



## Support more workers using graphics-accelerated VDI desktops

A new 14th generation Dell EMC PowerEdge R740xd server equipped with NVIDIA Tesla M10 GPUs and powered by Intel Xeon Scalable processors delivered high-density graphics acceleration in a virtual enterprise environment

As more users move to modern, graphics-intensive Microsoft® Windows® 10 environments, companies using a virtual desktop infrastructure (VDI) need increasingly robust server resources to support them. Your company should strive to get the most from each server and maximize datacenter space while providing an excellent end-user experience.

One way to accomplish this is with NVIDIA® Tesla® M10 graphics processing units (GPUs), which work seamlessly with the VMware Horizon® virtual desktop and application platform, augmenting the processors in a server to improve the performance of graphics-accelerated workloads. Tight integration between VMware Horizon and NVIDIA Virtual GPU technology makes this platform ideal for delivering high-performance graphics acceleration and a rich, immersive user experience for 2D and 3D applications.

In a simulated VDI environment at Principled Technologies, we tested a new Intel® Xeon® Scalable processor-powered 14th generation Dell EMC™ PowerEdge™ R740xd server, which supports three Tesla GPUs, and a 13th generation Dell EMC PowerEdge R730 server, which supports only two Tesla GPUs. Following the NVIDIA recommendation not to exceed 32 VDI users per GPU for an optimal Windows 10 experience, the newer server supported 96 graphics-accelerated desktops and the older one supported 64 of them.<sup>1</sup> Depending on the current and future needs of your company, both Dell EMC PowerEdge servers are excellent options for supporting office workers in a VDI environment using Microsoft Office 2016, media-rich browsers, and other graphics-intensive apps.



\*than a previous-generation server



Dell EMC PowerEdge R740xd  
**supported 50% more  
desktop users\***

## Dell EMC PowerEdge Multi-Vector Cooling

To tackle the cooling needs that higher-performance components and denser configurations bring, Dell EMC PowerEdge Engineering has developed an approach that includes the following:



- Highly reliable, customized fans and custom heatsinks
- Advanced thermal design to increase airflow throughout the chassis
- Sensors that measure temperature and redirect airflow accordingly
- User customization options in the integrated Dell Remote Access Controller (iDRAC) web interface

Learn more at [http://en.community.dell.com/techcenter/extras/m/white\\_papers/20444244/](http://en.community.dell.com/techcenter/extras/m/white_papers/20444244/)

## GPUs: No longer limited to graphics-intensive fields

For years, those who perform tasks such as computer-aided design and video editing have required extremely powerful computers to support the heavy graphics requirements of the applications they use. Other professionals, who rely primarily on office productivity applications to do their jobs, have had lower computational demands, which has made them good candidates for a virtual desktop infrastructure.

Productivity software is changing, though. As a 2016 Forbes article notes, "Use of graphics acceleration is expanding to improve the experience of office productivity applications like Outlook®, Office 2016, web browsers, Adobe® Photoshop®, and the Windows 10 operating system. And by some estimates, more than half of enterprise users access at least one graphics accelerated application."<sup>2</sup>

To improve server performance and perform the heavy-duty graphics and visual processing work modern applications require, the Dell EMC PowerEdge R740xd, powered by Intel Xeon Scalable processors, uses NVIDIA Tesla M10 GPU accelerators. For servers using these high-performing components, proper cooling is essential to achieve optimal thermal control inside a server. The Dell EMC PowerEdge R740xd employs PowerEdge Multi-Vector Cooling (see box above) to optimize cooling and support high performance. This unique feature allows the Dell EMC PowerEdge R740xd to host up to three Tesla GPUs in a dense system configuration while maintaining optimal cooling and airflow throughout the server chassis.



Tesla M10 GPU accelerator

## Integration with VMware Horizon

If you seek strong, GPU-accelerated performance, a solution with VMware and NVIDIA technologies can help. NVIDIA vGPUs in a VMware Horizon environment can assist in creating an immersive user experience within graphics-heavy applications. Whether you work in creative or knowledge-driven fields, your business could benefit from this hardware and software solution.





## Validate the performance of virtual environments with Login VSI

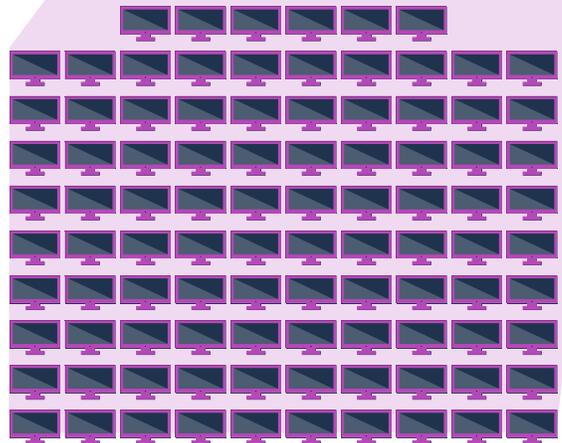
The Login VSI test tool creates a virtual workload that simulates real-world usage of a system. Login VSI offers multiple types of workloads that assess server performance and end-user experience. We chose the Knowledge Worker workload, which executes tasks in the following Microsoft apps: Outlook, Internet Explorer®, Word, PowerPoint®, and Excel®. The workload also includes tasks in Adobe Reader, the Login VSI photo viewer, and Doro PDF viewer. For more information, see <https://www.loginvsi.com/blog/login-vsi/665-simulating-vdi-users-introduction-to-login-vsiworkloads>.

## Support more workers to optimize datacenter space

Datacenter space is precious, and every additional VDI session your company can support within a given amount of rack space helps the company save in multiple ways. To learn about the VDI capabilities of the new 14th generation Dell EMC solution, we executed the Login VSI Knowledge Worker workload against the Dell EMC PowerEdge R740xd server running VMware ESXi 6.5 with three NVIDIA GPUs and then ran the same workload on a 13th generation Dell EMC PowerEdge R730, also running VMware ESXi™ 6.5, equipped with its maximum of two NVIDIA GPUs.

We found that the Dell EMC PowerEdge R740xd server handled 50 percent more Knowledge Worker VDI sessions than the R730 server did—96 sessions versus 64 sessions. Both servers maintained CPU utilization levels below 80 percent during testing. For detailed information from testing, see [Appendix C](#).

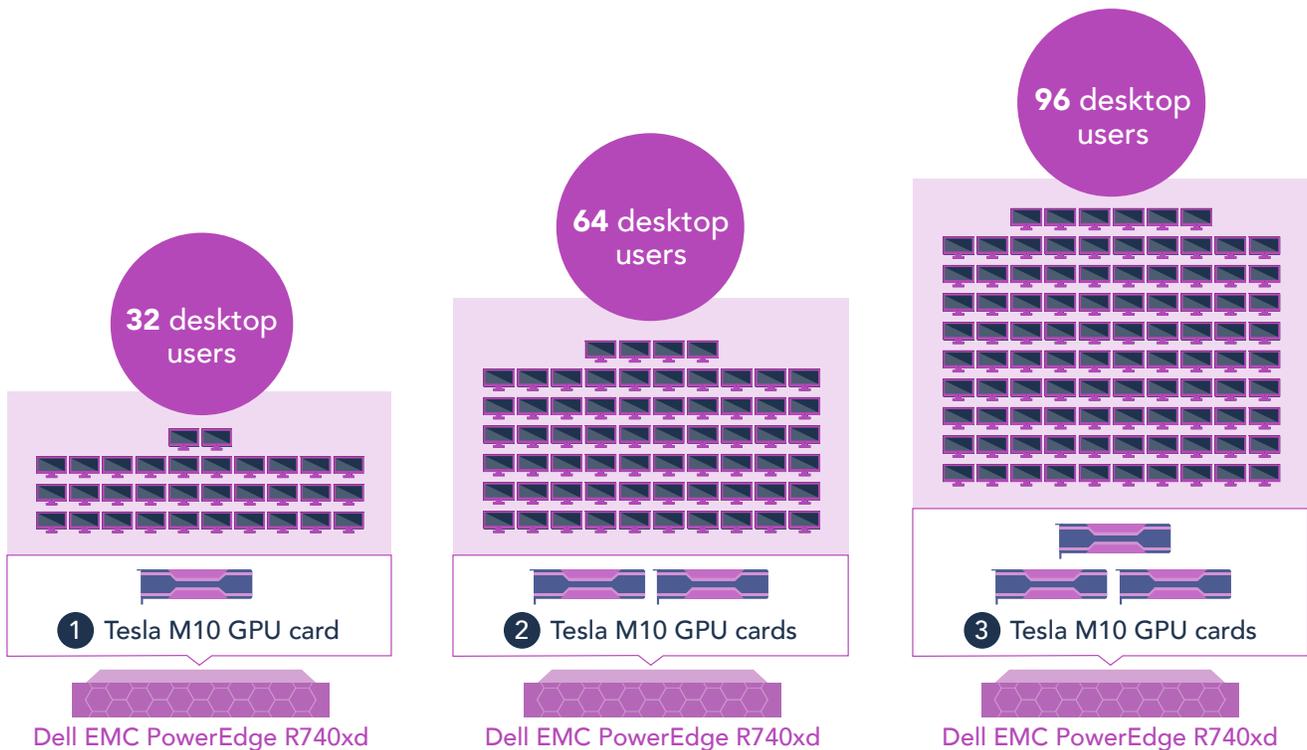
Support up to  
**96 desktops**  
with the Dell EMC  
PowerEdge R740xd



## True scalability

In theory, having two or three times as much of a given computing resource should translate to being able to perform two or three times as much work. In practice, a variety of factors can create bottlenecks that impede this true scalability. Our testing showed that the R740xd with three GPUs could handle these real-world factors with ease.

