

Citrix XenDesktop 5.5 on VMware 5 with Hitachi Virtual Storage Platform



Reference Architecture Guide

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Reference Architecture Guide

The purpose of this reference architecture on Hitachi Virtual Storage Platform is to present a Microsoft Windows 7 virtual desktop infrastructure environment that does the following:

- Lowers administration costs
- Improves system efficiency
- Maintains performance

Using a building block design, this reference architecture helps you deploy Citrix XenDesktop in a virtualized environment using the following:

- VMware vSphere
- Hitachi Dynamic Provisioning
- Hitachi Compute Blade 2000
- Hitachi Virtual Storage Platform

This reference architecture assumes a light end-user workload. There is guidance for sizing and deploying a Microsoft Windows 7 virtual desktop infrastructure (VDI) to support up to 160 users per building block. You can add building blocks to scale up to many thousands of users.

This paper is intended for you if you are an IT administrator responsible for desktops and storage administration. You need some familiarity with Hitachi Storage Navigator, VMware vSphere, and Citrix XenDesktop components.

Note — All testing was done in a lab environment. In production environments, results can be affected by many factors that cannot be predicted or duplicated in a lab. Conduct proof-of-concept testing using your target applications in a non-production, isolated test environment that is identical to your production environment. Following this recommended practice allows you to obtain results closest to what you can expect to experience in your deployment.

Solution Overview

This solution uses one Hitachi Compute Blade 2000 chassis with eight E55A2 server blades. The configuration of these blades is as follows:

- Two blades as an infrastructure block to host all of the XenDesktop and vSphere components used for the environment
- Six blades as three desktop building blocks used to host all of the virtual desktops
 - Each desktop block consists of two E55A2 server blades and a Hitachi Dynamic Provisioning pool on Hitachi Virtual Storage Platform.

Figure 1 is an overview of the environment used in the Hitachi Data Systems lab to validate the building blocks used in this reference architecture.

