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# Abstract

IOPS is the most challenging resource in hosted desktop environments. This study reports on tests that demonstrate how Quest HyperCache, a feature of Quest® Workspace™ Desktop Virtualization, can significantly reduce IOPS consumption and thereby reduce workload execution time, including provisioning time.

# Introduction

## About the Study

IOPS is the most challenging resource in hosted desktop environments. The goal of this study was to assess how Quest HyperCache, at scale, can help with IOPS consumption. HyperCache is a feature of Quest Workspace Desktop Virtualization (formerly vWorkspace) that is designed to drive down the IOPS requirement while delivering faster performance for both VDI and RD Session Host. HyperCache will drive down both disk read and disk write operations, with more emphasis on reads. Many studies are available that look at the IOPS consumption of individual machines or over a single hypervisor. This paper, however, looks at the impact on 3,000 virtual machines. To monitor IOPS usage we used the Disk Reads/sec and Disk Writes/sec counters in PerfMon. The tests and simulations were carried out in the Microsoft Enterprise Engineering Center (EEC) in Redmond, Washington in April 2012. The software tested was Quest Workspace Desktop Virtualization 7.6 (QWDV), Hyper-V 2008 R2 SP1 and SCVMM 2012. The provisioning tests were done using parent-child clone technologies. Parent-child means that there is a parent virtual machine (VM) and any desktops subsequently provisioned have access to that parent and store the differences in a child VM, which is therefore a fraction of the size of the parent. This approach reduces provisioning time and storage, but it does not address the challenge of IOPS. This study would not have been possible without the support from everyone within the EEC; however, Loay Shbeilat of Microsoft deserves special recognition for going above and beyond.

## About Quest Workspace Desktop Virtualization

Quest Workspace Desktop Virtualization manages, secures and provisions virtual desktop environments and also 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/desktop-virtualization/>.

# Summary of Results

This study yielded the following key results and conclusions:

- 3,000 Windows 7 SP1 virtual desktops were provisioned in 41 minutes using Quest HyperCache and Instant Provisioning, as compared to approximately seven hours using native SCVMM and Hyper-V provisioning methods.
- When provisioning 50 virtual desktops, we see a reduction in Read IOPS of 91% and Write IOPS of 61%.
- The HyperCache feature of Quest Workspace Desktop Virtualization also reduces IOPS during provisioning of Microsoft Windows RD Session Hosts.
- When executing a medium workload with LoginVSI on a RD Session Host on a single Hyper-V host, we see a saving of 80% for Read IOPS and 16% for Write IOPS.
- When executing a medium workload with LoginVSI in 150 Windows 7 virtual desktops on a single Hyper-V host, we see a saving of 62% for Read IOPS and 69% for Write IOPS.

# Test Details

## Infrastructure

The following high-level diagram illustrates the basic topology of the test environment:

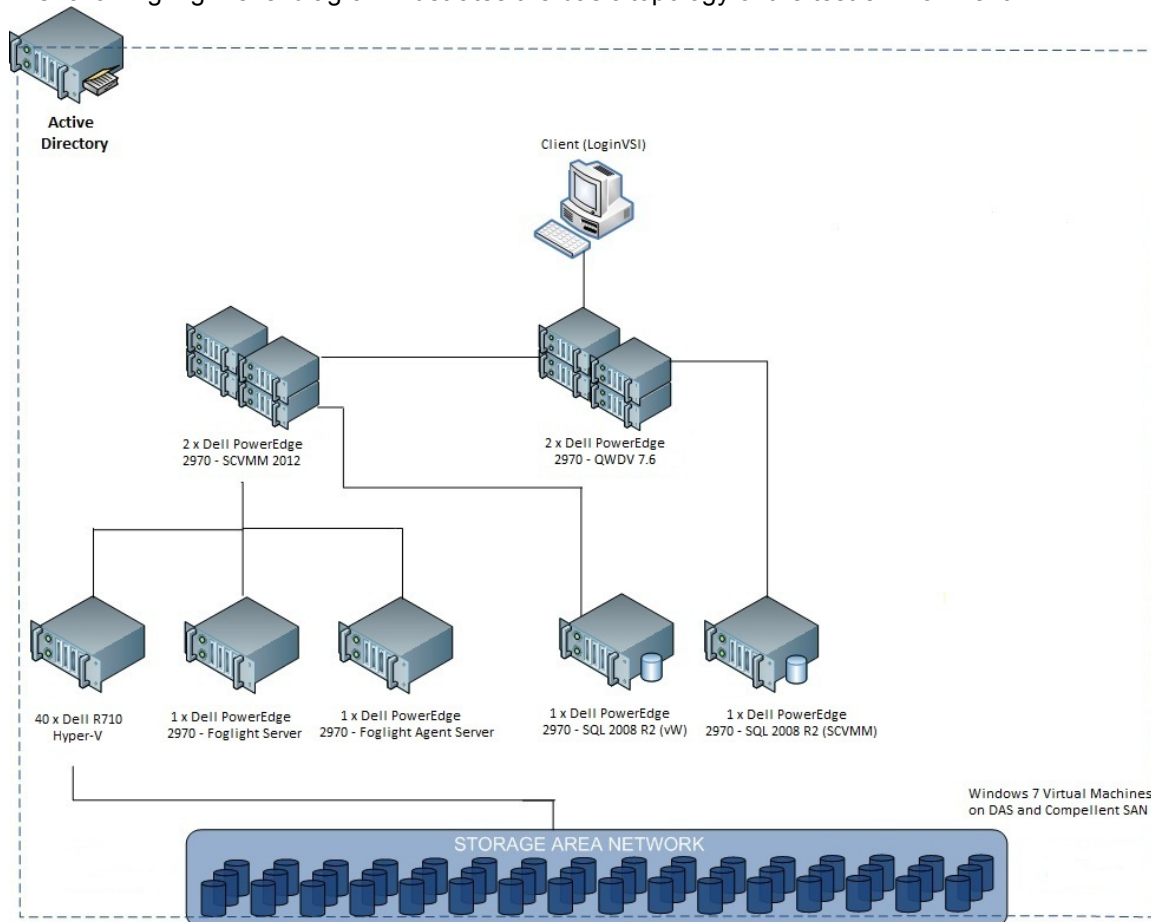


Diagram 1. Basic topology of the test environment.

Full details of the hardware and software used in this study are provided in Appendix A. Specific configuration for Quest Workspace Desktop Virtualization can be found in Appendix B.

## Operations

Provisioning and simulating a workload allows us to validate the HyperCache feature and prove that it lowers IOPS requirements, thus reducing storage requirements and helping to drive down costs of hosted desktop solutions. The tests were all carried out on the same infrastructure: 40 Hyper-V Hosts, two SCVMM servers and one Quest Workspace Desktop Virtualization server. For the PerfMon results provided in graph format in this document, a moving average of 2 was used. Test 1: IOPS Provisioning 50 Windows 7 SP1 (VDI) Desktops

Provisioning virtual desktops is normally one of the most time-consuming operations. With HyperCache and Instant Provisioning (Quest's built-in Sysprep mechanism), we were able to reduce Windows 7 VDI provisioning time from 15–20 minutes per desktop (depending on hardware) to about two minutes (also depending on hardware).

In the first test, we looked at the impact on time and IOPS when creating 1,000 Windows 7 SP1 virtual desktops over 20 Hyper-V hosts. During the creation of the desktops, we utilize the built-in QWDV load balancing mechanism. The result is that each host ends up with roughly 50 virtual desktops. In this test, all the Hyper-V hosts have direct attached storage (DAS). Figure 1 shows specific disk counters from HyperV-33 provisioning 50 desktops with HyperCache. You will notice that Disk Writes (in red) never exceeds 300 and Disk Reads (in purple) never exceeds 8; this is because HyperCache is serving the master template from memory-based cache. The averages were 5.12 Disk Reads/sec and 186.86 Disk Writes/sec.

