

DESKTOP VIRTUALIZATION WITH VMWARE VIEW 5 COMPARED TO CITRIX XENDESKTOP 5.5

VMware® View™ 5

Performed better than or equal to Citrix® XenDesktop® 5.5
with equivalent settings on LoginVSI workloads
simulating common office applications



When planning a virtual desktop infrastructure, performance matters. You want to ensure that your VDI platform can deliver a solid user experience while minimizing the impact on network bandwidth and other critical resources.

We set out to compare the single-desktop performance of VMware View 5 and Citrix XenDesktop 5.5 over the LAN (Local Area Network). We first examined the default settings of the two platforms to ensure our test result would be comparable. We found that VMware View 5 defaults to lossless compression while Citrix XenDesktop defaults to lossy compression. We therefore ran two set of tests using several different Login VSI workloads: one set with both platforms using equivalent lossy compression levels, and the other set with both platforms using lossless compression levels.

Throughout all our performance testing, we found that VMware View 5 was equal or superior to XenDesktop 5.5 in bandwidth consumed and CPU resources required from both client and server when running common office applications over the LAN. Only in the unique case of client-side Flash movie rendering did Citrix XenDesktop 5.5 perform better than VMware View 5. The reduction in bandwidth and CPU across our wide variety of workloads means that View-based virtual desktops can achieve greater density, which can result in cost savings for an organization.



LOSSLESS VS. LOSSY DATA COMPRESSION—A PRIMER

Virtual desktop protocols use compression algorithms to efficiently deliver text, images, and multimedia from the datacenter to the end-user device. **Lossless data compression** allows the original data to be reconstructed exactly from compressed data. In cases where perfect fidelity to the original image is not necessary, **lossy data compression** allows for an approximation of the original data in exchange for a savings in bandwidth and compute resources.

Both compression methods have specific use cases and benefits, so neither is superior to the other. In a VDI setting, lossless data compression is preferable when it is critical that the decompressed data be identical to the original. For example, a surgeon looking at an MRI needs a fully lossless image so as not to confuse minor image imperfections with soft tissue damage. By contrast, a participant in an online seminar will benefit greatly from the savings in bandwidth that lossy data compression provides, while still enjoying high-quality picture and sound.

Out of the box, PCoIP® protocol, used by VMware View 5, and HDX protocol, used by Citrix XenDesktop 5.5, use very different approaches to delivering data from the datacenter to the end-user's device. By default, PCoIP renders images up to 30 frames per second (FPS), achieving lossless reproduction once stable, and HDX renders images at up to 24 FPS, settling at 'normal quality' lossy reproduction. To compare the performance of these two protocols, we created both lossy and lossless testing scenarios where both PCoIP and HDX were yielding similar image quality to the receiver. We ran a series of Login VSI tests and used a frame grabber to capture rendered images for both PCoIP and HDX to ensure neither platform had any unfair advantage with respect to lossy or lossless compression. We zoomed in on several sample screens to analyze quality levels for both PCoIP and HDX. We made adjustments to each setup to ensure that our performance tests were a fair comparison.

Using these new adjusted settings, we then measured the CPU and bandwidth usage of each platform during our Login VSI test runs to see which solution used less of each.

For information for our test system, see [Appendix A](#). For our test methodology, see [Appendix B](#).

BANDWIDTH AND CPU UTILIZATION WITH VMWARE VIEW 5 AND CITRIX XENDESKTOP 5.5

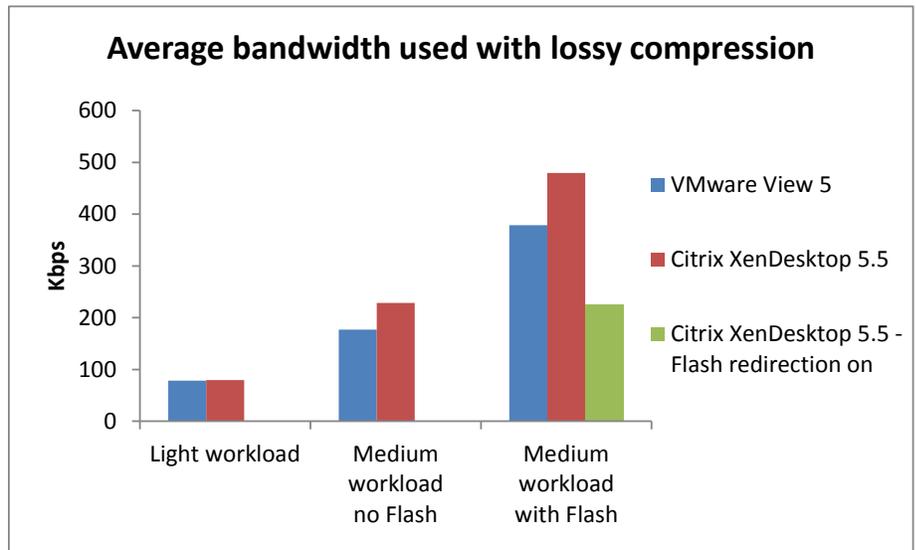
As Figures 1 and 2 show, with both lossy and lossless compression, VMware View 5 average bandwidth usage was less than or equal to that of Citrix XenDesktop 5.5 when running common office applications. The only exception to this was the unique case of the Medium workload with Flash, where XenDesktop's use of Flash redirection

for the Flash movie trailer in Login VSI resulted in lower bandwidth usage. While the redirection approach has advantages, it is also dependent upon a variety of conditions. First, Flash redirection requires a rich client capable of rendering the media. The content must also be accessible by both the client and the VM. Both client and VM also must have supported browsers and compliant versions of Adobe® Flash® Player installed. If any one of these components is not functioning, or is not compatible, the system will fail back to server-side rendering. Citrix dedicated a troubleshooting guide just for Flash redirection, which is located at <http://support.citrix.com/article/ctx127188>.

Using Flash redirection also raises various security concerns, as Citrix details on their support Web site: “Caution: Flash Redirection requires significant interaction between the user device and server components. Therefore, this feature should be used only in environments where security separation between the user device and server is not needed. User devices should be configured to use the Flash Redirection features only with trusted servers. Flash Redirection requires the Flash Player be to be installed on the user device. Therefore, Flash Redirection should be enabled only if the Flash Player itself is secured.”¹

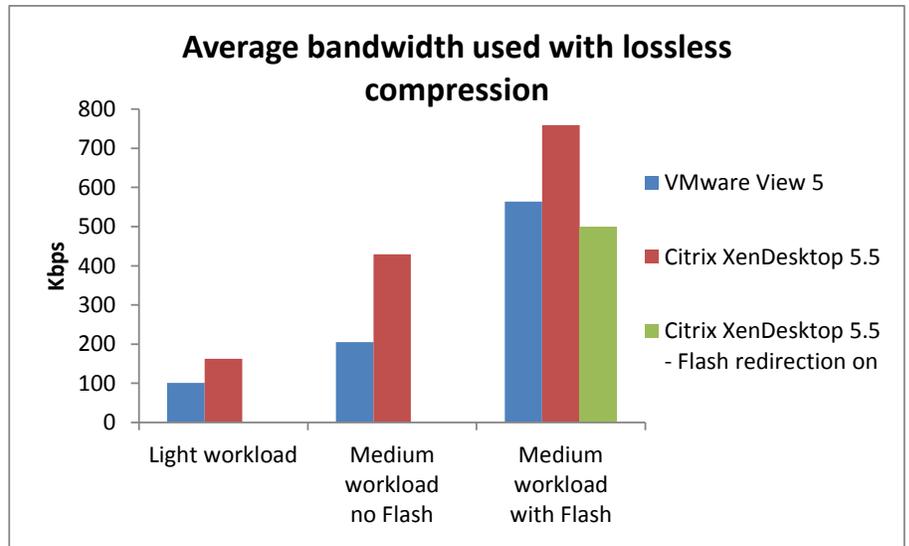
For more detailed test results, including impact of the Flash movie trailer during the tests, see [Appendix E](#).

Figure 1. With lossy compression, VMware View 5 average bandwidth usage was less than or equal to that of Citrix XenDesktop 5.5.



¹ <http://support.citrix.com/proddocs/topic/xenapp65-admin/hd-flash-wrapper-ad.html>

Figure 2. With lossless compression, VMware View 5 average bandwidth usage was less than that of Citrix XenDesktop 5.5.



As Figures 3 and 4 show, with both lossy and lossless compression, VMware View 5 average virtual desktop CPU utilization was less than that of Citrix XenDesktop 5.5. Again, only in the workload that included the Flash movie trailer did XenDesktop 5.5 using Flash redirection show lower CPU utilization.

Figure 3. With lossy compression, VMware View 5 average virtual desktop CPU utilization was less than that of Citrix XenDesktop 5.5.

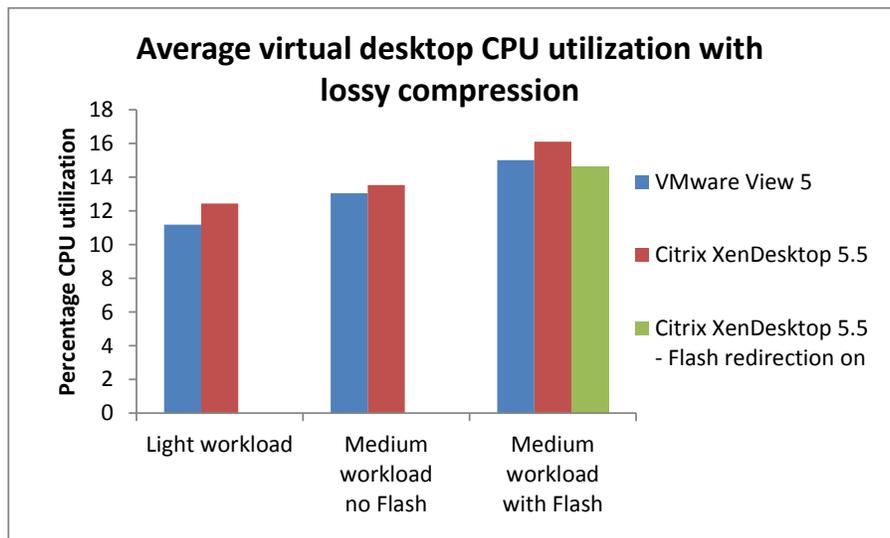
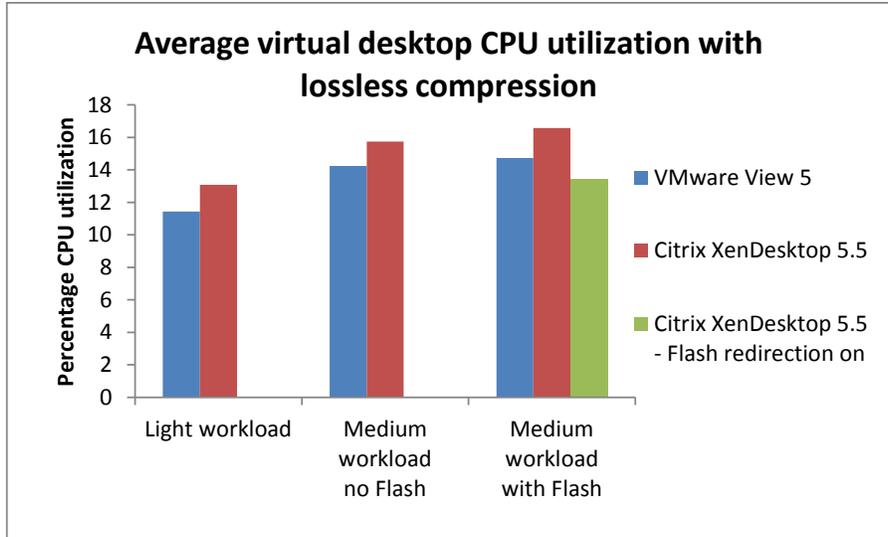


Figure 4. With lossless compression, VMware View 5 average virtual desktop CPU utilization was less than that of Citrix XenDesktop 5.5.



As Figures 5 and 6 show, with both lossy and lossless compression, VMware View 5 average client CPU utilization was less than that of Citrix XenDesktop 5.5. This includes all tested workloads including those that contained the Flash Movie trailer.

Figure 5. With lossy compression, VMware View 5 average client CPU utilization was less than that of Citrix XenDesktop 5.5.

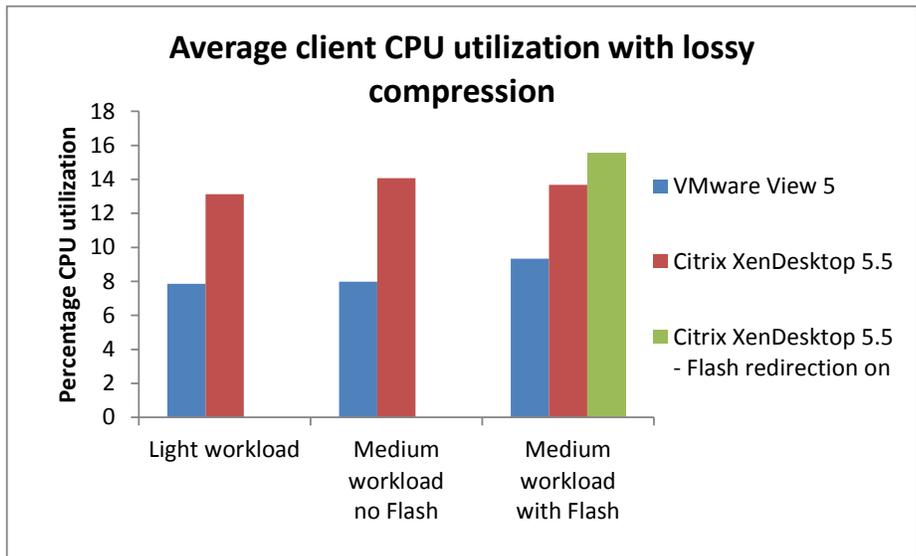
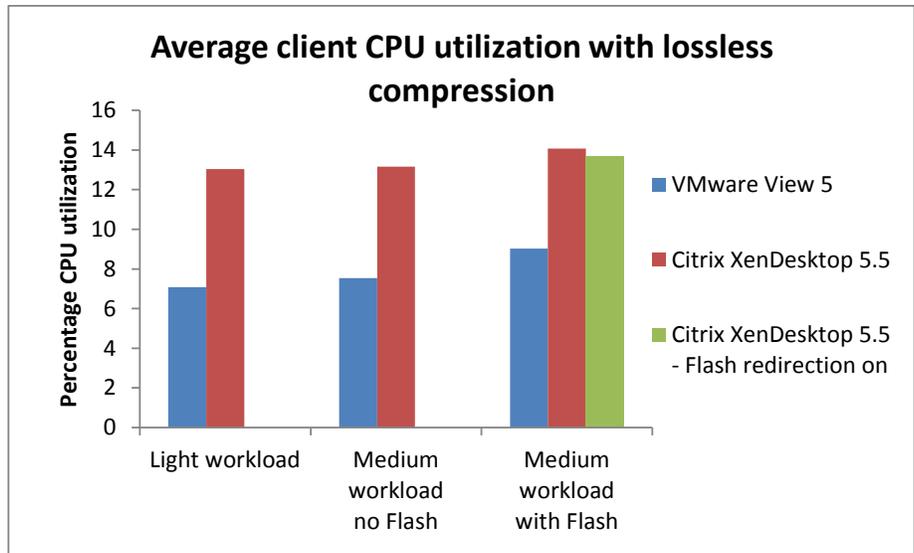


Figure 6. With lossless compression, VMware View 5 average client CPU utilization was less than that of Citrix XenDesktop 5.5.



DEVIATING FROM THE DEFAULT—ABOUT OUR SETTINGS

Before we ran our tests we first analyzed the output of each product at default settings with both set to lossy compression. We took screen prints from various points in the Login VSI workloads with a frame grabber (see Figure 7). When we analyzed the screen prints closely, we discovered that HDX at default (normal) lossy compression levels had a noticeable deficit in image quality (left column). To make the protocols more comparable, we adjusted the HDX lossy compression level to 'low' (i.e., increased image quality). To make PCoIP render lossy images, we disabled build to lossless, and dropped the maximum initial image quality from 90 to 70. Finally, because HDX defaults to 24 FPS, we also changed PCoIP to 24 FPS. With the new settings, the HDX low lossy compression images (center column) are more comparable to PCoIP lossy images (right column). Figure 7 shows examples of this image quality. For more detail on the settings used, see [Appendix C](#).



Figure 7. Image quality for lossy images.

To further investigate, we set the images to black and white, changed the Reds value from 40 percent to 100 percent, and changed the Blues value from 20 percent to 60 percent. This process enabled us to better see the level of pixilation for each setting. In Figure 8, you can see that both HDX default lossy compression (left column) and HDX low lossy compression (center column) render images that are inferior in quality to the PCoIP lossy images (right column).

