Deploy virtual desktops faster and more easily with VMware Instant Clone Technology

Save time and scale out faster compared to Citrix PVS

It's not always easy to predict virtual desktop infrastructure (VDI) demand. Creating and deploying pools of virtual desktops to meet users' ever-changing OS and application requests can be a time-consuming and difficult task, potentially leaving users waiting for the resources they need.

Giving IT admins a fast, easy, scalable virtual desktop platform can help save time in their busy days while minimizing potential wait time for VDI users. With more availability, your IT admins can focus on troubleshooting user issues, or they can work to improve your organization's datacenter by devoting time to larger initiatives.

VMware Instant Clone Technology created disposable VM clones for virtual desktop infrastructure (VDI) faster than Citrix Provisioning Service (PVS) in the Principled Technologies datacenter. What's more, an IT admin can add clones to an existing pool to meet a surge in demand in just four steps. We'll explain how our findings with VMware Instant Clone Technology can help your IT staff and ultimately your users.

Scale easily with VMware Instant Clones

Initial deployment

10 VMs · **15:16** ➝ **200** VMs · **03:58**

Scale up deployment
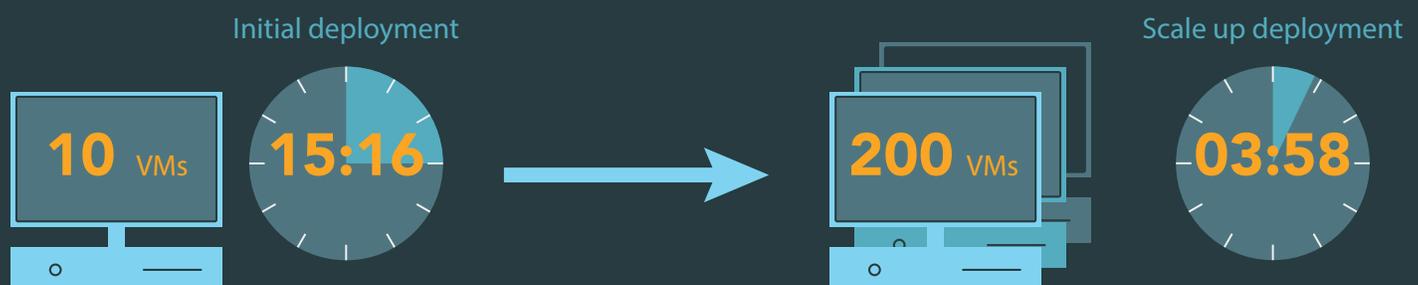
Putting VDI in perspective

Industries as diverse as healthcare, finance, government, retail, manufacturing call centers, education, and more all have the common requirement to support and secure a mobile workforce. Organizations around the globe often have a dispersed workforce using many PCs, laptops, and mobile devices distributed to field offices and remote locations. Employees will use several of these devices throughout a workday. Rather than customization, employees need standardized applications. Disposable virtual desktops without local storage are ideal in this situation.

Now, imagine an IT staff that oversees these systems for a national bank, major hospital, retail chain, or manufacturer. They're likely responsible for updating many end-user applications in addition to managing the systems. So although this IT team can have many members, they have a lot to do. Saving time on common tasks can let the IT staff tackle other tasks promptly—for example, troubleshooting a hardware issue in an executive's office.

Simplifying deployment and saving time with VMware Instant Clone Technology

According to VMware, "VMware Horizon and Instant Clone Technology enables next generation virtual desktops that are generic, disposable, customizable, and stateful. Deployment and patching is simplified for administrators because instant clones do not need to be refreshed, recomposed, or rebalanced. Image changes can be scheduled during the day with no downtime for the users. When the user logs out of their desktop session, a new clone is instantly created using the latest image, and the desktop is immediately available for login."

Our testing showed that IT admins can deploy desktops faster and more easily using VMware Horizon with Instant Clone Technology than if they used Citrix XenDesktop with PVS. When IT staff can deploy and scale out an existing pool of desktops more quickly, employees won't wait on VDI deployment or applications updates. Admins update applications at the image level without interrupting employee VDI sessions.
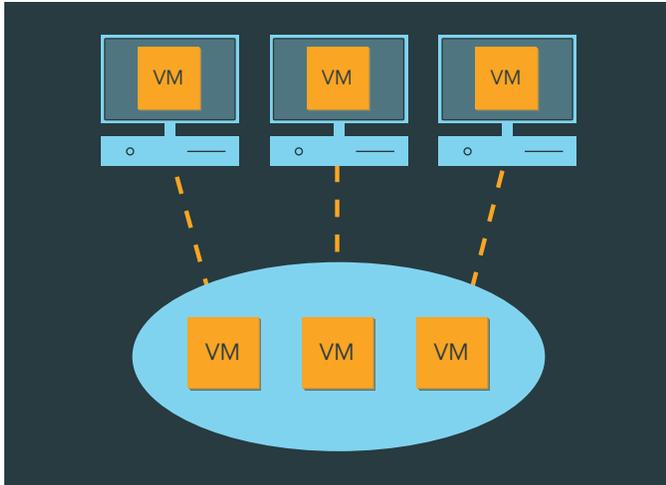
Create a pool of cloned VMs for instant desktop deployment with Instant Clone Technology

VMware Horizon 7 Enterprise Edition offers Instant Clone Technology for VDI desktop deployment. Instant Clone Technology clones a running parent VM in-memory and deploys the VMs with copy-on-write resource sharing. As a result, the clones share disk and memory resources with the parent. Clones exist in a pool and are always ready for instant user login.

What we found

We first deployed 10 clones from a single parent VM. As this was the initial deployment, the necessary time and steps included installing the target software onto the parent VM, allowing the VDI software to create the source files to clone from, and finally the clone-out process itself. VMware Horizon completed this task faster due to a shorter target agent install time and a faster VM deployment rate. VMware Horizon also required fewer steps to complete the initial deployment.

We then scaled out the existing deployment to 50, 100, and 200 VMs. As the VDI pool was already in place for both environments, we measured only the time and steps required to expand the pool to 50, 100, and 200 VMs. VMware Horizon required fewer steps thanks to a more simplified interface and deployed VMs faster thanks to a parallelized deployment process.

Time savings

	15:16		28:33
46.5%			

0 to 10 VMs

Steps savings

	34		74
54%			

0 to 10 VMs

■ *VMware* ■ *Citrix*
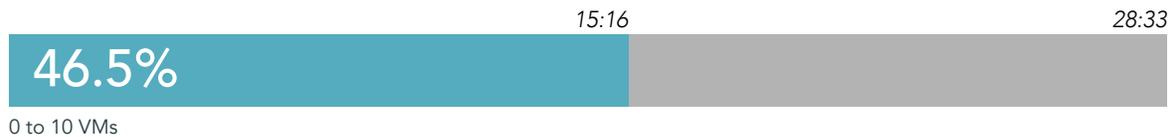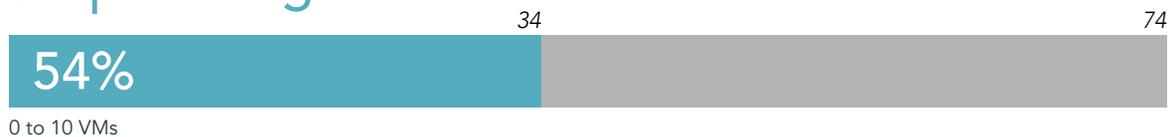
Deploy 10 VMs faster and in fewer steps

We started with a goal of deploying 10 clones from a single parent VM to a clone pool. Our admin needed just 15 minutes and 16 seconds to create and deploy 10 fully functional clones using VMware Instant Clone Technology and VMware Horizon. In comparison, our admin needed 28 minutes and 33 seconds to complete the same deployment using Citrix PVS and Citrix XenDesktop. That's a savings of 13 minutes and 17 seconds for Instant Clone Technology, or a savings of 46.5 percent of the time needed to complete the same task with the Citrix option.