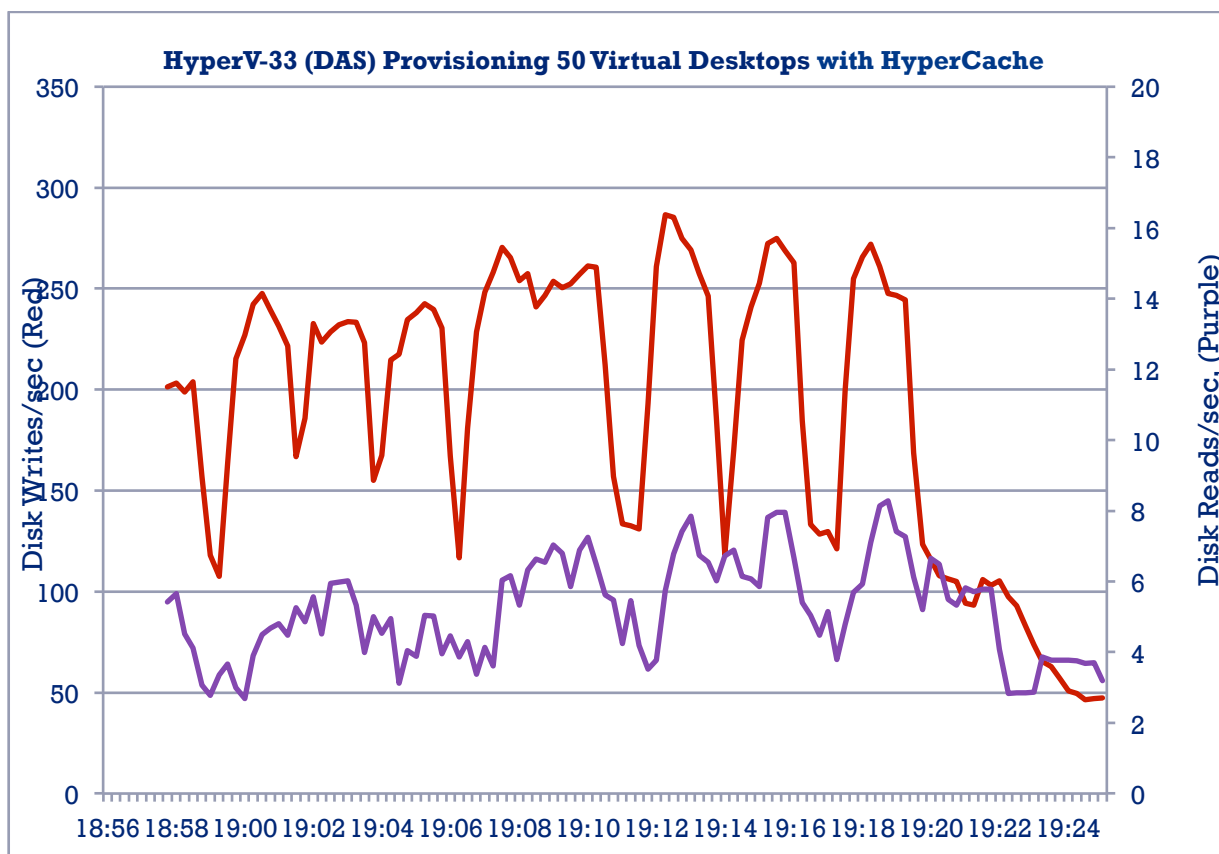


Figure 1. Disk Reads/sec and Disk Writes/sec on HyperV-33 provisioning 50 desktops with HyperCache

Figure 2 shows the same Hyper-V host, based on hardware spec., provisioning 100 desktops without HyperCache. You will notice that without HyperCache, the IOPS is significantly higher. (In Test 2 you will see the results from the provisioning of 3,000 desktops over 40 hosts, which is a better comparison based on number of virtual machines being created per host.)

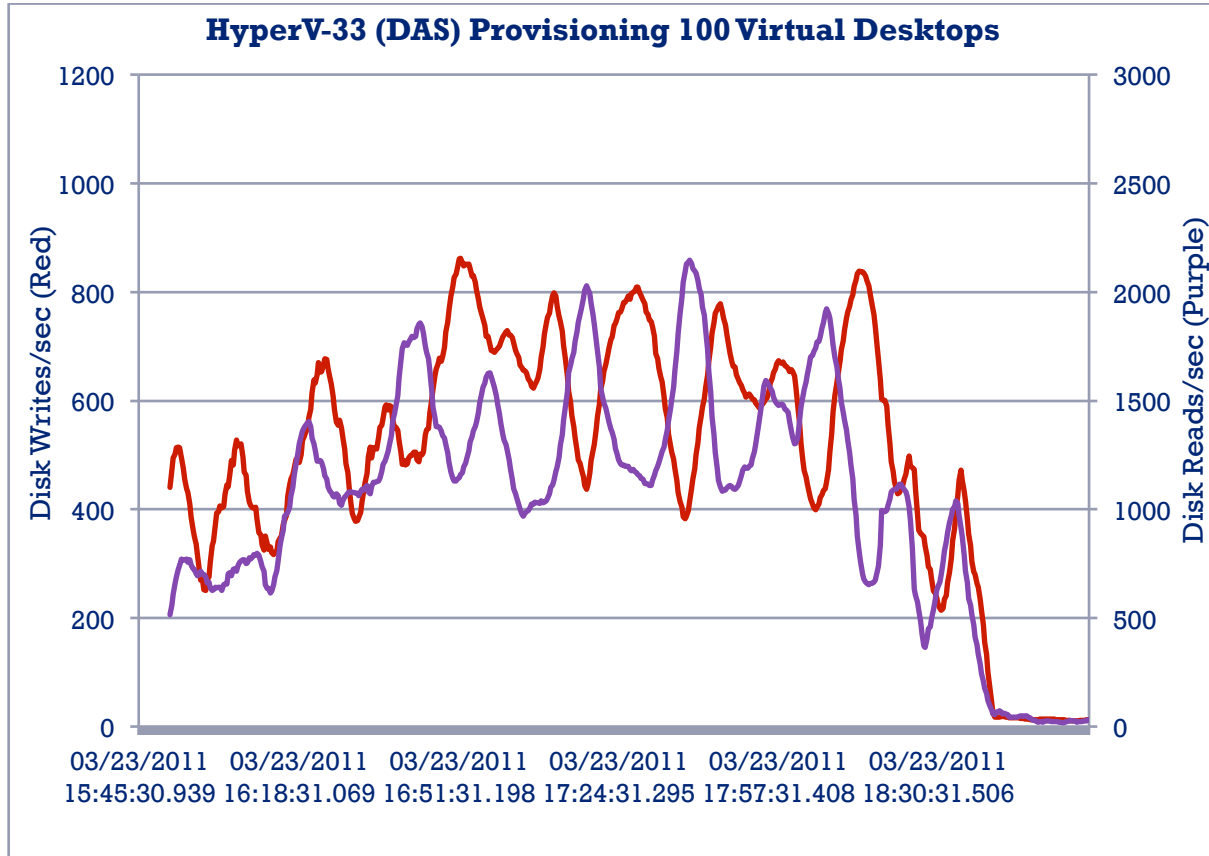


Figure 2. Disk Reads/sec and Disk Writes/sec on HyperV-33 provisioning 100 desktops *without* HyperCache



Figure 3 shows CPU and disk usage on HyperV-33 provisioning 50 desktops. (HyperV-33 was one of the 20 Hyper-V hosts.) CPU and disk are both underutilized, and this operation took roughly 25 minutes to complete, which means we were provisioning only two desktops a minute.

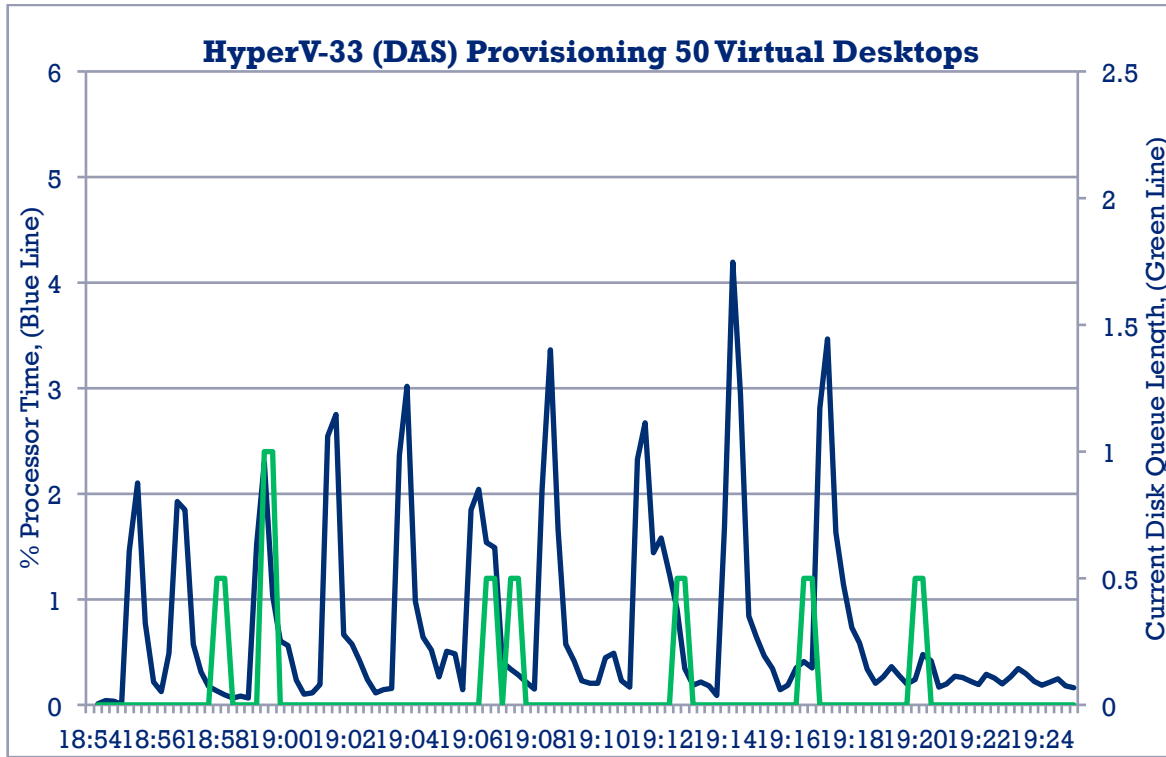


Figure 3. CPU and disk usage on HyperV-33 provisioning 50 desktops

Figure 4 shows the CPU and disk usage on the Quest connection broker during the provisioning process. It reveals how under-utilized the broker is and how the provisioning of 1,000 desktops in 30 minutes puts no demand on CPU and memory.