To demonstrate the increased VDI capabilities of the Dell EMC PowerEdge R740xd with NVIDIA GPUs, we ran our Login VSI Knowledge Worker workload not only on a fully populated server with three GPUs, but also on servers with one and two GPUs. As the illustration below shows, with a single NVIDIA GPU, the server supported 32 desktop users. The user count doubled to 64 when we doubled the GPU count, and tripled to 96 users when we tripled the GPU count. This kind of linear scalability can be very valuable to companies because it allows them to precisely predict the computing resources a predetermined number of users will require.



## Conclusion

Effectively delivering computing resources for office workers via VDI requires powerful servers. The new 14th generation Dell EMC PowerEdge R740xd server with three NVIDIA Tesla M10 GPUs and powered by Intel Xeon Scalable processors supported 1.5 times as many VDI sessions as the previous-generation PowerEdge R730 server with two Tesla GPUs did. What's more, it achieved this increase without using any additional rack space. If your organization is using a VDI solution or considering implementing one, the Dell EMC PowerEdge R740xd can allow you to support more workers in 2U than the older-generation option.

1 "The Right vGPU Profile for Windows 10," accessed October 3, 2017 <https://blogs.nvidia.com/blog/2016/11/29/vgpu-profile-for-windows-10/>

2 "NVIDIA's New Tesla M10 Could Drive Enterprise VDI Reassessment" by Patrick Moorhead, accessed September 1, 2017, <https://www.forbes.com/sites/patrickmoorhead/2016/05/18/nvidias-new-tesla-m10-could-drive-enterprise-vdi-reassessment/#1342699e5941>

On July 17, 2017, 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. We concluded hands-on testing on August 11, 2017.

## Appendix A: System configuration information

Server configuration information	Dell EMC PowerEdge R740xd	Dell EMC PowerEdge R730
BIOS name and version	Dell EMC 1.0.7	Dell EMC 2.4.3
Operating system name and version/build number	VMware ESXi 6.5.0 5969303	VMware ESXi 6.5.0 5969303
Date of last OS updates/patches applied	8/17/17	8/17/17
Power management policy	Performance	Performance
Processor		
Number of processors	2	2
Vendor and model	Intel Xeon Gold 6152	Intel Xeon processor E5-2690 v4
Core count (per processor)	22	14
Core frequency (GHz)	2.1	2.6
Memory module(s)		
Total memory in system (GB)	384	256
Number of memory modules	24	8
Vendor and model	Hynix HMA82GR7AFR8N-VK	Samsung M393A4K40BB1-CRC0Q
Size (GB)	16	32
Type	PC-19200 Dual Rank	PC-19200 Dual Rank
Speed (MHz)	2,666	2,400
Local storage		
Number of drives	6	6
Drive vendor and model	Dell P/N 0XCRDV (PX05SRB384Y)	Dell P/N 0XCRDV (PX05SRB384Y)
Drive size (TB)	3.84	3.84
Drive information (speed, interface, type)	12Gbps SAS SSD	12Gbps SAS SSD
Network adapter		
Vendor and model	Intel 10G 2P X520 Adapter	Intel 10G 2P X520 Adapter
Number and type of ports	2 x 10GbE	2 x 10GbE
Driver version	17.5.10	17.5.10



<b>Server configuration information</b>	<b>Dell EMC PowerEdge R740xd</b>	<b>Dell EMC PowerEdge R730</b>
<b>Cooling fans</b>		
Vendor and model	Nidec® UltraFlo 4VXP3-X30	Minebea® 06038DA-12S-EWH
Number of cooling fans	6	6
<b>Power supplies</b>		
Vendor and model	Dell D1600E-S0	Dell L1100E-S1
Number of power supplies	2	2
Wattage of each (W)	1,600	1,100



## Appendix B: How we tested

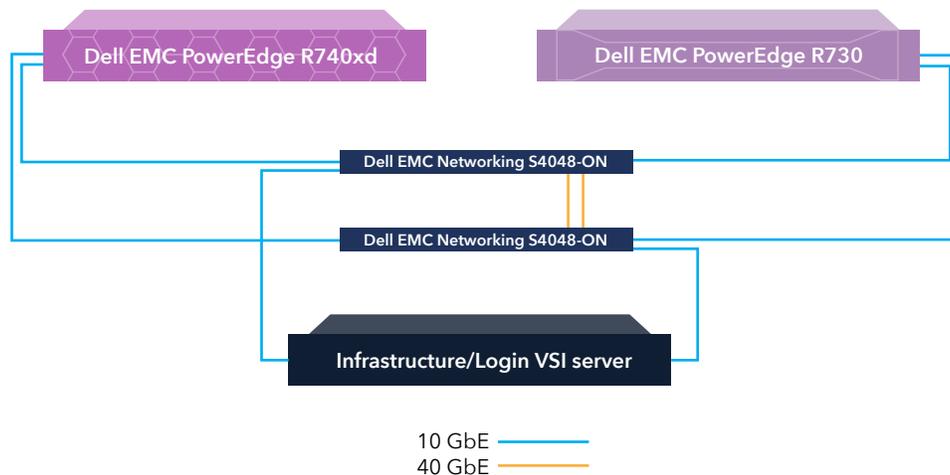
The table below details our physical server configuration. We installed VMware ESXi 6.5 onto one Dell EMC PowerEdge R720 server to act as an infrastructure server that hosted the following:

- one Windows Server® 2012 R2 VM configured to be an Active Directory® domain controller with DNS, DHCP, and NTP roles
- one VMware Horizon® 7 Composer server VM
- one VMware Horizon 7 Connection server VM
- one VMware vCenter® server appliance
- one SQL Server® 2014 VM
- one Login VSI management VM
- 10 Windows 7 (x64) Enterprise launcher VMs

We then installed ESXi 6.5 on one Dell EMC PowerEdge R730 equipped with 256 GB of server RAM to be able to host 64 virtual desktops and on one R740xd server equipped with 384 GB of server RAM to be able to host 96 virtual desktops. We also installed two NVIDIA Tesla M10 GPUs cards on the R730 server and three NVIDIA Tesla M10 GPUs cards on the R740xd server, and deployed VMware Horizon desktop pools with Windows 10 (x64) Enterprise linked clones onto both servers. We assigned two vCPUs, one virtual adapter, and 3 GB of fully reserved guest memory to each linked clone VM. The servers in the testbed used SSD-based local storage to host all VMs. See [Appendix C](#) for performance information.

We cabled together two Dell EMC Networking S4048-ON switches connecting two of the 40GbE ports on each switch to create a redundant network configuration, and created management and VM private traffic VLANs across 10GbE ports on both switches. The infrastructure server and both servers under test used two bonded 10GbE connections for networking.

Server name	Role
Infrastructure	Infrastructure server and Login VSI server
Dell EMC R730 desktop host	Server under test and desktop host
Dell EMC R740xd desktop host	Server under test and desktop host



## Server details

### VM configuration details

VM name	Quantity	OS	vCPUs	Memory (GB)	Server host	Role(s)
DC1	1	Windows Server 2012 R2	2	8	Infrastructure	Microsoft Active Directory server, DNS, DHCP
SQL	1	Windows Server 2012 R2	4	16	Infrastructure	SQL database server for vCenter and Horizon Composer
vCenter	1	VMware vCenter Server Virtual Appliance	24	48	Infrastructure	vCenter appliance
Composer	1	Windows Server 2012 R2	4	16	Infrastructure	VMware Horizon Composer server
Connection	1	Windows Server 2012 R2	4	16	Infrastructure	VMware Horizon Connection server
CIFS 1	1	Windows Server 2012 R2	4	16	Infrastructure	Login VSI management console and log server
Launcher	10	Windows 7 Enterprise (x64)	1	12	Launchers	Login VSI launchers
DELL_VDT	200	Windows 10 Enterprise (x64)	2	3	Dell_vDT	VMware Horizon virtual desktops

### Installing ESXi 6.5 on systems under test and infrastructure server

1. Insert the VMware vSphere® installation media, power on the server, and boot from the DVD drive.
2. Select the standard vSphere installer, and allow the files to copy into memory.
3. At the welcome screen, press F11.
4. At the keyboard language selection screen, press Enter.
5. Enter a password twice for the root user, and press Enter.
6. Choose to install to the local SD card.
7. Allow the installer to finish installing vSphere, and reboot the server.