In addition to taking less time, deploying 10 VMs to the clone pool using VMware Instant Clone Technology required fewer steps. Our admin deployed the 10 VMs in 34 steps. When the admin used the Citrix solution to do the same task, it took 74 steps. That's 40 fewer steps, or 54 percent fewer steps than it would take when using Instant Clone Technology.

Scale out to 50, 100, and 200 VMs faster and in fewer steps

It took our admin just 1 minute and 54 seconds to create and deploy the additional 40 virtual desktops using VMware Instant Clone Technology and VMware Horizon. Scaling to 100 and to 200 clones using Instant Clone Technology took less than 2 and a half minutes and less than 4 minutes, respectively.

In comparison, it took our admin 8 minutes and 45 seconds to create and deploy the additional 40 clones using Citrix PVS and Citrix XenDesktop. That's a savings of 6 minutes and 51 seconds for Instant Clone Technology.

Time savings

1:54		*8:45*
78.2%		
10 to 50 VMs		

2:28		*14:16*
82.7%		
10 to 100 VMs		

3:58		*25:34*
84.4%		
10 to 200 VMs		

Steps savings

4		*17*
76.4%		

☐ *VMware* ☐ *Citrix*

Looking at it another way, VMware Instant Clone Technology scaled an existing clone pool to 50 VMs in less than a quarter of the time that it took Citrix PVS to do so.

Scaling to 100 and 200 VMs using PVS took 14 minutes and 16 seconds and 25 minutes and 34 seconds, respectively. Instant Clone Technology scaled the pool to 100 VMs in less than a fifth of the time that it took PVS, saving 11 minutes. Scaling the pool to 200 VMs using Instant Clone Technology took less than a sixth of the time and saved more than 21 minutes.

In addition to saving time, scaling out the pool of existing VMs took only 4 steps. It's the same process for scaling out the pool from 10 to 50 VMs, 10 to 100 VMs, and 10 to 200 VMs. In comparison, scaling out available VMs using Citrix PVS and Citrix XenDesktop required 17 steps. Instant Clone Technology scaled VMs in just a quarter of the number of steps that it took the Citrix option, a difference of 13 steps.

VMware expects to see similar savings in terms of reduced deployment time and fewer deployment steps for published applications with the release of VMware Instant Clones for RDSH.

Conclusion

Desktop VMs can play a unique role in keeping your organization moving, but deploying desktops to meet demand can be time consuming and require a lot of effort. You can free up your IT staff's schedule with the simple deployment process of VMware Instant Clone Technology and VMware Horizon. We deployed an initial 10 VMs in less time and in fewer steps using Instant Clone Technology than when we used Citrix PVS and Citrix XenDesktop. Scaling out the existing pool of 10 VMs to 50, 100, and 200 VMs was also easier and faster using Instant Clone Technology. VMware Instant Clone Technology and VMware Horizon can help your busy IT staff quickly meet the ever-increasing demand for instant desktops.

On October 28, 2016, we finalized the hardware and software configurations we tested. Updates for current and recently released hardware and software appear often, so unavoidably these configurations may not represent the latest versions available when this report appears. For older systems, we chose configurations representative of typical purchases of those systems. We concluded hands-on testing on October 31, 2016.

Appendix A: What we tested

For our testing, we chose configurations representative of typical systems that you can find in service today.[1] We ensured this hardware would not create any performance bottlenecks for the deployment use cases we selected. See Appendix E for performance data.

The table below provides detailed configuration information for the test systems.

System	Virtual desktop host
General	
Number of processor packages	2
Number of cores per processor	8
Number of hardware threads per core	2
System power management policy	Max Performance
CPU	
Vendor	Intel®
Name	Xeon®
Model number	E5-2650
Socket type	FCLGA2011
Core frequency (GHz)	2.00
Bus frequency	8 GT/s
L1 cache (KB)	32 + 32 (per core)
L2 cache (KB)	256 (per core)
L3 cache (MB)	20
Platform	
Vendor and model number	Dell EMC PowerEdge™ C8220
Motherboard model number	0W6W6G
BIOS version	2.6.0
Integrated LOM	Intel I350
Memory module(s)	
Total RAM in system (GB)	128
Vendor and model number	Samsung® M393B1K70DH0-CK0
Type	PC3-12800R
Speed (MHz)	1,600
Speed running in the system (MHz)	1,600

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1 Based on an average server life cycle of five years: http://www.computerworld.com/article/2517337/computer-hardware/pulling-the-plug-on-old-hardware--life-cycle-management-explained.html?page=2

System	Virtual desktop host
Size (GB)	8
Number of RAM module(s)	16
Chip organization	Double-sided
Rank	Dual
Host bus adapter	
Vendor and model number	QLogic BR-425/825
Firmware version	3.31
Driver version	3.2.6.0

The table below provides detailed configuration information for the storage array.

Storage	Dell EMC VNX® 5700
Number of storage controllers per array	2
RAID level	1/0
Numbers of enclosures	7
Number of drives active (hot spares)	88 (8)
Drive size (GB)	300
Drive RPM	15K
Drive type	6Gb SAS 3.5"
EMC FAST® Cache	
Number of SSDs used	9
Capacity per SSD (GB)	200

Appendix B: How we tested

The following figure presents the infrastructure configuration of the VMware Horizon 7 environment.

VM name	Hosted OS	Role(s)	Server	Memory	No. of vCPUs	Storage used
DC1	Microsoft® Windows® 2012 R2 x64 Datacenter	AD Domain Controller, DHCP, DNS, NTP	Infrastructure	8	2	EQL
Horizon Connection	Windows 2012 R2 x64 Datacenter	Horizon Connection Server	Infrastructure	8	4	EQL
Windows 10 Master	Windows 10 x64 Enterprise	Desktop master image	Servers under test	2	1	VNX

The following figure presents the infrastructure configuration of the Citrix XenDesktop environment.

VM name	Hosted OS	Role(s)	Server	Memory	No. of vCPUs	Storage used
DC1	Microsoft Windows 2012 R2 x64 Datacenter	AD Domain Controller, DHCP, DNS, NTP	Infrastructure	8	2	EQL
LIC	Windows 2012 R2 x64 Datacenter	XenDesktop License Server	Infrastructure	8	4	EQL
PVS	Windows 2012 R2 x64 Datacenter	XenDesktop Provisioning Services	Infrastructure	8	4	VNX
XD	Windows 2012 R2 x64 Datacenter	XenDesktop Delivery Controller, Studio	Infrastructure	8	4	EQL
vCenter	VMware vCenter Virtual Appliance	VMware Virtual Center, SQL server	Infrastructure	8	2	EQL
Windows 10 Master	Windows 10 x64 Enterprise	Desktop master image	Servers under test	2	1	VNX

We used five Dell EMC PowerEdge C8220 servers with VMware vSphere® 6.0 installed as our infrastructure and desktop hosts. We used one host for all infrastructure VMs and clustered the remaining four hosts for virtual desktops.