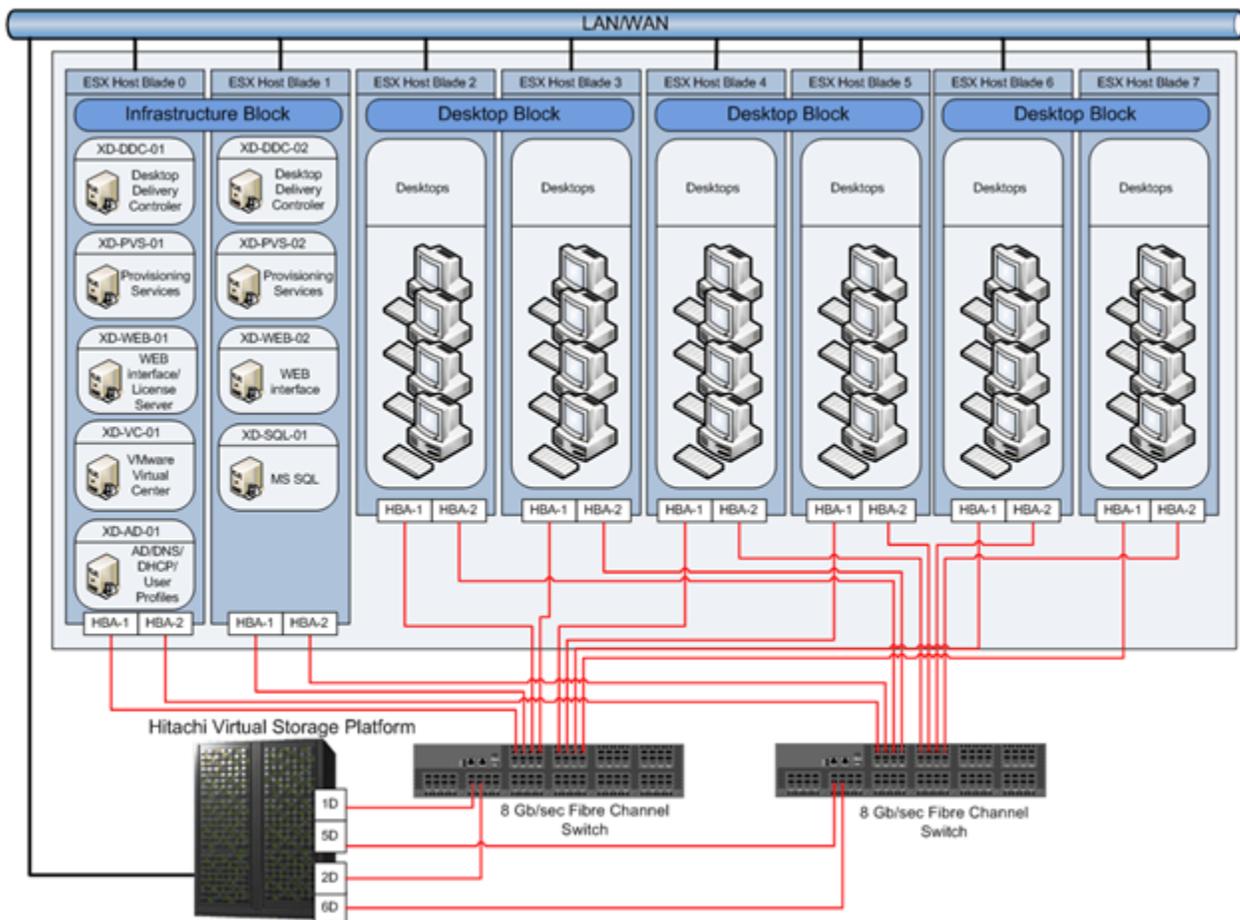


Figure 1

One of the most important factors to consider when sizing a virtual desktop infrastructure environment for performance is to define the type of end-user workload. The basis of the user workloads described in this paper is the workloads used by the [Login Consultants Login VSI load testing tool](#). Table 1 describes the three main types of workers and the expected type of applications they use.

Table 1. Workload Definition

<i>Workloads</i>	<i>User Workload</i>
Light	<ul style="list-style-type: none"> ■ Microsoft Outlook ■ Microsoft Word ■ Microsoft Internet Explorer
Medium	<ul style="list-style-type: none"> ■ Microsoft Outlook ■ Microsoft Word ■ Microsoft Excel ■ Microsoft PowerPoint ■ Microsoft Internet Explorer ■ Adobe Reader and PDF printer ■ 7-Zip
Heavy	<ul style="list-style-type: none"> ■ Microsoft Outlook ■ Microsoft Word ■ Microsoft Excel ■ Microsoft PowerPoint ■ Microsoft Internet Explorer ■ Adobe Reader and PDF printer ■ 7-Zip ■ Media Player

This reference architecture focuses on the light user workload, as described in Table 1, to build out a scalable and converged server and storage virtual desktop infrastructure solution using Hitachi components.

The following are characteristics of a light user, as defined by the Login Consultants Login VSI tool:

- **Light User Workload**—These users do the following:
 - Use Microsoft Word for editing document files
 - Use Microsoft Outlook to view and compose email messages
 - Browse simple Web sites
 - Only two applications are opened simultaneously
-

Key Solution Components

The following are descriptions of the components used in this reference architecture.

Hitachi Virtual Storage Platform

[Hitachi Virtual Storage Platform](#) is the first 3-D scaling storage platform designed for all data types. Its storage architecture flexibly adapts for performance, capacity, and multi-vendor storage. Combined with the unique Hitachi Command Suite management platform, it transforms the data center.

- **Scale Up**—Meet increasing demands by dynamically adding processors, connectivity, and capacity in a single unit. Provide the highest performance for both open and mainframe environments.
- **Scale Out**—Meet multiple demands by dynamically combining multiple units into a single logical system with shared resources. Support increased demand in virtualized server environments. Ensure safe multi-tenancy and quality of service through partitioning of cache and ports.
- **Scale Deep**—Extend storage value by virtualizing new and existing external storage systems dynamically. Extend the advanced functions of Hitachi Virtual Storage Platform to multivendor storage. Offload less demanding data to external tiers to save costs and to optimize the availability of tier-one resources.

The trend in desktop virtualization is to consolidate the I/O workload of many desktops onto a single storage system. Consolidating more virtual machines on a physical host requires storage systems to be able to dynamically add more storage resources to keep pace with the I/O demand. The 3-D scaling capability of Hitachi Virtual Storage Platform meets that requirement.

Hitachi Dynamic Provisioning

On Hitachi storage systems, [Hitachi Dynamic Provisioning](#) provides wide striping and thin provisioning functionalities.

Using Hitachi Dynamic Provisioning is like using a host-based logical volume manager (LVM), but without incurring host processing overhead. It provides one or more wide-striping pools across many RAID groups. Each pool has one or more dynamic provisioning virtual volumes (DP-VOLs) of a logical size you specify of up to 60 TB created against it without allocating any physical space initially.