### Installing the NVIDIA VMware Host Driver on systems under test

1. Access the hosts via ESXi Shell or SSH to install the vGPU Manager VIB.
2. Place the host in maintenance mode.
3. Use the following command to install the vGPU Manager package:  

```
esxcli software vib install -v directory/NVIDIA-vGPUVMware_ESXi_6.5_Host_Driver_367.106-1OEM.650.0.0.4598673.vib
```
4. Upon installation completion, reboot the ESXi host, and remove it from maintenance mode.

### Creating a master Windows 2012 R2 VM

1. Via the VMware web client, connect to the infrastructure server.
2. Under Basic Tasks in the VMware vSphere client, select Create a new virtual machine.
3. Choose Custom, and click Next.
4. Assign a name to the VM, and click Next.
5. Select infrastructure as the host, and click Next.
6. Select the appropriate storage, and click Next.
7. Choose Virtual Machine Version 11, and click Next.
8. Choose Windows, choose Microsoft Windows Server 2012 R2 (64-bit), and click Next.
9. For CPUs, select one virtual processor socket and two cores per virtual socket, and click Next.
10. Choose 4 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 100 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. Click the Resources tab, and click Memory.
19. Select Reserve all guest memory, and click OK.
20. Connect the VM virtual CD-ROM to the Microsoft Windows Server 2012 R2 installation disk.
21. Start the VM.

### Installing the Microsoft Windows Server 2012 R2 operating system on the VM

1. Open VM console.
2. Leave the language, time/currency format, and input method as default, and click Next.
3. Click Install Now.
4. Choose Windows Server 2012 R2 Datacenter Edition (Server with a GUI), and click Next.
5. Accept the license terms, and click Next.
6. Click Custom: Install Windows only (advanced).
7. Select Drive 0 Unallocated Space, and click Next, at which point Windows begins automatically and restarts automatically after completing.
8. Enter the administrator password twice, and click OK.
9. Install VMware Tools. For more information, see [kb.vmware.com/selfservice/microsites/search.do?language=en\\_US&cmd=displayKC&externalId=340](http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340).
10. Reboot the server.
11. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.
12. Enable remote desktop access.
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. Power off the VM.
15. Right-click the launcher VM, and select Template→Convert to Template.

### Installing Microsoft Active Directory and DNS services on DC1 in infrastructure server

Deploy a Windows Server 2012 R2 VM from template named DC1, and log in as administrator.

1. Launch Server Manager.
2. Click Manage→Add Roles and Features.
3. At the Before you begin screen, click Next.
4. At the Select installation type screen, leave Role-based or feature-based installation selected, and click Next.
5. At the Server Selection Screen, select the server from the pool, and click Next.
6. At the Select Server Roles screen, select Active Directory Domain Services. Click Add Features when prompted, and click Next.
7. At the Select Features screen, click Next.
8. At the Active Directory Domain Services screen, click Next.
9. At the Confirm installation selections screen, check Restart the destination server automatically if required, and click Install.

### Configuring Active Directory and DNS services on DC1

After the installation completes, a screen should pop up with configuration options. If not, click the Tasks flag in the upper-right section of Server Manager.

1. Click Promote this server to a Domain Controller.
2. At the Deployment Configuration screen, select Add a new forest. In the Root domain name field, type `test.local`, and click Next.



3. At the Domain Controller Options screen, leave the default values, and enter a password twice.
4. Click Next four times to accept default settings for DNS, NetBIOS, and directory paths.
5. At the Review Options screen, click Next.
6. At the Prerequisites Check dialog, allow the check to complete. If there are no relevant errors, check Restart the destination server automatically if required, and click Install.
7. When the server restarts, log on using `test\Administrator` and the specified password.

## 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 = 172.16.10.1
  - End IP address = 172.16.100.254
  - Subnet mask = 255.255.0.0
12. Check the Activate This Scope box.
13. At the Add or Edit DHCP Scopes screen, click Next.
14. Select 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 that the DHCP server install succeeded.
18. Click Close.

## Installing SQL Server 2014 on SQL01 in infrastructure server

1. Deploy a Windows Server 2012 R2 VM named SQL01, and log in as administrator.
2. Prior to installing SQL Server, add the .NET Framework 3.5 feature to the server.
3. Mount the installation DVD for SQL Server 2014.
4. Click Run SETUP.EXE. If Autoplay does not begin the installation, navigate to the SQL Server 2014 DVD, and double-click it.
5. In the left pane, click Installation.
6. Click New SQL Server stand-alone installation or add features to an existing installation.
7. Select Enter the product key, and enter the product key. Click Next.
8. Click to accept the license terms, and click Next.
9. Click Use Microsoft Update to check for updates, and click Next.
10. Click Install to install the setup support files.
11. If there are no failures, click Next.
12. At the Setup Role screen, choose SQL Server Feature Installation, and click Next.



13. At the Feature Selection screen, select Database Engine Services, Full-Text and Semantic Extractions for Search, Client Tools Connectivity, Client Tools Backwards Compatibility, Management Tools – Basic, and Management Tools – Complete. Click Next.
14. At the Installation Rules screen, after the check completes, click Next.
15. At the Instance configuration screen, leave the default selection of default instance, and click Next.
16. At the Server Configuration screen, choose NT Service\SQLSERVERAGENT for SQL Server Agent, and choose NT Service\MSSQLSERVER for SQL Server Database Engine. Change the Startup Type to Automatic. Click Next.
17. At the Database Engine Configuration screen, select the authentication method you prefer. For our testing purposes, we selected Mixed Mode.
18. Enter a password for the system administrator account, and confirm it.
19. Click Add Current user. This may take several seconds.
20. Click the Data Directories tab to relocate the system, user, and temp db files.
21. Change the location of the root directory to the D:\ volume.
22. Click Next.
23. At the Error and usage reporting screen, click Next.
24. At the Installation Configuration Rules screen, check that there are no failures or relevant warnings, and click Next.
25. At the Ready to Install screen, click Install.
26. After installation completes, click Close.
27. Close the installation window.
28. Open SQL Server 2014 Configuration Manager, and expand Protocols for MSSQLSERVER.
29. Right-click Named Pipes, and choose Enabled.
30. Click OK, and restart the SQL service.

### Setting up databases for VMware vCenter and VMware View® Composer™ in infrastructure server

1. Log onto SQL01 as TEST\administrator.
2. From the server desktop, open SQL Server Configuration Manager.
3. Click SQL Server Network Configuration→Protocols for MSSQLSERVER.
4. Right-click TCP/IP, and select Enabled.
5. Click SQL Services, right-click SQL Server Browser, and select Properties.
6. In the SQL Server Browser Properties, select the Services tab, change the Start mode to Automatic, and click OK. Repeat this step for the SQL Server Agent service.
7. Start the SQL Server browser service and then start the SQL Server Agent service.
8. From the SQL Server desktop, open SQL Server Management Studio.
9. Click Connect.
10. Select the Databases folder, right-click, and select New Database.
11. Type vCenter for the name of the new database.
12. Select the Databases folder, right-click, and select New Database.
13. Type composer for the name of the new database.
14. Click Options, change the recovery model from full to simple, and click OK.

### Installing VMware vCenter 6.5 in infrastructure server

1. Mount the image, navigate to the vcsa folder, and launch VMware-ClientIntegrationPlugin-x.x.x.exe.
2. In the wizard that appears, click Next.
3. Accept the terms of the license agreement, and click Next.
4. Leave the default installation directory, and click Next.
5. Click Install.
6. Click Finish.
7. In the mounted image's top directory, open vcsa-setup.html.
8. When prompted, click Allow.
9. Click Install.
10. Accept the terms of the license agreement, and click Next.
11. Enter the FQDN or IP address of the host onto which the vCenter Server Appliance will be deployed.
12. Provide a username and password for the system in question, and click Next.
13. To accept the certificate of the host you chose to connect to, click Yes.
14. Select the appropriate datacenter, and click Next.
15. Select the appropriate resource, and click Next.
16. Provide a name and password for the VM, and click Next.



17. Select Install vCenter Server with an Embedded Platform Services Controller, and click Next.
18. Select Create a new SSO domain.
19. Provide a password, and confirm it.
20. Provide an SSO Domain name and SSO Site name, and click Next.
21. Set an appropriate Appliance Size, and click Next.
22. Select an appropriate datastore, and click Next.
23. Select Use an embedded database (PostgreSQL), and click Next.
24. At the Network Settings page, configure the network settings as appropriate for your environment, and click Next.
25. Review your settings, and click Finish.
26. When installation completes, click Close.
27. Log into vCenter VM as `TEST\administrator`.
28. From the VMware vCenter 6.5 install media, click Autorun.
29. To start the install wizard, click Run.
30. Select vCenter Server for Windows, and click Install.
31. At the Install wizard welcome screen, click Next.
32. Accept the End User License Agreement, and click Next.
33. Select embedded deployment and the deployment type, and click Next.
34. Verify the system name, and click Next.
35. Enter and confirm the password you wish to use with the Administrator account for vCenter Single Sign On, and click Next.
36. Select Use Windows Local System Account and the service account, and click Next.
37. Select Use an external database, and enter database credentials. Click Next.
38. At the Configure Ports screen, click Next.
39. Accept the default installation path, and click Next.
40. Click Install.
41. Using the vSphere web client, log into the vCenter server as `DOMAIN\administrator`.
42. Right-click the root of vCenter, and click New Data center.
43. Name the new datacenter as `datacenter`.
44. Add the servers under test and infrastructure servers to the datacenter.