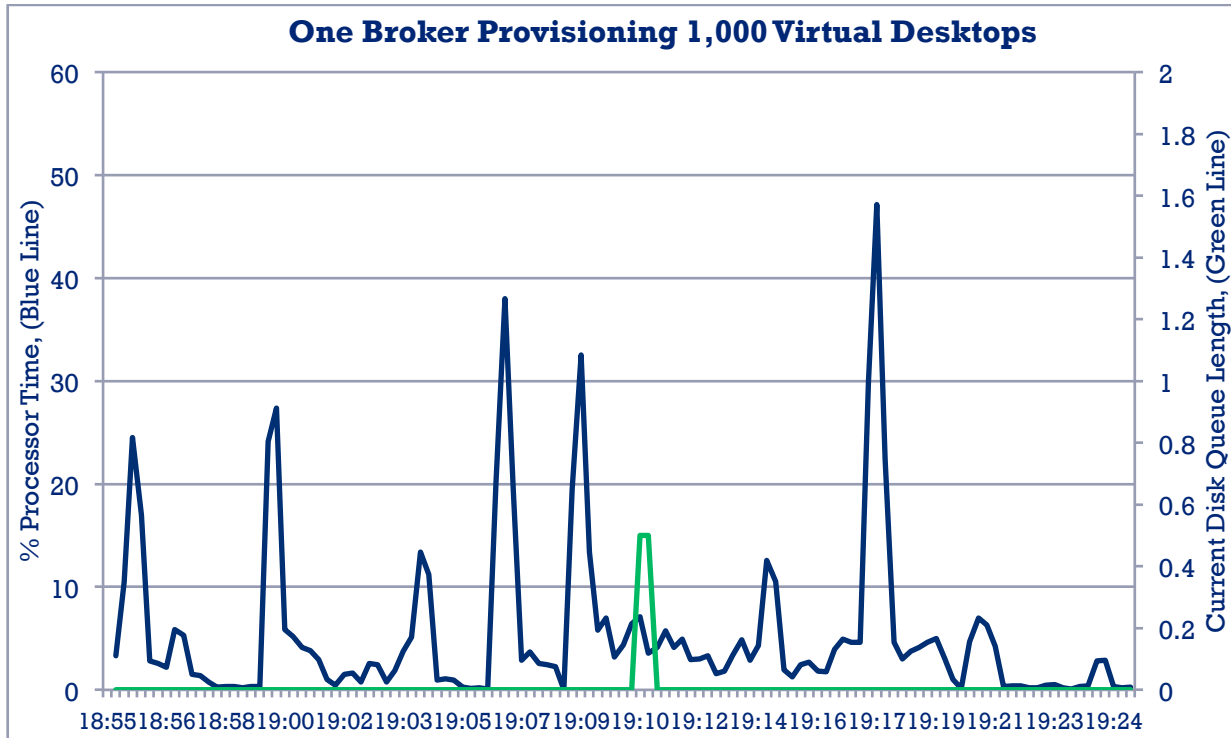


Figure 4. CPU and disk usage with one broker provisioning 1,000 desktops

### Test 2: IOPS Provisioning 75 Windows 7 SP1 (VDI) Desktops

In this test, we provisioned 3,000 desktops more than 40 Hyper-V hosts, so each host contained approximately 75 virtual desktops. The total time to provision the 3,000 virtual desktops using Quest HyperCache was 41 minutes, as compared to approximately seven hours using native SCVMM and Hyper-V provisioning methods.

Figure 5 shows specific disk counters from HyperV-35 provisioning 75 desktops. You will notice that Disk Writes/sec doesn't exceed 1000 and Disk Reads/sec doesn't exceed 30; this is because HyperCache is serving the master template from memory-based cache. Even as we scaled up the number of desktops per host from Test 1 to Test 2, you can see that Disk Reads/sec remains extremely low. The average Disk Reads/sec was 5.8 and the average Disk Writes/sec was 156.4. When provisioning 100 desktops without HyperCache, the average Disk Reads/sec was 1,011 and the average Disk Writes/sec was 478.

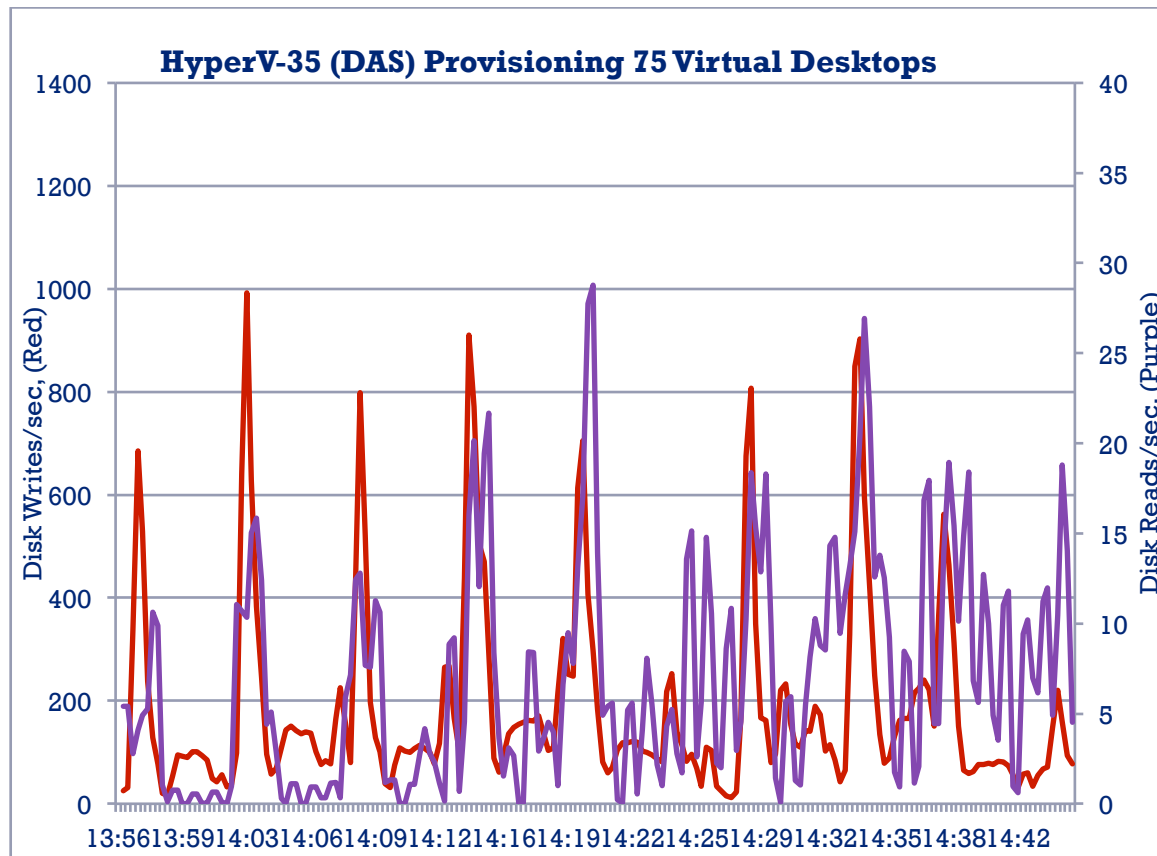


Figure 5. Disk Reads/sec and Disk Writes/sec on HyperV-35 provisioning 75 desktops with HyperCache

Figure 6 shows CPU and disk usage on HyperV-35 provisioning 75 desktops. (HyperV-35 was one of the 40 Hyper-V hosts.) CPU and disk are both underutilized, and the operation took roughly 41 minutes to complete, which means we were provisioning approximately 73 desktops a minute across all hosts, or two per host.

