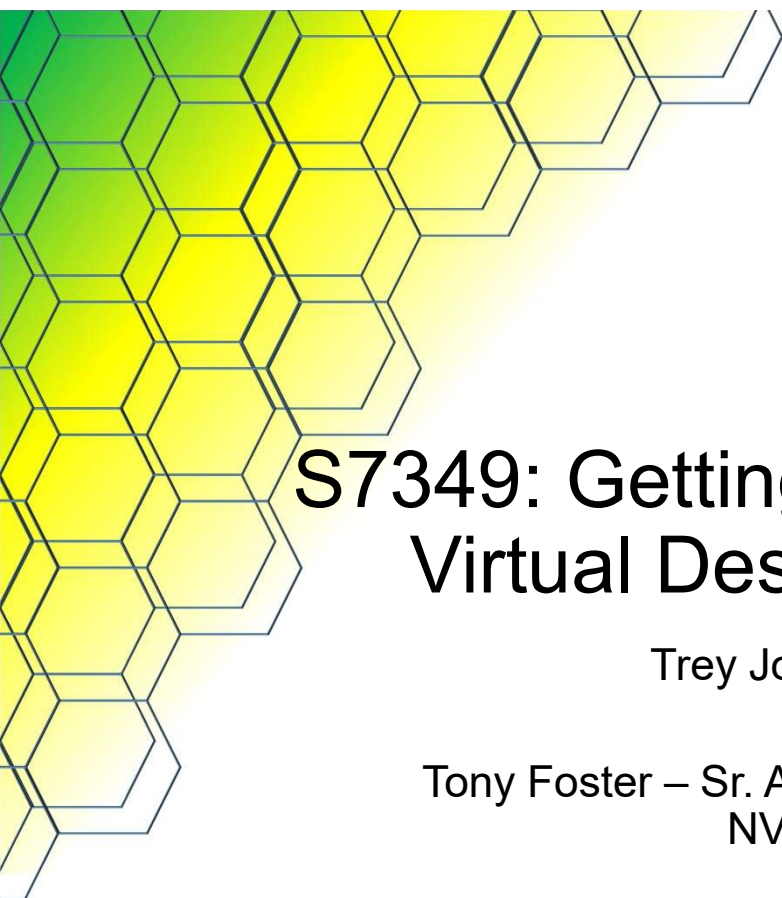




S7349: Getting Started with GPUs for Linux Virtual Desktops on VMware Horizon

Trey Johnson – Sr. Architect, Lincare, Inc.

Tony Foster – Sr. Advisor, Technical Marketing, Dell Technologies
NVIDIA GRID Community Advisor

Agenda

- Overview
- Host Configuration
- Licensing
- Virtual Machine Configuration
- Testing
- References & Resources

Assumptions

- Ability to manage a VMware Horizon Environment
- Ability to Administer Linux Desktops

Results WILL vary!

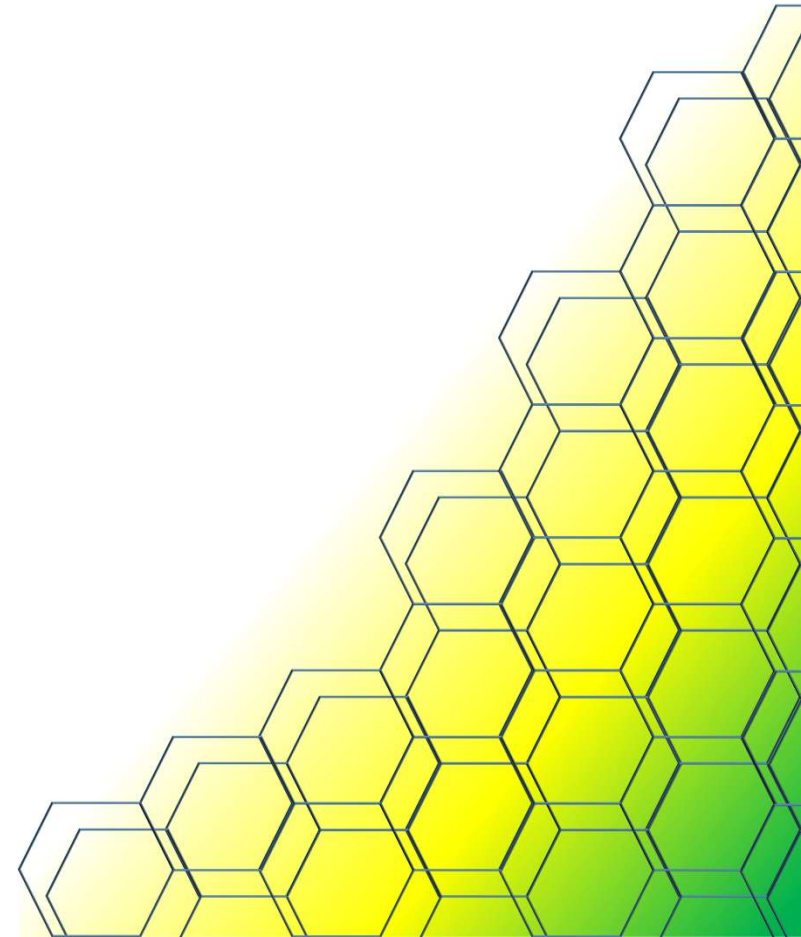
Not covered today:

- Integration of Linux Desktops with Directory Services
- VMware Horizon Installation
- Linux VM image optimization
- Basic Linux VM administration tasks



Overview

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Why?

- Started as a Customer Request
- Test Performance
- Some Items Easily Overlooked
- Share with the Community



UBUNTU

Hardware Specs

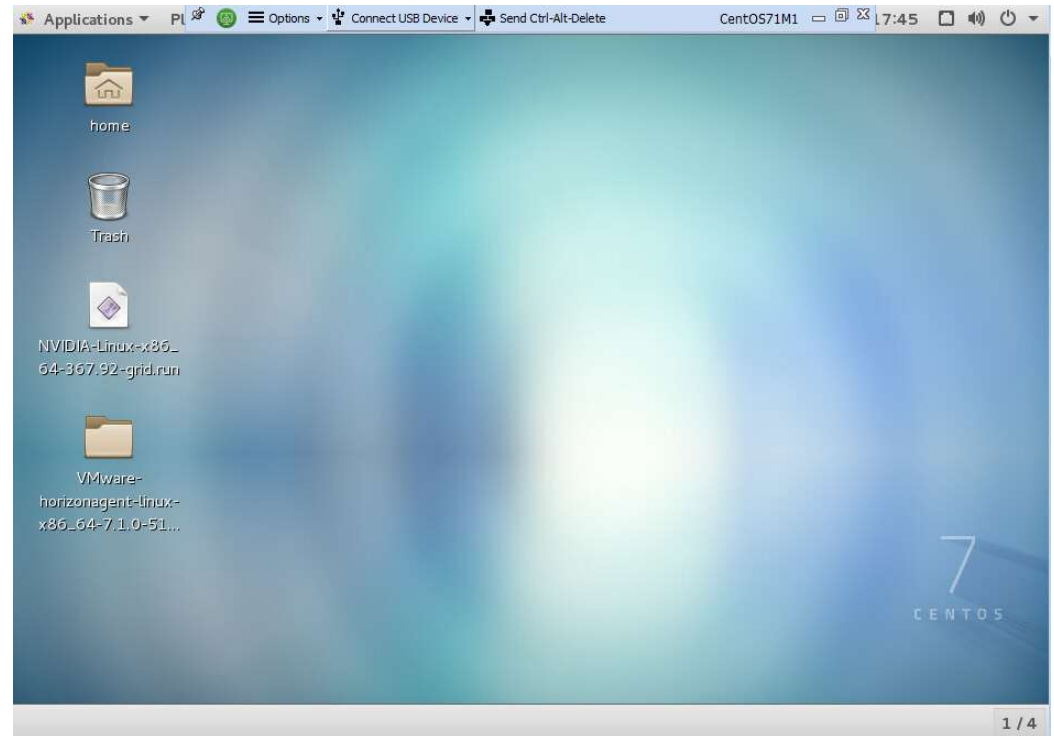
- Testing on Cisco UCS C240 M4 Servers
 - Dual E5-2670 v3 – 12 Core Procs
 - 260GB of RAM
 - NVIDIA M60 @ 367.92 (Version 4.2)
- VMware vSphere 6.0 Update 2 (Build 3620759)
- vCenter Server Appliance (6.5.0.5200)
- VMware Horizon 7.1.0
 - Basic Environment Only
 - *Sub-optimal*
- Management environment on separate host
 - vCenter Appliance
 - AD/DNS (Windows 2k8 R2)
 - Jump Box (Windows 2k8 R2)
 - NVIDIA GRID License Server (CentOS7.1)
 - vSphere Connection Server (Windows 2k8 R2)
- Horizon View Client run on Jump box

