

Desktop Virtualization: A Cost and Performance Comparison

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Abstract

This white paper presents the result of research comparing the cost and performance of desktop virtualization using the four most well-known desktop virtualization products and their preferred hypervisors:

- Quest vWorkspace 7.5 with Hyper-V Server R2 SP1
- Citrix XenDesktop 5.5 with XenServer 5.6 SP2
- VMware View 5.0 with ESXi 5.1
- Citrix VDI-in-a-Box 5 with Hyper-V R2 SP1

Introduction

The cap-ex cost of a desktop virtualization deployment can be perceived as prohibitive. Important factors in this cost are the expenses of storage and management software. Quest vWorkspace 7.5 was specifically designed to lower these costs, enabling customers to adopt desktop virtualization at the lowest cost possible while still fulfilling the requirements of both SMB and enterprise customers.

This paper presents the result of research comparing the cost and deployment speed of desktop virtualization using the four most well-known desktop virtualization products and their preferred hypervisors:

- Quest vWorkspace 7.5 with Hyper-V Server R2 SP1
- Citrix XenDesktop 5.5 with XenServer 5.6 SP2
- VMware View 5.0 with ESXi 5.1
- Citrix VDI-in-a-Box 5.0 with Hyper-V R2 SP1

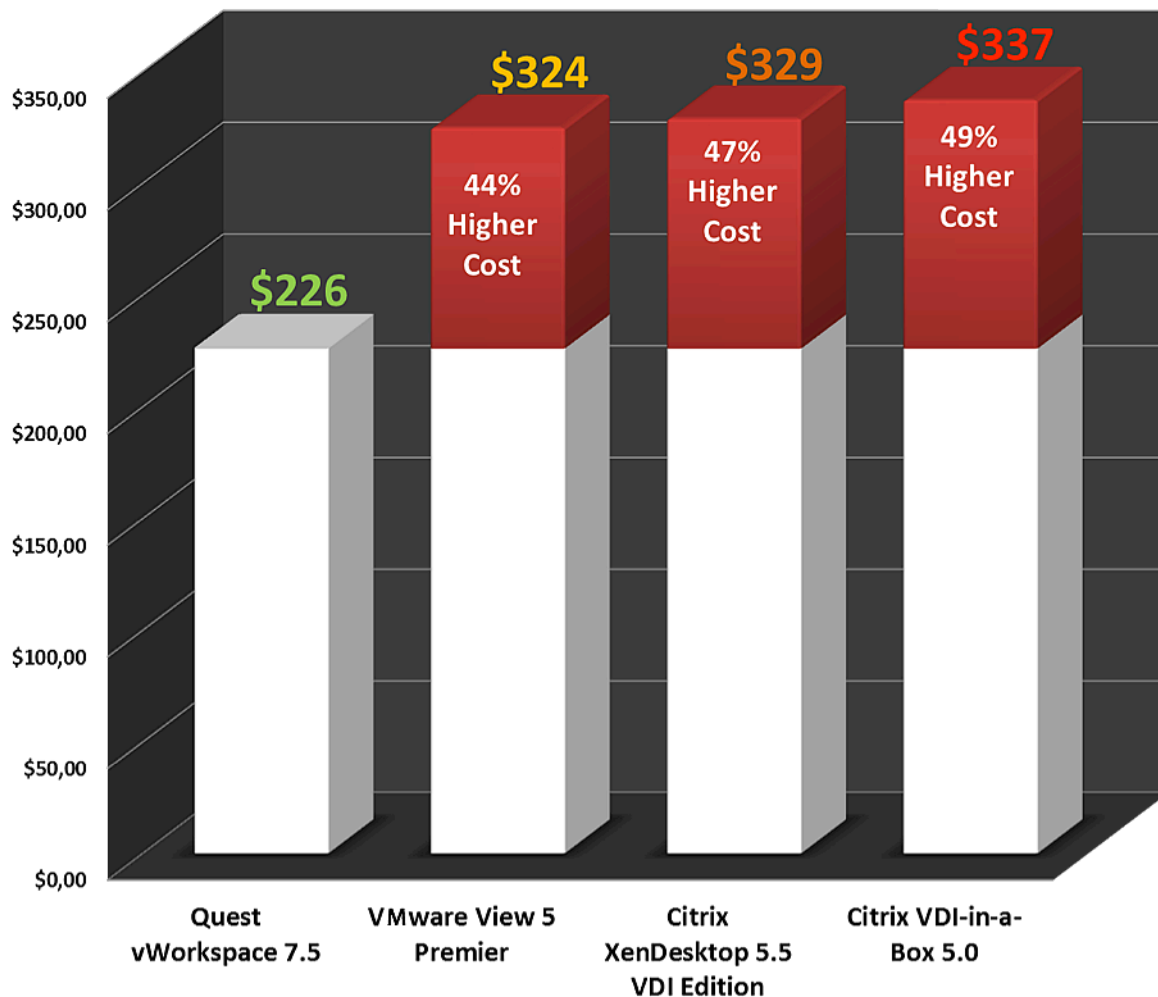
Summary of Results

The research found that vWorkspace 7.5 provides the lowest cost desktop virtualization on the market today, due in part to significant storage savings. It also provides the fastest possible provisioning times, delivering, right out of the box, unparalleled agility and flexibility for organizations of any size.

Cost Savings

vWorkspace 7.5 delivers the lowest cost per user among other solutions on the market today:

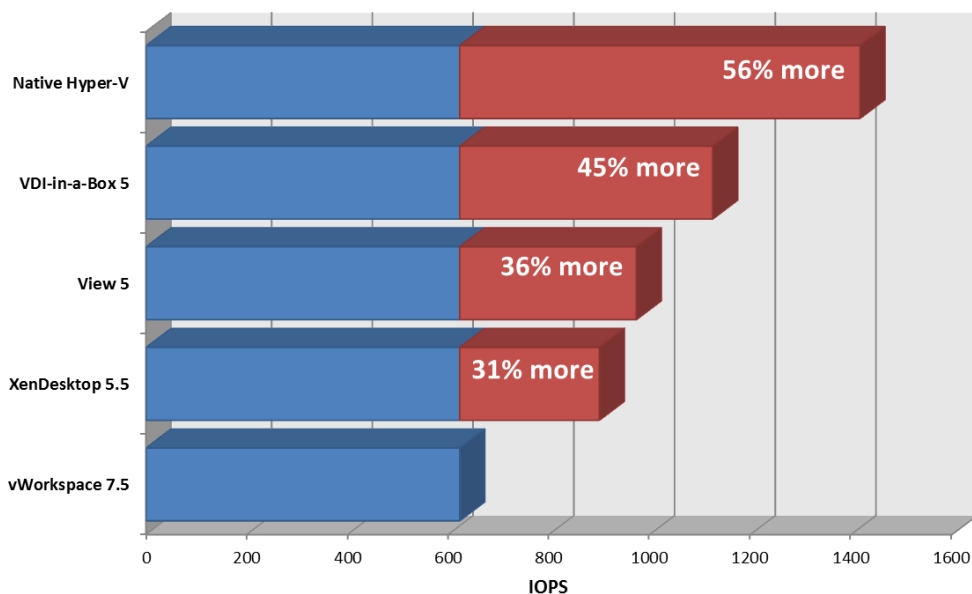
Annual VDI CapEx Cost per User



Storage Savings

One important factor in the cost of desktop virtualization is storage (input/output operations per second, or IOPS). Because of patent-pending technologies in the vWorkspace Hyper-V Catalyst Components, such as HyperCache and HyperDeploy, vWorkspace 7.5 is able to save a minimum of 30 percent in IOPS using the industry-standard LoginVSI benchmark.

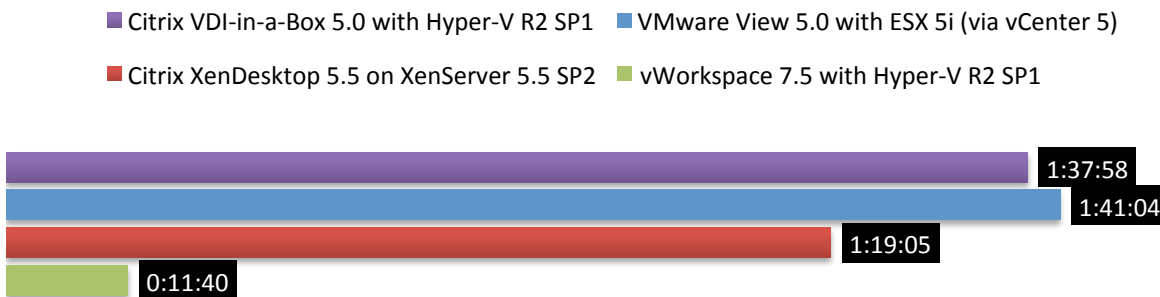
Average IOPS Requirements for 150 Desktops



