Commodity hardware design guide on Boston Limited hardware

Citrix validated solution

CITRIX®

citrix.com

About this design guide

This guide provides high-level design details that describes the architecture for XenDesktop 7.1 Citrix Validated Solution running on Commodity Hardware. The architecture is based on the fundamentals of how cloud computing works in conjunction with commodity hardware to considerably lower the total cost of ownership for a Citrix XenDesktop environment.

This guide has been created through architectural design best practices obtained from Citrix Consulting Services and through lab testing, and is intended to provide guidance for solution evaluation.

More enterprises are looking toward desktop virtualization as a solution to rising IT costs, security concerns, and the user demands of BYOD, all while enabling employees to work from anywhere, at any time and from any device. But can a desktop virtualization solution have a lower or equivalent total cost of ownership (TCO) than the traditional approach of procuring physical desktops? Is there a solution that meets all benefits of scalability and performance while maintaining a lower TCO?

"Commodity Hardware" provides a way to deliver a desktop virtualization solution that modernizes the workforce and enhances user productivity while maintaining a lower TCO.

Citrix has collaborated with Boston Limited to leverage its Supermicro-based commodity hardware stack for designing a robust and scalable XenDesktop architecture. Boston Limited is one of Supermicro's most respected technology partners and a world-renowned systems integrator. Supermicro, a global leader in high-performance, high-efficiency server technology and innovation, is powering Boston Limited's entire hardware stack, including servers, switches, and storage.

At its core, the solution works using software components such as Citrix XenDesktop 7.1 in combination with Microsoft Hyper-V 2012 R2 and Windows Storage Spaces. The hardware stack includes rack-based servers equipped with SATA 6Gbit/s 7mm 2.5" SSD for hosting the IOPS hungry write cache and four-way AMD 12 Core Opteron processors for servicing the hosted shared desktop workloads catering for heavy task-based and knowledge workers. The architecture eliminates the need for SAN and relies on traditional JBoD (Just a Bunch of Disks) managed by Windows Server 2012 clustered file services for hosting user data.

XenDesktop 7.1 is the market leader for delivering Windows apps and desktops as secure mobile services from a cloud-ready platform while simplifying management, reducing costs and enhancing security. Running Citrix services on Microsoft Hyper-V 2012 R2 significantly enhances the functionality of the operating system, applications, and desktops being delivered to users. Windows Storage Spaces is being eliminated to make way for better management and provisioning of new storage features.

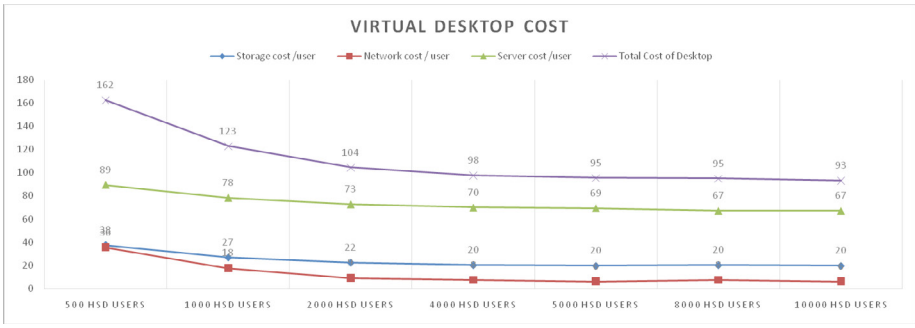
Note: This document does not provide step-by-step or detailed configuration instructions. It defines the architecture used in designing the solution and performing the testing. This document is intended for the IT professional and other business executives to gain a better understanding of how a virtual desktop solution can be implemented with lower TCO.

Solution objective

Desktop virtualization is now a mainstream technology, and customers are looking for a pragmatic and cost-effective approach of deploying XenDesktop within their organizations.

The objective of this guide is to validate a Citrix XenDesktop hosted shared desktop architecture on commodity hardware while keeping organizations' business needs in consideration. The solution is designed to deliver performance and reliability at par with enterprise-class hardware while keeping the per-user capital expenditure for storage, compute, and network well within the range of $125 USD for concurrency of more than 1,000 users.

Prices in USD	500 HSD Users	1000 HSD Users	2000 HSD Users	4000 HSD Users	5000 HSD Users	8000 HSD Users	10000 HSD Users
Storage cost/user	38	27	22	20	20	20	20
Network cost user	36	18	9	8	6	8	6
Server cost/user	89	78	73	70	69	67	67
Total Cost of Desktop	162	123	104	98	95	95	93



Relevance of commodity hardware

Commodity hardware is readily available and affordable. A device that uses commodity hardware has components that were previously available or designed and not necessarily unique to that device. Enterprises often use commodity hardware with file servers, or cluster it to provide large-scale computing power, or to maximize savings in IT design.

Based on ongoing research efforts and the continuing advancements of computing and networking technology, it is believed that use of commodity hardware is vital in creating a cost-effective and easily scalable cloud solution. And this is poised to have a major impact on our society's data-centric commercial and scientific endeavors.

Applying the same concept, Citrix has built a solution along with Boston Limited to deliver a cost-effective yet powerful and scalable virtual desktop at a price point lower or equivalent to that of a standard PC.

XenDesktop 7.1 on commodity hardware architecture

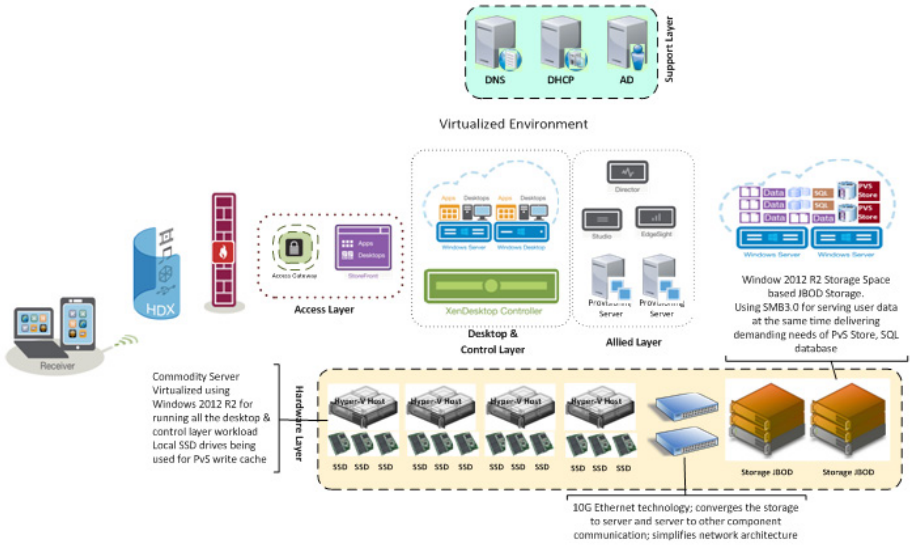
We believe that a new class of hardware is required to meet the specific needs of virtual desktop workloads. This guide touches on the notion of an enterprise server for desktop-class workload, which is cost-effective yet has enough operating resources to meet the high demands of heavy task-based and knowledge users. The architecture defined below is based on these principles and is targeted at shared desktop workloads delivered using the Citrix Provisioning Services 7.1 technology.

Each of these desktop-class servers is equipped with 48 2.8GHz AMD Opteron processor cores and 256 GB of RAM to satisfy the compute needs of shared desktop workloads for up to 200 users. The key differentiator is the use of enterprise-class SATA Solid State Drives, which provide excellent endurance from low-cost 19nm NAND. The cost of these drives is one-third when compared with SLC NAND-based SAS SSDs. Each server is equipped with three SMART Storage Systems CloudSpeed 1000 SSDs. Two of these drives configured with Windows Server 2012 R2 Storage Spaces are utilized to host the volatile write cache and can service-write IOPS in the range of 100 per user, thus effectively managing boot & login storms and IO intensive operation such as antivirus scanning.

The construct of this Citrix-validated solution is based on many decisions made during validation testing. Testing was carried out using the Login VSI 4.0 Virtual Session Indexer (VSI), an industry-standard tool for user/session benchmarking. Login VSI allows comparisons of platforms and technologies under the same repeatable load. The “medium” VSI workload is expected to approximate the average office worker during normal activities and was the workload used throughout testing.

The testing was conducted on a scaled-down replica of the expected production environment. Only the hosted shared desktop FlexCast model workloads were tested using the XenDesktop template policy “High Server Scalability” running in “Legacy” graphics mode. Therefore, the bill of materials described within this document is extrapolated based on single-server scalability test results with these policy settings in place. These Citrix policies allow the greatest host density for each FlexCast model.

