

# NVIDIA vGPU Software for Citrix Virtual Apps & Desktops on Citrix Hypervisor

**Deployment Guide** 

## **Document History**

# VersionDateAuthorsDescription of Change01Aug 17, 2020AFS, JJC, EAInitial Release02Dec 16, 2020AFS, JJC, EAFormatting update

#### nv-quadro-vgpu-deployment-guide-citrixonxenserver-v1-112020

## **Table of Contents**

Chapter 1. Getting Started	5
1.1 Why NVIDIA vGPU?	5
1.2 NVIDIA vGPU Architecture	6
1.3 NVIDIA vGPU Software Licensed Products	8
1.4 Supported Graphics Protocols	8
1.5 Before You Begin	8
1.5.1 Server BIOS Settings	9
1.5.2 Citrix GPU Utilization Patch	9
1.5.3 Citrix Virtual Machine Requirements	9
1.5.3.1 Additional Sizing Resources for Citrix	9
1.5.4 Virtual GPU Evaluation licenses	10
Chapter 2. Installing Citrix Hypervisor	. 11
2.1 Choosing the Installation method	11
2.2 Installing Citrix Hypervisor	11
Chapter 3. Installing Citrix XenCenter	. 22
3.1 Installing Citrix XenCenter	22
3.2 Post Installation	23
3.2.1 Adding a Server with XenCenter	23
3.2.2 Adding Licenses to Your XenCenter	26
Chapter 4. Building Citrix Virtual Apps & Desktops	. 29
4.1 Installing the Citrix Delivery Controller	29
4.2 Configuring the Citrix Delivery Controller	33
Chapter 5 NVIDIA vGPU Manager Installation	40
5.1.1 Conving the RPM file to a Citrix Hypervisor Host	40
5.1.2 Installing the NVIDIA vGPU manager from XenCenter	41
Charter C Depleving the NV/DIA vCDU Software Licence Server	40
6.1 Deploying the NVIDIA VGPU Software License Server	. 49
6.1 1 Hardware and Software Requirements	49
6.1.2 Platform Configuration Poquiromonts	49
6.1.2 Notwork Ports and Management Interface	49 50
6.2. Installing the NVIDIA vGBL Software Licence Server on Windows	50
6.2 Installing the Jova Puntima Environment on Windows	50
6.2.2 Installing the License Server Software on Windows	
6.2.2 Obtaining the License Server's MAC Address	32
6.2.4 Managing your License Server and Getting your License Files	
6.2.4 Creating a License Server on the NVIDIA Licensing Portal	55
6.2.4.1 Creating a License Server on the NVIDIA Licensing Portal	55

6.2.4.2 Downloading a License File	57
6.2.5 Installing a License	58
Chapter 7. Selecting the Correct vGPU Profiles	61
7.1 The Role of the vGPU Manager	61
7.2 The Full List of vGPU Profiles	61
Chapter 8. Creating Your First vGPU Virtual Desktop	63
8.1 Creating a Virtual Machine	63
8.2 Installing Citrix VM Tools	71
8.3 Adding the VM to the Domain	74
8.4 Installing the Citrix Virtual Delivery Agent	77
8.5 Additional Virtual Machine Settings	
8.6 Installing NVIDIA Driver in Windows Virtual Desktop	
8.7 Licensing NVIDIA vGPU (Update 11.0)	
8.7.1.1 Licensing NVIDIA vGPU on Windows	
Chapter 9. Creating a Citrix Machine Catalog	90
9.1 Creating a Citrix Machine Catalog for Virtual Desktops and Apps	91
Chapter 10. Creating a Citrix Delivery Group	97
10.1 Creating a Citrix Delivery Group for Virtual Desktops	97
10.2 Creating a Citrix Delivery Group for Virtual Applications	103
Chapter 11. Creating Citrix Policies for NVIDIA vGPU	109
11.1 Creating a Citrix Policy for NVIDIA vGPU	109
11.2 Creating Microsoft Group Policy for NVIDIA vGPU	112
Chapter 12. Citrix Workspace App	114
12.1 Locating Citrix StoreFront Web Site	114
12.2 Installing Citrix Workspace App	115
12.3 Launch a Citrix Virtual Desktop	
Chapter 13. Troubleshooting	121
13.1 Forums	
13.2 Filing a Bug Report	
Appendix A. About This Document	123
A.1 Related Documentation	
A.2 Support Contact Information	
Appendix B. Installing & Licensing NVIDIA Driver in Linux Virtual Desktop	124
B.1 Installing NVIDIA Driver in Linux Virtual Desktop	
B.2 Licensing NVIDIA vGPU on Linux	126
Appendix C. GPU Resource Allocation	128
C.1 vGPU Assignment	

# **Chapter 1. Getting Started**

NVIDIA virtual GPU (vGPU) allows multiple virtual machines (VMs) to have simultaneous, direct access to a single physical GPU, using the same NVIDIA graphics drivers that are deployed on non-virtualized operating systems. It also enables multiple GPUs to be aggregated and allocated to a single virtual machine to power the most demanding workloads. This gives VMs unparalleled graphics performance and application compatibility, together with cost-effectiveness and scalability brought about by sharing a GPU among multiple workloads.

This chapter covers how NVIDIA vGPU solutions fundamentally alters the landscape of desktop virtualization and enables users and applications of all levels of complexity and graphics requirements to utilize said solutions. It also describes the NVIDIA vGPU architecture, the GPUs recommended for virtualization, the three virtual GPU software editions, and key standards supported by NVIDIA virtual GPU technology.

## 1.1 Why NVIDIA vGPU?

The promise of desktop virtualization, realized for server workloads years ago, is flexibility and manageability. Initially, desktop virtualization was used where the flexibility and security were the primary drivers due to cost considerations. Over the last five years, the cost of desktop virtualization has been coming down quickly due to advances in storage, multi-core processors, and software advances from virtualization leaders like Citrix.

The big remaining challenge for desktop virtualization is providing a cost-effective yet rich user experience. There have been attempts to solve this problem with software graphics or shared GPU technologies, but those technologies do not support the rich applications needed to be successful and ensure end user adoption. This compared to dedicated GPU pass-through that provide 100% application compatibility, but only for the highest end user cases due to the high cost with limited density of virtual machines per host server.

Due to the lack of scalable, sharable, and cost-effective per user GPUs that provide 100% application compatibility, providing a cost-effective rich user experience has been challenging for broad use cases in desktop virtualization. Meanwhile, high-end 3D applications simply did not work in a virtualized environment or were so expensive to implement with pass-thru it was reserved for only the most limited of circumstances.

Today, this is no longer true thanks to the NVIDIA vGPU solution combined with Citrix Virtual Desktops and Apps running on Citrix Hypervisor. NVIDIA vGPU gives you the best of both worlds where multiple virtual desktops or applications share a single physical GPU, and multiple GPUs on a single physical PCI card, all providing the 100% application compatibility of pass-through graphics, but with lower cost since multiple virtual session hosts can share a single graphics card to provide a rich,

yet more cost-effective user experience. With Citrix Virtual Apps and Desktops, you are able to centralize, pool, and more easily manage traditionally complex and expensive, distributed workstations and desktops. Now all your user groups can take advantage of the promise of virtualization.

## 1.2 NVIDIA vGPU Architecture

A high-level architecture of NVIDIA vGPU is illustrated below. The NVIDIA virtual GPU enabled VDI environment is illustrated below in Figure 1.1. Here, we have GPUs in the server, and the NVIDIA vGPU manager software (VIB) is installed on the host server. This software enables multiple VMs to share a single GPU or if there are multiple GPU's in the server, they can be aggregated so that a single VM can access multiple GPUs. This GPU enabled environment, provides not only unprecedented performance, but it also enables support for more users on a server because work that was typically done by the CPU, can be offloaded to the GPU. Physical NVIDIA GPUs can support multiple *virtual* GPUs (vGPUs) and be assigned directly to guest VMs under the control of NVIDIA's Virtual GPU Manager running in a hypervisor.

Guest VMs use the NVIDIA vGPUs in the same manner as a physical GPU that has been passed through by the hypervisor. In the VM itself, vGPU drivers are installed which pertain to the different license levels that are available. The NVIDIA RTX Virtual Workstation (RTX vWS) license pertains to the NVIDIA RTX Enterprise driver, whereas the NVIDIA Virtual PC (vPC) and NVIDIA Virtual Applications (NVIDIA vApps) pertain to the NVIDIA graphics driver.

#### Figure 1.1 NVIDIA vGPU Platform Solution Architecture



NVIDIA vGPUs are comparable to conventional GPUs in that they have a fixed amount of GPU-Memory and one or more virtual display outputs or *heads*. Multiple heads support multiple displays. Managed by the NVIDIA vGPU Manager installed in the hypervisor, the vGPU Memory is allocated out of the physical GPU frame buffer at the time the vGPU is created. The vGPU retains exclusive use of that GPU Memory 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. Figure 1.2 shows the vGPU internal architecture. VM's guest OS leverages direct access to the GPU for performance and critical fast paths. Non-critical performance management operations use a para-virtualized interface to the NVIDIA Virtual GPU Manager.



#### Figure 1.2 NVIDIA vGPU Internal Architecture

# 1.3 NVIDIA vGPU Software Licensed Products

NVIDIA virtual GPU software divides NVIDIA GPU resources so the GPU can be shared across multiple virtual machines running any application.

- > The portfolio of NVIDIA virtual GPU software products for desktop virtualization is as follows:
- NVIDIA RTX Virtual Workstation (vWS)
- NVIDIA Virtual PC (NVIDIA vPC)
- NVIDIA Virtual Applications (NVIDIA vApps)

To run these software products, you need an NVIDIA GPU and software license that addresses your specific use case. For NVIDIA Virtual Applications (NVIDIA vApps) you can use Citrix Virtual Apps and for NVIDIA Virtual PC (NVIDIA vPC) and NVIDIA RTX Virtual Workstation (vWS) you can use Citrix Virtual Desktop.

For further details on vGPU licensing, please refer to the vGPU Packaging and Licensing-Guide.

## 1.4 Supported Graphics Protocols

This version of NVIDIA vGPU software includes support for:

- ▶ Full DirectX 12, Direct2D, and DirectX Video Acceleration (DXVA)
- OpenGL 4.6
- NVIDIA vGPU SDK (remote graphics acceleration)
- Vulkan 1.1
- > OpenCL and CUDA applications WITHOUT Unified Memory are supported on supported GPUs.
- NVIDIA CUDA Toolkit and OpenCL Support on NVIDIA vGPU Software

Note: Unified Memory and CUDA tools are **NOT** supported on NVIDIA vGPU

## 1.5 Before You Begin

This section describes the general prerequisites and some general preparatory steps that must be addressed before proceeding with the deployment.

Note: This deployment guide assumes you are building an environment as a proof of concept and is not meant to be a production deployment, as a result, choices made are meant to speed up and ease the process. See the corresponding guides for each technology, and make choices appropriate for your needs, before building your production environment.

## 1.5.1 Server BIOS Settings

Configure the BIOS as appropriate for your physical hosts, as described below:

- Hyperthreading Enabled
- Power Setting or System Profile– High Performance
- CPU Performance (if applicable) Enterprise or High Throughput
- Memory Mapped I/O above 4-GB Enabled (if applicable)
- VT-d or AMD IOMMU Enabled

#### 1.5.2 Citrix GPU Utilization Patch

KB4586830 & KB458639 address an issue with incorrect Canonical Display Driver (CDD) buffer flushing, which degrades performance in Remote Desktop Protocol (RDP) Windows 2000 Display Driver Model (XDDM) scenarios. This issue affects applications that use graphics processing units (GPU) to operate, such as Microsoft Teams, Microsoft Office, and web browsers.

- Server 2016 <u>KB4586830</u>
- Server 2019 <u>KB4586839</u>

Please follow the steps below to enable KB4586830 on Server 2016. It is not enabled by default post installation.

- To Enable the fix reg add HKEY\_LOCAL\_MACHINE\SYSTEM\CurrentControlSet\Policies\Microsoft\FeatureManagement\ Overrides /v 1826589834 /t REG\_DWORD /d 1 /f
- To Disable the fix reg add HKEY\_LOCAL\_MACHINE\SYSTEM\CurrentControlSet\Policies\Microsoft\FeatureManagement\ Overrides /v 1826589834 /t REG\_DWORD /d 0 /f

#### 1.5.3 Citrix Virtual Machine Requirements

Before getting started with a deployment, please review the following Guest OS requirements below.

- Delivery Controller
- Virtual Delivery Agent (VDA) for single-session OS
- Virtual Delivery Agent (VDA) for multi-session OS

#### 1.5.3.1 Additional Sizing Resources for Citrix

- Database sizing tool for XenDesktop 7
- <u>Citrix VDI Best Practices for XenApp and XenDesktop 7.15 LTSR</u>
- Citrix Virtual Apps and Desktops Single-Server Scalability
- Complete system requirements

### 1.5.4 Virtual GPU Evaluation licenses

In order to run a PoC/trial of NVIDIA Virtual GPU, a vGPU license is required. An evaluation license is available at the <u>vGPU Evaluation</u> site.

# Chapter 2. Installing Citrix Hypervisor

This chapter covers the following Citrix Hypervisor installation topics:

- Choosing an install method
- Preparing the USB boot media
- Installing Citrix Hypervisor from the USB media
- Initial host configuration

Note: This deployment guide assumes you are building an environment as a proof of concept and is not meant to be a production deployment, as a result, choices made are meant to speed up and ease the process. See the corresponding guides for each technology, and make choices appropriate for your needs, before building your production environment.

For the purpose of this guide, Citrix Hypervisor 8.2.0 is used as the hypervisor version.

## 2.1 Choosing the Installation method

With the ability to install from USB drive, Citrix Hypervisor offers flexibility verses local hard drive install. Please see documentation regarding best practices for logs when booting from USB or similar. This lab used the server's remote console and virtual media to boot from ISO file.

## 2.2 Installing Citrix Hypervisor

Tip: Throughout the installation, quickly advance to the next screen by pressing F12. Use Tab or the arrow keys to move between options and Space or Enter to select. Press F1 for general help.

After bootup through USB Boot Media, the Welcome to Citrix Hypervisor screen will display.



1. Press **[Enter]** to begin preparing installation. The system will scan your hardware to make sure an installation is compatible.

The following Select Keymap window displays.



2. Select your desired keyboard layout using the arrow keys and press [Enter].

The Welcome to Citrix Hypervisor Setup window displays.



3. Back up any data that you want to preserve. Installing Citrix Hypervisor overwrites data on any hard drives that you select to use for the installation. Select **OK** by pressing **[Enter]**.

The End User License Agreement (EULA) displays.

CITR	IX LICENSE A	GREEMENT			1
This user	is a legal customer (" icable provi	agreement ("Ad you"), and the ding entity is	REEMENT") bet providing Citr hereinafter r	ween the end- ix entity (the eferred to as	
"CIT (her "MAI iden	RIX"). Your einafter " NTENANCE") tified at	location of ree PRODUCT") and determines https://www.cit	ceipt of the maintenance the providing trix.com/buy/li	Citrix product (hereinafter entity as censing/citrix-	
PROD AGRE	iding-entiti UCT, YOU ARE EMENT. IF Y	es.html. BY AGREEING TO BI OU DO NOT AG	INSTALLING AND E BOUND BY THE GREE TO THE	ZOR USING THE TERMS OF THIS TERMS OF THIS	E 5 4
	Accept	EULA		Back	
	-				-

4. Read the EULA and then accept by pressing [Enter] to proceed.

A system hardware warning may appear if hardware virtualization has not been enabled in the System BIOS. While installation can still proceed, make sure to enable hardware virtualization in the System BIOS after installation reboot to avoid any complications with XenCenter.

The Select Primary Disk window displays.



5. If you have multiple hard disks, choose a Primary Disk for the installation. This will overwrite any data upon the Primary Disk. Select **Ok** and press **[Enter]**.

The Virtual Machine Storage window displays.



6. Choose which disks you want to use for Virtual Machine Storage. Enable thin provisioning for optimized storage if you would like to do so. Select and **Ok** and press **[Enter]**.

Note: See Citrix documentation for support on thin provisioning: <u>https://support.citrix.com/article/CTX233865</u>

The Select Installation Source window displays.



7. Select Local Media as your Installation Source. Then navigate to OK and press [Enter].

The Verify Installation Source window displays.

	Verify Installation Source Would you like to test your media? Skip verification Verify installation source Back		.*
<tab>/<alt-tab> be</alt-tab></tab>	etween elements i	1	<f1> Help screen</f1>

8. Select Skip verification. Then navigate to OK and press [Enter].

The Set Password window displays.



9. Create and confirm a root password for the Citrix Hypervisor Host in the password field. This is the password used when connecting to the Citrix Hypervisor Host from XenCenter. Then navigate to **OK** and press **[Enter].** 

CAUTION: To prevent unauthorized access, your selected root password should contain at least eight (8) characters and consist of a mix of lowercase and capital letters, digits, and special characters.

The Networking window displays.

Which network into	erface would you	like to us	se for
connecting to the	iz8:4f:eb:82)	der on your	NOSTI
eth1 (b0:20 eth2 (b0:20	:28:4f:eb:83) :28:4f:eb:80)		
eth3 (60:20	5:28:4f:eb:81)		
Ok.		Back	

10. Specify the Network Interface or Ethernet connection you want to use for the management server on your host. Select **Ok** and press **[Enter]**.

Planes seedify bey estimation should be configured
for the management interface on this host.
(=) Automatic configuration (DHCP)
( ) Static configuration:
Subnet mask:
Gateway:
U J USE ULANS VLAN (1-4094):
Dk. Back
the second se

11. Specify automatic configuration (DHCP) or Static Configuration. If selecting Static Configuration, enter the required information into the field. Navigate to **OK** and press **[Enter]**.

The Hostname and DNS Configuration windows displays.

( ) Automatically set via DHCP (*) Manually specify:	
DNS Configuration	
(-) Automatically set via DHCP	
DNS Server 1:	
DNS Server 2:	
Back	

12. Specify the host name and the DNS configuration manually or automatically through DHCP. If you manually configure the DNS, enter the IP addresses of your primary DNS server as well as any secondary servers if needed. Navigate to **OK** and press **[Enter]**.

The Select Time Zone window displays.



13. Configure Time Zone for Citrix Hypervisor. Select the appropriate listing. Navigate to **OK** and press **[Enter].** 



14. Select the appropriate city for local time zone. Navigate to OK and press [Enter].

The **System Time** window displays.



15. Configure the system time with NTP servers. Select Using NTP. Navigate to **OK** and press [Enter].

The NTP Configuration window displays.

