

# Quest vWorkspace Integration and Scalability with Microsoft Hyper-V and System Center Virtual Machine Manager

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A study of scalability and functional integration at high loads  
performed at Microsoft's Enterprise Engineering Center, June 2010

Written by  
Quest Software, Inc.

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# Introduction

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## About the Study

The goal of this study is to validate the scalability of a virtual desktop infrastructure built on Quest vWorkspace and Microsoft Hyper-V, integrating with Microsoft System Center Virtual Machine Manager to automate management and provisioning of Windows 7 virtual desktops. The tests and simulations focused on how the end-to-end solution scales under high load. In June 2010, Quest completed this study at the Enterprise Engineering Center, Microsoft's premier customer-facing product validation facility.

This report focuses on scalability and integration of the system components. Further studies to be performed in Q4 2010 will focus on performance optimization and even larger farm sizes.

## About Quest vWorkspace

Quest vWorkspace manages, secures and provisions virtual desktop environments as well as brokers connections. It delivers virtual applications and desktops from multiple hypervisors, Remote Desktop Session Hosts (Terminal Servers) and blade PCs through a single user access point and management center, while increasing user adoption with an optimal user experience. For more information, see <http://www.quest.com/vworkspace/>.

# Summary of Results

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This study yielded the following key results and conclusions:

- Each Quest vWorkspace connection broker can comfortably handle incoming connections and heartbeats for 1,024 virtual desktops, with capacity available to scale to 2,000. Extra connection brokers can be added instantly because load balancing between brokers is automatic. Therefore, Quest vWorkspace farms can expand to 25,000 desktops and more.
- Quest vWorkspace directly integrates with SCVMM to manage and automate the creation, deletion and management of Windows 7 virtual desktops on Hyper-V, using differencing disks to save disk space and accelerate creation of virtual disk images.
- The highest loads on the SCVMM server occurred during creation of VMs. The SCVMM server was heavily loaded when creating and preparing 1,024 virtual desktops over a two-hour period across 16 Hyper-V hosts.
- Power operations (startup and shutdown of virtual desktops) placed the highest load on the storage system, with disk performance (IOPS) levels at least 10 times the level seen during typical knowledge worker activity. IOPS is the biggest performance limiter in VDI management operations.
- A full build and sysprep of 1,024 virtual Windows 7 desktops across 16 hosts took over two hours when limited to no more than 10 in progress at a time on each host server. A full boot of 1,024 virtual Windows 7 desktops took just over 20 minutes when limited to no more than 10 in progress at a time. Therefore, both operations should be scheduled to ensure desktops are available when users need them.
- The use of differencing disks on drive arrays on each host server is a viable option for VDI, with up to 64 virtual desktops on each host possible using differencing disks from one master image.

# Test Details

## Test Infrastructure

The diagram below shows the relationship between the key infrastructure pieces used in the test. A group of client computers initiates 1,024 remote desktop sessions to Windows 7 VMs hosted on 16 Hyper-V host servers, through the Quest vWorkspace connection brokers. vWorkspace is also used to create, delete, start and stop all Windows 7 VMs, working through System Center Virtual Machine Manager. Each Hyper-V server contains eight hard disk drives, six of which are dedicated to storage of virtual disk images for the Windows 7 VMs in a RAID 0+1 configuration. All VMs use “child” differencing disk images linked to a master parent image stored on each host.