A Dell EMC EqualLogic PS6110XS array hosted all infrastructure VMs, and a Dell EMC VNX 5700 storage array hosted all virtual desktops under test and our Citrix Provisioning Services VM. Each server, as well as the VNX 5700 array, was connected to a Fibre Channel switch.

Installing the infrastructure

Installing VMware ESXi™ 6.0 on the infrastructure servers and servers under test

1. Attach the installation media.
2. Boot the server.
3. At the VMware Installer screen, press Enter.
4. At the EULA screen, press F11 to Accept and Continue.
5. Under Storage Devices, select the appropriate virtual disk, and press Enter.
6. Select US as the keyboard layout, and press Enter.
7. Enter the root password twice, and press Enter.
8. Press F11 to start installation.
9. After the server reboots, press F2, and enter root credentials.
10. Select Configure Management Network, and press Enter.
11. Select the appropriate network adapter, and select OK.
12. Log into the server using the VMware vSphere client.
13. Select the Configuration tab, and click Networking.
14. Click Add Networking…
15. Create the Mgmt_Net network for management.
16. Click Add Networking…
17. Create the PRIV_NET network for private traffic.
18. Select the configuration tab, and click Storage.
19. Click Add Storage, and add the necessary datastores to all available servers.
20. Click the Configuration tab, and select Time configuration to configure server time.
21. Click DNS and Routing, and confirm the settings.

Installing VMware vCenter™ 6.0

1. On a machine that has a connection to the infrastructure host, mount the vCenter Server 6.0 ISO image.
2. Open the vcsa folder and install the Client Integration Plug-in.
3. In the root of the ISO image, run vcsa-setup.html and wait for the prompt to allow the Client Integration Plug-in to run.
4. Click Yes to allow the Client Integration Plug-in to run.
5. On the vCenter Server Appliance 6.0 splash screen, click Install.
6. Accept the license agreement, and click Next.
7. Enter the hostname or IP address of the infrastructure server, provide the management credentials, and click Next.
8. Click Yes.
9. Enter a name and password, and click Next.
10. Select the radio button for vCenter Server and Embedded Platform Services Controller, and click Next.
11. Select the radio button for Create a new SSO domain, and enter a password.
12. Enter a site name, and click Next.
13. Select Tiny (up to 20 hosts, 400 VMs), and click Next.
14. Select a datastore on the Dell EMC EqualLogic PS6110XS array, and click Next.
15. Select the Use an embedded database (vPostgres) radio button, and click Next.
16. Enter network settings for the appliance, and click Next.
17. Click Finish.
18. Using the vSphere web client, log into the vCenter server using the credentials previously provided.
19. Right-click the root of vCenter, and click New Data center.
20. Name the new datacenter datacenter
21. Add the servers under test and infrastructure servers to the datacenter.

Creating a Windows Server® 2012 R2 VM template for infrastructure VMs

1. Add the infrastructure server to an existing VMware vCenter server's inventory.
2. In the VMware vSphere client, under Basic Tasks, select Create a new virtual machine.
3. Choose Custom, and click Next.
4. Assign the name template vm to the virtual machine, and click Next.
5. Select infrastructure as the host, and click Next.

6. Select a datastore on the Dell EMC EqualLogic PS6110XS storage, and click Next.
7. Select Virtual Machine Version 11, and click Next.
8. Select Windows, select Microsoft Windows Server 2012 (64-bit), and click Next.
9. For CPUs, select one virtual processor socket and one core per virtual socket, and click Next.
10. Choose 2 GB RAM, and click Next.
11. Click 1 for the number of NICs, select VMXNET3, connect to the PRIV-NET network, and click Next.
12. Leave the default virtual storage controller, and click Next.
13. Choose to create a new virtual disk, and click Next.
14. Make the OS virtual disk size 60 GB, choose thin-provisioned lazy zeroed, specify external storage, and click Next.
15. Keep the default virtual device node (0:0), and click Next.
16. Click Finish.
17. Right-click the VM, and choose Edit Settings.
18. Connect the VM virtual CD-ROM to the Microsoft Windows Server 2012 R2 installation disk.
19. Start the VM.

Installing Microsoft Windows Server 2012 R2 Datacenter Edition

1. When prompted to boot from DVD, press any key.
2. When the installation screen appears, click My language is English (United States).
3. Leave language, time/currency format and input method as default, and click Next.
4. Click Install now.
5. When the installation prompts you, enter the product key.
6. Select Windows Server 2012 R2 Datacenter (Server with a GUI), and click Next.
7. Check I accept the license terms, and click Next.
8. Click Custom: Install Windows only (advanced).
9. Select Drive 0 Unallocated Space, and click Next, at which point Windows begins automatically and restarts automatically after completing.
10. When the Settings page appears, enter and reenter the Password and Reenter Password fields with the same password.
11. Log in with the password you set up previously.
12. Install VMware Tools. For more information, see kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340.
13. Reboot the server.

Configuring Windows Update

1. In the left pane of the Server Manager window, click Local Server.
2. In the main frame, next to Windows Update, click Not configured.
3. In the Windows Update window, in the main pane, click Let me choose my settings.
4. Under Important updates, select Never check for updates (not recommended), and click OK.
5. In the left pane, click Check for updates, and install all available updates.
6. Close the Windows Update window.
7. Reboot the server when required.

Converting VM into a template

1. Right-click the `template` VM, and select Template.
2. Select Convert to template.

Deploying the infrastructure VMs

1. Select Inventory→VMs and Templates.
2. Right-click the `template` VM, and select Deploy Virtual Machine from this Template…
3. Under the name field, enter the appropriate VM name, and select the infrastructure server as the inventory and host location. Click Next.
4. Select the appropriate storage destination, and click Next.
5. Add the appropriate amount of memory for the server role.
6. Click Finish.

7. After the server reboots, log in using administrator credentials.
8. Click Start→Control Panel→Network Connections→ View network status and tasks→Change adapter settings.
9. Right-click the PRIV-NET NIC, and select Properties.
10. Double-click Internet Protocol Version 4 (TCP/IPv4)
11. Select Use the following IP address, and set the appropriate IP address, Subnet mask, Default gateway, and DNS server.
12. Click OK twice.
13. Complete steps 1 through 13 to deploy the other VMs.

Installing Active Directory Domain Services and DNS on DC1

1. Log into `DC1` VM as `test\administrator`
2. Open Server Manager.
3. On the Welcome screen, click manage, and click Add roles and features.
4. At the initial Before you begin screen, click Next three times.
5. At the Server Roles screen, select Active Directory Domain Services.
6. On the pop-up window, click Add Features.
7. Click Next three times.
8. Verify the desired role is being installed, and click Install.
9. Once installation has finished, close the Add roles and features wizard.
10. In Server Manager, click the flag at the top, and select the Promote this server to a domain controller link.
11. Select Add a new forest, type `test.local` as the name of the root domain, and click Next.
12. On the Domain Controller Options window, enter a password, and click Next.
13. On the DNS Options screen, click Next.
14. On the Additional Options screen, click Next.
15. On the Review Options screen, click Next.
16. On the Prerequisites screen, verify all prerequisites have passed, and click Install.
17. Once Active Directory Domain Services finishes installing, click Finish, and restart the system.