Copyright (c) 2009-2020 Citr Please specify d use (e.g. pool.m	ix Systems, Inc. -  NTP Configuration  - etails of the NTP serve tp.org)?	ers you wish to
NTP Server 1: MTP Server 2: NTP Server 3:		Back
<tab>/<alt-tab> between el</alt-tab></tab>	ements i	i <f1> Help screen</f1>

16. Select NTP is configured by the DHCP server or conversely enter at least one NTP server name in the fields below. Navigate to **OK** and press **[Enter]**.

The **Confirm Installation** window displays.



17. Confirm the Installation by selecting **Install XenServer.** Then press **[Enter]** to proceed with installation. Wait for the installation to finish.

The Installation Complete window displays.



18. Eject the installation media. Press [Enter] to reboot the server.

The Citrix Hypervisor configuration console will display upon reboot.



Record the IP address from the Management Network Parameters for use in the next section, Installing Citrix XenCenter.

Note: If you properly set everything during installation, nothing should be required from this console. All additional configurations can be performed through XenCenter which is covered in a later section.

## Chapter 3. Installing Citrix XenCenter

This chapter covers installing Citrix XenCenter, including:

- Citrix XenCenter Setup and Installation
- Adding a Server with XenCenter
- Installing Licenses for Citrix Hypervisor with XenCenter

## 3.1 Installing Citrix XenCenter

- 1. Download the XenCenter installer from the Citrix download site at <u>www.citrix.com</u> or enter the IP address of the server into your browser.
- 2. Install Citrix XenCenter to a computer that you want to manage your servers. Select the Installer and open the Citrix XenCenter Setup Wizard.
- 3. Follow the Setup wizard, select **Next** to continue.



4. Choose an install location and select either the **All Users** or **Just Me** radio button as needed. Select **Next** to continue.

Citrix XenCenter Set	up			-		×
Custom Setup						
Select the way you t	want features to be insta	alled.				
Click the icons in the t	ree below to change the	way feat	ures will be	installed.		
Ctrix	XenCenter Citrix Hypervisor Healt	h Check :	Citrix Xen	Center		
_	1		This feat hard drive	e. It has 1	s 59MB on of 1	your
			subfeatu	res selecte res require	d. The 5316KB o	n
<	)	3	your hard	drive.		
Location: C:	Program Files (x86)\Citr	ix XenCer	nter\	1	Browse	
Install for:						
All Users	() Just Me					
Darat	Dick Linnon		de L	Next	1	-el

#### 5. Select Install to proceed.

		×
change any of yo	ut	
	change any of yo	change any of your

6. Select **Finish** to conclude installation of XenCenter Appliance.

## 3.2 Post Installation

This section describes post install and configuration for XenCenter.

### 3.2.1 Adding a Server with XenCenter

1. Launch XenCenter from the Start Menu. A prompt will appear to periodically check for updates and new versions of Citrix Hypervisor and XenCenter if available. Select **Yes** or **No**, as needed.

Search.	Q 😣	XenCenter		
💮 XenCenter	Hom	<ul> <li>Search</li> <li>Citrix Hypervisc</li> <li>Industry leading open sour- and desktop virtualization</li> </ul>	<b>) [</b> ce platform for cloud server	
		XenCenter      Would you like XenCente      Citrix Hypervisor updates      Show internet proxy settings	? X r to periodically check the internet for and new versions of XenCenter? Yes No	
nfrastructure		=°		
Objects     Organization Views     Saved Searches     Notifications	•	Add a Server	Purchase Support	Try Desktop Virtualization

2. Click the **Add New Server** icon to open the Add New Server dialog box. In the Server field, enter the IP address of the Citrix Hypervisor server that was previously recorded in section 3.1. Enter the root username and password that was set during Citrix Hypervisor installation. Select **Add** to continue.

Note: An SSL security certificate may pop up. Click accept to continue.

(S) KerCetter	- 5 *
File View Pool Server VM S	torage Templates Tools Help
G Back - G Forward - 🛃 Add	New Server 🛛 🖳 New Pool 🛅 New Stockige 🛅 New YM 🛛 🙆 Shut Down 🎯 Reboot 🕕 Sulpend
Search.	XenCenter
le XenCenter	Home Search
	Citrix Hypervisor   Industry leading open source platform for cloud server   add New Server   Add New Server   Add New Server   Add New Server   Priver   User login credentials   User name: root   Password:
Infrastructure Objects Infrastructure Infrastructu	Add a Server Etuchase Support Try Desktop Virtualization
O Saved Searches	

- 3. A Save and Restore Connection State dialog box will appear. Click **Save and restore connection state on startup** when XenCenter is launched if appropriate. Select **OK** to continue.
- 4. The Health Check Overview window will display. Enroll for Health Checks if appropriate.

😣 Health Check Overview		?	×
Health Check will automatically uplo Hypervisor pools. <u>Privacy Statement</u>	ad a server status report to Citrix Insight Services, ba	ed on a predefined schedule configured on your Citrix	
Pool	Status	Citrix Hypervisor Test	
Citrix Hypervisor Test	Health Check not enabled	Not enrolled into Health Check Enroll now	
Show this dialog when connectin	g to servers that are not enrolled into Health Check	Close	

### 3.2.2 Adding Licenses to Your XenCenter

1. Within the XenCenter **Tools** pulldown, select **License Manager**.

Note: You can use Citrix Hypervisor without a license (Free Edition). However, this edition will provide a restricted set of features.

S XenCenter									-		×
File View Pool Server VM Sto	orage Templates	Fools Help Server Status Report	W VN	1 (0	Shut Dow	n 😪 Reboot	e 🔘 Si	ispend			
Search Q	Citrix Hype	Health Check	ix Vi	rtual Ap	ops and D	esktops Pren	nium)	Logged in	n as: Loca	al root ac	count
🗉 💮 XenCenter	General Memon	License Manager	PU	USB	Console	Performance	Ucerc	Search	-		
🕀 🛅 Citrix Hypervisor Test	Server Gener	Install Update Rolling Pool Upgrade		050	Console	- enominance	Users	Scarch			
	Properties	Options						E	opand all	<u>Collaps</u>	se all

2. The License Manager window will display. Select Assign License.

Note: For further information on Citrix Licensing see the Licensing Product Documentation.

License Manager			?
Pool/Host	License	Status	Citrix Hypervisor Test
Citrix Hypervisor Test	Citrix Hypervisor Express	X Unlicensed	License Type: Citrix Hypervisor Express Sockets: 2 Not eligible for support
			Buy Licenses

3. Enter the IP Address and appropriate License version in accordance with the License Server. Select **Ok** to continue.

Pool/Host	- 1	icense	Status	. 1	Citrix	Hypervisor Test
atris Hypervisor Test	Apoly License	State of the second second	O Hilfson	2	×	Type
	The second second			1.1.00	-	pervisor Express
	to assign a new i	cense to the servers you selected	), enter the details, and then	CHER OK		
	License Server	PLANT PROPERTY.		27000		
	License					eligible for support
	O Citrix Hypen	isor Premium Per-Socket (2 reg	uired)			
	Citrix Virtual	Apps and Desktops Premium				
	O Cibrix Virtual	Apps and Desktops				
	Citrix Virtual	Apps and Desktops Citrix Cloud				
	O Citrix Hypen	visor Standard Per-Socket (2 requ	aired)			
	10000			_	_	
			OK	Canc	el	mee
		-		_		

4. If configured correctly, the License Manager will update the status as Licensed within the Status column. Click close.

Poperios	License	Status	Citrix Hypervisor Test
Citrix Hypervisor Test	Citrie Virtual Apps and Desktops Premium	* licensed	License Type Critrix Virtual Apps and Desktops Premium Sockets: 2 License Expires: January 1, 2022 License Server: 27000 Eligible for support Citrix Virtual Apps and Desktop: Premium features enabled Buy Licenses

# Chapter 4. Building Citrix Virtual Apps & Desktops

This chapter covers installation and configuration of the core components for a Citrix Virtual Apps & Desktops environment, including:

- Citrix Delivery Controller, Citrix Studio, Citrix License Server
  - Note: For the latest install and configure information refer to Citrix's Install Core Components Section of the <u>Citrix Virtual Apps and Desktops Product Documentation</u>. Additionally, Citrix offers solutions for deploying Delivery Controllers to the Cloud. Citrix Cloud is outside the scope of this document, so please consult Citrix and refer to the <u>Citrix Cloud Product Documentation</u> if you choose to have any components of your Citrix infrastructure in the Cloud.
    - Note: A VM with a Windows Server OS was pre-created. This VM will host the Delivery Controller, Citrix Studio and License Server. The following sections describe the installation and configuration of these core components.

## 4.1 Installing the Citrix Delivery Controller

The Citrix Delivery Controller Server must meet the requirements listed in section 1.5.3 Citrix Virtual Machine Requirements.

Use the following procedure to install Citrix Delivery Controller:

- 1. Attach the iso file to the server OS and open it via File Explorer.
- 2. Launch the Auto Select Application and accept the Windows User Account Control Popup.
- 3. Click Start for Virtual Apps and Desktops section.

Deliver applica • Hybrid cloud, cloud ar • Centralized and flexibl Manage your deliver	ations and desktops to any us d enterprise provisioning management y according to your needs:	er, anywhere, on	any device.
Virtual App	DS Deliver applications		Start
Virtual App	os and Desktops deliver application	ns and desktops	Cancel
	CITRIX		

4. Select **Delivery Controller** to launch the Citrix Virtual Apps and Desktops installer.

Get Started		P	repare Machines an	d Images	
Delivery Controller		v	rinual Delivery A	gent for Windows Multi-session OS	
Start here. Select and install th essential services like License !	e Delivery Con erver and Stor	troller and other in eFront. m	nstall this agent to nulti-session OS vir	deliver applications and desktops from tual machines or physical machines.	Windov
Extend Deployment			_		
Extend Deployment Citrix Director		Citrix Studio	•	Self-Service Password Reliet	
Extend Deployment Citrix Director Citrix License Server	•	Citrix Studio Universal Print Server		Self-Service Password Rellet Session Recording	

 Scroll and read and through the Software License Agreement. Click the radio button, I have read, understand, and accept the terms of the license agreement to accept the agreement. Select Next to continue.

Location: C/Program Files/Citrix Change
Component (Select all)     Delivery Centroller     Distributes applications and desktops, manages user access, and optimizes     connections.     Studia     Create, configure, and manage infrastructure components, applications, and deskto     Directer     Monitor performance and troubleshoot problems.     Ucense Server     Manages product licenses.     StoreFront     Provides authentication and resource delivery services for Citrix Workspace app,     enabling you to create centralized enterprise stores to deliver applications, deskto     and other resources to userver applications, desktop

6. The Core Components window allows you to choose an install location as well as the core components which can be installed. For the purposes of POC/trial, ensure all components are selected and click **Next**.

Note: In a production environment, only Delivery Controller and Studio should be checked. Director, License Server, & StoreFront, should all reside on their own isolated servers. See the <u>Citrix Virtual Apps &</u> <u>Desktops Install & Configure Product Documentation</u> for production deployment instructions.

and a second	
Licensing Agreement	Feature (Select all)
<sup>r</sup> Core Components Features Firewall	Install Microsoft SQL Server 2017 Express CU16 This is an optional component. If you have an existing SQL Server for storing deskto and application configurations and settings, do not select this option.
Summary Install	Install Windows Remote Assistance Select this only if you need the shadowing feature of Director Server.
Diagnostics	

7. The Features window allows you to choose which Features to install. Ensure all features are selected and click **Next**.

8. The Firewall window allows you to configure Windows Firewall. Select the **Automatically** radio button and click **Next**.

	Firewall			
✓ Licensing Agreement	The default ports are	isted below.		Printable versio
Core Components	Daliuses Controller	Director	Linners Constan	Charac Frank
V Features	Delivery Conduct.	Director	Drenke server	SIDIEFIDIA
Firewall	80 TCP	80 TCP	7279 TCP	80 TCP
Summary	89 TCP	443 TCP	27000 TCP	443 TCP
Install	443 TCP		8083 TCP	
Diagnostics			8082 TCP	
	Configure firewall rule	2		
	<ul> <li>Automatically Select this option to created even if the</li> </ul>	o automatically creat Windows Firewall is t	e the rules in the Windows turned off.	Firewall. The rules will be
	C Manually Select this option if yourself.	iyou are not using W	lindows Firewall or if you wa	ant to create the rules

#### 9. On the Summary window select Install.

	Summary	
/ Licensing Agreement / Core Components	Review the prerequisites and confirm the components you want to in Installation directory	stalL
/ Firevall Summary Instell Diagnostics Finish	CAProgram Files/Clinx Prerequisites Microsoft INET Framework 4.7.1 Local Host Cache Storage (LocalDB) Microsoft SQL Server 2017 Express CU16 Microsoft SQL CLR Types (x86) Microsoft SQL CLR Types (x84) Microsoft SMO Objects (x84) Microsoft SMO Objects (x84) Microsoft Internet Information Services Windows Remote Assistance Feature	
	Delivery Controller Studio Director License Server	

Accept any *Reboot Prompts* and reconnect to the server.

10. In the Diagnostics window, select the appropriate option to *Collect diagnostic information* according to your organization policies.

	Diagnostics
<ul> <li>Licensing Agreement</li> <li>Core Components</li> <li>Features</li> <li>Firewall</li> <li>Summany</li> <li>Install</li> <li>Diagnostics</li> <li>Finish</li> </ul>	Collect diagnostic information Critrix Cell Home periodically collects information about system and product configuration performance, errors, and more. The information is transmitted to Citrix so our support and product teams can resolve issues proactively. Learn more about Cell Home. NOTE: The feature can be disabled later. Connect "Requires Citrix Cloud login
	Next

- 11. Select **Next** to continue.
- 12. Select Finish to complete the install.

	Finish Installation		
✓ Licensing Agreement	The installation completed successfully.		V Success
<ul> <li>✓ Licensing Agreement</li> <li>✓ Core Components</li> <li>✓ Peetures</li> <li>✓ Firewall</li> <li>✓ Summary</li> <li>✓ Install</li> <li>✓ Diagnostics.</li> <li>Finish</li> </ul>	Prerequisites Microsoft .NET Framework 4.7.1 Windows Remote Assistance Feature Local Host Cache Storage (LocalD8) Microsoft SQL GRA Types (x66) Microsoft SQL CLR Types (x66) Microsoft SQL CLR Types (x64) Microsoft SUC D Dijects (x64) Microsoft D Dijects (x64) Microsoft D Dijects (x64) Microsoft SUC D Dijects (x64) Microsoft D D Dijects (x64) Microsoft D D D D D D D D D D D D D D D D D D D	Installed Installed Installed Installed Installed Installed Installed Installed Installed Installed Installed Installed Installed	
	Component Initialization	Initialized	
	🗹 Launch Studio		Minish

# 4.2 Configuring the Citrix Delivery Controller

The following steps use Citrix Studio to configure the Citrix Delivery Controller.



- 1. If Citrix Studio was not launched automatically after the install, launch **Citrix Studio** from the Windows Start Menu.
- 2. Select Deliver applications and desktops to your users.
- 3. On the Introduction window, ensure the "A fully configured, production-ready Site (recommended for new users)" radio button is selected.

Studio	Introduction
Introduction Databases Licensing Cannection Network Additional Features Summary	You have two options when creating a new Site. The simplest option is to automatically treate a fully configured, production-ready Site. The second, more advanced option is to create an empty Site, which you must configure yourself. What kind of Site do you want to create? A fully configured, production-ready Site (recommended for new users) An empty, unconfigured Site Site name

4. In the **Site name:** type in a Site name.

Site Setup

tudio	Databases			
	Databases store Choose how yo	information about Site setup, confu	iguration logging and monitoring.	
Timoducian Databases Dicensing	Create and set up databases from Studio (Not can provide details of costing empty databases on the database server databases on the database server			
Connection Nybright Anditional Features Summary	Data type Site: Monitoring:	Detabase name Cisria-SiteSite Cisria-SiteMonitoring	Location (formats) Locatives' sqlexpress Locatives' sqlexpress	
	Logong. Cow-SiteLogging		Localhostisglexpress	
	Specify addition	al Delivery Controllers for this Site	(esm more Selent_	

5. On the Licensing window in the "License server address:" ensure localhost:27000 is specified.

Note: In a production environment, you should provide the FQDN of your separate License Server, & correct port number.

6. Next, ensure the "Use the free 30-day trial" radio button is selected and click Next.

Note: In a production environment, you should use the existing license from the FQDN License Sever.

Studio	Licensing			
	License server address: liscalhest 27000	Connect		
A Minoduction		Connected to trusted serve View certificat		
✓ Databases	I want to:			
Licensing Connection	Use the free 30-day trial You can add a license later.			
Network Additional Features	Use an existing license The product list below is generated by the license server			
Summary	There are no suitable licenses on your license server. You can allocate licenses using your License Access Code or you can add licenses from your network.			
	Manual Providence In			

- 7. On the Connection Window perform the following tasks.
  - a) Under the **Connection type:** drop down menu, select **Citrix Hypervisor.**
  - b) In the **Connection address:** enter the URL for your Citrix Hypervisor.
  - c) In the **Username:** enter your Citrix Hypervisor administrator's username.
  - d) In the **Password:** enter the Citrix Hypervisor administrator's password.
  - e) In the **Connection name:** enter a name for this connection.
Site Setup

itudio	Connection		
	Select a Connection type hardware), select 'No ma	. If machine management is not used (for example when using chine management.'	physica
<sup>#</sup> Introduction	Connection type:	Citrix Hypervisor®	
<sup>®</sup> Databases <sup>®</sup> Licensing	Connection address:	Example: http://citrix-hypervisor.example.com	
Connection	User name:	Example: root	
Additional Features	Password:		
Summary	Connection name:	Example: MyConnection	
	Create virtual machines	using:	
	Studio tools (Mac	hine Creation Services)	
	Select this option	when using AppDisks, even if you are using Citrix Provisioning.	
	Other tools		

- 8. Ensure the **Other tools** radio button is selected and click **Next**.
- 9. On the Additional Features window, click **Next**.