VM Specs

- CentOS 7.1 (x64)
 - 4 vCPU
 - 8GB vRAM

GPU

- GRID_m60-4q vGPU Profile
- GRID_m60-8q vGPU Profile
- Passthrough



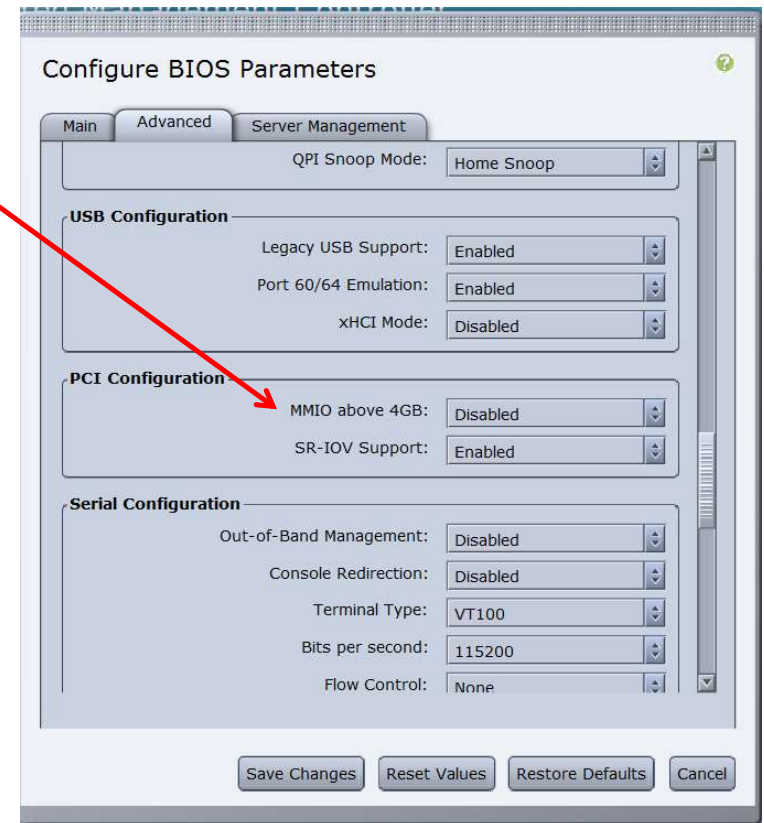


Host Configuration

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BIOS

- Cisco Servers: MMIO above 4GB set to Disabled
- Some Cisco Servers (M3) MMCFG changed
 - Navigate to PCI Configuration Section
 - MMCFG BASE → 2GB (from Auto)
- Dell Power Edge, IBM, or HPE: Unaware of special BIOS settings



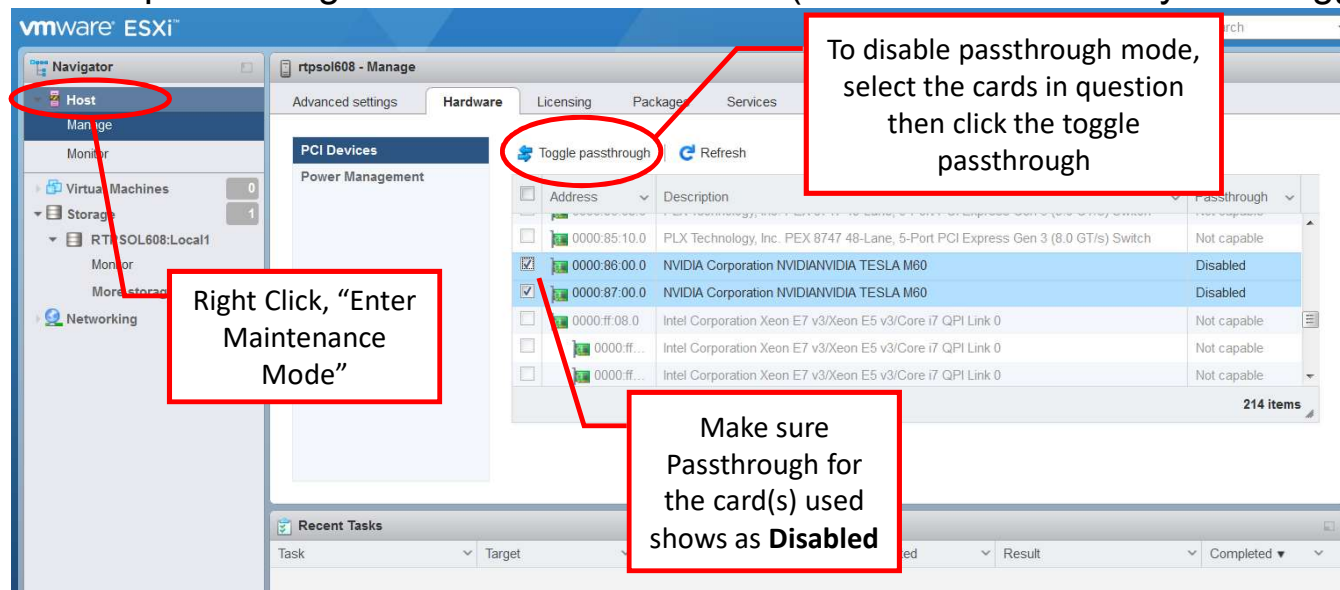
Installing gpumodeswitch VIB

→ **Other NVIDIA VIBs will need removed**

1dnrd.me/MdSwErr

More

1. Enter Maintenance Mode on the ESXi host
(`esxcli system maintenanceMode set --enable true`)
2. Insure passthrough is disabled on the GPU (a reboot is necessary after toggling)



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10

Installing gpumodeswitch VIB

3. Stop xorg: `/etc/init.d/xorg stop`
4. **Remove other NVIDIA VIBs (optional)**
 - `esxcli software vib list | grep -i nvidia`
 - `esxcli software vib remove -n [NVIDIA-driver-package]`
 - **Reboot host**
5. **Install the gpumodeswitch VIB**
 - `esxcli software vib install -v [full-path]/ NVIDIA-GpuModeSwitch-10EM.600.0.0.2494585.x86_64.vib --no-sig-check`
 - **Reboot the host**
6. **Run** `gpumodeswitch --listgpumodes`
7. **Run** `gpumodeswitch --gpumode graphics`
 - **Reboot the host**
8. **Remove gpumodeswitch VIB**
 - **Reboot the host**

1drnrd.me/GPUMSW

More

TIP:

`lspci -n | grep 10de`
check the status of GRID cards.

10de is a unique id for NVIDIA cards

Class 300 is graphics mode
Class 302 is compute mode

1drnrd.me/grep10de

Installing the Virtual GPU Manager (VIB)

1drnr.me/UGvGPU42 

1. Enter maintenance mode on the ESXi host
`esxcli system maintenanceMode set --enable true`
2. Stop xorg: `/etc/init.d/xorg stop`
3. Install the Virtual GPU Manager VIB
`esxcli software vib install -v [full-vib-path] / [vib-name].vib`
4. Start xorg: `/etc/init.d/xorg start`
5. Reboot ESXi host
6. Verify the VIB version loaded
 1. `vmkload_mod -l | grep nvidia`
 2. `nvidia-smi`
7. Exit Maintenance Mode
`esxcli system maintenanceMode set --enable false`

Configure For Passthrough

- Select Manage on the Host
- Hardware tab -> PCI Devices
- Scroll to and Select the NVIDIA Entries
- Click Toggle passthrough
- Reboot

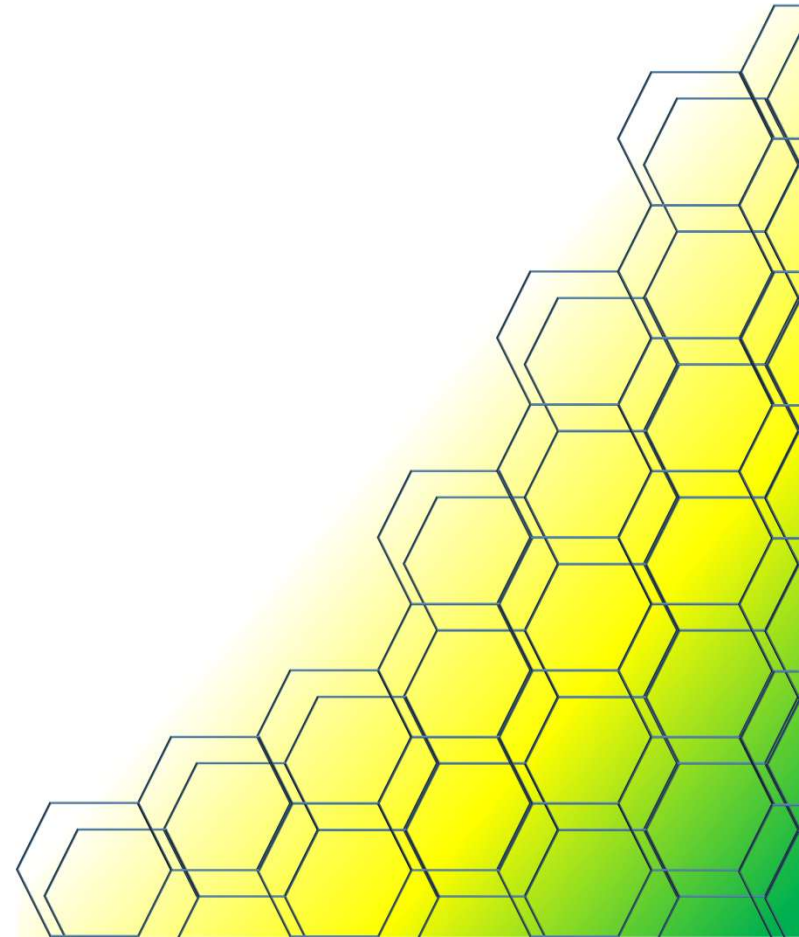
The screenshot shows the Proxmox VE web interface. The 'Hardware' tab is selected in the top navigation bar. On the left sidebar, 'PCI Devices' is selected. The main area displays a table of PCI devices with columns for checkboxes, Address, Description, and Passthrough status. The NVIDIA Corporation NVIDIA Tesla M60 device is selected, and the 'Toggle passthrough' button is highlighted.