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. Open Server Manager.
2. Select Manage, and click Add Roles and Features.
3. Click Next twice.
4. Select DHCP Server, and click Next.
5. At the Introduction to DHCP Server screen, click Next.
6. At the Specify IPv4 DNS Settings screen, type `test.local` for the parent domain.
7. Enter the preferred DNS server IPv4 address, and click Next.

8. At the Specify IPv4 WINS Server Settings screen, select WINS is not required for applications on the network, and click Next.
9. At the Add or Edit DHCP Scopes screen, click Add.
10. At the Add Scope screen, enter the Name DHCP Scope name.
11. In the next box, set the following values, and click OK.

- Start IP address = `172.0.0.20`
- End IP address = `172.0.3.200`
- Subnet mask = `255.255.252.0`

12. Click Activate This Scope.
13. At Add or Edit DHCP Scopes, click Next.
14. Click Enable DHCP v6 Stateless Mode, and click Next.
15. Leave the default IPv6 DNS Settings, and click Next.
16. At the Authorize DHCP server dialog box, select Use current credentials.
17. At the Confirm Installation Selections screen, click Next. If the installation is set up correctly, a screen displays saying that DHCP server install succeeded.
18. Click Close.
19. Click Start→Run, and type `DHCPmgmt.msc`
20. Click DHCP→`DC1.test.local`→IPv4→Server Options
21. Right-click Server Options, and select Configure options.
22. Activate option 66 Boot Server Host Name:

- String value = `<ip of the Provisioning server>`

23. Activate option 67 Boot file Name:

- String value = `ARDBP32.BIN`

24. Click OK.

Installing VMware Horizon 7

Joining the Horizon Connection Server VM to the domain

1. Log into the `HC` VM as the local user.
2. In Server Manager, click WORKGROUP.
3. Click Change.
4. Enter `HC` as the computer name and select the Domain radio button.
5. Click OK.
6. Enter credentials for `test\administrator`, and click OK.
7. Click OK.
8. Click OK.
9. Click Close.
10. Click Restart Now.

Installing the Horizon Connection Server

1. Log into the `HC` VM as the local user.
2. In Server Manager
3. Log into `HC` VM as `test\administrator`, and launch the VMware Horizon 7 Connection Server installation file.
4. At Welcome, click Next.
5. Accept the terms of the license agreement, and click Next.
6. Leave the default installation location, and click Next.
7. Select Horizon 7 Standard Server, click Install HTML Access, select IPv4 and click Next.
8. Enter a password for the backups, and click Next.
9. Select Configure Windows Firewall automatically, and click Next.
10. Select Authorize a specific domain user or domain group, type `test\administrator`, and click Next.
11. Uncheck Participate anonymously in the user experience improvement program, and click Next.
12. Click Install.
13. Click Finish.

14. Browse to `https://hc.test.local/admin`, and log in with `test\administrator`.
15. Browse to View Configuration➔Servers, and click Add.
16. Enter the vCenter address and credentials, and click Next.
17. Click View certificate, and click Accept.
18. Select Do not use View Composer, and click Next.
19. At the Storage page, click Next.
20. At the Ready to Complete page, click Finish.

Installing Citrix XenDesktop

Installing and configuring Microsoft SQL 2008 R2 on License Server VM

1. Log into `LIC` VM as `test\administrator`
2. Insert the installation media, and click OK to install .NET framework.
3. Wait for the SQL Installer to launch. On the left menu, click Installation.
4. Click New installation or add features to an existing installation. Click OK.
5. Enter the Product Key, and click Next.
6. Select I accept the license terms, and click Next.
7. To install the Setup Support Files (required), click Install.
8. Resolve any issues displayed in the setup wizard, and click Next.
9. At Setup Role, select SQL Server Feature Installation, and click Next.
10. Select Database Engine Services, Full-Text Search, Client tools Backwards Compatibility, Management Tools Basic and Complete, and click Next twice.
11. Accept instance configuration defaults, and click Next.
12. Accept defaults for disk space requirements, and click Next.
13. Click Use the same account for all SQL Server services, select NT Authority\System, and click OK. Click Next.
14. Select Mixed Mode, and enter a password for the SA account. Click Add Current User, and click Next.
15. Accept defaults for error reporting, and click Next.
16. Review installation configuration rules check, and click Next.
17. To begin the installation, click Install.
18. At the completion screen, click Close.
19. Run Windows Update to receive all updates and security patches.

Setting up an ODBC Data Source Name on License Server VM

1. Log into `LIC` VM as `test\administrator`
2. Select Start, Run, and type `odbcad32.exe`. Press Enter.
3. Click the system DSN tab.
4. Click Add.
5. Click SQL Server Native Client 10.0, and click Finish.
6. In Create a New Data Source to SQL Server, type `LIC`
7. For Server, select SQL, and click Next.
8. Change authentication to With SQL Server authentication using a login ID and password entered by the user, type `sa` as the Login ID, use the password you defined in SQL server setup for the SA account, and click Next.
9. Accept defaults settings and click Next.
10. Click Finish.
11. To confirm correct configuration, click Test Data Source….
12. To create the ODBC connection, click OK.

Installing and configuring Citrix XenDesktop License Server

1. Log into `LIC` VM as `test\administrator`
2. Mount XenDesktop installation media, and click Start on XenDesktop.
3. Select Citrix License Server.
4. Select I have read, understand, and accept the terms of the license agreement, and click Next.
5. At Core Components, click Next.
6. Under Firewall, select Automatically configure firewall rules, and click Next.
7. Click Install.
8. Click Finish.

Installing and configuring Citrix XenDesktop 7.11 Delivery Controller

1. Log into `XD` VM as `test\administrator`
2. Mount XenDesktop installation media, and click Start on XenDesktop.
3. Click Delivery Controller.
4. Select I have read, understand, and accept the terms of the license agreement, and click Next.
5. Select Delivery Controller, Studio, Director, StoreFront, and click Next.
6. Under Features, select Install SQL server 2012 SP2 Express, and click Next.
7. Under Firewall, select Automatically configure firewall rules, and click Next.
8. Click Install.
9. When completed, click Finish.
10. Open Citrix Studio.
11. Click Deliver applications and desktops to your users.
12. Select A fully configured, production-ready Site, and click Next.
13. Choose Create and set up databases from Studio and Enter the Database name, enter location for the Site, Monitoring, and Logging database, and click Next.
14. Enter License server address, and click Connect. Select appropriate license, and click Next.
15. Connect to vCenter server, and enter credentials. Click Next
16. Select Network, give it a resource name, and click Next.
17. Select Storage, and click Next.
18. On Additional Features, click Next.
19. Click Finish.