The figure below depicts the solution architecture that makes up the requirements for delivering a XenDesktop 7.1 hosted shared desktop solution onto commodity hardware:



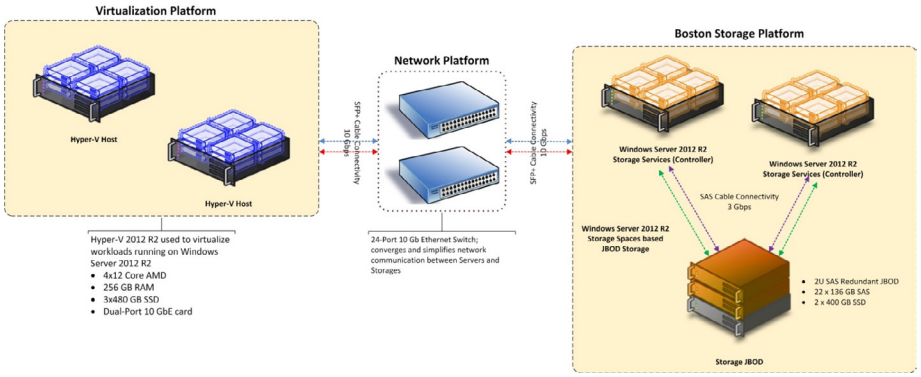
The following Citrix and Microsoft components are required to deploy the reference architecture:

- Citrix XenDesktop 7.1: hosted shared desktop and app virtualization platform
- Citrix Provisioning Server 7.1: workload delivery platform
- Citrix StoreFront Services 2.1: desktop and app resource enumeration
- Microsoft SQL 2012 SP1: database platform
- Microsoft Hyper-V Windows Server 2012 R2: hypervisor platform
- Microsoft Windows Server 2012 R2 Storage Services: storage management platform
- Hardware: Boston servers, switches, and storage

Hardware stack

This section incorporates details about the proposed hardware stack for hosting the XenDesktop 7.1 hosted shared desktop solution on commodity hardware. It defines the type and amount of physical resources required to support the solution.

The figure below depicts the physical connectivity between Supermicro server, switches, and storage as configured in the test environment.



Note: The above diagram has 2U JBoD, which was used during testing. For 1000 users solution BOM, 4U JBOD is recommended as described in subsection below.

Servers

Boston 2U AMD Quad Socket Server Solution – VDI Cluster BOS-CIWL4P-01

Enterprise-grade 2U servers used for hosting XenDesktop infrastructure components, related Microsoft components, and virtual desktop workloads.

Outline Specifications for
Boston Fenway 2U AMD Quad Socket Server Solution – VDI Cluster

Key Features (Can Support)

- Four AMD Opteron™ 6000 series (6300 ready) processors (Socket G34) 16/12/8/4-Core ready; HT3.0 Link support
- Up to 1TB DDR3 1600MHz ECC Registered DIMM; 32x DIMM sockets
- 2x PCI-e Gen 2.0 x16 slot
  1x PCI-e Gen 2.0 x8 slot
  1x UIO or x8 slot
- Dual-port GbE LAN Controller, 4x USB 2.0 ports, 1x dedicated LAN for system management (IPMI 2.0)
- 6x Hot-swap SATA Drive Bays
- 1400W High-efficiency Redundant Power Supplies **Gold Certified**
- 6x 4-pin PWM fans with optimal fan speed control

Suggested server configuration

Server	
Selection summary	
Barebone	VDI Cluster BOS-CIWL4P-01
Processor	4 x 12C Opteron 6348 2.8GHz 16M
Memory	16 x 16GB DDR3-1600 ECC regRoHS
Hard drive	3 x SMART CloudSpeed 1000 480GB cMLC
PCIe card	Intel chipset based Supermicro Dual-Port 10Gbit Ethernet Card SFP+
Configured tech specs	
Barebones	
Memory technology	DDR3 ECC Reg.
Form factor	2U rack-mount
Color	Black
Memory slots	Thirty two 240-pin DIMM sockets
Power	1400W Redundant high-efficiency power supply
Optical drive	Slim DVD-ROM drive
Back panel	PS/2 keyboard and mouse ports
Processors	
Product line	AMD Opteron 6300 Series Processor
Socket	Socket G34
Clock speed	2.80 GHz
Hypertransport	6.4 GT/s
L3 cache	16 MB
L2 cache	16x 1MB
Cores/Threads	12C / 12T
AMD Turbo Core Technology	Yes
Memory	
Technology	DDR3
Type	240-pin RDIMM
Speed	1600 MHz
Error checking	ECC
Signal processing	Registered
Network cards	
Transmission speed	10Gbit per second
Model	Intel chipset based Supermicro Dual-Port 10Gbit Ethernet Card SFP+

Switches

Supermicro **SSE-X24SR**, a Layer 3 Ethernet switch, delivers high performance and density as well as advanced switching capabilities for meeting 10Gbit Ethernet networking requirements scaling from small business to enterprise. A comprehensive routing and protocol software suite ensures optimal performance in even the most demanding enterprise-class networking environments.

Entire network communication takes place between servers and storage traverse via these two switches.

24 Ten Gigabit Ethernet Ports SFP+Connectors

Out-of-band RS-232 Management Port

Switching Capacity: 480 Gbps

Storage

Boston 4U JBoD Solution BOS-CISSJB-01

Boston's BOS-CISSJB-01 is storage JBoD that provides up to 45 hot-swap hard drive bays in an efficient 24U form factor designed for most commonly encountered applications. This storage is managed using two storage controllers running Windows Server 2012 R2 Storage Services on Boston 1U AMD Server Solution – Storage Head BOS-CISHN-01.

Outline Specifications for

- Boston 4U JBoD Solution

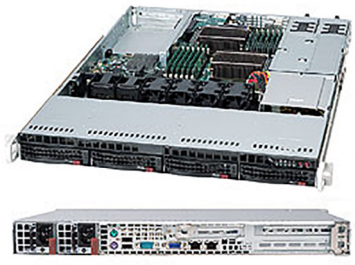
Key Features (Can Support)

- **High Efficiency Power & High Storage Capacity**
- Extra High-Density 4U JBOD Storage Chassis
- High-Availability Features: Redundant, Hot-pluggable cooling system, Power Supplies, Hot-swap drives
- Redundant (1+1) 1400W Gold Level power supply with PMBus function
- Maximum 3.5" hot-swap drives density 45x (24 front + 21 rear) HDD bays; E26- 2x Expanders support SAS2 (6Gb/s)
- 7x 8cm (middle) Hot-swap cooling fans, redundant cooling

Boston 1U AMD Server Solution – Storage HeadBOS-CISHN-01

Outline Specifications for

- Boston 1U AMD Server Solution – Storage Head



Key Features (Can Support)

- Dual AMD Opteron™ 6000 series (6300 ready) processors (Socket G34) 16/12/8/4-Core ready; HT3.0 Link support
- Up to 512GB DDR3 1600MHz ECC Registered DIMM; 16x DIMM sockets
- Intel® 82576 controllers, Dual-Port Gigabit Ethernet
- 4x 3.5" Hot-swap Drive Bays
- 2 (x8) PCI-E 2.0 (via riser card)
- Integrated IPMI 2.0 + KVM with dedicated LAN
- 650W Redundant Power Supply

Suggested server configuration

Boston 4U JBoD solution BOS-CISSJB-01 Storage: Usable space per user 10GB in mirror configuration	
Selection summary	
Chassis	Boston 4U JBoD Solution BOS-CISSJB-01
Storage drive	43 x Western Digital 3.5” 600GB 10000 RPM SAS 2 x Optimus Ascend, 2.5” 400GB SAS SSDs with 3.5” convertor
Mounting rails	Quick-release rack-mount mounting rails
Configured tech specs	
Chassis	
Product type	4U rack-mount
Color	Black
Watts	1400W Gold-level PWS with PM BUS
External drive bays	43 x Western Digital 3.5” 600GB 10000 RPM SAS 2 x Optimus Ascend, 2.5” 400GBSAS SSDs with 3.5” convertor
Cooling fans	7x8cm (Middle) hot-swap cooling fans, redundant cooling
Hard drives	
Rotational speed	10000RPM
Cache	64MB

Boston 1U AMD server solution – Storage HeadBOS-CISHN-01	
Selection summary	
Barebone	1U, Dual SKT, Dual AMD chipset SR5690 + SP5100,650W High-Efficiency Gold PSU
Processor	2 x AMD Opteron 8C 6320 2.8GHz 16M 6.4GT/s HT Links
Memory	8 x 8GB DDR3-1600 2Rx4 ECC regRoHS
Hard drive	2 x Western Digital 3.5” 500GB 7.2K RPM SATA
PCIe card	Intel chipset based Supermicro Dual-Port 10Gbit Ethernet Card SFP+
PCI express card	LSI 9207-8e HBA

Software stack

This section incorporates details about different layers involved in software stack“required for building and supporting the XenDesktop 7.1 hosted shared desktop solution on commodity hardware. It is broken down into following five layers:

User layer

The user layer represents the different user types that will access the hosted shared desktops from their end-point devices. These user groups represent the use case of “heavy task workers” or “knowledge workers” having almost similar requirements. The details of what is delivered to this user group are discussed within the desktop layer.

