A Converged Appliance for Software-Defined VDI: Citrix XenDesktop 7.6 on Citrix XenServer and NexentaStor

A converged appliance delivers scalable, reliable VDI while saving money and administrative effort.

Companies are virtualizing their desktop environments to improve security, increase workforce flexibility, and simplify desktop and application management. For small and medium companies, however, the cost of the backend infrastructure for virtual desktop infrastructure (VDI) remains an obstacle to adoption. Software-defined storage can help solve this challenge by providing a cost-effective storage solution that delivers performance and scalability for future growth. This paper describes a converged VDI appliance—based on Citrix XenDesktop, Citrix XenServer, NexentaStor Software-Defined Storage, and industry-standard x86 servers with local storage—and reveals how it performed in tests of scalability and reliability.

CiTRIX®

Executive Summary

While virtual desktop infrastructure (VDI) deployments promise major cost savings and productivity benefits for organizations, adopters should be aware that VDI has significantly different performance, scale and management requirements than other enterprise systems, which typically consist of separate storage and compute components without any validation or synergy between them.

This separation of storage is a major pain point in VDI deployments. Externally shared data storage systems supply applications with capacity, performance, and data protection, but their limited automation and inability to adapt in real time to dynamic changes cause problems with VDI. Manual allocation of storage to VDI is labor intensive and requires scheduled downtime that negatively impacts the total cost of ownership (TCO).

In contrast, a software-defined solution helps to separate data management from its associated hardware and simplifies the management of VDI environments. Specifically, it enables organizations to:

- Automate storage management for greater agility.
- Separate the data from the administration of the storage.
- Make storage hardware and software purchase decisions independent from concerns about over- or under-utilization or about the interoperability of the storage resources.
- Realize cost efficiencies that drive a higher ROI and effectively reduce TCO for VDI.

This whitepaper describes an integrated Citrix-Nexenta VDI converged appliance that relies on software-defined storage to deliver a highly automated, reliable, and cost-effective converged desktop and storage infrastructure running on industry-standard x86 hardware. Nexenta and Citrix worked together to create this appliance, which consists of Citrix XenServer, Citrix XenDesktop, and Nexenta's NexentaStor software-defined storage (SDS).

Conclusion of Testing and Validation

The integrated Citrix-Nexenta VDI converged appliance performed admirably in all the tests we performed, proving its value from a compute, storage, and scalability perspective. The system was able to present 345 desktops at full workload while using a minimal amount of physical space, power, and cooling resources—without approaching a LoginVSI VSIMax number. Its architecture easily scaled up or down to provide an agile approach to VDI design and implementation, and throughout, the storage solution maintained a low latency and high cache hit percentage. The only limiting factor to the scalability of the solution is the CPU load on the XenServer hosts.

At the same time, the converged appliance eliminated the siloed approach for separate storage and compute, resolving the storage challenges normally associated with VDI, thus simplifying VDI deployment.

Our tests showed that this converged appliance solution offers a simple and cost-effective VDI solution that delivers excellent performance and user experience, regardless of the size and scale of the project. Its building-block format makes it easy to transition from small proof-of-concept to large production environments. By adding an additional XenServer hypervisor, organizations can easily expand capacity beyond the initial 345 users. Each hypervisor can house up to 175 users in a highly available format.

Appliance Overview and Test Goals

The converged infrastructure appliance we developed uses Citrix XenServer, Citrix XenDesktop, and Nexenta's NexentaStor storage software running on industry-standard x86 hardware. A converged appliance that starts at 4U for up to 345 desktops and can simply scale to 6U for 1,000 desktops.

- XenServer is a cost-effective, open-sourced hypervisor that syncs very well with the open SDX strategies of NexentaStor. XenServer matches the feature set of other industry-standard hypervisors, and when paired with NexentaStor, it provides the foundation for a cost-effective VDI infrastructure.
- Widely known as the leader in virtual desktop brokering, Citrix XenDesktop is utilized to deploy the virtual desktops. XenDesktop allows for multiple deployment options to fit the desktop environments as needed. In this converged infrastructure, Machine Creation Services provides the desktop brokering, presenting advanced desktop graphics, expedited user logins and the required features to support small to medium enterprise user needs. Integration with Citrix XenServer allows for advanced features such as IntelliCache.
- NexentaStor helps solve the storage challenges of VDI and also enables a converged appliance approach that simplifies a VDI deployment for greater cost effectiveness, a better end-user experience, and maximum uptime. At the same time, it supports key capabilities such as nondisruptive operations, unified storage, multiprotocol architecture, storage efficiency, read and write performance improvement, and cost-efficient data protection.

This paper describes the tests that we ran on the appliance to:

- Validate the converged infrastructure's ability to scale and reliably support up to 1,000 virtual desktops.
- Prove that a converged architecture could slash costs using a software-defined solution running on industry-standard hardware.

Audience

This document is intended for IT decision makers, architects, and partners who are seeking to implement XenDesktop solutions for their customers.

Findings

The validation results show that a single 2U server with two computing nodes, two storage nodes, and a single 2U JBOD chassis can support up to 345 VDI sessions at less than 5% of storage utilization. This converged architecture will easily scale to support 1,000 dedicated desktops by simply adding more compute nodes.

The converged architecture demonstrates that by using NexentaStor software, businesses can build a cost-effective, high-performance, highly scalable, and reliable VDI solution based on industry-standard x86 hardware that can be easily deployed for less than $400 total cost per dedicated desktop for 1,000 users (cost per desktop excludes networking, Microsoft software, and endpoint device).