Deployment Speed

In addition, vWorkspace is significantly faster to deploy virtual desktops than the other solutions:

Time to provision 150 virtual desktops



Overview of vWorkspace 7.5

Quest vWorkspace 7.5 was designed to allow customers to adopt desktop virtualization at the lowest cost possible while still being able to fulfill the requirements of both SMB and enterprise customers. Accordingly, it introduces a game-changing set of features:

- **Scalability** – Patent-pending technologies in Hyper-V Catalyst components of vWorkspace 7.5, such as HyperCache and HyperDeploy, offer breakthrough scalability improvements right out of the box. This drastically improves scalability – for virtual desktops hosted on SANs, local storage (DAS) and all other forms of storage – and significantly reduces the cost of desktop virtualization.
- **Load balancing** –vWorkspace Desktop Clouds continuously ensure the best performance for virtual desktops with advanced load balancing schemes. You can add capacity to a vWorkspace Desktop Cloud in seconds, for unparalleled elasticity.
- **Fast deployment** – With the new vWorkspace Desktop Cloud capability, customers can deploy virtual desktop environments of any size in mere minutes while using the free Microsoft Hyper-V Server.

These are just some of the enhancements introduced in vWorkspace 7.5. For a full listing, please visit <http://www.quest.com/vworkspace/new-release.aspx>.

Test Design and Setup

Some analysts say that storage costs make up 30% of the total cost of a VDI deployment. And the amount of IOPS (input/output operations per second) required to support a given VDI deployment plays a crucial role in storage costs.

To assess the IOPS requirements for the four different virtualization products, LoginVSI was used. The tests performed were focused on an out-of-the-box experience: both the desktop virtualization product and the associated hypervisor were set up using only the defaults wherever possible.

Using exactly the same server configuration each time (see the appendix), a user load of 150 users was simulated using the LoginVSI medium workload for each desktop virtualization product and its associated hypervisor. The virtual desktops were provisioned using exactly the same template. Only RDP connections were used, in order to prevent protocol performance from impacting the IOPS testing results.

The time required to provision 150 virtual desktops was also measured. The exact time window measured was from the moment that provisioning was initiated from the management console until the last provisioned virtual desktop was ready to accept user sessions.

The following sections describe the setup of each desktop virtualization solution tested. For full details of the setup for each product, see the appendix.

Quest vWorkspace 7.5 with Hyper-V Server R2 SP1

vWorkspace 7.5 is the latest release of Quest vWorkspace. Among other new functionality, it introduces the Hyper-V Catalyst Components, which provide breakthrough scalability improvements for virtual desktops hosted on the Microsoft Hyper-V platform. Two key components are HyperCache and HyperDeploy, which dramatically reduce the IOPS required for VDI deployments on Hyper-V. (The Hyper-V Catalyst components provide a similar result for RD session hosts running on Hyper-V but this is out of the scope of this document.)

In addition, HyperCache and HyperDeploy allow for extremely fast provisioning of virtual desktops, as fast as provisioning a fully functional virtual desktop every four seconds on commodity hardware, right out of the box.

Hyper-V Server R2 SP1 was chosen as the hypervisor for use in the test of Quest vWorkspace 7.5 because Quest believes it provides the best price/performance ratio for a typical VDI workload. vWorkspace 7.5 also supports both VMware ESX and Parallels Virtuozzo Containers.

One single vWorkspace 7.5 connection broker installed in 'simple mode' was used. This connection broker was configured to use the Hyper-V R2 SP1 host. The vWorkspace 7.5 Quick Start Wizard was used to create a Desktop Cloud with 150 virtual desktops.

Citrix XenDesktop 5.5 with XenServer 5.6 SP2

At the time this paper was written, XenDesktop 5.5 was the latest release of Citrix's main desktop virtualization product. Citrix's own hypervisor, XenServer, was used in the tests because it ships with XenDesktop 5.5 and it is the hypervisor most often deployed with XenDesktop, according to [Citrix sources](#). Specifically, XenDesktop 5.5 VDI edition and XenServer 5.6 SP2 were used.