	Address	Description	Passthrough
☐	0000:84:00.0	PLX Technology, Inc. PEX 8747 48-Lane, 5-Port PCI Express Gen 3 (8.0 GT/s) Switch	Not capable
☐	0000:85:08.0	PLX Technology, Inc. PEX 8747 48-Lane, 5-Port PCI Express Gen 3 (8.0 GT/s) Switch	Not capable
☐	0000:85:10.0	PLX Technology, Inc. PEX 8747 48-Lane, 5-Port PCI Express Gen 3 (8.0 GT/s) Switch	Not capable
☒	0000:86:00.0	NVIDIA Corporation NVIDIA Tesla M60	Active
☐	0000:87:00.0	NVIDIA Corporation NVIDIA Tesla M60	Enabled



Licensing

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NVIDIA GRID Licensing

- License Editions

1dnrd.me/GRIDlicUG

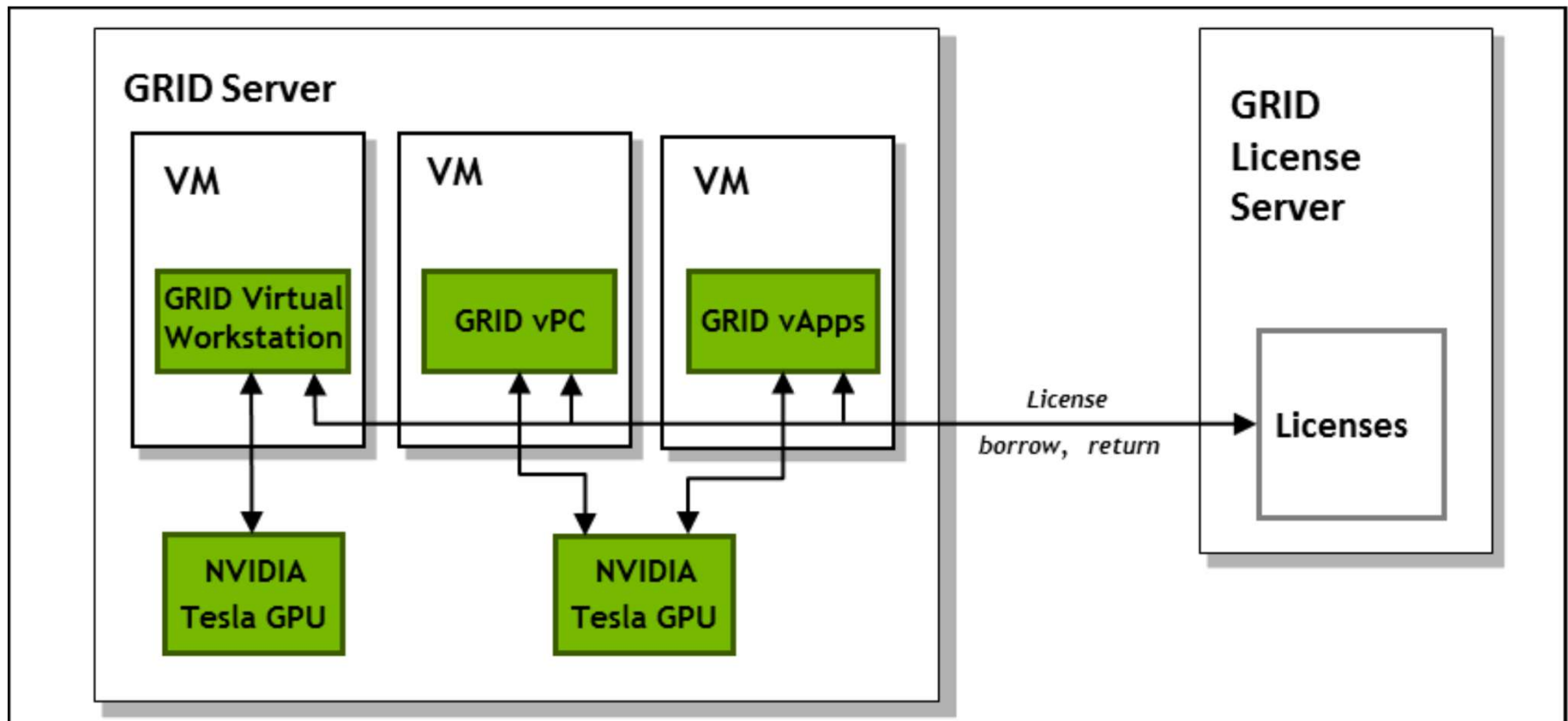
More

Edition	Features
GRID Virtual Application	• Virtual GPUs for virtual application computing
GRID Virtual PC	• Virtual GPUs for business desktop computing
GRID Workstation	• Virtual GPUs for midrange and high-end workstation computing • Workstation graphics on GPU passthrough

- Each edition offers multiple virtual GPU options

! Currently vGPUs that require licensing run at full capability even without a license. However, on Windows, until a license is acquired, users are warned each time a vGPU fails to get a license. These warnings cease after a license is acquired.

GRID License Activation Model



Install GRID License Server

- Windows or Linux
 - Windows 7 / 8 / 8.1 / 10 / Server 2008 R2
 - Red Hat Enterprise Linux 7.1 64-bit
 - CentOS 7.1 64-bit (141MB disk space)
- Static IP Address
- License File Bound to MAC Address
- *Detailed* in “GRID License Server Release Notes”
- CentOS Used

License Server Installation - CentOS

- Install JRE

```
java -version
```

```
sudo yum install java (if not installed or lower than V.1.7)
```

- Install Apache Tomcat

```
sudo yum install tomcat tomcat-webapps
```

```
sudo systemctl enable tomcat.service
```

```
sudo systemctl start tomcat.service
```

- Install License Server

```
tar xzf NVIDIA-linux-2015.09-0001.tgz
```

```
sudo ./setup.bin
```

GRID License Server Configuration

- Respond to questions using “Next” to navigate
- At the Firewall Options
 - License Server (Port 7070) **Checked**
 - Management Interface (Port 8080) **Unchecked**
- Click Done to Finish Installation
- Verify Install by going to
`http://localhost:8080/licserver`



Generate License File

- Login to NVIDIA Enterprise
- Click **Register License Server** on left (1)
 - Enter Mac Address (2)
 - Alias (optional)
 - Site Name (optional)
- Click **Map-Add-ons** (3)
 - Enter quantity of GRID Licenses (4)
 - Click **Map Add-Ons** button (5)
- Click **Download License File** (6)
- Install license by using the “License Management” section (7)
 - Click the **Choose File** (8) button browse for the `bin` file containing the licenses.
 - Click the **Upload** button (9)

Generate License File



NVIDIA SOFTWARE LICENSING CENTER > REGISTER LICENSE SERVER

Software & Services

- Product Information
- Product Search
- License History
- Search Line Items
- Recent Product Releases
- Redeem Product Activation Keys

Rendering Licensing

- Search Licenses
- View Licenses By Host
- View Licenses Generated by User

Grid Licensing

- Search License Servers

1 **Register License Server**

Register License Server

To register a license server to your account, provide the MAC address and additional information below.

Note: Please do not use special characters (-:_./) or spaces in the MAC Address.