Architecture Overview

Solution at a Glance

- Self-contained and small footprint design includes all necessary elements for XenDesktop
- Industry-standard x86 hardware with local storage optimal for small and medium businesses
- Simple to build and easy to scale by independently adding individual building blocks
- Built-in fault tolerance capability to ensure business continuity and quality

Baseline Configuration for 100 to 300 Desktops

- 2U QUAD NODE
  - 2 XenServer with XenDesktop
    - Dual E5-2683 v3 14-Core Processor
    - 384 GB Memory
  - 2 NexentaStor Head Nodes
    - Dual E5 2623 3.0 Ghz Processor
    - 256 GB RAM
    - LSI 9207-8e SAS HBA
- 2U JBOD
  - 22 –2.5" 10K 1.2TB SAS HDDs
  - 2 - 2.5" SAS 10 DWPD SSD




Configuration Matrix up to 1,000 Desktops

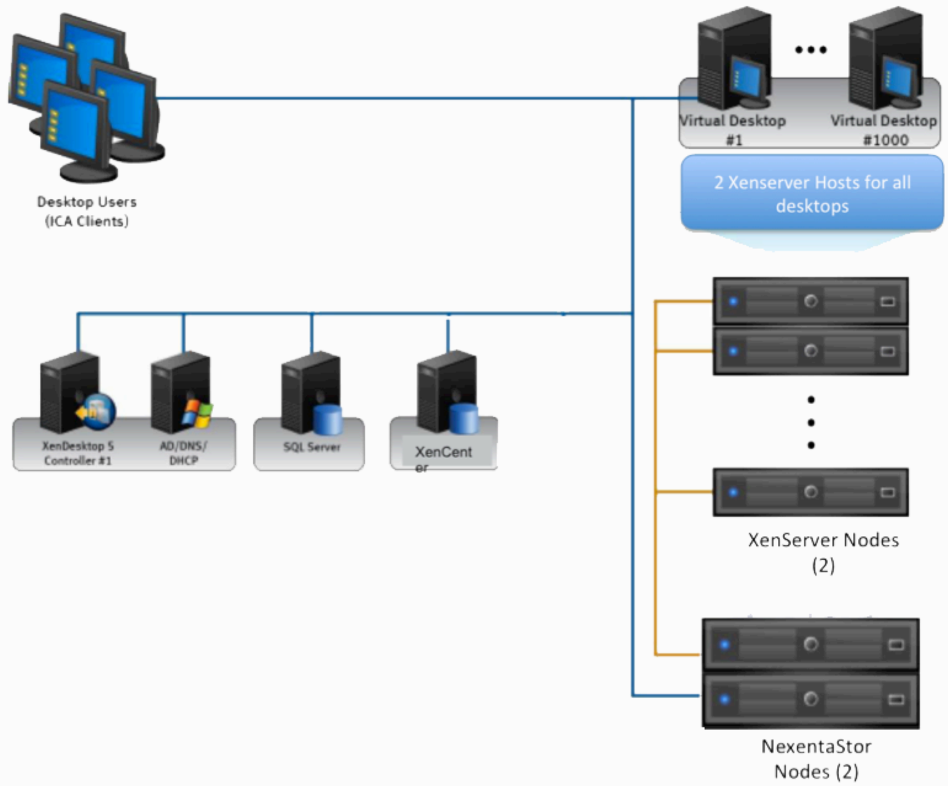


	Number of Users			
	100	250-300	500-600	750-1000
Chassis 2 - 2U				
Node 1			XenServer	XenServer
Node 2			XenServer	XenServer
Node 3				XenServer
Node 4				XenServer
Chassis 1 - 2U				
Node 1		XenServer	XenServer	XenServer
Node 2	XenServer	XenServer	XenServer	XenServer
Node 3	NexentaStor	NexentaStor	NexentaStor	NexentaStor
Node 4	NexentaStor	NexentaStor	NexentaStor	NexentaStor
JBOD - 2U				
HDD	12	22	22	22
SSD	2	2	2	2

Logical Architecture

Reference architecture logical diagram

Figure 1 depicts the logical architecture of the midsize solution.



Desktop Specs:
Memory 2 GB
CPU 400 Mhz
Image Size 40 Gb

Architectural components

Core Infrastructure

We deployed 345 virtual desktops using Machine Creation Services and server VDI configuration and created a single XenDesktop 7.6 site. Because test objectives do not require high availability for infrastructure components, we used only one Delivery Controller, but most organizations would want multiple Delivery Controllers. We also installed on separate virtual machines StoreFront 2.6, Citrix License Server, and Microsoft SQL Server 2012 for a data store. Again, most organizations would probably require multiple implementations of StoreFront.

To support Citrix profile management, we deployed a Windows file server, and to provide authentication, we deployed a single Active Directory domain controller server.

We deployed all core infrastructure components on a XenServer 6.5 pool that consists of two servers with attached NexentaStor NFS storage.

Load Simulation Infrastructure

To support test objectives and ensure that the load simulation infrastructure did not negatively affect core components, we deployed the Login VSI server, client launchers, and Provisioning Services server for client launchers on hardware that was not connected to the NexentaStor storage array.