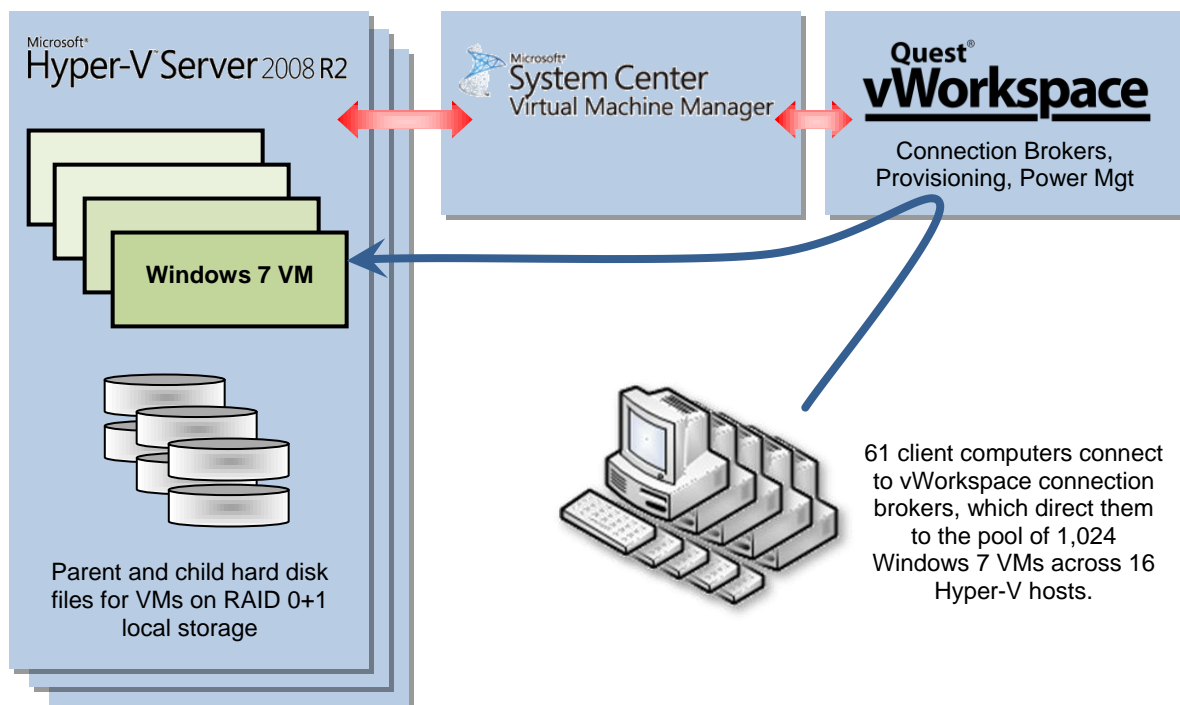


Figure 1. Key infrastructure components used in the test

## Test Operations

Automated power, logon/logoff and VM provisioning operations were used to validate Quest vWorkspace’s ability to integrate and scale in large VDI deployments using Microsoft’s virtualization solutions, System Center Virtual Machine Manager and Hyper-V. The tests discussed in this paper revolved around a “building block” containing one SCVMM server, 16 Hyper-V hosts, and 64 Windows 7 virtual desktops on each Hyper-V host, for a total of 1024 virtual desktops. Multiple building blocks can be joined to a vWorkspace farm for massive scalability from a single console.

In order to simulate user loads, 61 Windows 7 client computers each launched multiple connections to virtual desktops, and scripted tests performed simulated user actions at specified intervals.

# Lab Configuration

The basic configuration of the Microsoft and Quest vWorkspace test laboratory configuration is shown below, with the primary network traffic flows indicated.

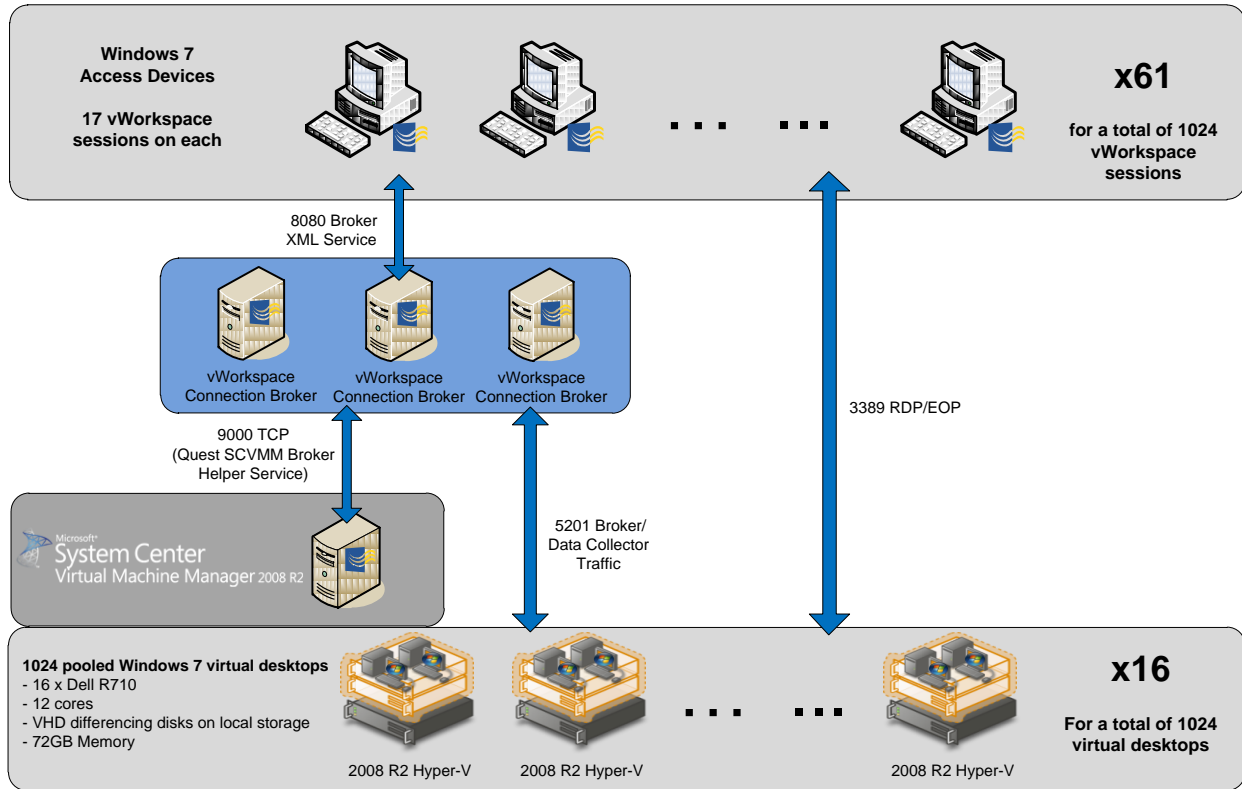


Figure 2. Test lab configuration

For complete specifications of the hardware and software used in the configuration, see Appendix A.

# Tests and Results

## Test 1: Quest vWorkspace Broker Scalability

The highest-stress scenario for the connection broker is a logon storm. In this test, connections and logons to 1,024 Windows 7 virtual desktops were initiated through one, then two, and then three load-balanced Quest vWorkspace connection brokers. Automated scripts initiated a new logon on each of the 61 Windows clients every 12 seconds until all 1,024 sessions were connected over four minutes. In other words, the brokers were hit with 61 new logons in each 12 second period until 1,024 users were connected.