Deploying Hitachi Dynamic Provisioning avoids the routine issue of hot spots that occur on logical devices (LDEVs). These occur within individual RAID groups when the host workload exceeds the IOPS or throughput capacity of that RAID group. Dynamic provisioning distributes the host workload across many RAID groups, which provides a smoothing effect that dramatically reduces hot spots.

When used with [Hitachi Virtual Storage Platform](#), Hitachi Dynamic Provisioning has the benefit of thin provisioning. Physical space assignment from the pool to the dynamic provisioning volume happens as needed using 42 MB pages, up to the logical size specified for each dynamic provisioning volume. There can be a dynamic expansion or reduction of pool capacity without disruption or downtime. You can rebalance an expanded pool across the current and newly added RAID groups for an even striping of the data and the workload.

Hitachi Dynamic Provisioning in a Citrix XenDesktop environment allows a leveling of the workload across a large number of disks. This allows sizing the disks for an average workload instead of a peak burst workload.

The advantages of using Hitachi Dynamic Provisioning in a virtual desktop infrastructure are:

- **Performance balance**—Distributes data across all disks in the pool
- **Over provisioning**—Allows over provisioning of the storage

Hitachi Compute Blade 2000

[Hitachi Compute Blade 2000](#) is an enterprise-class blade server platform. It features the following:

- Configuration flexibility
- Eco-friendly power-saving capabilities
- Fast server failure recovery using a N+1 cold standby design that allows replacing failed servers within minutes

VMware vSphere 5

[VMware vSphere 5](#) is a virtualization platform that provides a datacenter infrastructure. It features vSphere Distributed Resource Scheduler (DRS), high availability, and fault tolerance.

VMware vSphere 5 has the following components:

- **ESXi 5.0**—This is a hypervisor that loads directly on a physical server. It partitions one physical machine into many virtual machines that share hardware resources.
- **vCenter Server**—This allows management of the vSphere environment through a single user interface. With vCenter, there are features available such as vMotion, Storage vMotion, Storage Distributed Resource Scheduler, High Availability, and Fault Tolerance.

Use of the round robin multipathing policy in vSphere 5 distributes load across multiple host bus adapters (HBAs) and multiple storage ports. Use of DRS with Hitachi Dynamic Provisioning automatically distributes loads on the ESX host and across the back end of the storage system.

Citrix XenDesktop 5.5

[Citrix XenDesktop](#) is a desktop virtualization solution that transforms Windows desktops and applications into an on-demand service available to any user, anywhere, on any device. With XenDesktop, you can securely deliver individual Windows, web and SaaS applications, or full virtual desktops, to PCs, Macs, tablets, smart phones, laptops and thin clients—all with a high-definition user experience.

This reference architecture describes a proven approach to help simplify the design and planning of the most commonly used form of virtual desktops, Provisioning Services (PVS).

Solution Design

Using the key solution components, this reference architecture provides the infrastructure details and methodology for calculating the compute and storage requirements necessary to build a desktop block while sustaining ideal performance supporting a light end-user workload.

Infrastructure Block

An infrastructure block in this solution consists of two X55A2 server blades hosting the Citrix XenDesktop and VMware ESX infrastructure components dedicated to hosting administrative machines. Table 2 has the hardware configuration of the two infrastructure server blades.

Table 2. Infrastructure Block Server Blade Configuration

<i>Hardware</i>	<i>Detail Description</i>	<i>Quantity</i>
Hitachi Compute Blade 2000 X55A2 server blade	<ul style="list-style-type: none"> ■ 2 x 6-Core Intel Xeon X7670 processors ■ 64 GB Memory 	2

Table 3 has the major software components.

Table 3. Infrastructure Block Software Components

<i>Software</i>	<i>Version</i>
VMware vCenter	5
Citrix XenDesktop 5.5	5.5
Citrix Provisioning Server	5.6 SP2
VMware ESX	5
Microsoft Windows Server	2008 R2, 64-bit Enterprise
Microsoft SQL Server	2008, 64-bit Enterprise

Desktop Block

A desktop block in this solution consists of two X55A2 server blades hosting VMware ESX that are dedicated to hosting all virtual desktop machines which users access remotely. The desktop block is the basis for a building block design from which multiple desktop blocks can be added to scale out your virtual desktop infrastructure environment.

Table 4 shows the desktop block hardware configuration.