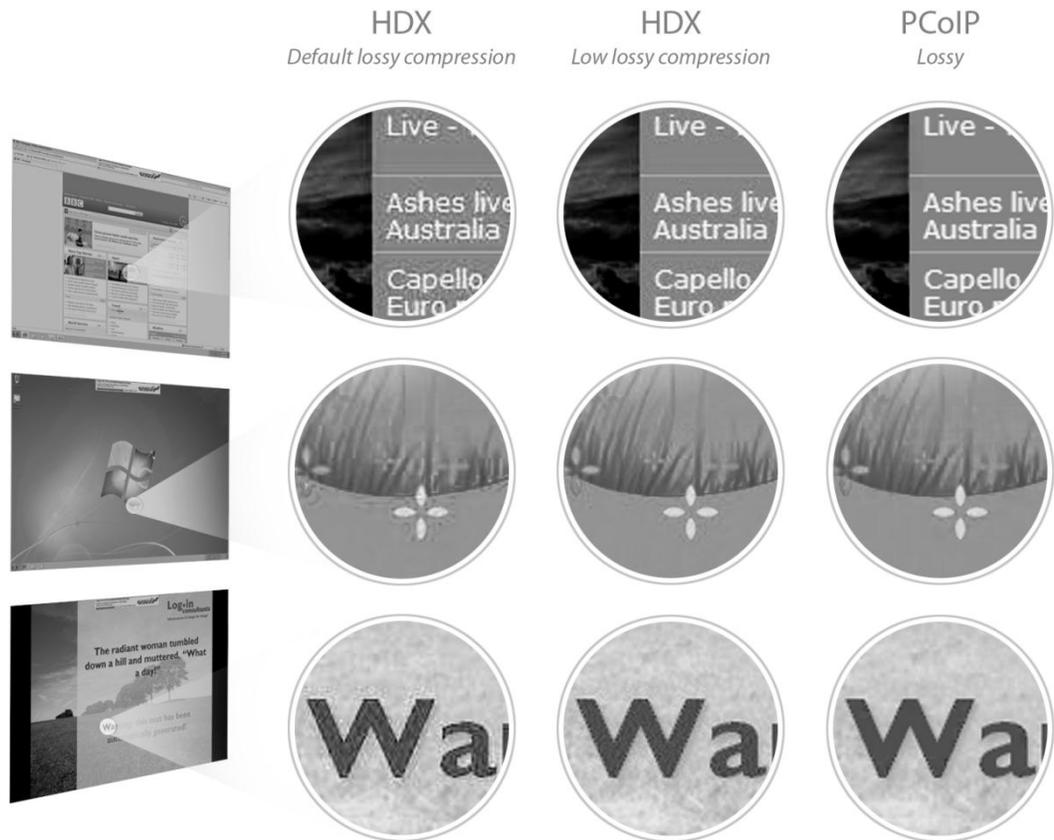


Figure 8. Image quality for lossy images, viewed in black and white.

After settling on the appropriate setting for lossy compression, we then moved to an analysis of the lossless configurations. We changed HDX to render lossless, as this is the PCoIP default. We set HDX lossy compression to none, and changed HDX to 30 FPS. View 5 by default renders lossless at 30 FPS. Figure 9 shows a comparable lossless image quality.



Figure 9. Image quality for lossless images.

We again changed the images to black and white to confirm that the images were consistent. Figure 10 confirms a similar image quality when lossless rendering is used.



Figure 10. Image quality for lossless images, viewed in black and white.

OUR FINDINGS

Figures 11 through 13 present average bandwidth usage and percentage CPU utilization for the two approaches across the three workloads. The workloads used are described in detail in Appendix D. For more detailed test results, see [Appendix E](#).

Light workload			
Activity	VMware View 5	Citrix XenDesktop 5.5	Percentage VMware View 5 win
Lossy compression			
Average bandwidth in Kbps	78.45	79.33	1.1%
Virtual desktop CPU utilization percentage	11.18	12.43	10.1%
Client CPU utilization percentage	7.86	13.12	40.1%
Lossless compression			
Average bandwidth in Kbps	101.23	162.8	37.8%
Virtual desktop CPU utilization percentage	11.43	13.09	12.7%
Client CPU utilization percentage	7.08	13.04	45.7%

Figure 11. Average bandwidth usage and CPU utilization for the light workload. Lower numbers are better (except for percentage win).

Medium workload no Flash			
Activity	VMware View 5	Citrix XenDesktop 5.5	Percentage VMware View 5 win
Lossy compression			
Average bandwidth in Kbps	176.83	228.33	22.6%
Virtual desktop CPU utilization percentage	13.05	13.53	3.5%
Client CPU utilization percentage	7.98	14.08	43.3%
Lossless compression			
Average bandwidth in Kbps	204.84	429.3	52.3%
Virtual desktop CPU utilization percentage	14.25	15.74	9.5%
Client CPU utilization percentage	7.54	13.16	42.7%

Figure 12. Average bandwidth usage and CPU utilization for the Medium workload no Flash. Lower numbers are better (except for percentage win).

Medium workload with Flash				
Activity	VMware View 5	Citrix XenDesktop 5.5	Percentage VMware View 5 win over XenDesktop 5.5	Citrix XenDesktop 5.5 with FMR
Lossy compression				
Average bandwidth in Kbps	378.62	479.54	21.0%	225.29
Virtual desktop CPU utilization percentage	15.01	16.10	6.8%	14.65
Client CPU utilization percentage	9.33	13.68	31.8%	15.53
Lossless compression				
Average bandwidth in Kbps	563.59	759.21	25.8%	497.33
Virtual desktop CPU utilization percentage	14.73	16.58	11.2%	13.43
Client CPU utilization percentage	9.02	14.07	35.9%	13.66

Figure 13. Average bandwidth usage and CPU utilization for the Medium workload with Flash. Lower numbers are better (except for percentage win).

FINAL THOUGHTS

In a true apples-to-apples comparison where lossy and lossless policies are applied equally to both platforms to yield a comparable user experience, VMware View 5 demonstrates equal or better efficiency in LAN bandwidth consumption and in client and server side CPU utilization when compared to Citrix XenDesktop 5.5 on common office applications. This advantage in efficiency can translate into greater density, better user experience and lower cost for an organization using VDI technologies.

APPENDIX A – TEST SERVER AND STORAGE CONFIGURATION

Figure 14 provides detailed configuration information for the test server, and Figure 15 provides configuration information for the EMC® VNX™ 5500 storage array.

System	Dell™ PowerEdge™ R910 server
Power supplies	
Total number	4
Vendor and model number	Dell
Wattage of each (W)	1,100
Cooling fans	
Total number	6
Vendor and model number	Delta Electronics Inc. PFC1212DE
Dimensions (h x w) of each	120mm x 38mm
Volts	12
Amps	4.80
General	
Number of processor packages	2
Number of cores per processor	8
Number of hardware threads per core	16
System power management policy	Active Power Controller
CPU	
Vendor	Intel®
Name	Xeon®
Model number	X7560
Stepping	D0
Socket type	LGA 1565
Core frequency (GHz)	2.26
Bus frequency (MHz)	3,200
L1 cache	8 x 32KB Data, 8 x 32KB Instruction
L2 cache	8 x 256 KB
L3 cache (MB)	24
Platform	
Vendor and model number	PowerEdge R910
Motherboard model number	P658H
BIOS name and version	Dell Inc. 2.2.3
BIOS settings	Default
Memory module(s)	
Total RAM in system (GB)	256
Vendor and model number	Samsung M393B1G70DJ1-CF8
Type	PC3-8500R
Speed (MHz)	1,066
Speed running in the system (MHz)	1,067
Timing/Latency (tCL-tRCD-tRP-tRASmin)	7-7-7-34.7
Size (GB)	8

System	Dell™ PowerEdge™ R910 server
Number of RAM module(s)	32
Chip organization	Dual
Rank	4Rx4
Operating system	
Name	ESXi 5.0.0 (504890)
File system	VMFS
Kernel	5.0.0
Language	English
RAID controller	
Vendor and model number	PERC H700
Firmware version	12.10.1-0001
Cache size (MB)	512
Hard drives	
Vendor and model number	Dell/Seagate ST9146852SS
Number of drives	16
Size (GB)	146
RPM	15,000
Type	SAS
Vendor and model number	Broadcom® NetXtreme® II BCM5709
Type	Integrated
Optical drive(s)	
Vendor and model number	TEAC DV-28S
Type	SATA
USB ports	
Number	4
Type	2.0

Figure 14. Detailed configuration information for the server.

About the EMC VNX 5500 storage array

The EMC VNX 5500 storage array is a tiered storage solution that provides several options for capacity and performance levels to best meet your company's needs. The EMC VNX uses FAST Cache to intelligently tier storage based on the applications being used, automatically moving frequently read data to high-performance SSDs to provide both high capacity and high performance. To learn more about the EMC VNX series, visit

<http://www.emc.com/storage/vnx/vnx-series.htm>.

System	EMC VNX 5500 storage array
Storage	
Number of 15-disk processor enclosures	1
Power supplies	
Total number	2
Disk array enclosures	
Number of 25-disk array enclosures	1
Number of 15-disk array enclosures	1
Data movers	
Number of VNX 5500 data movers	1
Disks	
Number of 100GB SSDs	8
Number of 300GB SAS drives	20
Number of 2TB NL SAS drives	10
Operating system	
Name	Unisphere
Storage Fabric	
Vendor and model number	4 Gb FC

Figure 15. Detailed configuration information for the storage.

APPENDIX B – TEST METHODOLOGY

Here, we explain the detailed steps we followed to set up our test scenario. Figure 16 shows our test environment.

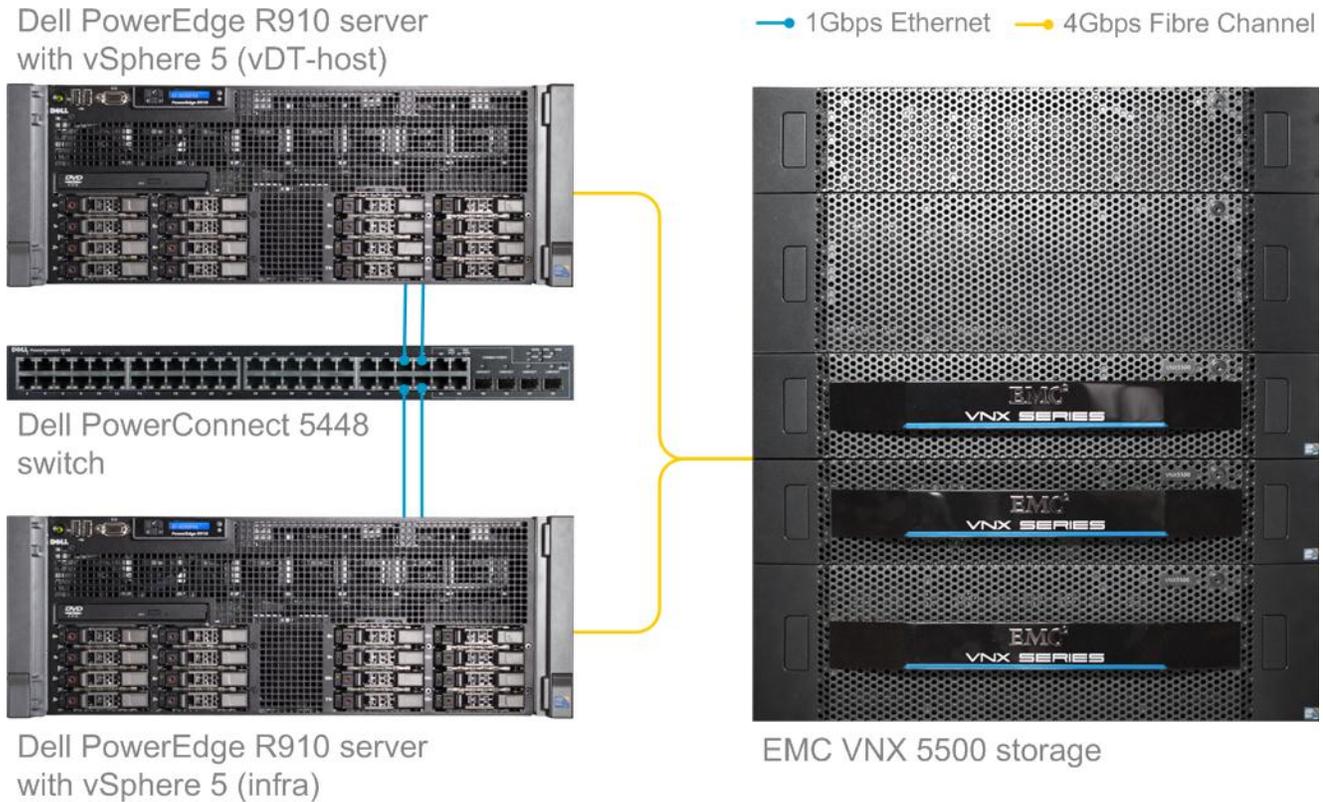


Figure 16. Our test environment.

Figure 17 details our virtual machine specifications.

VM name	Hosted OS	Role (s)	Host	Memory	# vCPUs
DC1	Win 2008 R2 x64 Enterprise	AD Domain controller VSI Share, DHCP,DNS,NTP, AD roaming profiles	infra	4 GB	2
XD-DDC	Win 2003 R2 x64 Enterprise	XenDesktop Delivery Controller, License Server	infra	4 GB	4
VMW-View	Win 2008 R2 x64 Enterprise	VMware View Connection server	infra	4 GB	4
XD-PVS	Win 2008 R2 x64 Enterprise	XenDesktop Provisioning Services	infra	4 GB	4
vCenter	Win 2008 R2 x64 Enterprise	VMware Virtual Center, Composer	infra	4 GB	4
Launcher	Windows 7 x 64 Enterprise	Login VSI Master launcher	infra	4 GB	2

VM name	Hosted OS	Role (s)	Host	Memory	# vCPUs
XD-gold	Windows 7 x 64 Enterprise	XenDesktop master image	vDT-host	2 GB	1
View-gold	Windows 7 x 64 Enterprise	View master image	vDT-host	2 GB	1

Figure 17. Virtual machine specifications.

We configured a Dell PowerEdge R910 with VMware vSphere™ (ESXi) 5.0 to host all VDI infrastructure components for VMware View 5.0 and Citrix XenDesktop 5.5. We installed a Dell PowerEdge R910 with VMware vSphere 5.0 to host virtual desktops for both VMware View 5.0 and Citrix XenDesktop 5.5

We installed and configured a Dell PowerConnect™ 5448 switch with one network for data. We connected each Dell PowerEdge R910 server to the data network.

We connected both Dell PowerEdge R910s to an EMC VNX 5500 storage array via 4 Gb FC and configured the array to host the virtual desktops. To optimize read operations for each platform, we put the master virtual desktop image on a dedicated 3-disk array of high performance SSDs.

Setting up the storage

EMC VNX 5500 storage array

To host all testing infrastructure, we installed a Dell PowerEdge R910 server. We configured the Dell PERC H700 array controller to use 16 146GB SAS disks in a RAID 10 configuration to host the ESXi hypervisor.

To host all virtual desktops, we installed a second Dell PowerEdge R910 server. We configured the Dell PERC H700 array controller to use 16 146GB SAS disks in a RAID 10 configuration to host the ESXi hypervisor.

We configured the EMC VNX 5500 storage array to present a high-performance LUN consisting of a three-disk SSD RAID group to host the Windows® 7 master images for both VMware View 5.0 and Citrix XenDesktop 5.5 and our domain controller. We created a FAST Cache enable storage pool. From the pool, we provisioned a 500 GB LUN to host all infrastructure and Login VSI launchers, and another 500 GB LUN for all virtual desktop change disks.

Setting up the internal storage on the Dell PowerEdge R910 (infra) for host operating system installation

1. Enter the RAID controller BIOS by pressing Ctrl+R at the relevant prompt during boot.
2. Highlight Controller 0, and press F2.
3. Select Create New VD.
4. Select all 16 drives, select RAID level 10, tab to the OK button, and press Enter. Accept the warning regarding initialization.
5. Select the new virtual drive, press F2, and select Initialization, Start Init.
6. Wait for the initialization operation to complete.
7. Repeat steps 2 through 6 for the remaining internal volume, selecting drives three and four.
8. Press Escape, and choose to Save and Exit to return to the boot sequence.

Setting up the internal storage on the Dell PowerEdge R910 (vDT-host) for host operating system installation

1. Enter the RAID controller BIOS by pressing Ctrl+R at the relevant prompt during boot.
2. Highlight Controller 0, and press F2.
3. Select Create New VD.
4. Select all 16 drives, select RAID level 10, tab to the OK button, and press Enter. Accept the warning regarding initialization.

5. Select the new virtual drive, press F2, and select Initialization, Start Init.
6. Wait for the initialization operation to complete.
7. Repeat steps 2 through 6 for the remaining internal volume, selecting drives three and four.
8. Press Escape, and choose to Save and Exit to return to the boot sequence.

Setting up the external storage FAST Cache and RAID groups

1. Open EMC Navisphere.
2. Log in as sysadmin
3. Click System→System Management→Manage Cache.
4. In the VNX5500 storage system properties, click the FAST Cache tab, and click Create.
5. Select Enclosure 0 Disk 10 and 11, and click OK.
6. Click Storage→Storage Configuration→Storage Pools.
7. Click RAID Groups, and click Create.
8. Create storage.
9. In the General tab, select RAID 0.
10. In the General tab, for disks, click Manual and select Disk enclosure 0, SSD disks 4, 5 and 6, and click Apply.
11. Click Create.
12. In the General tab, select RAID 5.
13. In the General tab, for disks, click Manual, and select Disk enclosure 0:
 - a. Disk enclosure 0: SSD disks 7, 8, 9
 - b. Disk enclosure 1: SAS disks 0-19
14. In the Advanced tab, select the check box next to FAST cache Enabled, and click OK.

Provisioning LUNS

1. Open Storage →LUNs.
2. Click Create:
 - a. For Storage pool type, click RAID group.
 - b. For Storage pool for new LUN=, select 0
 - c. For Capacity, type 271.00 GB
 - d. For LUN ID, select 0
 - e. For Name, type SSD and click Apply.
3. Click Create:
 - a. For storage pool type, click RAID group.
 - b. For storage pool for new LUN, =select pool0
 - c. For capacity, type 500.00 GB
 - d. For number of LUNS to create, select 2
 - e. For Name, type LUN and for starting ID, type 1 and click Apply.

Creating a storage group

1. Click Hosts, and under Storage groups, click Create.
2. For Storage Group Name, type VDI and click OK.
3. Open the storage group VDI.
4. Click the LUNs tab.
5. Expand SPA, and highlight LUN1, LUN2, and SSD. Click Add, and click Apply.
6. Click OK to confirm, and click OK to exit.