Out-of-the-box, XenDesktop 5.5 on XenServer 5.6 SP2 was not able to host more than 80-90 virtual desktops, which made it unsuitable to take part in the IOPS testing. Advanced tuning of the XenServer hypervisor was needed to allow it to host 150 desktops. The following procedures were followed to perform the changes on XenServer: <http://support.citrix.com/article/CTX124086>. The default installation options were used, installing all the XenDesktop components on a single server. XenDesktop 5.5 Quick Deploy was used to provision the 150 VMs.

VMware View 5.0 with ESX 5i

At the time this paper was written, View 5.0 was the latest version of VMware View, VMware's desktop virtualization product. VMware vCenter 5.0 and VMware ESX 5i were used to perform the tests since this is the only supported deployment option.

Three servers were used in this setup. One (virtual) server was installed to be the View Connection server, another (virtual) server was the vCenter, and one physical ESX 5i host was used. One automated desktop pool was used to create a pool of 150 desktops.

Citrix VDI-in-a-box 5 with Hyper-V Server R2 SP1

In May of 2011 Citrix acquired Kaviza. Later in 2011 Citrix launched the Kaviza product as 'Citrix VDI-in-a-Box'. In November 2011, version 5.0 was released which introduced support for Microsoft Hyper-V. The IOPS testing done was done with the 5.0 release and using Microsoft Hyper-V.

Citrix VDI-in-a-Box comes in the form of a Linux appliance that needs to be loaded on a Hyper-V host. VDI-in-a-Box was configured to interface with a Hyper-V R2 SP1 host. It is important to note that VDI-in-a-Box does not support Hyper-V Dynamic Memory so the 150 virtual desktops had to be provisioned in two batches. First 75 virtual desktops were provisioned and then reconfigured to use Dynamic Memory using a PowerShell script. Then this procedure was repeated for the second batch of virtual desktops, resulting in a total of 150 virtual desktops as required for the tests.

Native Microsoft Hyper-V

Tests were also performed using Microsoft Hyper-V R2 SP1 for comparison purposes. The tests were identical to the vWorkspace 7.5 tests with the exception that HyperCache was not enabled.

Test Procedure and Methodology

Test Procedure

Login VSI 3.0 was used to generate a workload of 150 concurrent users on a single dedicated server. Login VSI is the standardized benchmark for VDI and SBC environments and used by key vendors in the desktop virtualization space. The LoginVSI 3.0 medium workload was used for these tests. This workload simulated a medium knowledge worker using Office, IE and PDF. The medium workload opens up to five apps simultaneously. The typing rate was 160 ms per character. Approximately one minute of idle time was included to simulate real-world users. Each loop opened and used:

- Outlook 2010 – 10 messages are browsed.
- Internet Explorer 8 – One instance is left open to BBC.co.uk and one instance is browsed to Lonelyplanet.com , Wired.com and heavy Flash movie trailer (480p) of Kick Ass the movie.
- Word 2010 – One instance to measure response time and one instance to review and edit a document.
- FreeMind (an open source Java application) - a map was edited
- Bullzip PDF Printer & Acrobat Reader – The Word document is printed and reviewed to PDF.
- Excel 2010 – A very large, randomized sheet is opened.
- PowerPoint 2010 – A presentation is reviewed and edited.
- 7-zip (command-line version) – The output of the session is zipped.

Test Methodology

Unless mentioned otherwise, Quest staff consistently used these methodologies to perform their tests:

- Before each test was started, the server host and launcher infrastructure were completely restarted to ensure the test was not influenced by previous tests.
- In all tests the virtual desktops were pre-booted.
- Each test was initiated at least 25 minutes after the last VM had been started.
- All tests were performed at least twice.
- All I/O tests were performed with a five-second collection interval.
- All tests were performed using local storage.

Test Results

Individual Product Results

Quest vWorkspace 7.5 with Hyper-V Server R2 SP1

Windows Performance Monitor was used to monitor the local disk activity and determine the total amount of IOPS used during a LoginVSI medium workload run that simulated 150 concurrent users. LoginVSI logs were used to determine when the test started and completed. The template virtual machine was located on a second Hyper-V host on a 1 Gbps LAN.

vWorkspace 7.5 with Hyper-V R2 SP1	RUN1	RUN2	Average
Time to provision 150 desktops	11:29	11:51	11:40
Average IOPS for 150 LoginVSI Medium sessions	616	630	623

Citrix XenDesktop 5.5

The built-in IOstat command of XenServer was used to monitor the local disk activity and determine the total amount of IOPS used during a LoginVSI medium workload run that simulated 150 concurrent users. LoginVSI logs were used to determine when the test started and completed.

