

# Reviewer's Guide for HDX 3D Pro

## GPU virtualization with Citrix XenDesktop, using NVIDIA GRID graphics board on VMware vSphere 6

Citrix HDX 3D Pro supports NVIDIA GRID vGPU on both Citrix XenServer and VMware vSphere. Set up evaluation lab on VMware's hypervisor using this guide.



## Audience

NVIDIA GRID<sup>™</sup> vGPU<sup>™</sup> feature NVIDIA Kepler-based GPUs that, for the first time, allow hardware virtualization of the GPU, and Citrix HDX 3D Pro was the first solution to support this capability back in 2013. This means multiple users can share a single GPU, improving user density while providing true PC performance and application compatibility. Until 2015, Citrix XenServer was the only hypervisor to support GRID vGPU when VMware vSphere 6 added support. Citrix HDX 3D Pro is the first solution to support NVIDIA GRID vGPU on any platform: XenServer, vSphere, CloudPlatform, or Bare Metal.

This Reviewer's Guide will help you deploy the infrastructure to perform a hands-on evaluation of Citrix HDX 3D Pro on VMware vSphere 6. It is a companion to the Reviewer's Guide for HDX 3D Pro on Citrix XenServer, available at <a href="http://www.citrix.com/xendesktop/3D">www.citrix.com/xendesktop/3D</a>. Hardware-accelerated GPU sharing for desktop and server workloads addresses the demand for <a href="http://wirtualized.design.engineering.workstations">wirtualized.design.engineering.workstations</a> in industries like CAD, CAM, Manufacturing, GIS, Construction, Healthcare, Education, and even knowledge workers. This evaluation guide is intended to provide a simplified, self-service proof of concept. The next step, after this guide, is to conduct a more exhaustive technology assessment with the help of your local Citrix consultant.

This guide walks through the following topics:

- How to obtain the necessary components for the feature review
- Install NVIDIA GRID vGPU, and configure vGPU in VMware vSphere 6
- Assign vGPU-profiles to XenDesktop 7.6 Windows VM's
- Publish vGPU-accelerated Virtual Desktops (VDI) using Citrix Studio
- Access hardware accelerated graphics apps using Citrix Receiver
- Use benchmark and monitoring tools to validate 3D applications performance with vGPU

Pre-requisites:

• Knowledge of setting up vSphere 6 infrastructure including vCenter Server, virtual networking, and certificates

- Working knowledge of Citrix XenDesktop and XenApp concepts, and NVIDIA GPU hardware
- Expert knowledge of Windows domain administration, networking, and systems troubleshooting

#### **Disclaimer of Liability**

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## What is NVIDIA GRID vGPU?

The Virtual Graphical Processing Unit (vGPU) feature enables multiple virtual machines to directly access the graphics processing power of a single physical GPU. NVIDIA GRID vGPUs are comparable to conventional GPUs in that they have a fixed amount of GPU frame buffer and one or more virtual display outputs or heads. Under control of the NVIDIA vGPU Manager installed in the hypervisor, the vGPU frame buffer is allocated out of the physical GPU frame buffer at the time the vGPU is created. The vGPU retains exclusive use of that frame buffer until it is destroyed. All vGPUs resident on a physical GPU share access to the GPU's engines, including the graphics (3D), and video decode and encode engines. Guest VMs use GRID vGPU in the same manner as a physical GPU that has been passed through by the hypervisor: an NVIDIA driver loaded in the guest VM provides direct access to the GPU for performance-critical fast paths, and a paravirtualized interface to the GRID vGPU Manager. vGPU sharing uses the same NVIDIA graphics drivers that are deployed on non-virtualized operating systems.

Figure 1 shows an overview of this communication flow.

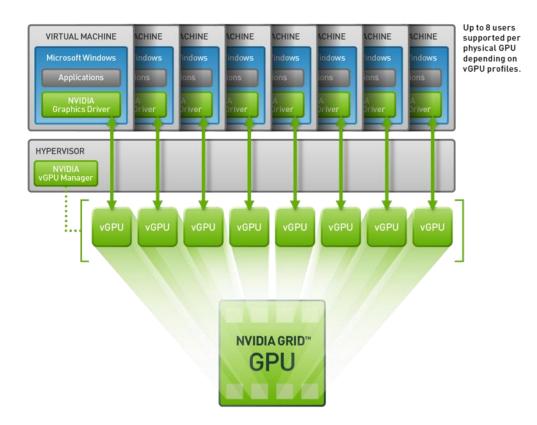


Figure 1 Direct graphics interface between the Physical GRID GPU and vSphere virtual machines (VM)

## Where to Download the Necessary Components?

All the software required to enable vGPU technology is available on <u>http://www.citrix.com/go/vGPU</u> Sign in using your Citrix Account or sign-up for a free account, to access the trial software. Review the release notes and known issues for GRID Virtual GPU before proceeding with installation.

Component	Build	Location
NVIDIA Certified Server Hardware	Hardware	GRID-enabled Servers
NVIDIA GRID K1 or K2	Hardware	
Thin-clients or Laptops	Hardware	
Microsoft Windows (Desktop OS)	See NVIDIA GRID drivers page for up-to-date OS and Codec version support	<u>http://www.nvidia.co</u> <u>m/drivers</u>
Citrix XenDesktop 7.6	90-day Free Trial available	http://www.citrix.com /tryxendesktop
VMware vSphere 6	60-day Free Trial available	<u>VMware Trial</u> <u>Download</u>
NVIDIA GRID vGPU package	See NVIDIA GRID drivers page for up-to-date driver version, OS, and Codec version support	<u>http://www.nvidia.co</u> <u>m/vGPU</u>

## An important note about GRID vGPU profiles

Before we begin this review, it is important to understand the meaning of *vGPU profiles* and its role in the GPU virtualization architecture. NVIDIA Grid K1 and K2 cards contain multiple GPU on board. Each physical GPU (pGPU) can host several different types of virtual GPU (vGPU). These *vGPU profiles* are preset definitions that allocate fixed share of the total frame-buffer from the total available on board, depending on the expected workload. The usage pattern spans from high-density knowledge workers with business graphic needs at the lower end, all the way to high-performance designers and visual computing engineers that demand a workstation-like experience from the VDI workspace. Figure 2 lists the different vGPU profiles and their maximum display and graphics memory allocations.

NVIDIA GRID Graphics Board	Virtual GPU Profile	Application Certifications	Graphics Memory	Max Displays Per User	Max Resolution Per Display	Max Users Per Graphics Board	Recommended Use Case
	*K280Q	<ul> <li>Image: A set of the set of the</li></ul>	4 GB	4	2560x1600	2	Designer
	K260Q	×	2 GB	4	2560x1600	4	Designer/Power User
GRID K2	K240Q	×	1 GB	2	2560x1600	8	Designer/Power User
	K220Q	×	512 MB	2	2560x1600	16	Designer/Power User
	*K180Q	<ul> <li>Image: A second s</li></ul>	4 GB	4	2560x1600	4	Entry Designer
GRID K1	*K160Q	<ul> <li>Image: A set of the set of the</li></ul>	2 GB	4	2560x1600	8	Power User
GRID KI	K140Q	<ul> <li>Image: A second s</li></ul>	1 GB	2	2560x1600	16	Power User
	K120Q	<ul> <li>Image: A second s</li></ul>	512 MB	2	2560x1600	32	Power User

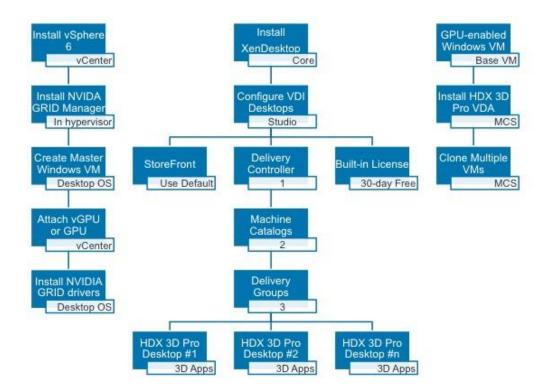
Figure 2 vGPU Types and Use-Cases

#### **Recommended vGPU Types for Citrix HDX 3D Pro**

To run successful evaluation of the high-end virtual design engineering solution, please select virtual GPU profiles ending in Q. The GPU profiles ending in Q undergo the same rigorous application certification process as NVIDIA® Quadro® workstation-class processors. For a list of certified applications, download <u>NVIDIA GRID Remote Workstation Certifications</u>. The GRID K100 and K200 GPU profiles are being phased out and will not be available with newer drivers.