Setting up the infrastructure server (infra) and the virtual desktop hosts (vDT-host)

BIOS settings

We used the latest BIOS updates on each of the two Dell PowerEdge R810s and the Dell PowerEdge R910. We adjusted the default BIOS settings by enabling Virtualization Technology, disabling C-States, and setting the performance profile to maximum performance.

Installing VMware vSphere 5.0 (ESXi) on the PowerEdge R910 (infra)

1. Insert the ESXi 5.0 disk, and select Boot from disk.
2. On the Welcome screen, press Enter.
3. On the End User License Agreement (EULA) screen, press F11.
4. On the Select a Disk to install or Upgrade Screen, select the relevant volume to install ESXi on, and press Enter.
5. On the Please Select a Keyboard Layout screen, press Enter.
6. On the Enter a Root Password Screen, assign a root password, and confirm it by entering it again. Press Enter to continue.
7. On the Confirm Install Screen, press F11 to install.
8. On the Installation complete screen, press Enter to reboot.

Configuring ESXi after installation

1. On the ESXi 5.0 screen, press F2, enter the root password, and press Enter.
2. On the System Customization screen, select Troubleshooting Options, and press Enter.
3. On the Troubleshooting Mode Options screen, select enable ESXi Shell, and press Enter.
4. Select Enable SSH, press Enter, and press Esc.
5. On the System Customization screen, select Configure Management Network.
6. On the Configure Management Network screen, select IP Configuration.
7. On the IP Configuration screen, select Set static IP; enter an IP address, subnet mask, and default gateway; and press Enter.
8. On the Configure Management Network screen, press Esc. When asked if you want to apply the changes, press Y.
9. Log into infra as `root` with the vSphere client.
10. Select the Configuration tab, and click Networking.
11. Click Add Networking...
12. Create a virtual machine network called `VDI-NET` and select the appropriate adapters.
13. Select vSwitch0 properties...
14. Click vSwitch, and click Edit...
15. Click the NIC Teaming tab, and change load balancing to Route based on IP hash.
16. Ensure both adaptors are active.
17. Click OK.

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16. Ensure both adaptors are active.
17. Click OK.

Adding the ESXi servers to the EMC storage group

1. Open EMC Navisphere.
2. Log in as `sysadmin`
3. Click hosts, and under storage groups, click the VDI storage group, and click Properties.
4. In the Storage Group Properties box, click the Hosts tab.
5. Add infra and vDT-Host, and click OK.
6. Reboot both esxi servers.

Creating the ESXi datastore (SSD)

1. Log into infra as `root` with the vSphere client.
2. Click Configuration tab→Storage→Add Storage.
3. Select LUN0, and click Next.
4. Select VMFS-5, and click Next.
5. Review the disk layout, and click Next.
6. For Datastore name, type `SSD` and click Next.
7. For Capacity, select Maximum available space, and click Next.
8. Click Finish to create the datastore.

Creating the ESXi datastore (LUN1, 2)

1. Log into infra as `root` with the vSphere client.
2. Click Configuration tab→Storage→Add Storage.
3. Select LUN1, and click Next
4. Select VMFS-5, and click Next.
5. Review the disk layout, and click Next.
6. For Datastore name, type `LUN1` and click Next.
7. For Capacity, select Maximum Available Space, and click Next.
8. Click Finish to create the datastore.
9. Repeat steps 1 through 8 to create LUN2.

Setting up a VM to host Microsoft® Windows Active Directory® server (DC1)

1. Connect to the infra server via the VMware vSphere client.
2. Log in as `root` to the infra server.
3. In the vSphere client, connect to the vCenter™ Server, and browse to the ESXi host.
4. Click the Virtual Machines tab.
5. Right-click, and choose New Virtual Machine.
6. Choose Custom, and click Next.
7. Assign the name `DC1` to the virtual machine, and click Next.
8. Select `infra` for the host, and click Next.
9. Select SSD for the storage, and click Next.
10. Choose Virtual Machine Version 8, and click Next.
11. Choose Windows, choose Microsoft Windows Server® 2008 R2 (64-bit), and click Next.
12. For CPUs, select one virtual processor socket, and 2 cores per virtual socket, and click Next.
13. Choose 4 GB RAM, and click Next.
14. Click 1 for the number of NICs, select VMXNET3, connect to the VDI-NET network, and click Next.
15. Leave the default virtual storage controller, and click Next.
16. Choose to create a new virtual disk, and click Next.
17. Make the OS virtual disk size 40 GB, choose thick-provisioned lazy zeroed, specify the OS datastore on the external storage, and click Next.
18. Keep the default virtual device node (`0:0`), and click Next.
19. Click Finish.
20. Right-click the VM, and choose Edit Settings.
21. On the Hardware tab, click Add...
22. Click Hard Disk, and click Next.
23. Click Create a new virtual disk, and click Next.
24. Specify 15 GB for the virtual disk size, choose thin provisioning, and specify SSD.
25. Choose SCSI (`0:1`) for the device node, and click Next.
26. On the Hardware tab, click Add...
27. Click Create a new virtual disk, and click Next.
28. Specify 50 GB for the virtual disk size, choose thin provisioning, and specify SSD.
29. Choose SCSI (`0:2`) for the device node, and click Next.
30. Click Finish, and click OK.
31. Click the Resources tab, and click Memory.
32. Select reserve all guest memory, and click OK.
33. Connect the VM virtual CD-ROM to the Microsoft Windows Server 2008 R2 installation disk.
34. Start the VM.

Installing the Microsoft Windows Server 2008 R2 operating system on the VM

1. Choose the language, time and currency, and keyboard input. Click Next.
2. Click Install Now.
3. Choose Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
4. Accept the license terms, and click Next.
5. Click Custom.
6. Click the Disk, and click Drive options (advanced).
7. Click New→Apply→Format, and click Next.
8. After the installation completes, click OK to set the Administrator password.
9. Enter the administrator password twice, and click OK.
10. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.

11. Enable remote desktop access.
12. Change the hostname to DC1 and reboot when prompted.
13. Run diskmgmt.msc.
14. Select the 15 GB secondary volume, name it `profiles` format it NTFS, and assign it drive letter E
15. Select the 50 GB secondary volume, name it `share` format it NTFS, and assign it drive letter F
16. Set up networking for the data network:
 - a. Click Start→Control Panel, right-click Network Connections, and choose Open.
 - b. Right-click the VM traffic NIC, and choose Properties.
 - c. Uncheck TCP/IP (v6).
 - d. Select TCP/IP (v4), and choose Properties.
 - e. Set the IP address as `172.0.0.10/255.255.252.0`
17. Install VM tools. For more information, see http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340
18. Reboot.

Installing Active Directory and DNS services on DC1

1. Click Start→Run, type `dcpromo` and click OK.
2. At the Active Directory Domain Services Installation Wizard welcome screen, check the Use advanced mode installation option, and click Next.
3. In the Choose a Deployment Configuration dialog box, select Create a new domain in a new forest, and click Next.
4. At the FQDN page, type `VDI.com` and click Next.
5. At the NetBIOS name prompt, leave the name VDI, and click Next.
6. At the Forest Functionality level, select Windows Server 2008 R2, and click Next.
7. At the additional Domain Controller Options, leave DNS server selected, and click Next.
8. At the System Folder Location screen, change to `E:\` leave the default options, and click Next.
9. Assign a Directory Services Restore Mode Administrator account password, and click Next.
10. At the Summary screen, review your selections, and click Next.
11. Once Active Directory Domain Services finishes installing, click Finish, and restart the system.
12. Run `dnsmgmt.msc`.
13. Create a reverse lookup zone for DC1.
14. Create static entries for `infra` and `vDT-host`.
15. Open Windows Explorer, and create a file called `e:\profiles`
16. Assign permissions of read/write to the `VDI\everyone` group.

Configuring the Windows time service on DC1

To ensure reliable time, we pointed our Active Directory server to a physical NTP server.

1. Open a command prompt.
2. Type the following:


```

W32tm /config /syncfromflags:manual /manualpeerlist:"<ip address of a NTP server>"
W32tm /config /reliable:yes
W32tm /config /update
W32tm /resync
Net stop w32time
Net start w32time
      
```

Setting up DHCP services on DC1

1. Click Start→Administrative Tools→Server Manager→Add Roles.

2. Select DHCP Server, and click Next.
3. At the Introduction to DHCP Server screen, click Next.
4. At the Specify IPv4 DNS Settings screen, type `vdi.com` for the parent domain.
5. Type the preferred DNS server IPv4 address, and click Next.
6. At the Specify IPv4 WINS Server Settings screen, select WINS is not required for applications on the network, and click Next.
7. At the Add or Edit DHCP Scopes screen, click Add.
8. At the Add Scope screen, enter the Name DHCP Scope name.
9. In the next box, set the following values, and click OK.
 - Start IP address=`172.0.0.101`
 - End IP address=`172.0.3.200`
 - Subnet mask=`255.255.252.0`
10. Check the Activate This Scope box.
11. At the Add or Edit DHCP Scopes screen, click Next.
12. Click the Enable DHCP v6 Stateless Mode radio button, and click Next.
13. Leave the default IPv6 DNS Settings, and click Next.
14. At the Authorize DHCP server dialog box, select Use current credentials.
15. At the Confirm Installation Selections screen, click Next. If the installation is set up correctly, a screen displays saying that DHCP server install succeeded.
16. Click Close.
17. Click Start→Run and type `DHCPmgmt.msc`
18. DHCP→`dc1.vdi.com`→IPv4→Server Options.
19. Right-click Server Options, and select Configure options.
20. Activate option 66 Boot Server Host Name.
 - String value=`<ip of the XenDesktopController>`
21. Activate option 67 Boot file Name.
 - String value= `ARDBP32.BIN`
22. Click OK.

Setting up the Login VSI share and Active Directory users

For Login VSI to work correctly, you must create a CIFS share, Active directory OU, and Active directory. For more information on Login VSI, see <http://www.loginvsi.com/en/admin-guide/installation.html>

1. Open Windows Explorer, and create a file called `f:\share`
2. Assign permissions of read/write to the VDI/everyone group.
3. Right-click the `f:\share` folder, and select Properties.
4. Click the sharing tab, and click Share...
5. Add everyone to the Read/Write group, and click Share.
6. From the login VSI 3.5 media, run the login VSI AD Setup.
7. Keep the defaults, and click Start.

Creating roaming profiles for users

1. Open active directory users and computers.
2. Browse to `VDI.com`→Login_VSI→Users→Target.
3. Select all login VSI users, and right-click Properties.
4. Click the Profiles tab.
5. Check box Profile path, and type `e:\profiles\%username%`
6. Click OK.

Setting up a VM to host the vCenter server (vCenter)

Setting up a VM to host the vCenter server

1. Connect to the infra server via the vSphere client.
2. Log into infra with the VMware vSphere client.
3. In the vSphere client, connect to the vCenter Server, and browse to the ESXi host.
4. Click the Virtual Machines tab.
5. Right-click, and choose New Virtual Machine.
6. Choose Custom, and click Next.
7. Assign the name `vCenter` to the virtual machine, and click Next.
8. Select infra for the host, and click Next.
9. Select LUN1 for the storage, and click Next.
10. Choose Virtual Machine Version 8, and click Next.
11. Choose Windows, choose Microsoft Windows Server 2008 R2 (64-bit), and click Next.
12. For CPUs, select one virtual processor socket, and 2 cores per virtual socket, and click Next.
13. Choose 4GB RAM, and click Next.
14. Click 1 for the number of NICs, select VMXNET3, connect to the VDI-NET portgroup, and click Next.
15. Leave the default virtual storage controller, and click Next.
16. Choose to create a new virtual disk, and click Next.
17. Make the OS virtual disk size 40 GB, choose thick-provisioned lazy zeroed, specify the OS datastore on the data1, and click Next.
18. Keep the default virtual device node (0:0), and click Next.
19. Connect the VM virtual CD-ROM to the Microsoft Windows 2008 R2 installation disk.
20. Click Finish.
21. Right-click the vCenter VM, and click Edit settings.
22. Click the Resources tab, and click Memory, and check box Reserve all guest memory, and click OK.
23. Start the VM.

Installing the Microsoft Windows Server 2008 R2 operating system on the VM

1. Choose the language, time and currency, and keyboard input. Click Next.
2. Click Install Now.
3. Choose Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
4. Accept the license terms, and click Next.
5. Click Custom.
6. Click the Disk, and click Drive options (advanced).
7. Click New→Apply→Format, and click Next.
8. After the installation completes, click OK to set the Administrator password.
9. Enter the administrator password twice, and click OK.
10. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.
11. Enable remote desktop access.
12. Change the hostname to `vCenter5` and reboot when prompted.
13. Set up networking for the data network:
 - a. Click Start, Control Panel, right-click Network Connections, and choose Open.
 - b. Right-click the VM traffic NIC, and choose Properties.
 - c. Uncheck TCP/IP (v6).
 - d. Select TCP/IP (v4), and choose Properties.
 - e. Set the IP address, subnet, gateway, and DNS server.
14. Join the VDI domain.

15. Reboot the system.
16. Install VM tools. For more information, see http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340
17. Reboot.

Installing VMware vCenter

1. Log onto the vCenter as `VDI\administrator`
2. From the VMware vCenter5 install media, click Autorun.
3. Click Run to start the install wizard.
4. Click the Install button on the VMware vSphere 5.0 wizard.
5. Select the Install wizard language as English, and click OK.
6. At the Install wizard welcome screen, click Next.
7. Agree to the license agreement, and click Next.
8. Enter user information and a license key, and click Next.
9. Select Install the SQL express instance, and click Next.
10. Select the system account for the vCenter Server service account, and click Next.
11. Keep the installation directory as `C:\Program Files\VMware\Infrastructure\`, and click Next.
12. Select Create a standalone VMware vCenter Server instance, and click Next.
13. Keep the vCenter default ports, and click Next.
14. Select 1024 MB for the JVM memory, and click Next.
15. Click Install to finish the vCenter server installation.
16. Restart the server when complete.
17. Using the vSphere client, log into vCenter5 as `VDI\administrator`
18. Right-click the root of vCenter, and click New Data center.
19. Name the New datacenter `VDI`
20. Add the ESX server named `vDT-Host` to the datacenter.
21. Add the ESX server named `infra` to the datacenter.

Setting up ODBC DSN for composer

1. From the vCenter desktop, Open Start→All Programs→Microsoft SQL Server 2008 R2→Configuration Tools→SQL Server Configuration Manager.
2. Click SQL Server Network Configuration→Protocols for `VIM_SQLEXP`.
3. Right-click TCP/IP, and select Enabled.
4. Click SQL Services→right-click SQL server browser, and select Properties.
5. IN the SQL Server Browser properties, select the Services tab, change the Start mode to Automatic, and click OK.
6. Start the SQL server browser service.
7. Select Start→Run→`odbcad32.exe`.
8. Click the system DSN tab.
9. Click Add.
10. Click SQL Server, and click Finish.
11. In the Create a New Data Source to SQL Server text box, enter the connection name type: `composer`
12. For Server, select `vCenter\VIM_SQLEXP`, and click Next.
13. Leave authentication as default, click Next twice, and click Finish.
14. Click OK to create the composer ODBC connection.

Setting up VMWare composer

1. Open the View5 media folder, and run the file names `VMware-viewcomposer-2.7.0-481620.exe`.
2. At the Welcome screen and the Patents screen, click Next.
3. Accept the VMware end user license agreement, and click Next.

4. Leave the Destination folder as default, and click Next.
5. In the Database information box, for source name type `composer` for user name type `VDI\Administrator` and type the password, click Next.
6. Leave the default SOAP port, and click Next.
7. Click Install, and click finish.

Setting up a VM to host the VMware View 5 connection server

1. Log into vCenter with the VMware vSphere client.
2. In the vSphere client, browse to the ESXi host named `infra`.
3. Click the Virtual Machines tab.
4. Right-click, and choose New Virtual Machine.
5. Choose Custom, and click Next.
6. Assign the name `View5` to the virtual machine, and click Next.
7. Select `infra` for the host, and click Next.
8. Select `LUN1` for the storage, and click Next.
9. Choose Virtual Machine Version 8, and click Next.
10. Choose Windows, choose Microsoft Windows Server 2008 R2 (64-bit), and click Next.
11. For CPUs, select one virtual processor socket, and 2 cores per virtual socket, and click Next.
12. Choose 4GB RAM, and click Next.
13. Click 1 for the number of NICs, select `VMXNET 3`, connect to the `VDI-NET` portgroup, and click Next.
13. Leave the default virtual storage controller, and click Next.
14. Choose to create a new virtual disk, and click Next.
15. Make the OS virtual disk size 40 GB, choose thick-provisioned lazy zeroed, specify the OS datastore on the external storage, and click Next.
16. Keep the default virtual device node (`0:0`), and click Next.
17. Connect the VM virtual CD-ROM to the Microsoft Windows Server 2008 R2 installation disk.
18. Right-click the `View5` VM, and click Edit settings.
19. Click the Resources tab, click Memory, check box Reserve all guest memory, and click OK.
20. Click Finish.
21. Start the VM.

Installing the Microsoft Windows Server 2008 R2 operating system on the VM

1. Choose the language, time and currency, and keyboard input. Click Next.
2. Click Install Now.
3. Choose Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
4. Accept the license terms, and click Next.
5. Click Custom.
6. Click the Disk, and click Drive options (advanced).
7. Click New→Apply→Format, and click Next.
8. After the installation completes, click OK to set the Administrator password.
9. Enter the administrator password twice, and click OK.
10. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.
11. Enable remote desktop access.
12. Change the hostname to `view5` and reboot when prompted.
13. Set up networking for the data network:
 - a. Click Start→Control Panel, right-click Network Connections, and choose Open.
 - b. Right-click the VM traffic NIC, and choose Properties.
 - c. Uncheck TCP/IP (v6).
 - d. Select TCP/IP (v4), and choose Properties.

- e. Set the IP address, subnet, gateway, and DNS server.
14. Join the VDI domain.
15. Install VM tools. For more information, see http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340
16. Reboot.

