



GPUMODESWITCH

DU-07764-001 | April 2016

User Guide



DOCUMENT CHANGE HISTORY

DU-07764-001

Version	Date	Authors	Description of Change
1.0	8/30/2015	AC	Initial release
2.0	4/15/2016	PD	Described the mode without interaction and VMware ESXi support

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Chapter 1. INTRODUCTION

`gpumodeswitch` is a command-line tool that is used to switch supported NVIDIA GPUs between *compute* and *graphics* mode. This chapter describes these modes and when to use them. Chapter 2 describes how to use `gpumodeswitch`.

1.1 COMPUTE AND GRAPHICS MODE

NVIDIA Tesla GPUs are shipped in a configuration optimized for high-performance compute (HPC) applications:

Setting	Value	Notes
Classcode	3D Controller	This classcode indicates to operating systems (OS) that the GPU is not intended for use as a primary display device.
Memory BAR	8 gigabytes	Tesla GPUs expose a large memory <i>base address register</i> (BAR) for direct access to the framebuffer from the CPU, and other PCI Express devices.
I/O base BAR	Disabled	The GPU need not consume any legacy I/O resources when used as a non-display device.
ECC protection	Enabled	Error Correcting Code (ECC) is enabled on the GPU framebuffer to protect against single- and multi-bit memory errors.

Table 1 Compute mode settings

Collectively this GPU configuration is referred to as *compute mode*. While compute mode is optimal for HPC usage, it can cause compatibility problems with OS and hypervisors when the GPU is used primarily as a graphics device:

- ▶ Some OS require that the GPU advertise a VGA display controller classcode in order for the GPU to be used as a primary graphics device.
- ▶ Some hypervisors cannot support passthrough of GPUs with large memory BARs to guest virtual machines.

To address these problems, certain NVIDIA Tesla GPUs support setting the GPU into *graphics mode*:

Setting	Value	Notes
Classcode	VGA Controller	This classcode indicates to OS that the GPU can function as a primary display device.
Memory BAR	256 megabytes	The GPUs a smaller memory BAR for direct access to the framebuffer.
I/O base BAR	Enabled	The GPU exposes an I/O BAR to claim the resources require to operate as a VGA controller.
ECC protection	Disabled	ECC protection is disabled by default, though it can still be enabled by use of the <code>nvidia-smi</code> management tool

Table 2 Graphics mode settings

The mode of the GPU is established directly at power-on, from settings stored in the GPU's non-volatile memory. `gpumodeswitch` is used to program the mode of the GPU by updating the GPU's non-volatile memory settings.

1.2 WHEN TO USE GRAPHICS MODE

We recommend that graphics mode be used whenever supported Tesla products are used in the following scenarios:

- ▶ GPU passthrough with hypervisors that do not support large BARs. At the time of publication, this includes Citrix XenServer 6.2, 6.5, VMware ESXi 5.1, 5.5, 6.0, Red Hat Enterprise Linux 7.0, 7.1.
- ▶ GPU passthrough to Windows VMs on Xen and KVM hypervisors.
- ▶ GRID Virtual GPU deployments.
- ▶ VMware vSGA deployments.



Note: consult individual NVIDIA product release notes for the latest information on compatibility with compute and graphics modes.

1.3 SUPPORTED PRODUCTS

At the time of writing, `gpumodeswitch` is supported on the following products:

- ▶ Tesla M60
- ▶ Tesla M6

Chapter 2. USING GPUMODESWITCH

`gpumodeswitch` is a command line utility that runs on Windows, Linux, or VMware ESXi. This chapter describes how to use `gpumodeswitch`, and the optional Linux boot packages included with `gpumodeswitch`.

2.1 SUPPORTED ENVIRONMENTS

`gpumodeswitch` can be run in the following environments

- ▶ Windows 64-bit command prompt
- ▶ Linux 32/64-bit shell (including Citrix XenServer dom0)
- ▶ VMware ESXi hypervisor



Note: If the server platform hosting the Tesla GPUs does not natively run any of the supported environments, we recommend temporarily booting Linux on the server; the `gpumodeswitch` release package includes bootable Linux images for this purpose. These images are described in section 2.5.

