



# NVIDIA RTX Enterprise Release 515 Drivers, Version 516.59

For NVIDIA RTX, Quadro, Quadro Notebook, NVS, and Data Center GPUs  
Windows 10 and Windows 11

Release Notes

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# Chapter 1. Introduction to Release Notes

This edition of *Release Notes* describes the Release 515 family of NVIDIA<sup>®</sup> RTX, Quadro<sup>®</sup>, NVS<sup>™</sup>, Data Center, and Quadro Notebook Drivers for Microsoft<sup>®</sup> Windows<sup>®</sup> 10 and Windows 11. NVIDIA provides these notes to describe performance improvements and bug fixes in each documented version of the driver.

## 1.1 Structure of the Document

This document is organized in the following sections:

- ▶ [Release 515 Driver Changes](#) gives a summary of changes, and fixed and open issues in this version.
- ▶ [The Release 515 Driver](#) describes the NVIDIA products and languages supported by this driver, the system requirements, and how to install the driver.
- ▶ [NVIDIA Tesla Compute Cluster Mode](#) describes the Tesla Compute Cluster mode.

## 1.2 Changes in this Edition

This edition of the *Release Notes* for Windows 10 includes information about NVIDIA graphics driver version 516.59, and lists changes made to the driver since version 512.78.

These changes are discussed beginning with the chapter [Release 515 Driver Changes](#).

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# Chapter 2. Release 515 Driver Changes

This chapter describes open issues for version 516.59, and resolved issues and driver enhancements for versions of the Release 515 driver up to version 516.59.

The chapter contains these sections:

- ▶ [Version 516.59 Highlights](#)
- ▶ [Changes in Version 516.59](#)

## 2.1 Version 516.59 Highlights

This section provides highlights of version 516.59 of the NVIDIA Release 515 Driver for Windows 10 and Windows 11.

- ▶ [Existing Support](#)
- ▶ [What's New in Version 516.59](#)
- ▶ [What's New in Release 515](#)
- ▶ [Discontinued and Unsupported Features](#)
- ▶ [Limitations in This Release](#)

### 2.1.1 Existing Support

This release supports the following APIs:

1. Open Computing Language (OpenCL™ software) 3.0 for NVIDIA® Maxwell™ and later GPUs
2. OpenGL® 4.6
3. Vulkan® 1.3
4. DirectX 11
5. DirectX 12
6. NVIDIA® CUDA® 11.7

This driver installs NVIDIA RTX Desktop Manager version 203.05.

## 2.1.2 What's New in Version 516.59

### 2.1.2.1 New Features

- ▶ Refer to [Changes in Version 516.59](#) and [What's New in Release 515](#) for the list of new features introduced since Release 510.

## 2.1.3 What's New in Release 515

The section summarizes the following driver changes in Release 515 (since Release 510).

### 2.1.3.1 NVIDIA RTX Production Branch Driver

Release 515 is the latest Production Branch release of the NVIDIA RTX Enterprise Driver. The new Production Branch provides improvements over the previous branch in the areas of application performance, API interoperability (e.g., OpenCL/Vulkan), and application power management.

Production Branch drivers are a superset of the NVIDIA Studio Drivers and provides all the benefits of the Studio Driver of the same version in addition to NVIDIA RTX-specific enhancements and testing.

### 2.1.3.2 New Features

- ▶ This release includes bug fixes and driver component enhancements to improve performance.
- ▶ Studio Application/Feature Support:
  - **Blender 3.2**—support for OpenVDB platform enabled, offering infinite 3D index space to import/export massive USD files
  - **BorisFX Sapphire 2022.5**—support for multi-GPU systems, enabling GPU scaling and GPU-accelerated performance increases with plugins (e.g., Blackmagic DaVinci Resolve)
  - **Topaz Denoise AI 3.7.0**—support for TensorRT to allow faster inference speeds with NVIDIA GPUs

### 2.1.3.3 NVIDIA OpenCL Vulkan Interop

The NVIDIA OpenCL driver has added support for the following new provisional extension specifications released by Khronos. The specifications are for OpenCL external semaphore and external memory.

1. [https://www.khronos.org/registry/OpenCL/specs/3.0-unified/html/OpenCL\\_Ext.html#cl\\_khr\\_semaphore](https://www.khronos.org/registry/OpenCL/specs/3.0-unified/html/OpenCL_Ext.html#cl_khr_semaphore)
2. [https://www.khronos.org/registry/OpenCL/specs/3.0-unified/html/OpenCL\\_Ext.html#cl\\_khr\\_external\\_semaphore](https://www.khronos.org/registry/OpenCL/specs/3.0-unified/html/OpenCL_Ext.html#cl_khr_external_semaphore)
3. [https://www.khronos.org/registry/OpenCL/specs/3.0-unified/html/OpenCL\\_Ext.html#cl\\_khr\\_external\\_memory](https://www.khronos.org/registry/OpenCL/specs/3.0-unified/html/OpenCL_Ext.html#cl_khr_external_memory)

NVIDIA is seeking developer feedback on this new extension support.

### 2.1.3.4 OpenCL External semaphore and memory extensions

The set of new External Memory and Semaphore Sharing extensions provides a generic framework that enables OpenCL to import external memory and semaphore handles exported by external APIs—using a methodology that will be familiar to Vulkan developers—and then use those semaphores to synchronize with the external runtime, coordinating the use of shared memory.