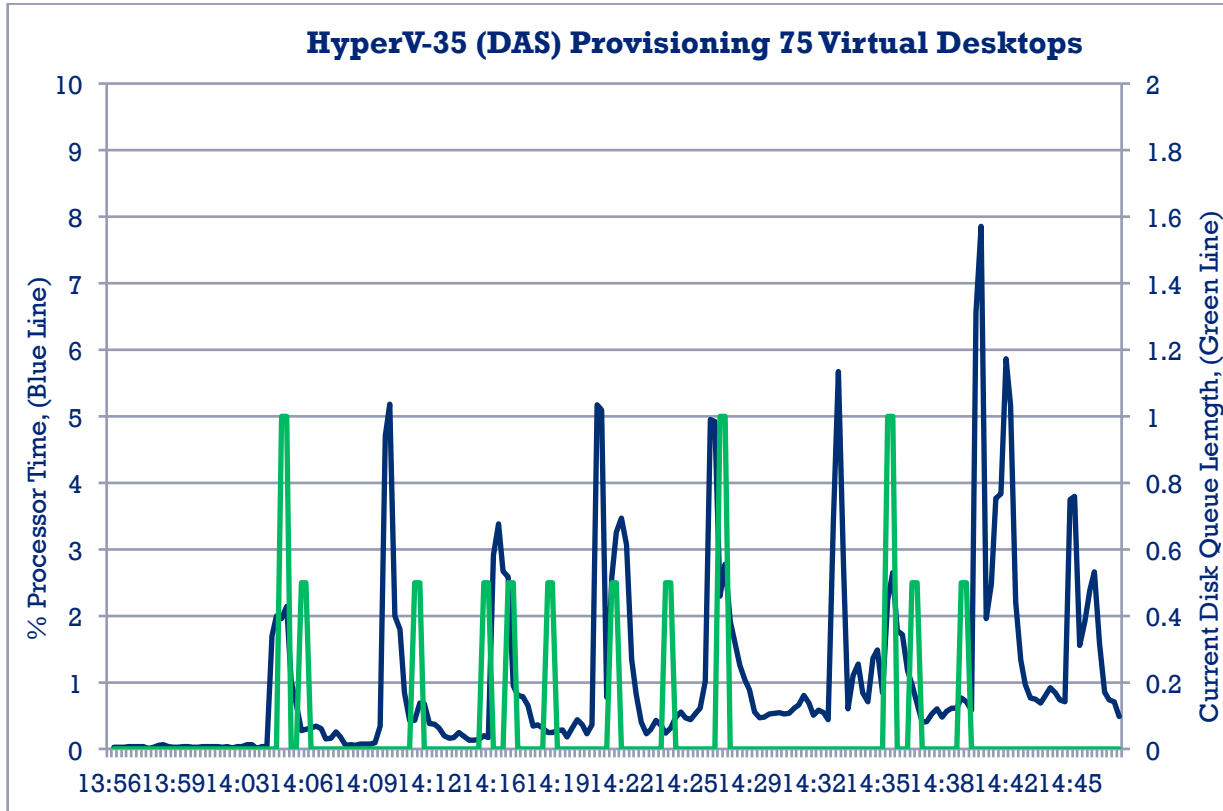


Figure 6. CPU and disk usage on HyperV-35 provisioning 75 desktops

Figure 7 highlights the impact on CPU and disk of the QWDV broker when provisioning 3,000 virtual desktops. As you can see, we weren't resource-constrained by the action.

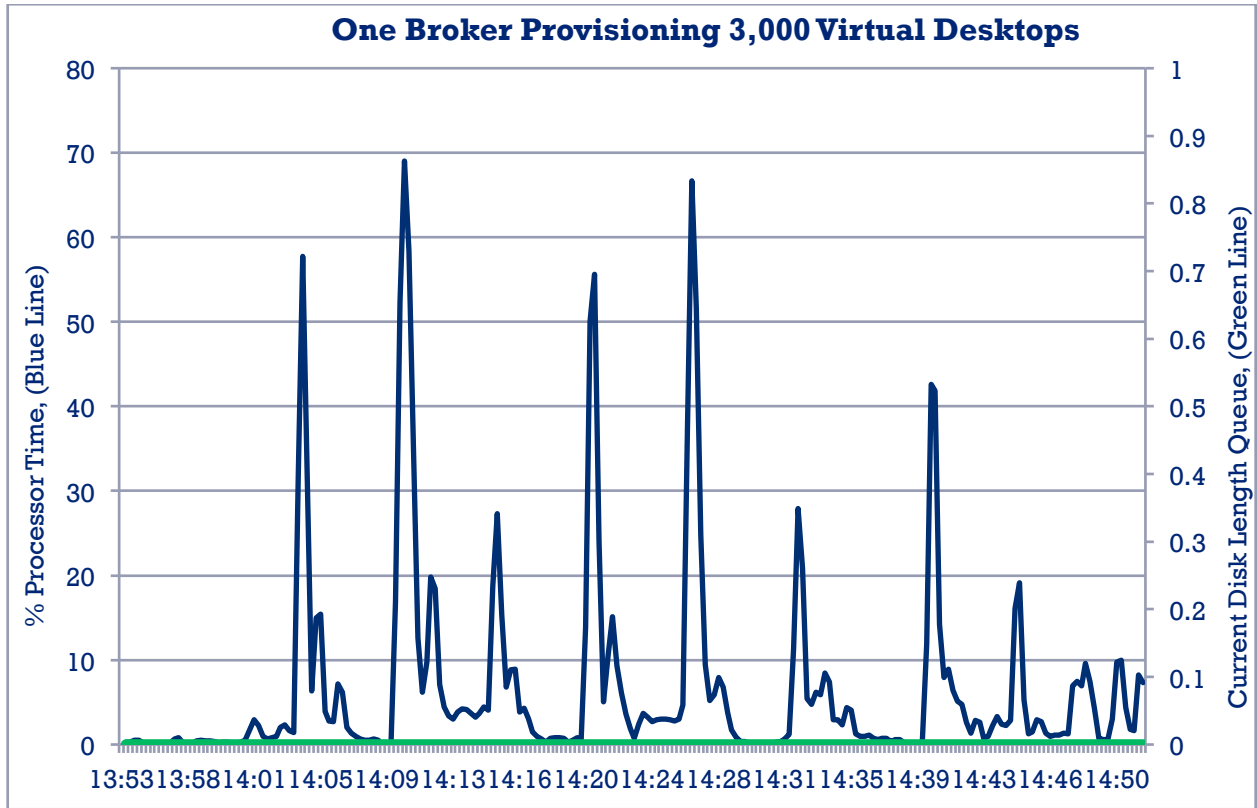


Figure 7. CPU and disk usage for one broker provisioning 3,000 desktops

### Test 3: IOPS for RD Session Host Provisioning

The Quest HyperCache feature is not limited to VDI. With Quest Workspace Desktop Virtualization 7.5, or above, you can use many of the techniques used for VDI to provision RD Session Hosts, such as Microsoft Differencing Disks and Quest HyperCache. In test 3, we investigated the performance of Microsoft RD Session Hosts in conjunction with Quest Workspace Desktop Virtualization and HyperCache. Provisioning 200 RD Session Hosts over 40 Hyper-V hosts took approximately 40 minutes to complete. The Hyper-V hosts typically ended up with four RD Session Hosts each, but because we were using two different server architectures, those with the higher spec. ended up with five or six virtual machines.

Figure 8 shows the Disk Reads/sec and Disk Writes/sec for HyperV-39 when provisioning five RD Session Hosts. Even with the spike in Disk Reads/Sec, we still maintained an average of 12.4; the average for Disk Writes/Sec was 11.49.

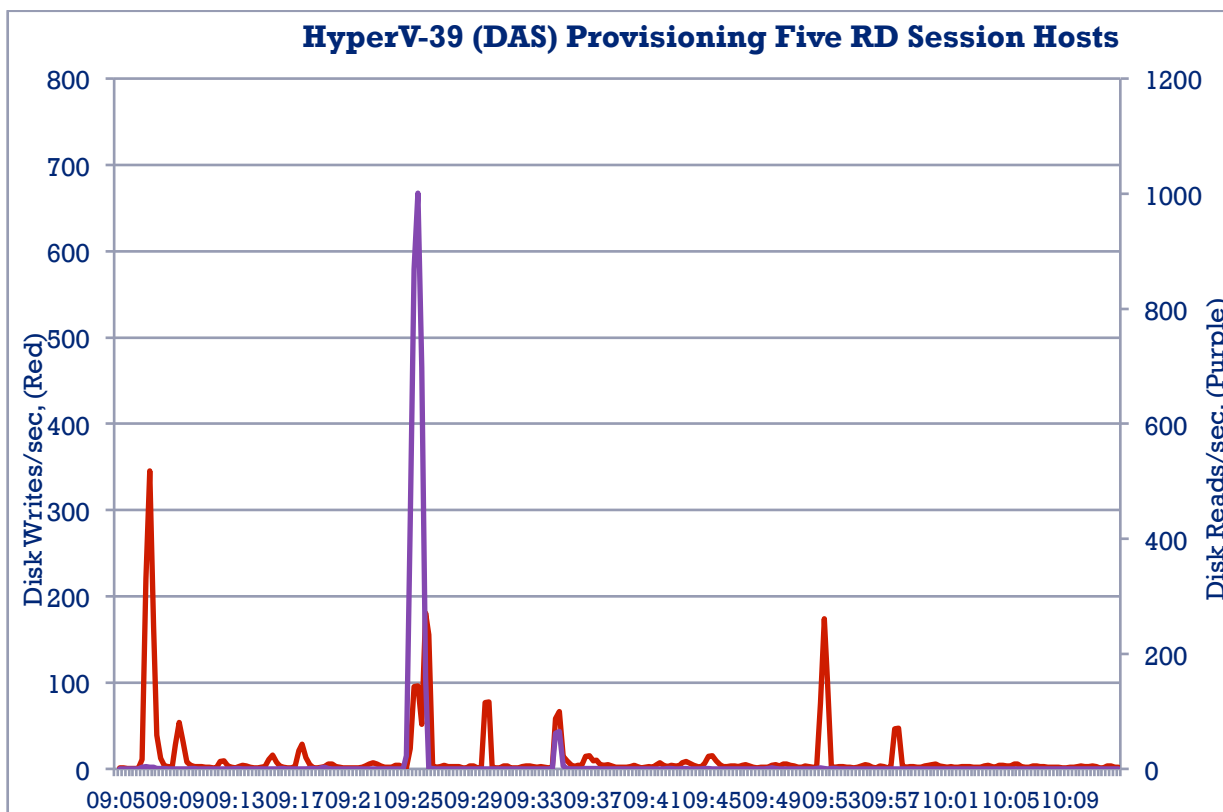


Figure 8. Disk Reads/sec and Disk Writes/sec on HyperV-39 provisioning five RD Session Hosts with HyperCache

Figure 9 shows the CPU and disk usage of a Hyper-V host provisioning five Microsoft RD Session Hosts; the results are similar to those when provisioning VDI virtual machines (Figure 6). The main difference when provisioning VDI and RD Session Hosts is that Session Hosts yield a lower disk queue length; however, this is to be expected since we are provisioning five virtual machines as compared to 75 virtual machines per host in our VDI tests.