## **Flowchart of Steps**

This Reviewer's Guide will help you deploy the infrastructure to perform a hands-on evaluation of Citrix HDX 3D Pro on VMware vSphere 6. The high-level steps involved are outlined as follows:



The flowchart describes the following steps required to complete this evaluation:

#### [vSphere operations]

1. Start with a fresh VMware vSphere 6 server on a GRID supported hardware. Set up vCenter to manage the server, if not already present in the network.

2. Download the NVIDIA GRID vGPU Manager and install in the hypervisor

#### [vCenter operations]

- 3. Create a Windows 7 or 8.1 VM (this will be the base image)
- 4. Assign a virtual GPU (vGPU) profile to the base image

#### [Windows Guest VM operations]

- 5. Create the master VM, using the vGPU-enabled Windows base image:
- a. Install NVIDIA vGPU guest OS driver
- b. Install VMTools
- c. Install Citrix HDX 3D Pro VDA
- 6. Install the required graphical applications on the base image

#### [XenDesktop Studio operations]

7. Create a Machine Catalog using the base image

#### 8. Create Delivery Group, assign users, and publish the desktops

#### [Endpoint/Client operations]

- 9. Access virtual desktops using Citrix Receiver. No GPU is required on the end-point devices
- 10. Validate GPU sharing by multiple desktops, using monitoring tools

#### **Pre-requisites**

Go to *Control Panel*  $\rightarrow$  *Add/Remove Programs* and ensure the following components are updated on your target virtual machine before you begin the 3D optimization process.

Tools and Applications	
Hypervisor Tools	Latest VMware Tools
Windows Applications	<ul> <li>Adobe <u>Flash Player</u>; Adobe <u>Reader</u></li> </ul>
	<ul> <li>Java <u>Plugin</u></li> </ul>
	<ul> <li>Microsoft .NET Framework 4</li> </ul>
GPU performance and statistics	Find a list of sample utilities in Appendix
3D Apps to evaluate the technology	Find a list of sample apps in Appendix

## **VMware vSphere Installation**

A working and correctly configured vSphere infrastructure is a pre-requisite to using this guide. The instructions to set up the vSphere infrastructure, including the hypervisor, networking, vCenter server, certificates, and operating system templates is outside the scope of this guide. Please refer VMware Product Documentation for latest instructions on preparing a server for NVIDIA GRID vGPU and vSphere.

## NVIDIA GRID driver installation on a vSphere host

The NVIDIA Virtual GPU Manager is installed and runs within vSphere's microkernel. It is provided as an VIB file, which must be copied to the vSphere host and then installed by means of the *escli* command.

<u>Steps for installing the NVIDIA GRID GPU driver for vSphere 6 hypervisor environment:</u>

1. Download the NVIDIA GRID vGPU Pack and extract the contents; available on http://www.nvidia.com/drivers

Important: Do not select the GRID Series drivers.

## **NVIDIA Driver Downloads**

Option 1: Manually find dr	ivers for my NVIDIA products.		Help
Product Type:	GRID	0	
Product Series:	NVIDIA GRID VGPU	0	
Product:	GRID K1	0	
Operating System:	VMware vSphere ESXi 6.0	0	
Language:	English (US)	SEAR	сн

2. Enable the "ESXi Shell" and the SSH protocol on the vSphere host from within the Troubleshooting menu of the vSphere Configuration Console

Troubleshooting Mode Options	ESXi Shell
Disable ESXi Shell Disable SSH Modify ESXi Shell and SSH timeouts Modify DCUI idle timeout Restart Management Agents	ESXi Shell is Enabled Change current state of the ESXi Shell

3. Place the vSphere host into maintenance mode.

Navigator	T 172.16.26.6 Actions	•	=*	🔯 Alarms	Į>
	Actions - 172.16.26.6	or Manage Related Object	S	All (0) New (0)	Acknowledge
	New Virtual Machine	CPU	FREE: 41.45 G		
vCenter02.FLL.lab	New vApp	E E E E			
▼ hrtl-DC	🤭 New Resource Pool	HP ProLiant DL380p	43.00 MHz CAPACITY: 41.49 G		
🕨 🗊 DL380pGen8	heploy OVF Template	Gen8 MEMOF	Y FREE: 188.76 (		
🕶 🗊 vGPU	· · · · ·	Intel(R) Xeon(R) USED: 3	3.21 GB CAPACITY: 191.97 (		
172.16.26.6	Connection	2.60GHz STORA	SE FREE: 1.26		
	Maintenance Mode	🕨 🌉 Enter Maintenance Mode			
	Power	Exit Maintenance Mode	1 GB CAPACITY: 1.27		
	Certificates	• : 0			
	Storage	Connected		🛛 📝 Work In Progres	s J
	Add Networking	69 minutes			
	Add Diagnostic Partition			1	

4. Upload the NVIDIA driver (VIB file) to the */tmp* directory on the vSphere host using a tool such as <u>WinSCP</u>

- 5. Log in as root to the vSphere console through SSH using a tool such as <u>Putty</u>
- 6. Issue the following command to install the NVIDIA vGPU drivers

esxcli software vib install --no-sig-check -v /<path>/<filename>.VIB

esxcli software vib install --no-sig-check -v /tmp/NVIDIA-vgx-VMware\_ESXi\_6.0\_Host\_Driver\_346.42-10EM.6 .0.0.2159203.vib nstallation Result Message: Operation finished successfully. Reboot Required: false VIBs Installed: NVIDIA bootbank NVIDIA-vgx-VMware ESXi 6.0 Host Driver 346.42-10EM.600.0.0.2159203 VIBs Removed: VIBs Skipped: root@GPU03:~]

<u>Please note</u>: Although the display states "Reboot Required: false", a reboot is necessary for the vib to load and xorg to start.

7. Exit the vSphere host from maintenance mode, by means of the vSphere Web Client (see screenshot above) or by using the following command:

esxcli system maintenanceMode set -e false

<u>Please note:</u> The command will not return a response.

8. Reboot the host by means of the vSphere Web Client or by issuing the following command:

reboot

9. After the host rebooted successfully, verify if the kernel module has loaded successfully, using following command:

esxcli software vib list | grep -i nvidia

The command should return an output similar to the following:

```
[root@GPU03:~] esxcli software vib list | grep -i nvidia
NVIDIA-vgx-VMware_ESXi_6.0_Host_Driver 346.42-10EM.600.0.0.2159203
NVIDIA VMwareAccepted 2015-04-09
[root@GPU03:~]
```

10. Confirm the GPU detection using the following command:

nvidia-smi

The command should return an output similar to the following:

hu Ap:	r 91	15:34:1					rsion: 346.42		+	
GPU Fan	Name Temp	Perf	Persi: Pwr:U:	ste sag	ence-M ge/Cap	11 0	Bus-Id Memo:	Disp.A ry-Usage	Volatile   GPU-Util	Uncorr. ECC Compute M.
0 N/A	GRID 47C	K2 P8	30W		On 117W	i I	0000:06:00.0 10MiB /	Off 4095MiB	   0%	Off Default
1 N/A	GRID 40C	K2 P8	28W		On 117W	I	0000:07:00.0 10MiB /	Off 4095MiB	।   0%	Off Default
Proc	esses:		Type							GPU Memory Usage
			esses :							
 [root@(		_								

Please note: SMI also allows GPU monitoring using the following command:

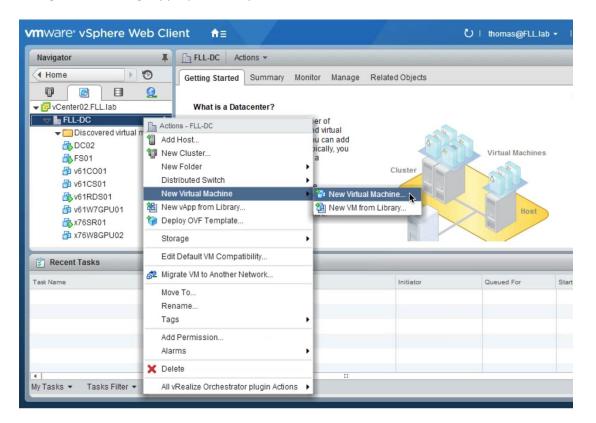
nvidia-smi -l

This command switch adds a loop, auto refreshing the display.