Installing and Configuring Citrix Provisioning Services 7.11

1. Mount Provisioning service installation media to the `PVS` VM, and click Console Installation.
2. Click Install.
3. At Welcome, click Next.
4. Select I accept the terms in the license agreement, and click Next.
5. Enter User Name and Organization, and click Next.
6. On the destination folder screen, click Next.
7. Click Install.
8. Click Finish.
9. Mount Provisioning service installation media, and click Server Installation.
10. At the prompt, click Yes.
11. At Welcome, click Next.
12. Select I accept the terms in the license agreement, and click Next.
13. Enter user name and organization, and click Next.
14. On the destination folder screen, click Next.
15. Click Install.
16. Click Finish.
17. At Welcome, click Next.
18. At DHCP services, select The service that runs on another computer. Click Next.
19. At PXE services, select The service that runs on this computer. Click Next.
20. Select Create farm, and click Next.
21. Enter Database Server details, and click Next.
22. Provide New Farm information, and click Next.
23. Select the vDisk destination folder, and click Next.
24. Enter License Server details, and click Next.
25. Select Specified user account, and enter credentials. Click Next.
26. Keep the default number of days between password updates, and click Next.
27. Keep the default primary interface and communication ports, and click Next.
28. Select Use the Provisioning Services TFTP service, and click Next.
29. Leave the stream service at defaults, and click Next.
30. Click Finish, and click Done.

Creating the master desktop image
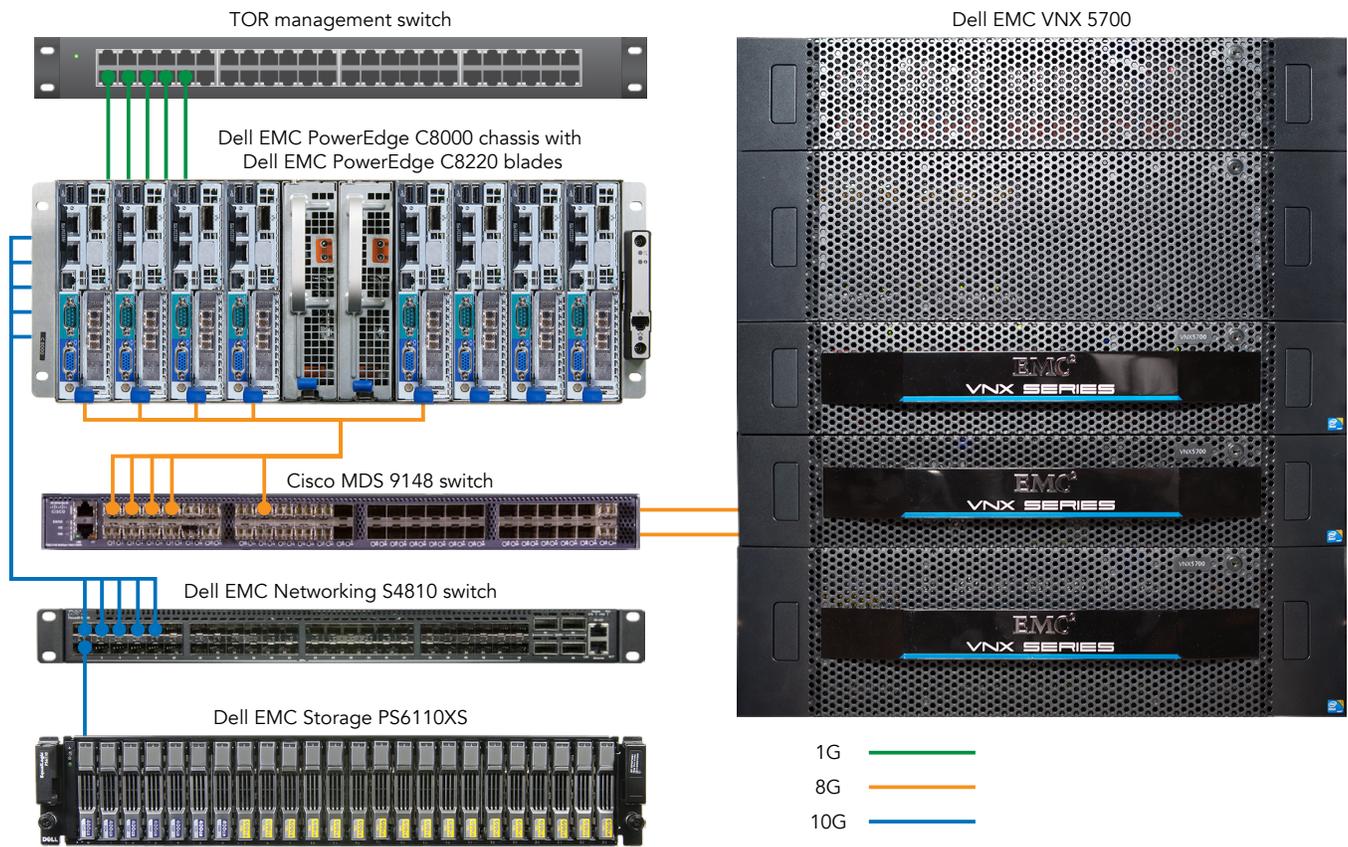
Creating the Windows 10 Master VM

1. In the VMware vSphere client, under Basic Tasks, select Create a new virtual machine.
2. Choose Custom, and click Next.
3. Assign the appropriate name to the virtual machine, and click Next.
4. Select infrastructure as the host, and click Next.
5. Select the appropriate storage, and click Next.
6. Select Virtual Machine Version 11, and click Next.
7. Select Windows, select the appropriate version of Microsoft Windows, and click Next.
8. For CPUs, select one virtual processor socket and one core per virtual socket, and click Next.
9. Choose 2 GB RAM, and click Next.
10. Click 1 for the number of NICs, select VMXNET3, connect to the PRIV-NET network, and click Next.
11. Leave the default virtual storage controller, and click Next.
12. Choose to create a new virtual disk, and click Next.
13. Make the OS virtual disk size 60 GB, choose thin-provisioned lazy zeroed, specify external storage, and click Next.
14. Keep the default virtual device node (0:0), and click Next.
15. Click Finish.
16. Connect the VM virtual CD-ROM to the Microsoft Windows installation disk.
17. Start the VM.

Installing Windows 10 onto the master VM

1. Leave the default Language, Time and currency format, and keyboard input method, and click Next.
2. Click Install Now.
3. Check I accept the license terms, and click Next.
4. Click Custom: Install Windows only (advanced).
5. Select the drive for installation, and click Next.
6. When installation completes, click Customize settings.
7. On the next three pages, move all sliders to the OFF position, and click Next.
8. Select Join a Domain, and click Next.
9. Enter a username and password, and click Next.
10. Restart the VM, and log in with the domain administrator account.
11. Install VMware Tools. For more information, see kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340.
12. Reboot.
13. Turn off the firewall and User Account Control.
14. Shut down the VM.

Appendix C: Testbed diagram

The following figure shows how we configured the servers under test.

TOR management switch

Dell EMC VNX 5700

Dell EMC PowerEdge C8000 chassis with
Dell EMC PowerEdge C8220 blades

Cisco MDS 9148 switch

Dell EMC Networking S4810 switch

Dell EMC Storage PS6110XS

1G ———
8G ———
10G ———

Appendix D: Steps comparison

Initial deployment (10 VMs)

VMware Horizon 7

Installing the VMware Horizon 7 Agent

1. Browse to the VMware Horizon 7 media, and run the VMware-viewagent file.
2. Click Run.
3. At the Welcome screen, click Next.
4. Accept the VMware end-user license agreement, and click Next.
5. Specify the protocol to be used.
6. Select defaults, and click Next.
7. Click Install.
8. Click Finish.
9. After installation completes, click reboot.