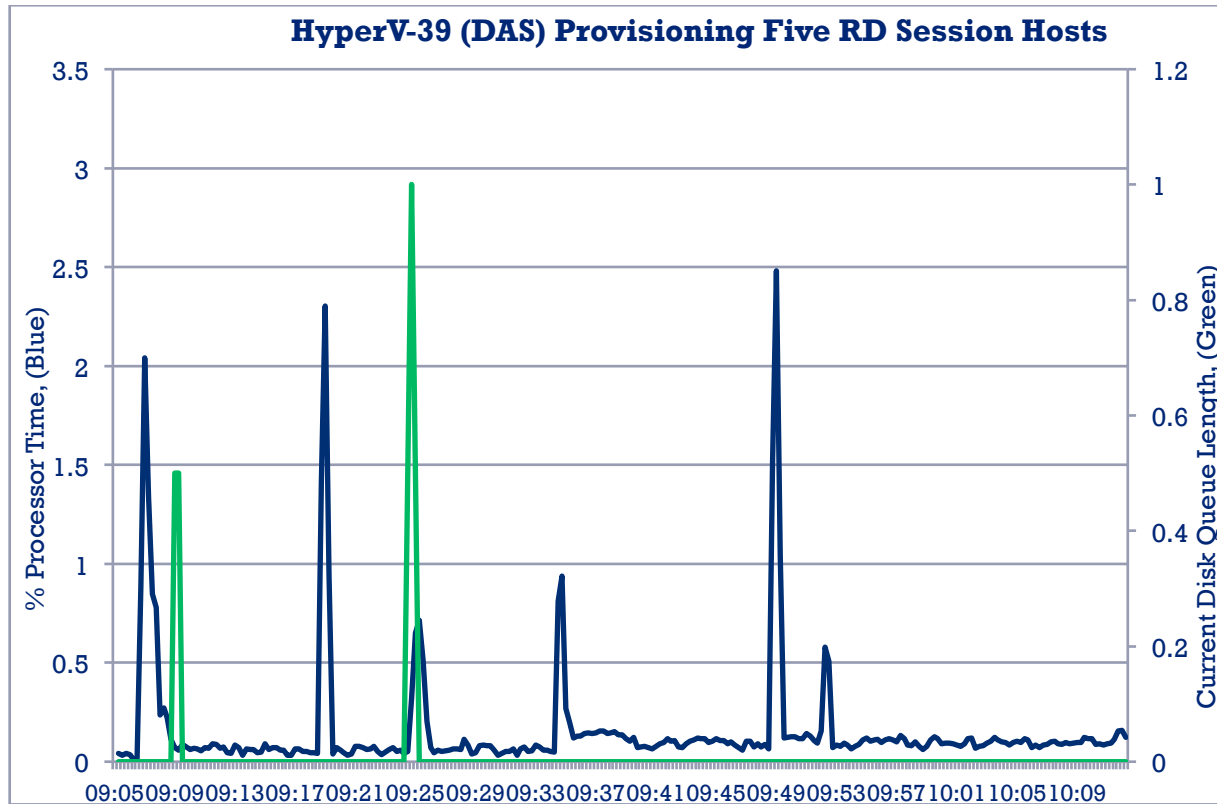


Figure 9. CPU and disk usage on HyperV-39 provisioning five RD Session Hosts with HyperCache

Figure 10 shows the CPU and disk usage of the Quest Workspace Desktop Virtualization Broker provisioning the RD Session Hosts. It reveals how under-utilized the broker is.

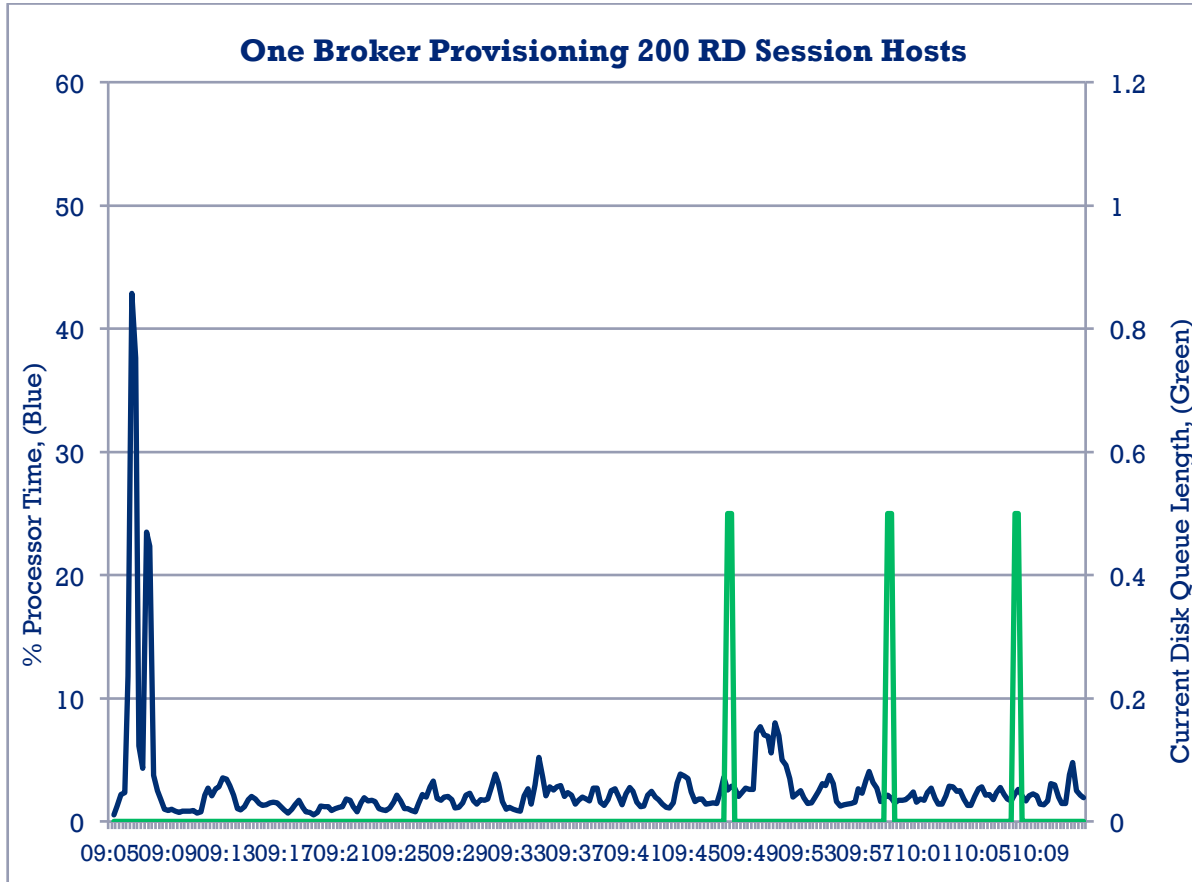


Figure 10. CPU and disk usage on one broker provisioning 200 RD Session Hosts with HyperCache



**Test 4: IOPS for RD Session Host with Simulated Load**

For the next test, we used the LoginVSI to simulate a workload within the RD Session Host virtual machines. With VSI, the “medium” workload option was used. Unfortunately we ran out of time in the EEC and therefore had to conduct this testing on a Dell T7500 after the engagement. Figure 11 shows the Disk Reads/sec and Disk Writes/sec for the Hyper-V host with Quest HyperCache when executing a medium workload with LoginVSI on a single virtual RD Session Host. The average Disk Reads/sec was 20 and the average Disk Writes/sec was 49. For a Hyper-V host without HyperCache (see Figure 12), the average Disk Reads/sec was 102 and Disk Writes/sec was 58.

Bear in mind these figures are a single RD Session Host. Typically we see customers running four RD Session Hosts per Hyper-V host (depending on hardware). Assuming a linear increase, this equates to 80 Disk Reads/sec and 196 Disk Writes/sec with HyperCache, and 408 Disk Reads/sec and 232 Disk Writes/sec without HyperCache.