2.2 WHAT'S IN THE PACKAGE

File	Description
gpumodeswitch.exe	Windows executable
nvflsh64.sys	Windows 64-bit driver module
gpumodeswitch	Linux executable, also usable on XenServer dom0
NVIDIA-GpuModeSwitch-10EM.600.0.0.2494585.x86_64.vib	vSphere Installation Bundle (VIB) for VMware ESXi
gpumodeswitch.iso	Bootable Linux ISO image
gpumodeswitch.zip	Bootable Linux image for use with USB storage (e.g. a flash key)

2.3 INSTALLING THE GPUMODESWITCH VIB

If you are using VMware ESXi as your hypervisor, you must install the `gpumodeswitch` VIB before attempting to run `gpumodeswitch`.

To install the VIB you need to access the ESXi host through the ESXi Shell or secure shell (SSH). For information about how to enable ESXi Shell or SSH for an ESXi host, see the VMware documentation.

1. Put the ESXi host into maintenance mode.

```
# vim-cmd hostsvc/maintenance_mode_enter
```

2. If an NVIDIA driver is already installed on the ESXi host, remove the driver.

- a) Get the name of the VIB package that contains the NVIDIA driver.

```
# esxcli software vib list | grep -i nvidia
```

- b) Remove the VIB package that contains the NVIDIA driver.

```
# esxcli software vib remove -n NVIDIA-driver-package
```

NVIDIA-driver-package is the VIB package name that you got in the previous step.

3. Run the `esxcli` command to install the VIB.

```
# esxcli software vib install -v /NVIDIA-GpuModeSwitch-10EM.600.0.0.2494585.x86_64.vib
```

4. Take the host out of maintenance mode.

```
# vim-cmd hostsvc/maintenance_mode_exit
```

5. Reboot the ESXi host.

```
# reboot
```


2.4 RUNNING GPUMODESWITCH

gpumodeswitch supports these operations:

- ▶ Listing the current mode of GPUs in the host
- ▶ Changing the mode of individual or all GPUs

For each operation, gpumodeswitch writes a log file that contains information about the operation. For details, see “Log files created by gpumodeswitch,” on page 11.

2.4.1 Prerequisites for running gpumodeswitch

Before running gpumodeswitch, ensure that the prerequisites for your environment are met:

- ▶ For Linux and VMware ESXi, ensure that you can run gpumodeswitch as root.
- ▶ For Windows, ensure that the following prerequisites are met:
 - You have administrator permissions (see Figure 2 on page 14).
 - The nvflash64.sys driver is in the same directory as the gpumodeswitch executable.

2.4.2 Listing current GPU modes

To list the current mode of all GPUs in the system, use `--listgpumodes`:

```
# gpumodeswitch --listgpumodes

NVIDIA GPU Mode Switch Utility Version 1.02
Copyright (C) 2015, NVIDIA Corporation. All Rights Reserved.

PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00
Adapter: PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (47,8747) : uChip 25AA320A 1.8-5.5V 4Kx8S, page
GPU Mode: N/A

Tesla M60           (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00
Adapter: Tesla M60    (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
GPU Mode: Graphics

Tesla M60           (10DE,13F2,10DE,113A) H:82:SP16 S:00,B:84,PCI,D:00,F:00
Adapter: Tesla M60    (10DE,13F2,10DE,113A) H:82:SP16 S:00,B:84,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
GPU Mode: Compute

#
```

2.4.3 Switching GPU modes

To switch a GPU's mode, use the `--gpumode` command: `--gpumode graphics` switches to graphics mode, `--gpumode compute` switches to compute mode.



Note: after a GPU mode switch, the server platform should be rebooted to ensure that the modified resources of the GPU are correctly accounted for by any OS or hypervisor running on the platform.