CPU load samples from the servers running the connection brokers were taken every 15 seconds. Other metrics were gathered but no other resource on the server was significantly loaded so only % CPU Time (Total) is shown in the charts below. Note that there is no extra configuration required to add more connection brokers to the vWorkspace farm; the vWorkspace connector software on each client automatically load balances between all available connection brokers, providing scalability and fault tolerance.

The results shown below speak for themselves: a single broker easily handled the logon storm with capacity to spare. With slightly reduced logon frequency, one broker could easily handle 2,000 desktops or more. The charts with two and three brokers show how load balancing increases scalability by sharing the load across multiple servers.

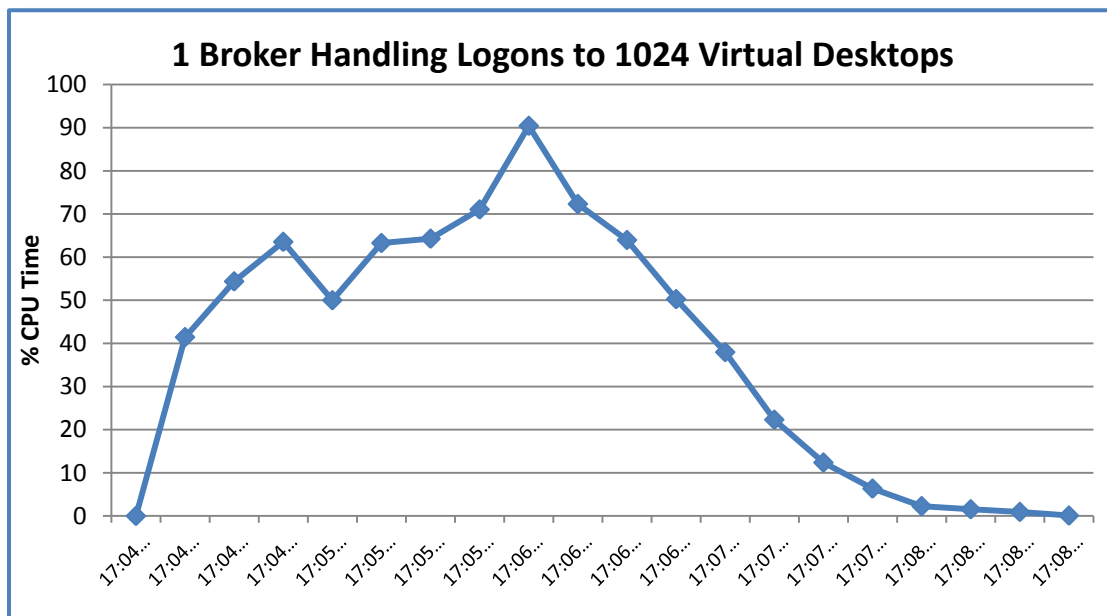


Figure 3. Percent CPU used with one broker handling a logon storm

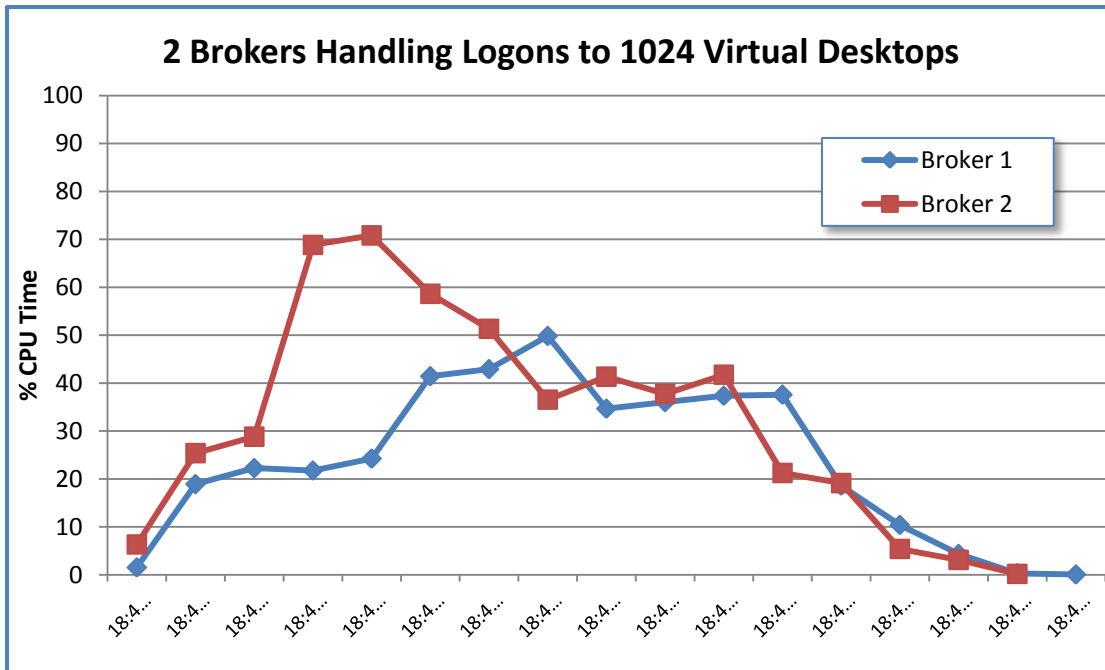


Figure 4. Percent CPU used with two brokers handling a logon storm

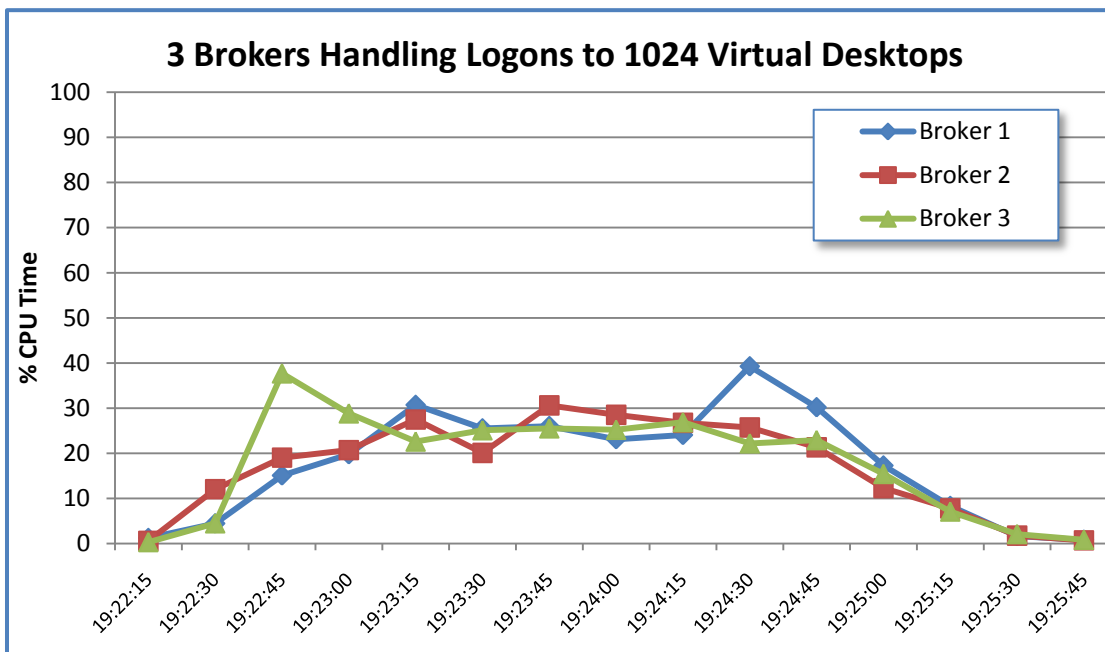