Installing the VMware View 5 connection server

1. Log into the server named view5.
2. Click Install Media for View Connection Server.
3. To begin the install wizard, click Next.
4. Agree to the license agreement, and click Next.
5. Keep the destination directory as C:\Program Files\VMware View\Server\, and click Next.
6. Select View Standard Server, and click Next.
7. Allow View Server to configure the firewall, and click Next.
8. Click Next.
9. Click Finish.
10. Reboot the View 5 server.
11. Log out of View 5.

Configuring the VMware View 5 connection server

1. Open a Web browser to <the view server ipaddress>/admin.
2. Log in as administrator
3. Open View Configuration→Servers.
4. In the vCenter Servers workspace, click Add..
5. In the add vCenter Server settings, add the vCenter, and enable View composer. Click OK.
6. Open View Configuration→Product Licensing and Usage.
7. Click Edit license..
8. Enter a valid license serial number, and click OK.
9. Close the view 5 administrator.

Setting up a VM to host XenDesktop

1. Connect to the infra server via the vSphere client.
2. Log into infra with the VMware vSphere client.
3. In the vSphere client, connect to the vCenter Server, and browse to the ESXi host.
4. Click the Virtual Machines tab.
5. Right-click, and choose New Virtual Machine.
6. Choose Custom, and click Next.
7. Assign the name XD-55 to the virtual machine, and click Next.
8. Select infra for the host, and click Next.
9. Select LUN1 for the storage, and click Next.
10. Choose Virtual Machine Version 8, and click Next.
11. Choose Windows, choose Microsoft Windows Server 2008 R2 (64-bit), and click Next.
12. For CPUs, select one virtual processor socket, and 2 cores per virtual socket, and click Next.
13. Choose 4GB RAM, and click Next.
14. Click 1 for the number of NICs, select VMXNET3, connect to the VDI-NET portgroup, and click Next.
15. Leave the default virtual storage controller, and click Next.
16. Choose to create a new virtual disk, and click Next.
17. Make the OS virtual disk size 40 GB, choose thick-provisioned lazy zeroed, specify the OS datastore on the data1, and click Next.

18. Keep the default virtual device node (0:0), and click Next.
19. Connect the VM virtual CD-ROM to the Microsoft Windows 2008 R2 installation disk.
20. Click Finish.
21. Right-click the vCenter VM, and click Edit settings
22. Click the Resources tab, click Memory, check box Reserve all guest memory, and click OK.
23. Start the VM.

Installing the Microsoft Windows Server 2008 R2 operating system on the VM

1. Choose the language, time and currency, and keyboard input. Click Next.
2. Click Install Now.
3. Choose Windows Server 2008 R2 Enterprise (Full Installation), and click Next.
4. Accept the license terms, and click Next.
5. Click Custom.
6. Click the Disk, and click Drive options (advanced).
7. Click New→Apply→Format, and click Next.
8. After the installation completes, click OK to set the Administrator password.
9. Enter the administrator password twice, and click OK.
10. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.
11. Enable remote desktop access.
12. Change the hostname to XD-55 and reboot when prompted.
13. Set up networking for the data network:
 - a. Click Start, Control Panel, right-click Network Connections, and choose Open.
 - b. Right-click the VM traffic NIC, and choose Properties.
 - c. Uncheck TCP/IP (v6).
 - d. Select TCP/IP (v4), and choose Properties.
 - e. Set the IP address, subnet, gateway, and DNS server.
14. Join the VDI domain.
15. Reboot the system.
16. Install VM tools. For more information, see http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340
17. Reboot.

Installing Citrix XenDesktop 5.5

We installed XenDesktop desktop delivery controller and Provisioning services on two virtual machines to use vSphere. Before we can use XenDesktop and vSphere server, we needed to edit the vCenter proxy.xml file to allow access via http.

Editing the vCenter prox.xml file to allow http access

1. Open a console to the vCenter Server, and login as VDI\administrator
2. Open Wordpad, and edit the file C:\Users\All Users\VMware\VMware VirtualCenter\proxy.xml.
3. Find the /sdk entry.
4. Change httpsWithRedirect to httpAndHttps .
5. Save the proxy/xml file, and reboot the vCenter.

Installing the Citrix XenDesktop delivery Controller

We installed the Citrix XenDesktop and XenDesktop licensing server on the XD-55 VM.

1. Log into the server named XD-55.
2. Insert the media for Citrix XenDesktop 5.5.
3. Click Install XenDesktop.

4. Click I accept the terms and condition, and click Next.
5. Select all components to install, install SQL Express, and click Next.
6. Allow firewall ports to be open if necessary, and click Next.
7. Click Install.
8. Leave the checkbox next to Configure XenDesktop after closing checked, and click Close.
9. In the root of the Citrix Desktop Studio tool, click Desktop deployment.
10. Type `XD-site` for site name, use the default database option, and click Next.
11. Select Citrix XenDesktop Platinum, and click Add the appropriate license file for XenDesktop.
12. For host type, select VMware virtualization and fill out the following fields:
 - a. Enter the host address as `http://vcenter.vdi.com/sdk`
 - b. Enter the username as `administrator`
 - c. Enter the administrator password
 - d. Enter the connection name as `vCenter`
 - e. Select Manually create virtual machines.
13. Click Finish to create the site.
14. Open the Citrix Desktop Studio.
15. Select Browser→Desktop Studio→Configuration→Hosts, and click Add Host.
16. In Add Host Wizard, ensure vCenter is selected, and click Next.
17. For cluster, select vDT-host, for storage, select LUN1, for guest network, select VDI-Net, and click Next.
18. Name the Host `vDT-host` and click Finish.

Setting up a VM to host Provisioning Services

1. Connect to the infra server via the vSphere client.
2. Log into infra with the VMware vSphere client.
3. In the vSphere client, connect to the vCenter Server, and browse to the ESXi host.
4. Click the Virtual Machines tab.
5. Right-click, and choose New Virtual Machine.
6. Choose Custom, and click Next.
7. Assign the name `XD-PS` to the virtual machine, and click Next.
8. Select infra for the host, and click Next.
9. Select LUN1 for the storage, and click Next.
10. Choose Virtual Machine Version 8, and click Next.
11. Choose Windows, choose Microsoft Windows Server 2008 R2 (64-bit), and click Next.
12. For CPUs, select one virtual processor socket, and 2 cores per virtual socket, and click Next.
13. Choose 4GB RAM, and click Next.
14. Click 1 for the number of NICs, select VMXNET3, connect to the VDI-NET portgroup, and click Next.
15. Leave the default virtual storage controller, and click Next.
16. Choose to create a new virtual disk, and click Next.
17. Make the OS virtual disk size 40 GB, choose thick-provisioned lazy zeroed, specify the OS datastore on the data1, and click Next.
18. Keep the default virtual device node (0:0), and click Next.
19. Connect the VM virtual CD-ROM to the Microsoft Windows 2008 R2 installation disk.
20. Click Finish.
21. Right-click the XD-PS, and choose Edit Settings.
22. On the Hardware tab, click Add...
23. Click Hard Disk, and click Next.
24. Click Create a new virtual disk, and click Next.
25. Specify 50 GB for the virtual disk size, thick-provisioned lazy zeroed, and specify SSD.

26. Choose SCSI (1:0) for the device node, and click Finish.
27. Click the new SCSI controller, and click Change type...
28. Select VMware Paravirtual, and click OK.
29. Click the Resources tab, click Memory, check box Reserve all guest memory, and click OK.
30. Start the VM.

Installing SQL Express on XD-PS

A SQL database is required for Provisioning Services; we used the included SQL express installation files on the Citrix Provisioning Service media to create a database on the XD-PS host.

1. Log into the server named XD-PS.
2. Insert the media for Citrix Provisioning services 6.0.
3. Browse to the SQL Express 2005Express\directory, and run SQLEXPRESS.exe.
4. Accept the End user agreement, and click Next.
5. At the Welcome screen, click Next.
6. Verify the system passes the system configuration check, and click Next.
7. Enter a name and organization, and click Next.
8. Select the default features, and click Next.
9. Select Windows authentication, and click Next.
10. Check both boxes to Enable user instances, add user to the SQL Server administrator Role, and click Next.
11. Click Next for error usage reporting, and click Next.
12. Click Install.
13. When completed, click Next , and Finish.
14. From the vCenter desktop, open Start→All Programs→Microsoft SQL Server 2005→Configuration Tools→SQL Server Configuration Manager.
15. Click SQL Server Network Configuration→Protocols for SQLEXPRESS.
16. Right-click TCP/IP, and select Enabled.
17. Click SQL Services→right-click SQL server browser, and select Properties.
18. In the SQL Server Browser properties, select the services tab, change the start mode to Automatic, and click OK.
19. Start the SQL server browser service.

Installing Citrix Provisioning Services 6 on XD-PS

1. Log into the server named XD-PS as VDI\administrator
2. Insert the media for Citrix Provisioning services 6.0.
3. Click Auto Run.
4. Click Server installation.
5. Click Install server.
6. At the welcome screen, click Next.
7. Accept the license agreement, and click Next.
8. Enter user name and organization name, and click Next.
9. Accept the default installation path, and click Next.
10. Select complete setup, and click Next.
11. Click Install.
12. Click Finish.
13. The Provisioning services configuration wizard will automatically launch. Click Next to begin.
14. For DHCP, select Service runs on another computer, and click Next.
15. For PXE services, click Service runs on this computer, and click Next.
16. For Farm creation, click Create farm, and click Next.

17. For the database server, for server name, type `XD-PS` and for instance name, type `SQLEXPRESS` and click Next.
18. For the farm, enter the following, and click Next:
 - Database name= `ProvisioningServices`
 - Farm= `farm`
 - Site= `site`
 - Collection name= `Collection`
 - Farm Administrator group= `VDI/builtin/administrators`
19. For the store path, enter Store name= `Store` and for Path, browse to the root of the 50 GB SSD LUN `e:\` and click Next.
20. Enter `XD-55.vdi.com` for the license server, and click Next.
21. Enter the `VDI\Administrator` Password twice, click the checkbox next to Configure the database for the account, and click Next.
22. Keep the default number of days between password updates, and click Next.
23. Keep the primary interface and communication ports, and click Next.
24. Keep the TFTP service at default, and click Next.
25. Leave the stream service at default, and click Next.
26. Click Finish.

Installing Citrix Provisioning Services Administrative Console XD-PS

1. Insert the media for Citrix Provisioning services 6.0.
2. Click Auto run.
3. Click Console installation.
4. Click Install to install the broker snap in.
5. Click I accept the terms in the License agreement, and click Install.
6. Click Finish.
7. At the welcome screen for Provisioning services Console, click Next.
8. Accept the licensing agreement, and click Next.
9. Enter a user name and organization name, and click Next.
10. Accept the default install path, and click Next.
11. Accept the default install type, and click Next.
12. Click Install and Finish.

Setting up a Windows 7 Enterprise x64 image template

Using the vSphere client, we created a Windows Enterprise x64 VMs base image and converted it into a template. Using our template, we deployed two VMs on vDT-host for gold image creation on VMware View, and XenDesktop. We also deployed a login VSI launcher on infra.

For the gold image VMs, we installed Microsoft Office 2007, installed the Login VSI target software, added them to the VDI domain, added them to the Login VSI OU, and installed the respective VMware View 5 and XenDesktop 5.5 agents.

For the Login VSI launcher VM, we installed the VMware View 5 client, the XenDesktop receiver and added it to the VDI domain, added it to Login VSI OU in Active Directory, and then installed the Login VSI Launcher software.

Installing the Windows 7 Enterprise (x64) base image VM

1. Log into the vCenter.
2. In the vSphere client, connect to the vCenter Server, and browse to the infra host.
3. Click the Virtual Machines tab.

4. Right-click, and choose New Virtual Machine.
5. Choose Custom, and click Next.
6. Assign the name as `win7-temp` and click Next.
7. Select infra for the host, and click Next.
8. Select LUN1.
9. Choose Virtual Machine Version 8, and click Next.
10. Choose Windows, choose Microsoft Windows 7 (64-bit), and click Next.
11. For CPUs, select one virtual processor socket, and 1 cores per virtual socket, and click Next.
12. Choose 2GB RAM, and click Next.
13. Click 1 for the number of NICs, select E1000, and click Next.
14. Leave the default virtual storage controller, and click Next.
15. Choose to create a new virtual disk, and click Next.
16. Make the OS virtual disk size 20 GB, choose thick-provisioned lazy zeroed, specify the OS datastore on the external storage, and click Next.
17. Keep the default virtual device node (0:0), and click Next.
18. Click Finish.
19. Click Finish, and click OK.
20. Right-click the `win7-temp` VM, and click Edit settings
21. Click the Resources tab, click Memory, and check box Reserve all guest memory.
22. Click the Hardware tab, CD/DVD Drive, and Connect the VM virtual CD-ROM to the Microsoft Windows 7 x64 installation disk.
23. Click OK.

Installing the Windows 7 Enterprise (x64) on the base image VM

1. When the installation prompts you, press any key to begin setup.
2. Enter your language preferences, and click Next.
3. Click Install.
4. Accept the license terms, and click Next.
5. Select Custom, and select the drive that will contain the OS.
6. Click Install, and the setup begins.
7. Type `user` for the username and change the computer name, and click Next.
8. Enter no password, and click Next.
9. For system protection, select Use recommended settings, and click Next.
10. Enter your time zone, and click Next.
11. Select the Work Network setting, and click Next.
12. Use Windows Update to patch the Windows 7 installation.
13. Install VMware tools
http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340
14. Reboot.

Installing Windows 7 Enterprise (x64), optimizing Windows 7

Adjusting page file

1. Log in as `administrator`
2. Right-click Computer→Properties→Change settings→Advanced→Performance→Settings.
3. In Performance settings, select the Advanced tab, and select Change for Virtual Memory.
4. Deselect automatically manage page file.
5. Select Custom size, type `2048` for both values, and select Set.

Disabling Windows Firewall

The domain GPO automatically disables the Windows Firewall.

Installing Office 2007 Professional and convert to template

1. From the Office 2007 media, run Setup.
2. Enter the product key for Office 2007, and click Continue.
3. Accept the licensing agreement.
4. Select default installation.
5. Click Install.
6. Download and run Office 2007 Service Pack 2.
7. Reboot the system.
8. Shutdown the VM.
9. Right click, and select template → convert to template.

Deploying the gold image from VMware View from template

1. In vSphere Client, browse to home → VMs and templates.
2. Right-click win7-temp deploy a virtual machine from template.
3. For Name, type `view_gold` and click Next.
4. Click Datacenter, and click Next.
5. Click the vDT-host server, and click Next.
6. Select LUN1, and click Next.
7. Select customization using existing customization specifications, select the appropriate file, and click Next.
8. Click Finish to deploy the `view_gold` VM.
9. Repeat steps 1 through 8 to deploy a `XD_gold` VM.
10. Repeat steps 1 through 8 to deploy a `Launcher_1` VM to host infra.

Preparing view_gold for deployment

Installing Login VSI target software on view_gold

1. Log into the `view_gold` VM as `VDI\administrator`
2. Browse to `\vsi-install\Target setup`.
3. Run the `setup.exe`.
4. In the Target Setup wizard, specify the VSI share ([\\dc1\share](#)).
5. Click Start.
6. When prompted with security warnings, click OK.
7. Reboot the system.

Installing the View 5 agent on view_gold

1. Browse to the VMware View 5 media, and run the `VMware-viewagent-x86_64-5.0.0-481677.exe` file.
2. Click Run.
3. At the Welcome screen, click Next.
4. At the Patents screen, click Next.
5. Accept the VMware End user License agreement, and click Next.
6. Select defaults, and click Next.
7. Click Install.

Configuring Regedit for Quick prep (kb.vmware.com/kb/1026556)

1. Click Start → Run, and type `regedit`
2. Browse to `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\vmware-viewcomposer-ga`.
3. Right-click `SkipLicenseActivation`, and click Modify...
4. Change the value from 1 to 0.

Enable ClearType Fonts

1. Click Start→Run, and type `cttune.exe`
2. Check the Turn on ClearType box, and click Next.
3. Follow the wizard to enable ClearType fonts.

Cleaning up the on view_gold VM.

1. Click Start→Run→services.msc.
2. In the Services menu, select Windows Search, and change it from Disabled to Automatic (delayed start).
3. Close the Services menu.
4. Click Start→Control Panel→View Devices and Printers.
5. In the Services and Printers window, delete the XPS printers and document writers.
6. Shutdown the Virtual machine.

Preparing XD_gold for deployment

Installing Login VSI target software on XD_gold

1. Log into the XD_gold VM as `VDI\administrator`
2. Browse to `\vsi-install\Target setup`.
3. Run the setup.exe.
4. In the Target Setup wizard, specify the VSI share ([\\dc1\share](#)).
5. Click Start.
6. When prompted with security warnings, click OK.
7. Reboot the system.

Installing the XD agent on XD_gold

1. Browse to the Citrix XenDesktop media, and run the `XdAgent_64.msi` file.
2. Click the checkbox next to I accept the terms in the license agreement.
3. Click Install.
4. Click Finish.

Creating a ListOfDDCs entry in the registry on XD_gold

1. Click Start→Run, and type `regedit`
2. Browse to `HKEY_LOCAL_MACHINE\Software\Wow6432\Citrix\VirtualDesktopAgent`.
3. Create a string value called `ListOfDDCs`
4. Right-click the ListOfDDCs string, and click Modify...
5. Type `XD-55.vdi.com` and click OK.
6. Close the registry editor.

Cleaning up the View_gold Windows 7 virtual desktop

1. Click Start→Run→services.msc.
2. In the Services menu, select Windows Search, and change it from Disabled to Automatic (delayed start).
3. Close the Services menu.
4. Click Start→Control Panel→View Devices and Printers.
5. In the Services and Printers window, delete the XPS printers and document writers.