The template virtual machine was located on the same and only XenServer machine used in this test.

Citrix XenDesktop 5.5 on XenServer 5.5 SP2	RUN1	RUN2	Average
Time to provision 150 desktops	1h 20m 50s	1h 17m 23s	1h 19m 05s
Average IOPS for 150 LoginVSI Medium sessions	885	916	901

VMware View 5.0

VMware ESXtop was used to monitor the local disk activity and determine the total amount of IOPS used during a LoginVSI medium workload run that simulated 150 concurrent users. The ESXtop data was then imported into Windows Performance Monitor to extract the following data. LoginVSI logs were used to determine when the test started and completed.

The template virtual machine was located on a second ESX host on a 1 Gbps LAN.

VMware View 5.0 with ESX 5i (via vCenter 5)	RUN1	RUN2	Average
Time to provision 150 desktops	1h 42m 17s	1h 39m 51s	1h 41m 04s
Average IOPS for 150 LoginVSI Medium sessions	968	980	974

Citrix VDI-in-a-Box 5

Windows Performance Monitor was used to monitor the local disk activity and determine the total amount of IOPS used during a LoginVSI medium workload run that simulated 150 concurrent users. LoginVSI logs were used to determine when the test started and completed. The template virtual machine was located on the same and only Hyper-V host machine use in these tests.

Citrix VDI-in-a-Box	RUN1	RUN2	Average
Time to provision 150 desktops	1h 37m 54s	1h 38m 02s	1h 37m 58s
Average IOPS for 150 LoginVSI Medium sessions	1107	1144	1126

Native Microsoft Hyper-V

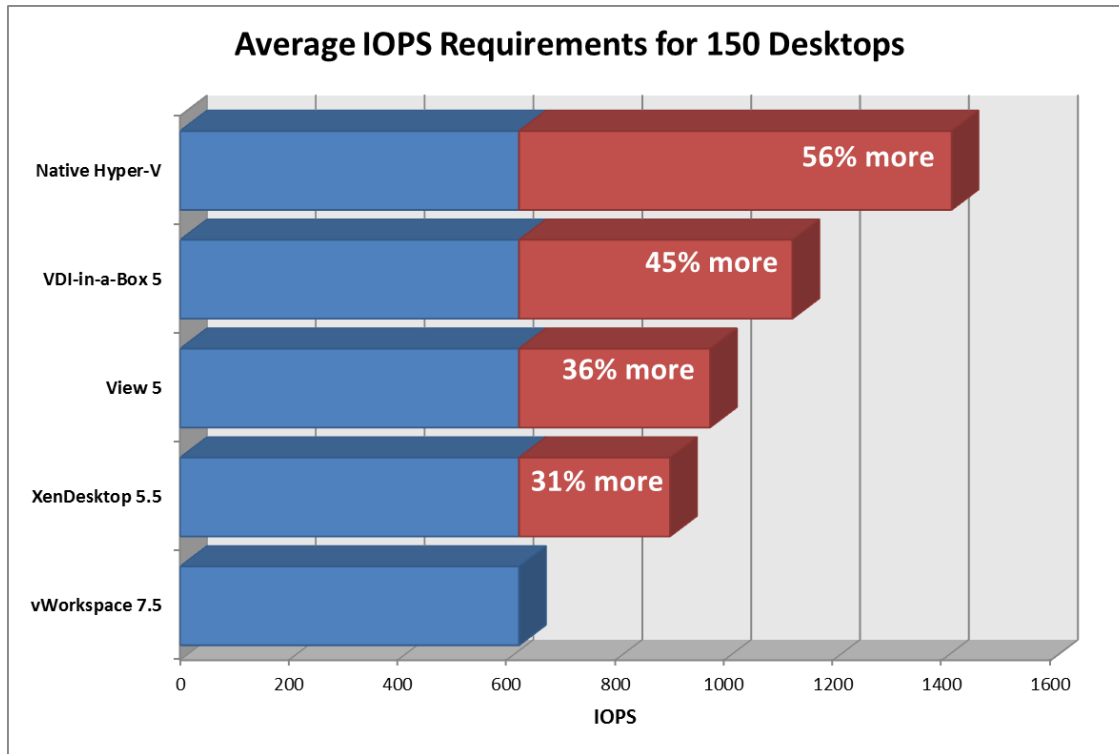
Tests were also performed using Microsoft Hyper-V R2 SP1 for comparison purposes. The time to provision the 150 virtual desktops was not measured because vWorkspace 7.5 was used to provision the desktops.