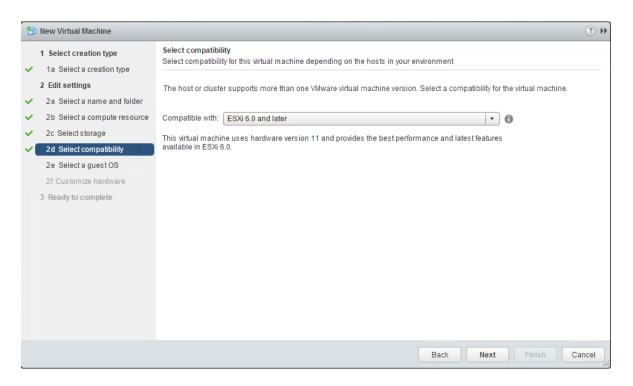
## Create a VDI base image

Use the following procedure to create the virtual machine that will be used as VDI base image later on:

1. Using vSphere Web Client, create a new VM. To do this, right-click a host or cluster and select New Virtual Machine. Work through the New VM wizard. Unless specified please select the configuration settings appropriate for your environment.



2. Select "ESXi 6.0 and later" from the Compatible with drop-down menu, to be able to leverage the latest features, including the mapping of shared PCI devices, which is required for vGPU functionality.



3. While customizing the hardware of the new VM, please add a new Shared PCI Device, select the appropriate GPU Profile and reserve all VM memory.

**<u>CAUTION</u>**: If you are creating a new virtual machine and using the vSphere Web Client's VM console functionality, then the mouse will not be usable within the virtual machine until after both the operating system and VMware tools have been installed. If you cannot utilize the traditional vSphere Client to connect to the VM, please do not enable NVIDIA GRID vGPU yet.

•	New Virtual Machine		• •	++
~	1 Select creation type 1a Select a creation type	Customize hardware Configure the virtual machine hard	dware	
~	2 Edit settings 2a Select a name and folder	Virtual Hardware VM Options	SDRS Rules	
ž	2b Select a compute resource 2c Select storage	Video card	pecify custom settings	
~	2d Select compatibility	<ul> <li>WCI device</li> <li>New SATA Controller</li> </ul>		
Ĩ	2e Select a guest OS 2f Customize hardware	Other Devices     New PCI device     N	VIDIA GRID VGPU	
	3 Ready to complete		d_k280q  Warning: The VM will not power on until its memory reservation equals its	
			memory size.	
			Note: Some virtual machine operations are unavailable when PCI/PCIe passthrough devices are present. You cannot suspend, migrate with vMotion, or take or restore snapshots of such virtual machines.	
		New device:	Mared PCI Device   Add	
			Compatibility: ESXi 6.0 and later (VM version 11)	
			Back Next Finish Cancel	]_

4. Install the Windows operating system and required applications according to corporate standards.

- 5. Install the VMware Tools
- 6. Join the VM to the domain

7. Enable "Allow remote connections to this computer" within the Windows System Properties menu

omputer Name	Hardware	Advanced	System Prot	ection Remo	ote
Remote Assist	ance				
Allow Rem	ote Assistan	ce connectio	ns to this com	puter	
What happens	s when I ena	ble Remote /	Assistance?		
				Advance	d
Remote Deskt	ор				
Choose an opt	tion, and the	n specify wh	o can connec	t.	
Choose an opt				t.	
	remote con	nections to th	nis computer	t.	
<ul> <li>Don't allow</li> <li>Allow removing</li> <li>Allow control</li> </ul>	remote con te connectio onnections o	nections to the this cor	nis computer nputer puters running		

## Display Drivers and Citrix Agent Installation on the base image

Use the following procedure to install the NVIDIA GRID vGPU drivers within the master VM (base image), followed by installation of the HDX 3D Pro virtual delivery agent (VDA) to prepare this VM to be managed by Citrix XenDesktop controller.

1. Copy the Windows drivers from within the NVIDIA GRID vGPU Driver Pack downloaded earlier, to the master VM. Alternatively download the drivers from <u>http://www.nvidia.com/drivers</u> and extract the contents.

Important: Do not select the GRID Series drivers.

## **NVIDIA Driver Downloads**

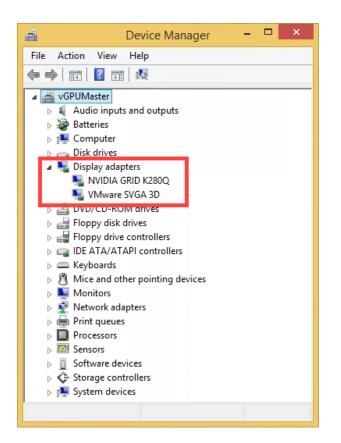
Option 1: Manually find dr	ivers for my NVIDIA products.		Help
Product Type:	GRID	0	
Product Series:	NVIDIA GRID vGPU	0	
Product:	GRID K1	0	
Operating System:	VMware vSphere ESXi 6.0	0	
Language:	English (US)	SEARCH	ł

2. Install the graphics drivers using the Express option and restart the VM after the installation has been completed successfully.

<u>CAUTION</u>: Please ensure that *remote desktop connections* have been enabled. After this step, the mouse will not be usable within the virtual machine when connecting from a vSphere Client.



3. In order to validate the successful installation of the graphics drivers as well as the vGPU device, open Windows Device Manager and expand the Display Adapter section.



4. To start the HDX 3D Pro VDA installation, mount the *XenApp and XenDesktop 7.6* (or higher) ISO image on the VM

5. Launch the Autostart menu, select "Virtual Deliver Agent for Windows Desktop OS" and follow the on-screen instructions. Please use the default settings unless specified.

Get Started	Prepare Machines and Images	Extend Deployment	
Delivery Controller Cannot be installed on this operating system.	Virtual Delivery Agent for Windows Server OS Cannot be installed on this operating	Citrix Director Incompatible OS	
	system.	Citrix License Server Incompatible OS	
		Citrix StoreFront	
	Virtual Delivery Agent for Windows	Incompatible OS	
	Desktop OS Install this agent to deliver applications and desktops from Windows desktop OS-based	Citrix Studio	
	VMs or physical machines.	Universal Print Server Incompatible OS	

#### 6. Install the VDA for HDX 3D Pro

XenDesktop 7.6	HDX 3D Pro
* Environment	HDX 3D Pro optimizes the performance of graphics-intensive programs and media-rich applications.
HDX 3D Pro	Configuration
Core Components Delivery Controller Features	Install the Virtual Delivery Agent (VDA) for HDX 3D Pro? O No, install the standard VDA Recommended for most desktops, including those enabled with Microsoft RemoteFX.
Firewall Summary Install	Yes, install the VDA for HDX 3D Pro Recommended if the machine will access a graphics processor for 3D rendering.
Finish	

7.	Reboot the VM after the VDA for HDX 3D Pro has been installed successfully	
<i>.</i>	Reboot the vin after the vortion how ob the has been instance successionly	٠

XenDesktop 7.6	Finish Installation	
Environment	The installation completed successfully.	✓ Success
<ul> <li>✓ HDX 3D Pro</li> <li>✓ Core Components</li> <li>✓ Delivery Controller</li> <li>✓ Features</li> </ul>	Prerequisites         ✓ Microsoft Visual x86 C++ 2005 Runtime         ✓ Microsoft Visual x86 C++ 2010 Runtime         Core Components         ✓ Virtual Delivery Agent	Installed Installed
<ul> <li>✓ Firewall</li> <li>✓ Summary</li> <li>✓ Install</li> <li>Finish</li> </ul>	Post Install Component Initialization	Initialized
	✓ Restart machine	Back

8. Once the VDA has been installed and VM rebooted successfully, you may install the graphics applications, benchmark tools, and sample models that you wish to deliver to all users. Please see <u>this</u> <u>blog for a starter list</u> of graphics tools you can use for evaluation and demo.