Preparing Launcher_1 for testing

We installed our launcher with the login VSI target software, and both View 5 and XenDesktop clients. To assist in automating our launchers with Citrix XenDesktop, we installed Python 2.6. For more information on how to use Login VSI and XenDesktop, please see <http://www.loginvsi.com/en/news/citrix-releases-whitepaper-on-how-to-use-vsi-in-testing-xendesktop>.

Installing the login VSI launcher

1. Log into the XD_gold VM as VDI\administrator
2. Browse to \vsi-install\Launcher setup.
3. Run the setup.exe.
4. In the Target Setup wizard, specify the VSI share ([\\dc1\share](#)).

Installing the VMware View 5 client

1. Browse to the VMware View 5 media, and run the VMware-viewclient-x86_64-5.0.0-481677.exe file.
2. Click Run.
3. At the welcome screen, click Next.
4. At the patents screen, click Next.
5. Accept the VMware End user License agreement, and click Next.
6. Select defaults, and click Next.
7. Click Install.

Installing the Citrix Receiver 13.0.0

1. Browse to the Citrix XenDesktop media, and run the XdAgent_64.msi file.
2. When the installation is complete, reboot the launcher.

Configuring View 5 - creating a pool and adding entitlements for Login VSI users

1. Open vCenter→Datacenter→Infra, and right-click the view_gold VM, select Snapshot→Take Snapshot.
2. Name the snapshot view_gold
3. Open the View Administrator.
4. Log in as administrator
5. Click Pools, and in the right windows, click Add...
6. Select Automatic Pool, and click Next.
7. Select floating, enable automatic assignment, and click Next.
8. Select View Composer linked clones, and click Next.
9. Type pool for the pool ID and display name, and click Next.
10. Leave the pool settings as defaults, and click Next.
11. Select Redirect disposable files to a non-persistent disk, type 4096 MB for Disk Size, and click Next.
12. For the naming patter, type View- leave the pool size as 1, and click Next.
13. For the pool setting use:
 - Default image: view_gold - view_gold
 - VM folder: /Datacenter/vm/Pool
 - Host or cluster: DataCenter/host/vd-host.vdi.com
 - Resource pool: /Datacenter/host/vd-host.vdi.com/Resources
 - Datastore=SSD (replica disk) LUN2(Linked clones), and click Next
14. For Guest customization select the following:
 - Domain: VDI.com
 - AD container: OU=Users, OU=Login_VSI
 - Select Use Quick Prep, and click Next.
15. Click Finish.
16. Click Pool, and click Entitlements...
17. Click Add, type Login_VSI_TS and click OK.
18. Click Desktops, and wait for the View-1 virtual desktop to report as ready.

Configuring XD5.5 - creating a pool and adding entitlements for Login VSI users

To prepare the XD_gold image for deployment, we installed the provisioning services target device installation software on the XD_gold VM and created vDisk to stream from our Provisioning Service server.

1. Log into XD_gold as VDI\Administrator
2. Browse to the Provisioning services media.
3. Execute the autorun.exe.
4. Click Target Device Installation.
5. Click Install DIM (Device Identity Management).
6. To Being the DIM wizard, click Next.
7. Accept the License agreement, and click Next.
8. Click Install, and Finish when completed.
9. Click Yes to reboot.
10. Log into XD_gold as VDI\Administrator
11. Browse to the Provisioning services media.
12. Execute the autorun.exe.
13. Click target Device Installation.
14. At the welcome screen for Provisioning Service Target Device Wizard, click Next.
15. Accept the License agreement, and click Next.
16. Enter user name and organization name, and click Next.
17. Accept the default path, and click Next.
18. Click Install.
19. Click Finish

Provisioning Services Imaging Wizard

1. At the Welcome screen, click Next.
2. For server, type XD-PS and click Next.
3. Select Create new vDisk, and click Next.
4. Name the vDisk XD_gold_vdisk and click Next.
5. For Microsoft Volume Licensing, click None, and click Next.
6. Select the image volume defaults, ensure the Capacity is 20 GB and the free space is greater than 30%. Click Next.
7. For target device name, type PVS_XD_gold and click Next.
8. Click Finish to begin creating the empty vDisk.
9. In vCenter, right-click XD_gold, and click Edit settings.
10. Click Options tab→Boot options, check the box to force BIOS Setup, and click OK.
11. When the vDisk has been completed, click Yes to Reboot the XD_gold VM.
12. In the VM BIOS, tab to the Boot menu, and change the boot order to:
 - a. CD-ROM Drive
 - b. Intel E1000
 - c. Hard Drive
 - d. Removable Devices
13. Tab to Exit, and save exiting changes.
14. When the VM boots, it will boot from PXE and Provisioning services will stream the vDisk to the device.
15. Log in as VDI\administrator
16. Provisioning services will now copy XD_gold to the vDisk.
17. Click Finish.
18. Shutdown XD_gold.

19. In vCenter, right-click XD_gold edit settings.
20. Remove hard Disk 1 (do not delete the vmdk), and click OK.
21. Click XD_gold, and click Edit settings.
22. Click Add new hard disk.
23. Create a new virtual disk, and click Next.
24. For size, enter 4 GB, and click Next.
25. Leave the device as SCSI (0:0), and click Next.
26. Click Finish, and OK.

Enabling XD_gold to boot from vDisk

1. Log into XD-PS as VDI\administrator
2. Open all programs→Citrix→Provisioning Services→Provisioning Service Console.
3. Open Provisioning Services→Farm→Site→Device Collections→Collections, and right- click PVS_XD_gold.
4. Change boot from Hard Disk to vDisk, and click OK.
5. Change mode from private mode to standard image mode.
6. Click the checkbox next to Enable Active Directory machine account password management.

Booting the VM_gold vm from vDisk and formatting the 4 GB change disk

1. In vCenter, right-click VM_gold, and click Start VM.
2. Log into VM_gold as VDI\administrator
3. Open disk manager.
4. Initialize disk0, and click Format NTFS.
5. Shutdown the VM.

Enabling the 4GB local disk as cache

1. Open all programs→Citrix→Provisioning Services→Provisioning Service Console.
2. Open Provisioning Services→Farm→site→Device collections→collections, and right-click PVS_XD_gold.
3. In the General tab, change the cache type to Cache on device hard drive, and click OK.

Deploying a XenDesktop pool with the XenDesktop Setup wizard

1. In vCenter right click VM_gold and template→convert to template.
2. Name the snap shot VM_gold_template.
3. Open the Provisioning services console →Farm→sites→site, right click and select XenDesktop Setup Wizard..
4. At the welcome, screen click Next.
5. Type XD-55 for the XenDesktop Controller, and click Next.
6. Click the host vDT-host, and click Set Template
7. Type the administrator Password and click get templates.
8. Click VM_gold_template and click OK, and Click Next.
9. Select the Provisioning services collection as collection and XD_gold_vdisk as the assigned vDisk, and click Next.
10. Enter the following, and click Next:
 - Number of virtual machines= 1
 - vCPUs=1
 - Memory=2048 MB
 - Active Directory= Create New accounts
11. For Active directory location click VDI.com→Login_VSI→computers.
12. For Base name type XD-0#, and click Next.
13. Select Create a new catalog, and name it catalog, and click Next.
14. Click Finish.

Creating Desktop group and adding the XD-01 VM

1. Log into XD-55.
2. Open the Citrix Desktop Studio→assignments, and click Create Desktop Group.
3. Select the catalog named catalog, add all machines, and click Next.
4. For users add the VDI\Login_VSI_TS group, and click Next.
5. Leave delegations as default, and click Next.
6. Name the group pool, and click Finish.

Configuring the power policy for the pool desktop group

1. Right-click pool, and click Properties.
2. Click power management, for weekdays select all hours, no action, and position the power on machines line to be uniform across all hours on the graph.
3. Click weekends and select all hours, no action, and position the power on machines line to be uniform across all hours on the graph, and click OK.

Configuring the Citrix XenDesktop 5 server - creating a catalog and Citrix XenDesktop group

1. Open the Citrix Desktop Studio.
2. Browse Desktop Studio→Machines. In the right window, right-click and select Create Catalog.
3. Machine type = pooled, Assignment =random, click Next.
4. Click desktop studio→PowerShell, and click Launch PowerShell.
5. In PowerShell, type `Set-BrokerDesktopGroup -Name "pool" -ShutdownDesktopsAfterUse $False`
6. Browse Desktop Studio→Assignments, and verify that there is 1 desktop available.

Installing the PCoIP and HDX GPO snap-ins for Active Directory

To make changes to the way PCoIP and HDX rendered images, we installed the Active Directory snap-in to our Default Domain Group policy. We also used a snap-in to disable the XenDesktop Welcome. The .adm files are located on the install media for VMware View and XenDesktop.

1. Log into DC1 as VDI\administrator
2. Open all programs→Admin Tools→Group Policy Management.
3. In the group policy management tool, open Forest→domains→VDI.com→right-click the default domain Policy, and click Edit.
4. Browse computer Configuration→policies, right-click Administrative templates, and click Add/Remove Templates...
5. Click Add...
6. Browse to the pcoip.adm.
7. Click Add...
8. Browse to the HdxFlash-Client.adm.
9. Click Add...
10. Browse to the WelcomeScreen.adm.
11. Close the GPO editor.

Disabling the HDX GPO snap-in

For all tests, we disabled the XenDesktop welcome screen.

1. Log into DC1 as VDI\administrator
2. Open all programs→Admin Tools→Group Policy Management.
3. In the group policy management tool, open Forest→Domains→VDI.com→right click the default domain Policy, and click edit.

4. Browse computer Configuration → policies → Administrative templates → Classic Administrative Templates (ADM) → Citrix Components, and edit the Disabled the Welcome Screen Policy.
5. Click Enabled, and OK.

APPENDIX C – SETTINGS USED IN TESTING

Setting HDX to Client side Flash Redirection

For all tests, we disabled the Xendesktop welcome screen.

1. Log into DC1 as `VDI\administrator`
2. Open all programs→Admin Tools→Group Policy Management.
3. In the group policy management tool, open Forest→Domains→VDI.com, right-click the default domain Policy, and click Edit.
4. Browse computer Configuration→Policies→Administrative templates→Classic Administrative Templates(ADM)→HDX MediaStream Flash Redirection- Client.
5. Edit the Enable HDX MediaStream Flash Redirection on the user device policy.
6. Click Enabled, select Always, and click OK. (Note: use 'Never' to enable server side redirection).

Setting PCoIP to lossy

For our testing, we set PCoIP to lossy by configuring the GPO plug-in for PCoIP.

1. Log into DC1 as `VDI\administrator`
2. Open all programs→Admin Tools→Group Policy Management.
3. In the Group policy management tool, open Forest→Domains→VDI.com, right-click the default domain Policy, and click Edit.
4. Browse computer Configuration→Policies→Administrative Templates→Classic Administrative Templates(ADM)→PCoIP Session Variables→Overridable Administrator Defaults.
5. Right-click Turn off Build-to-lossless feature. Right click, and click Edit.
6. Select the radio button for Enabled, and tick the box next to I accept to turn off the Build-to-lossless feature.
7. Click OK.
8. Right-click Configure PCoIP image quality levels, and click Edit.
9. Select Enabled, change Maximum Initial Image Quality to 70 and Frame Rate to 24, and click OK.
10. On the View 5 connection server, open a command window, and type `gpupdate /force`

Setting PCoIP to lossless (default)

PCoIP by default renders images as lossless at 30 FPS. To enable lossless, ensure all settings in the PCoIP Session Variables GPO are removed, and run `gpupdate /force` from the View connection server.

Setting HDX to lossy (low compression)

To configure HDX to render a similar image quality, we changed the default lossy compression from Normal to Low. This policy must be exclusively on, and ensure that the lossless policy is disabled.

1. Log into XD-55.
2. Open Desktop Studio→HDX Policy →user, and click New.
3. Name the policy `Lossy`
4. Click Next.
5. Add ICA\Lossy compression level, change the value to low, and click OK.
6. Click Next.
7. Click Add next to User or Group.
8. For group name, type `VDI\Login_VSI_TS` and click OK.
9. Click Next, and click Create.

Setting HDX to lossless

For lossless testing, we set HDX to 30 FPS and disabled all lossy compression. This policy must be exclusively applied, and ensure that the lossy policy is disabled.

1. Log into XD-55.
2. Open Desktop Studio → HDX Policy → user, and click New.
3. Name the policy `Lossy`
4. Click Next.
5. Add ICA\Max Frames Per Second.
6. Change the value to 30, and click OK.
7. Add ICA\Lossy compression level, change the value to none, and click OK.
8. Click Next.
9. Click Add next to User or Group.
10. For group name, type `VDI\Login_VSI_TS` and click OK.
11. Click Next, and click Create.

APPENDIX D – ABOUT THE WORKLOADS

Light workload

The Login VSI light workload runs fewer applications than the medium workloads with and without Flash, and closes applications soon after using them, as a typical task worker would do. In this workload, two applications are open simultaneously. The applications include the following:

- Microsoft Internet Explorer® browser
- Microsoft Word
- Microsoft Outlook®

Medium workload no Flash

The Login VSI medium no Flash workload simulates a medium-level knowledge worker using Microsoft Office, Internet Explorer, and PDFs. This workload completes the following tasks in different applications:

- Microsoft Outlook: Browsing a message
- Microsoft Word (TimerDoc): Initiate response timer to see how the program responds throughout the workload
- Microsoft Internet Explorer instance one: Maximizing, scrolling, and minimizing
- Microsoft Internet Explorer instance two: Navigating a Web site, maximizing, and scrolling
- Microsoft Word (UserRead): Reading and typing text, and printing to PDF
- Bullzip: Generating a PDF
- Adobe Reader®: Reading a PDF
- Microsoft PowerPoint®: Watching a presentation and adding a slide
- Microsoft Excel®: Reading and minimizing
- 7-Zip: Saving a ZIP file

Medium workload with Flash

The Login VSI medium workload (with Flash) simulates a medium-level knowledge worker using Microsoft Office, Internet Explorer, and PDFs. This workload completes the following tasks in different applications:

- Microsoft Outlook: Browsing a message
- Microsoft Word (TimerDoc): Initiate response timer to see how the program responds throughout the workload
- Microsoft Internet Explorer instance one: Maximizing, scrolling, and minimizing
- Microsoft Internet Explorer instance two: Navigating a Web site, maximizing, and scrolling
- Adobe Flash: Viewing a movie trailer
- Microsoft Word (UserRead): Reading and typing text, and printing to PDF
- Bullzip: Generating a PDF
- Adobe Reader: Reading a PDF
- Microsoft PowerPoint®: Watching a presentation and adding a slide
- Microsoft Excel: Reading and minimizing
- 7-Zip: Saving a ZIP file

APPENDIX E – DETAILED RESULTS

Light workload (1280x1024)

Bandwidth

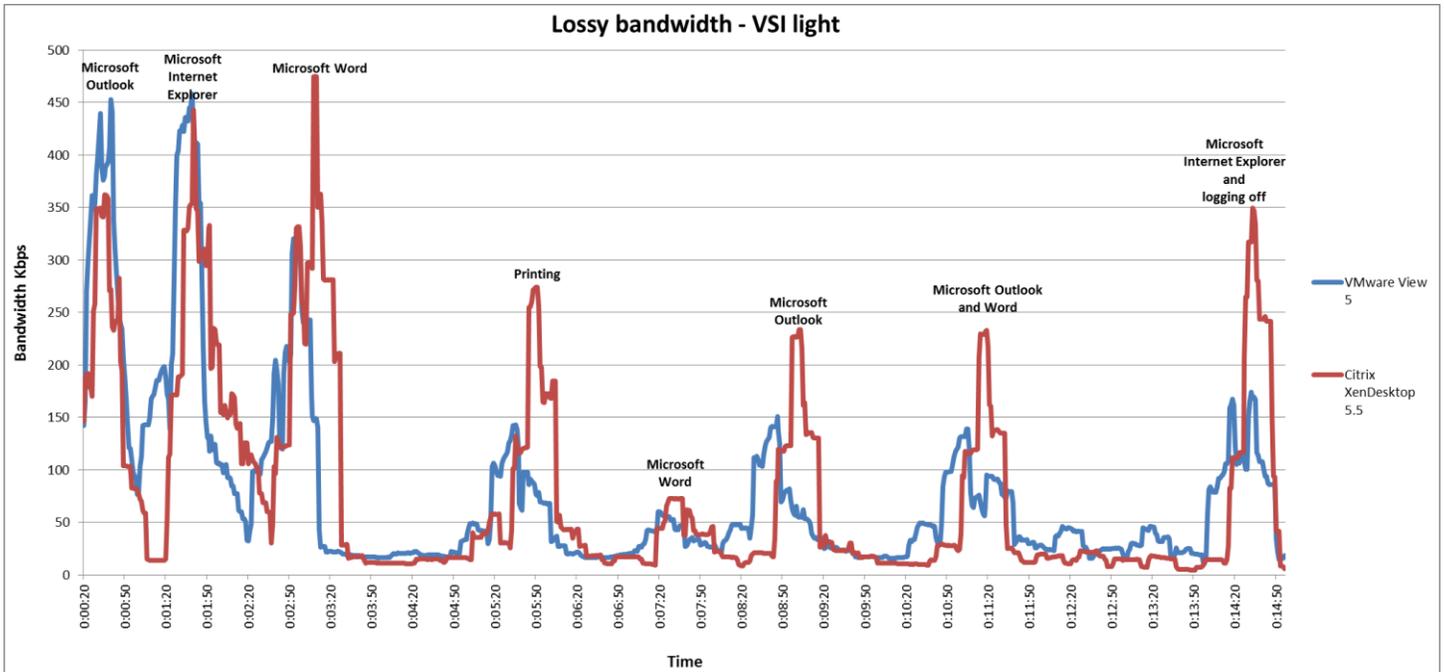


Figure 18. Bandwidth usage for the light workload with lossy compression.