### Setting up a database and ODBC DSN for VMware Horizon Composer

1. Deploy a Windows Server 2012 R2 VM named Composer.
2. Log onto the composer VM as `TEST\administrator`.
3. From the desktop of the Composer server, select Start, Run, and type `odbcad32.exe`. Press Enter.
4. Click the system DSN tab.
5. Click Add.
6. Click SQL Server Native Client 10.0, and click Finish.
7. In the Create a New Data Source to SQL Server text box, type the connection name `composer`.
8. For Server, select SQL, and click Next.
9. 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.
10. Select Change the default database to..., choose Composer from the pull-down menu, and click Next.
11. Click Finish.
12. Click Test Data Source.
13. To create the Composer ODBC connection, click OK.

### Setting up VMware Horizon Composer 7 in infrastructure server

1. Open the View 7 media folder, and run the file named `VMware-viewcomposer-7.2.x.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, type `composer` as the source name and `sa` as the user name. Enter the password, and click Next. Leave the default SOAP port, and click Next.
6. Click Install, and click Finish. Restart the server.



## Installing VMware Horizon Connection Server 7

1. Log into the server named Connection1.
2. Browse to VMware Horizon installation media, and click VMware-viewconnectionserver-x86\_64-7.2.x.exe.
3. Click Run.
4. At the Welcome screen, click Next.
5. Agree to the End User License Agreement, and click Next. Keep the default installation directory, and click Next.
6. Select View Standard Server, and click Next.
7. At the Data Recovery screen, enter a backup password, and click Next.
8. Allow View Server to configure the Windows firewall automatically, and click Next.
9. Authorize the local administrator to administer View, and click Next.
10. Choose whether to participate in the customer experience improvement program, and click Next.
11. Complete the installation wizard to finish installing View Connection Server.
12. Click Finish.
13. Reboot server.

## Configuring the VMware Horizon Connection Server

1. Open a Web browser to <horizon connection1 FQDN>/admin.
2. Log in as administrator.
3. Under Licensing, click Edit License.
4. Enter a valid license serial number, and click OK.
5. Open View Configuration → Servers.
6. In the vCenter Servers tab, click Add.
7. Enter vCenter server credentials, and edit the following settings:
  - Max concurrent vCenter provisioning operations: 20
  - Max concurrent power operations: 50
  - Max concurrent View Composer maintenance operations: 20
  - Max concurrent View Composer provisioning operations: 20
  - Max concurrent Instant Clone Engine provisioning operations: 20
8. Click Next.
9. At the View Composer screen, select View Composer co-installed with vCenter Server, and click Next.
10. At the View Composer domains screen, click Add.
11. Enter full domain name and user credentials.
12. Do not use Reclaim VM disk space or Enable View Storage Accelerator.
13. At the ready to complete screen, click Finish.

## Setting up a Windows 10 Enterprise (x64) ESXi base image VM in server under test

1. Log into the vCenter via the VMware Web client.
2. Click the Virtual Machines tab.
3. Right-click, and choose New Virtual Machine.
4. Select Create a new virtual machine.
5. Choose Custom, and click Next.
6. Assign the name View-gold, and click Next.
7. Select any host in the vDT cluster, and click Next.
8. Select the appropriate storage.
9. Choose Virtual Machine Version 11, and click Next.
10. Choose Windows, choose Microsoft Windows 10 (64-bit), and click Next.
11. For CPUs, select One virtual processor socket and two cores per virtual socket, and click Next.
12. Choose 3 GB RAM, and click Next.
13. Click 1 for the number of NICs, select VMXNET 3, 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 32 GB, choose Thin Provision, specify the OS datastore on the local storage, and click Next.
17. Keep the default virtual device node (0:0), and click Next.
18. Click Finish.
19. Click the Resources tab, click Memory, and check the Reserve all guest memory box.
20. Click the Hardware tab, CD/DVD Drive, and Connect the VM virtual CD-ROM to the Microsoft Windows 10 x64 installation disk.
21. Click OK.



## Installing Windows 10 Enterprise (x64) on the ESXi 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.
7. Type `user` for the username, and click Next.
8. Enter no password, and click Next.
9. At the system protection screen, 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. Install VMware Tools, and select Complete Installation. For more information, see [kb.vmware.com/selfservice/microsites/search.do?language=en\\_US&cmd=displayKC&externalId=340](https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=340).
13. Reboot.
14. Connect the machine to the Internet, and install all available Windows updates. Restart as necessary.
15. Join the domain, and restart the VM.
16. Install Microsoft Office Professional Plus 2016.

## Installing the VMware Horizon agent

1. Browse to the VMware Horizon View 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. Select defaults, and click Next.
6. Click Install.

## Configuring Regedit for QuickPrep

1. Click Start→Run, and type `regedit`.
2. Browse to `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\vmware-viewcomposer-ga`.
3. Right-click Skip License Activation, and click Modify.
4. Change the value from 0 to 1.
5. Shut down the machine, and take a snapshot of the final disk image.

## Optimizing the Windows 10 master image

1. From VMware, download the Windows optimization tool.
2. Extract the zip file, and run `VMwareOSOptimizationTool_b1xxx.exe`.
3. Click Template, and select Windows 10 (Horizon Air Hybrid).
4. Click Analyze.
5. Select All Suggestions, and click Optimize.
6. When settings have been applied, shut down the VM.

## Adding the NVIDIA vGPU to Windows 10 master image

1. Right-click the base image Windows 10 VM, and select Edit Settings.
2. From the New Device drop-down menu at the bottom of the windows, select PCI Shared Device.
3. Click Add.
4. Select NVIDIA GRID vGPU.
5. Select the `grid_m10_1b` GPU Profile.
6. Click OK.



## Installing the NVIDIA driver on Windows 10 master image

1. Power on the base image VM.
2. Browse to the NVIDIA installation media folder, and run 370.12\_grid\_win19\_server2016\_64bit\_international.exe.
3. Choose the default extraction path, and click OK.
4. To accept the NVIDIA software license agreement, click Agree and Continue.
5. Select Express installation, and click Next.
6. Upon installation completion, select Restart Now.
7. Confirm that drive installation was successful, and shut down the VM.
8. Right-click the base image Windows 10 VM, and click Snapshots→Take Snapshot.
9. Enter a name for the new snapshot, and click OK.

## Deploying virtual desktops using VMware Horizon

1. Open the View Administrator.
2. Log in as administrator.
3. Under Catalog, click Desktop Pools, and click Add.
4. Select Automatic Pool, and click Next.
5. Select Dedicated and Enable automatic assignment, and click Next.
6. Select View Composer linked clones, and click Next.
7. For the pool ID, type pool and display name, and click Next.
8. Under Remote Display Protocol, change the Default Display Protocol to PCoIP.
9. Under 3D Renderer, choose NVIDIA GRID VGPU, and click Next.
10. Under Naming Pattern, enter an appropriate name pattern for the pool.
11. Under Pool Sizing, enter the appropriate number of desktops and the number of spare (power on) desktops.
12. Select Provision all desktops up-front, and click Next.
13. Under View Composer Disks, select the defaults, and click Next.
14. Under Storage Optimization, select Do not use VMware Virtual SAN.
15. Under vCenter Settings, select the following depending on where you are deploying VMs:
  - Parent VM
  - Snapshot
  - VM folder location
  - Host or cluster
  - Resource pool
  - Data stores
16. Under Guest customization, select the following:
  - Domain: test.local
  - AD container: OU=Computers,OU=LoginVSI
17. Select Use Quick Prep, and click Next.
18. Click Finish.
19. After the wizard finishes, select Entitle users.
20. Select the LoginVSI group, and click OK.

## Installing the Login VSI 4 benchmark

### Setting up a VM to host the Login VSI share CIFS1 in infrastructure server

1. Deploy a Windows Server 2012 R2 VM named CIFS1, and log in as administrator.

### Installing the Login VSI benchmark on VSI\_shares

For Login VSI to work correctly, you must create a CIFS share(s), an Active Directory OU, and Active Directory users. For more information on Login VSI, see <https://www.loginvsi.com/documentation>. We created one dedicated Windows file share for VSI management (VSI1).

1. Create a folder named D:\share.
2. Right-click the D:\share folder, and click Properties.
3. Click the Sharing tab, and click Share.
4. Add everyone, system, and administrators to the Read/Write group, and click Share.



5. Unpack the Login VSI install media.
6. Open Datacenter setup\setup.exe.
7. At the welcome screen, click Next.
8. Select the share named \\vsishare\share, and click Next.
9. To start the Management Console when the setup is complete, check the Start Login VSI Management Console box, and click Finish.
10. At the management console, enter the path to your Login VSI license file, and click Save.