Graph 1: Infrastructure design

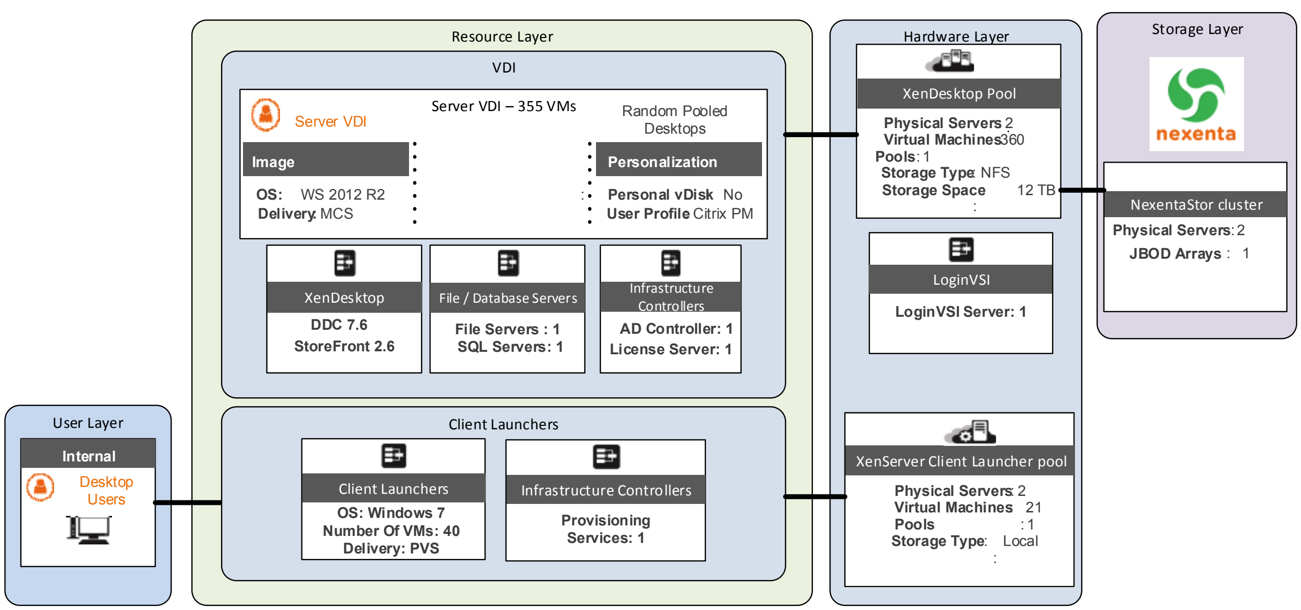


Table 1: Components

Component	Description	Hardware/ Software
Citrix Components		
Citrix XenServer 6.5 pool	2 hosts for desktops and infrastructure components XenServer 6.4.98-89346c (pre-release version of XenServer 6.5)	Software
Citrix XenServer 6.2 pool	2 hosts for client Launcher VMs XenServer 6.2.0-70446c	Software
Citrix XenDesktop 7.6 Controller	Windows Server 2012 R2 4 GB RAM 100 GB HDD 2 VCPUs	Software
Citrix XenDesktop 7.6 Server VDI	Windows Server 2012 R2 2 GB RAM 40 GB HDD 2 VCPUs	Software
Citrix Profile Management 5.2 File Server	Windows Server 2012 R2 4 GB RAM 100 GB HDD 2 VCPUs	Software
Citrix Licensing Server 11.12.1 build 14008	Windows Server 2012 R2 2 GB RAM 100 GB HDD 2 VCPUs	Software
Citrix StoreFront 2.6	Windows Server 2012 R2 4 GB RAM 100 GB HDD 2 VCPUs	Software
Citrix Provisioning Services 7.6 (for LoginVSI client launchers only	Windows Server 2012 R2 192 GB RAM 100 GB HDD 2 4-core CPUs	Software
Nexenta Components		
NexentaStor (Enterprise Edition) 4.0.3-FP2	NexentaStor 256 GB RAM 2 6-core CPUs 24 TB SAS HDD 400 GB SSD	Software

Other Components		
Microsoft SQL Server 2012	Windows Server 2012 R2 2 GB RAM 100 GB HDD 2 VCPUs	Software
Microsoft Active Directory domain controller	Windows Server 2012 R2 2 GB RAM 100 GB HDD 2 VCPUs	Software
Login VSI 4.1.1	Load simulation software	Software
Hardware Components		
2U 4 node server	The server is a high-end server comprising four system boards incorporated into a single 2U chassis acting as four separate nodes.	Hardware
JBOD	High-efficiency power and high-storage capacity 2U JBOD storage chassis with redundant, hot-pluggable cooling system, power supplies and hot-swap drives: 2 Toshiba PX02SMF020 - solid state drive - 200 GB - SAS 12Gb/s 22 Seagate Enterprise Performance 10K.7 ST1200MM0017 1.2TB 64MB Cache SAS 6Gb/s	Hardware
2 server nodes for XenServer	Each node consists of: 2 14-core Intel(R) Xeon(R) CPU E5-2683 v3 @ 2.00GHz 384 GB RAM 2 Seagate Constellation.2 ST91000640NS 1TB 7200 RPM 64MB Cache SATA drives 1 dual-port Intel® 10 GB Ethernet Controller X540-AT2	Hardware
2 server nodes for NexentaStor	Each node consists of: 2 4-core Intel(R) Xeon(R) CPU E5-2623 v3 @ 3.00GHz 256 GB RAM 2 Seagate Constellation.2 ST91000640NS 1TB 7200 RPM 64MB Cache SATA drives 1 dual-port Intel® 10 GB Ethernet Controller X540-AT2	Hardware
2 ProLiant DL360p Gen8 servers for Client Launcher VMs	2 x Intel(R) Xeon(R) CPU E5-2620 0 @2.00GHz 192 GB RAM 2TB Local HDD	Hardware
1 ProLiant DL360p Gen8 servers for Login VSI	2 x Intel(R) Xeon(R) CPU E5-2620 0 @2.00GHz 192 GB RAM 2TB Local HDD	Hardware