Windows Performance Monitor was used to monitor the local disk activity and determine the total amount of IOPS used during a LoginVSI medium workload run that simulated 150 concurrent users. LoginVSI logs were used to determine when the test started and completed. The average from two separate runs is displayed below.

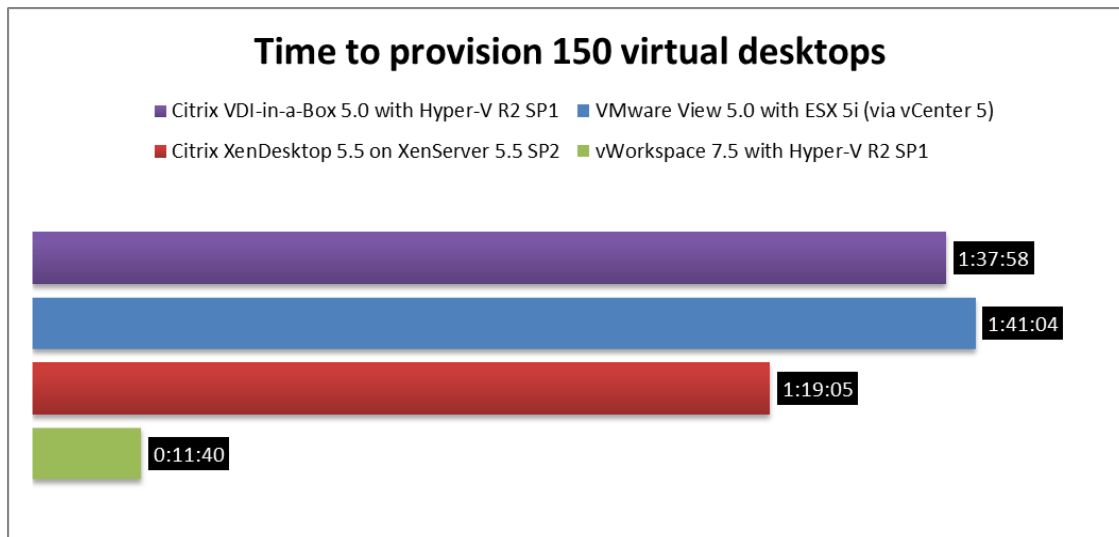
vWorkspace 7.5 with Hyper-V R2 SP1	RUN1	RUN2	Average
Time to provision 150 desktops	-	-	-
Average IOPS for 150 LoginVSI Medium sessions	1411	1425	1418

Product Comparison Results

Average IOPS Requirements



Time to Provision 150 Virtual Desktops



Total Cost per User

Desktop Virtualization Product	Quest vWorkspace 7.5 Desktop Edition	Citrix XenDesktop 5.5 VDI Edition	VMware View 5 Premier	Citrix VDI-in-a-Box 5.0
Hypervisor	Hyper-V R2 SP1	XenServer 5.6 SP2	ESXi 5.1	Hyper-V R2 SP1
Virtual desktop servers ¹	\$128	\$128	\$128	\$128
Hypervisor cost ²	\$0	\$0	bundled	\$0
SAN storage for VMs ³	\$50	\$65.50	\$68	\$72.50
Desktop virtualization product ⁴	\$47.52	\$65	\$83.33	\$53.33
Software Assurance ⁵	\$0	\$30	\$0	\$33
Production support ⁶	\$0	\$50	\$45.10	\$50
Microsoft licensing ⁷	\$0	\$0	\$0	\$0
Total cost per concurrent user per year	\$226	\$312	\$326	\$337