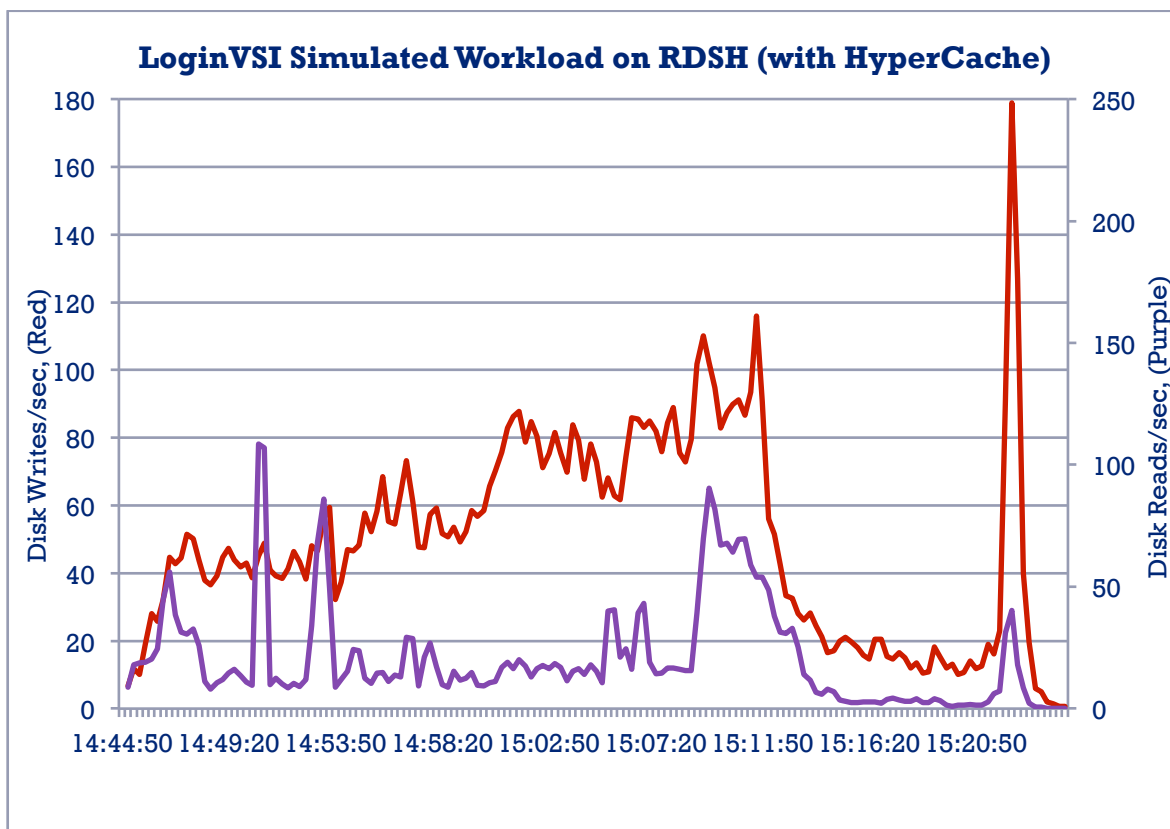


Figure 11. Disk reads and disk writes on Hyper-V with HyperCache when executing LoginVSI

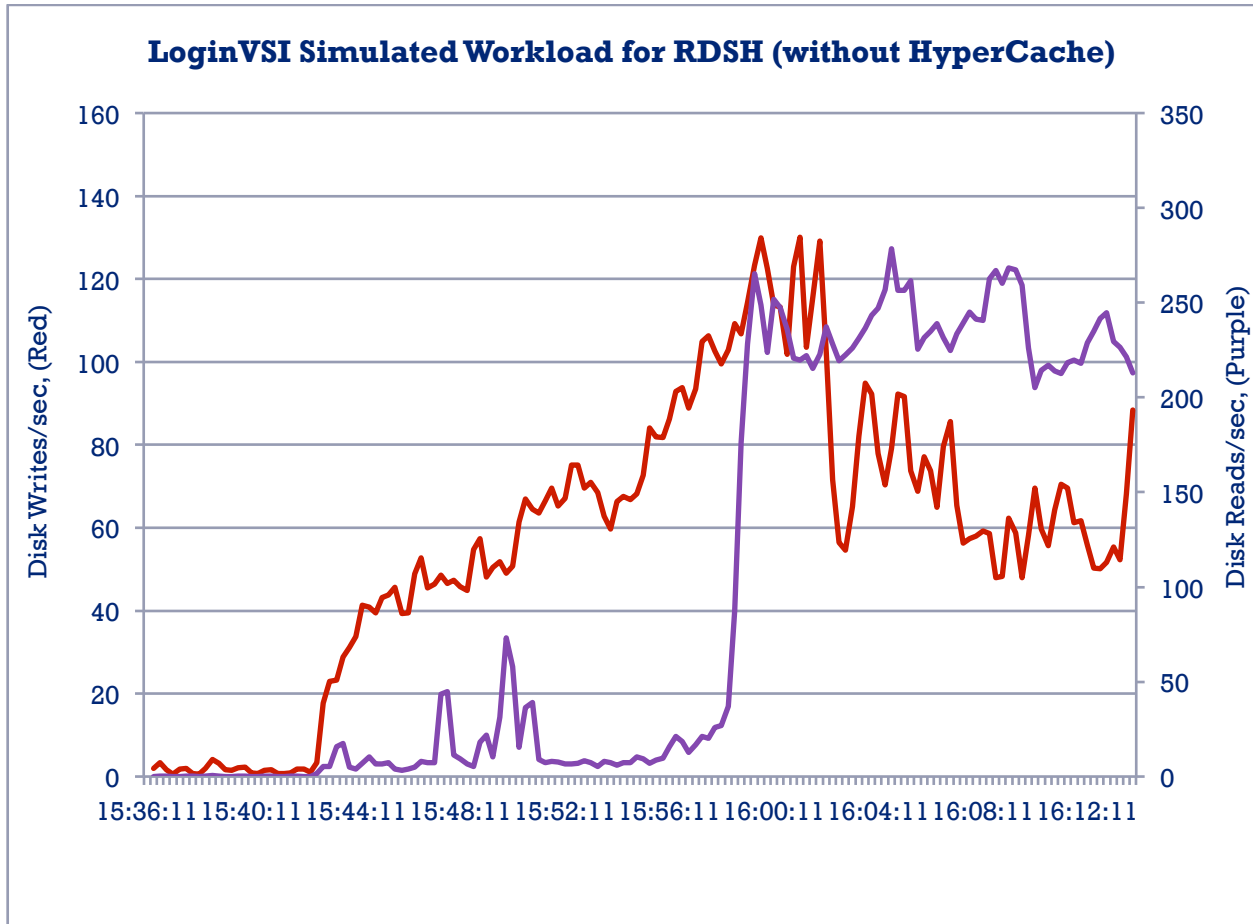


Figure 12. Disk reads and disk writes on Hyper-V when executing LoginVSI *without* HyperCache

### Test 4: IOPS for VDI with Simulated Load

Figure 13 highlights the Disk Reads/sec and Disk Writes/sec when executing the LoginVSI medium workload on a Hyper-V host running 150 Windows 7 SP1 virtual desktops with Quest HyperCache enabled. The average Disk Reads/sec was 247 and the average Disk Writes/Sec was 203.