Table 4. Infrastructure Block Server Blade Configuration

<i>Hardware</i>	<i>Detail Description</i>	<i>Quantity</i>
Hitachi Compute Blade 2000 X55A2 server blade	<ul style="list-style-type: none"> ■ 2 x 6-Core Intel Xeon X7670 processors ■ 144 GB Memory 	2

Table 5 has the major software components.

Table 5. Infrastructure Block Software Components

<i>Software</i>	<i>Version</i>
VMware ESX	5
VMware Tools Agent	5
Citrix XenDesktop Agent	5.5
Citrix Provisioning Server Agent	5.6 SP2
Microsoft Windows	7, 64 bit Enterprise

Server Design

Calculate the scaling for a desktop block using the following recommendations. Use the smaller of the two results as the recommended starting number of desktops per desktop block.

Calculate Maximum Users by Hardware

The following factors play a part to determine the number of desktops your hardware can support:

- User workload
- Desktop operating system
- Applications running on the desktops
- The amount of random access memory required for each desktop

The basis of the user workload categories is the average steady state IOPS per desktop. Use the IOPS per desktop in your environment to determine your user workload profile. After determining a user workload profile, use the memory and CPU core requirements to size the number of desktops your hardware can support. This reference architecture uses a light user workload.

Table 6 describes the different workloads.

Table 6. User Workload Descriptions

<i>User Group</i>	<i>Operating System</i>	<i>vCPU Allocation</i>	<i>Memory Allocation per User</i>	<i>Average Steady State IOPS*</i>	<i>Estimated Users/Core</i>
Light	Windows XP	1	768 MB to 1 GB	3-5	10 to 12
	Windows 7	1	1 GB to 1.5 GB	4-6	8 to 10
Medium	Windows XP	1	1 GB to 1.5 GB	6-10	8 to 10
	Windows 7	1	1.5 GB to 2 GB	8-12	6 to 8
Heavy	Windows XP	1	2 GB	20-40	4 to 6
	Windows 7	2	4 GB	25-50	2 to 4

*The IOPS estimates are an average of when the user is logged on to the virtual desktop and working. It is not a peak average, which takes into account start-ups, user log ons, and user log offs.

Use the guidelines in Table 6 with the following two formulas to estimate the scalability of a particular physical server.

- **Memory Perspective**

$$\text{NumberofUsers} = \frac{\text{ServerRAM} - \text{HypervisorOverheadRAM}}{(\text{AverageMemoryAllocation})/(\text{User})}$$

- **Core Perspective**

$$\text{NumberofUsers} = (\text{NumberofCores} - 1\text{core}) \times \left(\frac{\text{AverageUsers}}{\text{Core}} \right)$$

The smaller result from the two formulas is the *recommended* number of desktops your hardware can support.

Note—Each hypervisor has memory and CPU overhead, as shown in both equations. On the average, the hypervisor needs 6 GB to 8 GB of RAM. Subtract one core from the number of available cores to account for the CPU overhead.

For this example, the following are the calculations used to determine the number of users:

- All users are light users on Microsoft Windows 7
- The server configuration has 144 GB of RAM with 12 cores

The values used from Table 6 are the following:

- 1 GB of RAM per user
- Average of 8 users per core

The number of users from a memory perspective is 138 users.

$$138\text{Users} = \frac{144\text{GB} - 6\text{GB}}{(1\text{GB})/(\text{User})}$$

The number of users from a core perspective is 88 users.

$$88\text{Users} = (12\text{cores} - 1\text{core}) \times \left(\frac{\text{AverageUsers}}{\text{Core}} \right)$$

Using these calculations, the limitation on this environment is 88 users, based on limitations of the core.

The actual number of desktops your environment supports varies depending on the actual user workload.

Storage Design

This reference architecture uses Hitachi Dynamic Provisioning on Hitachi Virtual Storage Platform. This simplifies the management of the storage through the use of wide striping and on-line expansion of dynamic provisioning pools.

The storage used by the desktop block comprises a single dynamic provisioning pool. The basis of the sizing of the pool is assumptions made about the disks used and virtual desktop infrastructure environments.

- **Disk**
 - Disk speed
 - RAID level
 - Required IOPS
- **Virtual desktop infrastructure**
 - Estimated IOPS for light user workloads

Industry-standard numbers were used to calculate the number of IOPS required supporting 160 desktops.