Creating a VM snapshot

10. Log into vCenter.
11. Shut down the master VM.
12. Right-click the VM, and take a snapshot.

Deploying virtual desktops using VMware Horizon

13. Open the View Administrator.
14. Log in as `Administrator`.
15. Under inventory, click Desktop Pools, and click Add…
16. Select Automatic Pool, and click Next.
17. Select Floating, and click Next.
18. Select Instant clones, select vCenter server, and click Next.
19. Type `pool` for the pool ID and display name, and click Next.
20. Leave the pool settings as defaults, and click next.
21. Under Virtual Machine Naming, enter an appropriate name pattern for the pool.
22. Under Desktop Pool Sizing, type `10` for Max number of machines.
23. Select provision all desktops up-front, and click Next.
24. Select the defaults under storage optimization, and click Next.
25. Under vCenter Settings, select the Default Image Parent VM.
26. Select a snapshot.
27. Select a VM folder location.
28. Select a cluster.
29. Select a resource pool.
30. Select a datastore.
31. Under Guest customization, select the Domain and AD container, and click Next.
32. Check to entitle users, and click finish.
33. Click Add, and select user group.
34. Click Done.

Citrix XenDesktop

Installing Virtual Deliver Agent (VDA) on Windows 10 master VM

1. Mount XenDesktop installation media, and click Start on XenDesktop.
2. Click Virtual Delivery Agent for Windows Desktop OS.
3. Select Create a Master Image, and click Next.
4. At the HDX 3D Pro screen, click Next.
5. On the Core Components screen, click Next.
6. Provide XenDesktop Controller address, and click Test connection.
7. Click Add, and click Next.
8. At the Feature screen, click next.
9. Under Firewall, click Next.
10. At the Summary screen, click Install.
11. Choose not to call home, and click Next.
12. Click Finish.
13. Reboot the system.

Installing Citrix Provisioning Services target device on Windows 10 master VM

14. Open Provisioning Services installation media.
15. Click Target Device Installation.
16. Click Target Device Installation again.
17. On the Welcome screen, click Next.
18. Select I accept the terms in the license agreement, and click Next.
19. Enter user name and organization, and click Next.
20. On the destination folder screen, click Next.
21. Click Install.
22. Click Finish.

Launching Imaging Wizard and creating master vDisk

23. Select Launch Imaging Wizard, and click Finish.
24. On the Welcome screen, click Next.
25. Enter Provisioning Services site server information, and enter Windows Credentials. Click Next.
26. Select Create new vDisk, and click Next.
27. Enter Target Device name, and click Next.
28. Enter vDisk name, and click Next.
29. For Microsoft Volume Licensing, click None, and click Next.
30. On the What to image screen, select image entire boot disk, and click Next.
31. Select Do not optimize the hard disk again, and click Next.
32. Click Create.
33. Upon completion, click Continue.
34. To reboot the VM and shut down instead, click No.
35. In vCenter, right-click the VM, and click Edit settings.
36. Click Options tab→Boot options, check to force BIOS Setup, and click OK.
37. Power on the VM.
38. In the VM BIOS, tab to the Boot menu, and change the boot order to boot from network.
39. Tab to Exit, and select Exit Saving Changes.

40. Log in as `test\administrator`. Provisioning services will now copy the VM OS to the vDisk.
41. Click Done.
42. Shut down the VM.
43. In vCenter, right-click the VM, and select Template→Convert to Template.

Configuring the vDisk to Cache from RAM

44. Open Provisioning Services, Farm, Sites, Site, vDisk Pool, and right-click the appropriate vDisk.
45. Select Properties.
46. Under the General tab, change the Access mode from private image to standard image.
47. Change the cache type to Cache in device RAM, and adjust the RAM size to 256MB.
48. Click OK.
49. On Farm→Sites→Site→Device Collections, select the appropriate collection, and right-click the appropriate target device.
50. Select Properties.
51. Change the Boot from option to vDisk.
52. Click Ok.

Deploying a XenDesktop non-persistent pool with the XenDesktop Setup Wizard

53. Open the Provisioning Services Console→Farm→Sites→Site, right-click, and select XenDesktop Setup Wizard.
54. When the Setup wizard appears, click Next.
55. Enter the XenDesktop Controller address, and click Next.
56. Select the XenDesktop Host Resources, and click Next, and credentials for the host resources, and click OK.
57. Select the Windows 10 virtual machine template, and click Next.
58. Select the standard-mode vDisk that corresponds with the virtual machine template, and click Next.
59. Leave Create a new catalog selected, and enter a Catalog name describing the non-persistent pool, and click Next.
60. Leave Windows Desktop Operating System selected, and click Next.
61. Change the logon connection type to "A fresh new (random) desktop each time," and click Next.
62. Enter the number of virtual machines to create 10 VMs, and leave the default vCPU, Memory, and boot mode, and click Next
63. Leave Create new accounts selected, and click Next.
64. Expand the domain tree, and select the Citrix domain users group. Change the account naming scheme to describe the deployment pool, and click Next.
65. Review the deployment summary, and click Finish.

Creating a XenDesktop delivery group

66. Open the Citrix Desktop Studio, expand the Citrix Studio site, select the Delivery Groups tree item, and click Create Delivery Group.
67. At the welcome page, click Next.
68. Select the machine catalog for the delivery group, enter the number of machines (10), and click Next.
69. Leave the default Delivery Type (Desktops) selected, and click Next.
70. At the Users screen, select next
71. At the Application screen, click next.
72. At the Desktops screen, click next.
73. Enter a Delivery Group name, and click Finish.
74. Power on all the VMs.

Scale out deployment (50, 100, or 200 VMs)

VMware Horizon 7

1. Log in to View Administrator.
2. Select the desktop pool, and click Edit…
3. Adjust the number of VMs to 50, 100, or 200.
4. Click Done.

Citrix XenDesktop

1. Open the Provisioning Services Console→Farm→Sites→Site, and right-click and select XenDesktop Setup Wizard.
2. When the Setup wizard appears, click Next.
3. Enter the XenDesktop Controller address, and click Next.
4. Select the XenDesktop Host Resources, and click Next, and credentials for the host resources, and click OK.
5. Select the Windows 10 VM template, and click Next.
6. Select the standard-mode vDisk that corresponds with the VM template, and click Next.
7. Leave Create a new catalog selected, and enter a Catalog name describing the non-persistent pool, and click Next.
8. Leave Windows Desktop Operating System selected, and click Next.
9. Change the logon connection type to "A fresh new (random) desktop each time," and click Next.
10. Enter the number of VM to create 10 VMs and leave the default vCPU, Memory, and boot mode, and click Next
11. Leave Create new accounts selected, and click Next.
12. Expand the domain tree, and select the Citrix domain users group. Change the account naming scheme to describe the deployment pool, and click Next.
13. Review the deployment summary, and click Finish.
14. Open Citrix Studio.
15. Select the delivery group and click Add Machines.
16. Enter the number of machines to add to the delivery group (40).
17. Click Done.