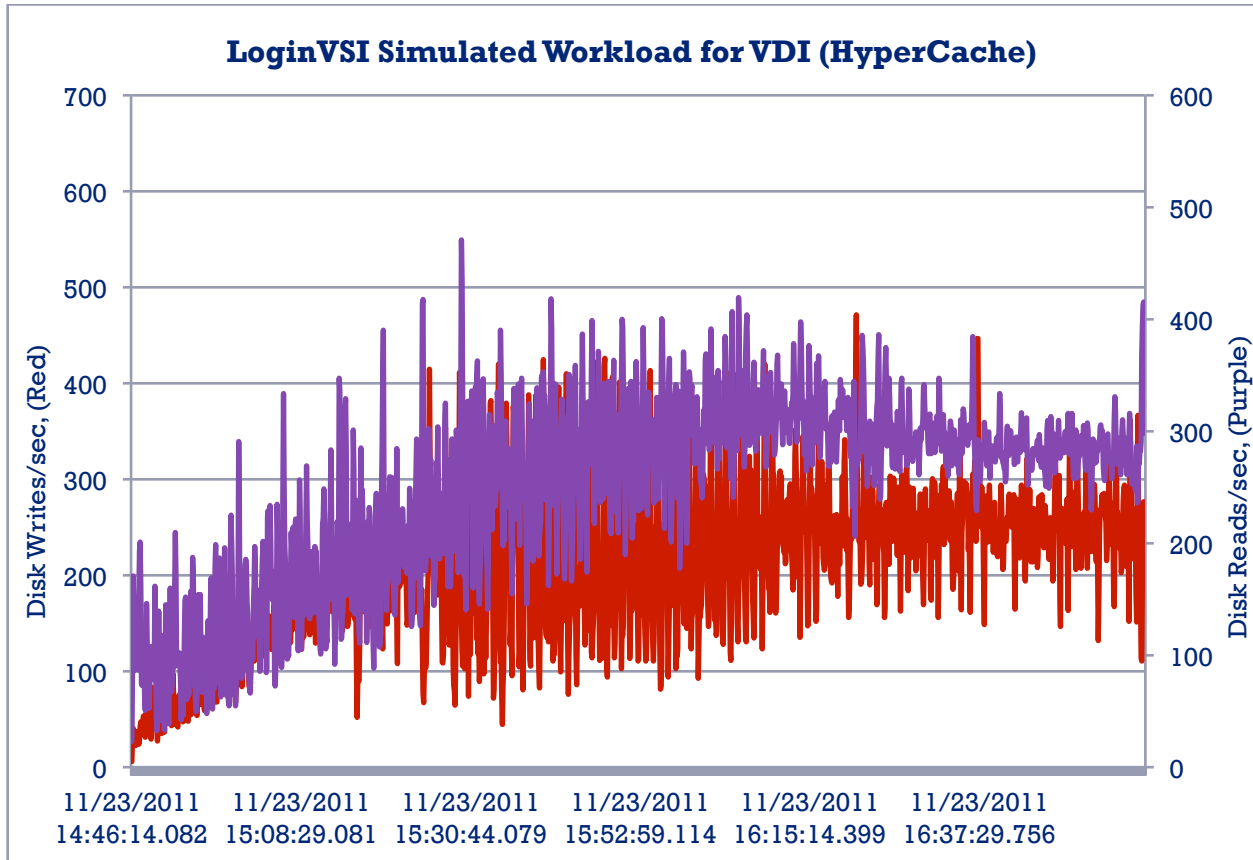


Figure 13. Disk Reads/sec and Disk Writes/sec on Hyper-V0 when executing LoginVSI with HyperCache

Figure 14 shows the Disk Reads/sec and Disk Writes/sec when executing the LoginVSI medium workload on a Hyper-V host running 150 Windows 7 SP1 virtual desktops without HyperCache. The average Disk Reads/Sec was 653 and the average Disk Writes/Sec was 648.

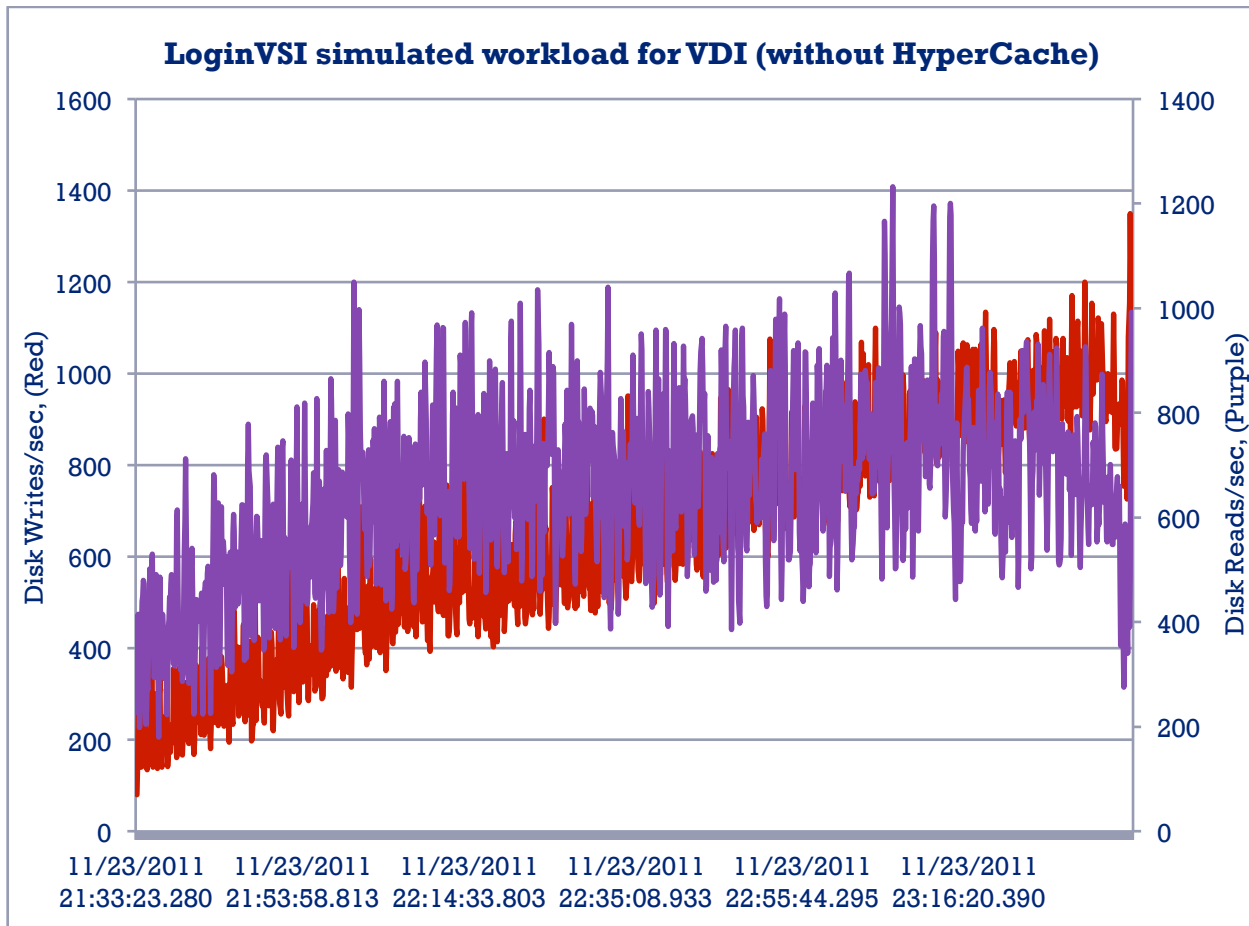


Figure 14. Disk reads and disk writes on Hyper-V when executing LoginVSI *without* HyperCache

Note that the data used for Figure 13 and Figure 14 came from a previous round of LoginVSI and HyperCache testing in November 2011 (see *Desktop Virtualization: A Cost and Performance Comparison*). These tests were done by configuring HyperCache to perform write optimizations for all virtual desktops.

## Final Words

The conclusions are at the start of this paper, so all that is left to say is thank you to Microsoft and the team at the Enterprise Engineering Center who worked so hard to help us run all these tests and achieve such a strong set of results.

# About the Authors

## **Matthew Evans**

Matthew Evans, a 17-year veteran of the IT industry, is a team lead for Quest's User Workspace Management (UWM) system consultants in Europe. He joined Quest in 2008 after spending 10 years at Wyse Technology. Matthew has participated in multiple large-scale VDI/RDSH projects and has served as the project manager to deliver three engagements at the Microsoft Enterprise Engineering Center (EEC) in Redmond, Washington. He is a VMware Certified Professional.

## **Terry Lewis**

Employed by Quest since 2000, Terry Lewis is a solutions architect for the company's User Workspace Management business. A Microsoft Certified Trainer, VMware Certified Professional, and former Citrix Certified Instructor, he brings years of experience as a system integrator, trainer and service provider for server-based computing, virtualization, security, and core enterprise technologies.

# Appendix A: Test Hardware Details

## Autoclient (Windows 7)

50 x Dell Optiplex

- Intel Dual Core 6600 @ 2.40 GHZ
- 2GB RAM
- Windows 7 Enterprise (7601) Service Pack 1

## Microsoft Hyper-V Hosts (Windows 2008 R2 SP1)

HyperV-1 – 20: Dell R710

- 2 x Intel Xeon Hex Core X5650 @ 2.67 GHz
- 96GB RAM
- 2 x SAS 15K 450GB RAID1 (OS), DATA drive is SAN
- Windows 2008 R2 Enterprise (7601) Service Pack 1

HyperV-31–50: Dell R710

- 2 x Intel Xeon Hex Core X5670 @ 2.93 GHz
- 72 GB RAM
- 2 x SAS 10K 300 GB RAID1 (OS), 6 x SAS 10K 300 GB (DATA) RAID0
- Windows 2008 R2 Enterprise (7601) Service Pack 1

Dell T7500 (used for additional LoginVSI testing)

- 2 x Intel Xeon Hex Core X5650 @ 2.67 GHz
- 48 GB RAM
- 1 x SATA 250 GB C:(OS)
- 1 x SATA 1.8 TB H:(HYPER-V)
- Windows 2008 R2 DataCenter (7601) Service Pack 1

## Microsoft SCVMM 2012 (Two Servers)

2 x Dell PowerEdge 2970

- 2 x dual-core AMD Opteron processor 2222 SE 3.00 GHz
- 32 GB RAM
- 2 x 10K 146 GB RAID1 (OS) and 6 x 10K 146 GB RAID10 (DATA)
- Windows 2008 R2 Enterprise (7601) Service Pack 1
- SCVMM 2012, version 3.0.6005.0; with hotfixes KB2663959 and KB2663960.