Site Setup

	Use the following features to customize your Site. You can also enable/disable and configure features later.
<ul> <li>Introduction</li> <li>Databases</li> <li>Licensing</li> <li>Connection</li> <li>Additional Features</li> <li>Summary</li> </ul>	Feature         AppDNA         Enable this feature to allow analysis of applications and operating systems, review compatibility issues, and take remedial actions to resolve them.         App-V Publishing         Enable this feature if you will use applications from packages on App-V servers. If you will use only applications from App-V packages on network share locations, you do not need to enable this feature.
	Back Next Cancel

10. On the Summary window, click **Finish**.

#### Site Setup

#### Summary Studio CTX-Site Site name: ✓ Introduction CitrixCTX-SiteSite Site database: Localhost\sqlexpress (no high availability) ✓ Databases ✓ Licensing Monitoring database: CitrixCTX-SiteMonitoring Localhost\sqlexpress (no high availability) Connection Logging database: CitrixCTX-SiteLogging ✓ Additional Features Localhost\sqlexpress (no high availability) Summary **Delivery Controllers:** he 15 localhost:27000 License server: Connection type: Citrix Hypervisor® here, the state stary Connection address: Connection name: **CTX-Connection** Create virtual machines with: Other tools Back Cancel

## Chapter 5. NVIDIA vGPU Manager Installation

This chapter covers the installation of the Nvidia vGPU Manager via two methods:

- Copying the .RPM file to Dom0 Server through a command line
- Installing the .ISO file through Citrix XenCenter

### 5.1.1 Copying the RPM file to a Citrix Hypervisor Host

Note: The update, .iso names, and versions are examples and may be different in your environment. As an example, the file will look similar to [Nvidia-vGPU-CitrixHypervisor-8.2-367.64x86\_64.rpm].

- 1. For this guide, PuTTY will be used to copy files from a remote Windows system to the Citrix Hypervisor.
- 2. Use the following command to copy the RPM file to dom0

```
pscp somefile root@<serverip>:/tmp
```

3. Use the following rpm command to install the package:

```
rpm -iv NVIDIA-vGPU-xenserver-8.2-450.80.x86_64.rpm
```

4. Restart the Citrix Hypervisor server:

shutdown -r now

5. After you restart the Citrix Hypervisor server, verify that the vGPU package has been installed and loaded correctly by checking the NVIDIA kernel driver:

```
[root@xenserver ~]#lsmod |grep nvidia
nvidia 8152994 0
i2c_core 20294 2 nvidia, i2c_i801
```

6. Verify that the NVIDIA kernel driver can successfully communicate with the vGPU physical GPUs in your host. Run the nvidia-smi command to produce a listing of the GPUs in your platform similar to:

```
[root@xenserver:~] nvidia-smi
Wed Jan 13 19:48:05 2021
+-----+
| NVIDIA-SMI 450.55 Driver Version: 450.55 CUDA Version: N/A |
|-----+
```

GPU Name Persistence-M | Bus-Id Disp.A | Volatile Uncorr. ECC | 
 Fan Temp Perf Pwr:Usage/Cap
 Memory-Usage
 GPU-Util
 Compute M.
 MIG M. 
 0
 Tesla T4
 On
 00000000:81:00.0 Off
 Off
 Off
 Off
 Default
 Off
 Off</ N/A 1 Tesla T4 On | 00000000:C5:00.0 Off | Off | N/A 31C P8 15W / 70W | 79MiB / 16383MiB | 0% Default | N/A \_\_\_\_\_ Processes: GPU GI CI PID Type Process name GPU Memory ID ID Usage \_\_\_\_\_ No running processes found +-----+ [root@xenserver:~]

### 5.1.2 Installing the NVIDIA vGPU manager from XenCenter

XenCenter can be used to install or update Supplemental Packs on the Citrix Hypervisor hosts. The NVIDIA Virtual GPU Manger supplemental pack is provided as a .iso file.

1. Navigate to Tools and select Install Update.



2. At the Before You Start window, read through the instructions, and select Next to continue.



3. Select the bottom option for **Select update or supplemental pack from disk**. Proceed to the file path where the NVIDIA Citrix Hypervisor Supplemental Pack .iso is located. Select **Next** to continue.

Note: The update, .iso names, and versions are examples and may be different in your environment. As an example, the file will look similar to [NVIDIA-vGPU-xenserver-8.2-450.80.x86\_64.iso]

th_	Q Gitrix Hyper	visor Test (Licensed with Citrix Virtual Apps )	and Desktops Premium)	Logged in as: L	ocal root a
Xen/Center	General Memory	Storage Networking NICs GPU USB C	onsole Performance Users Sears	th .	-
Windows 10 (64-b	o Sinstall Update			- ×	
Windows 10 (64-b DVD drives Local storage	Choose an existin	g update to install or upload a new one		0	
	Before You Start Select Update	Select Automated Updates, choose an update an update or supplemental pack file.	to be downloaded from Citrix, or brow	wse your computer for	
Selec	Select Servers	O Automated Updates			U (1 per G.
	Upload	XerrCenter will download and install all rel only a single reboot at the end.	eased updates on the current version f	from Citrix, usually with	U (2 per G
	Pre-checks	O Download update or new version from City	ar .		U(2 per G.
	Update Mode	Update Description	Date	Web Page	HU (4 per
	and a passe	XS82E011 Public Availability: Security f	ives to Xen Nov 23, 2020	Go to web page	4 (4 per G.
		XS82E010 Public Availability: Security f	ixes to Xem Nov 11, 2020	Go to web page	U (4 per G
		XS82E002 Public Availability: fixes to To Installation size 85.9 MB	ooistack Nov 3, 2020	Go to web page	U (8 per 0.
		Refresh List Restore Dismussed	Updates		U (8 per G.
Infortuation	-	Select update or supplemental pack from d	fick		U (16 per .
Objects		Filmane	NVIDIA-vGPU-senserver-8.2-450.30	x86 64.2 Biource	0 (16 per
Organization Views	CITRIX.				
			- Desilver	Nasta Canad	

4. Select the servers on which to install the .iso file. Navigate to **Next** to continue.

Before You Start	Select one or more servers where you want to apply the selected update. Servers where this update cannot be applied appear disabled in this list.	
Select Servers	Name	Version
Upload Pre-checks Update Mode Install Update	Citrix Hypervisor lest	8.2

5. The file will be uploaded from the local machine disk to the Citrix Hypervisor's selected storage location. After successful completion, select **Next** to continue.



6. Installation prechecks will begin. Once all prechecks are resolved, select Next to continue.



7. In the **Update Mode** window, select Allow XenCenter to carry out the post-update tasks as soon as the update has been applied. Then select **Install Update**.



8. Once the installation is complete, select **Finish** to continue. Reboot the server to conclude installment of the NVIDIA vGPU Manager via .iso file.

earch	Citrix Hypervis	or Test (Licensed with Citrix Virtual Apps and Desktops Premium)	Logged in as: Local root ac
A XenCenter     Citrix Hypervisor Test     Windows 10 (64-bit)     Windows 10 (64-bit)     DVD drives     Cocal storage     Removable storage	General Memory S So Install Update Install the update	torage Networking NICs GPU USB Console Performance Users Search –	· ×
	Before You Start Select Update Select Servers Upload Pre-checks Update Mode Install Update	XenCenter is now installing update NVIDIA-vGPU-xenserver-450.80 on your system.	J U (1 per G J (1 per G U (2 per G U (2 per G U (4 per G U (4 per G J (4 per G U (4 per G U (8 per G J (8 per G J (8 per G
Infrastructure			U (16 per . U (16 per .
Objects Organization Views	CITRIX.	The installation of update NVIDIA-vGPU-xenserver-450.80 was completed successfully.	
Cound Country		Finish	Cancel

## Chapter 6. Deploying the NVIDIA vGPU Software License Server

This chapter covers deployment of the NVIDIA vGPU software license server, including:

- Platform Requirements
- Installing the Java Runtime Environment on Windows
- Installing the License Server Software on Windows

## 6.1 Platform Requirements

Before proceeding, ensure that you have a platform suitable for hosting the license server.

### 6.1.1 Hardware and Software Requirements

- The hosting platform may be a physical machine, an on-premises virtual machine (VM), or a VM on a supported cloud service. NVIDIA recommends using a host that is dedicated solely to running the license server.
- The recommended minimum configuration is 2 CPU cores and 4 GB of RAM. A high-end configuration of 4 or more CPU cores with 16 GB of RAM is suitable for handling up to 150,000 licensed clients.
- At least 1 GB of hard drive space is required.
- > The hosting platform must run a supported operating system.
- On Window platforms, .NET Framework 4.5 or later is required.

### 6.1.2 Platform Configuration Requirements

- The platform must have a fixed (unchanging) IP address. The IP address may be assigned dynamically by DHCP or statically configured but must be constant.
- The platform must have at least one unchanging Ethernet MAC address, to be used as a unique identifier when registering the server and generating licenses in the NVIDIA Licensing Portal.
- > The platform's date and time must be set accurately. NTP is recommended.

### 6.1.3 Network Ports and Management Interface

The license server requires TCP port 7070 to be open in the platform's firewall, to serve licenses to clients. By default, the installer will automatically open this port. The license server's management interface is web-based and uses TCP port 8080. The management interface itself does not implement access control; instead, the installer does not open port 8080 by default, so that the management interface is only available to web browsers running locally on the license server host. Access to the management interface is therefore controlled by limiting remote access (via VNC, RDP, etc.) to the license server platform.

Note: If you choose to open port 8080 during license server installation, or at any time afterwards, the license server's management interface is unprotected.

## 6.2 Installing the NVIDIA vGPU Software License Server on Windows

The license server requires a Java runtime environment, which must be installed separately before you install the license server.

# 6.2.1 Installing the Java Runtime Environment on Windows

If a suitable Java runtime environment (JRE) version is not already installed on your system install a supported JRE before running the NVIDIA license server installer.

- 1. Download a supported 64-bit Oracle Java SE JRE or OpenJDK JRE.
  - a) Download Oracle Java SE JRE from the Java Downloads for All Operating Systems page.
    - i. Download Oracle Java SE JRE from the java.com: Java + You page.
  - b) Download OpenJDK JRE from <u>the Community builds using source code from OpenJDK project</u> on GitHub.
- 2. Install the JRE that you downloaded.
  - a) Oracle Java SE JRE installation:



#### b) OpenJDK JRE installation:

🚽 OpenJDK 1.8.0_201-1-oj	dkbuild Setup	8	×
	Welcome to the 1.8.0_201-1-ojd	OpenJDK kbuild Setup Wizaı	ď
	The Setup Wizard allows 1.8.0_201-1-ojdkbuild fe computer or to remove it continue or Cancel to ex	you to change the way Op vatures are installed on you from your computer. Click it the Setup Wizard.	enJDK r Next to
	Badi	Next	Cancel

- 3. Set the JAVA\_HOME system variable to the full path to the jre folder of your JRE installation.
  - a) For 64-bit Oracle Java SE JRE: C:\Program Files\Java\jre1.8.0\_191
  - b) For 64-bit OpenJDK JRE: C:\Program Files\ojdkbuild\java-1.8.0-openjdk-1.8.0.201-1\jre

Ensure that the path does not include any trailing characters, such as a slash or a space.

If you are upgrading to a new version of the JRE, update the value of the JAVA\_HOME system variable to the full path to the jre folder of your new JRE version.

- 4. Ensure that the Path system variable contains the path to the java.exe executable file.
  - a) For 64-bit Oracle Java SE JRE: C:\Program Files\Java\jre1.8.0\_191\bin

b) For 64-bit OpenJDK JRE: C:\Program Files\ojdkbuild\java-1.8.0-openjdk-1.8.0.201-1\bin

# 6.2.2 Installing the License Server Software on Windows

- 1. Unzip the license server installer and run setup.exe.
- 2. Accept the EULA for the license server software and the Apache Tomcat software used to support the license server's management interface.



3. Choose the destination folder where you want the license server software to be installed.



4. In the Choose Firewall Options dialog box, select the ports to be opened in the firewall.

To enable remote clients to access licenses from the server and prevent remote access to the management interface, use the default setting, which sets ports as follows:

- a) Port 7070 is opened to enable remote clients to access licenses from the server.
- b) Port 8080 is closed to ensure that the management interface is available only through a web browser running locally on the license server host.



5. After installation has completed successfully, click Done to exit the installer.



### 6.2.3 Obtaining the License Server's MAC Address

The license server's Ethernet MAC address uniquely identifies your server to the NVIDIA Licensing Portal. You will need this address to register your license server with the NVIDIA Licensing Portal to generate license files.

- 1. Open a web browser on the license server host and connect to the URL http://localhost:8080/licserver.
- 2. In the license server management interface, select **Configuration**.
- 3. On the License Server Configuration page that opens, in the **Server host ID** drop-down list, select the platform's ETHERNET address.

C S Attp://localhost:8080/lics	erver/serverProperties_view.ad	tion $ ho  ightarrow  $	Client Mana ×	û
	DIA.			
	License S	Server Configurati	on	
Licensed Clients	Properties	Value		Description
<ul> <li>Licensed Feature Usage</li> <li>License Management</li> <li>Configuration</li> </ul>	Server host ID	06407E06282C (ETHERNET)	~	Server's host ID used to uniquely identify the server to the NVIDIA licensing portal. If multiple ETHERNET IDs are available, select one and use consistently with licensing portal.
	General properties	- 5454 -		
Locense Wrent Manager	Server Version	2017.11		Server's executable version
About     Settings	Server Status	Alive		Indicates server state
2 Continge	License Generation			

# 6.2.4 Managing your License Server and Getting your License Files

To be able to download NVIDIA vGPU software licenses, you must create at least one license server on the NVIDIA Licensing Portal and allocate licenses to the server. After creating a license server and allocating licenses to it, you can download your license file.

### 6.2.4.1 Creating a License Server on the NVIDIA Licensing Portal

- 1. In the NVIDIA Licensing Portal, navigate to the organization or virtual group for which you want to create the license server.
  - a) If you are not already logged in, log in to the <u>NVIDIA Enterprise Application Hub</u> and click **NVIDIA LICENSING PORTAL** to go to the NVIDIA Licensing Portal.

b) **Optional:** If your assigned roles give you access to multiple virtual groups, select the virtual group for which you are creating the license server from the list of virtual groups at the top right of the page.

If no license servers have been created for your organization or virtual group, the NVIDIA Licensing Portal dashboard displays a message asking if you want to create a license server.

SEL ENTITLEMENTS			Urganization Example Corporation	Q
LICENSE SERVERS	E-101	in case of the second second second	Linear Comment	-
SOFTWARE DOWNLOADS	Entitlements	MANAGE ENTITLEMENTS	LICENSE SERVERS MANAGE SERVERS	CREATE SERVER
] VIRTUAL GROUPS	ENTITLEMENT / FEATURE EXPIRATION	ALLOCATED / TOTAL	▲ LICENSE SERVER / FEATURE IN USE	ALLOCATED
9 HISTORY	<ul> <li>Quintermonophilistering</li> </ul>		You do not have any license servers. Would you	like to create one?
级 USER MANAGEMENT	▲ @Hannanyhhidesannunw		CREATE LICENSE SERVER	
C ENTERPRISE SUPPORT				

2. On the NVIDIA Licensing Portal dashboard, click **CREATE LICENSE SERVER**.

The Create License Server pop-up window opens.

Server Name	Product	Licenses
Name this license server	Select a product	▼ 1
Description	Added Products	
Provide a short description	Product	Count
	No produ	ucts have been added yet
MAC Address		
MAC Address (XX:XX:XX:XX:XX: or XX-XX-XX-XX-XX)		
Failover server configuration is optional.     If configuring, you must provide a mame AND MAC address		
ailover License Server		
Failover License Server		
ailover MAC Address		
Failover MAC Address		

- 3. Provide the details of your license server.
  - a) In the Server Name field, enter the host name of the license server.
  - b) In the **Description** field, enter a text description of the license server. This description is required and will be displayed on the details page for the license server that you are creating.
  - c) In the MAC Address field, enter the MAC address of your license server.
- 4. Add the licenses for the products that you want to allocate to this license server. For each product, add the licenses as follows:
  - a) From the **Product** drop-down list, select the product for which you want to add licenses.
  - b) In the Licenses field, enter the number of licenses for the product that you want to add.
  - c) Click ADD.
- 5. Leave the Failover License Server and Failover MAC Address fields unset.
- 6. Click CREATE LICENSE SERVER.

### 6.2.4.2 Downloading a License File

Each license server that you create has license file associated with it. The license file contains all the licenses that you allocated to the license server. After downloading the license file, you can install it on the license server host associated with the license server on the NVIDIA Licensing Portal.

- 1. In the NVIDIA Licensing Portal, navigate to the organization or virtual group for which you want to download the license file.
  - a) If you are not already logged in, log in to the <u>NVIDIA Enterprise Application Hub</u> and click **NVIDIA LICENSING PORTAL** to go to the NVIDIA Licensing Portal.

- b) **Optional:** If your assigned roles give you access to multiple virtual groups, select the virtual group for which you are downloading the license file from the list of virtual groups at the top right of the page.
- 2. In the list of license servers on the NVIDIA Licensing Portal dashboard, select the license server whose associated license file you want to download.
- 3. In the License Server Details page that opens, review the licenses allocated to the license server.

	License Server Details		NVIDIA Application Hub	William Bradshaw (ORG_ADMIN)	Logout
DASHBOARD					
E ENTITLEMENTS		Organ	ization Example Corporat	tion	Q
LICENSE SERVERS	< excorpls1				
SOFTWARE DOWNLOADS	🛃 DOWNLOAD LICENSE FILE 🥜 MANAG		⊕ ADD FEATURES	DELETE SERVER	
UIRTUAL GROUPS	-				
) HISTORY					
竖 USER MANAGEMENT					
€ ENTERPRISE SUPPORT	Server Type FLEXERA	MAC Address 0000005E0055	Failover Server n/a	Failover MAC Address n/a	
	<b>Created</b> 03/07/2020 10:26 pm (UTC)	Last Modified 03/07/2020 10:26 pm (UTC)			
	Description Example Corporation license server				
	Product Licenses				
	GRID-Virtual-Apps 3.0	Product Key ID		Expiration D	ate
	10 / 10	and the second second second		never exp	ires
	Quadro-Virtual-DWS 5.0	Product Key ID		Expiration D	ate
	5/5		-	never exp	ires
≪ COLLAPSE					

4. Click **DOWNLOAD LICENSE FILE** and save the .bin license file to your license server for installation.

### 6.2.5 Installing a License

NVIDIA vGPU software licenses are distributed as .bin files for download from the NVIDIA Licensing Portal.

Before installing a license, ensure that you have downloaded the license file from the NVIDIA Licensing Portal.

1. In the license server management interface, select License Management.

2. On the License Management page that opens, click **Choose File**.

NVIDIA License Client Mar x	d X
← → C C localhost:8080/licserver/request_view.action	☆ =
License Management	
> Licensed Clients       Browse for the license file you received from the NVIDIA licensing portal, and then click Upload to process the license file.         > Reservations       Licensed Feature Usage         > License Management       Upload license file (.bin file):         > Configuration       Open	
G v k hicenses + 4 Search licenses	Q
Organize - New folder	0
<ul> <li>➢ About</li> <li>➢ Settings</li> <li>➢ Desktop</li> <li>➢ Downloads</li> <li>※ Recent Places</li> <li>※ Documents</li> <li>Music</li> <li>※ Pictures</li> <li>Yideos</li> </ul>	Type BIN File
Computer	2:08 PM

- 3. In the file browser that opens, select the .bin file and click **Open**.
- 4. Back on the License Management page, click **Upload** to install the license file on the license server. The license server should confirm successful installation of the license file.