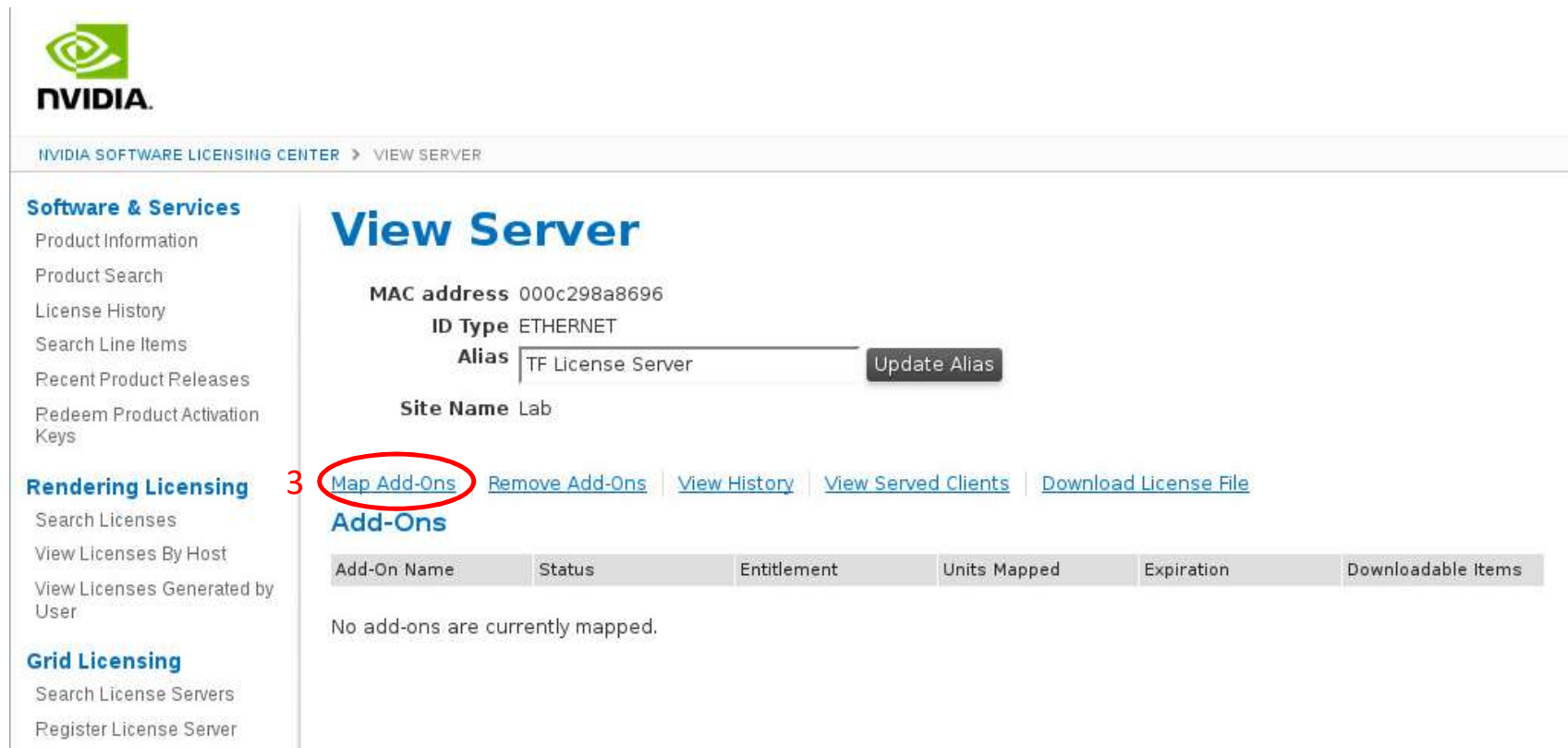
2 **MAC address***

Alias

Site Name

#GTC #S7349

Generate License File



NVIDIA

NVIDIA SOFTWARE LICENSING CENTER > VIEW SERVER

Software & Services

- Product Information
- Product Search
- License History
- Search Line Items
- Recent Product Releases
- Redeem Product Activation Keys

Rendering Licensing

- Search Licenses
- View Licenses By Host
- View Licenses Generated by User

Grid Licensing

- Search License Servers
- Register License Server

View Server

MAC address 000c298a8696

ID Type ETHERNET

Alias Update Alias

Site Name Lab

3 [Map Add-Ons](#) [Remove Add-Ons](#) [View History](#) [View Served Clients](#) [Download License File](#)

Add-Ons

Add-On Name	Status	Entitlement	Units Mapped	Expiration	Downloadable Items
No add-ons are currently mapped.					

Generate License File



NVIDIA SOFTWARE LICENSING CENTER > MAP ADD-ONS

Software & Services

Product Information
Product Search
License History
Search Line Items
Recent Product Releases
Redeem Product Activation
Keys

Rendering Licensing

Search Licenses
View Licenses By Host
View Licenses Generated by
User

Grid Licensing

Search License Servers
Register License Server

Administration *

Account Administrators

Map Add-Ons

Search Add-Ons for Server [000c298a8696](#)

Activation Code

Entitlement ID

Add-On Name

Feature Name

Search

Add-On Name	Activation Code	Entitlement	Expiration	Available Units in Line Item	Total Units in Line Item	Qty to Add
GRID Evaluation Edition	GRIDEvalPAK17878 [REDACTED]	GRIDEvalPAK17878 [REDACTED] (205939017)	Jul 13, 2017	128	128	4 [128]

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5

Map Add-Ons

23

Generate License File



NVIDIA SOFTWARE LICENSING CENTER > VIEW SERVER

Software & Services

Product Information
Product Search
License History
Search Line Items
Recent Product Releases
Redeem Product Activation
Keys

Rendering Licensing

Search Licenses
View Licenses By Host
View Licenses Generated by
User

Grid Licensing

Search License Servers
Register License Server

View Server

The add-ons were successfully mapped.

MAC address 000c298a8696

ID Type ETHERNET

Alias TF License Server

Update Alias

Site Name Lab

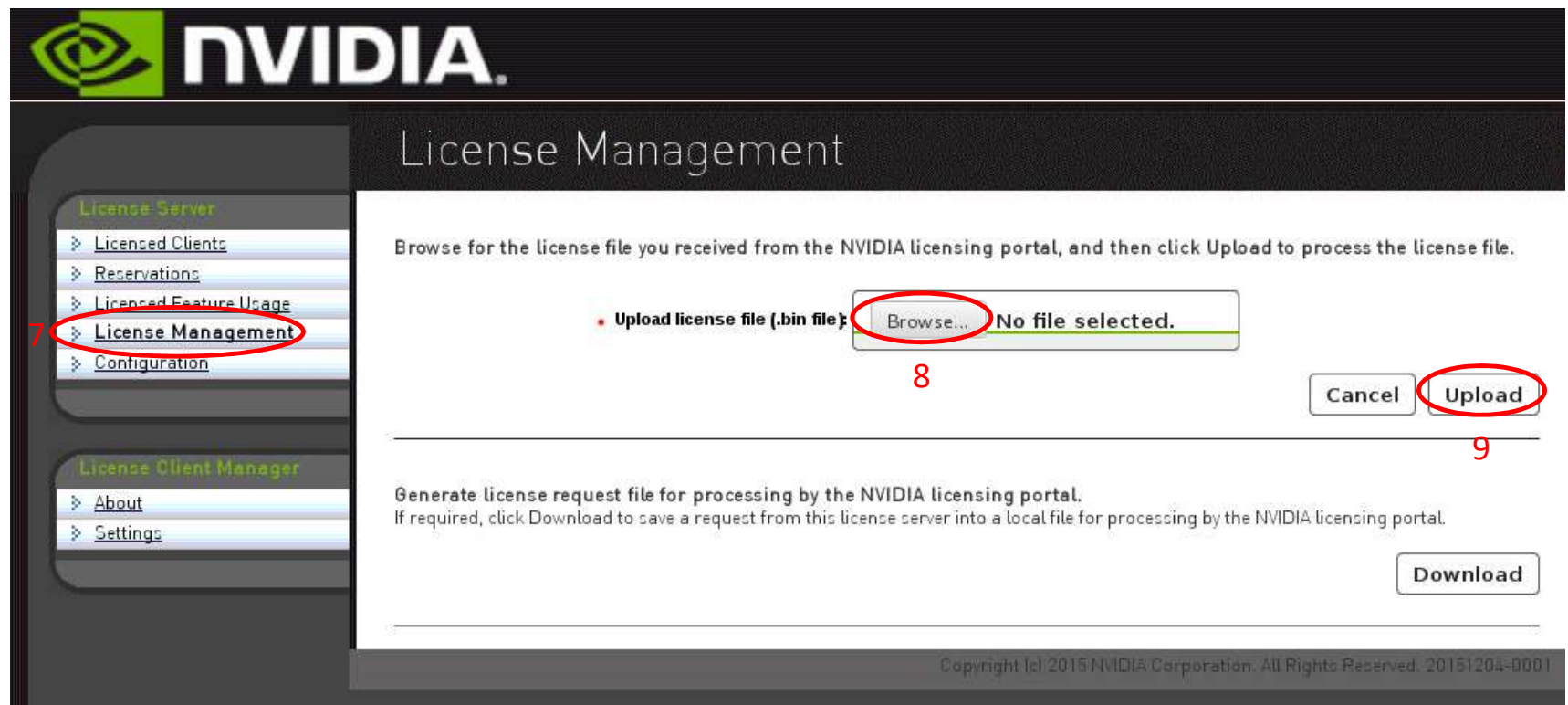
[Map Add-Ons](#) [Remove Add-Ons](#) [View History](#) [View Served Clients](#) [Download License File](#)

