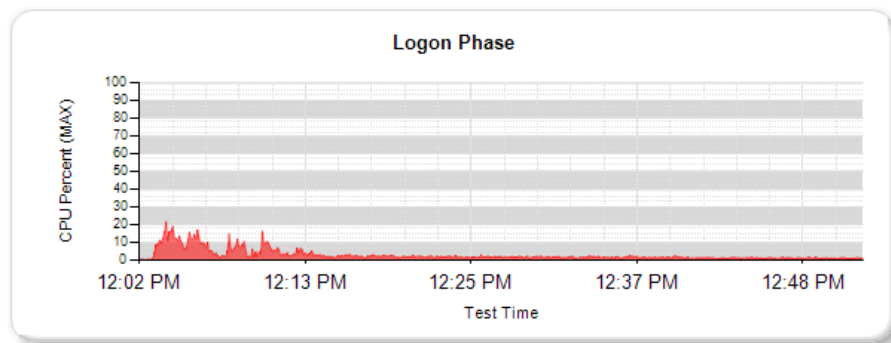


Figure 19: CPU utilization for PVS VM (Hosted Shared Desktops) during the login phase

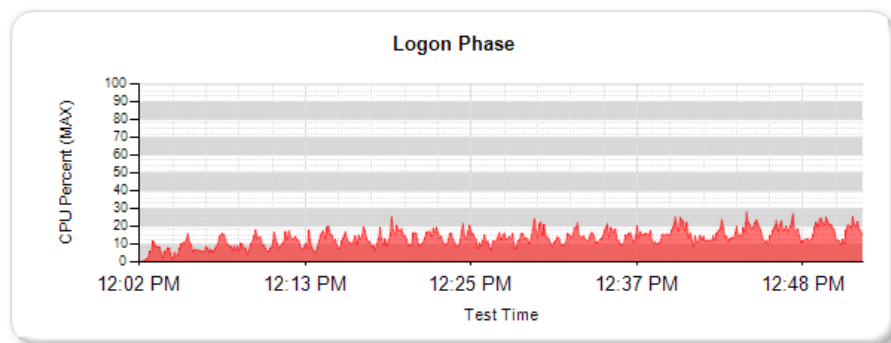


Figure 20: CPU utilization for PVS VM (VDI Desktops) during the login phase

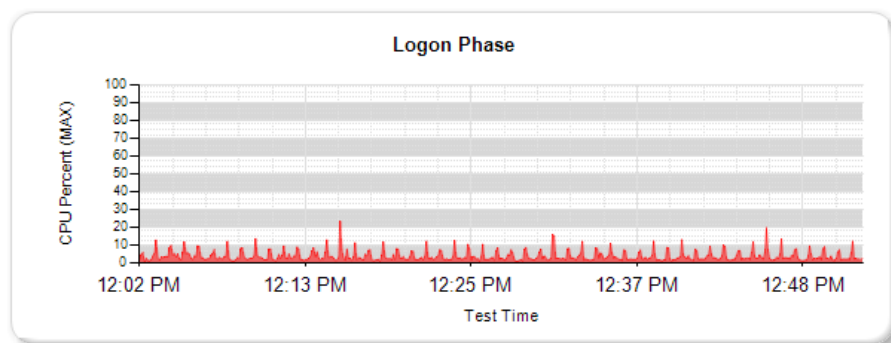


Figure 21: CPU utilization for vCenter Server VM during the login phase



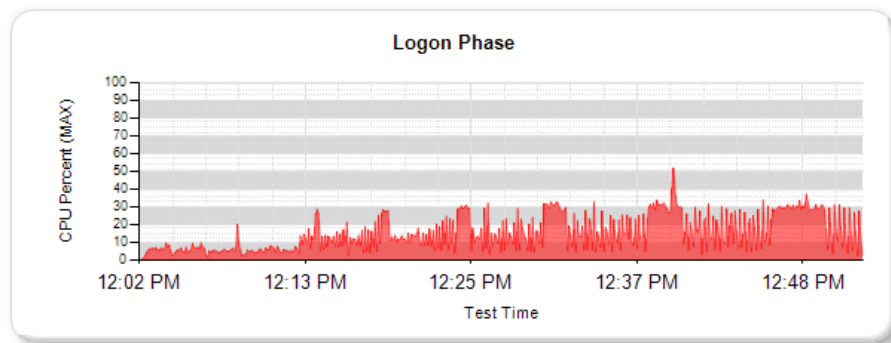