Testing Methodology and Results

Test Objectives

To assess scalability, we measured the number of concurrent user sessions we could host on a given test environment. To test reliability of the solution, we tested what happened in the event of a severe hardware incident.

User Capacity

To determine the number of concurrent user sessions, we simulated users connecting to a published desktop of XenDesktop 7.6 Server VDI hosted on the XenServer 6.5 server pool connected to the NexentaStor NFS array.

In these tests, the compute nodes presented the expected number of desktops to meet requirements. The only limiting factor to the scalability of the solution was the CPU load on the XenServer hosts.

We used Login VSI, a tool for standardized VDI performance and capacity testing, to generate VDI workloads and to measure performance. We created 345 desktops, launched them, and executed a workload program that simulated a typical workday. We wanted to determine whether the storage system and server infrastructure could successfully handle the workload demands without reaching a latency limit called VSImax.

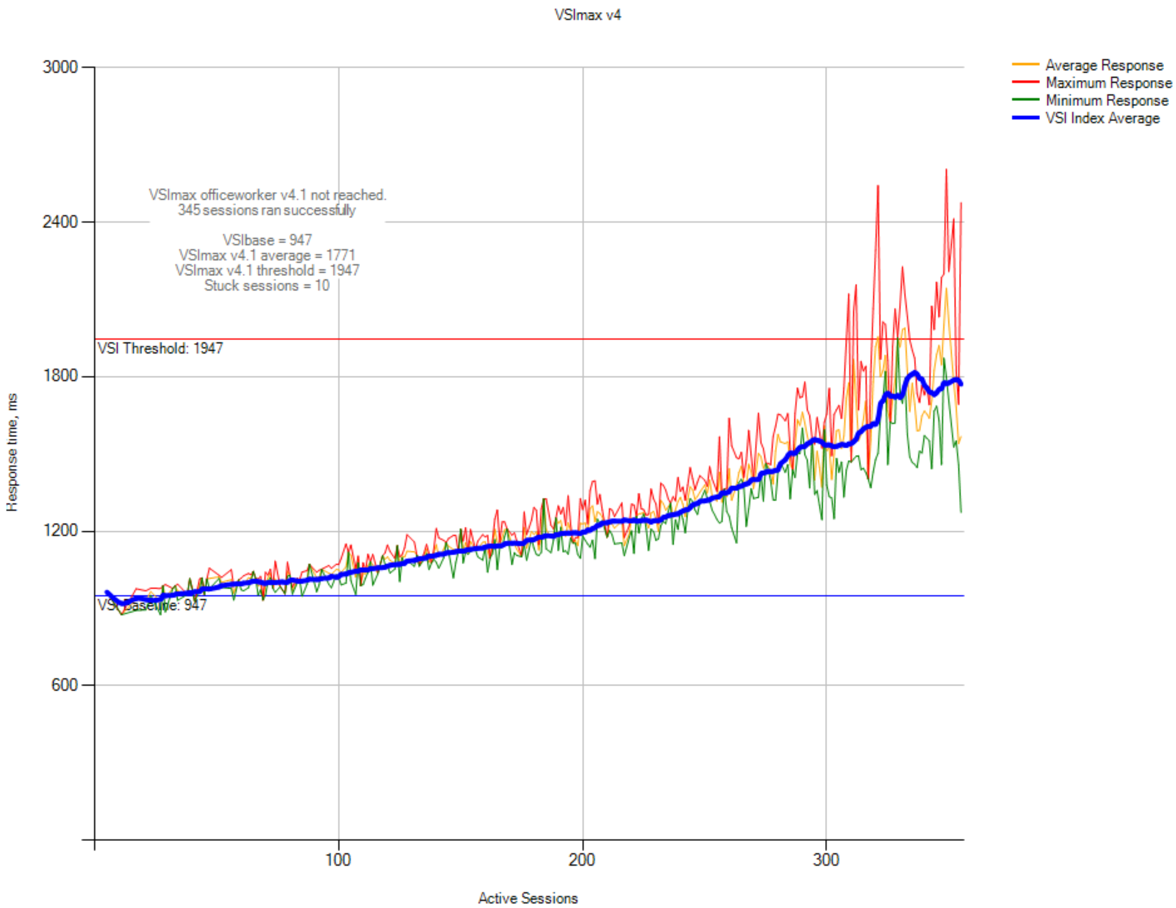
More about Login VSI and methods used to calculate VSImax can be found here:

http://www.loginvsi.com/documentation/index.php?title=VSImax

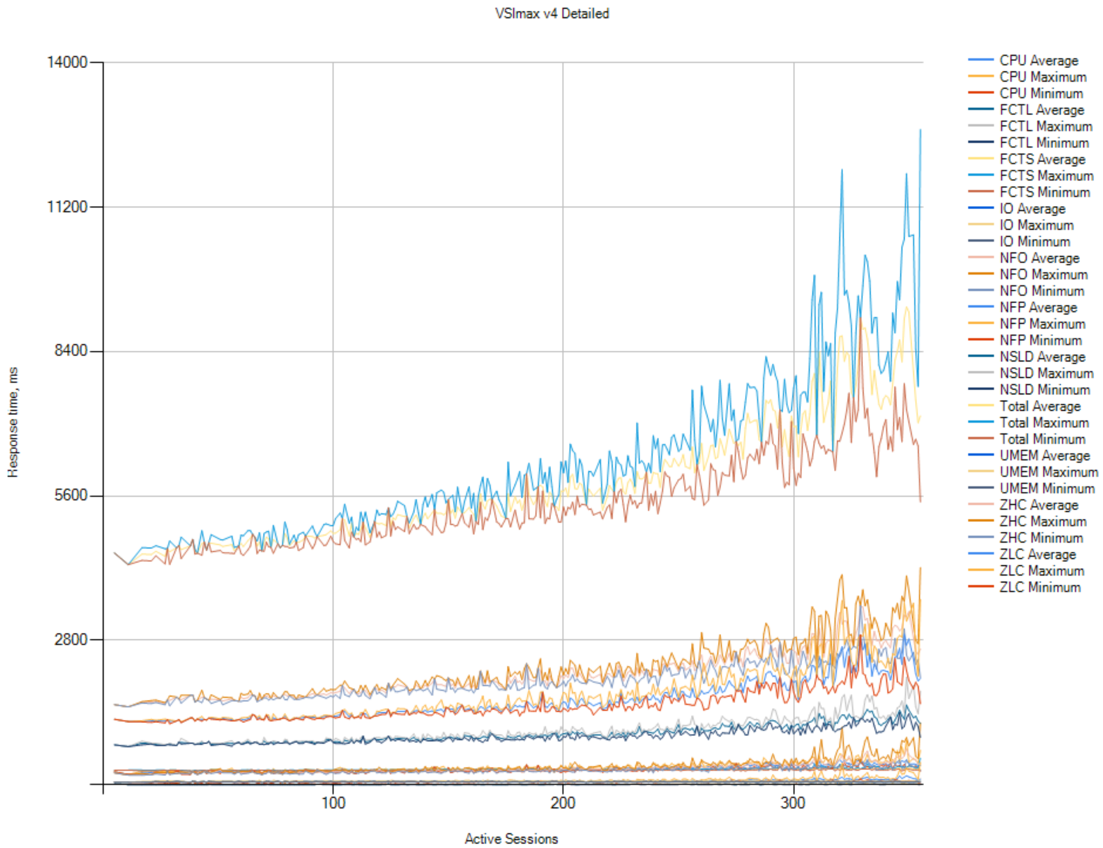
Login VSI successfully launched 345 desktops, and VSImax was not reached, indicating that we could have successfully deployed and managed more than 345 desktops in this environment. However, CPU on the XenServer hosts was close to the maximum utilization.

Login VSI data and IO stats on the NexentaStor software showed that we could have supported more than 1,000 desktops on the same storage configuration.