2.4.3.1 Switching all GPUs interactively

By default, the command works on all supported GPUs in the host. When prompted, type `y` to confirm the mode switch:

```
# gpumodeswitch --gpumode graphics

NVIDIA GPU Mode Switch Utility Version 1.02
Copyright (C) 2015, NVIDIA Corporation. All Rights Reserved.

Update GPU Mode of all adapters to "graphics"?
Press 'y' to confirm or 'n' to choose adapters or any other key to abort:
y
Updating GPU Mode of all eligible adapters to "graphics"

PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00
Adapter: PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (47,8747) : uChip 25AA320A 1.8-5.5V 4Kx8S, page
Cannot set GPU mode for this adapter

Tesla M60          (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00
Adapter: Tesla M60          (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page

Programming UPR setting for requested mode..
License image updated successfully.

Programming ECC setting for requested mode..
The display may go *BLANK* on and off for up to 10 seconds or more during the update
process depending on your display adapter and output device.

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
NOTE: Preserving straps from original image.
Clearing original firmware image...
Storing updated firmware image...
.....
```

```

Verifying update...
Update successful.

Firmware image has been updated from version 84.04.7C.00.00 to 84.04.7C.00.00.

A reboot is required for the update to take effect.

InfoROM image updated successfully.

Tesla M60          (10DE,13F2,10DE,113A) H:82:SP16 S:00,B:84,PCI,D:00,F:00
Adapter: Tesla M60          (10DE,13F2,10DE,113A) H:82:SP16 S:00,B:84,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page

Programming UPR setting for requested mode..
License image updated successfully.

Programming ECC setting for requested mode..
The display may go *BLANK* on and off for up to 10 seconds or more during the update
process depending on your display adapter and output device.

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
NOTE: Preserving straps from original image.
Clearing original firmware image...
Storing updated firmware image...
.....
Verifying update...
Update successful.

Firmware image has been updated from version 84.04.7C.00.00 to 84.04.7C.00.00.

A reboot is required for the update to take effect.

InfoROM image updated successfully.
#

```

2.4.3.2 Switching all GPUs without interaction

To switch all supported GPUs in the host without confirming the mode switch, use the `--auto` command.

```

# gpumodeswitch --gpumode graphics --auto

NVIDIA GPU Mode Switch Utility Version 1.23.0
Copyright (C) 2015, NVIDIA Corporation. All Rights Reserved.

NOTE: Unconfigured display adapter found, device not accessible:
      PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:03,PCI,D:00,F:00

NOTE: Unconfigured display adapter found, device not accessible:

```

```

      PLX (8747h)                (10B5,8747,10B5,8747) H:82:SP8 S:00,B:83,PCI,D:00,F:00

Tesla M60                      (10DE,13F2,10DE,113A) H:04:SP8 S:00,B:05,PCI,D:00,F:00
Adapter: Tesla M60            (10DE,13F2,10DE,113A) H:04:SP8 S:00,B:05,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page

Programming UPR setting for requested mode..
License image updated successfully.

Programming ECC setting for requested mode..
The display may go *BLANK* on and off for up to 10 seconds or more during the update
process depending on your display adapter and output device.

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
NOTE: Preserving straps from original image.
Clearing original firmware image...
Storing updated firmware image...
.....
Verifying update...
Update successful.

Firmware image has been updated from version 84.04.85.00.00 to 84.04.85.00.00.

A reboot is required for the update to take effect.

InfoROM image updated successfully.

Tesla M60                      (10DE,13F2,10DE,113A) H:04:SP16 S:00,B:06,PCI,D:00,F:00
Adapter: Tesla M60            (10DE,13F2,10DE,113A) H:04:SP16 S:00,B:06,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page

Programming UPR setting for requested mode..
License image updated successfully.

Programming ECC setting for requested mode..
The display may go *BLANK* on and off for up to 10 seconds or more during the update
process depending on your display adapter and output device.

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
NOTE: Preserving straps from original image.
Clearing original firmware image...
Storing updated firmware image...
.....
Verifying update...
Update successful.