Figure 22: CPU utilization for Delivery Controller VM during the login phase

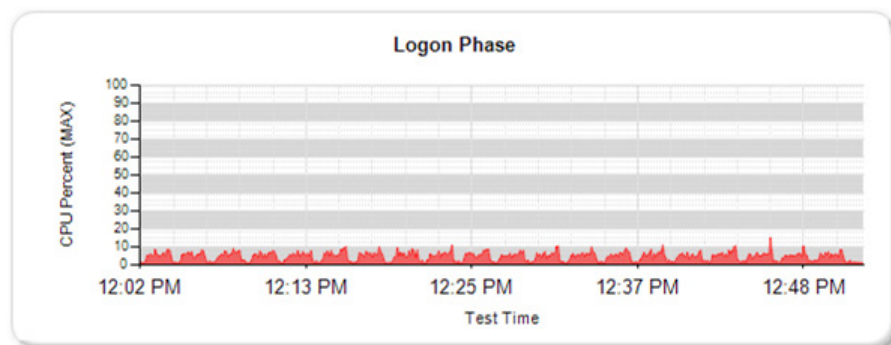


Figure 23: CPU utilization for StoreFront VM during the login phase

Steady state test

The following graphs show CPU utilization for XenDesktop infrastructure VMs during the steady state test itself.

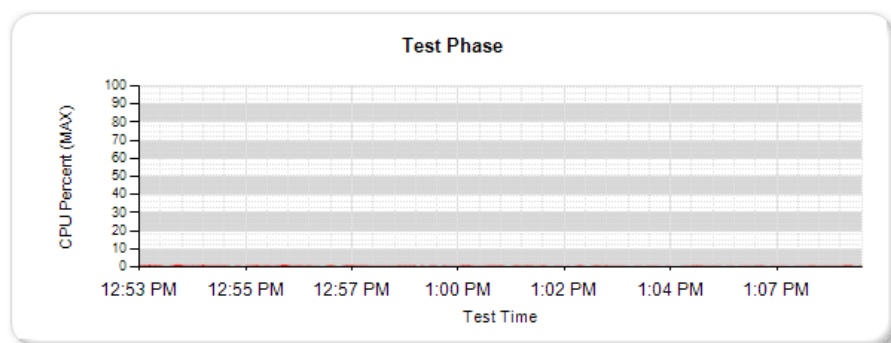


Figure 24: CPU utilization for PVS VM (Hosted Shared Desktops) during steady state test