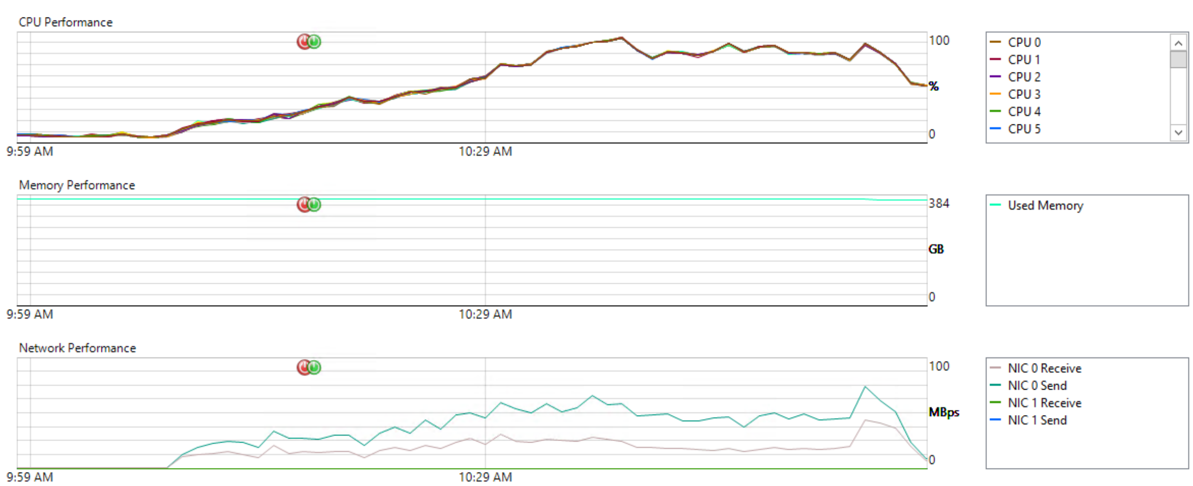
Graph 2: VSImax score



Graph 2: VSImax v4 Detailed



Graph 3: First XenServer host load



Graph 4: Second XenServer host load

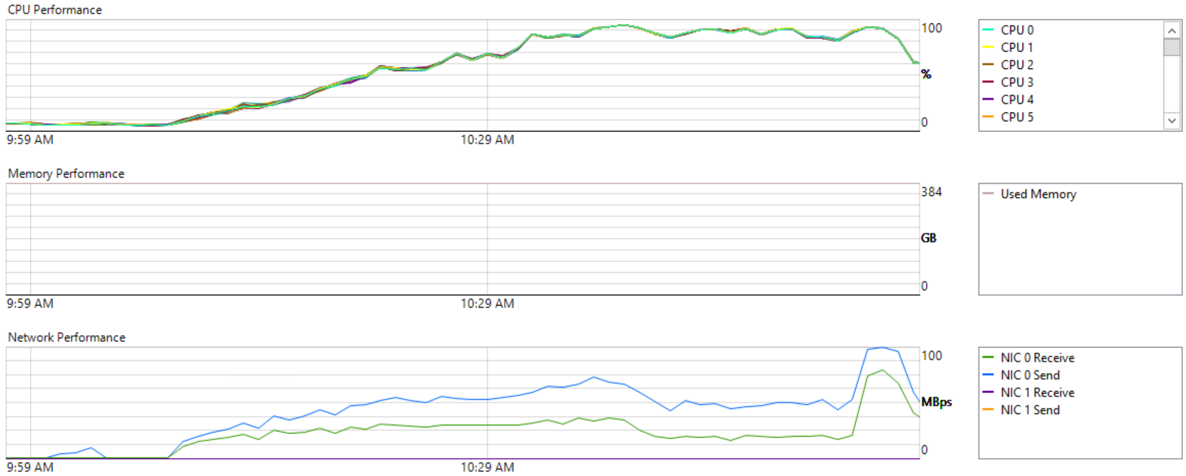


Table 2: Login VSI test information

Test name	345-user test
VSImax v4	345 sessions and baseline 947 ms
Benchmark mode	Disabled
VSI threshold reached?	No
VSIbaseline average response time (ms)	947
VSImax average response time threshold (ms)	1947
VSImax threshold was reached at sessions	Was not reached
VSI response time threshold headroom	1,776
Sessions are not responding	10
Corrected VSImax is	345
Total sessions configured	360
Total sessions successfully launched	360
Total timeframe of test in seconds	1,800
Average session launch interval in seconds	5
Amount of active launchers during test	40
Average session capacity per launcher	9

Table 3: VSI response time overview

VSI response time	
@ 50 sessions	977
@ 100 sessions	1,013
@ 150 sessions	1,096
@ 200 sessions	1,168
@ 250 sessions	1,243
@ 300 sessions	1,401
@ 350 sessions	1,598

Storage Failover

The high-availability plugin was deployed in the NexentaStor solution providing for storage failover. Testing was conducted to validate the desktop reaction during a storage failure event. Designed to emulate a severe hardware failure, the testing was conducted via software to show failed storage head nodes.

In the test, none of the published desktops disconnected or failed, even though the underlying storage cluster experienced a severe hardware incident.

We used Login VSI to generate workloads on 200 virtual desktops. After all test users had been logged on, we initiated a storage failover by failing over to the secondary node of the NexentaStor cluster. We then monitored session information using the Citrix Studio console to identify failed or disconnected desktops and monitored event logs on the infrastructure VMs.

During the first test run with 200 users logged on, we executed the Login VSI office worker workload profile and ran the storage failover operation once.

During the second test run, we focused on testing a highly loaded system. With all 345 users logged on, we executed the storage failover operation twice with a 10-minute interval.

For the third run, we sought to measure the failover time with low load on the system. We started 345 desktops plus all infrastructure servers but connected only one user to the published desktop.

Test description	Results/Data
Medium load, 200 users	Storage failover time - 30 seconds No disconnections, system faults, or application errors observed
High load, 345 users, first failover	Storage failover time - 27 seconds No disconnections, system faults, or application errors observed

High load, 345 users, second failover	Storage failover time - 32 seconds No disconnections, system faults, or application errors observed
Low load, 1 user	Storage failover time - 14 seconds No disconnections, system faults, or application errors observed