🗲 🕘 國 http://localhost:8080/lic:	erver/response_upload.action 🔎 🗸 🖒 🤕 NVIDIA License Client Man 🛪 [
	DIA.
	License Management
Extension Clients     Eccensed Clients     Reservations     Licensed Feature Usage     Licensed Feature Usage     License Management     Sconfiguration	Successfully applied license file to license server.     Browse for the license file you received from the NVIDIA licensing portal, and then click Upload to process the license file.     Upload license file (.bin file):     Browse
Decore Citer Nations ≥ About ≥ Settings	Cancel Upload Copyright [c] 2018 NV/DIA Corporation All Rights Reserved. 2018 06 0.243045

r	_
	_
	_
_	- 14
	_

Note: For additional configuration options including Linux server deployment, securing your license server, and license provisioning, refer to the <u>Virtual GPU Software License Server User Guide</u>.

## Chapter 7. Selecting the Correct vGPU Profiles

Choosing the right profile to maximize your stakeholders experience within the virtual instance is critical. Below, you will find guidance through the vGPU Manager and beyond to ensure your deployment is successful.

## 7.1 The Role of the vGPU Manager

NVIDIA vGPU profiles assign custom amounts of dedicated graphics memory to each virtual machine. NVIDIA vGPU Manager assigns the correct amount of memory to meet the specific needs within the workflow for the virtual machine user. Every virtual machine has dedicated graphics memory and must be assigned accordingly thus ensuring that it has the resources needed to handle the expected graphics load.

NVIDIA vGPU Manager allows multiple users to share each physical GPU by assigning the graphics resources of the available GPUs to virtual machines using a balanced approach. Depending on the number of GPUs within each NVIDIA card there can be multiple user types assigned.

## 7.2 The Full List of vGPU Profiles

vGPU profiles represent very flexible deployment options for virtual GPUs, varying the size of the allocated frame buffer memory depending on a number of factors, including the number and resolution of display heads. The division of frame buffer is what defines the number of users possible per GPU with that specific profile, while the number of heads defines the number of displays supported. Max resolution is consistent across all the profiles. The full list may also be found here: <u>https://docs.nvidia.com/grid/latest/grid-vgpu-user-guide/index.html</u>

Series	Optimal Workload
Q-series	Virtual workstations for creative and technical professionals who require the performance and features of NVIDIA RTX Enterprise Drivers
C-series	Compute-intensive server workloads, such as artificial intelligence (AI), deep learning, or high-performance computing (HPC)
B-series	Virtual desktops for business professionals and knowledge workers

A-series	App streaming or session-based solutions for virtual applications users
----------	---

Note: NVIDIA vGPU is a licensed product on all supported GPU boards. A software license is required to enable all vGPU features within the guest VM. The type of license required depends on the vGPU type.

- Q-series vGPU types require a NVIDIA RTX Virtual Workstation (vWS) license.
- C-series vGPU types require a NVIDIA Virtual Compute Server license but can also be used with a RTX vWS license.
- B-series vGPU types require a NVIDIA Virtual PC license but can also be used with a RTX vWS license.
- A-series vGPU types require a NVIDIA Virtual Applications license.

CAUTION: A NVIDIA Virtual Application license is required for Citrix Virtual Application deployments. A NVIDIA Virtual PC license is required for Citrix Virtual Desktop deployments.

## Chapter 8. Creating Your First vGPU Virtual Desktop

This chapter describes how to:

- Create and configure a virtual machine in Citrix XenCenter
- Install Windows and Citrix VM Tools on the VM
- Prepare the VM for use as the golden image for Citrix MCS or PVS
- Install Citrix Virtual Delivery Agent on the VM
- Adjust additional VM settings and enable VM console access
- Enable the NVIDIA vGPU and finalizing the installation
- GPU Resource Allocation and Placement

## 8.1 Creating a Virtual Machine

The procedures detailed within this guide will use the simplest setup of Citrix Hypervisor; a single Citrix Hypervisor with local storage done through Windows 10 (64-bit). The default values may vary depending on your environment.

1. To create a Windows VM, navigate to the toolbar and select the **New VM** button to open the New VM wizard. This wizard allows you to configure the VM via parameters such as CPU, storage, and networking resources.

Teaut		Test (Licensed with City Vistual Anna and Decktons Premium)		Logand in an Local root account
E CAL	General Memory Store	age Networking NICs Ground and Console Performance Users Search		Logged in the Local Post inclount
<ul> <li>Citrix Hypervisor Test</li> <li>Windows 10 (64-bit) (1)</li> <li>Windows 10 (64-bit) (2)</li> </ul>	Server General Pro	operties		
Windows 10 (64-bit) (3)	Properties		Expand all <u>Collapse all</u>	
Cocal storage	General		10	î
g	Names	Citrix Hypervisor Test		
	Description:	Default install of Citrix Hypervisor		
	Tags:	<none></none>		
	Folder	<none></none>		
	Enabled:	Yes		
	ISCSI IQN:	iqn.2020-11.com.example:ed7a5b73		
	Log destination:	Local		
	Server uptime:	9 days 17 hours 58 minutes		
	Toolstack uptime:	6 days 20 hours 24 minutes		
	UUID:	ac1ea8e8-c594-422b-b46c-ad915f7be3b5		
	License Details		🛞	
	Version Details			
	Updates			
Objects	Management Inte	erfaces		
O Saved Searches	• Memory		1 💌	
A Notifications 15	CPUs			

2. At the **Select a VM Template** window, navigate to the desired OS. For the purposes of this guide, select Windows 10 (64-bit). Select **Next** to continue.

Note: If the OS you are installing on your new VM is compatible only with the original hardware, check the Copy host BIOS strings to VM box. For example, use this option for an OS installation CD that was packaged with a specific computer. For more information go to <u>Citrix.com</u>.

learch	Citrix Hypervi	sor Test (Licensed with	Citrix Virtual Apps and Desktops Premium)				Logged in as: Local root account
🖻 🎧 XenCenter	General Memory	Storage Networking NICs	GPU USB Console Performance User	Search			
Windows 10 (64-bit) (1)	Server General	😣 New VM				- 0 ×	
Windows 10 (64-bit) (3)	Properties	Select a VM tem	plate			0	
Local storage	General						î
	Name:	Template	Search		Q		
	Description: Tags: Folder: Enubled: ISCS IQN: Log destination: Server uptime: Toolstack uptime: UUD: License: Detail Version Detail	Hame Installation Media Home Server CPU & BPU Storage Networking Finish	Name  Y Windows 8.1 (32-bit)  Windows 8.1 (32-bit)  Windows 18 (46-bit)  Windows 10 (32-bit)  Windows 10 (32-bit)  Windows Server 2012 R2 (46-bit)  Windows Server 2012 R2 (46-bit)  Windows Server 2016 (46-bit)  Windows Server 2016 (46-bit)  CentOS 7  CentOS 8  CentO	Category Windows Windows Windows Windows Windows Windows CentOS CentOS CentOS CoreOS Debian			
Infrastructure	Updates	CITRIA	C copy host bios straigs to via				
Objects	Management	This server is only licent	sed for Citrix Virtual Apps and Desktops workloads		- Transan	Next Cancel	
C Saved Searches	Memory						
Natifications (B)							
* Houndards	CPUs						

3. Provide a name and optimal description for the new VM. Select **Next** to continue.

Search_	Citrix Hypervis	or Test (Licensed with Citrix Virtual Apps and Desktops Premium)	Logged in as: Local root acco
E A XenCenter	General Memory S	orage Networking NICs GPU USB Console Performance Users	Search
Windows 10 (64-bit) (1)	Server General	New VM	- 0 ×
Windows 10 (64-bit) (2) Windows 10 (64-bit) (3) DVD drives	Properties	Name the new virtual machine	0
Kernovable storage	Name	Template Enter a name that will help you to identify the	e virtual machine later. This could be a name that describes its
	Description: Tags Folder: Enabled: ISCSI (Nk Log destination: Server uptime: Toolstack uptime: UUID: License: Detai Version: Detai	Name         Produces pare and handwide such as Price Unces           Installation Media         Presources pare and in the other such as be charged later.           Installation Media         You can also add a more detailed description           CPU & Memory         Name         Mindows 10 (64-bit) (6)           GPU         Description:	of the VM, if you want.
Infrastructure	Updates	entria	
Dbjects		D This server is only licensed for Citrix Virtual Apps and Desktops workloads	< Previous Next > Cancel
Organization Views	• Management .		Mr. 1 ~
Saved Searches	- Memory		
Notifications 15	COLL		

4. Choose the source of the OS media to install on the new VM. For the purpose of this guide, we will be selecting from a pre-existing ISO library and EUFI Boot mode. Find the ISO library in the drop-down list and select **Next** to continue.

Note: If you do not have a pre-existing ISO library, you can also attach an ISO to the host server's DVD drive and select it from the dropdown menu.

New VM		-	X	
enter Docate the operating	system installation media		0	cal root
Wir Wir Template Wir DV Name	Select the installation method for the operating system software you	want to install on the ne	w VM.	
Loc Installation Media	Install from ISO library or DVD drive:			SR-I
Rer Home Server	en_windows_10_business_editions_version_1803_updated_jan_		Vm	No
CPU & Memory	O Boot from network			No
GPU				No
Storage	Boot Mode			
Finish	O BIOS Boot			
	UEFI Boot			
	O UEFI Secure Boot			
				av.
ucture				44.1 1
citrix				
earch	r Citrix Virtual Apps and Desktops workloads	Province Next >	Cancel	

5. At the **Select a home server window**, select the appropriate Citrix Hypervisor server on which to place the VM. Choose **Next** to proceed.



6. Change the VM specifications for CPU and Memory to preference. Select Next to continue.

Back * Les Forward * Add	New Server	bols Help N Pool 🎦 New Storage 🛅 New VM 🛛 🚇 Shut Down 😝 Reboot 🎧 Suppend	
rehQ	Citrix Hypervi	isor Test (Licensed with Citrix Virtual Apps and Desktops Premium)	Logged in as: Local root ac
XenCenter	General Memory	Storage Networking NICs GPU USB Console Performance Users Search	
Windows 10 (64-bit) (1)	Server General	⊗ New VM ~ X	and the second second
Windows 10 (64-bit) (3)	Properties	D Allocate processor and memory resources	
Premovable storage	Name Description: Tags Folder: Enabled: iSCSIQNE Log destination: Server uptime Toolstack uptime: UUID: License Detai Version Detai	Template     Specify the number of virbal CPUs, their topology, and the amount of memory that will be allocated to the new virbal machine.       Name     Number of virbal CPUs, their topology, and the amount of memory that will be allocated to the new virbal machine.       Installation Media     Number of virbal CPUs, their topology, and the amount of memory that will be allocated to the new virbal machine.       Installation Media     Number of virbal CPUs, their topology, and the amount of memory that will be allocated to the new virbal machine.       CPU by Memory     I socket with 2 cores per socket       Storage     Memory.       A0 ()     GB (min = 2.0 GB, max = 1536 GB)	
frastructure	Updates		
ojects ganization Views	Management	This server is only licensed for Citrix Virtual Apps and Desktops workloads     Cancel	
ved Searches	Memory	I 🛞	
atifications (B)			

7. Attach a GPU to the new VM. The New VM wizard will allow designation of a dedicated GPU or virtual GPUs to the VM on a GPU enabled server via a configuration page. Select Add.

euren-	Citrix Hyperviso	r lest (Licensed with C	itrix Virtual Apps and Desktops Premium)		Logged in as: Local root account
An Center     Citric Hypervisor Test	General Memory Stor	rage Networking NICs	GPU USB Console Performance Users Search		
Windows 10 (64-bit) (1)	Server General	New VM		×	
Windows 10 (64-bit) (2)	Properties	Assign a virtual G	PU	0	
Removable storage	General T	femplate	You can improve graphics performance by assigning one or more virtual graphics processing units t VM.	o this	
	Description: III Tags: IIII Folder: C Enabled: C ISCSI (DN: S Log destination: N Server uptime: T Tootstack uptime: UUID: License Detai	lame Aome Server EPU & Memory <del>2PU</del> Corage Letworking inish	Virtual GPU type Virtual GPUs per GPU Max resolution Max displays Video RAM		
Infrastructure	Version Detai	TRIX.			
Objects	(I	This server is only licensed	for Citrix Virtual Apps and Desktops workloads < Previous Next >	Cancel	
Crganization Views	Management			100	
Q Saved Searches	Memory				
Notifications 15					

8. From the drop-down list select the desired GPU profile.

Aver-Center     Aver-Cent	hory Storage Networking nera New VM Template Name Installation Media Home Server CPU & Memory GPU Storage Networking Finish	g NICs GPU virtual GPU	U USB Console Performance Uses Search	Î
Windows 10 (64-bit) (1)     Windows 10 (64-bit) (2)	Assign a v Template Name Installation Media Home Server CPU & Memory GPU Storage Networking Finish	virtual GPU	Vitual GPU type	ŕ
Windows 10 (64-bit) (2)     Windows 10 (64-bit) (2)     VUD drives     UC drives     Removable storage     Removable storage     General     Severupt     Severupt     Toptstack     UUID:	Assign a v Template Name Installation Media Meme Server CPU & Memory GPU Storage Networking Finish	virtual GPU	You can improve graphics performance by assigning one or more virtual graphics processing units to this VM. Virtual GPU type Virtual GPUs per GPU Max resolution Max displays Video RAM Add Virtual GPU ? × virtual GPU ? × virtual GPU type	*
Removable storage General Norme Description Tags: Folder Enabled: ISCS JOM Log destin Server upt Toolstack: UUID:	Template Name Installation Media Home Server CPU & Memory GPU Storage Storage Finish	Select	Vou can improve graphics performance by assigning one or more virtual graphics processing units to this VM. Virtual GPU type Virtual GPU ? X Virtual GPU type	
Descriptio Taga Folder Enabled: ISCS ION Log deatin Server upt Toolstack UUID:	Installation Media Installation Media Installation Media Installation Media CPU & Memory GPU Storage Storage Storage Installation Storage	Select	Virtual GPU type Virtual GPUs per GPU Man resolution Max displays Video RAM Add.	
Tags: Folder: Enabled: (SCS) (DN- Log destin Server upt Toolstack: UUID:	Home Server CPU & Memory GPU Storage tion: Networking ne: Finish	Select	Virtual GPU ? × virtual GPU type	
Folder Enabled: ISCSI JON Server upt Toofstack UUID:	CPU & Memory GPU Storage Networking ne: Finish	Select	virtual GPU ? × virtual GPU type	
Enabled: ISCSI (JM Eog dettin Server upt Toolstack UUID:	GPU Storage tion: Networking ne: Finish	Select	vitual GPU type	
Log detit Log detit Server upt Tootstack UUID:	Storage tion: Networking ne: Finish	NVID	×	
Server upt Toolstack UUID:	ne: Finish	NVID		
Toolstack UUID:			A Corporation GM107GL [Tesla M10] GPUs	
UUID:	ptimes	Pas: GRI	i-through whole GPU D M10-8Q virtual GPU (1 per GPU, 5120x2880, 4 displays, multiple vGPU support)	
		GRI	D MI0-8A virtual GPU (1 per GPU, 1280x1024, 1 display) D MI0-4D virtual GPU (2 per GPU D 20x2880, 4 display)	
19 million (19 mil		GRI	D M10-4A virtual GPU (2 per GPU, 1280x1024, 1 display)	
License	Detai	GRI	D M10-2Q virtual GPU (4 per GPU, 5120x2880, 4 displays) D M10-2B4 virtual GPU (4 per GPU, 5120x2880, 4 displays)	
Version	citrix.			
Infrastructure Updates				
Dbjects	<ol> <li>This server is online</li> </ol>	nly licensed for (	Citrix Virtual Apps and Desktops workloads < Previous Next > Cancel	
Crganization Views •	ment			
Q Saved Searches + Memory				
A Notifications 15				

9. Navigate to Next to continue.

Search	Citrix Hypervi	sor Test (Licensed with	Citrix Virtual Apps and Desktops Premium)		Logged in as: Local root account
AnCenter     Ancenter	General Memory	torage Networking NICs	GPU USB Console Performance Users Search		
Windows 10 (64-bit) (1)	Server General	😂 New VM			
Windows 10 (d= bit) (2) Windows 10 (64-bit) (3) DVD drives Local storage	Properties	Assign a virtual	SPU	0	
	Nume Description Togis Folder Enabled SCSICR4 Log destination Server uptime Toolstack uptime UUD License Detai	Template Name Installation Media Home Server CPU & Kemony GPU Storage Networking Finish	Yew can improve graphics performance by assigning one or more virtual graphics processing unity.         Virtual GPU type       Virtual GPUs per GPU         Max       Max displays         Virtual GPU type       Virtual GPUs per GPU         Max       1         1       1200x1024         1       74:08         Max       1         Max       1	en booted.	
Infrastructura		CITRIX			
Objects	Updates	() This server is only licens	ed for Citrix Virtual Apps and Desktops workloads	Cancel	
Crossingtion Views	Management			1.00	
Saved Searches	Memory				
Notifications (B)					
* Houndarion (1)	CPUs				*

10. Configure storage for the new VM to desired specifications. You may also change the name, description, or size of your virtual disk by selecting Properties as well as add a new virtual disk by selecting Add. Select **Next** to continue after configuring storage appropriately for the VM.

Search	🔍 🚯 Citrix Hypervi	sor Test (Licensed wit	h Citrix Virtual Apps and Desktops Premium)			Logged in as: Local root account
Arcenter	General Memory	Storage Networking NIC	GPU USB Console Performance Users Search			
Windows 10 (64-bit) (1)	Server General	😣 New VM			- 0 ×	
Windows 10 (64-bit) (3) DVD drives Kocal storage	Properties	Configure store	ge for the new VM		0	~
Removable storage	Name Description: Tags: Folder: Enabled: iSCS1ON: Log detination: Server uptime: Toolstack uptime: UUD: License Detai	Template Name Installation Media Home Server CPU & Memory GPU Storage Networking Finish	The virtual machine template you selected earlier provides the vir properties of these virtual disks, ind add more disks if required. Atternatively, you can select the second option below to create a network and does not use any virtual disks. When you have finished configuring disks for the new virtual ma- step. (*) Use these virtual disks: Name Location Vindows 10 (64-bit) (4 Local storage on Citrix Hyperviso	tual disk listed below, Yo diskless VM that can be b chine, click Next to condir Size Shared TSIZ GB False	w can change the coted from the nue to the next Add Edt Dente	
Infrastruicture	Version Detai	CITRIX	Create a diskless VM that boots from the network			
Chiede	Updates	This server is only licer	sed for Citrix Virtual Apps and Desktops workloads	< Previous Next	> Cancel	
Constanting Marine	Management				1.0.1	
organization views					1.00	
Saved Searches	• Memory				10	
Notifications (15)	CPUs					

11. At the **Configure networking on the new VM** window, select the network that corresponds with the network that the VM requires. Select **Next** to continue.