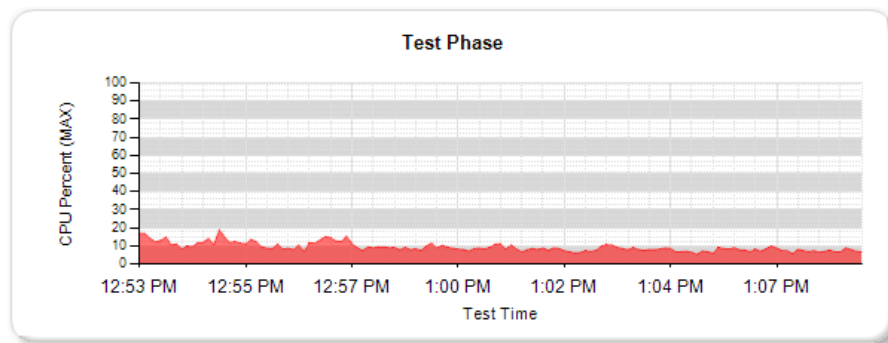


Figure 25: CPU utilization for PVS VM (VDI Desktops) during steady state test

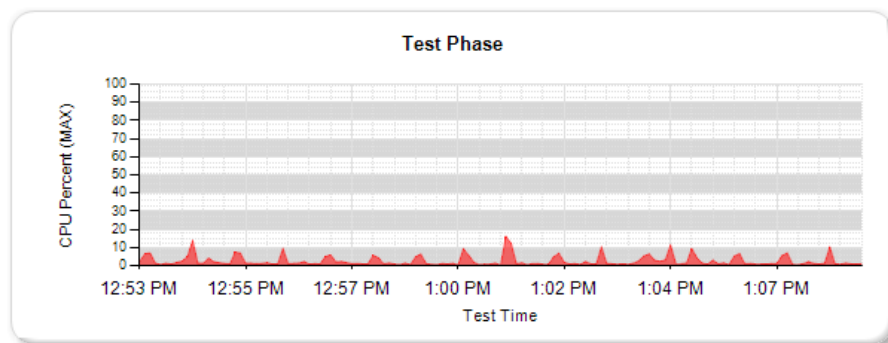


Figure 26: CPU utilization for vCenter Server VM during steady state test

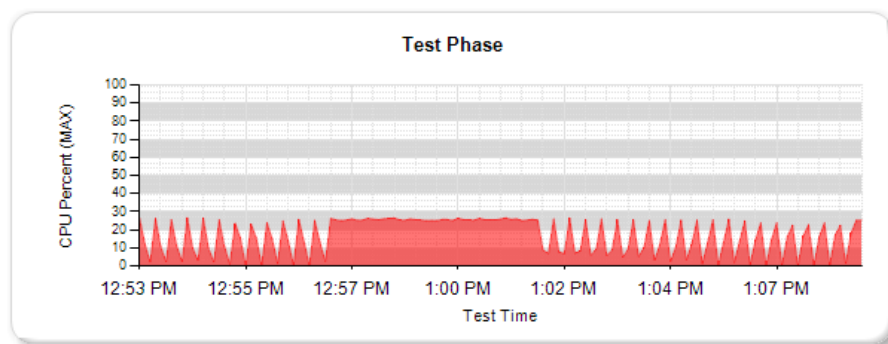


Figure 27: CPU utilization for Delivery Controller VM during steady state test



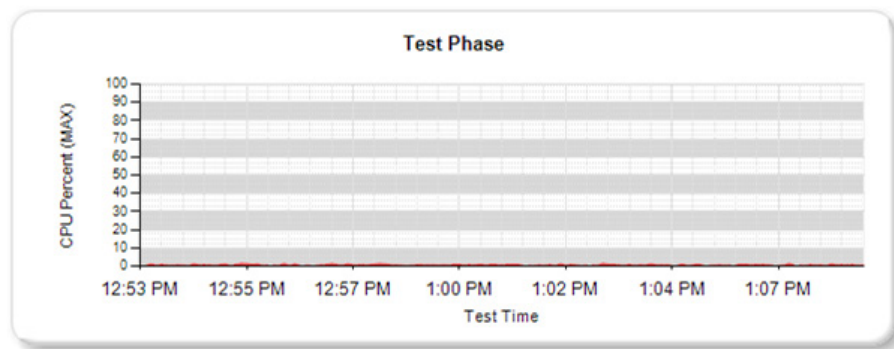


Figure 28: CPU utilization for StoreFront VM during steady state test

Memory

As with the boot storm, during the steady state test, less than 15% of memory was utilized on the PVS VMs; vCenter Server VM memory utilization was under 50%, and the Delivery Controller VM averaged 60%. Issues were found with the StoreFront VM. With only 2GB of memory it averaged 90% memory utilization.

Networking

During the steady state test, the PVS network traffic on the primary NIC peaked at 1.25Gbps for the Hosted Shared Desktop VMs and just under 2Gbps for the VDI Desktop VMs. For the vCenter Server VM, traffic was just under 200Mbps and for the Delivery Controller VMs it was just over 10Mbps.



Summary

None of the infrastructure VMs, other than the StoreFront VM which lacked sufficient memory, were overloaded or stressed during testing.

Looking at the data produced, the number of Delivery Controller and StoreFront VMs could have been reduced. For the PVS VMs, using a modular design requires at least two VMs but, looking at the data in the graphs above, the failure of a single PVS VM in one of the clusters would not have impacted the user experience. Further testing would be required to prove these hypotheses.



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About Citrix

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