Appendix E: Deployment data

The figures below show the CPU utilization percentage and network throughput on the four virtual desktop hosts during the initial base deployment. We collected data metrics with ESXTOP and averaged (in the case of CPU) or summed (in the case of network throughput) across all four hosts. Each chart shows the averages across all hosts used in testing.
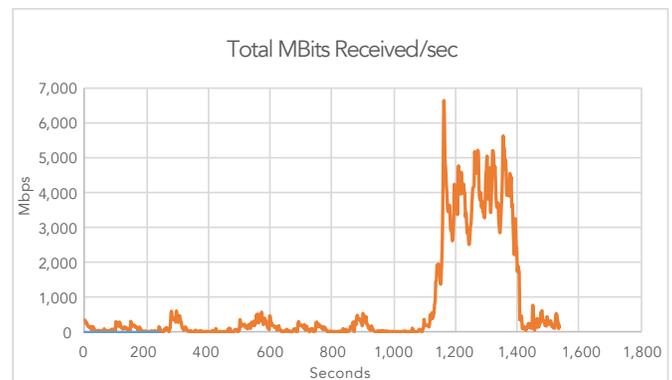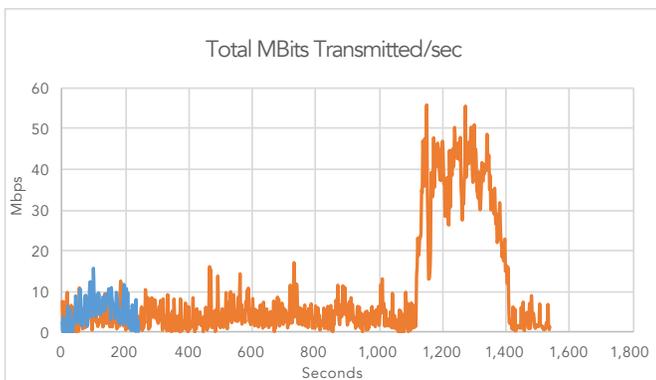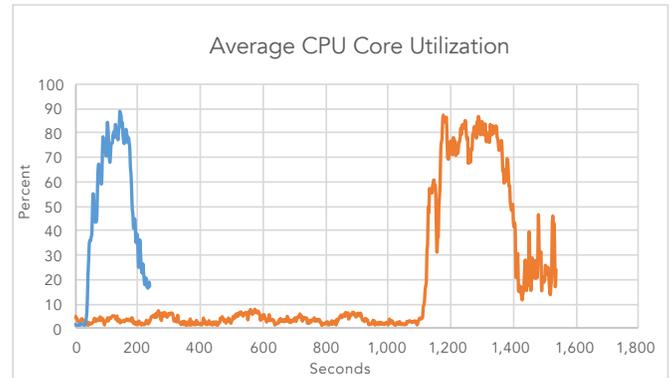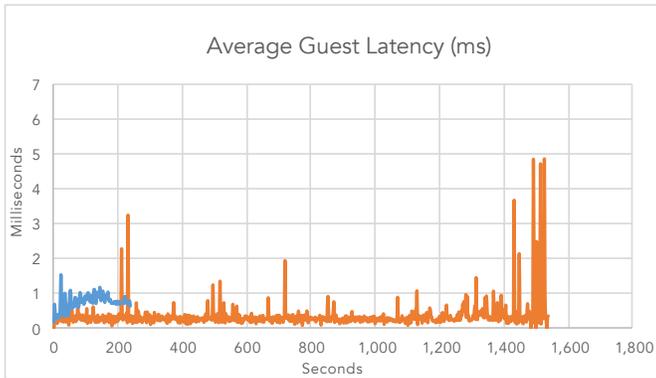
—— Horizon
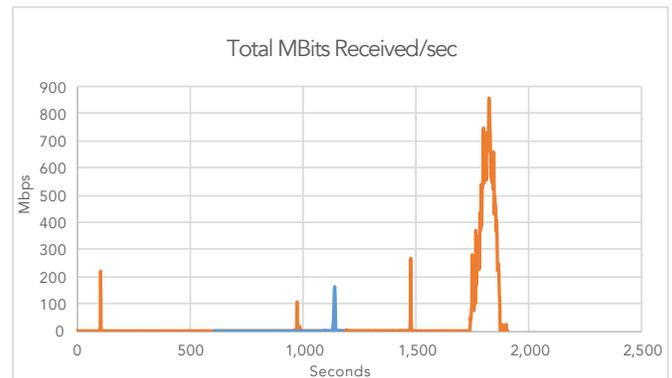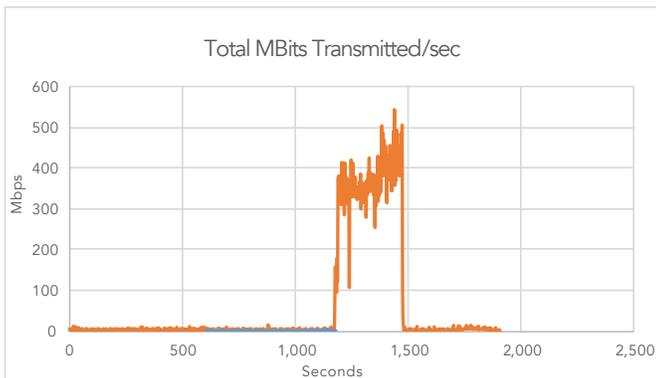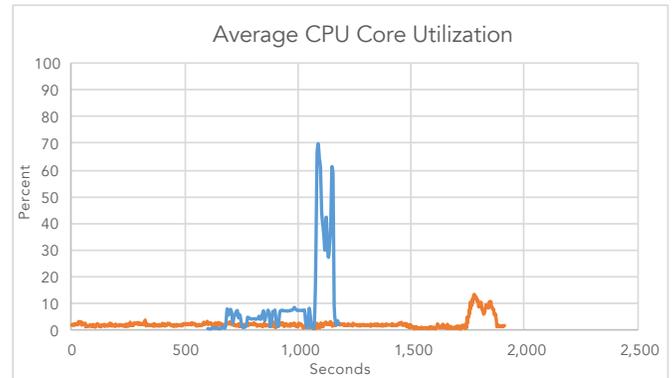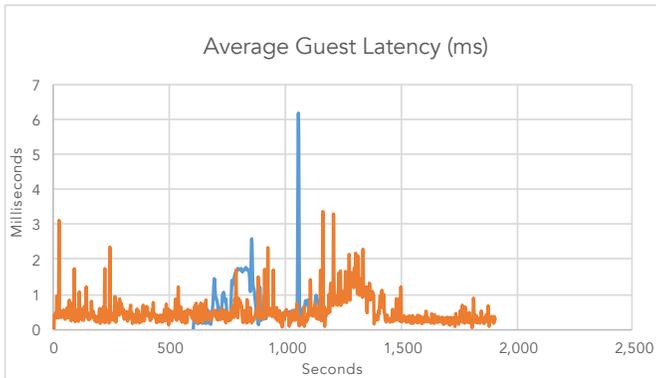
—— XenDesktop

The figures below show data metrics from the infrastructure host for XenDesktop during the initial base deployment.