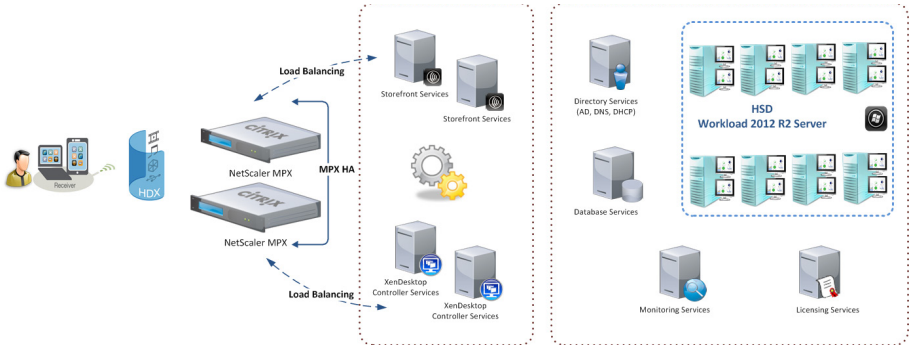
The following Citrix component is required on each end-point device for accessing virtual desktops and apps:

Citrix Receiver: Citrix Receiver is a universal software client provides secure, high-performance delivery of virtual desktops and applications on today’s latest tablet and smartphone devices. Receiver runs on virtually any operating platform, including Windows, Mac, Linux, iOS and Android.

Citrix Receiver 4.1 for Windows was used during the Citrix Validated Solution testing.

Access layer

The access layer consists of the servers responsible for providing connectivity to the XenDesktop 7.1 hosted shared desktop solution on commodity hardware. The figure below depicts the access scenario required for securely accessing the virtual environment.



The following Citrix components are required to achieve secure remote access:

- Citrix StoreFront: StoreFront provides a self-service subscription service to desktops and applications via an enterprise app store, giving users convenient access to all their resources. By creating a centralized enterprise app store with StoreFront, users will be able to enumerate and aggregate the available resources. A minimum of two StoreFront servers will be deployed to ensure high availability.
- Citrix NetScaler Gateway: NetScaler Gateway is a secure application and data access solution that gives administrators granular application and data-level control while empowering users with remote access from anywhere. NetScaler Gateway works in conjunction with StoreFront to authenticate the user and create an SSL tunnel between the end user and NetScaler Gateway to ensure secure remote access from any device. A customer can select a pair of either physical or virtual NetScaler appliances to host NetScaler Gateway in an active/active mode to ensure secure access is highly available with maximum capacity.

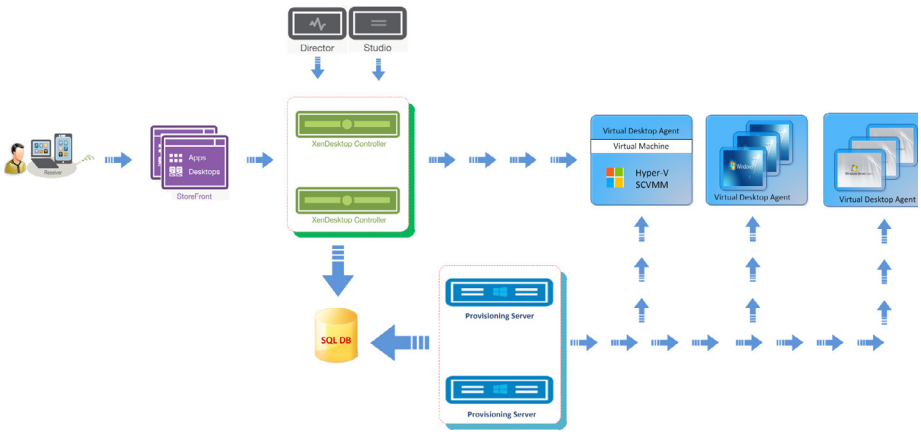
Desktop layer

The desktop layer focuses on the design considerations for the user's desktop, which can provide the right set of applications, capabilities and resources based on user needs.

The solution requires following Citrix components within the desktop layer:

- Citrix XenDesktop Delivery Controllers: These XenDesktop 7.1 servers act as brokers and manage the delivery of hosted shared Windows desktops and apps.

The figure below depicts the architecture of the XenDesktop farm and related infrastructure.



In the Citrix Validated Solution test setup, the XenDesktop farm consists of a single zone with two dedicated Controllers. StoreFront is utilized for the presentation of hosted shared desktop desktops to end users.

- Hosted shared workers: The hosted shared workers are deployed using Citrix Provisioning Services standard vDisk mode (read-only, many to one). A number of configuration settings are applied directly to the worker "golden image[1]" using Active Directory group policies to ensure optimal performance. The Microsoft Systems Center Endpoint Protection 2012 R2 antivirus client is included as part of the solution with specific configuration.

Based on the system testing carried out, the following table describes the most optimal configuration for the hosted shared desktop worker workload for user/ session density:

Hosted shared workers	
Virtual machine configurations	
Operating system	Windows Server 2012 R2
Memory	28 GB RAM
Processors	6 cores
Network	1 legacy network adapter 1 network adapter Connected to 10 Gbit ethernet network
WriteCache drive	40 GB
Session details	
Hosted shared desktops sessions per VM	Maximum 23 sessions
Count of hosted shared desktops worker VMs per host	8 VMs
Total number of sessions per	Maximum 184 sessions of medium workload of LoginVSI 4

The testing consisted of application sets representative of enterprise-level baseline applications. These applications are embedded as part of the hosted shared desktop worker golden image. The following table represents the application set that forms the hosted shared desktop workload profile.

Configuration	Decision
Citrix applications	• Citrix Provisioning Service Target Device x64 7.1.0.4022 • Citrix Receiver 14.1.0.0 • Citrix Virtual Delivery Agent 7.1.0.4330
Productivity applications	• Microsoft Office Professional Plus 2013
Baseline applications	• Adobe Acrobat Reader XI 11.0.00 • Adobe Flash Player v11.7.700.202 • Doro 1.82 • Java 7 Update 13 7.0.130 • Microsoft Monitoring Agent 7.1.101840.0 • System Center Endpoint Protection 4.3.220.0 • Internet Explorer 11 11.0.9600.16394 • 7Zip 9.2

To provision a streamlined desktop to users, optimizations and configurations are applied at several levels:

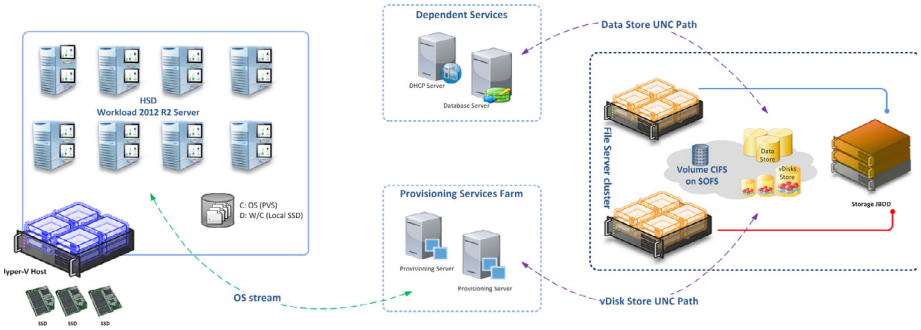
- Workload configuration gold image: Changes are made directly to the gold image. These changes are not applied using group policy objects (GPOs) and hence are required settings prior to generalizing the image. The image must be generalized while it is in writable mode (private or maintenance mode). Once the image has been generalized, it is immediately shutdown and reverted to a read-only mode (production or test mode) and is ready for many-to-one (many target devices to one vDisk image) deployment.
- Workload configuration GPO: These changes are applied via Active Directory GPO and are considered baseline configurations required in almost all instances. Typical use cases for this GPO are event log redirection, Citrix profile management configuration and target device optimizations. In addition, this GPO may have loopback processing enabled, allowing user-based settings to be applied to the virtual desktop Organization Unit level.
- User optimizations GPO. This Active Directory GPO contains optimizations for the user operations within the virtual desktop environment. User configurations cannot typically be deployed as part of the image and are independent. Typical use cases for this GPO are folder redirection and user-specific optimizations.

Control layer

The control layer contains all the infrastructure components required to support the access and desktop layers. This section outlines implementation of the infrastructure controllers and control hosts placed on commodity hardware.