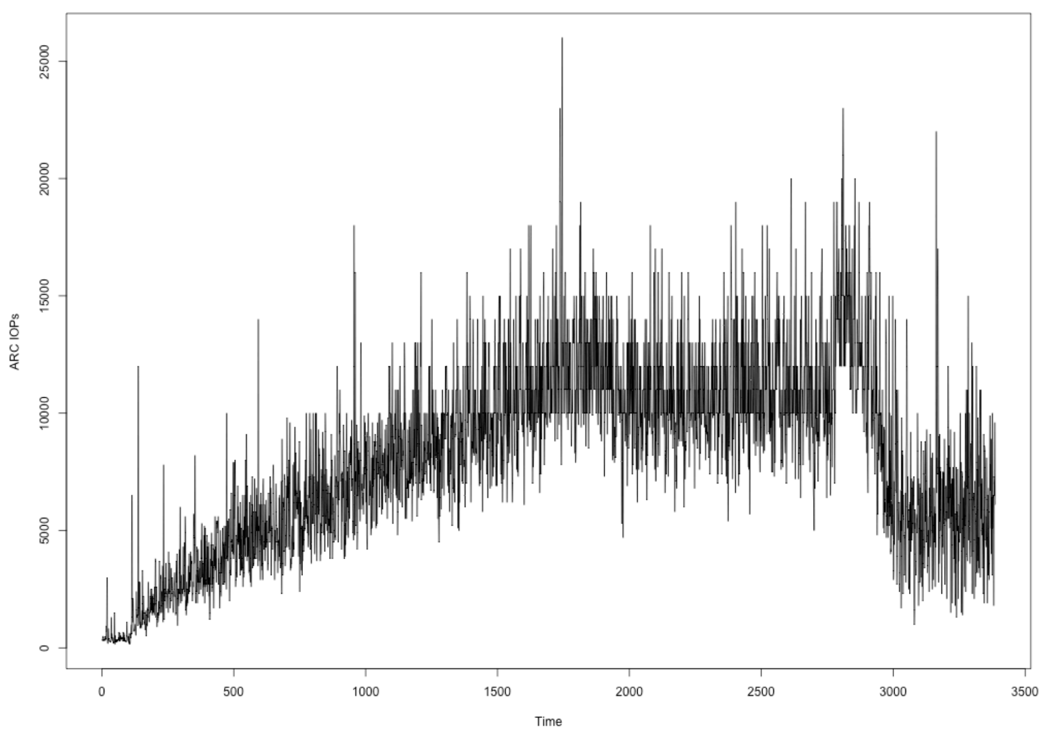
Storage Performance

Throughout the test cases, we monitored the NexentaStor storage solution for cache usage and NFS performance.

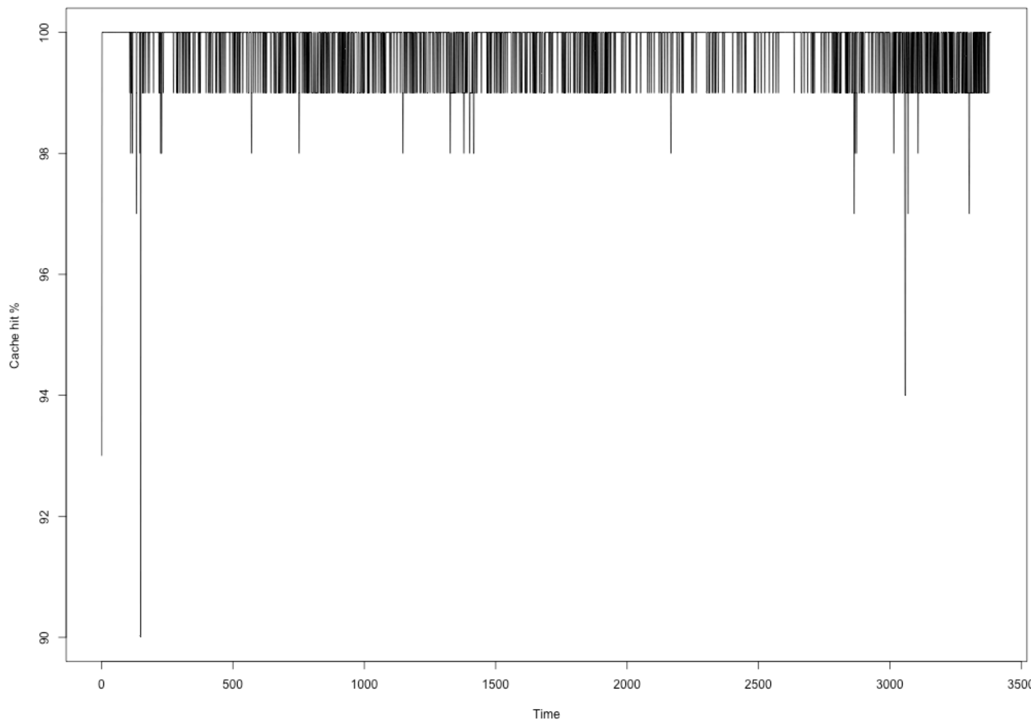
Cache Usage

Disk I/O is a common source of performance issues despite modern cloud environments, modern file systems, and huge amounts of main memory serving as file system cache. Understanding how well that cache is working is a key task while investigating disk I/O issues.

NexentaStor utilizes the ZFS file system. We viewed its performance through its Adaptive Replacement Cache (ARC), which is the ZFS main memory cache in DRAM, that can be accessed with sub-microsecond latency. An ARC read miss would normally read from the disk at millisecond latency, especially random reads. The L2ARC is a second layer of cache that sits in between the main memory cache and spinning disk, and extends the main memory cache using fast storage devices such as flash-memory-based SSDs.