- **User type**—Light workload user
- **Estimated IOPS per desktop**—4 IOPS
- **Estimated IOPS for 160 desktops**—640 IOPS

From a capacity standpoint, the validated environment configures each desktop with a 5 GB drive to be used for the write cache and page file. In addition to the cache drive, each desktop utilizes about 1 GB of storage for virtual machine files.

The following information was used to calculate the estimated storage capacity needed for 160 desktops.

- **Desktop cache drive**—5 GB
- **Hypervisor machine files**—1 GB
- **Total storage per desktop**—6 GB
- **Estimated storage capacity for 160 desktops**—960 GB

Use these values in calculations for the number of spindles and storage capacity needed to support the number of desktops in your environment. The following general formula is a starting point to calculate the total raw IOPS for a desktop building block.

$$TotalRawIOPS = \left(\frac{DiskSpeedIOPS}{Drive} \right) \times (NumberOfDiskDrives)$$

Based on 150 IOPS per drive and two RAID-10 (2D+2D) groups consisting of eight disks, the total raw IOPS the disks can sustain in the validated solution comes out to 1200 IOPS per building block.

$$TotalRawIOPS = \left(\frac{150IOPS}{Drive} \right) \times (8Drives)$$

$$TotalRawIOPS = 1200IOPS$$

Using these formulas, there are two RAID-10 (2D+2D) groups needed to meet the requirements of 640 sustained IOPS per desktop block. This also meets the storage capacity requirements of 960 GB per desktop block.

You can add more disks to increase the total raw IOPS for heavier desktop workload environments. Table 7 shows the storage configuration for the validated environment.

Table 7. Storage Configuration for Desktop Blocks

<i>Pool Name (ID)</i>	<i>RAID Group Configuration</i>	<i>Drive Type</i>	<i>Number of RAID Groups</i>	<i>Pool Capacity (TB)</i>	<i>DP-VOL Capacity (TB)</i>
HDP-XD-001	RAID-10 (2D+2D)	8 × 300 GB 10k RPM SAS	2	1.04 TB	1 TB
HDP-XD-002	RAID-10 (2D+2D)	8 × 300 GB 10k RPM SAS	2	1.04 TB	1 TB
HDP-XD-003	RAID-10 (2D+2D)	8 × 300 GB 10k RPM SAS	2	1.04 TB	1 TB

The storage for the infrastructure block consists of two RAID-5 (3D+1P) groups that are presented to the two servers in the infrastructure block. This hosts all of the infrastructure virtual machines during the testing. Table 8 shows the storage for the infrastructure block used during testing.

Table 8. Storage Configuration for Infrastructure Block

<i>Pool Name (ID)</i>	<i>RAID Group Configuration</i>	<i>Drive Type</i>	<i>Number of RAID Groups</i>	<i>Pool Capacity (TB)</i>	<i>DP-VOL Capacity (TB)</i>
HDP-INF-001	RAID-5 (3D+1P)	8 × 300 GB 10k RPM SAS	2	1.56 TB	1.56 TB

While the infrastructure servers and storage are components of the overall solution, the focus of this reference architecture is on the server and storage requirements for building the desktop block. The provided infrastructure block information is for a reference point in configuring your environment.

This reference architecture uses dynamic provisioning volumes of 1 TB without oversubscription for the desktop blocks.

If you plan to oversubscribe your storage, monitor your disk usage regularly so you can take action to prevent your storage from filling up. This can prevent users from accessing their desktops.

This environment provisions three 1 TB VMFS LUNs, one for each desktop block. Each LUN is capable of hosting 160 light user workload desktops.

Figure 2 shows the configuration for the dynamic provisioning pools used by the desktop block in the environment.