Add-Ons

Add-On Name	Status	Entitlement	Units Mapped	Expiration	Downloadable Items
GRID Evaluation Edition	License not generated	GRIDEvalPAK178782-c (205939017)	128	Jul 13, 2017	None

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Generate License File



Check Point

- Physical Cards Installed
- GPU Manager (VIB) Installed
- GRID License Server Installed, Configured, and Licensed
- Linux VM Created for Template



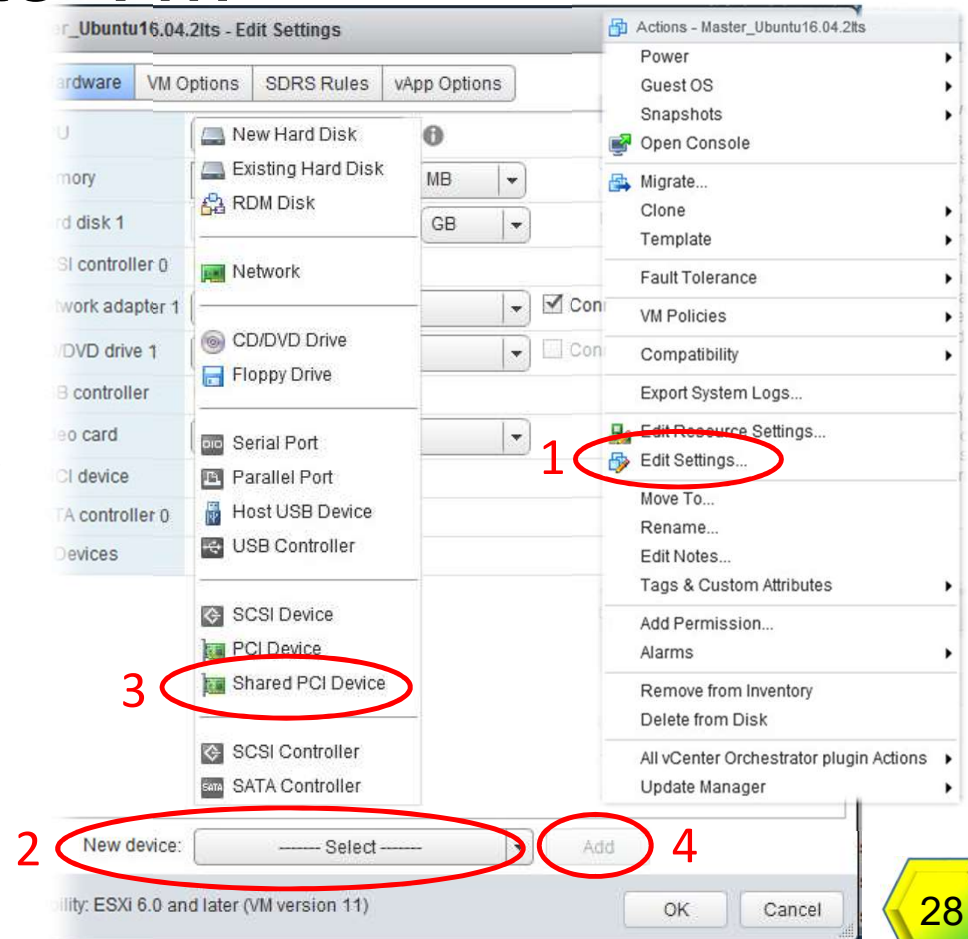
VM Configuration



#GTC #S7349

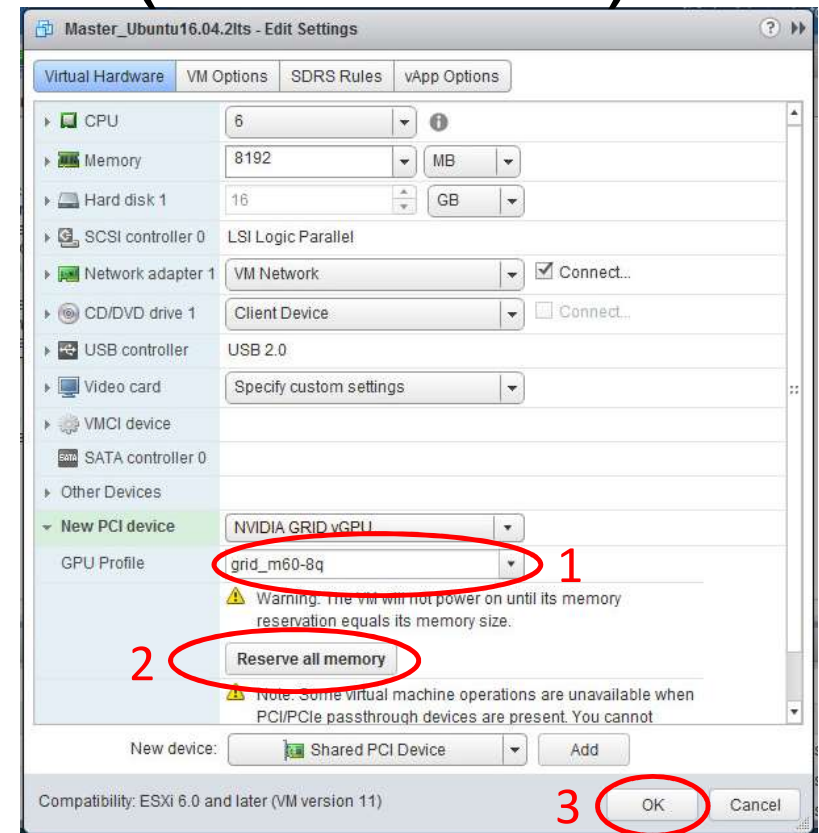
Add vGPU to Template VM

- With Linux VM Shutdown
- In the vSphere Web Client Right Click VM
 - Select Edit Settings (1)
- Click **New device** drop down (2)
 - Select Shared PCI Device (3)
- Click the Add button (4)



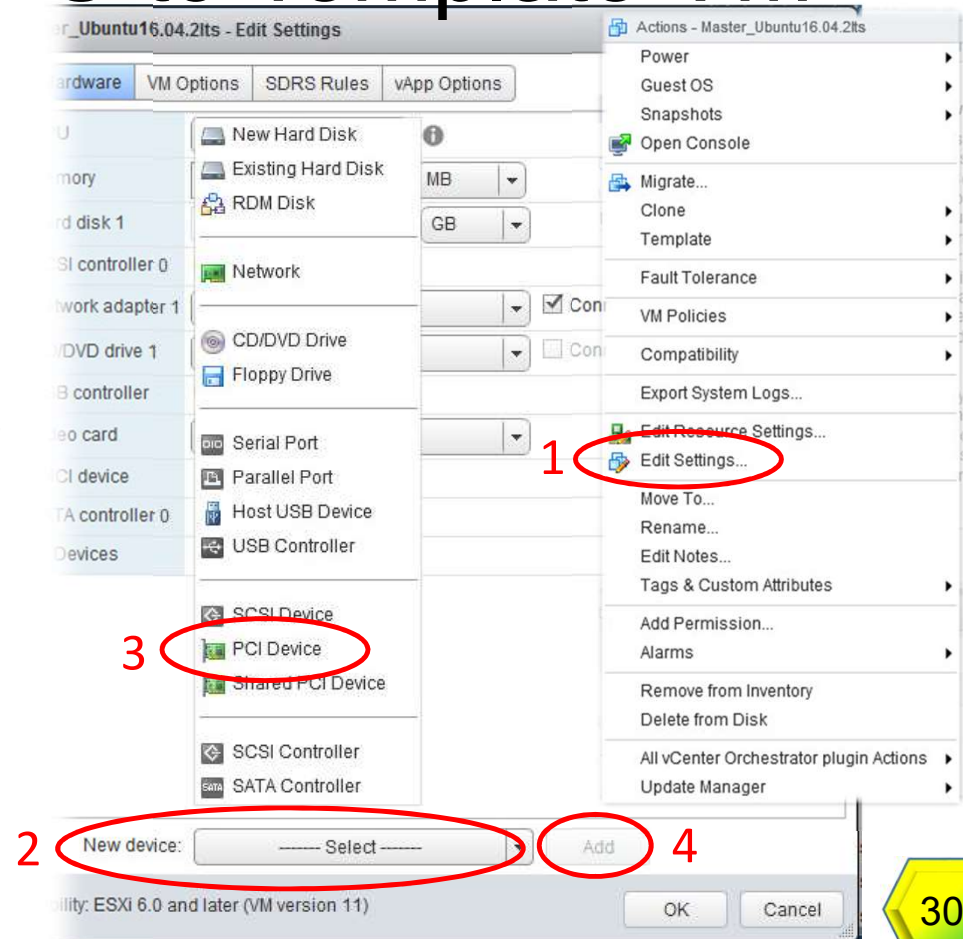
Add vGPU to Template VM (Continued)

- Select desired GPU profile (1)
- Click Reserve all Memory button (2)
- Click OK button (3)
- Power on VM



Add Pass Through GPU to Template VM

- With Linux VM Shutdown
- In the vSphere Web Client Right Click VM
 - Select Edit Settings (1)
- Click **New device** drop down (2)
 - Select PCI Device (3)
 - Click the Add button (4)
- Select Appropriate Device
- Click OK button
- Power on VM



Configure Linux Template VM

1drnrd.me/CfgHs7LD

More

- For Ubuntu disable Compiz for improved performance
 - <http://kb.vmware.com/kb/2114809>
- Configure networking to resolve the FQDN of the Connection Server
- For RHEL and CentOS
 - Map Host name to 127.0.0.1 in `/etc/hosts`
 - Verify virbr0 is disabled
 - `virsh net-destroy default`
`virsh net-undefined default`
`service libvirtd restart`



Important!