Figure 5. Percent CPU used with three brokers handling a logon storm

## Test 2: SCVMM Scalability

All tests in this paper used a single SCVMM server for all 1,024 virtual desktop VMs spread across 16 Hyper-V hosts, with 64 VMs on each. The tests which generated the highest load on the SCVMM server were those associated with provisioning operations—specifically, the creation and deletion of VMs.

Figure 6 shows the CPU load, sampled at 15-second intervals, for a test that booted 1,024 Windows 7 VMs on 16 Hyper-V host servers over about 20 minutes. The results show that the SCVMM server coped with some capacity to spare, with average CPU use around 60%.

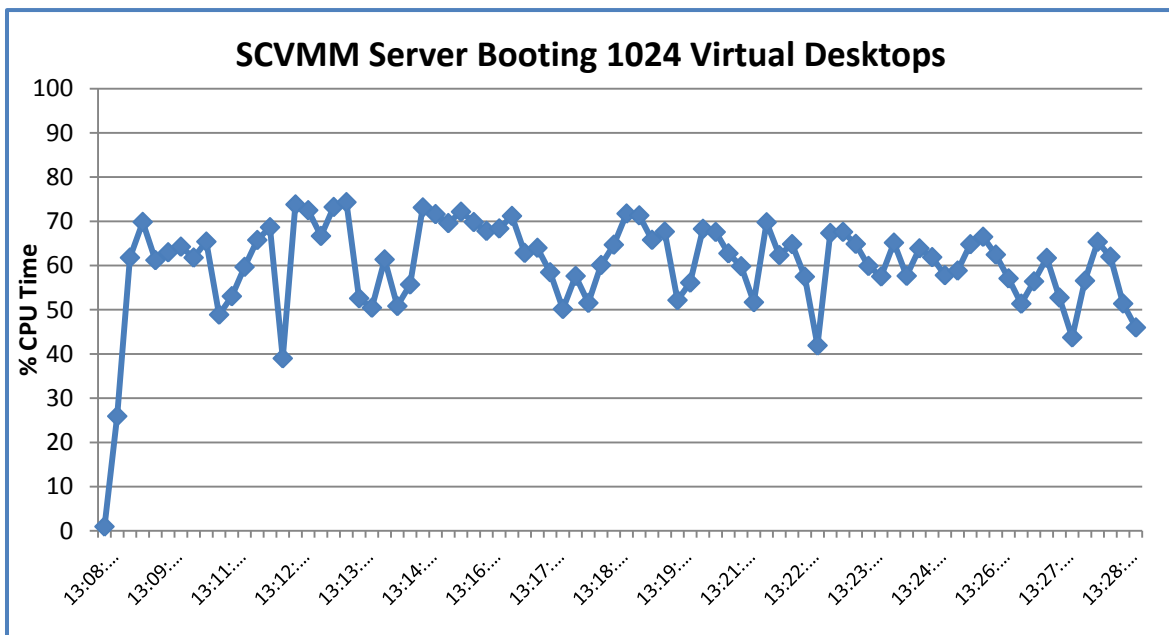


Figure 6. CPU load on an SCVMM server booting 1024 VMs

Figure 7 shows the CPU load, sampled at 15-second intervals, for a test that created and sysprep'd 1,024 Windows 7 VMs on 16 Hyper-V host servers in batches of 10 concurrent operations on each host over the course of about 2.5 hours. This test placed a higher load on the SCVMM server, primarily on CPU resources.