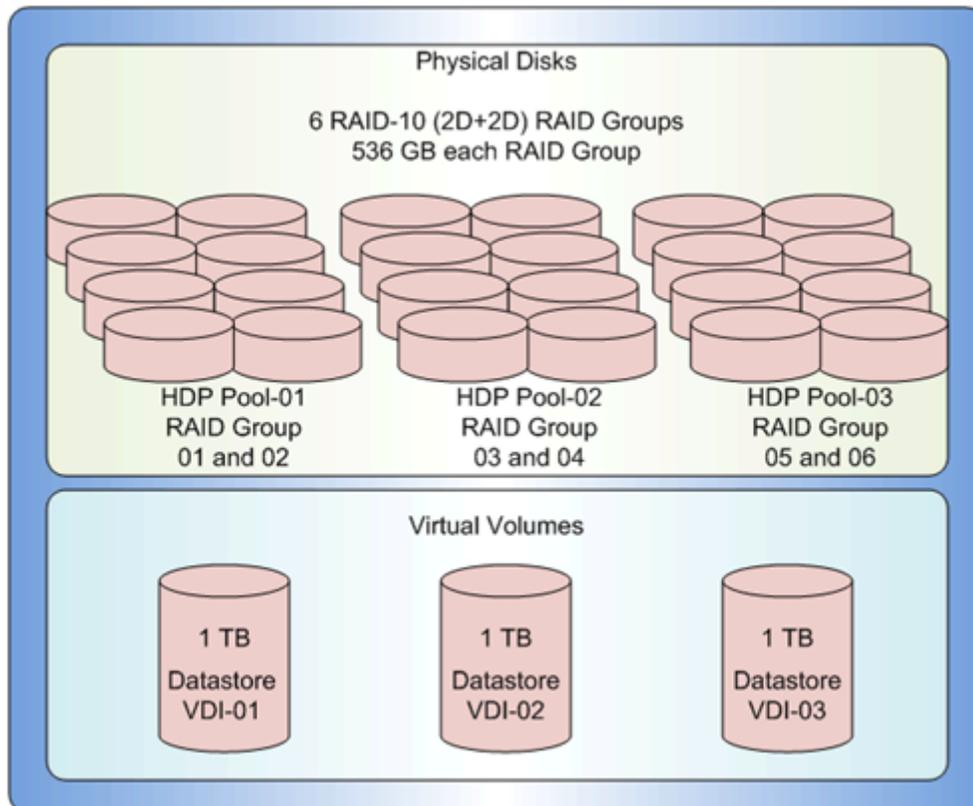


Figure 2

SAN Design

Hitachi Virtual Storage Platform and Hitachi Compute Blade 2000 connect to the SAN through two Brocade 5400 switches in this architecture.

Each of the two server blades in the infrastructure block and each of the six server blades in the desktop block have two Fibre Channel connections with a connection to each Brocade switch. This provides redundancy and load balancing. VMware native multipathing round-robin balances the I/O across both connections.

Hitachi Virtual Storage Platform has four Fibre Channel connections used, with two connections to each Brocade switch.

Figure 3 shows the SAN connectivity.

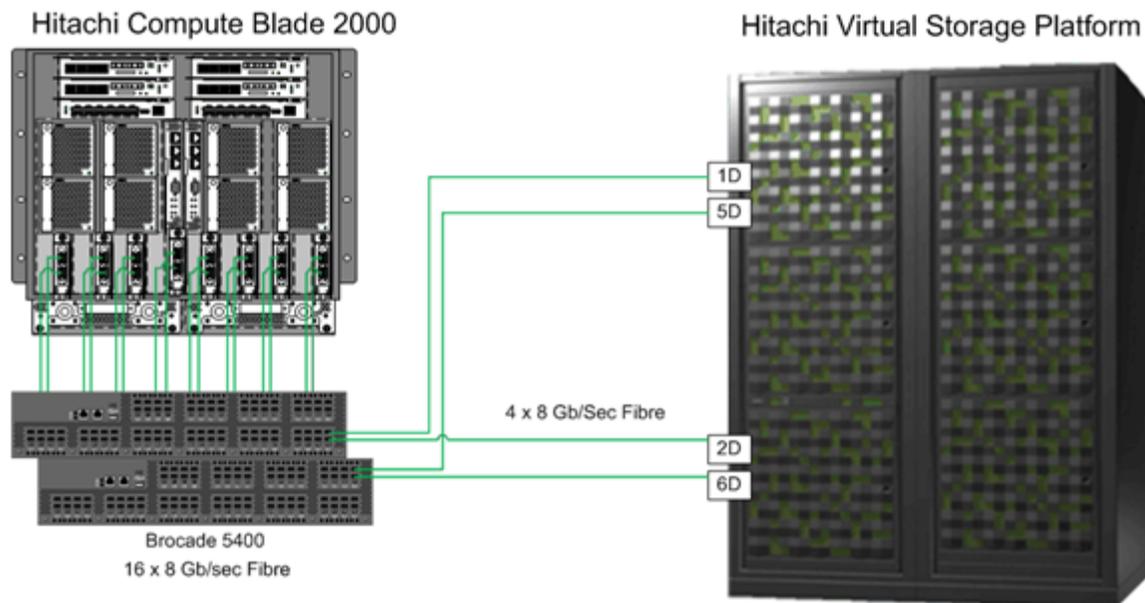


Figure 3

Citrix XenDesktop Design

Table 9 shows the configuration of each virtual machine that was installed on the VMware vSphere infrastructure block consisting of two Hitachi Compute Blade 2000 server blades.