Configure Linux Template VM

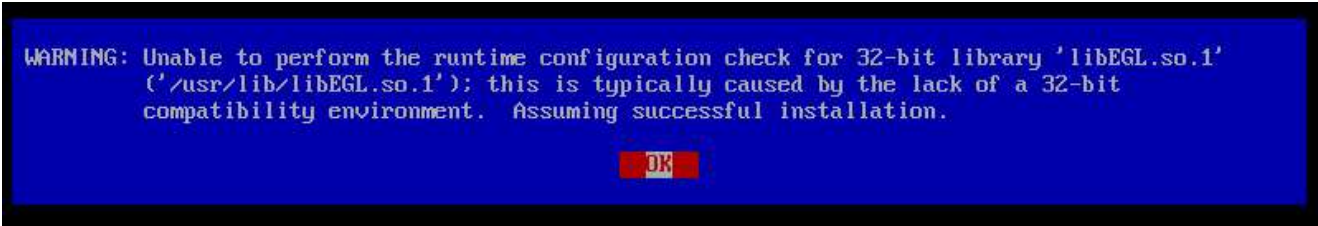
- Configure runlevel for 5
- Edit the `/etc/nsswitch.conf`
 - `hosts: cache db files dns`
- Disable Nouveau driver
 - Varies based on OS

Install Drivers in the VM

1drnrd.me/UGvGPU42 

- Copy the Linux GRID Driver Package to the VM
- `chmod +x NVIDIA-linux-x86_64-version-grid.run`
- Blacklist nouveau (varies among OS)
- **Before attempting to run the driver installer, exit the X server and terminate all OpenGL applications.**
 - RHEL & CentOS:
 1. `sudo init 3`
 2. `sudo service gdm stop`
 - Ubuntu:
 1. Use **CTRL-ALT-F1** to switch to a console login prompt.
 2. Log in and shut down the display manager: `sudo service lightdm stop`
- **GUEST OS Drivers Must Match VIB Version**
- Run the driver installer:
`sudo sh ./NVIDIA-Linux_x86_64-367.92-grid.run`

Finish Driver Configuration



```
WARNING: Unable to perform the runtime configuration check for 32-bit library 'libEGL.so.1'
('/usr/lib/libEGL.so.1'); this is typically caused by the lack of a 32-bit
compatibility environment. Assuming successful installation.
```

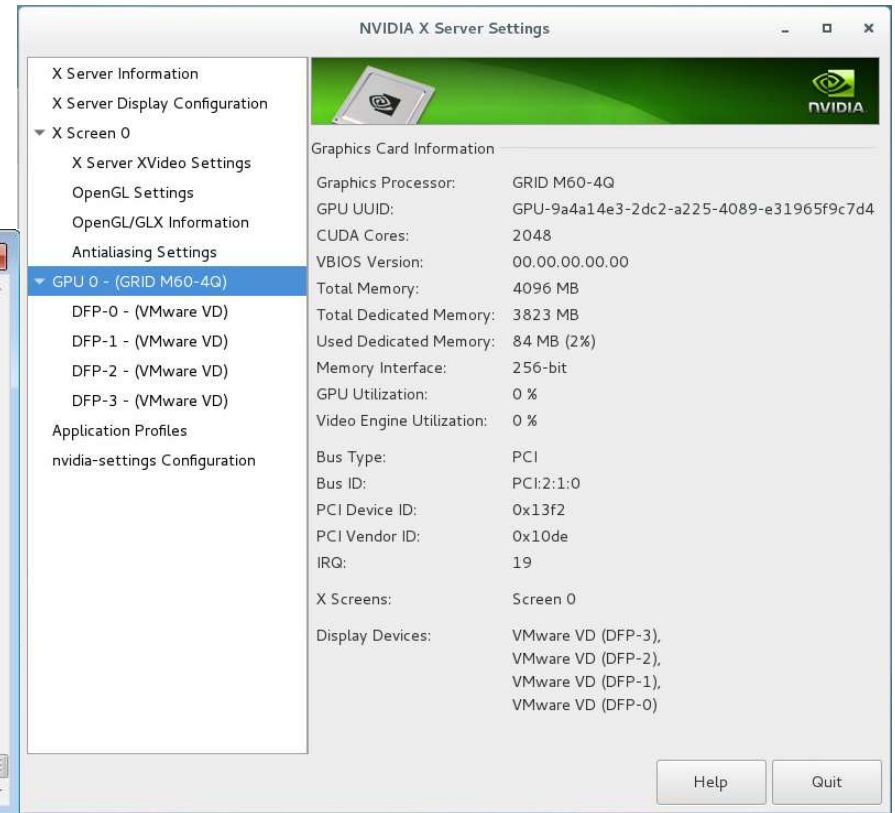
OK

- May get a 32-bit error
- Select Yes to update the X configuration
- Reboot the VM
- **Switch to Horizon, ssh, or VNC Console (Black Screen)**
- Install Horizon Linux Agent
 - Unpack the Horizon Linux Agent
 - `sudo sh ./[path]/install_viewagent.sh`
- Run: `nvidia-smi` (to validate that the card is present)
- Reboot
- Login and run: `nvidia-settings`

Result of nvidia-settings & nvidia-smi

- Notice it shows the information about the vGPU added

```
root@centos71m:~  
[root@centos71m ~]# nvidia-smi  
Thu May 4 15:59:34 2017  
+-----+  
| NVIDIA-SMI 367.92                Driver Version: 367.92      |  
+-----+  
| GPU Name          Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |  
| Fan  Temp  Perf  Pwr:Usage/Cap|      Memory-Usage | GPU-Util  Compute M. |  
+-----+  
| 0  GRID M60-4Q      Off   | 0000:02:01.0     On   |          N/A         |  
| N/A   N/A   P8     N/A /  N/A |    356MiB /  4095MiB |      0%    Prohibited |  
+-----+  
+-----+  
| Processes:                                     GPU Memory |  
|  GPU       PID    Type    Process name      Usage   |  
+-----+  
| 0          2775    G       /usr/bin/Xorg        39MiB   |  
| 0          6720    G       /usr/bin/gnome-shell  44MiB   |  
+-----+  
[root@centos71m ~]#
```



Configuring gridd.conf - vGPU

1. As root In Text Editor Open `/etc/nvidia/gridd.conf`
 1. `sudo vi /etc/nvidia/gridd.conf`
 2. Template can be found: `/etc/nvidia/gridd.conf.template`
2. Set the `ServerAddress` to the Address of your GRID License Server
3. Set the `FeatureType` to 1 for **vGPU**
4. Save Changes to the file (`esc : wq` for VI)
5. Restart the `nvidia-gridd` service
 - `sudo service nvidia-gridd restart`

Configuring gridd.conf – GRID Virtual Workstation (Passthrough)

1. As root In Text Editor Open `/etc/nvidia/gridd.conf`
 1. `sudo vi /etc/nvidia/gridd.conf`
 2. Template can be found: `/etc/nvidia/gridd.conf.template`
2. Set the `ServerAddress` to the Address of your GRID License Server
3. Set the `FeatureType` to 2 for the **GRID Virtual Workstation**
4. Save Changes to the file (`esc : wq` for VI)
5. Restart the `nvidia-gridd` service
 - `sudo service nvidia-gridd restart`

Licensed

The screenshot shows the NVIDIA License Client Manager web interface in a Mozilla Firefox browser. The browser's address bar displays the URL `localhost:8080/licserver/manageDevices_view.action?page=1`. The page title is "NVIDIA License Client Manager - Licensed Clients - Mozilla Firefox".

The interface features a dark header with the NVIDIA logo and the title "Licensed Clients". On the left, there is a sidebar with two main sections: "License Server" and "License Client Manager". The "License Server" section includes links for "Licensed Clients", "Reservations", "Licensed Feature Usage", "License Management", and "Configuration". The "License Client Manager" section includes links for "About" and "Settings".

The main content area displays a table of licensed clients. Above the table, there is a search bar labeled "Search (case-sensitive):" and a dropdown menu for "Search by:" set to "Client ID". Below the search bar, a message states: "Licensed Clients with features consumed or reserved. Click a Client ID for further details."

Client ID	Client Alias	Client Type	Licensed Features	License Reservations
 005056E48798	centos71m.vsphere.local		GRID-Virtual-WS (1)	

Below the table, it indicates "Page 1". At the bottom of the page, there is a copyright notice: "Copyright (c) 2015 NVIDIA Corporation. All Rights Reserved. 20151204-0001". The bottom right corner shows a pagination indicator "1 / 4" and a help icon.