### Configuring Login VSI: AD setup

1. On CIFS, open the VSI management console, and click "1. AD setup."
2. Type the following:

```
Base OU: DC=domain,DC=local
Username: LoginVSI
Password1: *****
Domain: (auto detect checked)
Number of users: 200
Formatting length: 4
Launcher user: Launcher-v4
Launcher password: *****
```
3. Click Save to .ps1.
4. Copy the VSIADSetup.ps1 file to \\DC1\c\$.
5. Log into DC1, and execute the VSIADSetup.ps1 in Windows PowerShell™.

### Setting up the Login VSI share and Active Directory users

1. Log into the CIFS server.
2. From the Login VSI media, run the Login VSI AD Setup.
3. Keep the default settings, and click Start.

## Creating Windows 7 Enterprise x64 image VSI launchers in the infrastructure server

Using the vSphere client, we created a Windows 7 Enterprise x64 VM with two vCPUs and 12 GB of memory.

### Installing VMware Horizon Client on the launcher

1. Accept the VMware license terms.
2. Select default options.
3. Accept or change the destination folder.
4. Click Install.

### Converting the launcher VM to a template

1. Right-click the launcher VM, and select Template→Convert to Template.

### Deploying the launchers VM from the launcher template

1. In vSphere Client, browse to HomeVMs and Templates.
2. To deploy a VM from the template, right-click the launcher template.
3. Type launcher\_1 as the new VM name, and click Next.
4. Click Datacenter, and click Next.
5. Click the launcher server, and click Next.
6. Select the appropriate storage, and click Next.
7. Select Customization using existing customization specifications, select the appropriate file, and click Next.
8. To deploy the new VM, click Finish.
9. Repeat steps 1 through 8, or use PowerCLI to deploy more launchers.



## Configuring VSI launchers for testing

After you have configured all 10 launchers and they are idle, use the Login VSI Management Console to add and enable the launchers to host a predetermined number of VDI sessions.

1. Log onto VSI\_Share as DOMAIN\administrator.
2. Open the Login VSI management console.
3. Click 2. Add Launchers.
4. At the Add launchers wizard, click Next.
5. Click batch entry, and type the following:

```
Name=launcher
Start number=1
Increment=1
Count=10
Maximum capacity=30
Formatting length=3
```

6. Click Next.
7. Click Finish.

## Running the Login VSI benchmark

Before we ran our test, we ran a “profile create” job in Login VSI to fully initialize each user’s profile. Next, we used 10 launchers to run a Knowledge Worker workload for 60 minutes. For more information on how to run a Login VSI test, see <https://www.loginvsi.com/products/login-vsi>.

## Collecting server performance and GPU data

We used ESXTOP to collect ESXi server performance data at 5-second intervals using the following command:

```
esxtop -b -d 5 -n 10000 > /temp/esxtoplog.csv
```

We also used the NVIDIA System Management Interface (nvidia-smi) utility to collect GPU performance data during testing using the following command:

```
nvidia-smi -q -d UTILIZATION -l -f /temp/gpulog.csv
```

We analyzed all the collected data and created performance charts to assess server and GPU resources performance. See [Appendix C](#) for details.

## About our test tool, Login VSI 4.1

Login Virtual Session Indexer (Login VSI) is a tool that helps assess the virtual desktop performance, capacity, and scalability of a server. The simulated desktop workload we tested is a scripted 48-minute loop that simulates a Login VSI user logging into a virtual desktop and performs office worker activities. After the loop finishes, it restarts automatically. Within each loop, Login VSI measures the response times of 10 specific desktop operations, five of which are more important. These measurements happen 16 times at regular intervals within each loop. The benchmark uses the response times of the five more important operations to determine VSI<sub>max</sub>, the point where VDI end-user experience starts to degrade due to high virtual desktop application response time.

Login VSI 4.1 reports the following metrics:

- Minimum Response: The minimum application response time
- Average Response: The average application response time
- Maximum Response: The maximum application response time
- VSI Baseline: Average application response time of the first 15 sessions
- VSI Index Average: Average response time dropping the highest and lowest 2 percent

For more information about Login VSI 4.1, see [www.loginvsi.com/product-overview](http://www.loginvsi.com/product-overview).



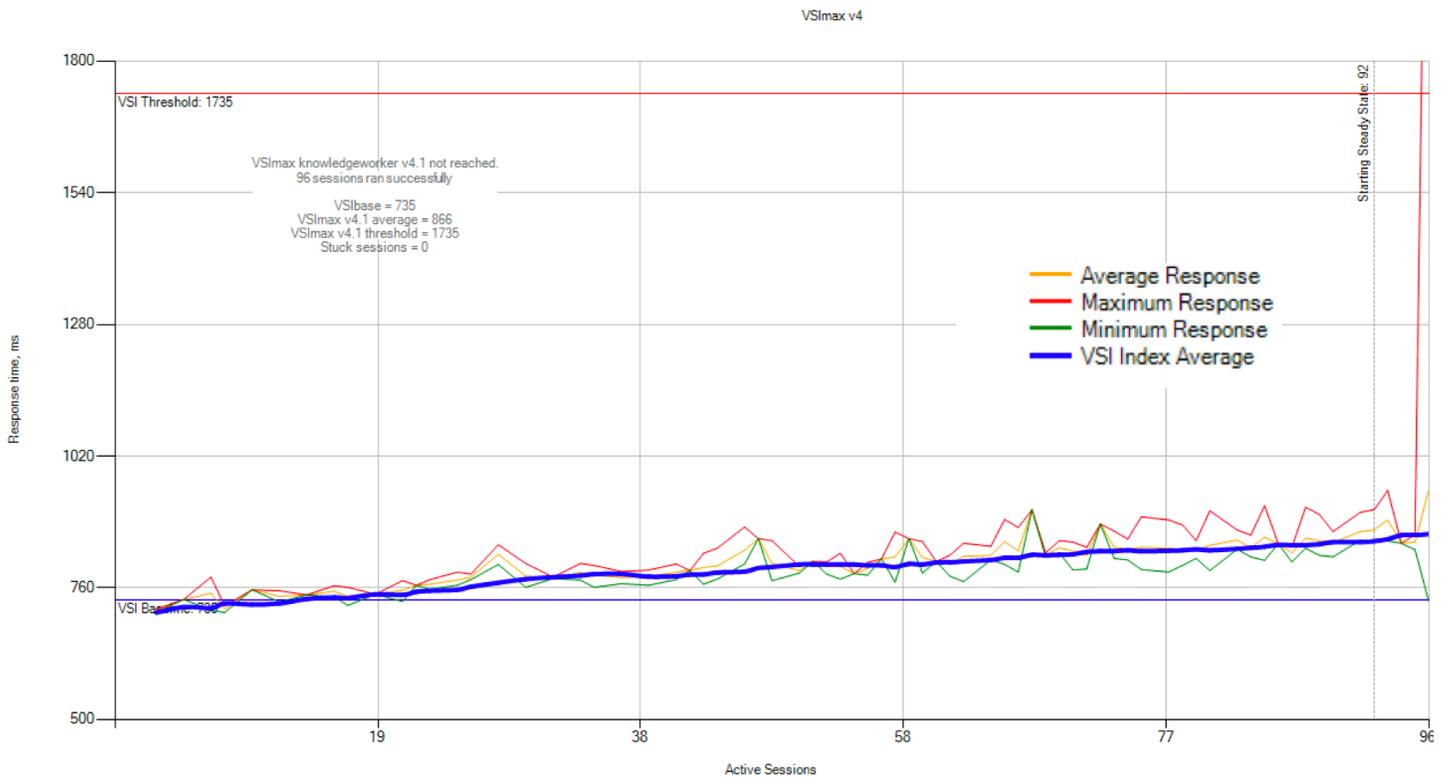
## Appendix C: Performance results

We analyzed data captured from Login VSI analyzer, ESXTOP, and NVIDIA-SMI to generate multiple performance graphs. Due to the nature of VDI testing, the storage subsystem and network resources were not heavily utilized, but we analyzed them to ensure that neither storage latency nor network bottlenecks affected our results. We determined that during our tests, both servers under test showed no indication of hardware bottlenecks.