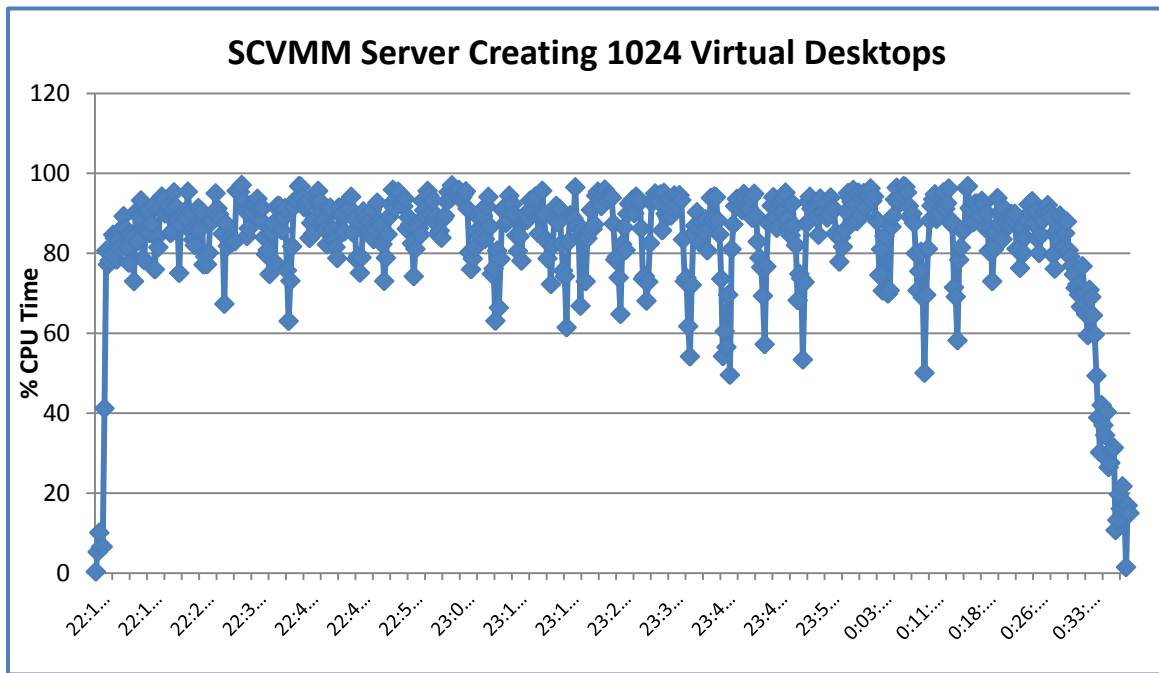


Figure 7. CPU load on an SCVMM server creating 1024 VMs

The results show that the SCVMM server managed all its tasks, but that average CPU load was over 80%. This suggests that the “building block” of a set of Hyper-V host servers and 1 SCVMM server should not host significantly more than 1,000 virtual desktops with the hardware configuration used.

## Test 3: Local Storage

The tests in this section all used Hyper-V differencing disks to reduce the time and storage required to provision the 64 VMs on each host. The master image was manually copied to each host, and then all 64 VMs were created and configured to boot from a differencing disk linked to the parent image. A side benefit of differencing disks is that they can increase read performance since the most frequently used parts of the parent image get cached in the disk controller and shared by all 64 guest VMs.

### Disk Resource Consumption during Knowledge Worker Simulation

The biggest consumption of disk resources (IOPS) occurs during power operations—the startup and shutdown of multiple VMs. In “steady state use” and during logons on VMs that have already been powered up for some time, IO load is comparatively light. In our environment we ran the “Knowledge Worker” simulation test described in the Microsoft white paper “[Remote Desktop Virtualization Host Capacity Planning in Windows Server 2008 R2.](#)” Figure 8 below shows that in the steady state, 64 Windows 7 VMs performing simulated knowledge worker actions generated around 125 IOPS. In the Microsoft paper with a different storage configuration they saw around 170 IOPS.

This compares favorably with [third-party guidelines](#), which suggest 5-10 IOPS per desktop once booted.