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Limitations

1drnrd.me/vGPU42RN 

- No VMware vMotion
- No VMware DRS
- No Snapshotting of running VMs
- No Instant Clones for Passthrough
- Instant Clones for vGPU in Horizon 7.1

Automated Pool in Horizon

- In desktop pools, right click **Add**
- Select **Automated Desktop Pool**
- Select pool type
- Select Clone type
- Enter pool info
- Configure Desktop pool settings
 - Default Display protocol: **VMware Blast**
 - Allow Users to Choose Protocol: **No**
 - 3D Render: [**Automatic** | **NVIDA GRID VGPU** | **Hardware**]
- Continue as normal

The screenshot shows the 'Add Desktop Pool - CentOS71_8q' wizard in the Horizon console. The 'Desktop Pool Settings' tab is active. The left sidebar shows the navigation tree with 'Desktop Pool Settings' selected. The main panel contains the following settings:

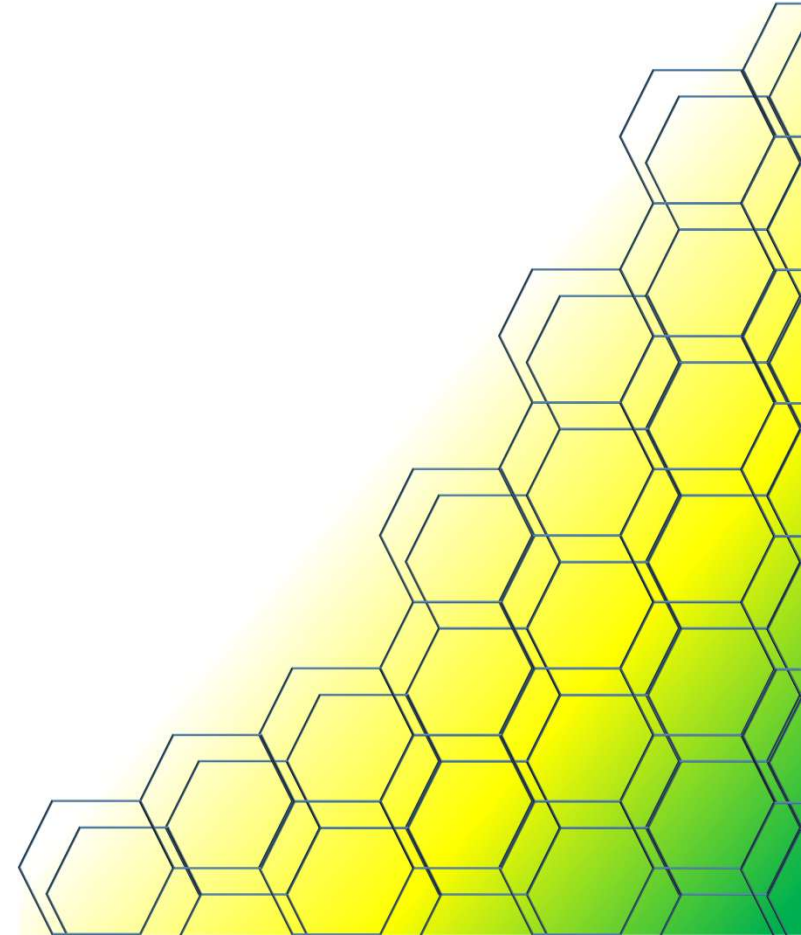
- General**
 - State: **Enabled** (dropdown)
 - Connection Server restrictions: **None** (button: Browse...)
- Remote Settings**
 - Remote Machine Power Policy: **Take no power action** (dropdown)
 - Automatically logoff after disconnect: **Never** (dropdown)
 - Allow users to reset/restart their machines: **No** (dropdown)
- Remote Display Protocol**
 - Default display protocol: **VMware Blast** (dropdown)
 - Allow users to choose protocol: **Yes** (dropdown)
 - 3D Renderer: **NVIDIA GRID VGPU** (dropdown, with 'Configure...' button)
 - Max number of monitors: **Automatic** (dropdown)
 - Max resolution of any one monitor: **NVIDIA GRID VGPU** (dropdown)
 - HTML Access: ☐ **Enabled** (checkbox)

At the bottom, there are buttons for '< Back', 'Next >', and 'Cancel'.



Testing

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Testing

- OpenGFX
- Won't run without an OpenGL capable graphics card
- Can highlight other problems



GFXBench – It Works!

gfxbench.com

More

Testing with M60-4Q

- Lowest FPS: Texturing @ 44.8432 Fps
- Highest FPS: Driver Overhead 2 @ 61.5149 Fps
- Off screen Lowest FPS: 1080p Texturing Offscreen @ 98.2536 Fps
- Off screen Highest FPS: 1080p Tessellation Offscreen @ 1212.62 Fps

Testing with M60-8Q

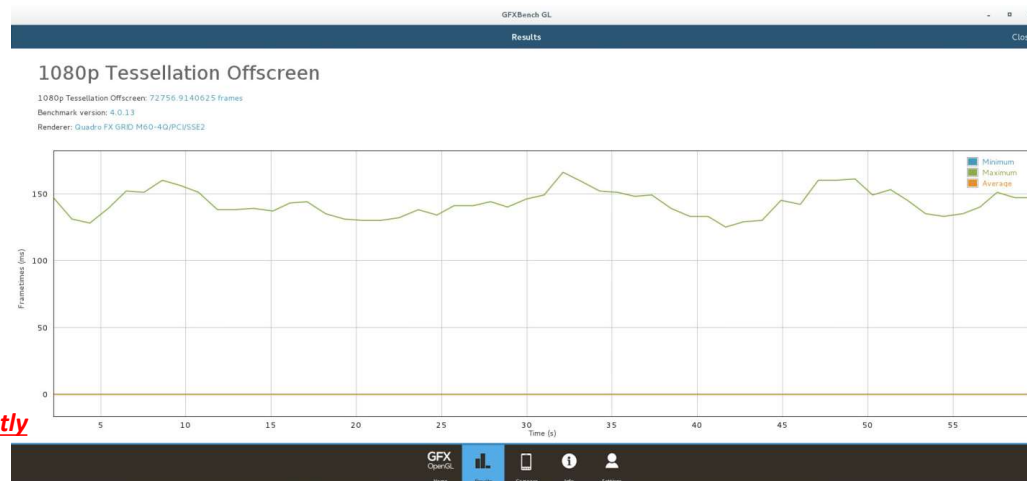
- Lowest FPS: Texturing @ 44.6732 Fps
- Highest FPS: Driver Overhead 2 @ 61.3333 Fps
- Off screen Lowest FPS: 1080p Texturing Offscreen @ 90.7743 Fps
- Off screen Highest FPS: 1080p Tessellation Offscreen @ 1212.87 Fps

Single pass results in a non-optimized environment, individual results may vary significantly