	Citrix Hypervisor Test (Licensed with Ci	trix Virtual Apps and Desktops Premium)	Logged in as: Local root account
E A XenCenter	General Memory Storage Networking NICs	GPU USB Console Performance Users Search	
Windows 10 (64-bit) (1)	Server General 😣 New VM		×
Windows 10 (64-bit) (2) Windows 10 (64-bit) (3) DVD drives Ko Local storage	Properties 20 Configure network	ng on the new VM	0
Removable storage	Nume:         Template           Description:         Name           Togi:         Natiliation Media           Hems Servet:         CPU & Memory           Folder:         CPU & Memory           Brablet:         Storage           Log destination:         Metworking           Server uptime:         Finish           Toolstack uptime:         License Detai           Version Detai         Citrup:C:	The virtual machine template you have selected provides the virtual network interfaces listed an configure or delete the default virtual network interfaces here, and add more if required.  With an entropy of the selected selected provides the virtual network interfaces of the selected sele	below. You Edit. Relete
Infrastructure	Updates		- Internet in the second se
Dijects	Management	for Citrix Virtual Apps and Desktops workloads	Cancel
O Saved Searches	Memory		
A Notifications 15	1.444		

12. Review all settings and then select **Create Now** to create the VM. An icon for your new VM appears under the server in the left Resources pane.

earch	Citrix Hyperviso	or Test (Licensed with	Citrix Virtual Apps and Deskt	tops Premium)		Logged in as: Local root account
Carlos VenCenter	General Memory Sto	orage Networking NICs	GPU USB Console Pe	rformance Users Search		
Windows 10 (64-bit) (1)	Server General	New VM			- 0 ×	
Windows to (64-bit) (2)	Properties	Ready to create	the new virtual machine		0	~
ing Kernovable storage	Name Description: Tags: Folder: Enabled: iSCS10N Log destination: Server uptime: UUD: License Detai Version Detai	Template Name Installation Media Installation Media Installation Media CPU & Memory CPU & Memory CPU & Memory CPU & Memory Resolution CPU & Complete CPU & C	All the necessary inform machine using the setti Receive these settings; if Name Installation URL Boot Mode Home Server VCPUs Topology Memory	ustion has been collected and the witard is ready to provis rigs shown below. Hencick's Previous if you need to change anything. Otherw ay take several minutes to create the new VM. Windows 10 (64-bit) Windows 10 (64-bit) Wind	ion the new virtual rise, click Create Now to	
Infrastructure	Updates					
Objects Organization Views	Management	This server is only licens	ed for Citrix Virtual Apps and Deskt	ops workloads < Previous	Create w Cancel	
Saved Searches	Memory					
Notifications 13	CPUs				1 🛞	

13. In the Resources pane, select the VM and then navigate to the **Console tab** to view the VM console.

1	Q 🐻 Windows 10 (64-b	it) (1) on 'Citrix Hypervisor Test'	Logged in as: Local root ac
XenCenter	General Memory Stora	ge Networking Console Performance Snapshots Search	
Windows T0 (64-bit) (1)	VM General Proper	ties	
Cocal storage	Properties		ixpand all Collapse all
SMB ISO library	General		8
	Name	Windows 10 (64-bit) (1)	
	Description:		
	Tagis:	<none></none>	
	Folder:	<none></none>	
	Operating System:	Unknown	
	Virtualization mode:	Hardware-assisted Virtualization (HVM)	
	BIOS strings copied:	No	
	Virtualization state:	I/O optimized Management Agent not installed Not able to receive updates from Windows Update	
		Read more about installing Sitrix VM Tools	
	Time since startup:	3 minutes	
	UUID:	e97b5d08-65fb-e21d-3aba-7d02b7f2a1ff	
	Boot Options		( <u>@</u> )
frastructure	CDUs		
ojects	cros		
ganization Views	Read Caching		
ved Searches			
otifications 10			
			Update

14. Install the Windows OS. Follow the installation screens and make your selections.

nch	🔾 🐻 Windows 10 (64-bit)	(1) on 'Citrix Hypervisor Test'						Logged	in as: Local root account
XenCenter	General Memory Storage	Networking Console Performance Snap	oshots Search						
Windows 10 (64-bit) (1)	DVD Drive 1: en_windows	10_business_edition_version_1809_updated	feb_2019_x64_dvd_2db976a7.is	:0		-			~ Eest
Cocal storage Removable storage	×	¢	Calendar	And more Mail	-	Xbox	8	Photos	
and the secondary		Calculator		n	N	D	Wa	hulu	
		Camera		My Office O	neNote		Microsoft Solitative Collection	Hulu	
		Connect	Explore				Ps		
		D Dalby Access	ŕ		е	<u>65</u>		Dalby Access	
		E	ANCTOSOT STOPE		scrosort Eage				
		G Feedback Hub	Microsoft To	-Q- Weather Si	S				
		Game bar	the second						
Infrastructure	e	Cet Help							
Objects Organization Views	٥.	Groove Music	Microsoft News	Spotify Music Vo	our Phone			51704	
Saved Searches		P Type here to search	0 EI	🔁 🧮 📫	Ŕ		x <sup>4</sup> ^	E da 11/19/2020	
Notifications 10	*								>

After the OS installation completes, reboot the VM.

## 8.2 Installing Citrix VM Tools

Citrix VM Tools for Windows must be installed on each Windows VM for the VM to have a fully supported configuration. A Windows VM will function without Citrix VM Tools, but performance is hampered and is not supported. Citrix VM Tools for Windows also enable certain functions and features, including cleanly shutting down, rebooting, suspending and live migrating VMs.

To install Citrix VM Tools for Windows:

- 1. Download the Citrix VM Tools for windows file onto the Windows VM. This file can be obtained from the <u>Citrix Hypervisor Downloads</u> page.
- 2. Run the managementagent.msi file to begin Citrix VM Tools installation. The VM Tools Installation wizard will display.

eanhQ	To Windows 10 (64-bit) (1) on 'Citrix Hypervisor Test'	Logged	in as: Local root account
Canter	General Memory Storage Networking Console Performance Snapshots Search		
Windows 10 (84-bit) (1) DVD drives Cocal storage SMB ISO library	DVD Drive f: <a href="mailto:keinights">cempty&gt;</a>		⊻ fisct
	Case Name of Production Productio		
	cîrețx		
Infrastructure			
Objects			
Organization Views -			
Saved Searches	🖬 🔘 Type have to search 🛛 🖬 📴 💼 🚱 🧥 🖈	- 11 da 11/16/2020 🖷	
	Send Ctrl+Alt+Del (Ctrl+Alt+Insert)	Scale Undock (Alt+Shift+U)	Fuliscreen (Ctrl+Enter)

- 3. Select Next on the Welcome to the Citrix Hypervisor PV Tools Setup Wizard.
- 4. Read the End-User License Agreement and Check the I accept the terms in the License Agreement check box and client Next.

nd-User License Ag	reement			
Please read the followi	ng license agreement	carefully		
Vindows Pere-Victualized Dri	vers Licenses Terms			-
This packege contains dew copping and distribution machines Your installari and/or distribution of the your distribute theme drive these drivers under terms defend, and hold Citrum S ("CITRI") harises from liabilicies, expenses (in fewel and wettiment shou connection with your feil terms	ice chivers for eac. with Den-based virtual on, use coopying ees drivers constitutes license terms. Should are you acut distribute intotantically. withstantically. yateba. Inc. any dasages costs. cluding sttorneys the incurved in ure to include such			
Hotwithstanding anything license terms, are of ope whall in all weys he gove license(s)indicated as ap at http://www.citrix.com/ You was not response as you	set forth in these a source components trad by any open source plicable to the drivers buy/licensing open-source. monohers balance	htai		
labels of sarks on the d TO THE EXTENT PERMITTED B	Y APPLICABLE 149			
☑ I accept the terms in	the License Agreemen	nt		

5. On the Destination Folder page, define an install location and click **Next**.

Citrix Hypervisor PV Tools Setup		-		X
Destination Folder				
Click Next to install to the default folder or c	lick Change to c	hoose another.		
Install Citrix Hypervisor PV Tools to:				
C:\Program Files\Citrix\XenTools\				1
Change				
	Back	Nevt	Can	el
	Back	Ivext	Cano	e

- 6. On the Installation and Update Setting Window, leave the Install I/O Drivers Now checkbox selected for optimal performance and functionality.
- 7. Choose the appropriate drop-down options for managing updates that are in line with your organizational needs and click, **Next**.
|  |   | -                                       |             | ^ |
|--|---|---|-------------|---|
| Installation and Update Settings<br>Click Next to accept recommended setting   | js  |   |             |   |
| I/O drivers improve performance, function  | ality and reliability                         |   |             |   |
| Install I/O Drivers Now  |   |   |             |   |
| The management agent automatically update  | ates itself when nev                          | versions are av                         | ailable     |   |
| Allow automatic management agent updat   | es  |   | ~           |   |
| The management agent can install I/O driv<br>Customers using Windows Update for I/O d  | vers when new vers<br>driver updates shou     | ions are availabl<br>Id not select this | e<br>option |   |
| Disallow automatic I/O driver updates by t   | he management ag                              | ent                                     | ~           |   |
| Send anonymous usage information to  | Citrix  |   |             |   |
| Automatic updates may be overridden by p   | oool policies                                 |   |             |   |
|  | Paul  | Neut                                    | Contraction | 4 |
|  | DdCk  | Next                                    | Cance       | 9 |
| Select Install.  |   |   |             |   |
| Citrix Hypervisor PV Tools Setup   |   |   |             | X |
| a annual barrent a serie a serie b   |   |   |             | _ |
| Ready to install Citrix Hypervisor P   | V Tools                                       |   |             |   |
| Ready to install Citrix Hypervisor P<br>Click Install to begin the installation. Click<br>installation settings. Click Cancel to exit th | V Tools<br>Back to review or a<br>ne wizard.  | change any of ye                        | our         |   |
| Ready to install Citrix Hypervisor P<br>Click Install to begin the installation. Click<br>installation settings. Click Cancel to exit th | V Tools<br>Back to review or one wizard.      | change any of yo                        | bur         |   |
| Ready to install Citrix Hypervisor P<br>Click Install to begin the installation. Click<br>installation settings. Click Cancel to exit th | V Tools<br>Back to review or a<br>te wizard.  | change any of y                         | bur         |   |
| Ready to install Citrix Hypervisor P<br>Click Install to begin the installation. Click<br>installation settings. Click Cancel to exit th | V Tools<br>Back to review or a<br>the wizard. | change any of y                         | our         |   |
| Ready to install Citrix Hypervisor P<br>Click Install to begin the installation. Click<br>installation settings. Click Cancel to exit th | V Tools                                       | change any of yo                        | our         |   |
| Ready to install Citrix Hypervisor P<br>Click Install to begin the installation. Click<br>installation settings. Click Cancel to exit th | V Tools<br>Back to review or a<br>the wizard. | change any of y                         | bur         |   |
| Ready to install Citrix Hypervisor P<br>Click Install to begin the installation. Click<br>installation settings. Click Cancel to exit th | V Tools<br>Back to review or the wizard.      | change any of y                         | bur         |   |
| Ready to install Citrix Hypervisor P<br>Click Install to begin the installation. Click<br>installation settings. Click Cancel to exit th | V Tools                                       | change any of y                         | bur         |   |

- 9. After Installation has finished, click **Finish**.
- 10. Restart the VM when prompted to complete the installation of Citrix VM Tools for Windows.

### 8.3 Adding the VM to the Domain

By joining the VM to the Windows Active Directory domain you are then able to manage it as you would any physical desktop in the domain.

Customize Windows on the virtual machine as follows:

- Join the domain
- Add appropriate Domain groups to Local Administrators
- Adding a VM to the domain:

#### 1. On the VM, go to Control Panel, System and Security, System

🛃 System				-		$\times$
🔶 🐳 👻 🛧 🔜 > Control Par	nel > System and Security > Sy	stem	v Ū Se	arch Control Panel		Ą
Control Panel Home	View basic information	about your compute	r			?
🌻 Device Manager	Windows edition					
👎 Remote settings	Windows 10 Pro N			1. A.		~
System protection	© 2017 Microsoft Corpora	tion. All	Wir	าดอพ	<u>'S</u> 1	()
Advanced system settings	rights reserved.		••••	10000		<u> </u>
	System					
	Processor:	Intel(R) Xeon(R) CPU E5-2	2667 v4 @ 3.2	0GHz 3.20 GHz (2	processo	ors)
	Installed memory (RAM):	8.00 GB				
	System type:	64-bit Operating System,	x64-based pi	rocessor		
	Pen and Touch:	No Pen or Touch Input is	available for	this Display		
	Computer name, domain, and	workgroup settings				-
	Computer name:	DESKTOP-NCHEFLP		Cha	nge setti	ings
	Full computer name:	DESKTOP-NCHEFLP				
	Computer description:					
	Workgroup:	WORKGROUP				
	Windows activation					
	Windows is not activated.	Read the Microsoft Softwa	re License Te	erms		
See also	Product ID: 00331-60000-0	0000-AA737		Activ	ate Wind	lows
Security and Maintenance						

2. This brings up the System Properties window, on the Computer Name tab click Change:

System Properties	5				х
Computer Name	Hardware	Advanced	System Protection	Remote	
Windows uses the following information to identify your computer on the network.					
Computer <u>d</u> escrip	otion:				
	Fo	or example: " omputer".	Kitchen Computer" o	r ''Mary's	
Full computer na	me: D	ESKTOP-NC	HEFLP		
Workgroup:	N	ORKGROU			
To use a wizard t Network ID. To rename this c	To use a wizard to join a domain or workgroup, click <u>Network ID.</u>				
workgroup, click	Change.			<u>u</u> nange	
		OK	Cancel	<u>A</u> pply	

3. On the Computer Name/Domain Changes window, enter in an appropriate Computer name, then Domain name, and click OK. Our chosen naming is shown below, use what is appropriate for your POC/trial.

System Properties	×
Computer Name/Domain Changes X	mote
You can change the name and the membership of this computer. Changes might affect access to network resources.	computer
Computer name: Win 10	ary's
Full computer name: Win10	
More	ırk ID
Member of	
Domain:	nge
gid.com	
O Workgroup:	
WORKGROUP	
OK Cancel	
OK Cancel	Apply

4. A security window pops up, fill in your specific domain administrator credentials and click OK:

Windows Security	×				
Computer Name/Doma	Computer Name/Domain Changes				
Enter the name and password to join the domain.	of an account with permission				
administrator					
•••••	0				
ОК	Cancel				

5. On successful authentication you will see the following welcome pop-up showing your VM is now on the domain (the domain name should reflect your domain information):



6. Click OK and the VM needs to reboot to complete the process, click OK again and the VM reboots immediately.



### 8.4 Installing the Citrix Virtual Delivery Agent

You need to install the correct version of the Citrix Virtual Delivery Agent (VDA) for your virtual machine. For the purpose of this guide, Citrix Virtual Apps and Desktop LTSR 7\_1912 was used, therefore this guide uses VDA agent within the exact same LTSR service branch version.

Use the following procedure to install the Virtual Delivery Agent:

- 1. Attach the iso file to the server OS and open it via File Explorer.
- 2. Launch the *Auto Select* Application and accept the Windows User Account Control Popup.
- 3. Click Start for Virtual Apps and Desktops section.

		X		
Deliver applica • Hybrid cloud, cloud and • Centralized and flexible Manage your delivery	tions and desktops to I enterprise provisioning management v according to your needs:	any user, anyw	vhere, on any	device.
Virtual App	S Deliver applications			Start
Virtual App	s and Desktops Delive	er applications and deskto	ps	Cancel
	c	itrix		

4. Select **Virtual Delivery Agent for Windows Single-session OS** to launch the Citrix Virtual Delivery Agent installer.

Get Started		Prepare Ma	achines and	Images	
Delivery Controller Cannot be installed on this operating system.		Virtual De Install this single-sess	Virtual Delivery Agent for Windows Single-session OS Install this agent to deliver applications and desktops from Windo single-session OS virtual machines or physical machines.		
			î.		
Extend Deployment Citrix Director Incompatible OS	•	Citrix Studio	•	Self-Service Password Reset	4
Extend Deployment Citrix Director Incompatible OS Citrix License Server Incompatible OS	•	Citrix Studio Universal Print Server Incompatible OS	€ 0	Self-Service Password Reset Incompatible OS Session Recording	4

Note: If you are using an Operating System that supports multiple user sessions, you will select Virtual Delivery Agent for Windows Multi-session OS.

#### 5. On the environment window, ensure the **Create a master MCS image** radio button is selected.

Note: In a production environment you may use a different VM provisioning method.

Environment Core Components Additional Components Delivery Controller Features Finevall Summary Install Diagnostics Finish	Configuration         I want to:
	Back

6. On the Core Components window, you can change the install location or leave the default location and click **Next.** 

	Core Components
<ul> <li>Environment</li> <li>Core Components</li> <li>Additional Components</li> <li>Delivery Controller</li> <li>Features</li> <li>Finevall</li> <li>Summary</li> <li>Install</li> <li>Diagnestics</li> <li>Finish</li> </ul>	Location: Ct/Program Files/Ctrrix         Change           Virtual Delivery Agent (Required)         The software agent that is installed on the virtual or physical machine that provides to virtual desktop or application to the user.           Citrix Workspace App         Citrix Workspace App           Clent software that enables users to access their documents, applications, and desktops from any device, including smartshones, tablets, and PCs.

7. The Additional Components window allows you to choose which Components to install. Leave the defaults selected and click **Next.** 



8. On the Delivery Controller window, type in the Fully Qualified Domain Name of your Delivery Controller in the **Controller address:** text field.

Environment	Configuration
Core Components	congulation
Additional Components	How do you want to enter the locations of your Delivery Controllers?
Delivery Controller	Do it manually *
Features	
Firewall	Controller address:
Summary	3
Install	Test connection / Idd
Diagnostics	The Contractor of Contractor
Finish	
	Note: Entry of invalid special characters will be ignored.
	Note: Any Group Policies that specify Delivery Controller locations will override settings

- 9. Click **Test connection..** then click **Add**.
- 10. Click Next.
- 11. The Features window allows you to choose which Features to install. Leave the defaults selected and click **Next**.