### Results for the Dell EMC PowerEdge R740xd

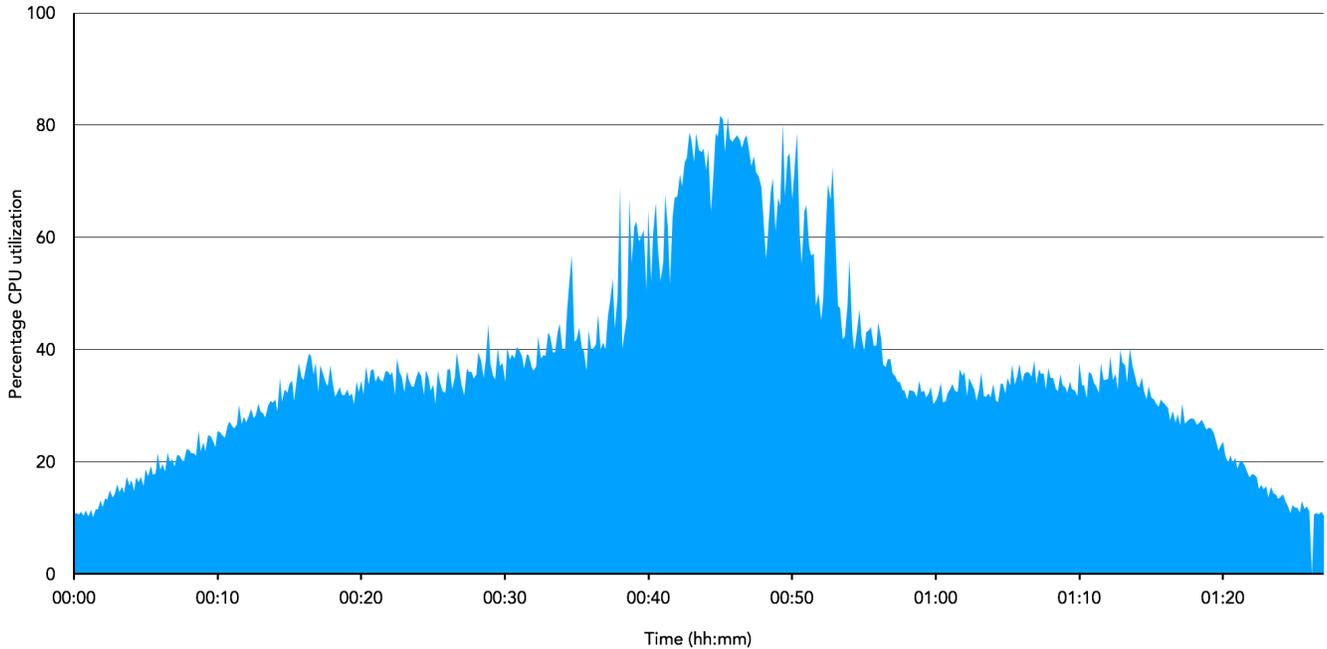
#### VSI Index Average

The VSI Index Average indicates that under the current server configuration, the Dell EMC R740xd server was capable of supporting 96 VDI users with excellent application response time. The test did not reach the VSI threshold, the point that triggers VSI<sub>max</sub> to indicate end-user experience degradation.



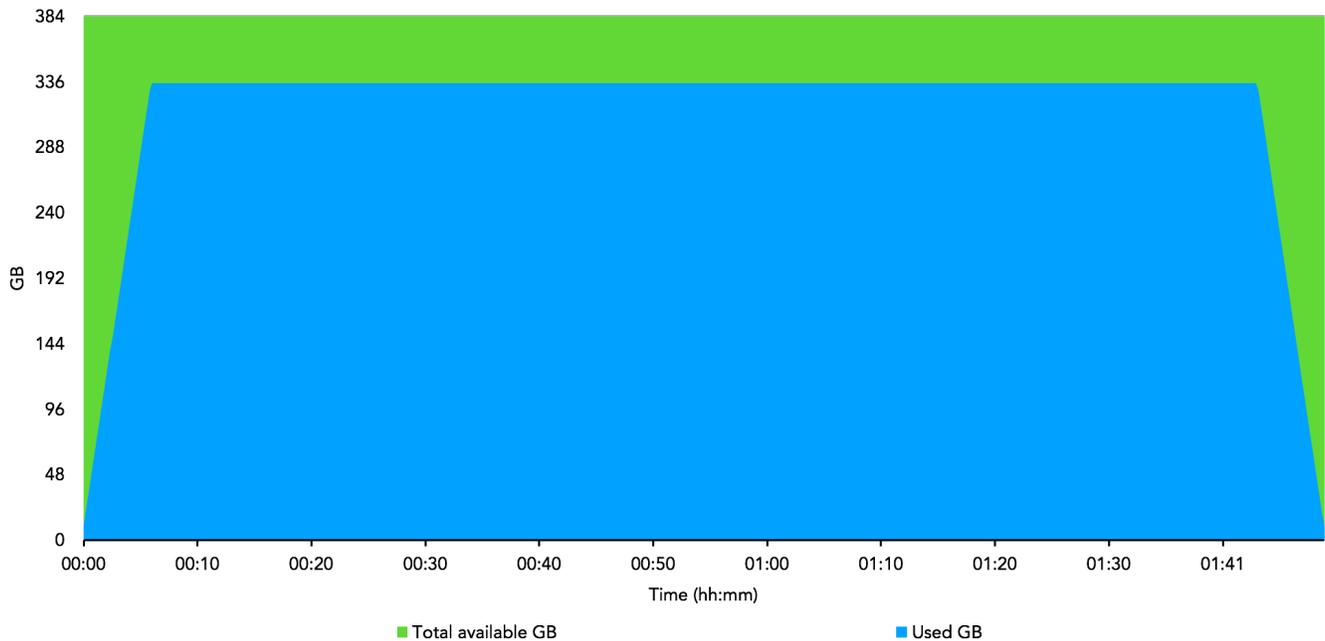
## Dell EMC PowerEdge R740xd Login VSI Knowledge Worker – 96 sessions

Dell EMC PowerEdge R740xd CPU utilization for 96 VDI users peaked at 80 percent, indicating there were no CPU bottlenecks during testing.



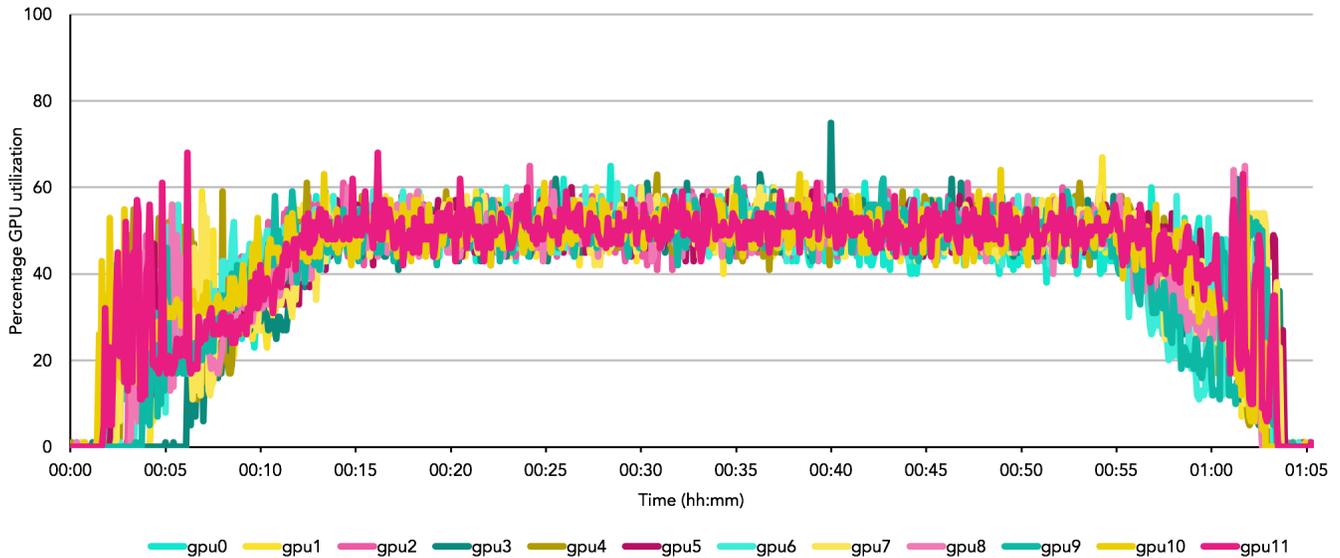
## Dell EMC PowerEdge R740xd memory utilization

We configured the Dell EMC PowerEdge R740xd with 384 GB of RAM to support 96 users with 3 GB of fully reserved memory each. Total consumed memory at peak, including hypervisor overhead, was 335 GB or 87.2 percent of total available memory.