SCVMM2 – Hyperv-1–20 (SAN)

SCVMM3 – Hyperv-31–50 (DAS)

**Quest Workspace Desktop Virtualization (Two Servers)**

2 x Dell PowerEdge 2970

- 2 x dual-core AMD Opteron processor 2222 SE 3.00GHz
- 32 GB RAM
- 2 x 10K 146 GB RAID1 (OS) and 6 x 10K 146 GB RAID10 (DATA)
- Windows 2008 R2 Enterprise (7601) Service Pack 1
- Quest Workspace Desktop Virtualization 7.6

**Microsoft SQL 2008 (Two Servers)**

2 x Dell PowerEdge 2970 (For SCVMM and QWVDV)

- 2 x Dual-Core AMD Opteron Processor 2222 SE 3.00GHz
- 32GB RAM, 2 x 10K 146GB RAID1 (OS) and 6 x 10K 146GB RAID10 (DATA)
- Windows 2008 R2 Enterprise (7601) Service Pack 1
- Microsoft SQL Server 2008 R2

**Quest Foglight for Virtual Desktops 5.6.3 (Two Servers)**

2 x Dell PowerEdge 2970

- 2 x dual-core AMD Opteron processor 2222 SE 3.00 GHz
- 32 GB RAM, 2 x 10K 146 GB RAID1 (OS) and 6 x 10K 146 GB RAID10 (DATA)
- Windows 2008 R2 Enterprise (7601) Service Pack 1
- Microsoft SQL Server 2008 R2

**Virtual Desktops**

Windows 7 Enterprise Service Pack 1

Dynamic Memory

- Startup memory 512 MB
- Maximum memory 2048 MB
- Memory buffer 20%

**SAN**

Compellent

120 disks:

- 12 – 200 GB SSD
- 48 – 1 TB SAS
- 60 – 600 GB SAS
- 8 – 8 Gb FC ports for host connections (currently using 4)
- 8 – 10 Gb FCoE
- 4 – 10 Gb iSCSI

12 GB cache



# Appendix B: Quest Workspace Desktop Virtualization Tuning

The number of concurrent actions was changed throughout the study to take timings; however, most timings were taken with a setting of 7.

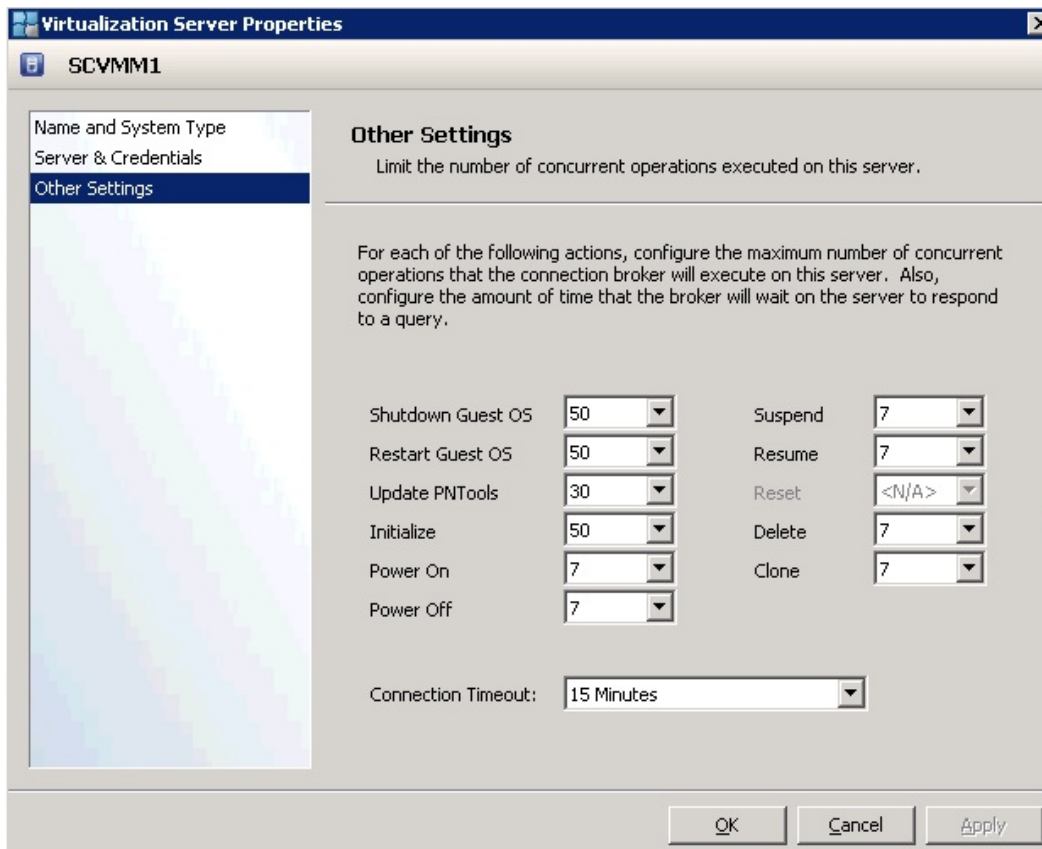


Figure 15. Setting the maximum number of concurrent operations on a server

Due to the high number of virtual desktops per pool, it is recommended that you set Refresh to Off in the console and then manually click Refresh when it is required.

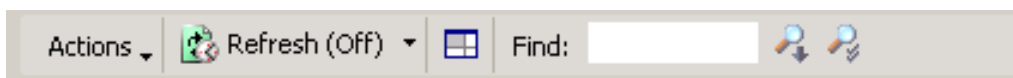


Figure 16. Setting Refresh to Off in the console

It is also recommended that you reduce the heartbeat interval from 1 minute to 10 minutes.

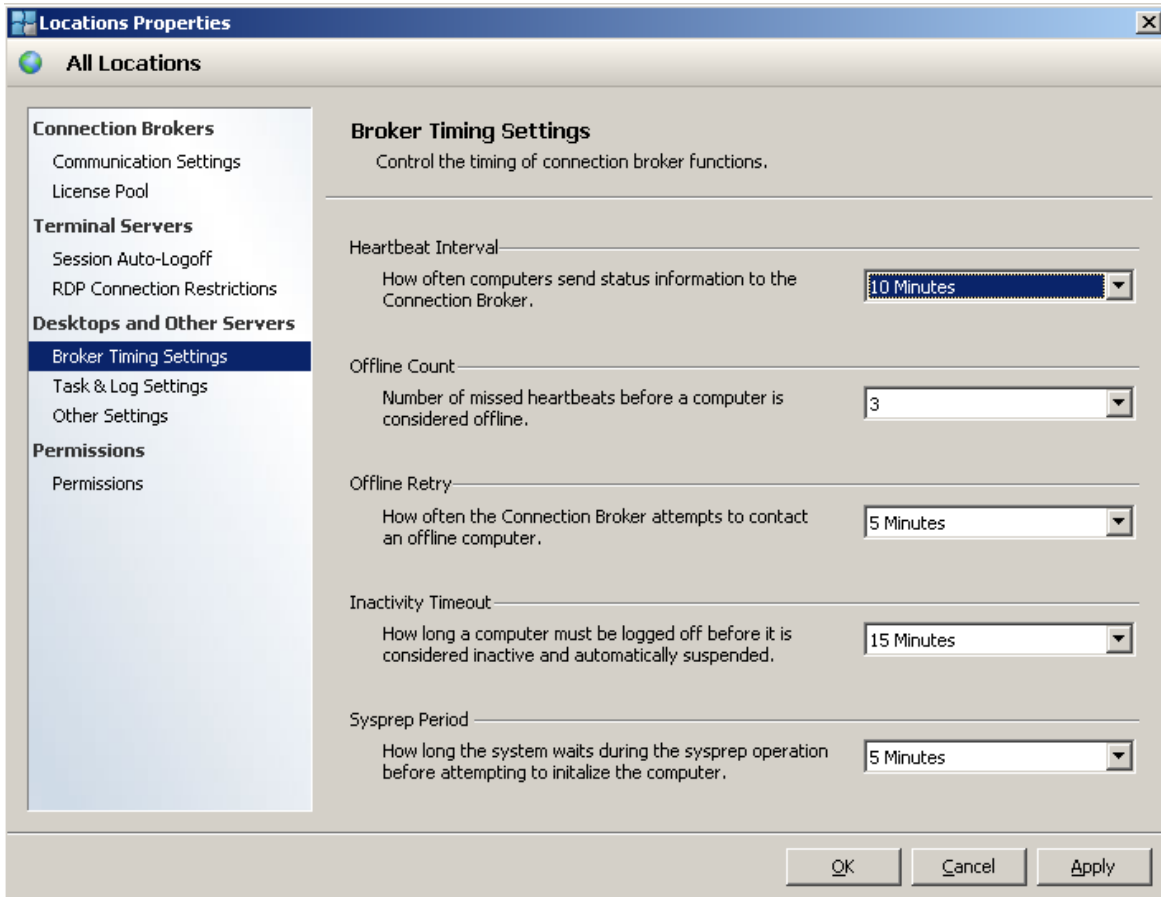


Figure 17. Changing the heartbeat interval from 1 minute to 10 minutes

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- Manage existing support cases

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