9. After the software have been installed, please *shutdown* the VM.

## **Provisioning Virtual Desktops**

Once we create a GPU enabled *base image*, as in the previous step, it is used as the source template to create a pool of virtual machines known as the *machine catalog*. This is called image provisioning. There are two ways to provision images: option 1 is using virtual machine cloning, and option 2 is using Machine Creation Services (MCS).

Full MCS support for vSphere vGPU will be added in a future release. At this time, MCS is supported with workaround, as discussed below. Please refer this article for the latest support statement: <a href="http://support.citrix.com/article/CTX200969">http://support.citrix.com/article/CTX200969</a>

Prerequisite for this step is the installation of a core XenApp / XenDesktop infrastructure, including a Controller, StoreFront and License Server.

Download the free trial and **Reviewer's Guide for XenDesktop 7.6** from the XenDesktop <u>Tech Info</u> Page for step-by-step instructions to set up the core infrastructure.

Further technical documentation is available on <u>eDocs.citrix.com/xendesktop</u>

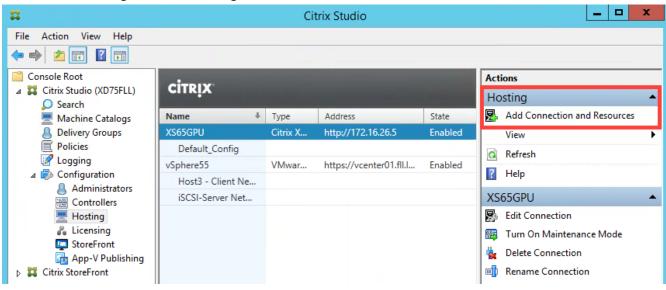
#### **Citrix Studio: Setting up the Host**

Once the VDI infrastructure has been set up, we use Citrix Studio console to complete the following steps:

- 1. Setting up the vSphere host connection to XenDesktop
- 2. Create a set of machines using clones (option 1) or machine creation services (option 2)
- 3. Assign users to the pool of machines, either one to one, or first available
- 4. Test the connection is working as expected, using Citrix Receiver

Use the following procedure to connect the XenApp or XenDesktop Controllers to the vSphere environment, which is used to host the virtual desktops.

1. Logon to the Controller as a Citrix administrator and open Citrix Studio



#### 2. Select Configuration $\rightarrow$ Hosting and start the "Add Connection and Resources" wizard

3. Select "Create a new Connection" and specify the vCenter credentials. This connection requires vCenter to be set up correctly with necessary certificates, database connections, and so on, which is outside the scope of this document. Please refer to VMware vSphere 6 documentation for more details. Citrix product documentation contains more information regarding the integration of XenApp and XenDesktop with vCenter (vSphere 6):

a. <u>Prepare the virtualization environment: VMware</u>

b. <u>Using the default vCenter certificate in XenDesktop POCs</u>.

Studio	Use an existing Connect	ion
	vSphere55	*
	Create a new Connectio	n
Connection	Connection type:	VMware vSphere ® 👻
Resources Storage	Connection address:	https://vcenter02.fll.lab
Summary	User name:	administrator@vsphere.local
	Password:	
	Connection name:	vSphere6
		The Connection name appears in Studio; it helps administrators identify the Connection.
	Create virtual machine	es using:
	Studio tools (M	achine Creation Services)
	Other tools	
		Back Next Cancel

- 4. Specify a name for the resource configuration and select the following:
- a. The vSphere Cluster to which the new VMs will be deployed
- b. The virtual network that will be connected to the VMs
- c. The storage that will be used to store the VMs as well as the Personal vDisks (optional)

	Add Connection and Resources	
Studio	Name for these resources:	
	Default Network with local SSD	
✓ Connection	Cluster	
Resources	Select a cluster for the new virtual machines.	
Storage	VGPU Browse	
	Select one or more networks for the virtual machines to use:           Image: Im	+
	VM Network	
	Back	xt Cancel

## Option 1 - Create a new machine catalog by cloning a template

Use the following procedure to create and configure a Machine Catalog.

- 1. Logon to the vSphere Web Console as an administrator.
- 2. Create a VM template based on the master VM by using the "Clone to Template" wizard.

	Power	•
Navigator	Guest OS	•
Home	Snapshots	r Manage Related Objects
	🛃 Open Console	CDII Mastar
✓ @ vCenter02.FLL.lab	🚔 Migrate	VGPU_Master Guest OS: Microsoft Windows 8 (32-bit)
▼ ll FLL-DC	Clone	Clone to Virtual Machine
🛨 🛅 Discovered virtual m	Template	Clone to Template
DC02	Fault Tolerance	Clone to Template in Library
🗗 v61CO01	VM Policies	Host: 172.16.26.6
🔁 v61CS01	Compatibility	› 🍂
	Export System Logs	
🗗 vGPU_Master	🚂 Edit Resource Settings	VM Storage Policies
🖆 x76GPU01	😼 Edit Settings	VM Storage Policies
🖆 x76GPU02	Move To	VM Storage Policy Compliance
🔁 x76GPU03	Rename	Last Checked Date
5 x76SR01	Edit Notes	
🚰 x76W8GPU02	Tags & Custom Attributes	• • • • • • • • • • • • • • • • • • •
	Add Permission	▼ Tags
	Alarms	Edit Assigned Tag Category
		This list is em
	Remove from Inventory	
C Descet Tesles	Delete from Disk	
😴 Recent Tasks	All vRealize Orchestrator plugin A	Actions >
Task Name	Target St	tatus Initiator Queued For

Follow the on-screen wizard to create the template.

3. Create one or more VMs based on the Master VM template using the New VM wizard.

<b>vm</b> ware <sup>®</sup> vSphere We	b Client	nt≘		Updated at 7:04 AM 👌	thomas@FLL.lab
Navigator	I D	vGPU_Template Actions	•		
	ා ලූ	tting Started Summary	Monitor Manage	Related Objects	
<ul> <li>✓ Ø vCenter02.FLL.lab</li> <li>✓ m FLL-DC</li> <li>✓ Discovered virtual r</li> <li>m DC02</li> <li>Ø ES01</li> </ul>	Actions - vG New VM fr Convert to Clone to T Clone to L Move To Rename Edit Notes Tags & Cu Add Permi Remove fr Delete from	om This Template Virtual Machine iemplate ibrary istom Attributes ission om Inventory	virtual te new ally plications, wirtual achines by I machine. achine is ted when a nuse a rtual	Contraction of the second seco	e
	- I '	Basic Tasks	tual machine	Explore Further	to mulato c
Recent Tasks		He Debloy to a new VI	tuar machine	Learn more about	templates
Task Name	Target	Status		Initiator	Queued For

Follow the on-screen wizard to create the VM(s). Remember to customize the VM(s) to prevent domain conflicts for hostname and machine SID, then join the VM(s) to the domain.

4. Logon to the Controller as a Citrix administrator and open Citrix Studio

5. Select Machine Catalogs and start the "Create Machine Catalog" wizard. Follow the on-screen instructions and keep the default configuration if not specified otherwise.