Table 9. Infrastructure Servers

<i>Virtual Machine</i>	<i>Configuration</i>	<i>Count</i>	<i>Infrastructure Blade</i>
Microsoft Active Directory <ul style="list-style-type: none"> ▪ DNS ▪ DHCP 	<ul style="list-style-type: none"> ▪ vCPU—1 ▪ vMemory—8 GB 	1	1
VMware vCenter	<ul style="list-style-type: none"> ▪ vCPU—2 ▪ vMemory—8 GB 	1	2
Microsoft SQL Server 2008 database for VMware vCenter and Citrix XenDesktop	<ul style="list-style-type: none"> ▪ vCPU—2 ▪ vMemory—4 GB 	1	1
XenDesktop delivery controllers	<ul style="list-style-type: none"> ▪ vCPU—4 ▪ vMemory—8 GB 	2	1 and 2
XenDesktop provisioning servers	<ul style="list-style-type: none"> ▪ vCPU—4 ▪ vMemory—8 GB 	2	1 and 2
XenDesktop web interface servers	<ul style="list-style-type: none"> ▪ vCPU—2 ▪ vMemory—4 GB 	2	1 and 2

A master image template for the virtual desktop is a single virtual machine configured as follows:

- One vCPU
- 1 GB of RAM
- A local 5 GB write cache drive running Microsoft Windows 7 Enterprise

All three building blocks use a single pool of non-persistent steamed desktops. The pool is based on this master image template.

This reference architecture uses Citrix Provisioning Services to stream desktops. Using Citrix Provisioning Services reduces the storage footprint of the virtual desktops.

Scalability

This reference architecture defines a 160-user desktop block for a light workload with the following:

- **Desktop Block**—Two Hitachi Compute Blade 2000 X55A2 server blades, each with the following per blade:
 - 2 × 6-Core Intel Xeon processors
 - 144 GB memory
- **Storage Block**—A single dynamic provisioning pool consisting of the following:
 - 8 × 300 GB 10k RPM SAS drives
 - 2 × RAID-10 (2D+2D) groups
- **Virtual Desktops**—Consists of the following:
 - 1 vCPU
 - 1 GB RAM
 - 5 GB local cache drive

To scale out the environment, add two additional desktop blocks plus a storage block at a time. Use the configurations defined in “Infrastructure Block” on page 8, “Storage Design” on page 12, and “Storage Design” on page 12.

Figure 4 shows scaling out the environment by adding additional desktop blocks.