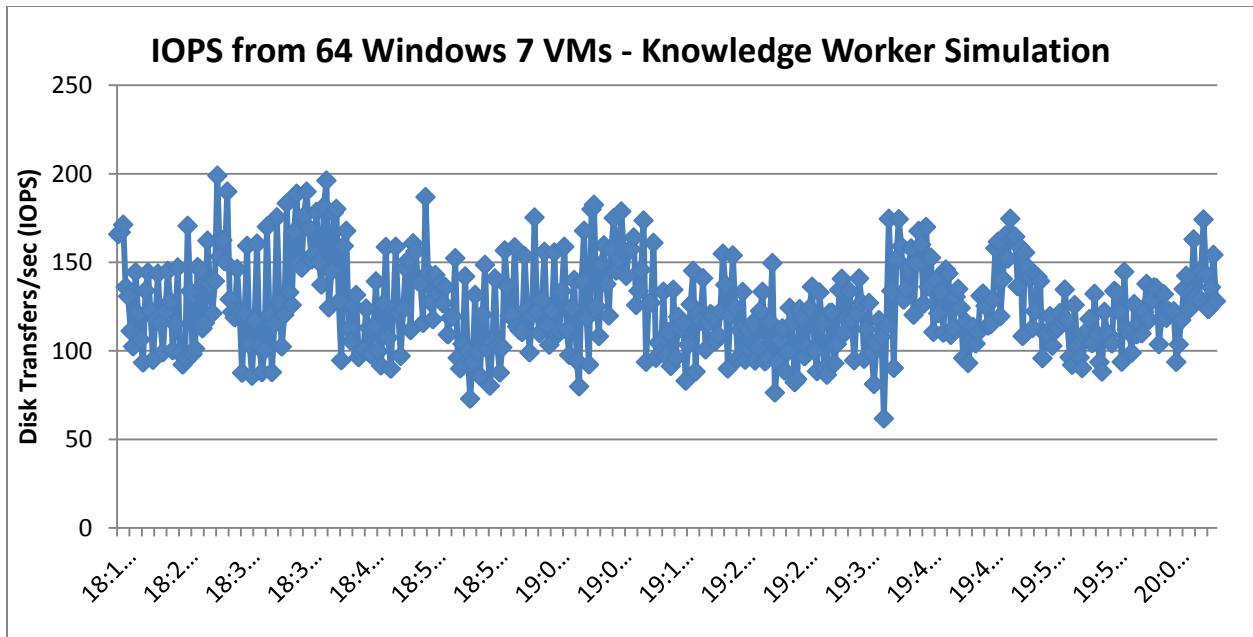


Figure 8. Consumption of disk resources (IOPS) during knowledge worker simulation

### Disk Resource Consumption during a “Boot Storm”

During power operations, the IO demands on storage are much higher, as shown in Figure 9, which shows performance during a “boot storm”.

The local storage array had six disks in a RAID 1+0 configuration: two mirrored banks of three striped disks. For optimum performance, it is recommended that the total queue length not exceed two per spindle; that is, the disk queue length should be 12 or less, indicated by the green dashed line on the chart. The startup of the 64 virtual desktops was staged by the vWorkspace broker so that a maximum of 10 VMs were between power-on and availability of the RDP Listener at any time. As soon as the RDP Listener on one became available, the next in line would be powered on, and so on until all 64 were up.

There is a clear point when the IO demands overwhelm the local storage system: the disk queue length increases and IOPS plateau at 1600 per second. This plateau was typically reached when booting desktops in the range of 40-50 (out of 64). (Quest will be revisiting the Microsoft Enterprise Engineering Center in Q4 2010 to optimize the Windows 7 images and investigate this limit further.) Therefore, to avoid overloading the disk system and hurting the user experience, power operations should be scheduled outside of work hours or staged over longer time periods.

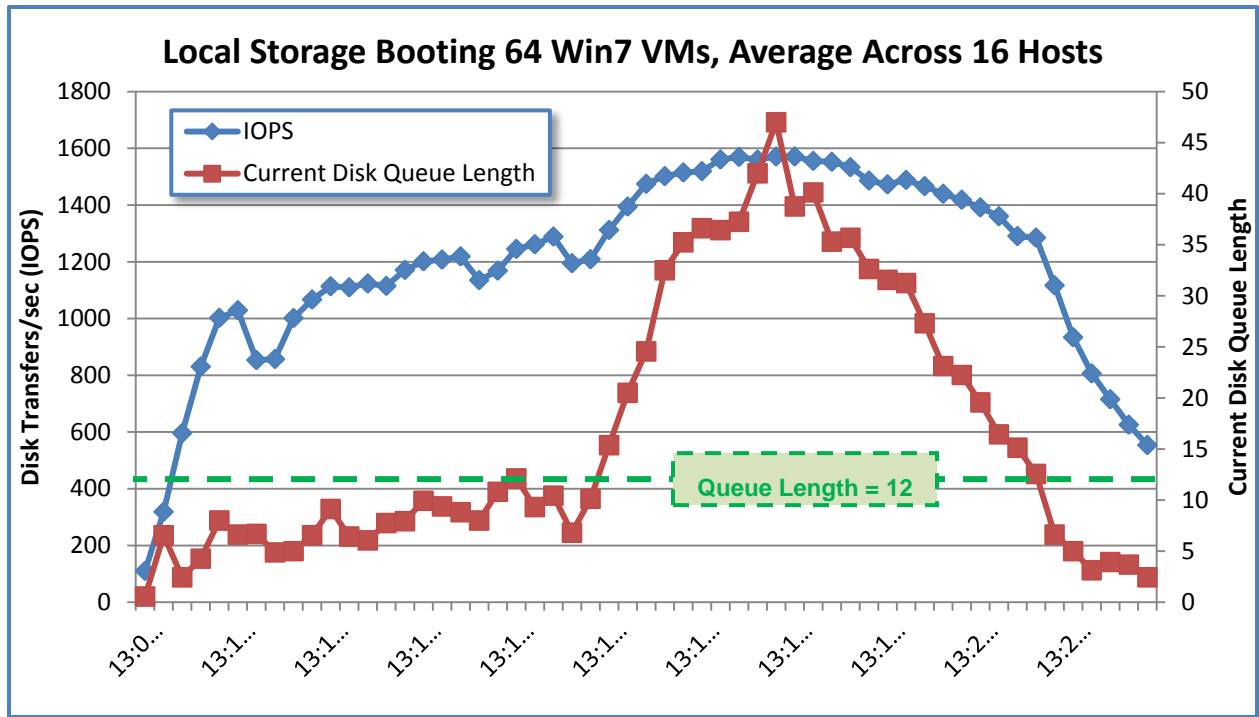


Figure 9. Consumption of disk resources (IOPS) during a “boot storm”

A large part of this disk IO during boot is caused by the need to create the page file and then swap physical memory onto disk as services, drivers and other Windows components are loaded into memory. Each Windows 7 VM had 1GB of RAM available, but the total virtual memory requirements are considerably higher and so disk IO becomes the limiting factor in scalability and performance for VDI. This is one area where Session Host (a.k.a. Terminal Server) performance characteristics are very different, where CPU and physical memory are the limitations on scalability.