		Citrix Studio		_ <b>_</b> ×
ile Action View Help				
• 🔿 🖄 📰 🚺				
Console Root				Actions
Citrix Studio (XD75FLL)	CITRIX			Machine Catalogs
Search	Machine Catalog +	Machine type	No. of mac Allocated	Teate Machine Catalog
Machine Catalogs	56-Win7	Windows Desktop OS (Vi	1 1 Allocated	
Policies	Allocation Type: Random	User data: On local disk	Provisioning method: Ma	View
Policies	AdminHSD	Windows Server OS (Virt	Provisioning method: Ma	🖸 Refresh
⊿	AdminHSD Allocation Type: Random	User data: On local disk	Provisioning method: Ma	Help
Administrators	21		Provisioning method: Ma	
Controllers	vGPU-vSphere6 Allocation Type: Random	Windows Desktop OS User data: -	Provisioning method: Ma	56-Win7
💻 Hosting	vGPU-XS65	Windows Desktop OS (Vi	Provisioning method. Ma	🖳 🖳 Add Machines
🔏 Licensing	Allocation Type: Random	User data: On local disk	Provisioning method: Ma	🖳 Edit Machine Catalog
🛄 StoreFront	W2012HSD		2 2	View Machines
🔂 App-V Publishing	Allocation Type: Random	Windows Server OS (Virt User data: Discard	Provisioning method: Ma	
🗱 Citrix StoreFront	21		1 1	🖳 🖳 Delete Machine Catalog
	Win10 Allocation Type: Random	Windows Desktop OS (Vi User data: On local disk	Provisioning method: Ma	🗐 Rename Machine Catalog
	Win81 - Dedicated		1 0	🚯 Upgrade Catalog
	Allocation Type: Static	Windows Desktop OS (Vi User data: On local disk	Provisioning method: Ma	Test Machine Catalog
	Win81-PVS		3	12
	Allocation Type: Random	Windows Desktop OS (Vi User data: Discard	3 3 Provisioning method: Citr	🕐 Help
	Allocation Type: Kandom	User data: Discard	Provisioning method: Citr	
	Details - 56-Win7			
	Details Machines Admin	istrators		
	Machine Catalog	Machine	<b>A</b>	
	Trainer 50	-Win7 Installed VDA indows De Operating Sy		
		anual	stem. windows / 5	
		ndom	+	

6. Select "Windows Desktop OS"

	Machine Catalog Setup
Studio	Operating System
	Select an operating system for this Machine Catalog.
✓ Introduction	Windows Server OS The Server OS Machine Catalog provides hosted shared desktops for a large-scale deployment of standardized machines.
Operating System Machine Management	Windows Desktop OS The Desktop OS Machine Catalog provides VDI desktops ideal for a variety of different
Desktop Experience Master Image	users. Remote PC Access
Virtual Machines	The Remote PC Access Machine Catalog provides users with remote access to their physical office desktops, allowing them to work at any time.
Computer Accounts Summary	There are currently no power management connections suitable for use with Remote PC Access, but you can create one after completing this wizard. Then edit this machine catalog to specify that connection.
	Back Next Cancel

7. Select "Machines that are power managed", select "Deploy machines using: Another service or technology".

	Machine Catalog Setup
Studio	Machine Management
<ul> <li>Introduction</li> <li>Operating System</li> <li>Machine Management</li> <li>Desktop Experience</li> <li>Virtual Machines</li> <li>Summary</li> </ul>	<ul> <li>This Machine Catalog will use:</li> <li>Machines that are power managed (for example, virtual machines or blade PCs)</li> <li>Machines that are not power managed (for example, physical machines)</li> </ul> Deploy machines using: <ul> <li>Citrix Machine Creation Services (MCS)</li> <li>Resources:</li> <li>Default Network with local SSD</li> <li>Citrix Provisioning Services (PVS)</li> <li>Another service or technology</li> <li>I am not using Citrix technology to manage my machines. I have existing machines already prepared.</li> </ul>
	Back Next Cancel

8. Select "I want users to connect to a new (random) desktop each time they log on", unless there is a specific need for a different configuration. For evaluations, this optimizes the use of hardware and allows the simplest configuration.

	Machine Catalog Setup
Studio	Desktop Experience
<ul> <li>✓ Introduction</li> <li>✓ Operating System</li> <li>✓ Machine Management</li> <li>Desktop Experience</li> <li>Virtual Machines</li> <li>Summary</li> </ul>	Which desktop experience do you want users to have?  I want users to connect to a new (random) desktop each time they log on.  I want users to connect to the same (static) desktop each time they log on.
	Back Next Cancel

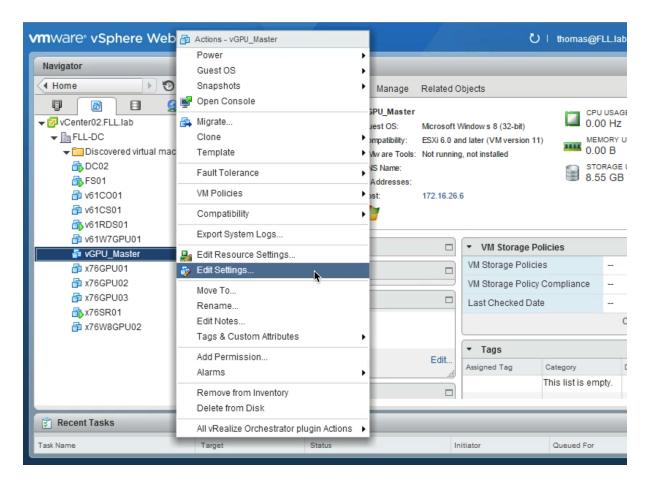
9. Click "Add", select the VM(s) created earlier and specify the Active Directory account / computer name for each of the VMs.

Studio	Virtual Machines				
	Import or add virtual n	nachines and their computer Ac	tive Directory	accounts:	
	VM name	Computer AD accou	nt		
✓ Introduction					
<ul> <li>Operating System</li> </ul>					
<ul> <li>Machine Management</li> </ul>					
Desktop Experience					
Virtual Machines					
Summary					
	Remove		mport list	Export list	Add VMs
	Select the VDA version	installed on these virtual mach	ines:		
	7.6 (recommended, to	access the latest features)			*
	Machines will require t	access the latest features) he selected VDA version (or new chine catalog. Learn more	ver) in order 1	to register in De	

10. Specify a name to identify the Machine Catalog and finish the Wizard.

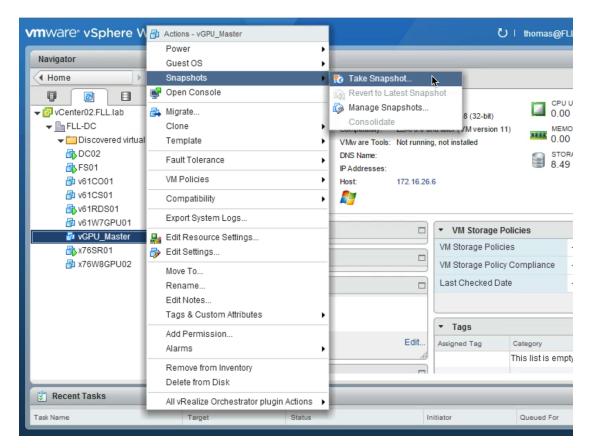
**Option 2 - Create a new Machine Catalog by means of Machine Creation Services (MCS)** Use the following procedure to create and configure a Machine Catalog. This option is recommended only for advanced users.

- 1. Logon to the vSphere Web Console as an administrator.
- 2. Open "Edit Settings..." of the master VM.