```

```
Firmware image has been updated from version 84.04.85.00.00 to 84.04.85.00.00.

A reboot is required for the update to take effect.

InfoROM image updated successfully.

PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00
Adapter: PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (47,8747) : uChip 25AA320A 1.8-5.5V 4Kx8S, page
Cannot set GPU mode for this adapter

Tesla M60          (10DE,13F2,10DE,113A) H:84:SP8 S:00,B:85,PCI,D:00,F:00
Adapter: Tesla M60          (10DE,13F2,10DE,113A) H:84:SP8 S:00,B:85,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page

Programming UPR setting for requested mode..
License image updated successfully.

Programming ECC setting for requested mode..
The display may go *BLANK* on and off for up to 10 seconds or more during the update
process depending on your display adapter and output device.

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
NOTE: Preserving straps from original image.
Clearing original firmware image...
Storing updated firmware image...
.....
Verifying update...
Update successful.

Firmware image has been updated from version 84.04.85.00.00 to 84.04.85.00.00.

A reboot is required for the update to take effect.

InfoROM image updated successfully.

Tesla M60          (10DE,13F2,10DE,113A) H:84:SP16 S:00,B:86,PCI,D:00,F:00
Adapter: Tesla M60          (10DE,13F2,10DE,113A) H:84:SP16 S:00,B:86,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page

Programming UPR setting for requested mode..
License image updated successfully.

Programming ECC setting for requested mode..
```

```
The display may go *BLANK* on and off for up to 10 seconds or more during the update
process depending on your display adapter and output device.
```

```
Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
NOTE: Preserving straps from original image.
Clearing original firmware image...
Storing updated firmware image...
.....
Verifying update...
Update successful.

Firmware image has been updated from version 84.04.85.00.00 to 84.04.85.00.00.

A reboot is required for the update to take effect.

InfoROM image updated successfully.

#
```

2.4.3.3 Switching individual GPUs

To switch the mode of an individual GPU, type **n** when prompted, then enter the index of the GPU you wish to switch:

```
# gpumodeswitch --gpumode graphics

NVIDIA GPU Mode Switch Utility Version 1.02
Copyright (C) 2015, NVIDIA Corporation. All Rights Reserved.

Update GPU Mode of all adapters to "graphics"?
Press 'y' to confirm or 'n' to choose adapters or any other key to abort:
n
Select display adapter:
<0> PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00
<1> Tesla M60          (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00
<2> Tesla M60          (10DE,13F2,10DE,113A) H:82:SP16 S:00,B:84,PCI,D:00,F:00
<3> PLX (8747h)        (10B5,8747,10B5,8747) H:--:NRM S:00,B:85,PCI,D:00,F:00
<4> PLX (8747h)        (10B5,8747,10B5,8747) H:86:SP8 S:00,B:87,PCI,D:00,F:00
<5> GRID K520          (10DE,118A,10DE,100D) H:88:SP8 S:00,B:89,PCI,D:00,F:00
<6> GRID K520          (10DE,118A,10DE,100D) H:88:SP16 S:00,B:8A,PCI,D:00,F:00
Select a number (ESC to quit): 1

Tesla M60              (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00
Adapter: Tesla M60     (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00

Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page

Programming UPR setting for requested mode..
License image updated successfully.

Programming ECC setting for requested mode..
```

The display may go *BLANK* on and off for up to 10 seconds or more during the update process depending on your display adapter and output device.

```
Identifying EEPROM...
EEPROM ID (EF,3013) : WBond W25X40A 2.7-3.6V 4096Kx1S, page
NOTE: Preserving straps from original image.
Clearing original firmware image...
Storing updated firmware image...
.....
Verifying update...
Update successful.

Firmware image has been updated from version 84.04.7C.00.00 to 84.04.7C.00.00.

A reboot is required for the update to take effect.

InfoROM image updated successfully.
#
```

2.4.4 Log files created by gpumodeswitch

For each operation that it performs, `gpumodeswitch` creates a log file that contains information about the operation. The file name and content of the log file depend on the operation.

Operation	Command	Log File Name	Log File Contents
List GPU modes	<code>--listgpumode</code>	<code>listgpumodes.txt</code>	A summary of GPU modes
Switch GPU modes	<code>--gpumode</code>	<code>setgpumode.txt</code>	A summary of the command executed

2.4.4.1 Log file for listing GPU modes

The `--listgpumode` command writes GPU mode information to a log file named `listgpumodes.txt`.