Environment	Easture (Salart all)
Core Components Additional Components	Optimize performance     Optimize desktop settings, <u>Learn more</u>
Delivery Controller Features	Use Windows Remote Assistance Enable Windows Remote Assistance. Learn more
Summary Install	Use Real-Time Audio Transport for audio Uses UDP ports 18500 - 16509. Learn more
Diagnostics Finish	MCS IO Enable MCS IC write cache for storage optimization. Learn more

12. The Firewall window allows you to configure Windows Firewall. Select the **Automatically** radio button and click **Next**.

	Firewall	
Environment     Core Components     Additional Components     Delivery Controller     Foatures     Firewall     Summary     Install     Diagnostics     Finish	The default ports are listed below. Controller Communications 80 TCP 1494 TCP 2598 TCP 8008 TCP 1494 UDP 2598 UDP	Printable version
	Configure firewall rules: Automatically Select this option to automatically create the rules in the created even if the Windows Firewall is turned off. Manually Select this option if you are not using Windows Firewall yourself.	Windows Firewall. The rules will be or if you want to create the rules Back Net Cancel

#### 13. Review your configuration on the Summary window and click Install.

<ul> <li>Environment</li> <li>Core Components</li> <li>Additional Components</li> <li>Delivery Controller</li> <li>Features</li> <li>Frevall</li> <li>Summary</li> <li>Install</li> <li>Diagnostics</li> <li>Finish</li> </ul>	Review the prerequisites and confirm the components you want to install. Installation directory CAProgram Files/Citrix Core Components Virtual Delivery Agent Citrix Workspace App Additional Components Citrix Workspace App Additional Components Citrix User Profile Manager Citrix User Profile Manager Dirux User Profile Manager Will Plugin Delivery Controllers JIC-NVECTMAN polab Features Optimize performance Firewall UDP Parts: 1494, 2596	Restart requires

- 14. Accept any *Reboot Prompts* and reconnect to the server.
- 15. In the Diagnostics window, uncheck *Collect diagnostic information*.



16. Click Next to continue.

17. On the Finish window, click **Finish** to complete the install and allow the server to restart.

	Finish Installation	
Environment	The installation completed successfully.	🗸 Succe
≪ Core Components ≪ Additional Components ≪ Delivery Controller ≪ Foaturos	Core Components Virtual Delivery Agent Citrix Workspace App Post Install	Installed Installed
<ul> <li>✓ Firewall</li> <li>✓ Summary</li> <li>✓ Install</li> </ul>	Component Initialization	Initialized
Finish		
	Restart marking	

# 8.5 Additional Virtual Machine Settings

Perform the following additional tasks on the virtual machine as required:



Note: To evaluate browser based HTML5 applications, consider using newer browsers that utilize hardware acceleration within virtual desktop environments.

Turn Off Windows Firewall for all network types.



CAUTION: THESE INSTRUCTIONS ASSUME THAT THE VM IS BEING USED AS A PROOF-OF-CONCEPT ONLY AND THAT DISABLING THE FIREWALL WILL THEREFORE POSE ONLY A MINIMAL SECURITY BREACH. ALWAYS FOLLOW YOUR ESTABLISHED SECURITY PROCEDURES AND BEST PRACTICES WHEN SETTING UP SECURITY FOR A PRODUCTION MACHINE OR ANY ENVIRONMENT THAT CAN BE ACCESSED FROM OUTSIDE YOUR NETWORK.

- Shut down the virtual machine once this is completed.
- Close the remote console; this will not be functional when vGPU is configured.

Note: Take a snapshot of the virtual machine to preserve your work. Label this snapshot prevGPU and revert to it if you encounter any problems going forward, such as driver issues.

# 8.6 Installing NVIDIA Driver in Windows Virtual Desktop

Start the appropriate driver for the GPU inside the VM. The following example shows the specific case for installation of the NVIDIA drivers with a M10 GPU.

1. Copy the 32-bit or 64-bit NVIDIA Windows driver package to the VM, open the zip file, and run setup.exe.



2. After a brief System Check, read through the EULA and select Agree and Continue.



3. Select the desired installation options and navigate to Next to continue.

dge	NVIDIA Installer	s Driver	x	
Bigrid.	Version 452.39 System Check Cicense Agreement Options Install Finish	Express (Recommended)     Upgrades existing drivers and retains current NVDA estings     Cyptom (Advanced)     Alows you to select the components you want to insta and provides the option for a clean installation.     Note: Some flashing might occur during the installation.		
-		BACK		

4. Wait for the installation to finish. Select Next to continue.



5. After the driver installation has completed, you may be prompted to reboot the VM. Select Restart Now to restart the VM. When the VM starts, it will boot to a Windows desktop.

koft. e		s Driver		-		
nid	Version 452.39	NVIDIA Instal	ler has finis	shed	NVIDIA	
	<ul> <li>License Agreement</li> <li>Options</li> <li>Install</li> <li>Finish</li> </ul>	Component NV/DIA WM Quadro View Graphics Driver	Veraion 2.35.0 200.93 452.39	Status Installed Installed Installed		
-					<u>C</u> LOSE	

6. To verify that the NVIDIA driver is running, right-click on the desktop and select NVIDIA Control Panel.

ecycle Bin			Î
Microsoft Edge			
22.39. grid_ n10. server		•	
016 server2 9,64bit int emational		View > Sort by > Refresh	
		Paste Paste shortcut	
		NVIDIA Quadro View New >	
manageme		<ul> <li>Display settings</li> <li>Personalize</li> </ul>	
P Type here to search	o 🖽 🔒 🛤 💼	9 🕻 4 🖂 8 🖏	^

7. In the NVIDIA Control Panel, select System Information. This interface shows the GPU Type in use by the VM, its features, and the NVIDIA driver version in use.

settings	NIVIDI	A				
Adjust image settings with preview Manage 3D settings	CONTROL PANE	Ê				
ensing Manage License	Version 452	System Information			×	
	GRID M10-	Oetailed information about	your NVIDIA hardware and the system it	's running on.	17	
		Display Components				
		System information	. N			
		Operating system: W	indows 10 ProJAS bit			
		DirectX runtime version: 12	.0			
		Bems	Details			
		GRID M10-8A.	Driver version: 452.39 Driver Type: Standard Direct3D API version: 12 Direct3D feature lev 11_0	4		
			Graphics clock: 1032 MH Memory data rate: 5.20 bit Memory bandwidth: 83,20 G Total available grap 10231 M	12 25. 1/5		
			Redenited unles me \$192 MD	About		
					_	
				Save	Close	

# 8.7 Licensing NVIDIA vGPU (Update 11.0)

NVIDIA vGPU is a licensed product. When booted on a supported GPU, a vGPU runs at reduced capability until a license is acquired. The performance of an unlicensed vGPU is restricted as follows.

Elapsed Time	Performance Degradation
20 minutes	<ul> <li>Frame rate is capped at 15 frames per second.</li> <li>The performance of applications and processes that use CUDA is degraded.</li> </ul>
24 hours	<ul> <li>Frame rate is capped at 3 frames per second.</li> <li>CUDA stops working and CUDA API function calls fail.</li> <li>GPU resource allocations for a vGPU are limited, which will prevent some applications from running correctly.</li> </ul>

These restrictions are removed when a license is acquired. After you license NVIDIA vGPU, the VM that is set up to use NVIDIA vGPU is capable of running all DirectX (up to and including DirectX12 and DX12-Raytracing on Turing architecture cards),OpenGL & Vulkan graphics applications.

If licensing is configured, the virtual machine (VM) obtains a license from the license server when a vGPU is booted on these GPUs. The VM retains the license until it is shut down. It then releases the license back to the license server. Licensing settings persist across reboots and need only be modified if the license server address changes, or the VM is switched to running GPU pass through.

Note: For complete information about configuring and using NVIDIA vGPU software licensed features, including vGPU, refer to <u>Virtual GPU Client Licensing User Guide</u>.

### 8.7.1.1 Licensing NVIDIA vGPU on Windows

- 1. Open NVIDIA Control Panel:
  - a) Right-click on the Windows desktop and select NVIDIA Control Panel from the menu.
  - b) Open Windows Control Panel and double-click the NVIDIA Control Panel icon.
- 2. In NVIDIA Control Panel, select the **Manage License** task in the **Licensing** section of the navigation pane.

Note: If the **Licensing** section and Manage License task are not displayed in NVIDIA Control Panel, the system has been configured to hide licensing controls in NVIDIA Control Panel. For information about registry settings, see <u>Virtual GPU Client Licensing User Guide</u>.

NVIDIA Control Panel		_ <b>D</b> X
<u>File Edit Desktop H</u> elp		
🕲 Back - 🕥 💰		
Select a Task	Manage License	-
Manage 3D settingsSet PhysX ConfigurationDisplay	You can enable additional features by applying a license.	
Set up multiple displays	Vour system does not have a valid GRID vGPU license. To access GRID vGPU features, enter license server details and apply.	
Adjust video color settings Adjust video image settings	Primary License Server:	
	Port Number:	E
	Secondary License Server:	
	Port number:	
	Description:	
<u></u>	Typical usage scenarios:	
System Information	۳	

#### The Manage License task pane shows that NVIDIA vGPU is currently unlicensed.

- 3. In the **Primary License Server** field, enter the address of your primary NVIDIA vGPU software License Server. The address can be a fully qualified domain name such as gridlicense1.example.com, or an IP address such as 10.31.20.45. If you have only one license server configured, enter its address in this field.
- 4. Leave the **Port Number** field under the **Primary License Server** field unset. The port defaults to 7070, which is the default port number used by NVIDIA vGPU software License Server.
- In the Secondary License Server field, enter the address of your secondary NVIDIA vGPU software License Server. If you have only one license server configured, leave this field unset. The address can be a fully qualified domain name such as gridlicense2.example.com, or an IP address such as 10.31.20.46.
- 6. Leave the **Port Number** field under the **Secondary License Server** field unset. The port defaults to 7070, which is the default port number used by NVIDIA vGPU software License Server.
- 7. Click **Apply** to assign the settings. The system requests the appropriate license for the current vGPU from the configured license server.
- 8. The vGPU within the VM should now exhibit full frame rate, resolution, and display output capabilities. The VM is now capable of running the full range of DirectX and OpenGL graphics applications.
- 9. If the system fails to obtain a license, see <u>Virtual GPU Client Licensing User Guide</u> for guidance on troubleshooting.

# Chapter 9. Creating a Citrix Machine Catalog

This chapter describes the following:

- Creating a Citrix Machine Catalog using Citrix Machine Creation Services (MCS) to deploy a Virtual Desktop
- Creating a Citrix Machine Catalog using Citrix Machine Creation Services (MCS) to deploy a Virtual Application

To create a pool of virtual machines for users to remotely access, a Citrix Machine Catalog must be configured and deployed via Citrix Studio. The Citrix Virtual Delivery Agent configured in the previous chapters to build out a pool of VMs. This chapter outlines how to create the pool of VMs by building a Citrix Machine Catalog with Citrix Machine Creation Services (MCS).

Note: Other machine deployment technologies are available like Citrix Provisioning (PVS) and is outside the scope of this document.

Please refer to Citrix product documentation for additional information regarding <u>machine catalog</u> and <u>deliver group</u> creation.

Part of creating a Citrix Machine Catalog involves choosing the correct type of operating system for your deployment. Citrix groups operating systems into three categories:

- Single-Session OS
  - Single-Session OS deployments allow for publishing only the Desktop or only the Application, but not within a single Citrix Machine Catalog.
- Multi-Session OS
  - Multi-Session OS deployments allow for the publishing of multiple desktops or multiple applications, as well as both desktops and applications within a single Citrix Machine Catalog.
- Remote PC Access.
  - Remote PC Access is outside the scope of a vGPU deployment.

Additionally, consult Citrix and your ISV partners to determine the best deployment method for your environment.

# 9.1 Creating a Citrix Machine Catalog for Virtual Desktops and Apps

1. Log on to the Citrix Delivery Controller and Launch Citrix Studio from the Windows Start Menu



- 2. On the left menu panel, click Machine Catalogs.
- 3. Under the Actions Menu on the Right, click Create Machine Catalog.

Console Root	CITDIN					Actions
Citrix Studio (Citrix)	CIIRIN					Machine Catalogs
<ul> <li>Machine Catalogs</li> <li>AppDisks</li> <li>Delivery Groups</li> <li>Applications</li> <li>Policies</li> <li>Configuration</li> <li>Administrators</li> <li>Controllers</li> <li>Hosting</li> <li>StoreFront</li> <li>StoreFront</li> <li>AppDNA</li> <li>Zones</li> <li>Stores</li> <li>Server Group</li> </ul>	Machine Catalog	* M	achine type	No. of machines	Allocated machin	<ul> <li>Create Machine Catalog View</li> <li>Refresh</li> <li>Help</li> </ul>

- 4. On the Introduction page click **Next**.
- 5. On the Operating System select either the **Single-session OS** radio button or the **Multi-session OS** radio button, in accordance with your VDA's operating system and NVIDIA vGPU licensing level.

Studio	Operating System
Introduction Operating System Machine Management Desktop Experience Master Image Virtual Machines Computer Accounts Summary	<ul> <li>Select an operating system for this Machine Catalog.</li> <li>Multi-session OS The multi-session OS machine catalog provides hosted shared desktops for a large-scale deployment of standardized Windows multi-session OS or Linux OS machines.</li> <li>Single-session OS The single-session OS machine catalog provides VDI desktops ideal for a variety of different users.</li> <li>Remote PC Access The Remote PC Access machine catalog provides users with remote access to their physical office desktops, allowing them to work at any time.</li> <li>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.</li> </ul>

Citrix groups operating systems into three categories:

- Single-Session OS deployments allow for publishing only the Desktop or only the Application, but not within a single Citrix Machine Catalog.
- Multi-Session OS deployments allow for the publishing of multiple desktops or multiple applications, as well as both desktops and applications within a single Citrix Machine Catalog.
- Remote PC Access is outside the scope of a vGPU deployment. Additionally, consult Citrix and your ISV partners to determine the best deployment method for your environment.

Please refer to Citrix product documentation for additional information regarding machine catalog creation.

6. On the Machine Management Page, ensure the Machines that are power managed (for example, virtual machines or blade PCs) radio button is selected, as well as the Another service or technology radio button and click Next.

tudio	Machine Management
	This Machine Catalog will use:
Introduction	Machines that are power managed (for example, virtual machines or blade PCs) Machines that are not power managed (for example, physical machines)
Machine Management	Deploy machines using:
Desktop Experience	Citrix Machine Creation Services (MCS)
Virtual Machines Summary	MCS is not available because you have not specified any storage and networking resources. Add resources in the Hosting node under Configuration.
	Another service or technology I am not using Citrix technology to manage my machines. I have existing machines already prepared.
	Note: For Linux OS machines, consult the administrator documentation for guidance.

7. On the Desktop Experience window, choose which type of desktop experience you would like. For purposes of POC/trail, chose I want users to connect to the same (static) desktop each time they log on.

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>Virtual Machines</li> <li>Summary</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> </ul>	
		5
	Pack Nevt Care	al

Machine Catalog Setup

8. On the Virtual Machines and Users window, select your previously created master image VM with the Citrix VDA installed by clicking, **Add VMs...**.

#### Machine Catalog Setup

Studio	Import or add virtual machines, their computer Ac them to users:	ctive Directory acc	counts, and opti	ionally assign
Introduction	VM name 🕴 Computer AD account		User name	s
Operating System	Windows 10 (64-b	nake 🖡		
Machine Management				
P Desktop Experience				
VMs and Users				
Summary	Remove	Import list	Export list	Add VMs.
Summary	Remove Select the minimum functional level for this catalog:	Import list 7.9 (or newe	Export list	Add VMs
Summary	Remove Select the minimum functional level for this catalog: Machines will require the selected VDA version (or that reference this machine catalog. Learn more	Import list 7.9 (or newer r newer) in order	Export list r) to register in De	Add VMs

- 9. Provide the Computer AD account name and usernames or accounts that will require access.
- 10. In the **Select the minimum functional level for this catalog:** drop-down menu ensures the latest functional level available is selected and click, **Next**.

Selecting a minimum function level lower than is available will result in a loss of new feature sets that may benefit or be required for you deployment needs.

11. On the Summary window, type a name for your Machine Catalog in the **Machine Catalog name:** text field.

Studio	Summary	
	Machine type:	Single-session OS
Introduction	Machine management:	Virtual
Operating System	Provisioning method:	Another service or technology
Machine Management	Desktop experience:	Users connect to the same desktop each time they log on
Desktop Experience	Number of machines added:	1
VMs and Users	VDA version:	7.9 (or newer)
Summary	Scopes:	
	Zone:	Primary
	Machine Catalog name:	
	Example: Windows 7 SP1 Sales -	2GB
	Machine Catalog description for	r administrators: (Optional)
	Example: Windows 7 SP1 deskto	ps for the London Sales office
	To complete the deployment, ass Delivery Groups and then Create	ign this Machine Catalog to a Delivery Group by selecting or Edit a Delivery Group.
		Pack Cancel

12. Click Finish.

# Chapter 10. Creating a Citrix Delivery Group

This chapter describes the following:

- Creating a Citrix Delivery Group to Deploy a Virtual Desktop
- Creating a Citrix Delivery Group to Deploy a Virtual Application

For users to remotely access virtual applications and desktops, a Citrix Delivery Group must be configured and deployed via Citrix Studio. The Citrix Virtual Delivery Agent and the Citrix Machine Catalog created and configured in the previous chapters to build out the Delivery group.

# 10.1 Creating a Citrix Delivery Group for Virtual Desktops

Now that you have a Citrix Machine Catalog created, the next step is to create a Delivery Group so that users can access the resource, in this case a Virtual Desktop.

- 1. Log on to the Citrix Delivery Controller and Launch Citrix Studio from the Windows Start Menu
- 2. On the left menu pane, click **Delivery Groups**.
- 3. On the right Actions menu, click Create Delivery Groups.