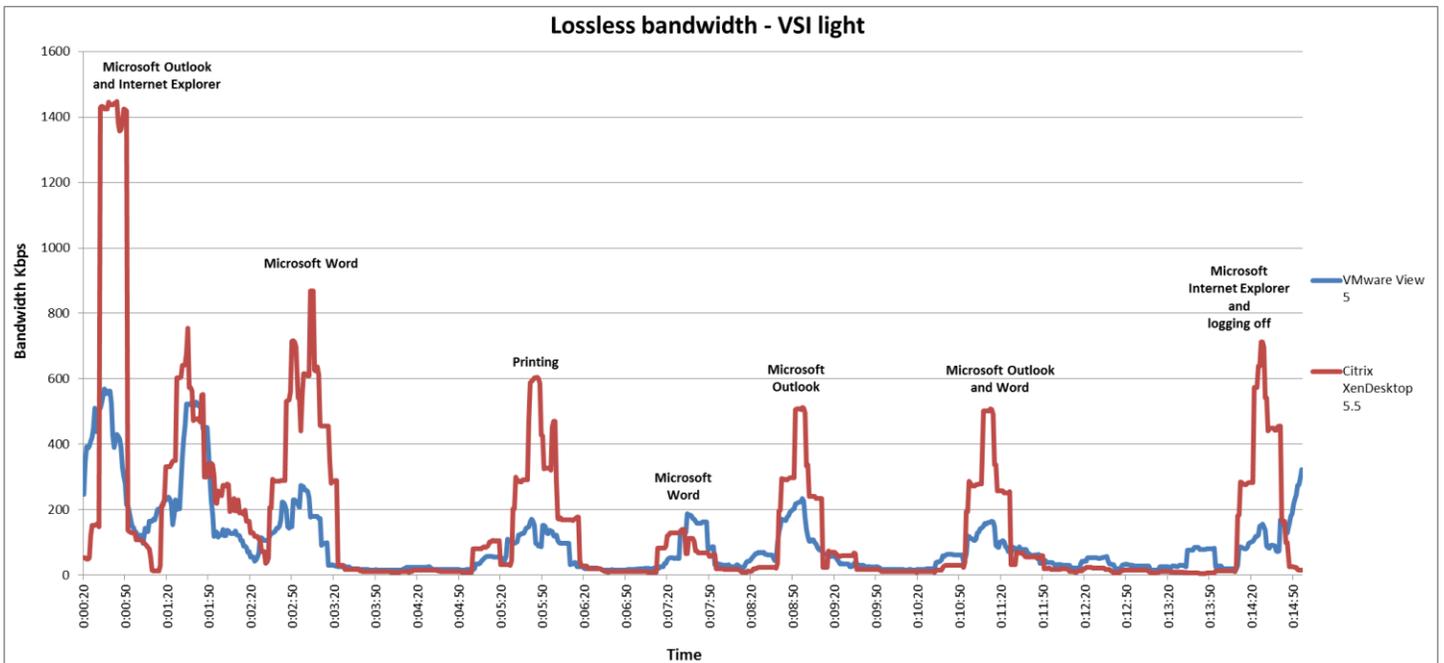


Figure 19. Bandwidth usage for the light workload with lossless compression.

Virtual desktop CPU utilization

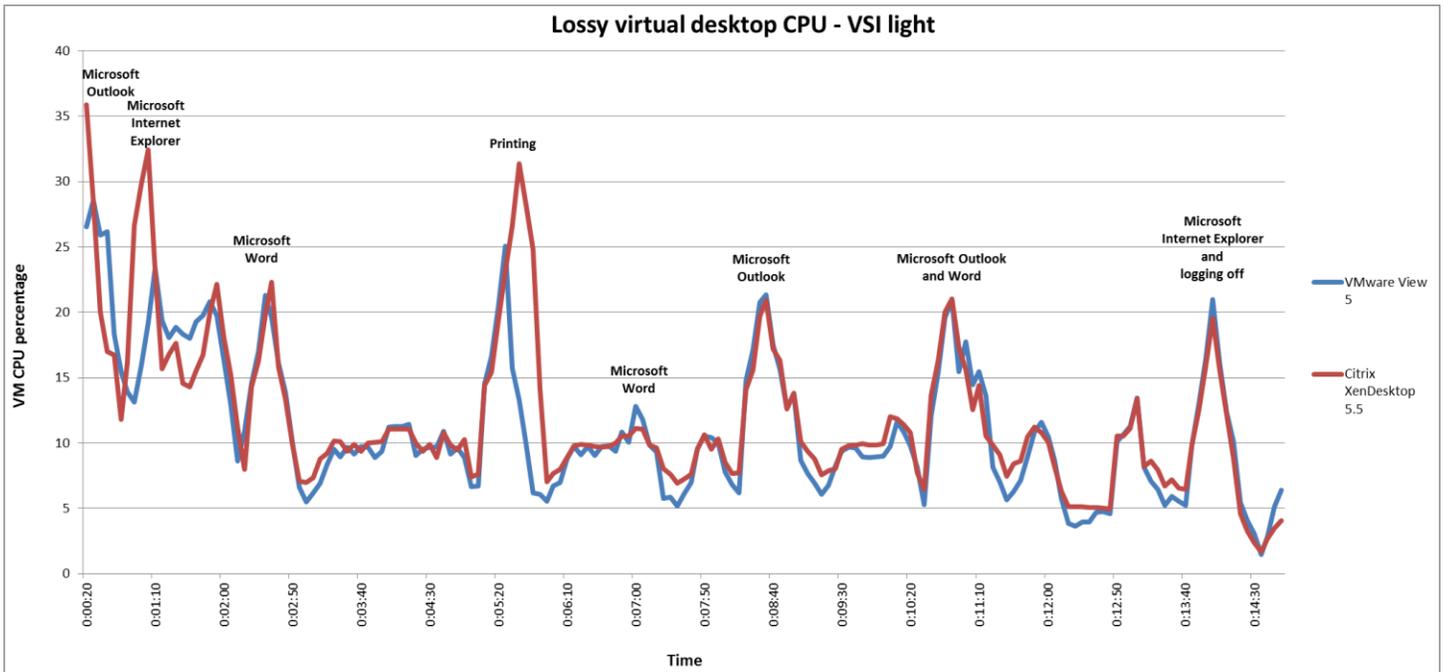


Figure 20. Virtual desktop CPU utilization for the light workload with lossy compression.

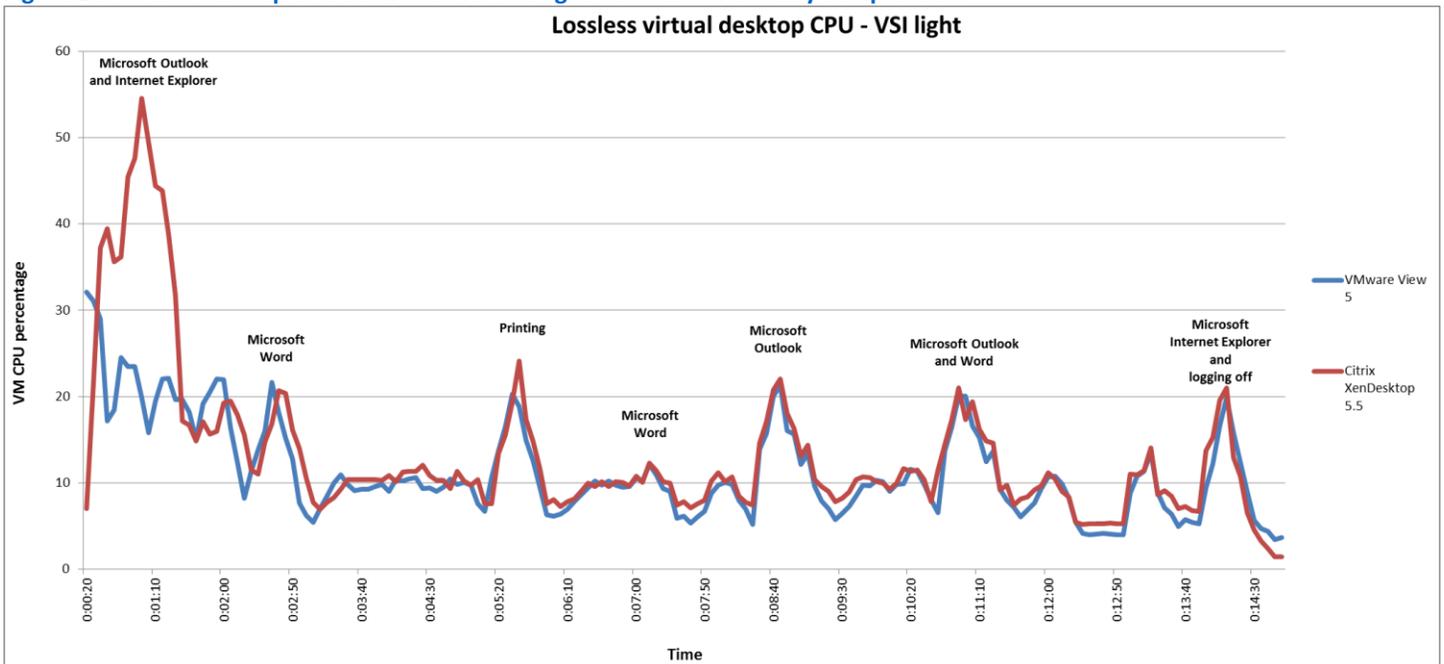


Figure 21. Virtual desktop CPU utilization for the light workload with lossless compression.

Client CPU utilization

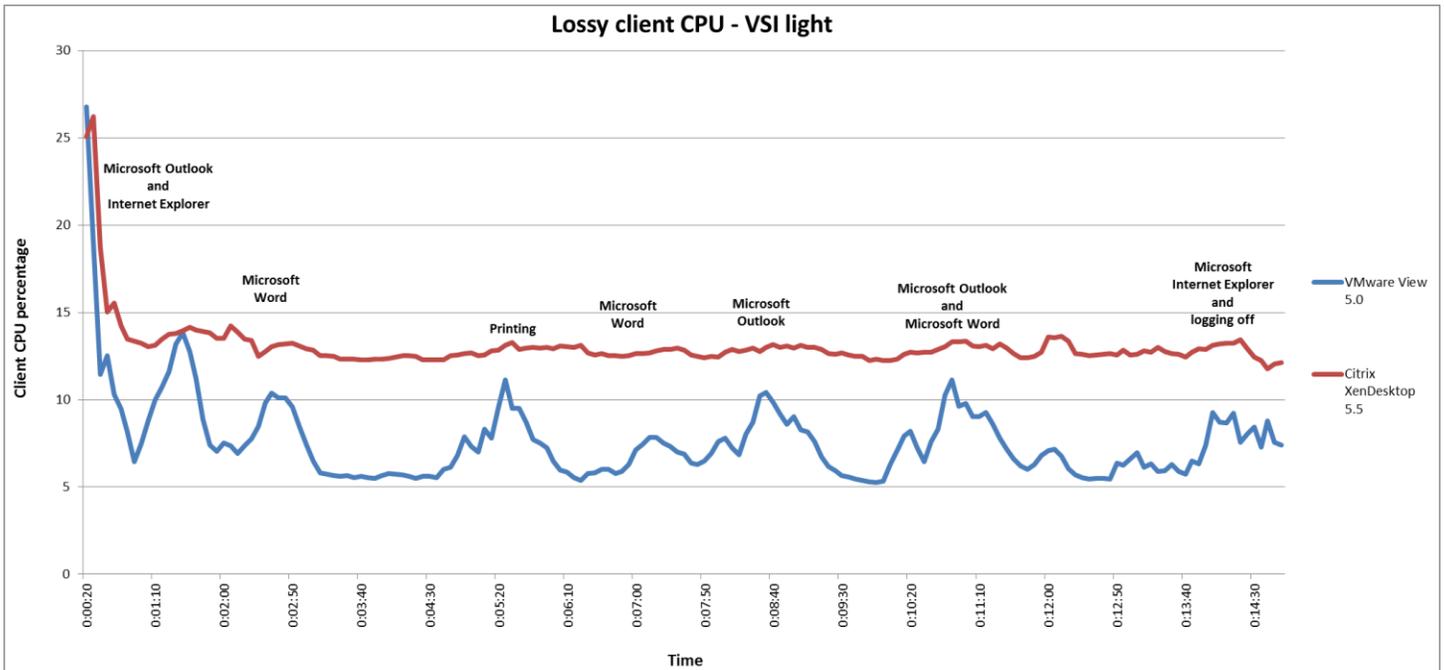


Figure 22. Client CPU utilization for the light workload with lossy compression.

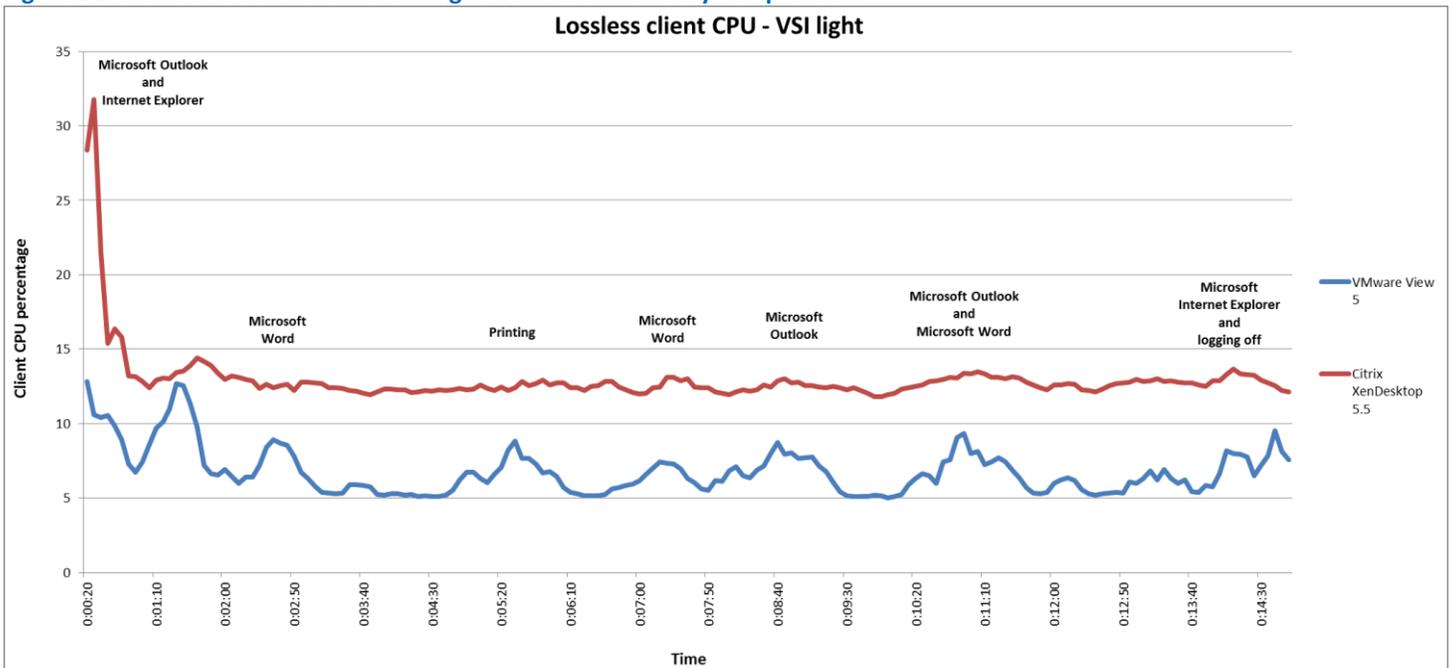


Figure 23. Client CPU utilization for the light workload with lossless compression.

Medium workload no Flash (1280x1024)

Bandwidth

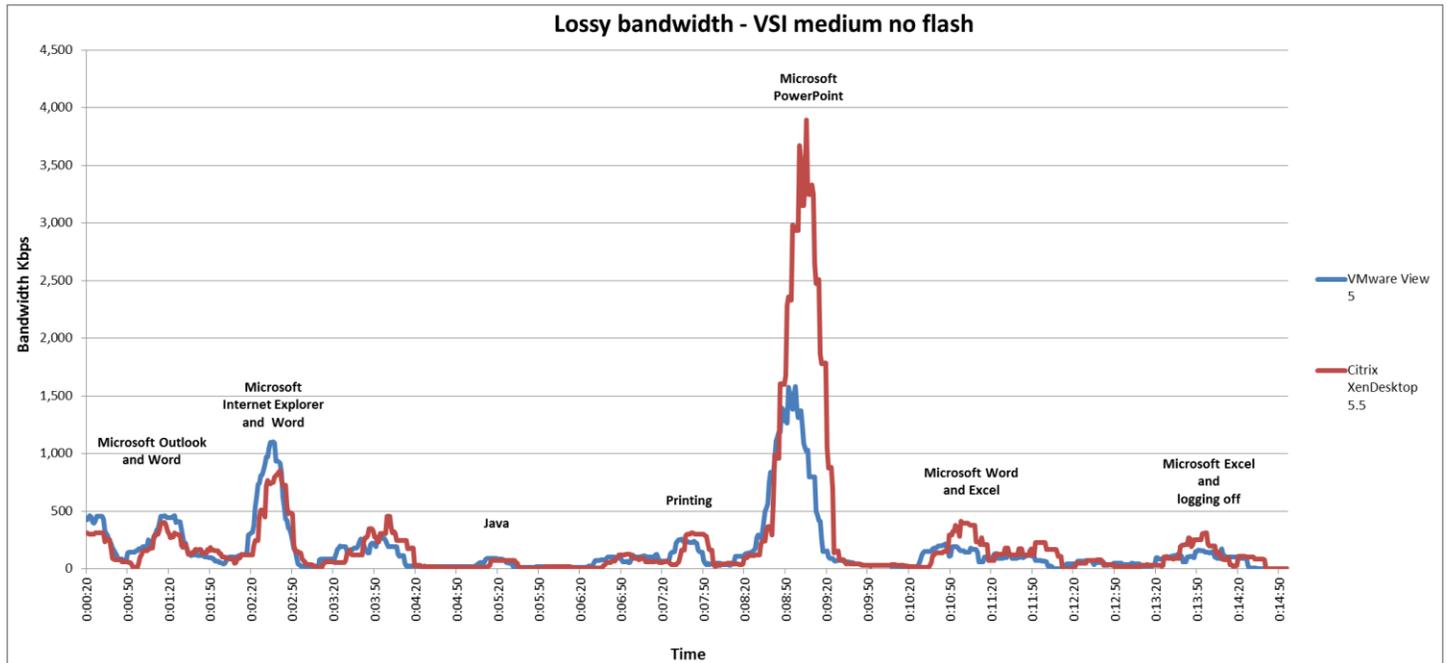


Figure 24. Bandwidth usage for the Medium workload no Flash with lossy compression.