## CPU Load during the Tests

Throughout the power, logon/logoff and create/delete tests, CPU load on the Hyper-V was never a constraint. Figure 10 shows the average CPU load on all 16 Hyper-V hosts during the boot of 64 virtual desktops on each one.

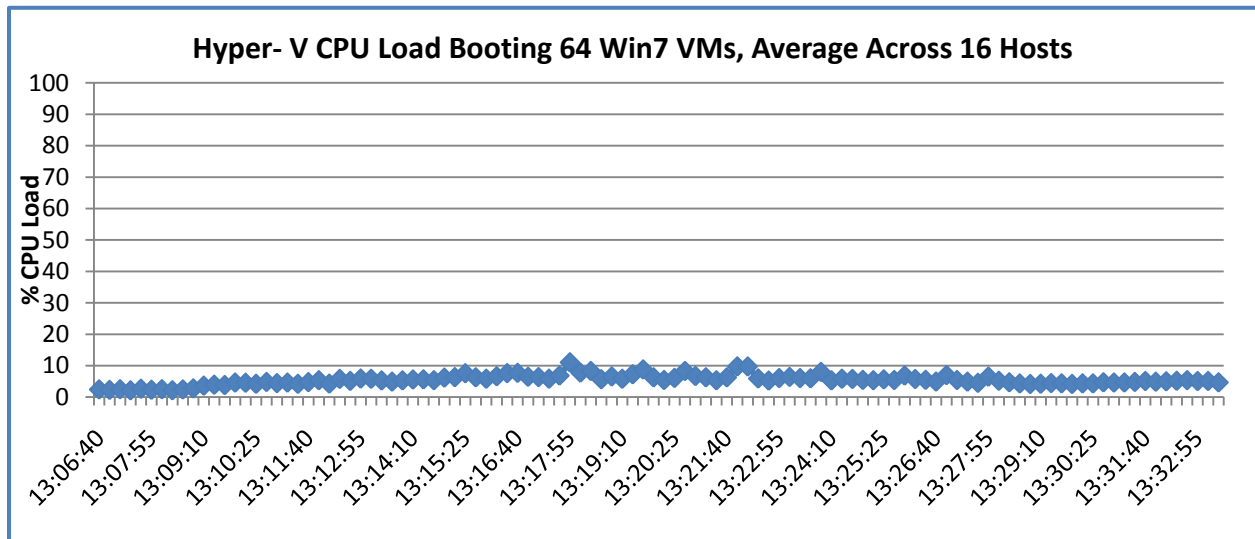


Figure 10. CPU load during boot tests

High IO activity was also seen during creation operations, but not in the same prolonged manner as during the boot storm. Nonetheless, creation of 64 VMs overloaded the storage system on occasion, with queue lengths peaking over 30. Therefore, provisioning of VMs should also be scheduled or done in small batches to avoid disruption to other users on the same host.

One final consideration is the ratio of disk read to disk write operations in each test. During the boot test, 86% of IO operations were reads, whereas during the provisioning test, only 48% were read operations. SSD storage systems are particularly quick at read operations, suggesting that they will deliver a massive increase in boot performance compared to rotational disks.

# Appendix A: Test Hardware Details

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## Servers

The following servers were used in the EEC lab for the test:

### Hyper-V hosts – 16 x Dell PowerEdge R710

- OS – Windows 2008R2 Hyper-V server
- Memory – 72 GB
- CPU – 2 x Intel Xeon 5670 (6 cores @ 2.93GHz)
- Storage – 2 x 300GB RAID 0 (OS partition) + 6 x 300 GB RAID 10 (Data partition)

### Domain controllers –2 x Dell PowerEdge 2970

- OS – Windows Server 2008R2 Enterprise
- Memory – 32 GB
- CPU – 2 x AMD Opteron 2222 SE (2 cores @ 3.00 GHz)
- Storage – 2 x 146GB RAID 0 (OS partition)

### SQL cluster – 2 x Dell PowerEdge 6950

- OS – Windows Server 2008R2 Enterprise
- SQL – SQL Server 2008
- Memory – 64 GB
- CPU – 4 x AMD Opteron 8222 SE (2 cores @ 3.00GHz)
- Storage – 2 x 146GB RAID 0 (OS partition) + 500GB shared LUN

### Infrastructure cluster- 2 x Dell PowerEdge 6950 (hosting 3 x vWorkspace 7.1 Connection Brokers)

- OS – Windows Server 2008R2 Enterprise
- Memory – 64 GB
- CPU – 2 x Intel Xeon 5670 (6 cores @ 2.93GHz)
- Storage – 2 x 146GB RAID 0 (OS partition) + 2 x 250GB CSV