3. Remove the shared PCI device 0 (NVIDIA GRID vGPU) by clicking the X button and close the settings menu.

🗗 vGPU_Master - Edit S	ettings	? >>
Virtual Hardware VM C	ptions SDRS Rules vApp Options	
F 🔲 CPU	2 • •	
Memory	4096 <b>v</b> MB <b>v</b>	
🕨 🛄 Hard disk 1	24 (GB V	
🕨 🛃 SCSI controller 0	LSI Logic SAS	
🕨 飅 Network adapter 1	VM Network	
▶ <ul> <li>▶ CD/DVD drive 1</li> </ul>	Client Device	
Floppy drive 1	Client Device	
🕨 🛄 Video card	Specify custom settings	
→ PCI device 0	NVIDIA GRID vGPU	2
GPU Profile	grid_k220q 🔹	Rem
	Note: Some virtual machine operations are unavailable when PCI/PCIe passthrough devices are present. You cannot suspend, migrate with vMotion, or take or restore snapshots of such virtual machines.	
SATA controller 0		
▶ ∰ VMCI device		
<ul> <li>Other Devices</li> </ul>		
New device:	Select Add	
Compatibility: ESXi 6.0 an	d later (VM version 11)	Cancel



#### 4. Create a snapshot of the master VM using the vSphere Web Console:

5. Logon to the Controller as a Citrix administrator and open Citrix Studio

6. Select Machine Catalogs and start the "Create Machine Catalog" wizard. Follow the on-screen instructions and keep the default configuration if not specified otherwise.

8		Citrix Studio		_ <b>_</b> ×
File Action View Help				
Þ 🄿 🖄 📰 🔛				
📋 Console Root				Actions
Citrix Studio (XD75FLL)	CITRIX			Machine Catalogs
Search Machine Catalogs	Machine Catalog +	Machine type	No. of mac Allocated	🗐 Create Machine Catalog
Delivery Groups	56-Win7	Windows Desktop OS (Vi	1 1 🔺	View
Policies	Allocation Type: Random	User data: On local disk	Provisioning method: Ma	
📝 Logging	AdminHSD	Windows Server OS (Virt	1 1	Q Refresh
⊿ is Configuration	Allocation Type: Random	User data: On local disk	Provisioning method: Ma	🛛 🛛 Help
Administrators	vGPU-vSphere6	Windows Desktop OS	1 1	56-Win7
Controllers	Allocation Type: Random	User data: -	Provisioning method: Ma	and the second distance of the second s
Hosting	vGPU-XS65	Windows Desktop OS (Vi	1 1 =	🖶 Add Machines
Licensing StoreFront	Allocation Type: Random	User data: On local disk	Provisioning method: Ma	🔣 Edit Machine Catalog
App-V Publishing	W2012HSD	Windows Server OS (Virt	2 2	🄄 🗾 View Machines
Citrix StoreFront	Allocation Type: Random	User data: Discard	Provisioning method: Ma	👼 Delete Machine Catalog
	Win10	Windows Desktop OS (Vi	1 1	Rename Machine Catalog
	Allocation Type: Random	User data: On local disk	Provisioning method: Ma	
	Win81 - Dedicated	Windows Desktop OS (Vi	1 0	🛛 🚯 Upgrade Catalog
	Allocation Type: Static	User data: On local disk	Provisioning method: Ma	🗟 Test Machine Catalog
	Win81-PVS	Windows Desktop OS (Vi	3 3	7 Help
	Allocation Type: Random	User data: Discard	Provisioning method: Citr	1 <b>-</b> .
				1
	Details - 56-Win7			
	Details Machines Admin	istrators		
	Machine Catalog	Machine	_	
			=	
	- Humer	-Win7 Installed VDA	version: 7.6.0.5026	
		indows De Operating Sy anual	stem: Windows 7 S	
		ndom	-	
	,			13

7. Select "Windows Desktop OS"

erating System  ct an operating system for this Machine Catalog.  Windows Server OS The Server OS Machine Catalog provides hosted shared desktops for a large-scale deployment of standardized machines.  Windows Desktop OS The Desktop OS The Desktop OS Machine Catalog provides VDI desktops ideal for a variety of different users.  Remote PC Access
<ul> <li>ct an operating system for this Machine Catalog.</li> <li>Windows Server OS The Server OS Machine Catalog provides hosted shared desktops for a large-scale deployment of standardized machines.</li> <li>Windows Desktop OS The Desktop OS The Desktop OS Machine Catalog provides VDI desktops ideal for a variety of different users.</li> </ul>
<ul> <li>Windows Server OS         The Server OS Machine Catalog provides hosted shared desktops for a large-scale deployment of standardized machines.     </li> <li>Windows Desktop OS         The Desktop OS Machine Catalog provides VDI desktops ideal for a variety of different users.     </li> </ul>
<ul> <li>The Server OS Machine Catalog provides hosted shared desktops for a large-scale deployment of standardized machines.</li> <li>Windows Desktop OS         The Desktop OS Machine Catalog provides VDI desktops ideal for a variety of different users.     </li> </ul>
<ul> <li>Windows Desktop OS The Desktop OS Machine Catalog provides VDI desktops ideal for a variety of different users.</li> </ul>
The Remote PC Access Machine Catalog provides users with remote access to their physical office desktops, allowing them to work at any time.
There are currently no power management connections suitable for use with Remote PC Access, but you can create one after completing this wizard. Then edit this machine catalog to specify that connection.
Back Next Cancel

8. Select "Machines that are power managed", select "Deploy machines using: Citrix Machine Creation Services (MCS)" and choose the vSphere host connection created earlier.

	Machine Catalog Setup
Studio	Machine Management
	This Machine Catalog will use:
✓ Introduction	Machines that are power managed (for example, virtual machines or blade PCs)
<ul> <li>Operating System</li> </ul>	Machines that are not power managed (for example, physical machines)
Machine Management	
Desktop Experience	Deploy machines using:
Master Image	<ul> <li>Citrix Machine Creation Services (MCS)</li> </ul>
Virtual Machines	Resources:
Computer Accounts	Default Network with local SSD
Summary	Citrix Provisioning Services (PVS)
	Another service or technology
	I am not using Citrix technology to manage my machines. I have existing machines already prepared.
	Back Next Cancel

9. Select "I want users to connect to a new (random) desktop each time they log on", unless there is a specific need for a different configuration.

	Machine Catalog Setup
Studio	Desktop Experience Which desktop experience do you want users to have?
<ul> <li>Introduction</li> <li>Operating System</li> <li>Machine Management</li> <li>Desktop Experience</li> <li>Master Image</li> <li>Virtual Machines</li> <li>Computer Accounts</li> </ul>	<ul> <li>I want users to connect to a new (random) desktop each time they log on.</li> <li>I want users to connect to the same (static) desktop each time they log on.</li> <li>Do you want to save any changes that the user makes to the desktop?</li> <li>Yes, save changes on a separate Personal vDisk.</li> <li>Yes, create a dedicated virtual machine and save changes on the local disk.</li> <li>No, discard all changes and clear virtual desktops when the user logs off.</li> </ul>
Summary	Back Next Cancel

10. Select the master VM as well as the snapshot created earlier. If you do not select a snapshot, XenDesktop will create a new snapshot.