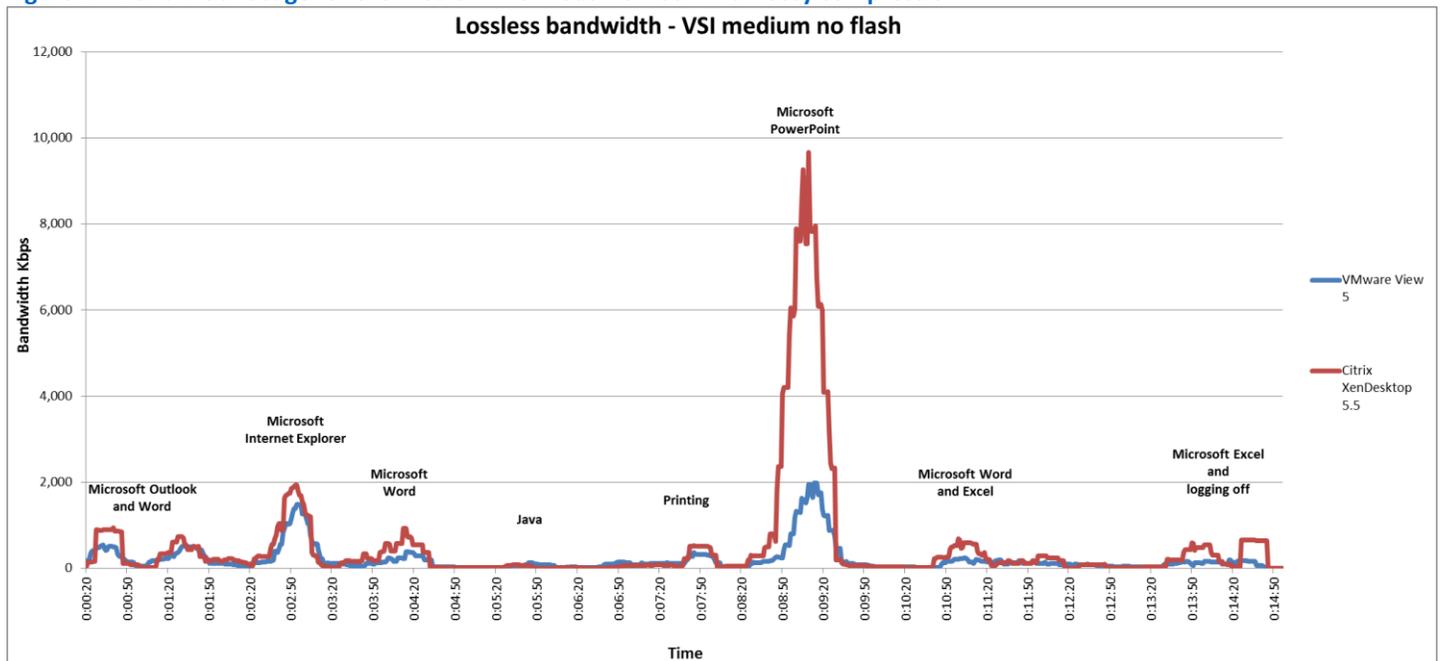


Figure 25. Bandwidth usage for the Medium workload no Flash with lossless compression.

Virtual desktop CPU utilization

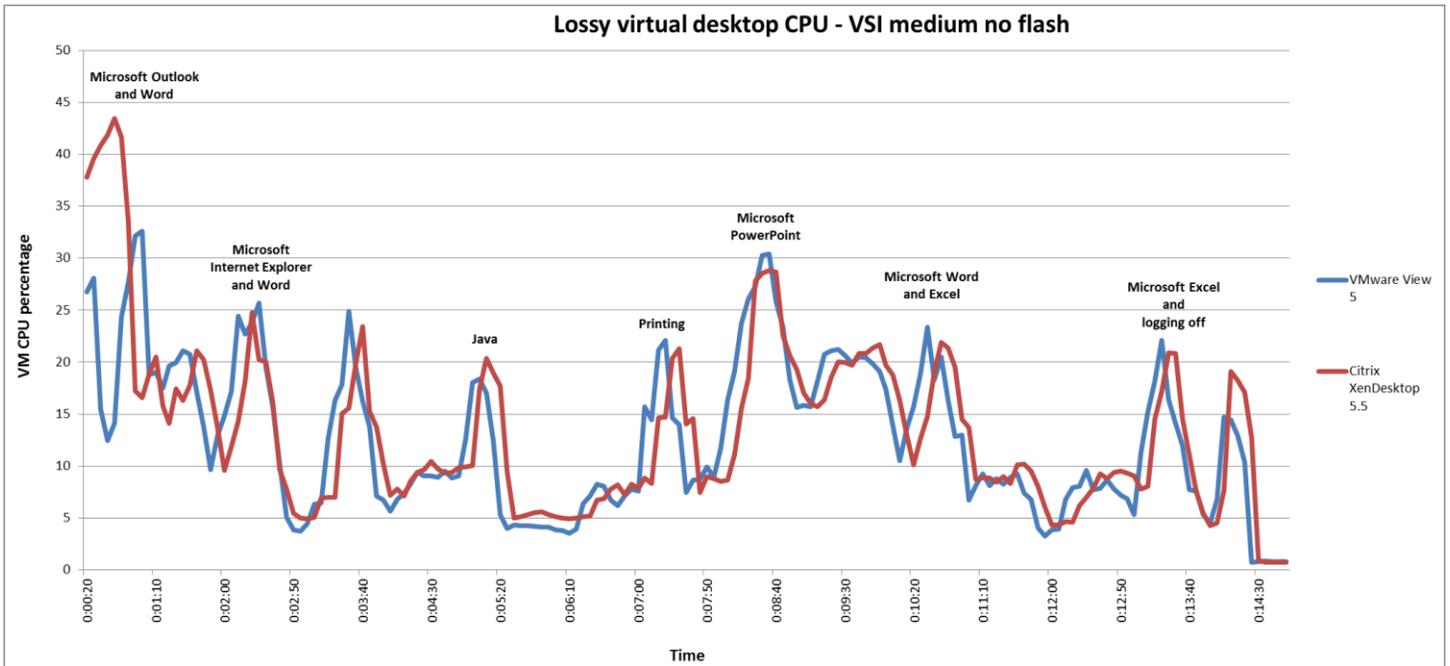


Figure 26. Virtual desktop CPU utilization for the Medium workload no Flash with lossy compression.

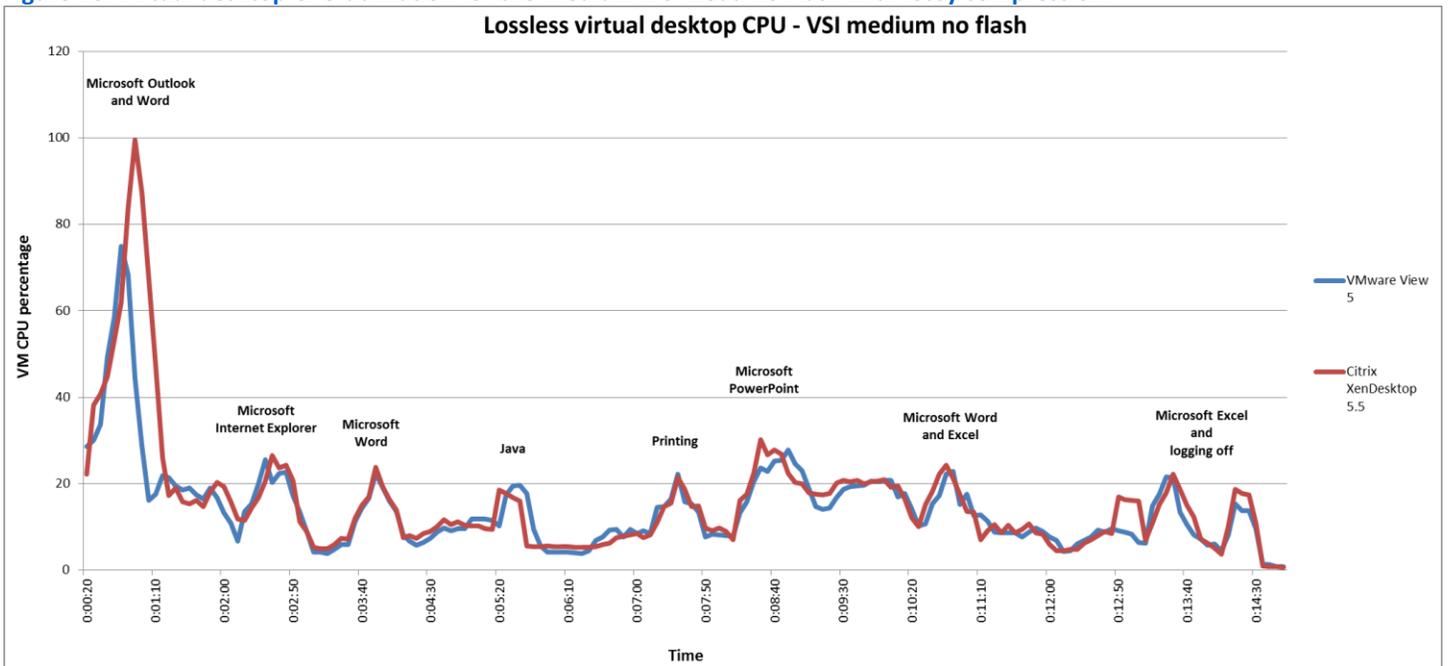


Figure 27. Virtual desktop CPU utilization for the Medium workload no Flash with lossless compression.

Client CPU utilization

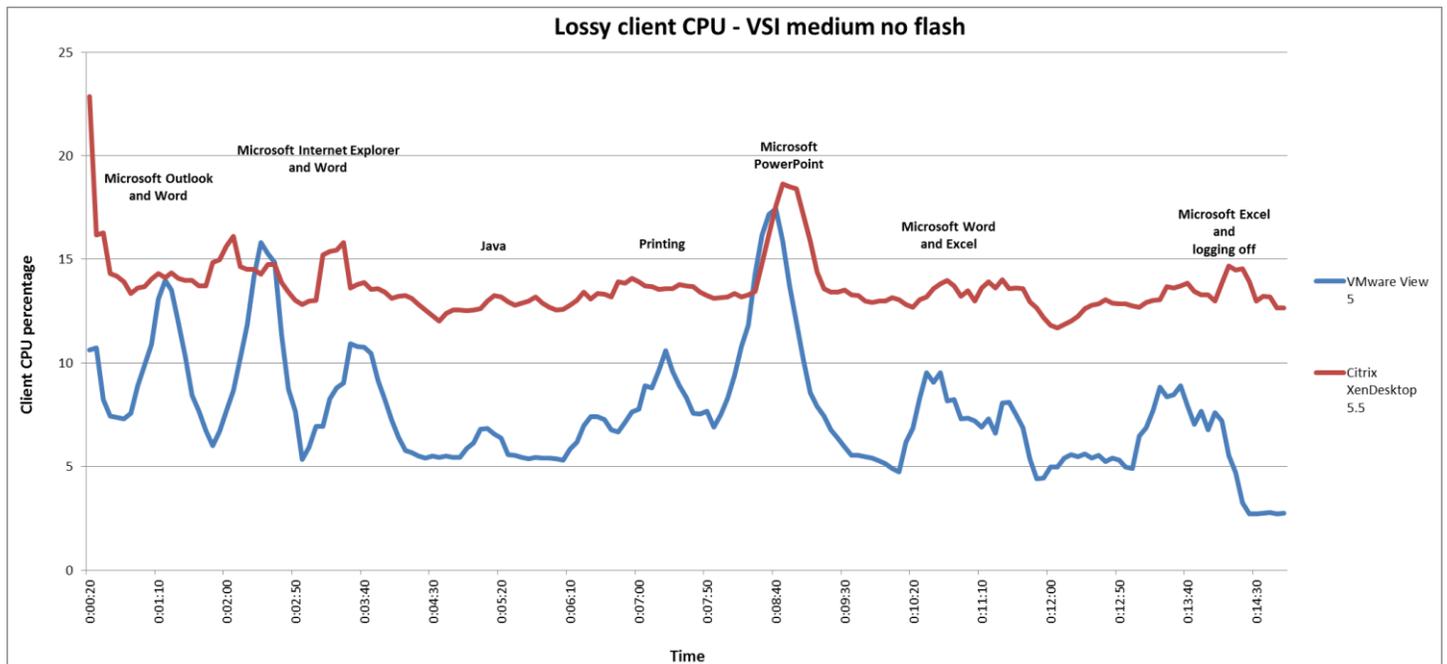


Figure 28. Client CPU utilization for the Medium workload no Flash with lossy compression.

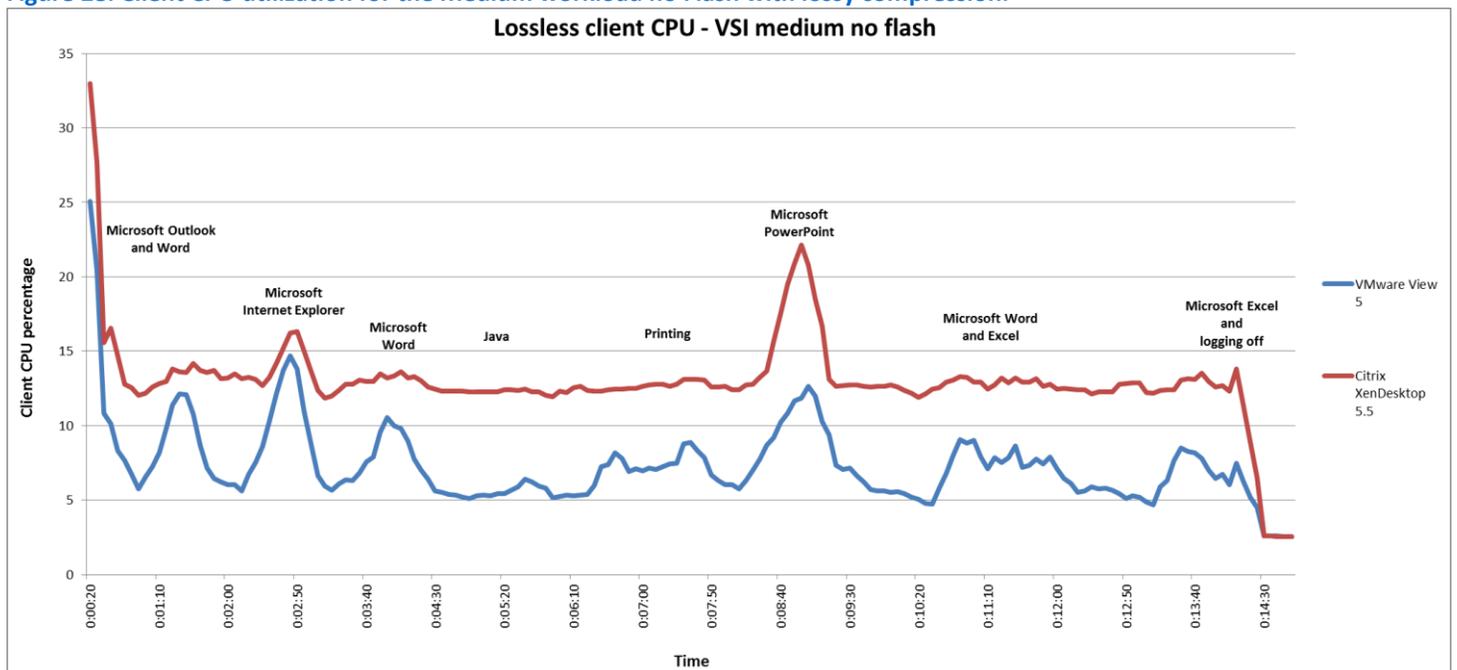


Figure 29. Client CPU utilization for the Medium workload no Flash with lossless compression.