The solution requires following Citrix and Microsoft components within the control layer:

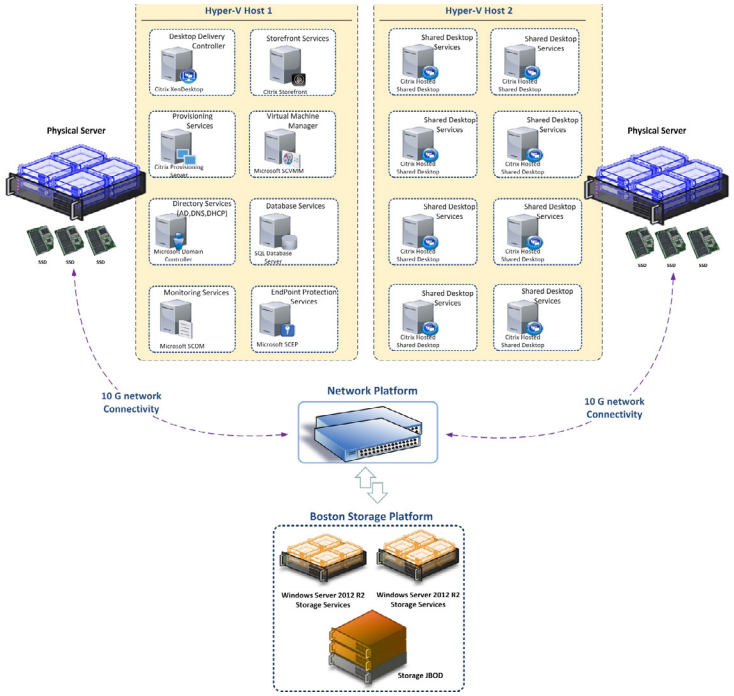
- Citrix Provisioning Services: The Provisioning Services environment consists of a single farm and single site. A single site is used to host the Provisioning Services servers for the XenDesktop hosted shared desktop workloads.



The table below depicts key decisions related to the Provisioning Services farm:

Configuration	Decision
Version	Citrix Provisioning Services 7.1
Servers	Two virtual Provisioning Services for high availability and load balancing
Boot services	• DHCP services enabled on DHCP server • Option 66 and 67 defined within DHCP scope
Hardware settings	• 2 x Virtualized Provisioning Server • Hyper-V VM guest • Windows Server 2012 R2 • 6 Cores • 16 GB RAM • 40 GB disk for operating system • 1 network adapter 10 GbE
Storage settings	Provisioning Services vDisk Store hosted on shared storage -Windows Storage Services SOFS.
Network settings	10 GbE network-connected network adapters assigned to both Provisioning Services servers.
PVS write cache settings	Local disk on the target device; a 40GB (E: drive) persistent virtual disk is associated to each target device

- Microsoft Hyper-V 2012: Microsoft Hyper-V 2012 R2 is utilized to provide the hypervisor hosting platform to the virtualized desktop workloads and the supporting infrastructure components.

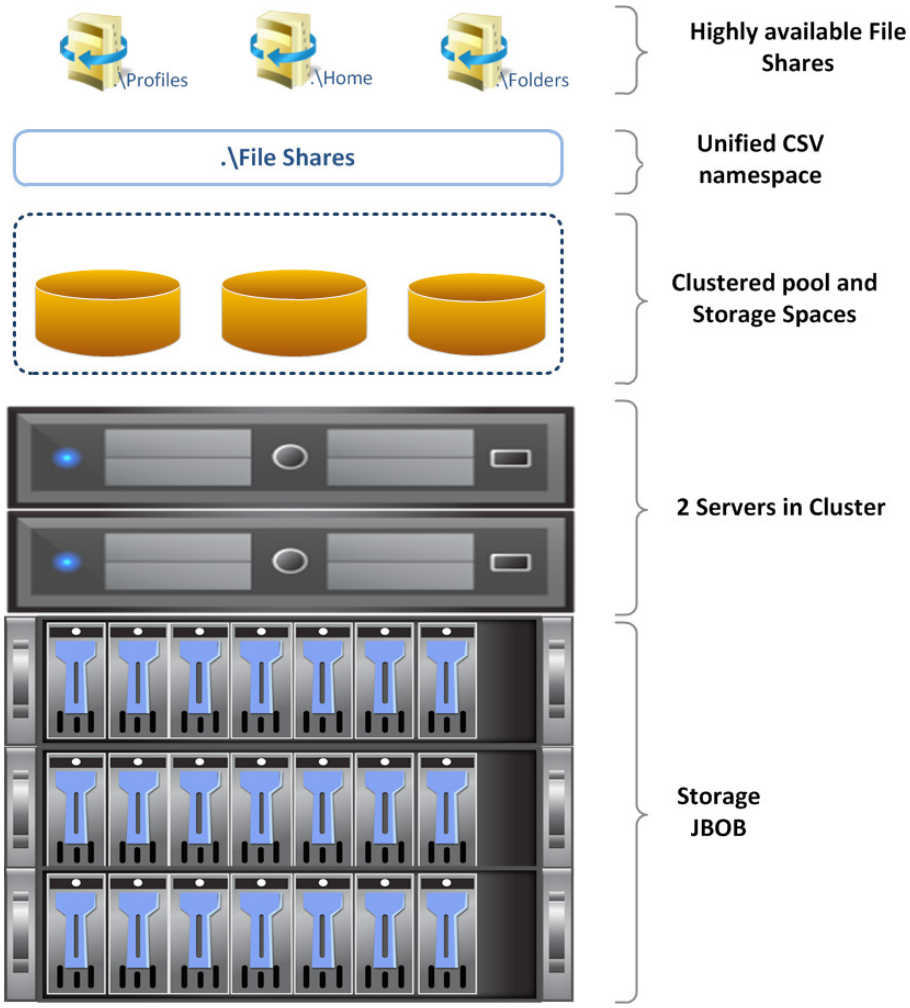


The table below depicts key decisions related to Hyper-V:

Configuration	Decision
Version	Microsoft Hyper-V 2012 R2
Hardware settings	2 x Boston VDI Cluster BOS-CIWL4P-01 • 4 x Twelve-Core AMD Opteron Model 6348 -2.8GHz • 16 x 16GB DDR3-1600 ECC regRoHS • 3 x SMART CloudSpeed 1000 480GB cMLC • Intel chipset based Supermicro Dual-Port 10Gbit Ethernet Card SFP
Storage settings	• Boot from local storage, 1 x CloudSpeed 1000 SSD used for operating system • Local storage used for write cache, 2 x CloudSpeed 1000 SSDs configured using Windows Server 2012 Storage Spaces Simple Space • CIFS ISO repository - only mounted as required
Network settings	Intel chipset based Supermicro Dual-Port 10Gbit Ethernet Card SFP+ Single subnet
Pool settings	2 x Hyper-V hosts

- Windows Storage Spaces and Clustering: The solution leverages the Windows Storage Spaces feature of Windows Server 2012 R2. Storage spaces takes disk management to next level by including performance improvement features such as auto-tier/write-back cache, and scale-out file services (SOFS), and allowing administrators to decouple management of physical and virtual disks. It is cost-effective, highly available, and scalable.

The figure below depicts basic architecture of how clustered storage space is configured for this solution:



Enterprise-grade SAS disks are grouped into a homogenous layer of logical volume called a storage pool, which is split into virtual disks based on redundancy. Such virtual disks now can be used as resources in a Windows cluster and are ensured to be highly available.

The solution leverages storage spaces in the workload and storage servers. In the workload servers, it uses simple spaces redundancy at virtual disk level backed by two SSD disks configured in the storage pool to support the write-cache data of the Provisioning Services-streamed machines. In the storage servers, two types of virtual disks, configured in two-way mirror redundancy and provided by Storage Spaces are used. These virtual disks are backed by storage pool of 22 10K RPM SAS drives and two SSDs. The virtual disk first supports user data and secondly supports application data such as the Provisioning Services vDisk Store. Both virtual disks are configured as "cluster" resources and are highly available across two nodes. The application data is a 500GB virtual disk carved out of 10k RPM SAS drives and is further enabled with SOFS, which ensures both nodes are equally loaded with storage requests from the client. The user data is a 964GB virtual disk with 64GB SSD auto-tier feature enabled. This ensures the SSD level performance for frequently accessed user data.