😫 Citrix Studio					- 0	×
File Action View Help						
Console Root V II Citrix Studio (Citrix)	CITRIX.	-			Actions	
<ul> <li>Search</li> <li>Machine Catalogs</li> <li>AppDisks</li> <li>Delivey Groups</li> <li>Applications</li> <li>Policies</li> <li>Configuration</li> <li>Administrators</li> <li>Controllers</li> <li>Hosting</li> <li>Licensing</li> <li>Stores</li> <li>Zones</li> <li>Stores</li> <li>Server Group</li> </ul>	Delivery Group	4 Delivering	No. of mac Sessions in	AppDisis	<ul> <li>Create Delivery Group View</li> <li>Refresh</li> <li>Help</li> </ul>	•

- 4. On the Introduction window, click **Next**.
- 5. On the Machines window, select the Machine Catalog that you created in the previous section and click **Next.**

Studio	Machines		
	Select a Machine Catalog.		
/ Introduction	Catalog	Type	Machines
Machines	Cix-vai	VDF Manual Static Local P	JISK I
Machine allocation			
Delivery Type			
Users			
Desktop Assignment Rules			
Summary			
	Machines assigned to users:	i	p
	Select specific machines that have	been assigned to users on the follow	ving screen.

6. On the Machine allocation window, enter your machine name and the usernames of the accounts that will require access to the desktop and click **Next.** 

Create	Delivery	Group
--------	----------	-------

	Machine name	Users	
Introduction	7984279-00	Triffpaller,	
Machines			
Machine allocation			
Delivery Type			
Users			
Desktop Assignment Rules			
Summary			
_			

7. On the Delivery Type window, leave the **Desktops** radio button selected and click **Next.** 

reste Delivery Group	
Studio Introduction Machines Delivery Type Users Desktop Assignment Rules Summary	Delivery Type You can use the machines in the Catalog to deliver desktops or applications to your users. Use the machines to deliver:
	Back Never Cancel

Because we previously chose a Machine Catalog type of "Single-Session OS" we must choose between deploying an application or a desktop. Had we created a Machine Catalog with a type of "Multi-Session OS," we would have had the option to deploy a desktop and an application.

Please refer to Citrix product documentation for additional information regarding <u>machine catalog</u> and <u>deliver group</u> creation.

Note: For NVIDIA vApps you can use Citrix Virtual Apps with a multi-session OS, and for NVIDIA vPC and RTX vWS you can use Citrix Virtual Desktop and is limited to single-session OS.

8. On the Users window, specify which users can access this delivery group. For POC/trial purposes leave the **Allow any authenticated users to use this Delivery Group**. radio button selected.



#### 9. Click Next

10. On the Desktop Assignment Rules window, click Add... Create Delivery Group

tudio	Desktop Assignment Rules Add users or groups who will be assigned a machine when they launch the desktop. When a machine is assigned to a user, it remains with that user, even if you later edit the Delivery Group
Introduction	and remove the assignment rule below.
Machines	Add assignments
Delivery Type	
Users	
Desktop Assignment Rules	
Summary	
	Add. Edit. Remove.

- 11. The Add Desktop Assignment Rule pops up. In the **Display name:** text field type a name for the Desktop that users will see.
- 12. For POC/trial purposes, leave the Allow everyone with access to this Delivery Group to have desktop assigned radio button selected.

	Display name:	Win 10	
tudio	Description:	Example: Assigned desktops for Finance Dept.	
		The name and description are shown in Citrix Workspace app.	hen a
Introduc	<ul> <li>Allow everyo</li> </ul>	ne with access to this Delivery Group to have a desktop assigned	
Machine	Restrict desk	op assignment to:	
Delivery	Add us	ers and groups	0
Users			
Rules			
Summar			
			1
	Add_	Remove	
	Maximum deskt	ops për usën: 1 - +	
	Enable deskt	op assignment rule	1

13. Select the Enable desktop assignment rule check box and click OK.

itudio	Desktop Ass Add users or g machine is ass	ignmen groups wi	t Rules ho will be assigned a machi a user, it remains with that most rule below	ne when they launch the desktop. When i user, even if you later edit the Delivery G
<sup>e</sup> Introduction <sup>e</sup> Machines	Name	4	Users	Desktops per user
Delivery Type	Win 10		All Delivery Group users c	an 1
Summary				

15. On the Summary window, type a name for the Delivery Group in the Delivery Group name: text field and click **Finish** to complete the creation of the Delivery Group.

14. Click, Next.

Create Delivery Group

Studio	Summary	
<ul> <li>Introduction</li> <li>Machines</li> <li>Machine allocation</li> <li>Delivery Type</li> <li>Users</li> <li>Desktop Assignment Rules</li> <li>Summary</li> </ul>	Machine Catalog: Machine type: Allocation type: Machines added: Delivery type: Users: Desktop assignment rules: Launch in user's home zone:	ctx-vdi Single-session OS Static TME\CTX-VDI 1 assigned to users Desktops Allow authenticated users Win 10 No
	Delivery Group name:	
	Citrix	
	Delivery Group description, used	d as label in Citrix Workspace app (optional):

# 10.2 Creating a Citrix Delivery Group for Virtual Applications

Now that you have a Citrix Machine Catalog created, the next step is to create a Delivery Group so that users can access the resource, in this case a Virtual Application.

- 1. Log on to the Citrix Delivery Controller and Launch Citrix Studio from the Windows Start Menu
- 2. On the left menu pane, click **Delivery Groups**.
- 3. On the right Actions menu, click Create Delivery Groups.

🗱 Citrix Studio				- 0	×
File Action View Help					
Console Root	CITRIX			Actions	
Search	and the second se			Delivery Groups	۲
Machine Catalogs AppDisks Delivery Groups Applications Policies Confrollers Controllers Hosting Controllers Hosting Controllers StoreFront App-V Publishing App-V Publishing Controllers StoreFront Controllers StoreFront Controllers Con	Delivery Group	4 Delivering	No. of mac Sessions in AppDis	is Create Delivery Group View Refresh Create Delivery Group	•

- 4. On the Introduction window, click **Next**.
- 5. On the Machines window, select the Machine Catalog that you created in the previous section and choose how many machines will be included in this delivery group. For POC/trial purposes, we choose 1 machine.

10-10 I	Select a Machine Catalon		
	Catalog	Туре	Machines
Introduction	Sample Application	RDS Manual Random	1
Machines			
Machine allocation			
Users			
Applications			
Desktop Assignment Rules			
Summary			
	Choose the number of machines for th	his Delivery Group: 1	- +
	Choose the number of machines for th	his Delivery Group: 1	-+

- 6. Click Next.
- 7. On the Users window, specify which users can access this delivery group. For POC/trial purposes leave the **Allow any authenticated users to use this Delivery Group**. radio button selected.

S	Users
✓ Introduction ✓ Machines Users Applications Desktops Summary	Specify who can use the applications and desktops in this Delivery Group. You can assign users and user groups who log on with valid credentials. Alternatively or additionally, you can enable access for unauthenticated users. <ul> <li>Allow any authenticated users to use this Delivery Group.</li> <li>Restrict use of this Delivery Group to the following users:</li> </ul> Add users and groups
	Add Remove Give access to unauthenticated (anonymous) users; no credentials are required to access ScoreFront This feature requires a StoreFront store for unauthenticated users. Sessions must launch in a user's home zone, if configured.

8. On the Application window, select the **Add...** dropdown menu.

Studio	Applications
✓ Introduction ✓ Machines ✓ Users Applications Desktops Summary	To add applications, click "Add" and choose a source. Then select applications from that source If you choose Application Groups, all current and future applications in the selected groups wi be added. You can also place new applications in a non-default folder and change application properties.
	Add Remove Properties Place the new applications in folder: Applications\ Change

9. Select Manually...

Studio	Applications
Introduction	To add applications, click "Add" and choose a source. Then select applications from that source If you choose Application Groups, all current and future applications in the selected groups w be added. You can also place new applications in a non-default folder and change application properties.
/ Users	Add applications
Applications	
Desktops	
Summary	
	and a second
	Add
	Add + Remove Properties From start menu
	Add Remove Properties From start menu Migually
	Add

10. On the Add Applications Manually popup window, type a path to the executable, an application name for users and an application name for administrators, then Click **OK**.

	Add Applications Manually		
Studio			
	Add an Application Manually		from that source
			lected groups will
Introduction	different network location.	mom a	ange application
Machines	Path to the executable file:		
P Users	C:\Windows\System32\notepad.exe	Browse	1 million 1
Applications	Command line argument (optional):		100000
Desktops Summary	Example: http://www.example.com		100.000
	Working directory:		19 N.
	Example: %ProgramFiles(x86)%Unternet Explarer	Browse	
	Application name (for user):		
	Sample Application		
	Application name (for administrator):		
	Sample Application		
		Canad	

11. Click Next

	Applications	
Introduction	To add applications, click "Add" and choose a source. Then select applications If you choose Application Groups, all current and future applications in the sel be added. You can also place new applications in a non-default folder and cha properties.	from that source ected groups will inge application
* Machines	Name	
Applications	Sample Application	
Desktops		
Summary		
	Add * Remove Proposties	
	Add   Remove Properties  Place the new applications in folder:	
	Add   Remove Properties.  Place the new applications in folder:  Applications\	

12. On the Desktops window, click Next.

	Desktops	
	Add users or groups who can launch a desktop from this Delivery G	iroup.
Introduction	Add assignments	
* Machines		
P Users		
<ul> <li>Applications</li> </ul>		
Desktops		
Summary		

Because we previously chose a Machine Catalog type of "Multi-Session OS" we have the option to deploy both Applications and Desktops. Had we created a Machine Catalog with type of "Single-Session OS," we would have only been able to deploy an application or a desktop. This section focuses on Application deployment, so we choose to not deploy a desktop.

Please refer to Citrix product documentation for additional information regarding <u>machine catalog</u> and <u>deliver group</u> creation.

13. On the Summary window, type a name for the Delivery Group in the **Delivery Group name:** text field and click **Finish** to complete the creation of the Delivery Group.

Studio	Summary	
	Machine Catalog:	Sample Application
Introduction	Machine type:	Multi-session OS
Machines	Allocation type:	Random
Users	Machines added:	PE\JJC-NVECTMSF 1 unassigned
Applications	Users:	Allow authenticated users
Desktops	Applications to add:	Sample Application
Summary	Folder for new applications:	Applications
	Launch in user's home zone:	No
	Delivery Group name:	
	Sample Application	
	Delivery Group description, used	d as label in Citrix Workspace app (optional):
# Chapter 11. Creating Citrix Policies for NVIDIA vGPU

This chapter describes the following:

- Creating a Citrix Policy for NVIDIA vGPU
- Creating a Microsoft Policy

A vGPU is not automatically accessible to a Citrix session. Both Citrix and Microsoft policies must be configured for a Citrix session to utilize the vGPU.

## 11.1 Creating a Citrix Policy for NVIDIA vGPU

The Citrix HDX 3D Pro protocol can utilize NVIDIA NVENC (Hardware-Accelerated Video Encoding). In order to utilize NVENC, the Optimize for 3D graphics workload Citrix Policy must be enabled.

Your full Citrix policy set depends on multiple parameters like application requirements, bandwidth requirements, & image quality requirements, etc. Only enabling the Optimize for 3D graphics workloads policy is only sufficient for a POC/trail purpose. Consult Citrix and your application partners to ensure you full Citrix Policy set is optimized for you deployment needs.

Additionally, refer to the Graphics Section of the <u>Citrix Virtual Apps and Desktop Product Documentation</u> for additional details.

- 1. Log on to the Citrix Delivery Controller
- 2. Launch Citrix Studio from the Windows Start Menu
- 3. Select **Policies** on the left menu pane, then select **Create Policy** on the right-side Action menu.

🔶 🕿 🔟 🔛			
Console Root  Contraction  Configuration  Configuration  Configuration  Configuration  Administrators  Controllers  Controllers  Apply Administrators  Apply Debining  Apply Publishing  Apply	CITRIX		Actions
	cineta		Policies
	Policies Templates Comparison M	pdeing	Create Policy
	Policies		View G Refresh
	Folicies	Untilitered	Help
	1 Unfiltered	Overview Settings Assigned to	Unfiltered
		Name:         Untiltered           Paintry:         3           Status:         Enabled           Description:         This is the system-created default policy, it cannot be deleted. Note that its settings will apply to all somections.	<ul> <li>Edit Policy-</li> <li>Disable Policy</li> <li>Save as Template_</li> <li>Holp.</li> </ul>

4. Search for **Optimize for 3D graphics workload** and click **Select**.

	Transferration of the second	11	
	(All Versions) ×	All Settings	Optimize for 3D X
Settings	Settings: 0 selected		View selected on
Users and Machines	<ul> <li>Optimize for 3D grap User setting - ICA\Grap</li> </ul>	nhics workload	Select
Summary	Not Configured (Defa	ult: Disabled)	

5. On the Edit Settings popup window, select the **Enabled** radio button and click **OK**.

Create Policy

lio	ant setting	
	Optimize for 3D graphics workload	
ings rs an mar	<ul> <li>Enabled This setting will be enabled.</li> <li>Disabled This cattion will be disabled</li> </ul>	ecte S
	<ul> <li>Applies to the following VDA versions</li> <li>Virtual Delivery Agent: 7.16 Server OS, 7.16 Desktop OS, 7.17 Server OS, 7.17 Desktop OS, 7.18</li> <li>Server OS, 7.18 Desktop OS, 1808 Server OS, 1808 Desktop OS, 1811 Server OS, 1811 Desktop OS, 1903 Server OS, 1903 Desktop OS, 1906 Desktop OS, 1909 Multi-session OS, 1909 Single-session OS, 1912 Multi-session OS, 1912 Single-session OS</li> </ul>	
	Description     This setting will configure appropriate default settings best suited for graphically intense     workloads. Enable this setting for users whose workload will focus on graphically intense     applications. This policy should only be applied in cases where a GPU is available to the session.     Any other settings that explicitly override the default settings set by this policy will take     precedence.	
	▼ Related settings	
	OK Cancel	

- 6. Click Next
- Select the appropriate machines to apply the policy to. For POC/trial purposes, select the All objects in the site radio button and click Next.
   Create Policy

Studio	Assign policy to	California and an other
	Selected user and machine objects	• All objects in the site
' Settings		
Users and Machines		
Summary		

8. Check the **Enable policy** checkbox and provide a name for the policy.

Studio	Summary View a summa	ry of the settings you configure	d and provide a name for your	new policy.
✓ Settings ✓ Users and Machines	Policy name: Description:	Policy0		Enable polic
Summary	1			
	Settings config	ured: 1	Assigned to: user and mach	ine objects
	Optimizz User setti Enabled	e for 3D graphics workload ing = ICA(Graphics (Default: Disabled)	The settings are applied to site.	all objects in the

#### 9. Click Finish

Note: There are several policies within Citrix Studio that affect performance and the efficient use of Virtual GPUs. Policies such as **Use Video Codec for Compression**, **Use hardware encoding for video codec** and **Target Frame Rate**.

Please refer to the following Citrix document which refers to these settings in more detail:

https://docs.citrix.com/en-us/tech-zone/design/design-decisions/hdx-graphics.html

### 11.2 Creating Microsoft Group Policy for NVIDIA vGPU

On Windows Server 2016 and Windows Server 2012 R2, Remote Desktop Services (RDS) sessions on a RD Session Host server use the Microsoft Basic Render Driver as the default adapter. To use the virtual GPU in RDS sessions and Citrix HDX 3D Pro sessions enable the **Use the hardware default graphics adapter for all Remote Desktop Services sessions** setting in the group policy.

Local Computer Policy > Computer Configuration > Administrative Templates > Windows Components > Remote Desktop Services > Remote Desktop Session Host > Remote Session Environment.

### Chapter 12. Citrix Workspace App

Before connecting to a virtual application or desktop over a Citrix HDX connection, the Citrix Workspace App will need to be installed and configured onto a desktop or device which the virtual desktop will be accessed from. For this guide, connect to the Citrix StoreFront and use the web site which can detect and download the receiver.

#### 12.1 Locating Citrix StoreFront Web Site

- 1. Locate the Citrix Storefront URL by opening **Citrix Studio** from the Windows menu on your Citrix Delivery Controller Server.
- 2. Expand Citrix StoreFront on the left menu pane and Select Stores.
- 3. Highlight the Store for your deployment in the top menu pane and select the **Receiver for Web Sites** tab under the Details section.
- 4. Right Click the URL and select Copy URL.



# 12.2 Installing Citrix Workspace App

1. Log into the physical device where you will be launching the virtual desktop from and open an internet browser. Navigate to the Citrix Storefront URL you previously copied in step 11.1.4. Click on **Detect Receiver**.

citrix Receiver	Welcome to Citrix Receiver Use Citrix Receiver to access your applications and desktops. Detect Receiver	

2. Review the Citrix license agreement and check the I agree with the Citrix license agreement checkbox and select **Download**.

citrix Receiver	Just a moment, we're detecting if Citrix Receiver is already installed. If Citrix Receiver is detected, you will see a window in a few seconds. Please choose Launch Application. If no window appears, proceed to download. If no window appears, proceed to download. I agree with the Citrix license agreement Dovgaload

3. Locate the downloaded installer program and double click to begin installation.



4. Click **Start** to begin the installation.

	Welcome to Citrix Workspace
	Citrix Workspace app installs software that allows access to virtual applications that your organization provides, including software that allows access to the applications that use your browser.
Workspace	<ul> <li>Allow applications access to your webcam and microphone.</li> <li>Allow applications to use your location.</li> <li>Allow access to local applications authorized by your company.</li> <li>Save your credential to sign in automatically.</li> </ul>
	Click Start to set up and install Citrix Workspace app on your computer.
CITRIX	

5. Select the I accept the license agreement check box and click Next.

#### License Agreement

You must accept the license agreement below to proceed.

CITRIX LICENSE AGREEMENT

Use of this component is subject to the Citrix license or terms of service covering the Citrix product(s) and/or service(s) with which you will be using this component. This component is licensed for use only with such Citrix product(s) and/or service(s).

CTX\_code EP\_R\_A10352779

I accept the license agreement

Next Cancel

6. Click Install

When enabled, single sign-on remembers your credentials for this device, so that you can connect to other Citrix applications without having to sign in each time. You should do this only if
your IT administrator has instructed you to. This will take effect the next time you log on to this device.
Enable single sign-on
For more information on configuring single sign-on, please see
Install Cancel
<b>ish</b> to complete the install.
rkspace
itrix.

Add Account

Finish

2

# 12.3 Launch a Citrix Virtual Desktop

1. Navigate back to the Citrix StoreFront web browser window and click Continue.

citrix Receiver	Install Citrix Receiver on your machine when the download is complete. Once you've installed Citrix Receiver, return here and click Continue.
--------------------	---

2. Enter a username and password.

citrix	domain\user or user@domain.com
StoreFront	Log On

3. Click **Desktops** in the top menu and select your desktop.

Citrix StoreFront	រិភិ HOME	DESKTOPS
Desktops All (1) Favorites (0)		
JJC-MS		

# Chapter 13. Troubleshooting

This section includes links and examples of where to explore and post in order to find solutions or assistance.