	Machine Catalog Setup				
Studio	Master Image				
✓ Introduction	The selected master image will be the template for all virtual machines in this catalog. (A master image is also known as a clone, golden, or base image.) Use the VDA for HDX 3D Pro when selecting a GPU-enabled snapshot or virtual machine.				
✓ Operating System	Select a snapshot (or a virtual machine):				
✓ Operating System ✓ Machine Management	<ul> <li>▼ ■ vGPU_Master  </li> <li>◆ vGPU_drivers_and_VDA_installed  </li> </ul>				
Machine Management     Sector Experience					
Master Image Virtual Machines Computer Accounts Summary					
	Select the VDA version installed on this snapshot (or virtual machine):				
	7.6 (recommended, to access the latest features)				
	Machines will require the selected VDA version (or newer) in order to register in Delivery Groups that reference this machine catalog. Learn more				
	Back Next Cancel				

11. Specify the number of VMs that will be created and review the resource configuration.

	Machine	Catalog Setup	
Studio	Virtual Machines		
	Number of virtual machin	es needed:	
✓ Introduction	3 - +		
<ul> <li>Operating System</li> </ul>	Configure your machines:		
✓ Machine Management	Name:		nd_VDA_installed
<ul> <li>✓ Desktop Experience</li> <li>✓ Master Image</li> </ul>	Virtual CPUs:	2	2 - +
Virtual Machines	Memory (MB):	4096	4096 - +
Computer Accounts	Hard disk (GB):	24	24
Summary			
		[	Back Next Cancel

12. Select the Active Directory – Organizational Unit (OU) in which the VMs will be created and specify a naming scheme.

	Machine Catalog Setup
Studio	Active Directory Computer Accounts
<ul> <li>Introduction</li> <li>Operating System</li> <li>Machine Management</li> <li>Desktop Experience</li> <li>Master Image</li> <li>Virtual Machines</li> </ul>	Each machine in a Machine Catalog needs a corresponding Active Directory computer account. Select an Active Directory account option: © Create new Active Directory accounts © Use existing Active Directory accounts Active Directory location for computer accounts: Domain: FLL.lab
Computer Accounts Summary	AppServers  Desktops  CU=Desktops,OU=Citrix,DC=FLL,DC=lab  Account naming scheme:  x76GPU## 0-9 x76GPU01  Back Next Cancel

13. Specify a name to identify the Machine Catalog and finish the Wizard

14. Go back to the vSphere Web Console, add the NVIDIA GRID vGPU to each newly created VM, and select the appropriate vGPU profile.

🗄 x76GPU02 - Edit Setti	ings	(* (*)
Virtual Hardware VM O	Options SDRS Rules vApp Options	
<ul> <li>CPU</li> <li>Memory</li> <li>Hard disk 1</li> <li>Hard disk 2</li> <li>SCSI controller 0</li> <li>Metwork adapter 1</li> <li>SCD/DVD drive 1</li> <li>Video card</li> </ul>	2   New Hard Disk   Existing Hard Disk   RDM Disk   B   RDM Disk   GB   Network   Connect   Floppy Drive   Serial Port	
<ul> <li>SATA controller 0</li> <li>WMCI device</li> <li>Other Devices</li> </ul>	<ul> <li>Parallel Port</li> <li>Host USB Device</li> <li>USB Controller</li> <li>SCSI Device</li> <li>PCI Device</li> <li>Shared PCI Device</li> <li>SCSI Controller</li> </ul>	
New device:	SATA Controller	
Compatibility: ESXi 6.0 an	nd later (VM version 11)	Cancel

#### **Create a new Delivery Group**

Use the following procedure to create and configure a Delivery Group.

1. Logon to the Controller as a Citrix administrator and open Citrix Studio

2. Select Delivery Groups and start the "Create Delivery Group" wizard. Follow the on-screen instructions and keep the default configuration if not specified otherwise.

		Citri	x Studio				
Action View Help							
🔿 🔁 📰 🔽 📷							
Console Root	ainaux					Act	ions
Citrix Studio (XD75FLL)	CITRIX					De	elivery Groups
Machine Catalogs	Delivery Groups Application	ons (14)				6	Create Delivery Group
Belivery Groups	Delivery Group	Machine ty	No. of mac	Sessions in	No. of app		View
Policies Very Constraints	56-Win7	Windows	1	0	0	a	Refresh
∠ogging ∠ Configuration	State: Maintenance mode	147 1	Unregiste	Disconne	-	?	Help
Administrators	AdminHSD State: Enabled	Windows	1 Unregiste	1 Disconne	· · · · · ·	Ac	IminHSD
Controllers	vGPU-vSphere6	Windows	1	0	0		
Licensing	State: Maintenance mode		Unregiste	Disconne			Add Applications
StoreFront	vGPU-XS65 State: Maintenance mode	Windows	1	0	0		
App-V Publishing Citrix StoreFront	W2012R2-HSD	Windows	Unregiste 2	Disconne	19		Turn On Maintenance M
	State: Enabled		Unregiste	Disconne			
	Windows 10	Windows	1	0	0		Delete Delivery Group
	State: Maintenance mode		Unregiste	Disconne			View Machines
	Windows 8-1 State: Maintenance mode	Windows	2 Unregiste	0 Disconne	0		View Applications
	Windows_81_PVD	Windows	3	0	0,	. 👼	Undo Upgrade Delivery G
		11	uninin		_		Test Delivery Group
Details - AdminHS						?	Help
	Details Applications Ma	chine Catalogs	Usage Adn	ninistrators			
	Delivery Group		State				
		ninHSD ninHSD	Enabled: Maintenance Registered M		Yes Off	-	

3. Select the number of desktops to be available to users in this Delivery Group, by selecting them from the machine catalog created earlier.

Machines elect a Machine Catalog. The Type of ras created. Catalog		made when the Catalog
elect a Machine Catalog. The Type co ras created. Catalog		made when the Catalog
vas created. Catalog		made when the Catalog
	Туре	Machines
vGPU_on_vSphere6	VDI MCS Random	
hoose the number of machines for th	his Delivery Group:	3 - +
	hoose the number of machines for t	hoose the number of machines for this Delivery Group:

5. Assign users to the delivery group, who will have permission to use these desktops.

Studio	Users	
	Specify who can use the applications and desktops in this Delivery Group. You can assign use and user groups who log on with valid credentials.	ers
Introduction	Assign users:	
Machines	FLL\Domain Users	
Delivery Type		
Users		
StoreFront		
Summary		
	Add Remove	
	Add Remove	

6. Specify a name to identify the Delivery Group and finish the Wizard.

## Using Citrix Receiver to Access vGPU-Enabled Desktops and Apps

This section shows the users launching 3D applications from XenDesktop 7.6 published desktops (VDI) using Citrix Receiver on the end-point devices. A standard Windows 7 laptop with 4GB or more RAM is the recommended end-point for this testing.

HDX 3D Pro supports a number of thin-clients, mobile devices, and fat-clients. See <u>Citrix.com</u> for details.

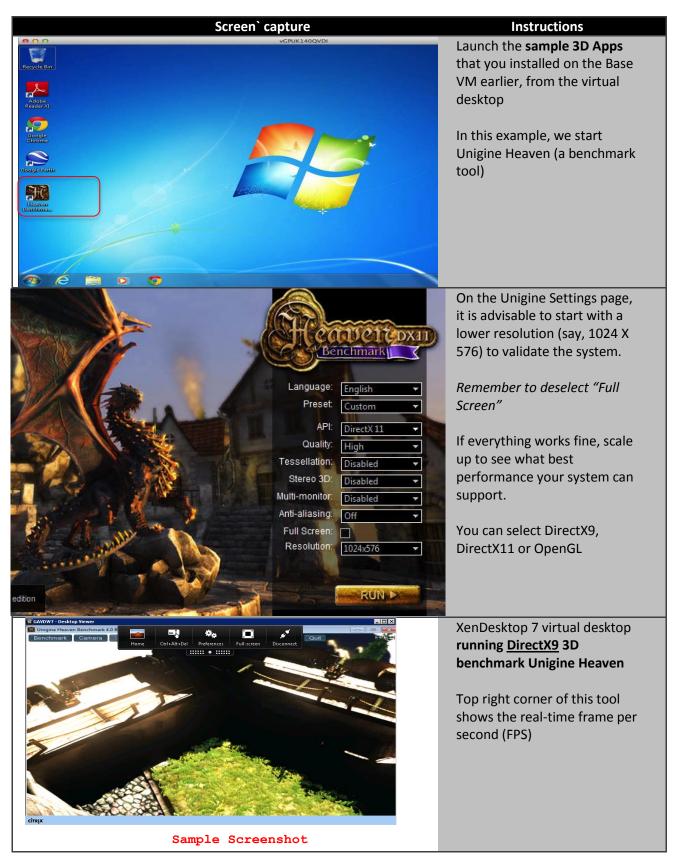
NOTE: These are NOT results of a performance test; the screenshots and values are merely *indicative*.