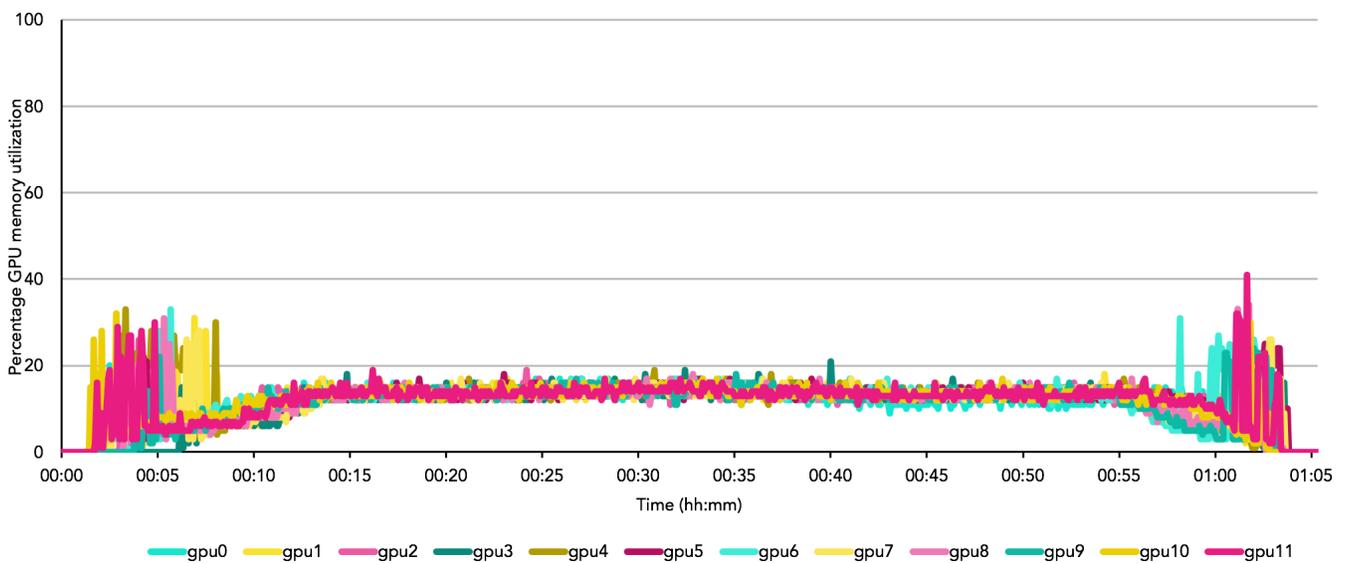
### NVIDIA Tesla M10 GPU utilization for three GPUs (four GPUs per board)

The NVIDIA GPU utilization indicates that during testing of all 96 VDI users, the GPUs had the capacity to handle more intense graphics workloads.



### NVIDIA Tesla M10 GPU memory utilization for three GPUs (four GPUs per board)

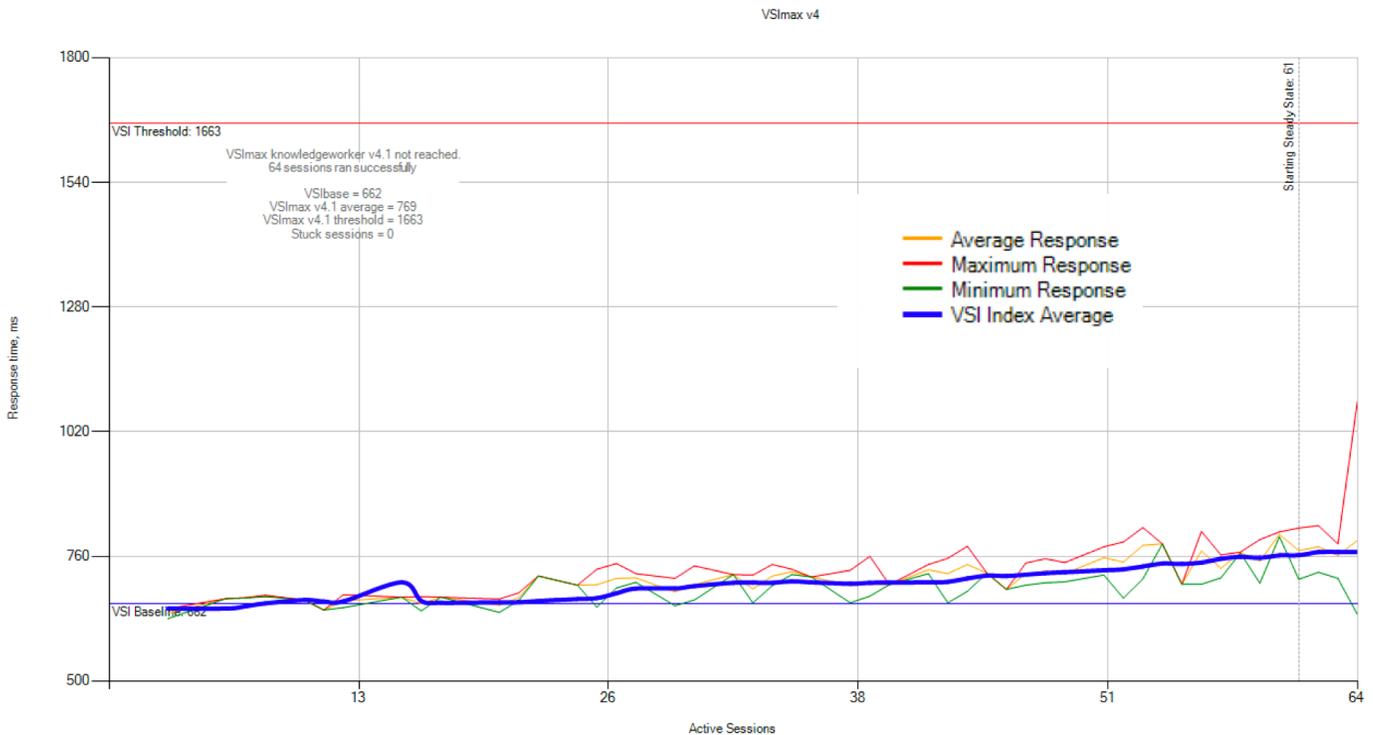
The NVIDIA GPU memory utilization indicates that during testing of all 96 VDI users, the GPUs had the capacity to handle more intense graphics workloads.



## Results for the Dell EMC PowerEdge R730

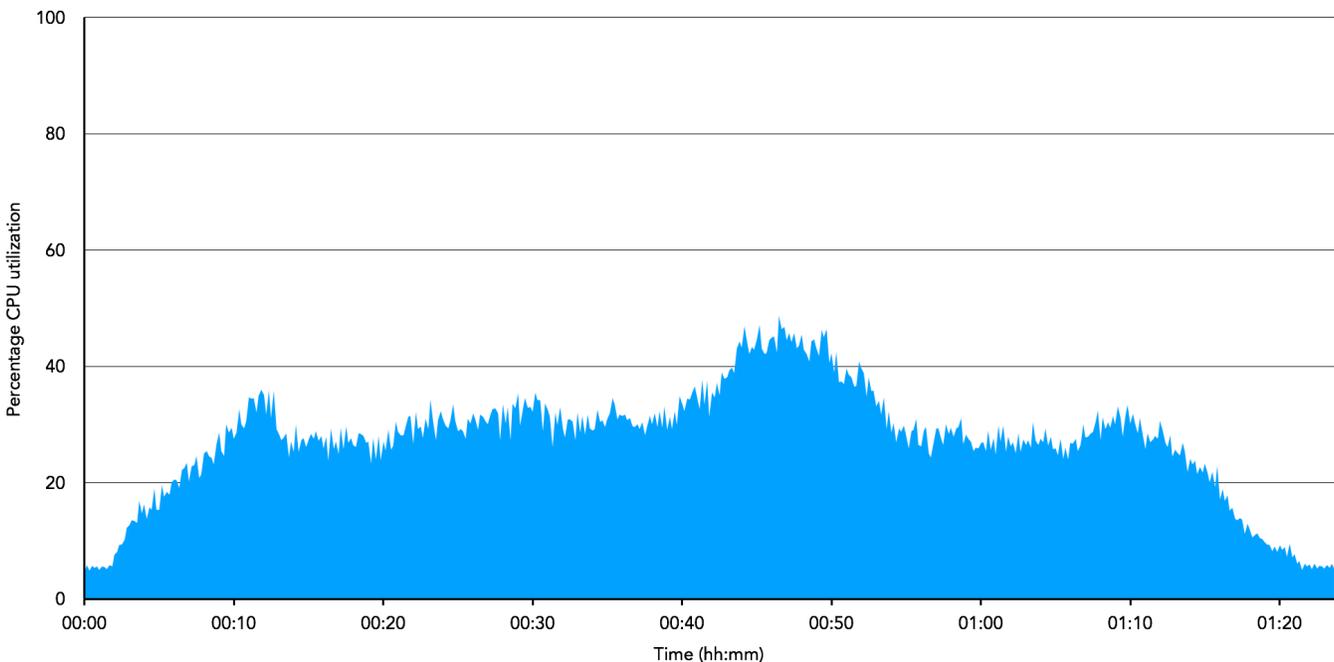
### VSI Index Average

The VSI Index Average indicates that under the current server configuration, the Dell EMC PowerEdge R730 server was capable of supporting 64 VDI users with excellent application response time.