The log file summarizes GPU modes:

```
# more /tmp/listgpumodes.txt
GPU ID:
PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00
GPU Mode: N/A
GPU ID:
Tesla M60           (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00
GPU Mode: Graphics
GPU ID:
Tesla M60           (10DE,13F2,10DE,113A) H:82:SP16 S:00,B:84,PCI,D:00,F:00
GPU Mode: Graphics
#
```

2.4.4.2 Log file for switching GPU modes

The `--gpumode` command writes GPU mode update information to a log file named `setgpumode.txt`.

The log file summarizes the command execution:

```
# more /tmp/setgpumode.txt
GPU ID:
PLX (8747h)          (10B5,8747,10B5,8747) H:--:NRM S:00,B:81,PCI,D:00,F:00
Cannot set GPU mode for this adapter
GPU ID:
Tesla M60           (10DE,13F2,10DE,113A) H:82:SP8 S:00,B:83,PCI,D:00,F:00
Successfully updated GPU mode to graphics.
GPU ID:
Tesla M60           (10DE,13F2,10DE,113A) H:82:SP16 S:00,B:84,PCI,D:00,F:00
Successfully updated GPU mode to graphics.
#
```

2.4.4.3 Changing the log file directory

By default `gpumodeswitch` creates the log file in the current working directory **if** the current working directory is writable. To change the directory in which the log file is created, use the `--outfilepath` option.

The following example commands create the log file in the `/tmp` directory:

- ▶ Listing current GPU modes:

```
# gpumodeswitch --listgpumodes --outfilepath /tmp/
```

- ▶ Switching GPUs to graphics mode:

```
# gpumodeswitch --gpumode graphics --outfilepath /tmp
```



Note: When using the bundled Linux bootable images (see section 2.5), the system boots into a read-only file system. Log files can be generated by using the `outfilepath` option to write the log files into `/tmp`.

2.5 LINUX BOOTABLE IMAGES

If your server platform is not running one of the `gpumodeswitch` supported environments, use one the Linux bootable images included in the release to boot your server to a minimal Linux environment that includes `gpumodeswitch`.

2.5.1 Booting directly from ISO

The `gpumodeswitch.iso` file in the release package is intended for direct boot on a server platform, using the server's remote management capability. Connect the ISO file as an emulated storage device on the server, reboot the server, and use the BIOS boot menu to select the emulated device for boot.

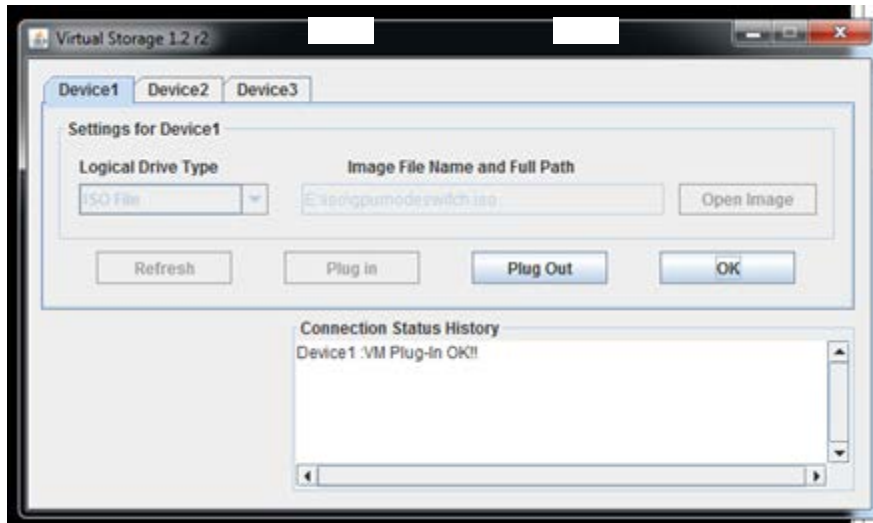


Figure 1 Connecting `gpumodeswitch.iso` via server remote management

The ISO image boots to a Linux shell prompt from which `gpumodeswitch` can be run directly. For instructions, see “Running `gpumodeswitch`,” on page 5.