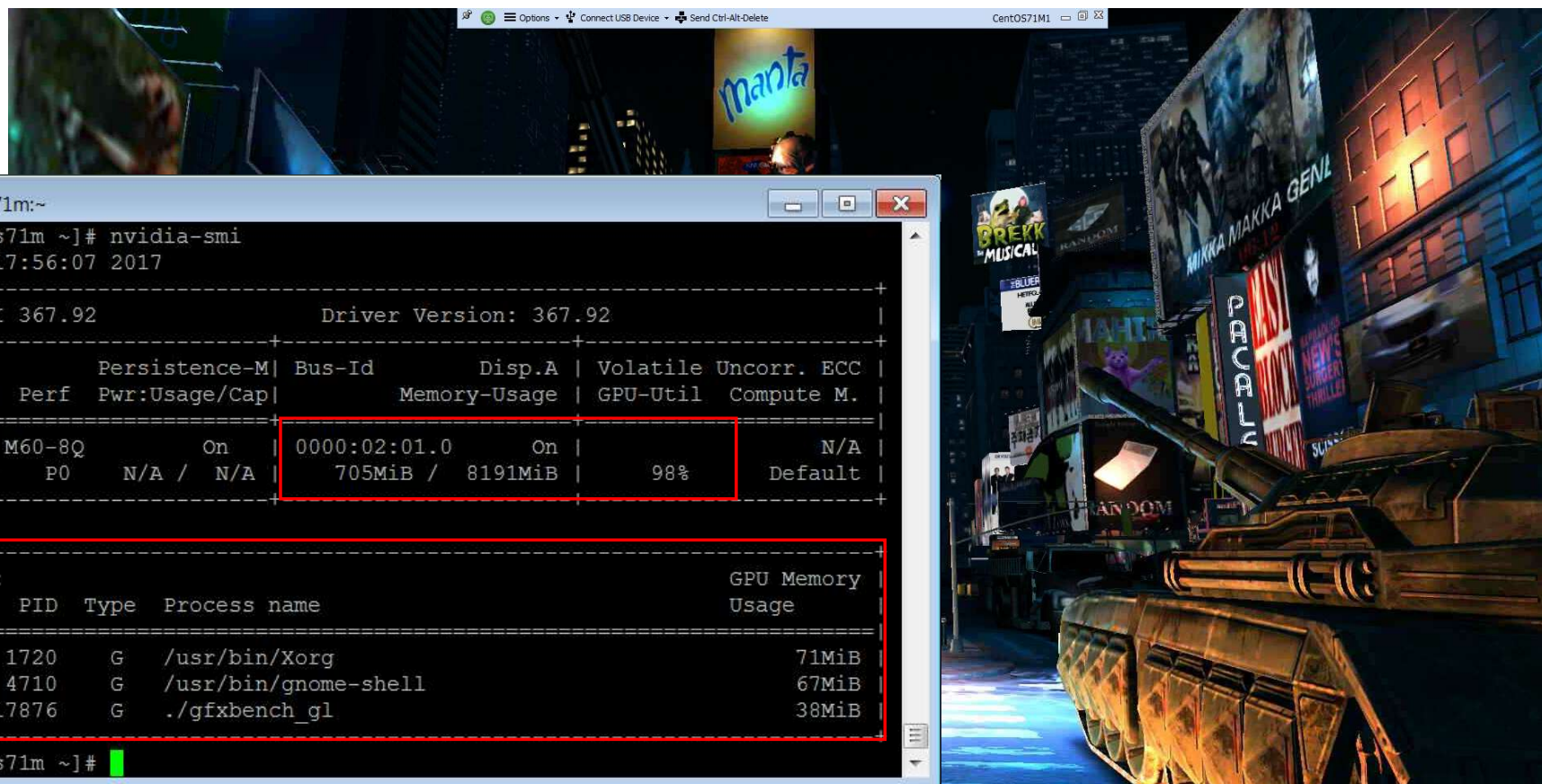
#GTC #S7349

Testing with Passthrough

- Lowest FPS: Texturing @ 43.8369 Fps
- Highest FPS: Tessellation @ 736.984 Fps
- Off screen Lowest FPS: 1080p Texturing Offscreen @ 137.295 Fps
- Off screen Highest FPS: 1080p Tessellation Offscreen @ 1316.73 Fps



Performance – nvidia-smi



```
root@centos71m:~# nvidia-smi
Thu May 4 17:56:07 2017

+-----+
| NVIDIA-SMI 367.92                Driver Version: 367.92 |
+-----+-----+
| GPU Name Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|      Memory-Usage | GPU-Util  Compute M. |
+-----+-----+
|  0  GRID M60-8Q      On   | 0000:02:01.0    On   |          N/A         |
| N/A   N/A   P0     N/A /  N/A | 705MiB / 8191MiB |    98%    Default   |
+-----+-----+

Processes:
+-----+
| GPU   PID   Type   Process name      | GPU Memory Usage |
+-----+-----+
|  0    1720   G      /usr/bin/Xorg       |         71MiB    |
|  0    4710   G      /usr/bin/gnome-shell |         67MiB    |
|  0    17876  G      ./gfxbench_gl       |         38MiB    |
+-----+-----+

[root@centos71m ~]#
```

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nvidia-smi stats

- Generates GPU statistics such as power samples, utilization samples, xid events, clock change events, and performance capping events
- Supported on Kepler or newer GPUs under Linux
- Supported on Tesla, GRID, and Quadro products
- *Experimental Feature*

```
rtpsol608.solutions1.rtp.lab.emc.com - PuTTY
[rtpsol608:~] nvidia-smi
Fri May 5 20:14:14 2017

+-----+
| NVIDIA-SMI 367.92                  Driver Version: 367.92 |
+-----+-----+
| GPU  Name      Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|      Memory-Usage | GPU-Util  Compute M. |
+-----+-----+
| 0   Tesla M60   On         | 0000:86:00.0  Off  |           Off       |
| N/A   50C    P0     70W / 150W | 8179MiB / 8191MiB |    40%    Default   |
+-----+-----+

+-----+
| Processes:                         GPU Memory |
|   GPU       PID    Type    Process name      Usage   |
+-----+-----+
|    0      154721   C+G    CentOS71_1         8160MiB |
+-----+

[rtpsol608:~] nvidia-smi stats
0, pwrDraw , 1494015268453762, 105
0, pwrDraw , 1494015268483821, 108
0, pwrDraw , 1494015268513762, 112
0, pwrDraw , 1494015268543851, 108
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```

```
root@centos71m:~
Fri May 5 16:15:41 2017

+-----+
| NVIDIA-SMI 367.92                  Driver Version: 367.92 |
+-----+-----+
| GPU  Name      Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|      Memory-Usage | GPU-Util  Compute M. |
+-----+-----+
| 0   GRID M60-8Q   On         | 0000:02:01.0  On  |           N/A       |
| N/A   N/A    P0     N/A /  N/A | 1163MiB / 8191MiB |    77%    Default   |
+-----+-----+

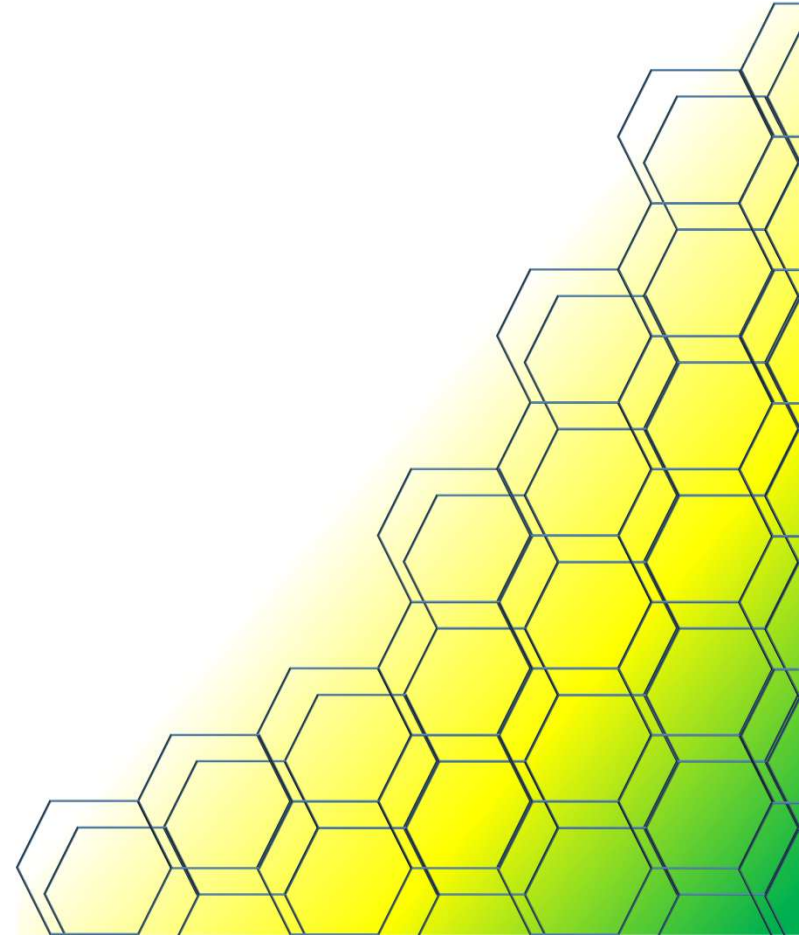
+-----+
| Processes:                         GPU Memory |
|   GPU       PID    Type    Process name      Usage   |
+-----+-----+
|    0      1839     G    /usr/bin/Xorg         48MiB |
|    0       4708     G    /usr/bin/gnome-shell  49MiB |
|    0       6013   C+G    ./gfxbench_gl       537MiB |
+-----+

[root@centos71m ~]#
```



Resources & References

#GTC #S7349



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 - http://us.download.nvidia.com/Windows/Quadro_Certified/GRID/363.24/ESXi-6.0/361.45.44-363.24-nvidia-grid-vgpu-user-guide.pdf
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- NVIDIA GRID Packaging, Pricing, and Licensing
 - <http://images.nvidia.com/content/grid/pdf/161207-GRID-Packaging-and-Licensing-Guide.pdf>
- Release Notes GRID vGPU for VMware vSphere Version 367.92/369.95 - 1drnrd.me/vGPU42RN
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- NVIDIA GRID™ VGPU™ DEPLOYMENT GUIDE FOR VMWARE HORIZON 6.1
 - <http://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/products/horizon/grid-vgpu-deployment-guide.pdf>
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- ThatVirtualBoy.com – Deploying Linux VDI Pools with Horizon 7
 - <https://thatvirtualboy.com/2016/09/27/deploying-linux-vdi-pools-with-horizon-7/>
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 - http://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/c/hw/C240M4/install/C240M4/gpu.html
- GFXBench
 - <http://gfxbench.com>

Questions?



- Thank you for attending
- Please complete the session survey in the mobile app

Tony Foster
@wonder_nerd
Tony.Foster@wondernerd.net
<https://wondernerd.net>

Trey Johnson
3.johnson@gmail.com