Note: Before troubleshooting or filing a bug report, review the release notes for information about known issues with the current release, and potential workarounds.

#### 13.1 Forums

- NVIDIA forums are a very inclusive source of solutions to many problems that may be faced when deploying a virtualized environment. Please search on the NVIDIA forums located here first:
- https://gridforums.nvidia.com/
- You may also wish to look through the NVIDIA Enterprise Services Knowledgebase to further find support articles and links here:
- https://nvidia-esp.custhelp.com/app/answers/list/autologout/1
- Keep in mind that not all issues within your deployment may be answered in the NVIDIA vGPU forums. You may also have to reference forums from the hardware supplier, the hypervisor and application themselves. Some examples of key forums to look through are here:
  - Citrix Forums: <u>https://discussions.citrix.com/</u>
  - HPE ProLiant Server Forums: <u>https://community.hpe.com/t5/ProLiant/ct-p/proliant</u>
  - Dell Server Forums: <u>https://www.dell.com/community/Servers/ct-p/ESServers</u>
  - Lenovo Server Forums: <u>https://forums.lenovo.com/t5/Datacenter-Systems/ct-p/sv\_eg</u>
  - Autodesk Knowledge Network: <u>https://knowledge.autodesk.com/</u>
  - Adobe Forums: <u>https://forums.adobe.com/welcome</u>
  - Dassault Systèmes User Groups: <u>https://www.3ds.com/support/users-communities/</u>

#### 13.2 Filing a Bug Report

When filing a bug or requesting support assistance, it is critical to include information about the environment, so that the technical staff that can help you resolve the issue. NVIDIA includes the

nvidia-bug-report.sh script within the. vib installation package to collect and package this critical information. The script collects the following information:

- Citrix version
- X.Org log and configuration
- PCI information
- CPU information
- GPU information
- esxcfg information for PLX devices
- **esxcfg** information for GPU devices
- VIB information
- NVRM messages from vmkernel.log
- System **dmesg** output
- Which virtual machines have vGPU or vSGA configured
- NSMI output

When running this script:

- You may specify the output location for the bug report using either the -o or –output switch followed by the output file name. If you do not specify an output directory, the script will write the bug report to the current directory.
- ▶ If you do not specify a file name, the script will use the default name nvidia-bug-report.log.gz.
- If the selected directory already contains a bug report file, then the script will change the name of that existing report file to nvidia-bug-report.log.old.gz before generating a new nvidia-bugreport.log.gz file.

To collect a bug report, issue the command:

\$ nvidia-bug-report.sh

The system displays the following message during the collection process:

nvidia-bug-report.sh will now collect information about your system and create the file 'nvidia-bug-report.log.gz' in the current directory. It may take several seconds to run. In some cases, it may hang trying to capture data generated dynamically by the vSphere kernel and/or the NVIDIA kernel module. While the bug report log file will be incomplete if this happens, it may still contain enough data to diagnose your problem.

Be sure to include the nvidia-bug-report.log.gz log file when reporting problems to NVIDIA.

# Appendix A. About This Document

#### A.1 Related Documentation

Refer to the NVIDIA Virtual GPU (vGPU) resources page <u>http://www.nvidia.com/gridresources</u> for additional information about NVIDIA vGPU technology, including:

- NVIDIA Virtual GPU Technology
- https://www.nvidia.com/en-us/design-visualization/technologies/virtual-gpu/
- Purchasing Guide for NVIDIA vGPU Solutions
- https://www.nvidia.com/en-us/design-visualization/buy-grid/
- NVIDIA GPU Datasheets
- <u>http://www.nvidia.com/object/grid-enterprise-resources.html#datasheet</u>
- Application Deployment Guides and Solution Overviews
- http://www.nvidia.com/object/grid-enterprise-resources.html#guides
- Customer Success Stories
- <u>http://www.nvidia.com/object/grid-enterprise-resources.html#case</u>
- White Papers
- <u>http://www.nvidia.com/object/grid-enterprise-resources.html#whitepapers</u>
- Videos <u>http://www.nvidia.com/object/grid-enterprise-resources.html#videos</u>

#### A.2 Support Contact Information

For technical support you should reach out to your local Citrix and NVIDIA vGPU teams for guidance.

For support when architecting your solution, your Citrix and NVIDIA vGPU teams are available to assist. Please be sure you are in touch with them and keep them up to date with your progress. If you do not know your correct account management teams, please reach out to the appropriate email below:

NVIDIA vGPU team: gridteam@nvidia.com

The NVIDIA vGPU resources page includes additional contact methods to help you get the answers you need as soon as possible.

# Appendix B. Installing & Licensing NVIDIA Driver in Linux Virtual Desktop

### B.1 Installing NVIDIA Driver in Linux Virtual Desktop

- Installation in a VM: After you create a Linux VM on the hypervisor and boot the VM, install the NVIDIA vGPU software display driver in the VM to fully enable GPU operation.
- Installation on bare metal: When the physical host is booted before the NVIDIA vGPU software display driver is installed, the vesa Xorg driver starts the X server. If a primary display device is connected to the host, use the device to access the desktop. Otherwise, use secure shell (SSH) to log in to the host from a remote host. If the Nouveau driver for NVIDIA graphics cards is present, disable it before installing the NVIDIA vGPU software display driver.

Installation of the NVIDIA vGPU software display driver for Linux requires:

- Compiler toolchain
- Kernel headers
- 1. Copy the NVIDIA vGPU software Linux driver package, for example NVIDIA-Linux\_x86\_64-390.75grid.run, to the guest VM or physical host where you are installing the driver.
- 2. Before attempting to run the driver installer, exit the X server and terminate all OpenGL applications.
  - a) On Red Hat Enterprise Linux and CentOS systems, exit the X server by transitioning to runlevel 3:

[nvidia@localhost ~]\$ sudo init 3

- b) On Ubuntu platforms, do the following:
  - i) Use CTRL-ALT-F1 to switch to a console login prompt.
  - ii) Log in and shut down the display manager:

[nvidia@localhost ~]\$ sudo service lightdm stop

3. From a console shell, run the driver installer as the root user.

sudo sh ./ NVIDIA-Linux\_x86\_64-352.47-grid.run

In some instances, the installer may fail to detect the installed kernel headers and sources. In this situation, re-run the installer, specifying the kernel source path with the --kernel-source-path option:

sudo sh ./ NVIDIA-Linux\_x86\_64-352.47-grid.run \
 -kernel-source-path=/usr/src/kernels/3.10.0-229.11.1.el7.x86\_64

4. When prompted, accept the option to update the X configuration file (xorg.conf).

NVIDIA Accelerated Gr	aphics Driver f	or Linux-x86_64 (352.47)
Would you like to run the nvi your X configuration file so restart X? Any pre-existing	dia-xconfig uti that the NVIDIA X configuration	lity to automatically update X driver will be used when you file will be backed up.
Yes		No
NVIDIA Software Installer for	• Unix/Linux	www.nvidia.com

- 5. Once installation has completed, select **OK** to exit the installer.
- 6. Verify that the NVIDIA driver is operational.
  - a) Reboot the system and log in.
  - b) Run nvidia-settings.

[nvidia@localhost ~]\$ nvidia-settings

The NVIDIA X Server Settings dialog box opens to show that the NVIDIA driver is operational.



 Installation in a VM: After you install the NVIDIA vGPU software display driver, you can license any NVIDIA vGPU software licensed products that you are using. For instructions, refer to <u>Virtual</u> <u>GPU Client Licensing User Guide</u>.

# B.2 Licensing NVIDIA vGPU on Linux

- 1. Start NVIDIA X Server Settings by using the method for launching applications provided by your Linux distribution. For example, on Ubuntu Desktop, open the Dash, search for NVIDIA X Server Settings, and click the **NVIDIA X Server Settings** icon.
- 2. In the NVIDIA X Server Settings window that opens, click **Manage NVIDIA License**. The License Edition section of the NVIDIA X Server Settings window shows that NVIDIA vGPU is currently unlicensed.
- 3. In the **Primary Server** field, enter the address of your primary NVIDIA vGPU software License Server. The address can be a fully qualified domain name such as gridlicense1.example.com, or an IP address such as 10.31.20.45. If you have only one license server configured, enter its address in this field.
- 4. Leave the **Port Number** field under the **Primary Server** field unset. The port defaults to 7070, which is the default port number used by NVIDIA vGPU software License Server.
- 5. In the **Secondary Server** field, enter the address of your secondary NVIDIA vGPU software License Server. If you have only one license server configured, leave this field unset. The address can be a fully qualified domain name such as gridlicense2.example.com, or an IP address such as 10.31.20.46.
- 6. Leave the **Port Number** field under the **Secondary Server** field unset. The port defaults to 7070, which is the default port number used by NVIDIA vGPU software License Server.

- 7. Click **Apply** to assign the settings. The system requests the appropriate license for the current vGPU from the configured license server.
- 8. The vGPU within the VM should now exhibit full frame rate, resolution, and display output capabilities. The VM is now capable of running the full range of DirectX and OpenGL graphics applications.
- 9. If the system fails to obtain a license, see <u>Virtual GPU Client Licensing User Guide</u> for guidance on troubleshooting.

# Appendix C. GPU Resource Allocation

#### C.1 vGPU Assignment

This chapter covers how VM's vGPUs will be allocated across the available physical GPUs in a host.

- vGPU Placement Policy
- Integrated GPU-pass-through
- Which vGPU Profiles are allowed on physical GPUs
- 1. Select the host server in the left resources pane. Navigate to the GPU tab. All physical GPU and vGPU resources available will display.



NVIDIA Corporation | 2788 San Tomas Expressway, Santa Clara, CA 95051 http://www.nvidia.com

Search Q	G Ci	trix Hype	ervisor T	est (	Licens	ed with	Citrix	Virtua	al App	s and D	esktop	s Premium)	Logged in as: Local root accou
AvenCenter     Citrix Hypervisor Test     Win10_vGPU     Win10_vGPU     Windows 10 (64-bit) (2)     Windows 10 (64-bit) (3)     DVD drives     DVD drives     Cocl storage     Removable storage	Genera	Memor	y Storag	e Net	working	NICs	GPU	U U	SB	Console	Perfo	mance Users	Search
	GPU												
	Plac	ement poli	icy: Maxin	num de	ensity: p	ut as ma	any VMs	as pos	sible o	n the sam	e GPU	Ed	
	205	GM107GL	Tesla M10	0]								N	Virtual GPU types:
SMB ISO library		1	1 1	Ĩ.	1.1	1		L L		1 1	1	1.1.	Pass-through whole GPU
													✓ GRID M10-8Q virtual GPU (1 pe
													GRID M10-8A virtual GPU (1 per
		6.5	1.1.1	÷.	1 1		1.1	i i	1	1.1	1.1.1	1.1	GRID M10-4Q virtual GPU (2 pe
													GRID M10-4A virtual GPU (2 per
													GRID M10-2Q Virtual GPU (4 pe
							1.1						GRID M10-28 virtual GPU (4 pe
				-		-			-		-		GRID M10-2A virtual GPU (4 per
													GRID M10-1Q virtual GPU (8 pe
		_											GRID M10-1B4 virtual GPU (8 p
			1 1	1	1 1	-	1	<u> </u>	1	1 1	-1-	1 1	GRID M10-1B virtual GPU (8 per
	$\square$											-	SRID M10-1A virtual GPU (8 pe
		-		_								_	SRID M10-0Q virtual GPU (16 p
Infrastructure		1-1-	1 1	1-	1 1		1	i i	- 1-	1-1	-  -	1 1	GRID M10-0B virtual GPU (16 pr
Dbjects													Edit Selected GPUs
Organization Views													
		1.1	1 1	i.	1.1	110	T	Ê Î	Ē	0.01	1.11	0.12-	
Saved Searches						-							

2. Select Edit under placement policy to modify GPU settings.

3. The options of maximum density or maximum performance can be viewed here for assigning the VMs to GPUs. The option for selecting integrated GPU will also display. Select the appropriate options for your deployment strategy.



4. In the right panel, select **Edit Selected GPUs** to see the resources allocated to each GPU as well as manage which vGPU profiles are allowed for use on the host server.

earch		Citrix Hy	pervisor Test	(Licensed wit	Citrix	Virtual Apps an	d Desktops P	remium)	Logged in as: Local root accourt
AvenCenter      Citrix Hypervisor Test      Win10_vGPU      Windows 10 (64-b      Windows 10 (64-b	Gi bit) (2)	eneral Men GPU	nory Storage I	Networking NIC:	GPU	USB Con	isole Performa	nce Users	Search
DVD drives	S GM107GL [Te	sla M10] (12:	GPUs)					?	X
Local storage	Select which vi	rtual GPU typ	pes are allowed o	n these GPUs.					GPU types:
SMB ISO library	Name			Virtual GPUs	ner GPU	Max resolution	Max displays	Video RAM	s-through whole GPU
	Pass-throug	ah whole GPI	U	Vincular of 03		Wax resolution	max dispidys	The offeren	D M10-8Q virtual GPU (1 per
	GRID M10-8	30		1 1 2	5120x2880	4	7.4 GB	D M10-8A virtual GPU (1 per	
	GRID M10-8	3A					7.4 GB	D M10-4Q virtual GPU (2 p	
	GRID M10-4	1Q			2	5120x2880	4	3.7 GB	D M10-4A virtual GPU (2 per
	GRID M10-4	1A			2	2 1280x1024	1	3.7 GB	D M10-2Q virtual GPU (4 per
	GRID M10-2	Q			4	5120x2880	4	1.8 GB	D M10-2B4 virtual GPU (4 pe
	GRID M10-2	2B4			4	5120x2880	4	1.8 GB	D M10-2B virtual GPU (4 per
	GRID M10-2	2B			4	5120x2880	4	1.8 GB	D M10-2A virtual GPU (4 per
	GRID M10-2	2A			4	1280x1024 5120x2880	1	1.8 GB	D M10-1Q virtual GPU (8 per
	GRID M10-	Q			8		4	896 MB	D M10-18 virtual GPU (8 per
	GRID M10-1	B4		8		5120x2880	4	896 MB	D M10-16 virtual GPU (8 per
							OK	Cancel	D M10-00 virtual GPU (16 pt
Infrastructure					1 1		1 1 1	-	GRID M10-0B virtual GPU (16 pe
Objects									Edit Selected GPUs
	17.35								Luit Scietted of Osin
Urganization views	•	1. 1	1. 1. 1		1. 1	1 1 1	1		

How vGPUs should be allocated will be dependent on your deployment needs. Consult Citrix and your NVIDIA representative to determine the best configuration for your environment.

#### Notice

This document is provided for information purposes only and shall not be regarded as a warranty of a certain functionality, condition, or quality of a product. NVIDIA Corporation ("NVIDIA") makes no representations or warranties, expressed or implied, as to the accuracy or completeness of the information contained in this document and assumes no responsibility for any errors contained herein. NVIDIA shall have no liability for the consequences or use of such information or for any infringement of patents or other rights of third parties that may result from its use. This document is not a commitment to develop, release, or deliver any Material (defined below), code, or functionality.

NVIDIA reserves the right to make corrections, modifications, enhancements, improvements, and any other changes to this document, at any time without notice. Customer should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

NVIDIA products are sold subject to the NVIDIA standard terms and conditions of sale supplied at the time of order acknowledgement, unless otherwise agreed in an individual sales agreement signed by authorized representatives of NVIDIA and customer ("Terms of Sale"). NVIDIA hereby expressly objects to applying any customer general terms and conditions with regards to the purchase of the NVIDIA product referenced in this document. No contractual obligations are formed either directly or indirectly by this document.

NVIDIA products are not designed, authorized, or warranted to be suitable for use in medical, military, aircraft, space, or life support equipment, nor in applications where failure or malfunction of the NVIDIA product can reasonably be expected to result in personal injury, death, or property or environmental damage. NVIDIA accepts no liability for inclusion and/or use of NVIDIA products in such equipment or applications and therefore such inclusion and/or use is at customer's own risk.

NVIDIA makes no representation or warranty that products based on this document will be suitable for any specified use. Testing of all parameters of each product is not necessarily performed by NVIDIA. It is customer's sole responsibility to evaluate and determine the applicability of any information contained in this document, ensure the product is suitable and fit for the application planned by customer, and perform the necessary testing for the application in order to avoid a default of the application or the product. Weaknesses in customer's product designs may affect the quality and reliability of the NVIDIA product and may result in additional or different conditions and/or requirements beyond those contained in this document. NVIDIA accepts no liability related to any default, damage, costs, or problem which may be based on or attributable to: (i) the use of the NVIDIA product in any manner that is contrary to this document or (ii) customer product designs.

No license, either expressed or implied, is granted under any NVIDIA patent right, copyright, or other NVIDIA intellectual property right under this document. Information published by NVIDIA regarding third-party products or services does not constitute a license from NVIDIA to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property rights of the third party, or a license from NVIDIA under the patents or other intellectual property rights of NVIDIA.

Reproduction of information in this document is permissible only if approved in advance by NVIDIA in writing, reproduced without alteration and in full compliance with all applicable export laws and regulations, and accompanied by all associated conditions, limitations, and notices.

THIS DOCUMENT AND ALL NVIDIA DESIGN SPECIFICATIONS, REFERENCE BOARDS, FILES, DRAWINGS, DIAGNOSTICS, LISTS, AND OTHER DOCUMENTS (TOGETHER AND SEPARATELY, "MATERIALS") ARE BEING PROVIDED "AS IS." NVIDIA MAKES NO WARRANTIES, EXPRESSED, IMPLIED, STATUTORY, OR OTHERWISE WITH RESPECT TO THE MATERIALS, AND EXPRESSLY DISCLAIMS ALL IMPLIED WARRANTIES OF NONINFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE. TO THE EXTENT NOT PROHIBITED BY LAW, IN NO EVENT WILL NVIDIA BE LIABLE FOR ANY DAMAGES, INCLUDING WITHOUT LIMITATION ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, PUNITIVE, OR CONSEQUENTIAL DAMAGES, HOWEVER CAUSED AND REGARDLESS OF THE THEORY OF LIABILITY, ARISING OUT OF ANY USE OF THIS DOCUMENT, EVEN IF NVIDIA HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Notwithstanding any damages that customer might incur for any reason whatsoever, NVIDIA's aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the Terms of Sale for the product.

#### Trademarks

NVIDIA, the NVIDIA logo, CUDA, NVIDIA OptiX, NVIDIA RTX, NVIDIA Turing, Quadro, Quadro RTX, and TensorRT trademarks and/or registered trademarks of NVIDIA Corporation in the U.S. and other countries. Other company and product names may be trademarks of the respective companies with which they are associated.

#### Copyright

© 2020 NVIDIA Corporation. All rights reserved.