Medium workload with Flash (1280x1024) Bandwidth

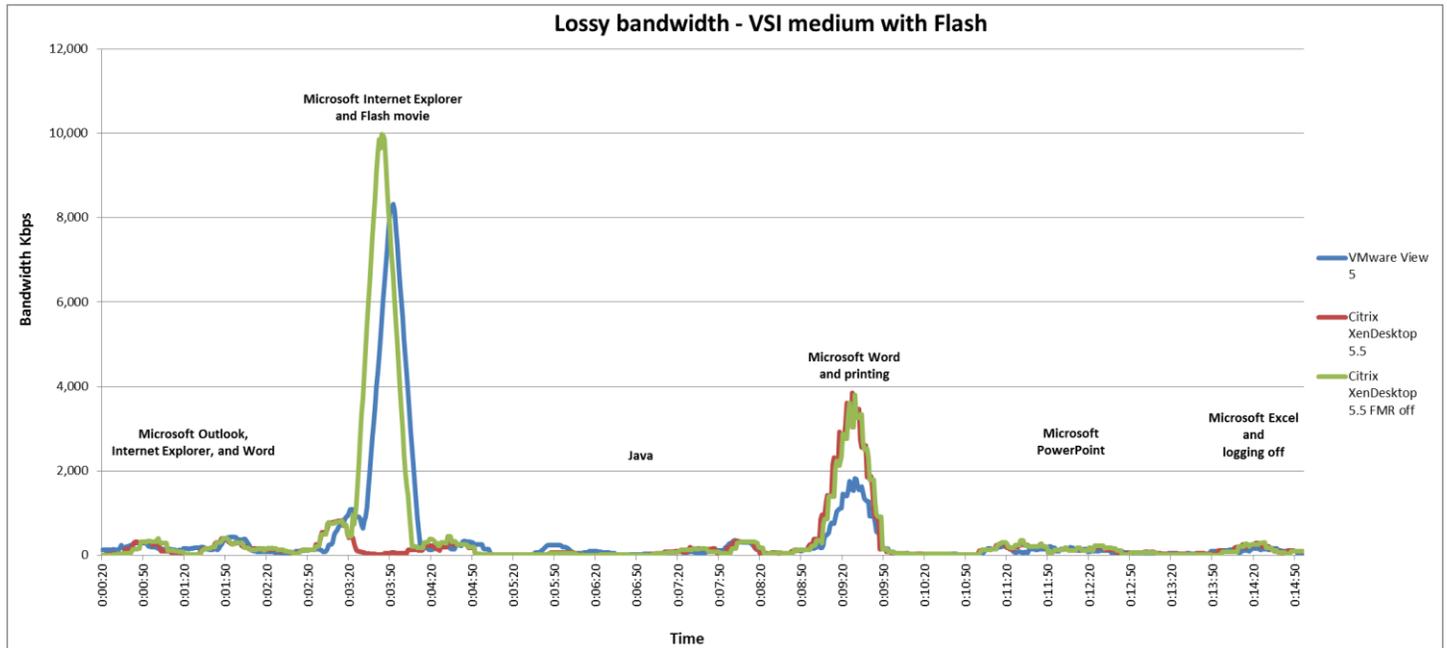


Figure 30. Bandwidth usage for the Medium workload with Flash with lossy compression.

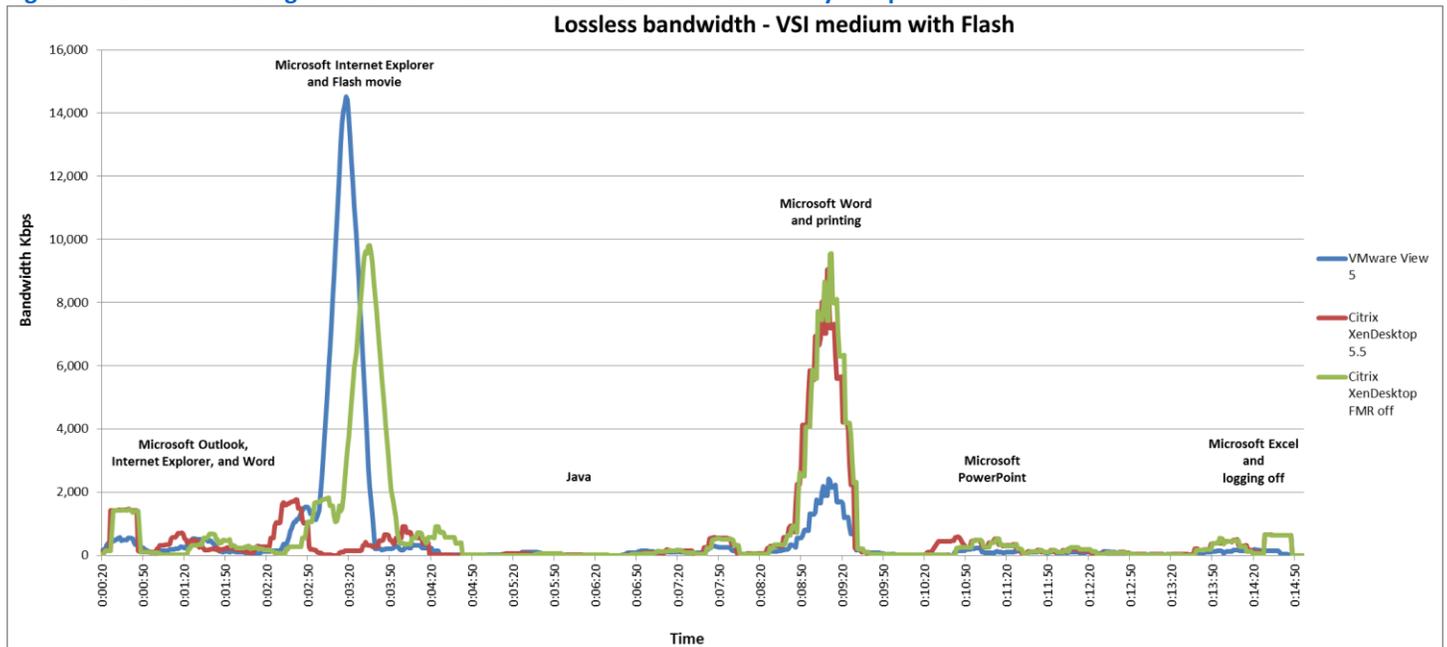


Figure 31. Bandwidth usage for the Medium workload with Flash with lossless compression.

Virtual desktop CPU utilization

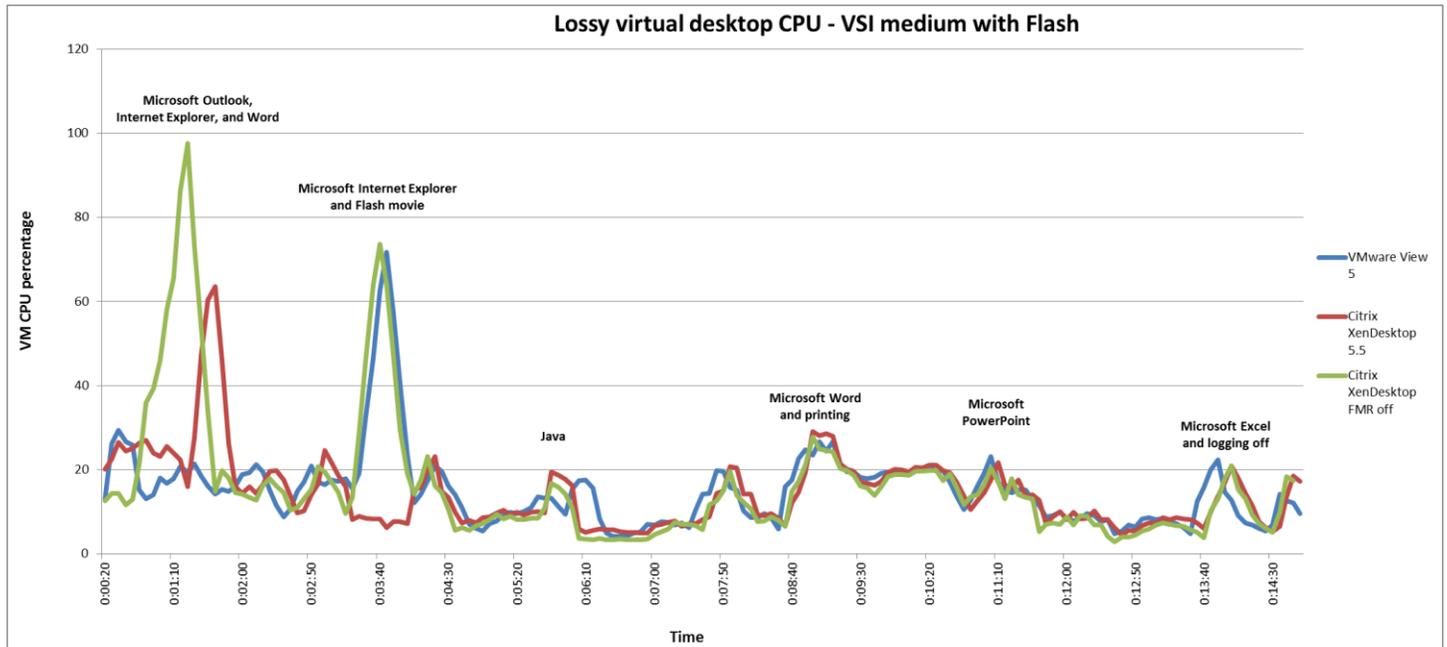


Figure 32. Virtual desktop CPU utilization for the Medium workload with Flash with lossy compression.

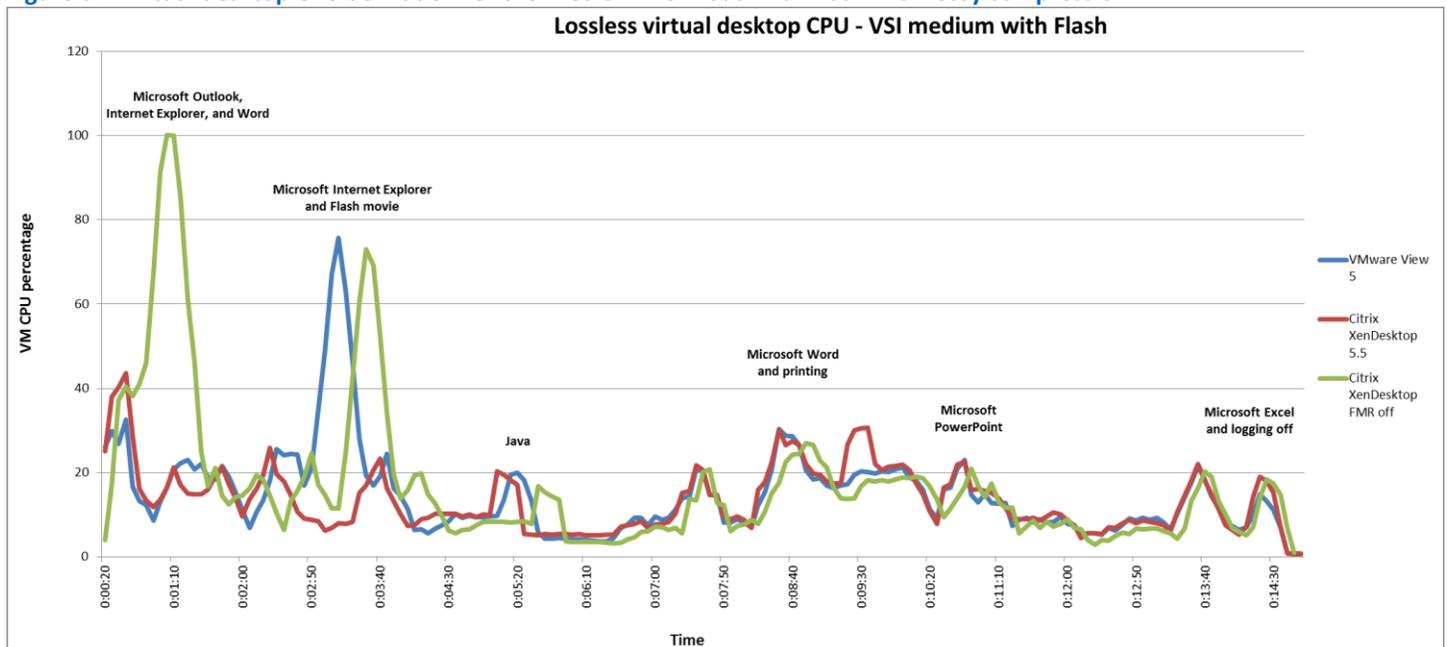


Figure 33. Virtual desktop CPU utilization for the Medium workload with Flash with lossless compression.

Client CPU utilization

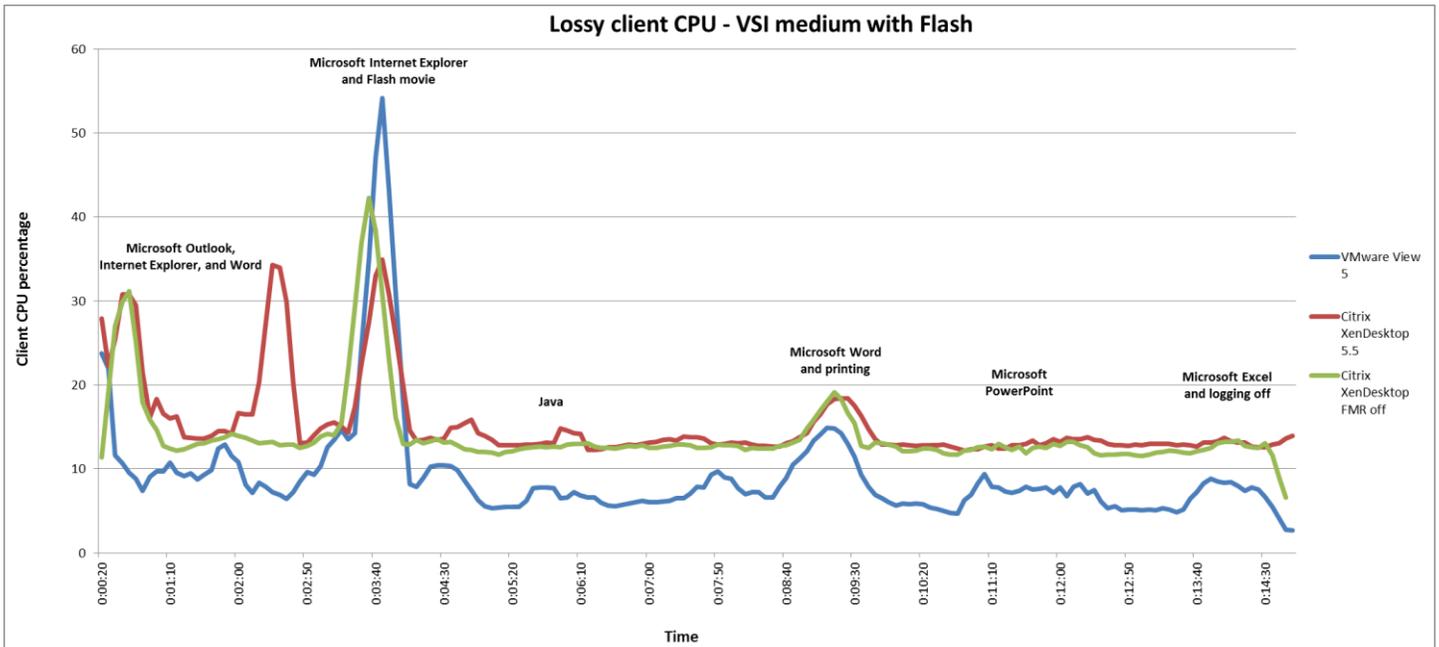


Figure 34. Client CPU utilization for the Medium workload with Flash with lossy compression.

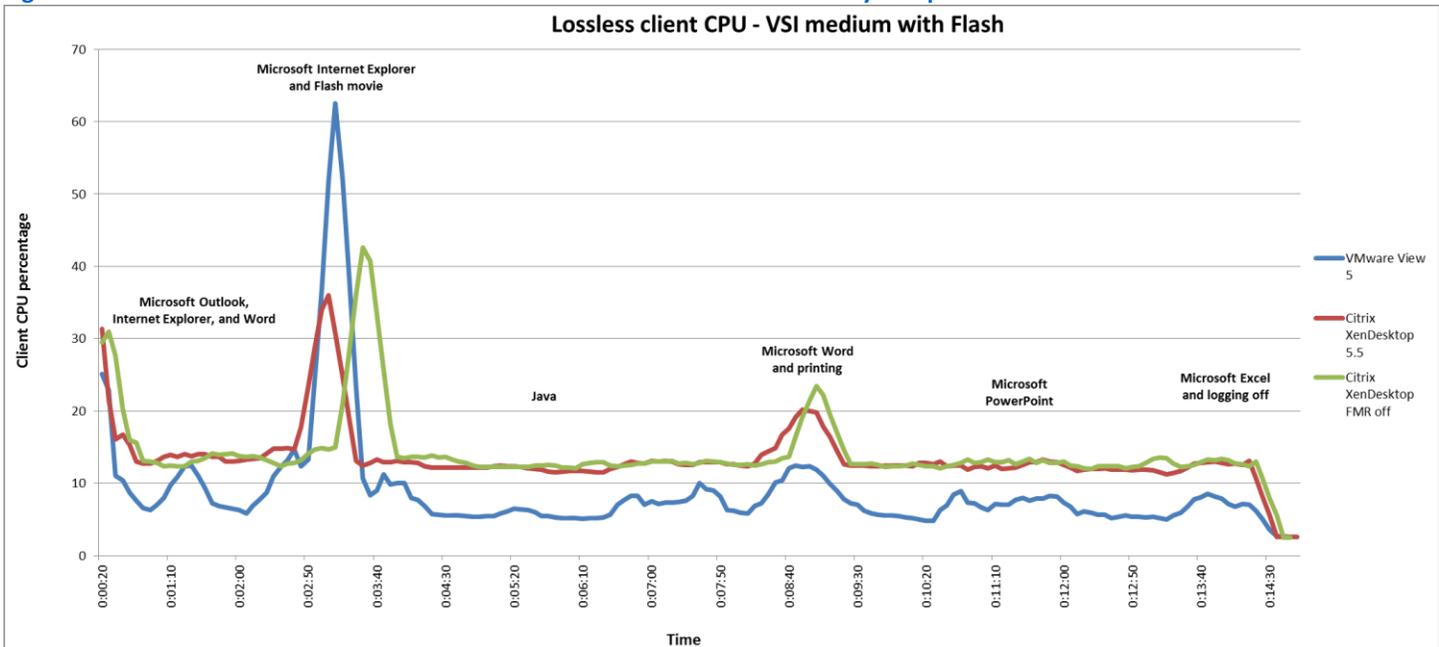


Figure 35. Client CPU utilization for the Medium workload with Flash with lossless compression.

ABOUT PRINCIPLED TECHNOLOGIES



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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.

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