2.5.2 Booting from a USB flash key

The `gpumodeswitch.zip` file in the release package is intended to be unpacked onto a USB flash key, which can then be used to boot the server.

On a Windows system, follow these steps to create a bootable USB key:

1. Connect a USB flash key of at least 64 megabytes in size.
2. In Windows Explorer, right-click on the USB drive and select `Format` to format it. **Note the driver letter that is assigned to the USB drive** (for example, `E:`).
3. Unzip `gpumodeswitch.zip` to the freshly formatted USB drive. Do this by right-clicking on the zip file, select “`Extract All...`”, browse to the USB drive’s letter, and then select `OK` to unzip the contents.
4. Open a Windows command prompt with Administrator privileges. Do this by searching for ‘`cmd`’, then right-click on the `cmd` program icon and selecting ‘`Run as administrator`’:

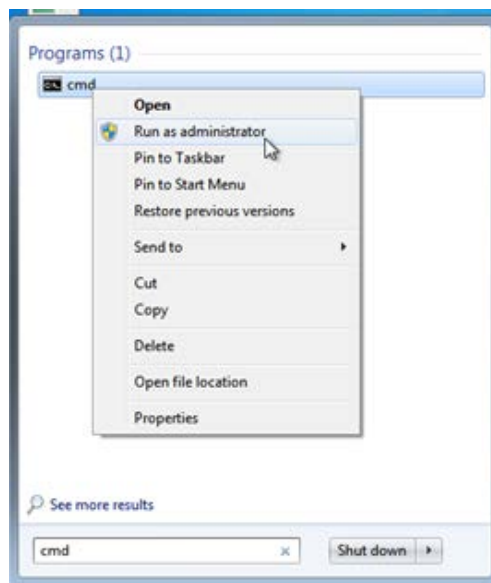


Figure 2 Launching an administrator command prompt

5. In the command prompt, change to the USB drive by typing its drive letter and then hitting return; for example, ‘`e:`’)
6. Run the following command, substituting your USB drive’s letter for ‘`e:`’ –


```
syslinux -m -a e:
```
7. Close the command prompt’s window, and eject and unplug the USB drive.
8. Boot the server from the USB drive.

The image boots to a Linux shell prompt from which `gpumodeswitch` can be run directly. For instructions, see “`Running gpumodeswitch`,” on page 5.

2.6 TROUBLESHOOTING

2.6.1 Unloading an existing NVIDIA driver

You cannot run `gpumodeswitch` in a non-Windows environment where an existing NVIDIA driver is already loaded on the GPU.

In a Linux environment or a XenServer environment, the `gpumodeswitch` command fails and an error is reported:

```
[root@xenserver ~]# ./gpumodeswitch --listgpumodes

NVIDIA GPU Mode Switch Utility Version 1.02
Copyright (C) 2015, NVIDIA Corporation. All Rights Reserved.
...

ERROR: In order to avoid the irreparable damage to your graphics
adapter it is necessary to unload the NVIDIA kernel driver first:

        rmmmod nvidia

[root@xenserver ~]#
```

In a VMware ESXi environment, the `gpumodeswitch` command is not available.

2.6.1.1 Linux

1. Halt any services that are using the GPU.
2. Unload the NVIDIA driver

```
[root@linux ~]# rmmmod nvidia
```

2.6.1.2 XenServer

1. Halt any VMs that are using the GPU.
2. Stop XenServer's `gpumon` service.

```
[root@xenserver ~]# service xcp-rrdd-gpumon stop
Stopping XCP RRDD plugin xcp-rrdd-gpumon: [ OK ]
```

3. Unload the NVIDIA kernel driver.

```
[root@xenserver ~]# rmmmod nvidia
```

2.6.1.3 VMware ESXi

Remove the driver and install the `gpumodeswitch` VIB as explained in “Installing the `gpumodeswitch` VIB,” on page 4.

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