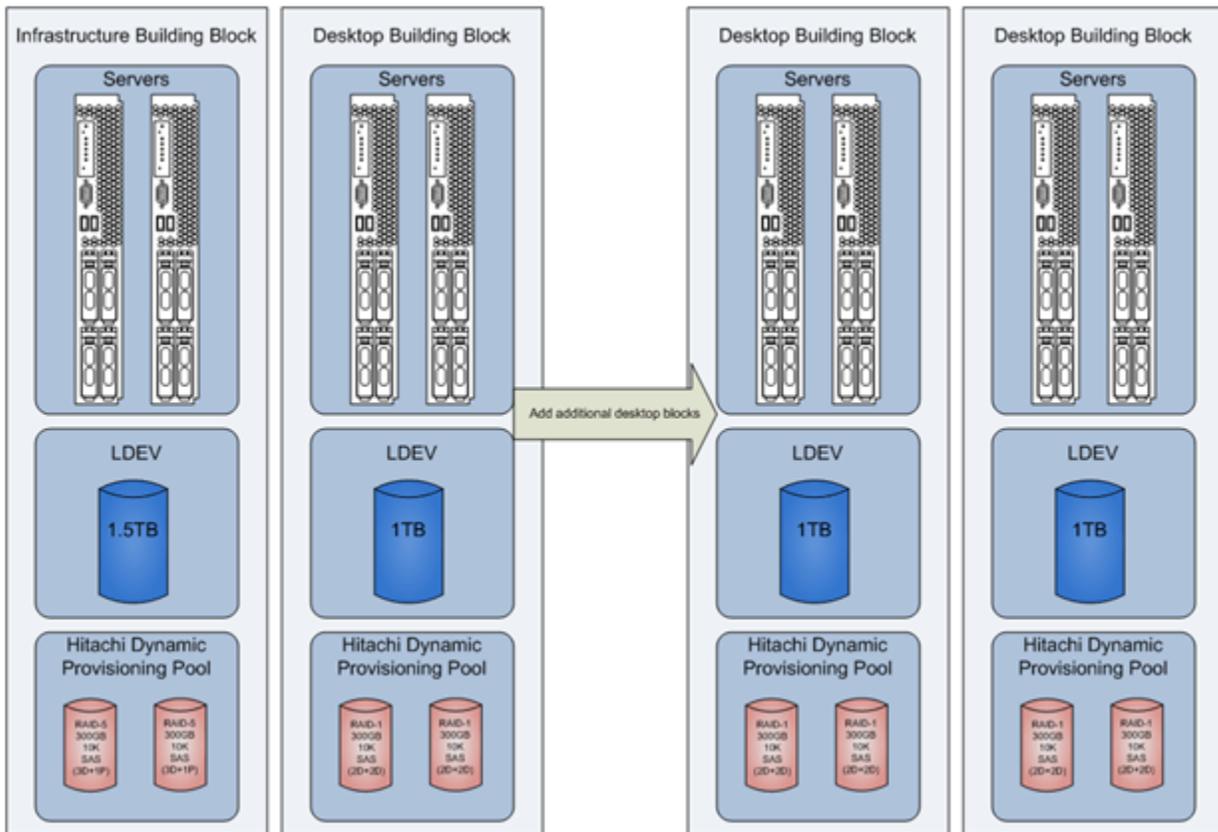


Figure 4

Engineering Validation

Complete information on validating the environment is in *Citrix XenDesktop 5.5 on VMware 5 with Hitachi Virtual Storage Platform Lab Validation Report*.

The scenarios used to validate this reference architecture included the following:

- Boot storm of all desktops
- Logon storm of all desktops
- User workload testing using Login VSI

Validation involved testing one infrastructure block with one desktop block running 160 users with a light workload. Then, to validate the scalability, the environment was then scaled out to two desktop blocks and to three desktop blocks.

Because the performance test results scaled linearly when testing additional desktop blocks, only the results from the single desktop block test are shown in this technical paper.

For the single desktop block and storage configuration used in this solution, with two groups configured as RAID-10 (2D+2D), the target for average total IOPS is below 600 IOPS for all tests.

Target CPU utilization for each test was as follows:

- **Boot Storm**—Peak utilization below 70%
- **Logon Storm**—Peak utilization below 55%
- **Steady State**—Average utilization below 90%

Table 10 shows an overview of the test results performed during solution validation.

Table 10. Test Results Overview

<i>Test Case</i>	<i>Average IOPS</i>	<i>CPU utilization</i>
Boot Storm	521	68% peak utilization
Login Storm	494	50% peak utilization
Steady State	530	65% average utilization

Tests results show that the architecture described in this document can run up to 160 Microsoft Windows 7 virtual desktops with 1 GB of RAM per server block without sacrificing performance and user experience.

None of the Citrix XenDesktop components showed significant resource utilization during any of the tests conducted. As more desktop blocks were added to the environment, the application response times remained relatively constant across all three test criteria.

Conclusion

This reference architecture supports up to 160 users with a light workload per desktop block.

Using the building block design consisting of desktop and storage blocks in this reference architecture can help you design a virtual desktop infrastructure environment.

When sizing out a virtual desktop infrastructure environment, characterize the user workload before migrating to a Citrix XenDesktop environment.

This document provides proven methods to assist you in sizing and testing your virtual desktop infrastructure environment. The conditions in your production environment can vary greatly from the lab environment at Hitachi Data Systems, and may not apply to your situation. A full desktop capacity planning assessment provides more precise sizing requirements for your environment.

For More Information

Hitachi Data Systems Global Services offers experienced storage consultants, proven methodologies and a comprehensive services portfolio to assist you in implementing Hitachi products and solutions in your environment. For more information, see the Hitachi Data Systems [Global Services](#) website.

Live and recorded product demonstrations are available for many Hitachi products. To schedule a live demonstration, contact a sales representative. To view a recorded demonstration, see the Hitachi Data Systems Corporate [Resources](#) website. Click the **Product Demos** tab for a list of available recorded demonstrations.

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