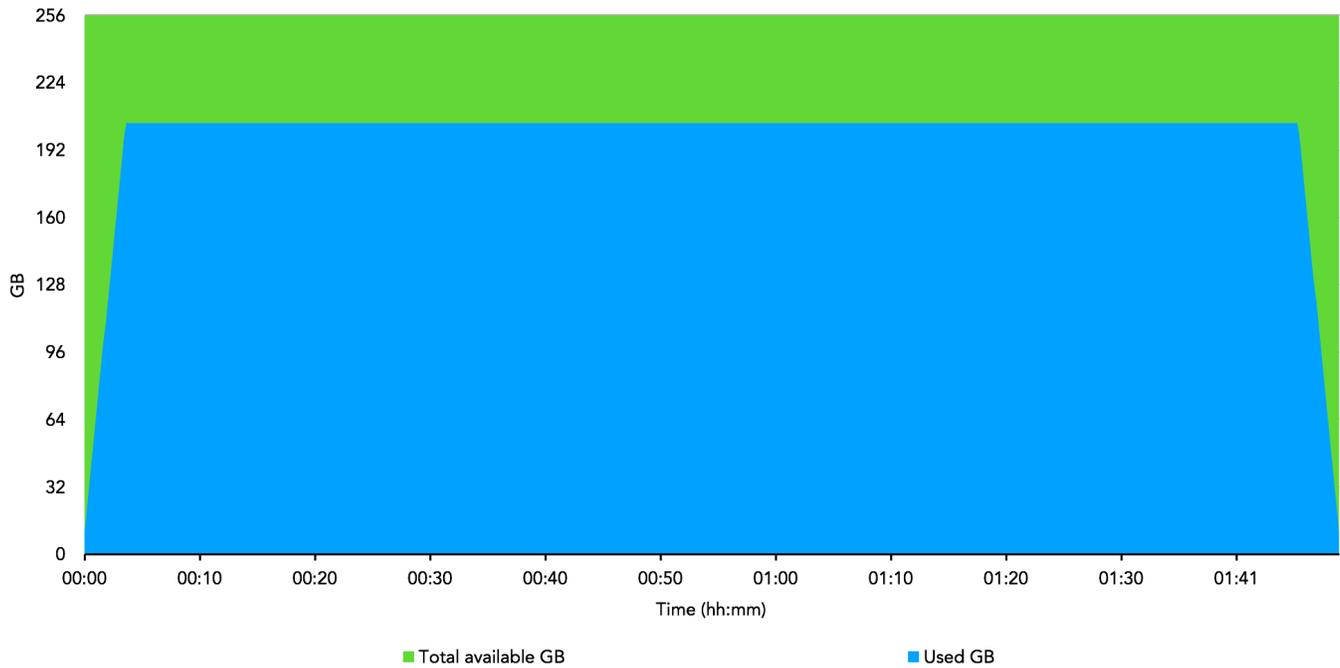
### Dell EMC PowerEdge R730 Login VSI Knowledge Worker – 64 sessions

The Dell EMC PowerEdge R730 CPU utilization for 64 VDI users peaked at 47 percent, indicating there were no CPU bottlenecks during testing.



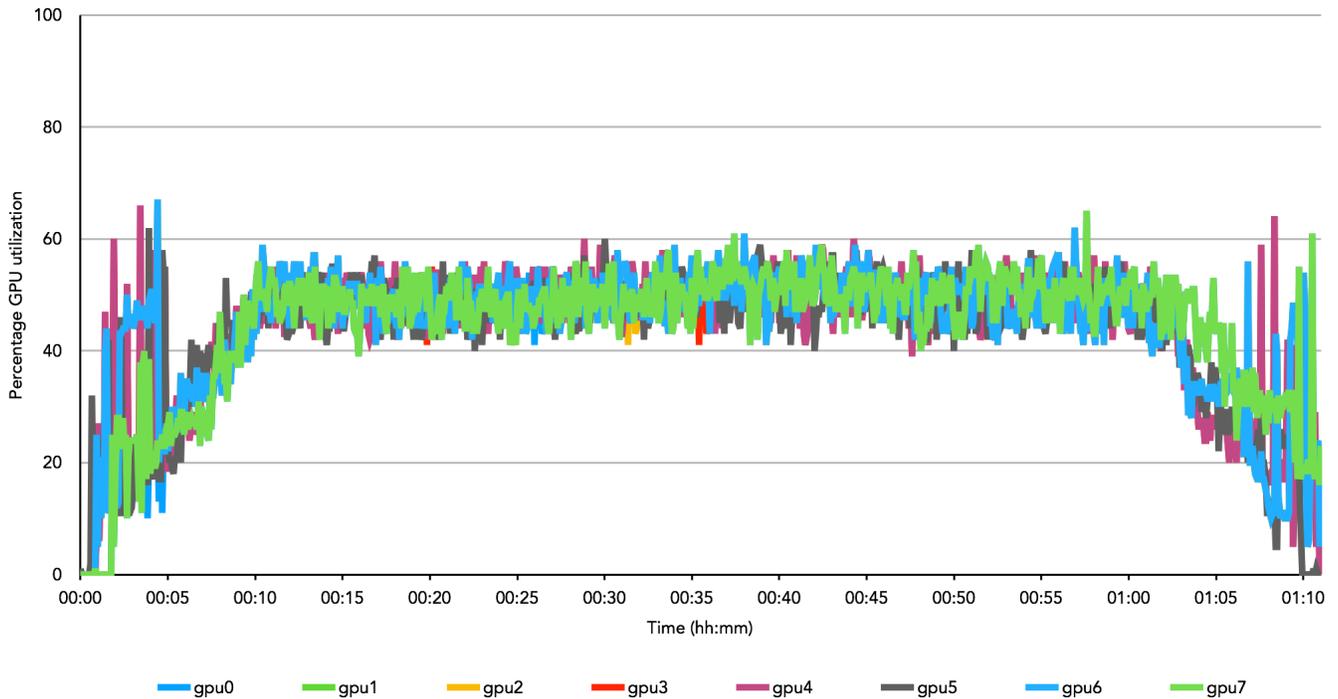
## Dell EMC PowerEdge R730 memory utilization

We configured the Dell EMC PowerEdge R730 with 256 GB of RAM to support 64 users with 3 GB of fully reserved memory each. Total consumed memory at peak, including hypervisor overhead, was 205 GB or 80 percent of total available memory.



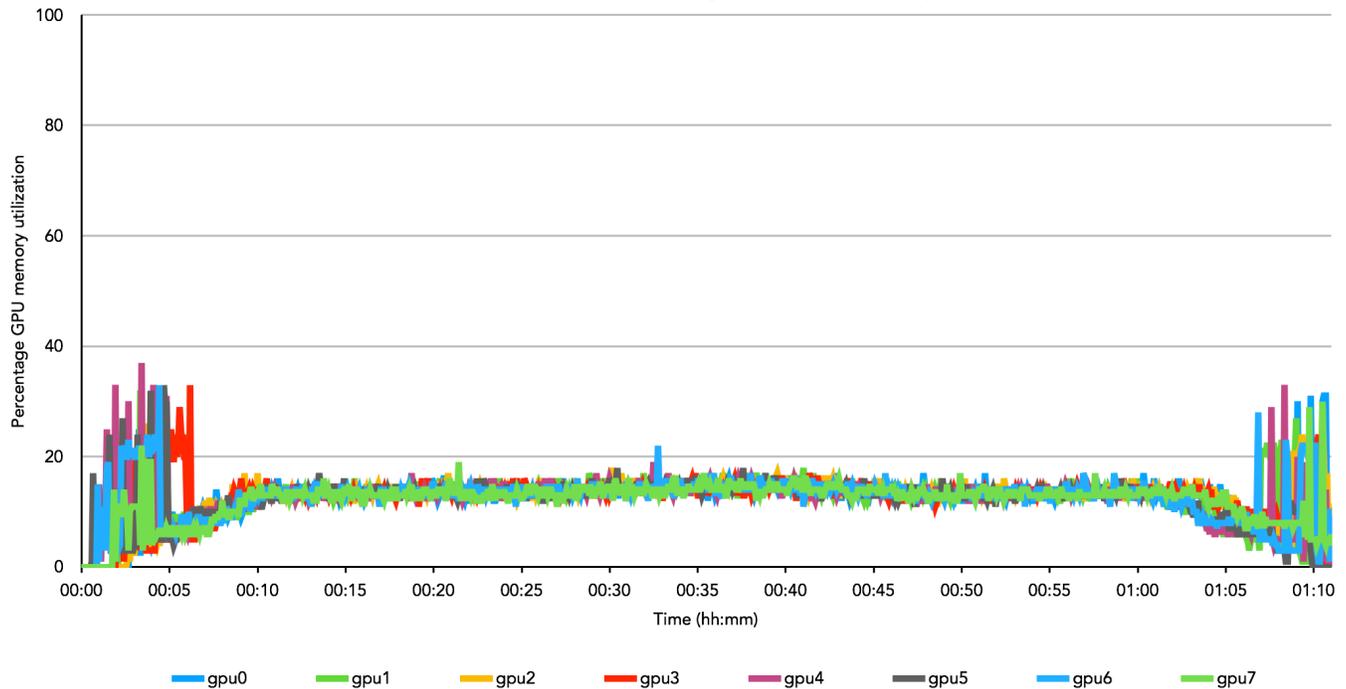
## NVIDIA Tesla M10 GPU utilization for two GPUs (four GPUs per board)

The NVIDIA GPU utilization indicates that during testing of all 64 VDI users, the GPUs had the capacity to handle more intense graphics workloads.



## NVIDIA Tesla M10 GPU memory utilization for two GPUs (four GPUs per board)

The NVIDIA GPU memory utilization indicates that during testing of all 64 VDI users, the GPUs had the capacity to handle more intense graphics workloads.



This project was commissioned by Dell EMC.



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