1. The annualized per-user costs for hardware, maintenance and data center. One study from a well-known analyst firm suggests a figure of \$173, while a study assuming a higher density of virtual desktops puts the cost at \$83. This paper uses the average of the two, which is \$128.
2. The licensing cost of the hypervisor used. For the tests reported in this paper, the cost for the hypervisor was zero or it was included in the license bundle of the desktop virtualization product.
3. Leading analyst firms cite a cost per user of \$50 when deploying non-persistent VDI. This figure was recalculated for the other solutions -- using IOPS savings figures from the "Average IOPS requirements" table -- to reflect the storage savings that vWorkspace 7.5 delivers.
4. The list price of the desktop virtualization product per concurrent user when purchasing licenses for 500 users, spread out over three years.
5. The cost for Software Assurance (SA) (the right to upgrade to the most recent version of the software). The listed price of vWorkspace includes three years of SA and production support. The list price of SA for Citrix VDI-in-a-Box is \$99 per user for three years; first-year maintenance is not included with the product. The listed price for Citrix XenDesktop VDI Edition includes first-year maintenance, so only two years of SA must be purchased. VMware View SA is not included in the desktop virtualization product purchase, but it is bundled with support (6). Prices are annualized.
6. The cost for 24x7x365 phone support for three years, annualized.
7. The cost for Microsoft Windows VDA (Virtual Desktop Access) licensing. VDA is free when the customer has Software Assurance. This calculation assumes that the customer already has SA (see 5).

Appendix: Component Specifications

Virtual Desktop Host

Server Model	HPDL380G67
CPU	Dual CPU Intel Hex-core Xeon X5660 @2.8-GHz
Memory	108GB; 1333MHZ
Disk	8 x 300GB , 10K RPM SAS
RAID level	RAID-1 for OS (2 disks), RAID 0 (6 disks) for VM volume (25% Read / 75% Write)
RAID controller	HP Smart Array P420i, 512Mb RAM, battery backed write cache
Network	2x HP NC382i s, 1 Gbps connection
Hyper-V version	Windows Server 2008 R2 Enterprise SP1, build 6.1.7601
XenServer version	5.6 SP2
ESX version	5.0.0.469512

Virtual Desktops

Windows version	Windows 7 Enterprise SP1, build 6.1.7601
CPU	1 vCPU
Memory config Hyper-V	DM: Startup 512 MB, max 3000 MB, 20% buffer, default memory weight
Memory config XenServer	DMC: minimum 512 MB, maximum 3000 MB
Memory config ESXi	1024 MB (memory overcommitted)
Disk	1 disk, 1 partition 15 GB
Optimizations	Windows 7 VRC optimizations (see projectvrc.com)

Launchers

Windows version	Windows Server 2008 R2 Enterprise SP1, build 6.1.7601 running on Hyper-V R2 SP1
CPU	2 vCPU
Memory	1024 MB of RAM (static memory)
Disk	1 disk, 1 partition 15 GB
RDP Version	Microsoft Remote Desktop Client 7.1, build 6.1.7601
Number of launchers	5
Network	1 Gbps

Launcher RDP Config

Screen Resolution	1024x786 resolution
Session Color Depth	16-bit color depth
Client Drive Mapping	disabled
Client Printing	disabled
Font Smoothing	disabled

Login VSI Configuration

Launch type	Parallel launching
Connection type	Customer command line with CSV
Sessions	150
Timeframe	90000
Workload type	Medium (with Office 2010)

vWorkspace Connection Broker Configuration (Single Server Setup)

CPU	2 vCPU
Memory	4 GB RAM
Network	1 Gbps
Version	7.5.0.533
Database	SQL Express
Operating System	Windows Server 2008 R2 Enterprise SP1, build 6.1.7601

Citrix Desktop Controller Configuration (Single Server Setup)

CPU	2 vCPU
Memory	4 GB RAM
Network	1 Gbps
Version	5.5
Database	SQL Express
Operating System	Windows Server 2008 R2 Enterprise SP1, build 6.1.7601

VMware View Connection Server Configuration

CPU	2 vCPU
Memory	4 GB RAM
Network	1Gbps
Version	5.0.0.481677
Database	SQL Express
Operating System	Windows Server 2008 R2 Enterprise SP1, build 6.1.7601

VMware vCenter Server Configuration

CPU	2 vCPU
Memory	8 GB of RAM
Network	1 Gbps
Version	5.0.0.16964
Database	SQL Express
Operating System	Windows Server 2008 R2 Enterprise SP1, build 6.1.7601

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