—— PVS
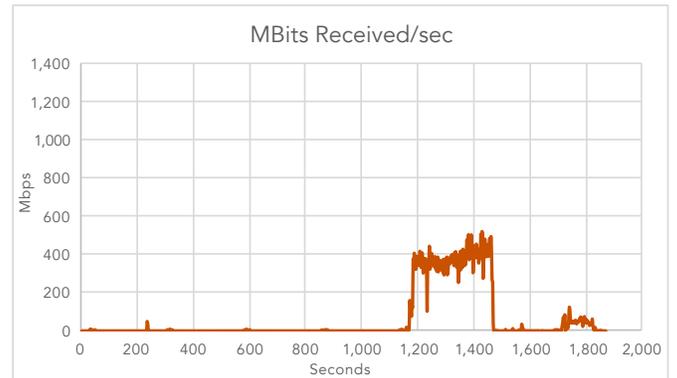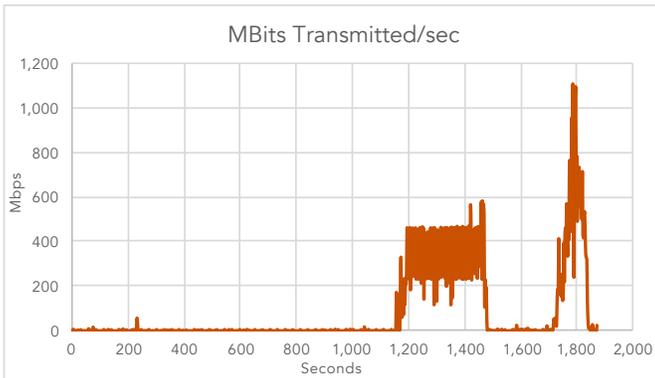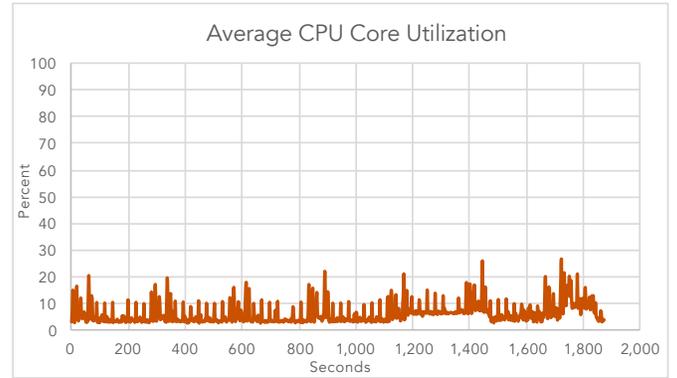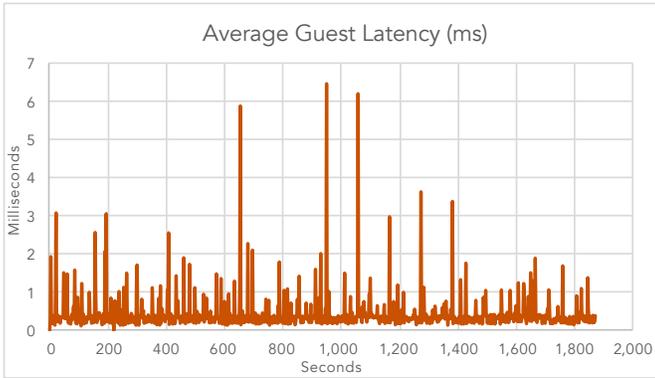
Average Guest Latency (ms)

Average CPU Core Utilization

MBits Transmitted/sec

MBits Received/sec

The figures below show the CPU utilization percentage and network throughput on the four virtual desktop hosts during the 200VM deployment scenarios. We collected data metrics with ESXTOP and averaged (in the case of CPU) or summed (in the case of network throughput) across all four hosts. Each chart shows the averages across all hosts used in testing.

—— Horizon

—— XenDesktop

Average Guest Latency (ms)

Average CPU Core Utilization

Total MBits Transmitted/sec

Total MBits Received/sec

The figures below show data metrics from the infrastructure host for XenDesktop during the 200VM deployment.

—— PVS

Average Guest Latency (ms)

Average CPU Core Utilization

MBits Transmitted/sec

MBits Received/sec
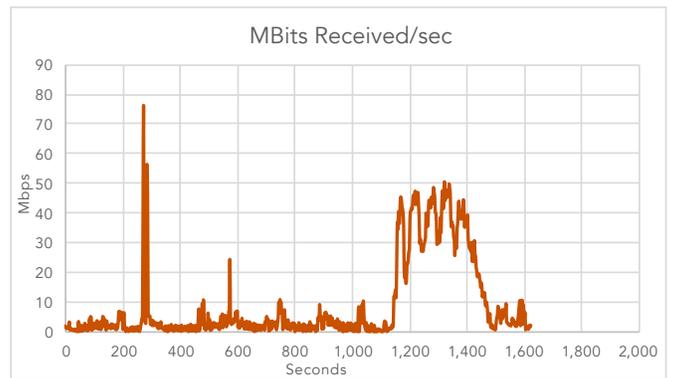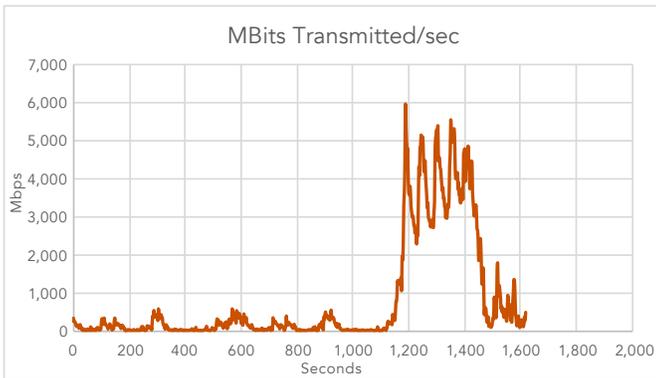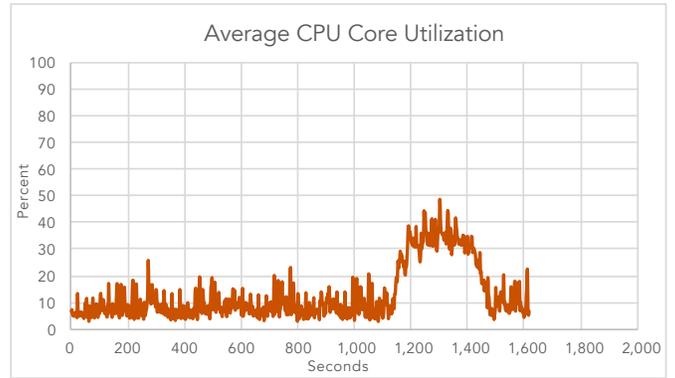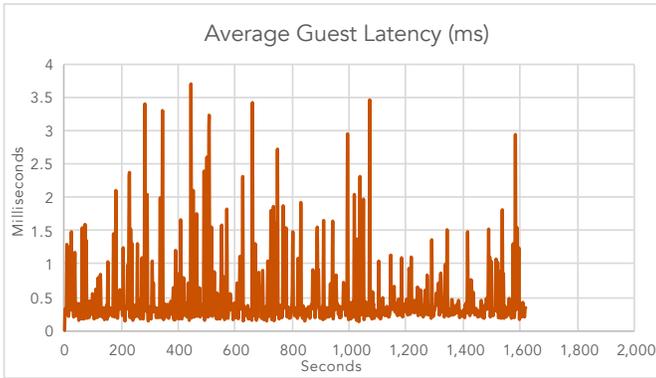
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