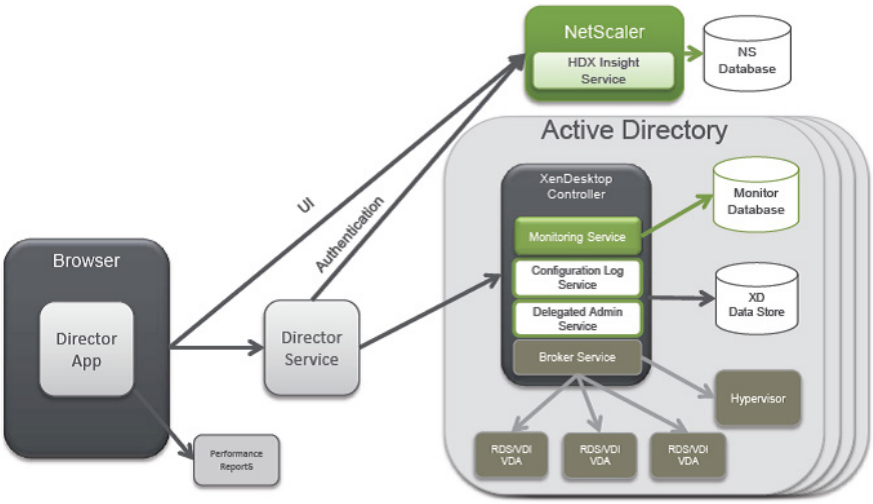
- Active Directory: Citrix leverages Active Directory for authentication and policy-setting enforcement for both users and computers. A Windows Server 2012 R2 Active Directory forest is leveraged for this solution.
- SQL Server Database: This database provides the foundation for the overall XenDesktop and Provisioning Services farm by storing all configuration metadata. Monitoring tools also require the database for storing historical data. A SQL Server 2012 Service Pack 1 is leveraged for supporting these services and to ensure high availability; a witness server implements SQL mirroring.
- Citrix License Server: The Citrix License Server is a required server component that provides license service requirements to the Citrix products included in this document. Redundancy is built into the license service via the built-in 30-day grace period. The underlying hypervisor can further facilitate service redundancy; therefore, a single server is prescribed
- DHCP on Windows Server 2012 R2: This solution uses a single DHCP server to provision IP addresses. But in production, a new failover feature in Windows Server 2012 R2 can be leveraged to have two DHCP servers serve IP addresses and option configuration to the same subnet or scope, providing uninterrupted availability of DHCP service to clients. The two DHCP servers can be configured to replicate lease information between themselves, allowing one server to assume responsibility for servicing clients for the entire subnet when the other server is unavailable, without using split scopes.

Monitoring layer

The monitoring layer focuses on performance monitoring and availability management solution for entire Citrix XenDesktop 7.1 environment. Citrix Desktop Director is used for monitoring Citrix components, and Microsoft System Center Operations Manager is used for monitoring the entire infrastructure, end to end.

Employ any of the following tools for comprehensively monitoring and managing a Citrix virtual desktop environment:

- Citrix Director: These tools address performance monitoring and management of platform and user experience through real-time assessment, environment health monitoring and user troubleshooting. They provide following capabilities:
  - Comprehensive monitoring and troubleshooting to understand every aspect of the Citrix XenDesktop environment.
  - The ability to correlate end-user experience with Citrix application and desktop delivery visibility into the Citrix protocol.
  - A single-pane-of-glass solution for troubleshooting and monitoring.
  - Capacity management and insight into health and performance trends.



Desktop Director provides a solutions approach to management and monitoring,

enabling IT to understand, troubleshoot, analyze, and plan for its entire Citrix virtualized environment through a single solution with a unified console.

- Microsoft SCOM 2012 R2: Operations Manager, a component of Microsoft System Center 2012, is software that helps administrators monitor services, devices, and operations for many computers from a single console. Operators can gain rapid insight into the state of the IT environment, services running across different systems, and workloads by using numerous views that show state, health, and performance information, as well as alerts generated for availability, performance, configuration, and security situations.

This solution uses SCOM for monitoring:

- Hyper-V infrastructure
- Storage and file server cluster

The following performance counter were monitored as part of the testing effort:

Component	Performance center
Windows Server 2012 R2 Hyper-V Workload Servers	• \Hyper-V Hypervisor Logical Processor(*)* • \Hyper-V Virtual Machine Health Summary* • \Hyper-V Dynamic Memory VM(*)* • \Hyper-V Virtual Network Adapter(*)\ • \Hyper-V Virtual Storage Device(*)* • \Hyper-V Legacy Network Adapter(*)* • \Hyper-V Virtual Switch(*)* • \PhysicalDisk(*)*
Windows Server 2012 R2 Storage Heads	• \Cluster CSV Block Redirection* • \Cluster CSV File System(*)* • \Cluster CSV Volume Manager(*)* • \Cluster Resources(_Total)* • \LogicalDisk(_Total)* • \Memory* • \Network Adapter(*)* • \Network Interface(*)* • \PhysicalDisk(_Total)* • \Processor(_Total)* • \SMB Server Sessions* • \Cache* • \Cluster CSV Volume Cache(*)* • \Cluster Resources(File Server)* • \Cluster Resources(Scale Out File Server)* • \Cluster Resources(Storage Pool)* • \LogicalDisk(*)* • \Processor(*)*

Scalability and performance testing

Testing focused on capturing the performance of commodity hardware and its resiliency during the entire process of the virtual desktop lifecycle.

Test metrics are gathered for all components such as the hypervisor, virtual desktop, network, storage, and the workload generation system, Login VSI, to determine the overall success of a test run. A test methodology is followed to provide consistency between runs.

Test methodology

The following test methodology is used for each test run to ensure consistent results:

- Before each test, all desktop VMs and clients are cleanly started.
- All VMs and client launchers are idle before the test.
- Boot phase: All desktop VMs are powered on and registered.
- Logon phase: All user session are launched and active in Login VSI.
- Test phase: At least two Login VSI loops are executed in each active session.
- Log-off phase: All users logged off after VSI completion.
- Test-run reports and data are gathered.
- All desktop VMs and clients are shut down.

Login VSI setup

The primary test tool used in the environment is Login VSI 4.0, consisting of the VSI Client Launcher, VSI Workload, VSI Console, and VSI Analyzer applications.

Login VSI 4.0 is used as the test orchestration and workload generation system to create the load of multiple users accessing the XenDesktop 7.1 environment and executing a typical user workflow within a session.

A predefined “medium workload” that simulates “heavy task user working” or “knowledge user working” is used for this test. The predefined workload is used to simulate user activities during the test and to find the maximum number of active sessions the environment is able to handle.

Each test run comprises a single phase executing for 3,600 seconds with 190 sessions. The overall log-on rate for the test run is 18.95 seconds.

After all users have logged on, the test is configured to simulate each user executing a medium workload Login VSI loop. The log-off sequence is initiated 120 seconds after the last session log-on.

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

System inventory

Physical hardware – Storage and compute

Function	Citrix infrastructure virtualization	Hosted shared desktops	Windows Storage Server
Hardware model	Boston VDI Cluster BOS-CIWL4P-01	Boston VDI Cluster BOS-CIWL4P-01	Boston Storage Head BOS-CISHN-01
Host count	1	1	2
Processor	12 Core x 4 sockets	12 Core x 4 sockets	8 Core x 2 socket
Memory	256 GB	256 GB	64 GB
Network	10 GbE	10 GbE	10 GbE
Storage type	Local SSD	Local SSD	JBOD SSD &SAS Drives
Operating system	Windows Server 2012 R2 Hyper-V	Windows Server 2012 R2 Hyper-V	Windows Storage Server 2012 R2
HA/Resiliency configuration	No HA	No HA	Windows Cluster

Virtual machines – XenDesktop infrastructure and virtual desktops

Function	Citrix desktop delivery controllers	Citrix Provisioning server	Citrix License server	Citrix StoreFront server	Citrix hosted shared desktop VM
Hardware model	Hyper-V VM	Hyper-V VM	Hyper-V VM	Hyper-V VM	Hyper-V VM
VM count	2	2	1	2	8
Number of cores	4	6	2	4	6
Memory	4 GB	16 GB	4 GB	4 GB	28 GB
Hard drive	40 GB	40 GB 500 GB (SOFS)	40 GB	40 GB	40 GB
Operating system	Windows Server 2012 R2	Windows Server 2012 R2	Windows Server 2012 R2	Windows Server 2012 R2	Windows Server 2012 R2

Other infrastructure

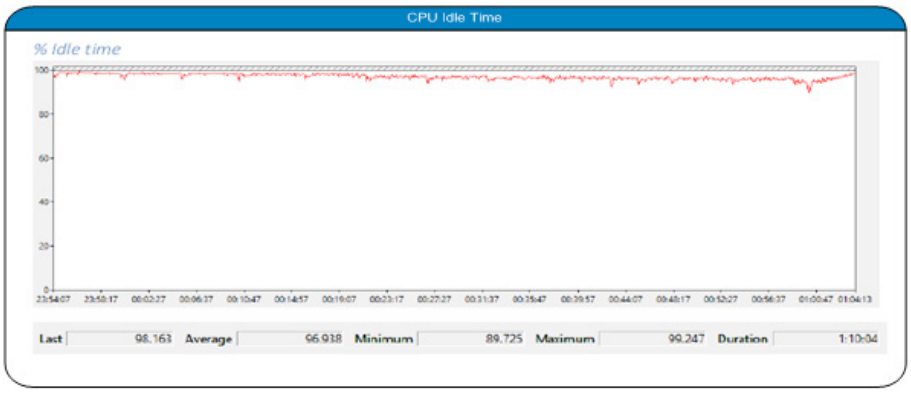
Function	Domain controller DNS DHCP	SQL 2012 SP1 server	Citrix consoles SCVMM 2012 R2	SCOM &SCEP 2012 R2	LoginVSI launcher
Hardware model	Hyper-V VM	Hyper-V VM	Hyper-V VM	Hyper-V VM	Hyper-V VM
VM count	1	1	1	1	4
Number of cores	2	4	2	2	2
Memory	4 GB	6 GB	6 GB	4 GB	4 GB
Hard drive	40 GB	500 GB (SOFS)	40 GB	40 GB	40 GB
Operating system	Windows Server 2012 R2	Windows Server 2012 R2	Windows Server 2012 R2	Windows Server 2012 R2	Windows Server 2012 R2