### SCVMM – 1 x Dell PowerEdge2970

- OS – Windows Server 2008R2 Enterprise
- SCVMM – System Center Virtual Machine Manager 2008 R2
- Memory – 32 GB
- CPU – 2 x AMD Opteron 2222 SE (2 cores @ 3.00 GHz)
- Storage – 2 x 146GB RAID 0 (OS partition) + 6 x 146GB RAID 5 (VMM data partition)

### Test automation – 10 x Dell PowerEdge SC 1435 (hosting 6 x Windows 7 clients per server)

- OS – Windows Server 2008R2 Enterprise
- Memory – 8 GB
- CPU – 2 x Opteron 2218 (2 cores @ 2.6 GHz)
- Storage – 2 x 146GB RAID 0 (OS partition)

# Software Resources

The following software was used in the test lab:

- Microsoft Windows 2008 R2
- Microsoft Windows 2008 R2 Hyper-V
- Microsoft Windows 7 Enterprise
- Microsoft System Center Virtual Machine Manager 2008 R2
- Microsoft SQL Server 2008
- Quest Software vWorkspace 7.1

# Network Infrastructure

The following figure illustrates the network infrastructure used in the test lab:

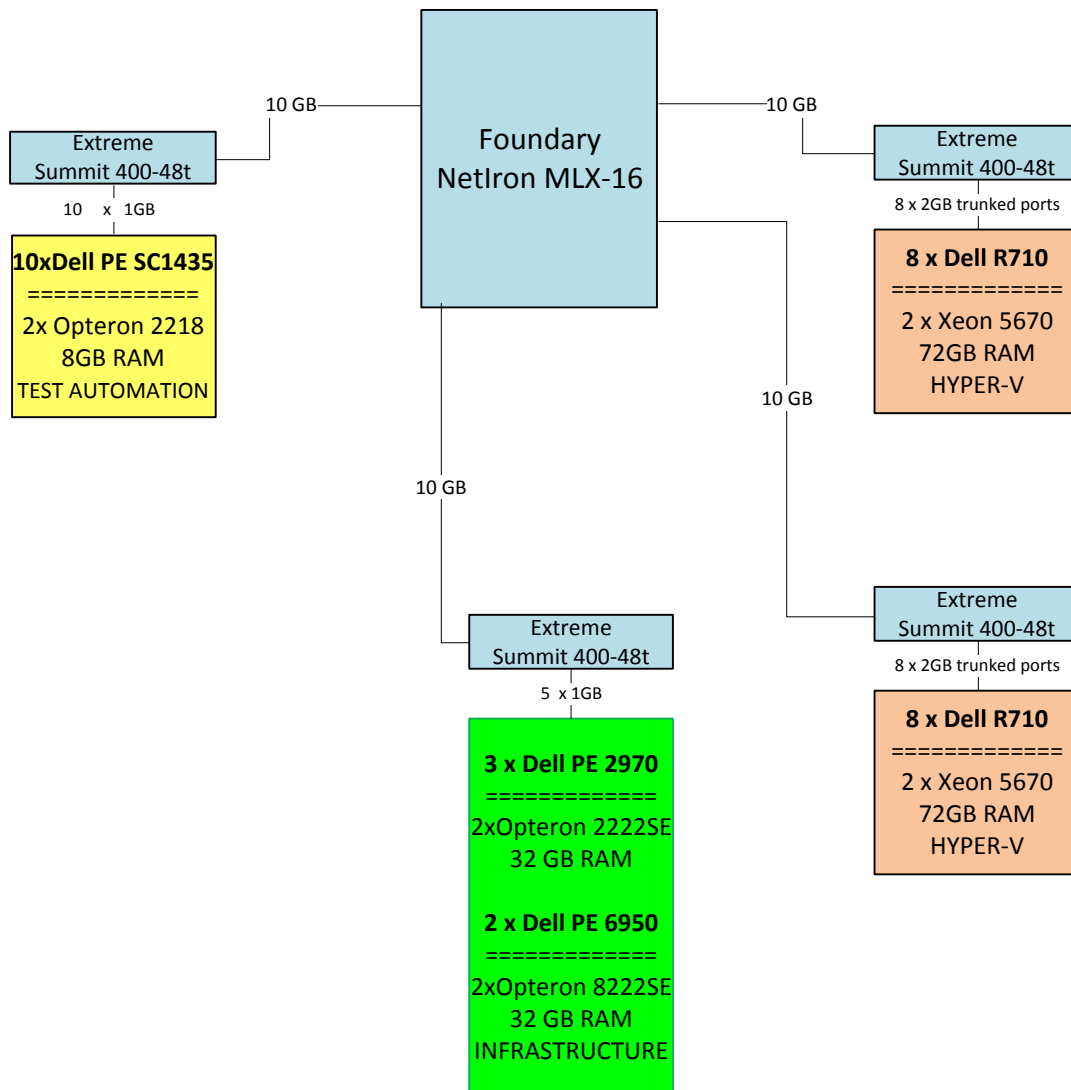


Figure 11. The network infrastructure used in the test lab

# Appendix B: Virtual Client Setup

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A total of 61 virtual clients running Windows 7 Enterprise were used to perform the stress test against the vWorkspace broker.

The following software was installed on each virtual client:

- Windows 7 Enterprise, 1GB memory allocated
- vWorkspace Connector for Windows
- vWorkspace Broker Stress Test Tool

The vWorkspace Broker Stress Test Tool was configured as follows:

- **Number of vWorkspace brokers** – 3
- **Number of logins per virtual client** – 17 (one virtual client will have only 4 logins)
- **Interval (in seconds) per login** – 12

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