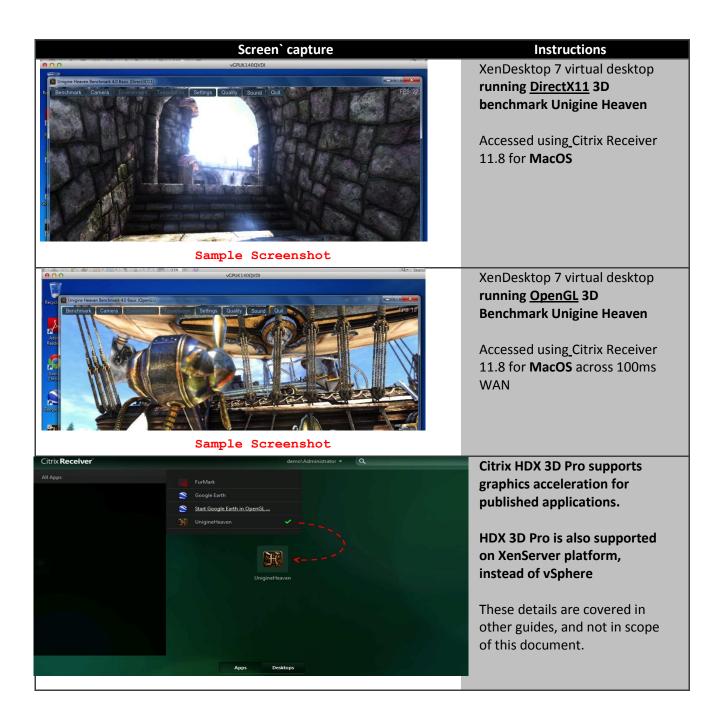
#### Launch desktops and applications on Windows client

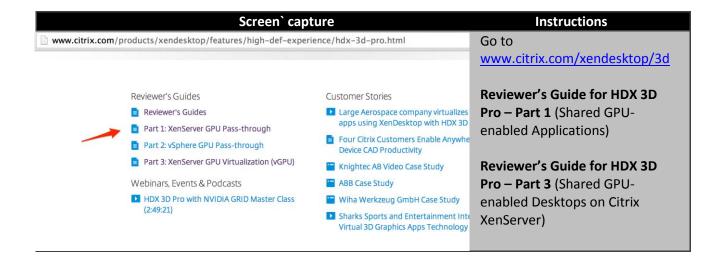
Citrix Receiver is the unified access client to access applications and desktops published in XenDesktop (and XenApp). Users connect to **StoreFront**, an enterprise app store installed as part of the XenDesktop infrastructure, with a domain user account having permissions to access those applications and desktops.

Scree	en` capture		Instructions
ⓒ Citrix Receiver - Windows Internet Explorer         ⓒ ⓒ ♥ D http://excal-ddc/Citrix/EvaITP2-MJWeb/         Citrix Receiver <sup>-</sup>	D	X Test User 1	On a client machine, Windows 7 in this case, open a browser and go to the default Storefront URL <u>http://<xendesktopddc_ip_o< u=""> r_FQDN&gt;/Citrix/StoreWeb</xendesktopddc_ip_o<></u>
Install Citrix Receiver to acc I agree with the <u>Citrix</u> Install Security details	icense agreement		If <b>Citrix Receiver</b> is not already installed on the client, you are prompted to install it. <b>Accept</b> the EULA, Click <b>Install</b> and follow the installation process. Return to the login page once it is installed.

Screen` capture	Instructions
	Login using valid domain user credentials.
Citrix Receiver User name: domainLuser or user@domain.com Password: Log On	Based on user permission in delivery group, you will see the desktops listed under the Desktops section.
	Toggle between Apps and Desktops from the tab-control at the bottom.
© 2013 Citrix Systems, Inc. All rights reserved.   Third Party Notices	DESKTODS
Citrix Receiver	DESKTOPS Click on the GPU-accelerated VDI Delivery Group that we created in an earlier step.
GAVOWI GAVONI GA	The green dot indicates a desktop is being prepared for you from the pool
Apps Desktops	
GAVDW7	Desktop Viewer window pops up. Citrix Receiver will initiate a connection to one of the virtual desktops.
Connecting .	
chapt	







# More Tools to Validate GPU is being Shared by the Virtual Desktops

See this blog for a big list of demo apps and benchmark utilities, collated by Citrix field over the years. These are neither supported nor endorsed by Citrix, but provided as suggestions to start your own evaluation. Performance and results will vary significantly based on your hardware configuration and graphic workload.

http://blogs.citrix.com/2014/08/13/citrix-hdx-the-big-list-of-graphical-benchmarks-tools-and-demos/

Please work with your Citrix representative to conduct a formal proof of concept testing, following the best-practices for fine-tuning as per the requirements of your organization.

## Conclusion

This concludes your evaluation of the NVIDIA GRID vGPU hardware-accelerated graphics in XenDesktop and XenApp 7.6.

Through this process, we set up a GRID compatible server with GRID K1/K2 cards from NVIDIA. Then we configured VMware vSphere 6 with the necessary NVIDIA drivers to enable GRID vGPU feature. Once that was done, we created a basic deployment of XenDesktop 7.6. Using Citrix Studio, we provisioned multiple vGPU-enabled Desktops to share the same physical GRID GPU. Finally, we launched virtual desktop and saw sample 3D apps in action, to validate multiple desktops are indeed sharing the GPU.

This is a simplified guide intended for a quick evaluation of the product features, using a narrow scope of work. For more advanced use-cases and deep-dive into the new features, please visit <a href="http://www.citrix.com/xendesktop/3d">www.citrix.com/xendesktop/3d</a> to find comprehensive documentation.

## **Resources and Further Reading**

HDX 3D Pro documentation - http://www.citrix.com/xendesktop/3d

Technical Blogs on HDX 3D Pro - <u>http://blogs.citrix.com/tag/hdx-3d-pro/</u>

Interesting blogs:

http://blogs.citrix.com/2014/08/13/citrix-hdx-the-big-list-of-graphical-benchmarks-tools-and-demos/

http://blogs.citrix.com/2014/05/06/optimising-the-performance-of-hdx-3d-pro-lessons-from-the-field-2/

### About the authors

**Thomas Berger** is a Senior Architect within the XenDesktop Product Marketing Team based out of Zurich, Switzerland. He started working in IT in 1999 as system admin and freelancing consultant. In 2004 he joined Citrix as Consultant within the EMEA Consulting organization, where he worked at numerous customer projects by assessing, designing and building enterprise-level architectures to successfully deliver desktops and applications using Citrix technologies. In 2011 he moved to Worldwide Consulting Solutions in order to focus on white paper and best practice development. In late 2013 he moved to Product Marketing in a technical capacity, now focusing on CI. Twitter <u>@thomas\_berger</u> or blog <u>http://blogs.citrix.com/author/thomasber/</u>

**Mayunk Jain** is a Senior Technical Marketing Manager in the desktop and application virtualization group at Citrix. His responsibilities include competitive intelligence, sales enablement, and creation of technical collateral such as product demos, performance benchmarks, and white papers. He is a speaker at major industry events and keenly involved in customer and partner enablement. Twitter <u>@mayunkj</u> or blog <u>http://blogs.citrix.com/author/mayunkj/</u>

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Citrix (NASDAQ:CTXS) is leading the transition to software-defining the workplace, uniting virtualization, mobility management, networking and SaaS solutions to enable new ways for businesses and people to work better. Citrix solutions power business mobility through secure, mobile workspaces that provide people with instant access to apps, desktops, data and communications on any device, over any network and cloud. With annual revenue in 2014 of \$3.14 billion, Citrix solutions are in use at more than 330,000 organizations and by over 100 million users globally. Learn more at <a href="http://www.citrix.com">http://www.citrix.com</a>.