Storage performance results

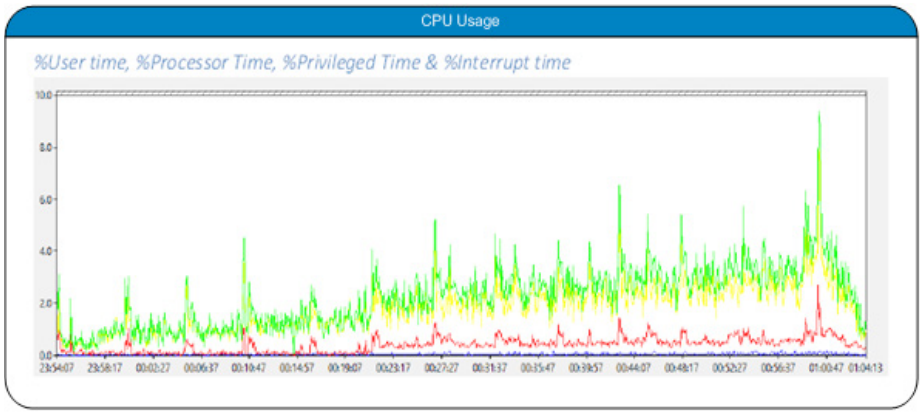
For the test setup, the Boston JBoD solution is configured with 22 10K RPM 140GB SAS drives and two Optimus 400GB SAS SSDs. The SSDs are primarily used for storage tier and write-back cache.

The storage head servers are configured with Windows storage spaces and clustering to achieve better performance and resiliency. The storage server is used as file share for storing user profiles, redirected folders, home drives (for storing user data), and as SOFS for storing vDisk and data stores. This data relies on a storage server configured with storage space two-way mirror resilience, auto-tier, and write-cache features.

The following graph shows CPU utilization:

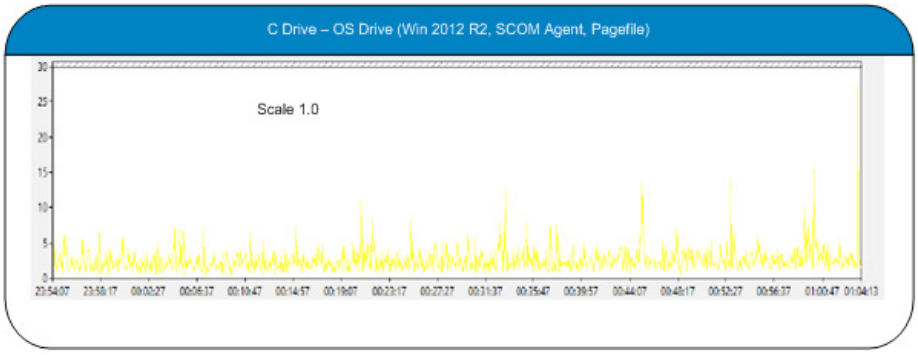


CPU idle time storage controllers

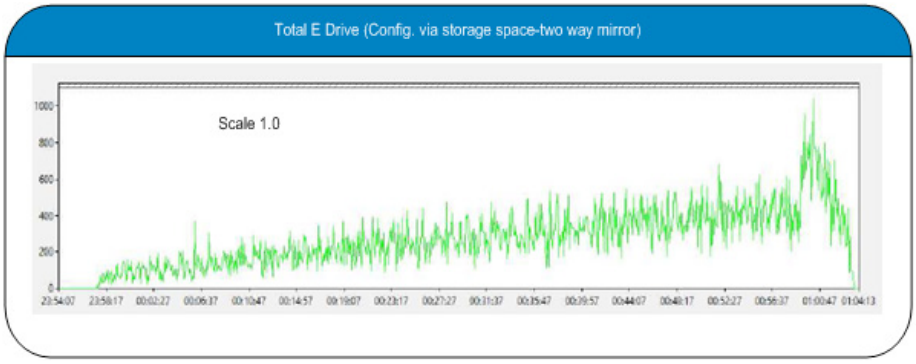


CPU usage on storage controllers

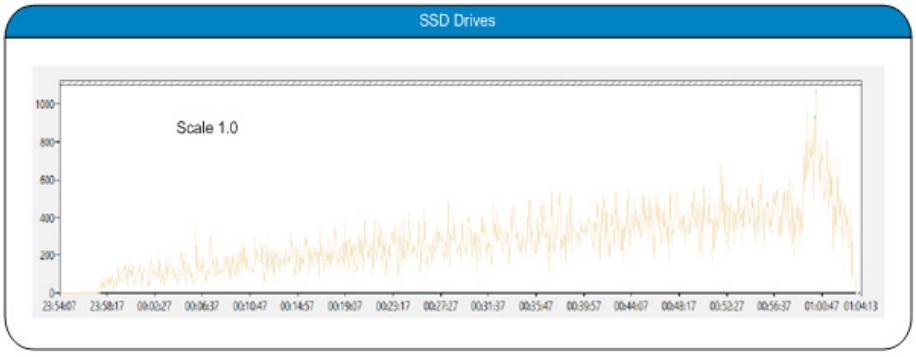
The following graph shows disk transfers/sec (IOPS) on different volumes and drives:



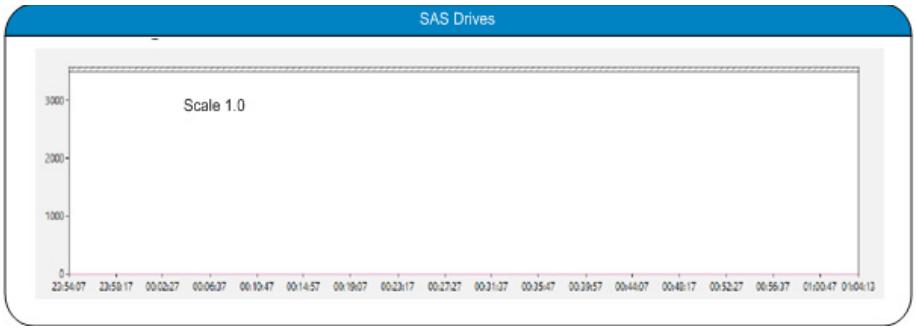
IOPS for Provisioning Services vDisk store on SOFS



IOPS for user data share (SSD + SAS drives)

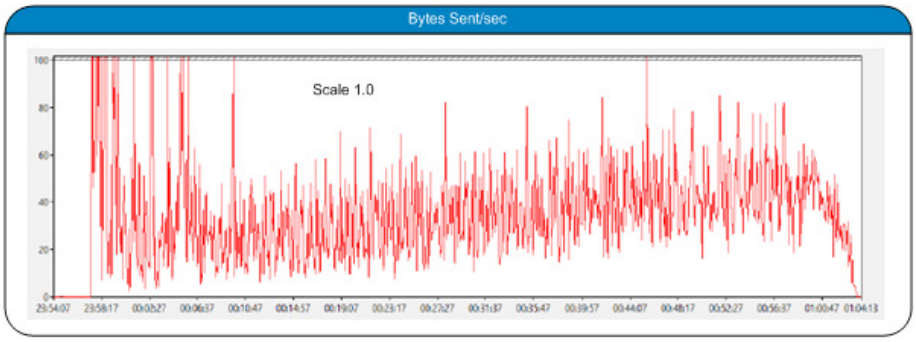


IOPS for user data share (two SSD drives)

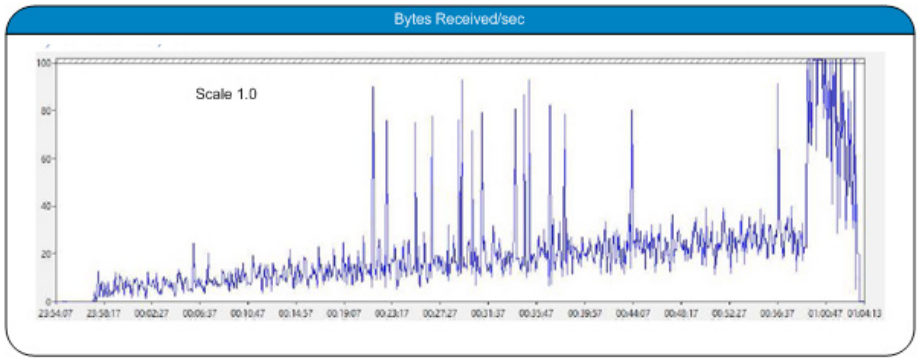


IOPS for user data share(22 SAS drives)

The following graph shows the network utilization:



Bytes sent/sec from the storage controllers



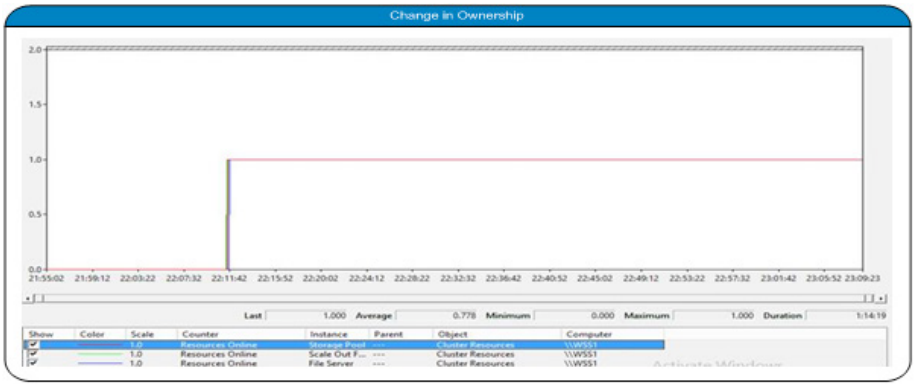
Bytes received/sec by the storage controllers

These graphs indicate the storage performance is up to the mark as expected, and CPU utilization is minimal. Most of the operations are served by SSD drives, which are used for caching. The network utilization is also minimal.

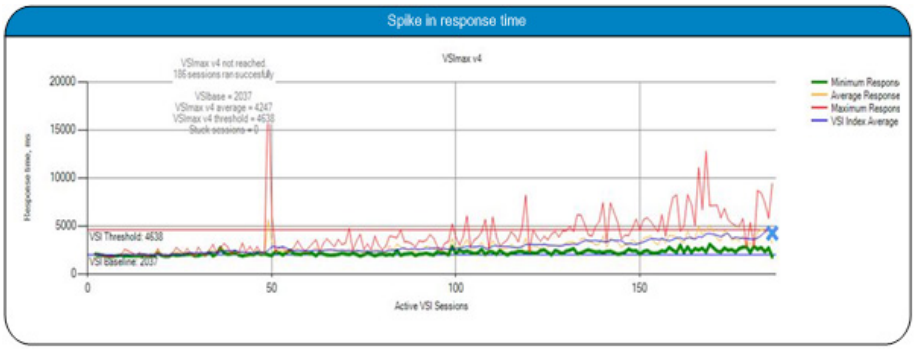
Note: The above storage statistics for user data share is in relation to the LoginVSI medium workload. The actual usage in production will vary among environments based on end-user activity.

In addition, we performed storage cluster failover testing to understand the impact on live user sessions. During failover, there was no impact on user sessions, as none of the sessions failed. A spike in response time is observed during the failover activity.

The following graph shows the change in ownership post failover, as well as the spike in response time.



Ownership changes from Storage Head WSS2 to Storage Head WSS1



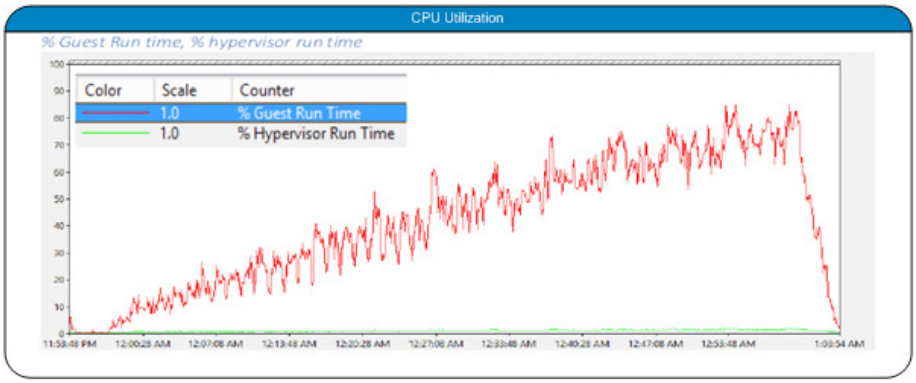
Spike in response time observed during failover

Host performance results

A Boston VDI Cluster BOS-CIWL4P-01desktop-class server is dedicated to host the hosted shared desktop workloads. One of the three CloudSpeed 1000 SSDs is used for host OS installation. The remaining two SSDs are configured as “simple space” using Windows Storage Spaces and store the write cache for the hosted shared desktop VMs.

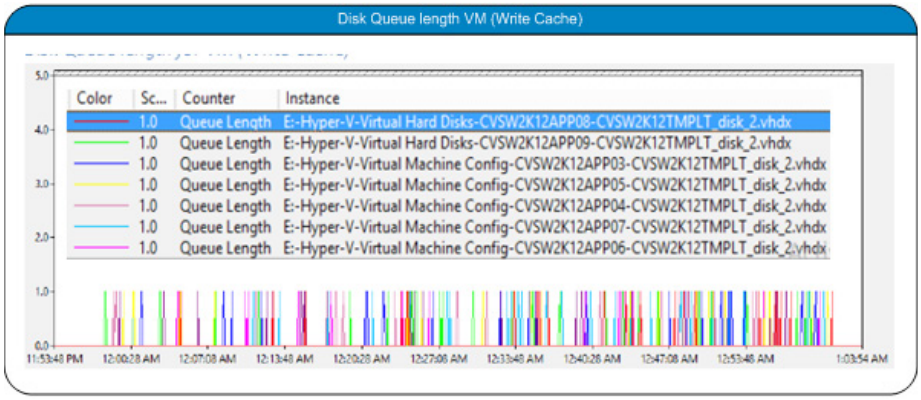
The single-server scalability testing using the LoginVSI 4.0 “medium workload” revealed that each Boston VDI Cluster BOS-CIWL4P-01 host can sustain maximum 184 concurrent user sessions of medium load type of LoginVSI 4.0

The following graph shows CPU utilization for host and VMs:

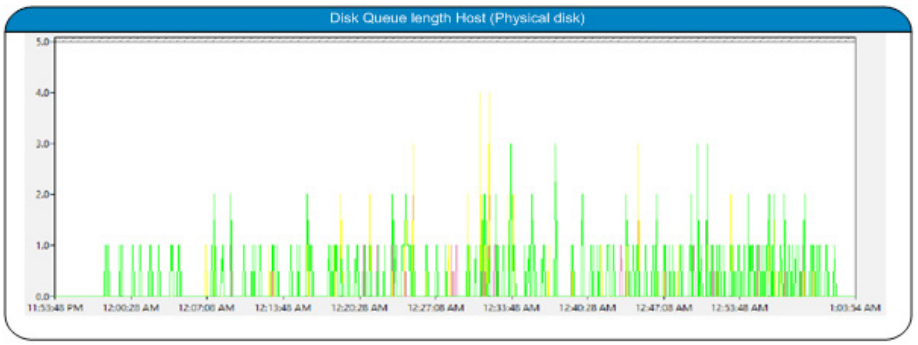


CPU utilization by host and guest VMs

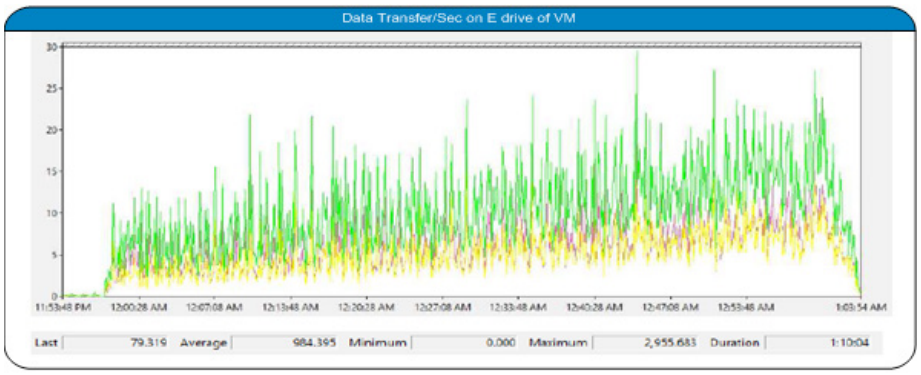
The following graph shows the disk performance:



Disk queue length for VM

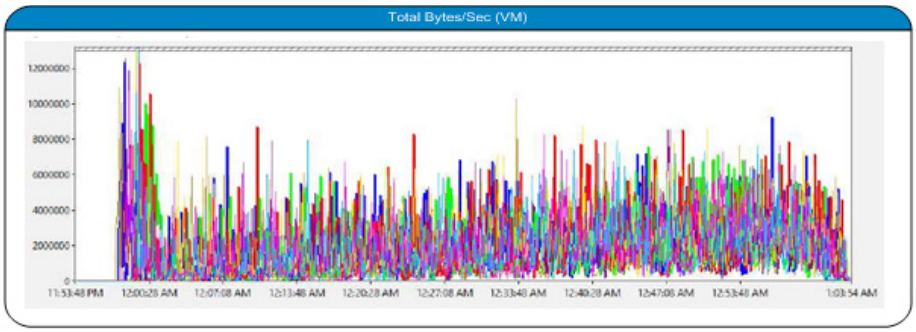


Disk queue length for physical server (write cache drive) IOPS on



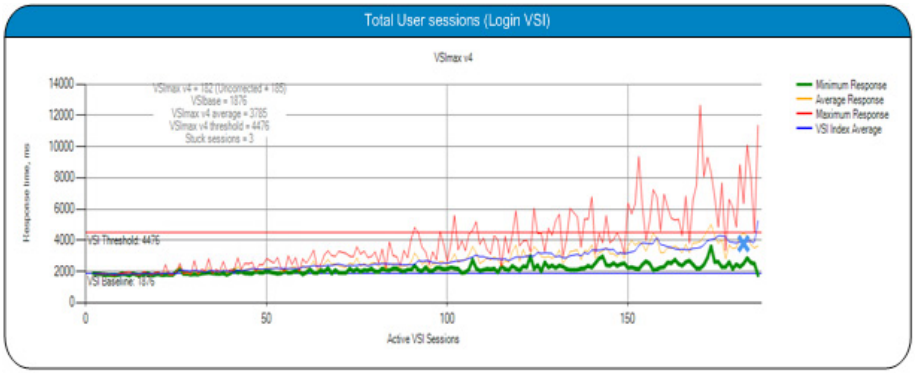
IOPS on write cache drive

The following graph shows the network utilization:



Total bytes/sec per VM

The following graph shows the total user sessions run during the testing:



Total user sessions

Conclusion

The primary objective of testing was to validate that Citrix XenDesktop 7.1 supports commodity hardware and delivers a high-performance virtual desktop at a price point lower or equivalent to that of a standard PC. The defined success criteria are:

- No server CPU utilization average to be more than 90 percent while under load
- Storage and network to perform within guidelines
- 180-200 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 commodity hardware met the initial objective.

Suggested Bill of Material

This section outlines the bill of material for compute, storage, and network required to host a Citrix XenDesktop 7.1 hosted shared desktop deployment for 1,000 users. With added cost, customers have the choice to further customize their hardware. For example, Intel Xeon Processor E5-2670 v2 (25M cache, 2.50 GHz) processors for the Boston VDI Cluster BOS-CIWL4P-01 and use of LSI CS 9286-8e 8-Port SAS Syncro RAID Kit for the Boston enhance performance and increase user density.

Note: The hardware sizing is extrapolated based on the outcome of our single-server scalability testing and field experience. User data storage requirements (three IOPS/user considered) can be further fine-tuned based on end-user requirements. Use cases, which require large mail archives to be stored on the home directory, tend to generate high IOPS on the supporting storage subsystem.

- A "four concurrent hosted shared desktop users per physical core" ratio has been considered for the calculations.
- JBoD-based storage considered for CIFS/user profile with per user 10GB in mirror configuration.
- The storage heads are expected to run Windows Server 2012 R2 Storage Services.
- User data (user profile, folder redirection and home directory) IOPS are considered as 3.0 per user.
- Server configuration accounts for 1 GB memory per user.
- No software licenses have been included in the bill of material.
- Direct Attached Storage for workload servers accounts for 100.0 IOPS (write cache) per user.
- Three-year RTB warranty.
- Prices are approximate list prices; taxes including clearance, duties, local body taxes, etc., are not considered.
- Contact your local Boston Limited representative for exact hardware prices.

Component		Quantity	Cost (USD)	Total Cost (USD)
Server Boston VDI Cluster BOS- CIWL4P-01		7	$11,170	$78,190
Selection summary				
Barebone	VDI Cluster BOS-CIWL4P-01			
Processor	4 x 12C Opteron 6348 2.8GHz 16M			
Memory	16 x 16GB DDR3-1600 ECC regRoHS			
Hard drive	3 x SMART CloudSpeed 1000 480GB cMLC			
PCIe card	Intel chipset based Supermicro Dual-Port 10Gbit Ethernet Card SFP+			
Operating system	No Operating System			
Warranty	3 Years RTB Warranty			
Configured Tech Specs				
Barebone				
Memory technology	DDR3 ECC Reg.			
Form factor	2U rack-mount			
Color	Black			
Memory slots	Thirty two 240-pin DIMM sockets			
Power	1400W Redundant high-efficiency power supply			
Optical drive	Slim DVD-ROM drive			
Back panel	PS/2 keyboard and mouse ports			
Processors				
Product line	AMD Opteron 6300 Series Processor			
Socket	Socket G34			
Clock speed	2.80 GHz			
HyperTransport	6.4 GT/s			
L3 cache	16 MB			
L2 cache	16x 1MB			
Cores/Threads	12C / 12T			
AMD Turbo Core Technology	Yes			

Memory				
Technology	DDR3			
Type	240-pin RDIMM			
Speed	1600 MHz			
Error checking	ECC			
Signal processing	Registered			
Network cards				
Transmission speed	10Gbit per second			
Model	Intel chipset based Supermicro Dual-Port 10Gbit Ethernet Card SFP+			
Networking				**$17,763.8**
Switch	Boston powered by Supermicro SSE-X24SR 24-Port 10Gbit Ethernet Switch	2 2	$8,206.4 $45.5	$16,412.8 $91
	SAS External Cascading Cable – CBL-0166L	18	$70	$1,260
	1 Meter 10GbE SFP+ Passive Copper Cable			
	3 Years RTB Warranty			
Storage: Usable space per user 10GB in mirror configuration		1	$17,991	$17,991
Boston 4U JBoD Solution BOS-CISSJB-01				
Selection summary				
Chassis	Boston 4U JBoD Solution BOS-CISSJB-01			
Storage drives	43 x Western Digital 3.5” 600GB 10000 RPM SAS Drives 2 x Optimus Ascend, 2.5” 400GB SAS SSDs with 3.5”” convertor			
Mounting rails	Quick-Release rack-mount Mounting Rails			
Warranty	3 Years RTB Warranty			

Configured tech specs				
Chassis				
Product type	4U rack-mount			
Color	Black			
Watts	1200W 1U GOLD LEVEL PWS WITH PM BUS			
External drive bay	43 x Western Digital 3.5” 600GB 10000 RPM SAS 2 x Optimus Ascend, 2.5” 400GB SAS SSDs with 3.5”” convertor			
Cooling fans	80x80x38 mm 7K RPM Chassis middle fan w/ housing			
JBOD kit				
	Power control card for JBOD			
	SAS BP external cascading cable			
	I2C CABLE FOR SATA LED, 51CM, LF			
	Low profile bracket. 85CM 2-PORT EXT IPASS TO INT IPASS, LP			
	I/O shield without any opening			
Hard drives				
Rotational speed	10000RPM			
Cache	64MB			

Boston 1U AMD server solution – Storage HeadBOS-CISHN-01		2	$4,410	$8,820
Selection summary				
Barebone	1U, Dual SKT, Dual AMD chipset SR5690 + SP5100,650W High-efficiency Gold PSU			
Processor	2 x AMD Opteron 8C 6320 2.8GHz 16M 6.4GT/s HT Links			
Memory	8 x 8GB DDR3-1600 2Rx4 ECC regRoHS			
Hard drive	2 x Western Digital 3.5" 500GB 7.2K RPM SATA			
PCIe card	Intel chipset based Supermicro Dual-Port 10Gbit ethernet card SFP+			
PCI express card	LSI 9207-8e HBA			
Operating system	No Windows Operating System			
Warranty	3 Years RTB warranty			

Total cost of solution	**$122,765**
Storage cost	$26,811
Network cost	$17,764
Server cost	$78,190
Total cost/User	**$122.7648**
Storage cost/user	$26.811
Network cost/user	$17.7638
Server cost/user	$78.19

Level 3, 1 Julius Avenue
North Ryde, Sydney 2113
02-8870-080

Corporate Headquarters
Fort Lauderdale, FL, USA

India Development Center
Bangalore, India

Latin America Headquarters
Coral Gables, FL, USA

Silicon Valley Headquarters
Santa Clara, CA, USA

Online Division Headquarters
Santa Barbara, CA, USA

UK Development Center
Chalfont, United Kingdom

EMEA Headquarters
Schaffhausen, Switzerland

Pacific Headquarters
Hong Kong, China

About Citrix
Citrix (NASDAQ:CTXS) is a leader in virtualization, networking and cloud infrastructure to enable new ways for people to work better. Citrix solutions help IT and service providers to build, manage and secure, virtual and mobile workspaces that seamlessly deliver apps, desktops, data and services to anyone, on any device, over any network or cloud. This year Citrix is celebrating 25 years of innovation, making IT simpler and people more productive with mobile workstyles. 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 people globally. Learn more at www.citrix.com

0414/PDF

citrix.com