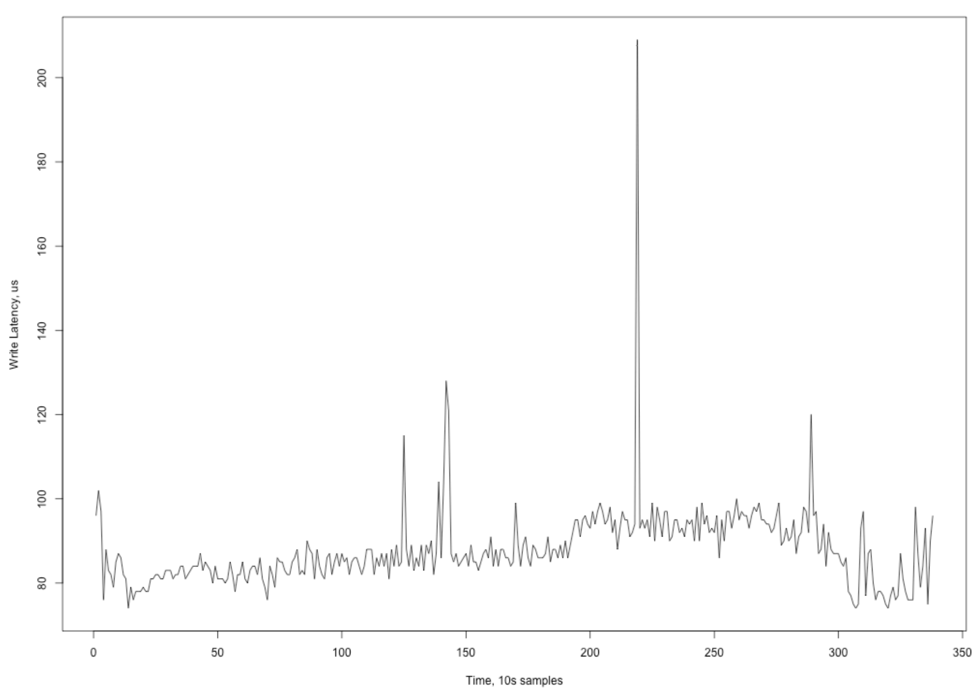
IO presented from the ARC resulted in IO ranging from 5,000 to a peak of 250,000 during the testing. The sustained usage resulted in an average of 10,000 during a steady state desktop load.



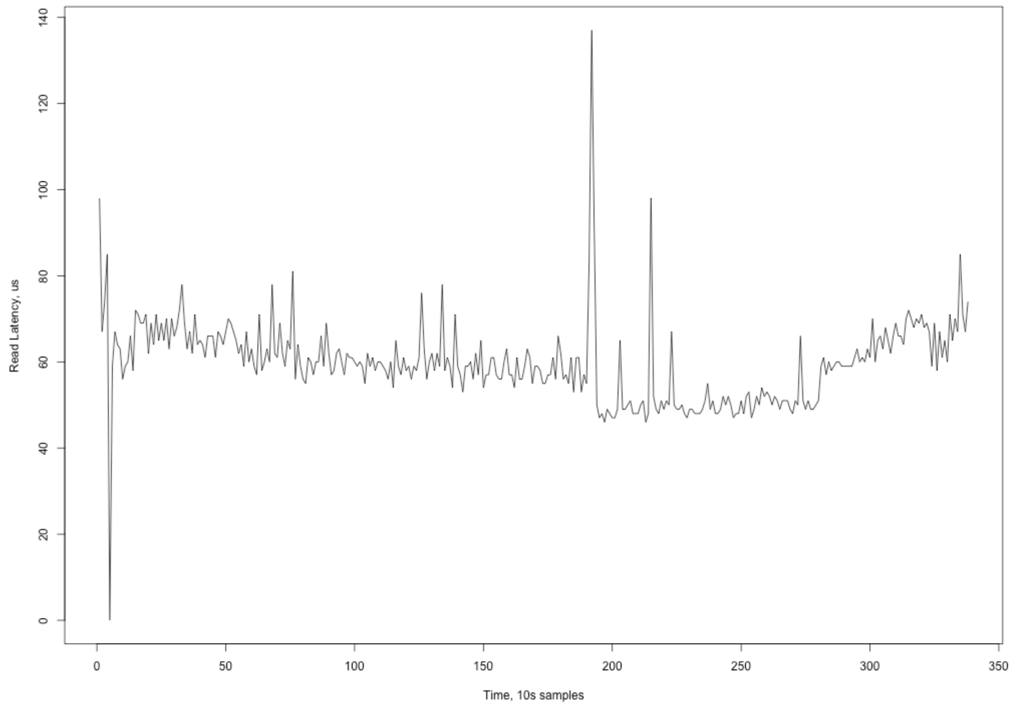
The average cache hit percent remained above 99 percent throughout the testing, indicating that the predominant portion of the storage was being presented by the RAM within the storage nodes.

NFS Performance

The converged solution utilized NFS presentation to the desktops. We gathered both read and write performance statistics throughout the Login VSI testing.



Normalized write latency throughout the testing remained at approximately 100 microseconds. This results in little to no wait time for writes from the end user to the storage. Occasional spikes are the result of the benchmarking workload and inconsistencies in application workload timing.



NFS read latency was in the 60 to 80 microsecond range throughout the testing—well below any latency concerns.

Corporate Headquarters
Fort Lauderdale, FL, USA

Silicon Valley Headquarters
Santa Clara, CA, USA

EMEA Headquarters
Schaffhausen, Switzerland

India Development Center
Bangalore, India

Online Division Headquarters
Santa Barbara, CA, USA

Pacific Headquarters
Hong Kong, China

Latin America Headquarters
Coral Gables, FL, USA

UK Development Center
Chalfont, United Kingdom

About Citrix

Citrix (NASDAQ:CTXS) is a leader in mobile workspaces, providing virtualization, mobility management, networking and cloud services to enable new ways to work better. Citrix solutions power business mobility through secure, personal workspaces that provide people with instant access to apps, desktops, data and communications on any device, over any network and cloud. This year Citrix is celebrating 25 years of innovation, making IT simpler and people more productive. With annual revenue in 2013 of $2.9 billion, Citrix solutions are in use at more than 330,000 organizations and by over 100 million users globally. Learn more at www.citrix.com.