The following key features are supported as part of these extensions:

1. Importing memory into buffers using FD, Win32 KMT and NT handles
2. Importing memory into images using FD, Win32 KMT and NT handles
3. Importing binary semaphores using FD, Win32 KMT and NT handles
4. Synchronizing using Wait and Signal on imported semaphores
5. Using buffers and images imported in OpenCL kernels and other APIs such as other regular `cl_mem`.

### 2.1.3.5 Limitations of the Current Implementation

1. Support for importing external memory and semaphores using FD handles on Linux and Win32 NT and KMT handles on Windows. No other handle types are currently available.
2. Support for binary semaphores only.
3. No support for exporting semaphore or memory from OpenCL.
4. `clEnqueueAcquireExternalMemObjectsKHR` and `clEnqueueReleaseExternalMemObjectsKHR` APIs are currently not required as execution hand-off can be managed through semaphore wait and signal. But, these may be required in the future for correct functionality.

### 2.1.3.6 NVIDIA OpenCL Compiler Upgrade

The NVIDIA OpenCL driver uses an embedded OpenCL Just-In-Time (JIT) compiler based on the legacy 3.4 versions of the NVVM optimizer component and CLANG compiler front-end. NVIDIA plans to upgrade its OpenCL JIT compiler to use version 7.0 of the CLANG front-end and NVVM optimizer component.

NVIDIA is releasing this new OpenCL compiler as an opt-in feature in this driver release, with the default OpenCL compiler remaining the same. In a subsequent driver release, the default compiler will be switched to use the new components, replacing the old compiler. This approach provides an opportunity to solicit feedback from OpenCL customers and work to ensure this feature meets functional and performance expectations for key use-cases prior to the final release.

### 2.1.3.7 Enabling the OpenCL NVVM 7.0 Compiler

As part of this driver install, a new compiler library should be visible in the system folder as `libnvidia-compiler-next` along with the old `libnvidia-compiler`. The driver by default will pick the old compiler unless the following environment variable is set:

```
NVCL_USE_NVVM70_COMPILER=1
```



### 2.1.3.8 NVVM 7.0 New Compiler Features

The new NVVM 7.0 based compiler takes advantage of years of development in the Clang+LLVM framework. In addition to several minor bug fixes and diagnostic improvements, this compiler introduces the following noteworthy features:

#### ► 16-bit floating point (half) type

16-bit floating point types or “half” type is available as a native data type in the new compiler. This type is enabled by the `cl_khr_fp16` feature guard pragma.

Example:

```
#pragma OPENCL EXTENSION cl_khr_fp16 : enable

half scalar_arith(half n, half k) {
    half w = n + k; 8
    half x = n - k; -1
    half y = w * x; -8
    half z = y / x; 8
    return -z;
}

__kernel void foo(__global int* x) {
    half a = 3.5H, b = 4.5H;

    if (scalar_arith(a, b) == -8.0)
        *x = 1;
    return;
}
```

#### ► 128-bit integer type

128-bit integer types or “(un)signed long long” is available as a native data type in the new compiler. This type is enabled by default and does not require any macros to be defined

Example:

```
typedef unsigned long long ULL;
typedef long long LL;

LL scalar_arith (ULL n, ULL k) {
    LL w = n + k;
    LL x = n - k;
    LL y = w * x;
    LL z = y / x;
    return -z;
}

__kernel void foo( global int* x)
    ULL a = 0x123456789ABCDEF0ULL;

    ULL b = 0xFEDCBA9876543210ULL;

    if (scalar_arith(a, b) < 0)
        *x = 1;
    return;
}
```

#### ► Upgraded math libraries

The built-in standard math functions (e.g. `sin()`, `cos()`) have been upgraded to be on par with CUDA C++. This ensures that your application benefits from high-performance math routines optimized for the latest GPU architectures.

### 2.1.3.9 Known Issues with NVVM 7.0-based Compiler

The new Clang/NVVM 7.0 based compiler has stricter error checking compared to the previous compiler. The following use-cases which were allowed with the older compiler may now throw an error.

1. Updating `const` variables after they have been assigned.
2. Using address spaces other than `global` for kernel pointer parameters.
3. Using `variadic` arguments in functions and blocks.

## 2.1.4 Discontinued and Unsupported Features

### 2.1.4.1 End of Support for 10-bit Grayscale Over DVI

Effective with Release 515, the ability to display 10-bit grayscale over DVI will no longer be supported. Displays requiring 10-bit packed pixel grayscale format will either show a different resolution than expected or corrupted output if not reconfigured to non-packed pixel mode.

### 2.1.4.2 Discontinued Support for Kepler Desktop GPUs

- ▶ Release 470 was the last driver branch to support desktop GPUs from the Kepler architecture generation.

## 2.1.5 Limitations in This Release

The following features are not currently supported or have limited support in this driver release:

### 2.1.5.1 External Graphics

- ▶ External GPU Surprise Removal

Not all applications have been designed to address surprise removal of the external GPU; disconnection of the external GPU while applications are running is not advised.

- ▶ Mixed GeForce/Quadro Products

Mixed GeForce/Quadro products are supported (Geforce GPU + Quadro eGPU, or Quadro GPU + Geforce eGPU), but requires installation of the GeForce driver package. The Quadro package does not install GeForce drivers.

### 2.1.5.2 OpenCL 3.0 Known Issues

- ▶ Device-Side-Enqueue related queries may return 0 values, although corresponding built-ins can be safely used by kernel.

This is in accordance with conformance requirements described at [https://www.khronos.org/registry/OpenCL/specs/3.0-unified/html/OpenCL\\_API.html#opencl-3.0-backwards-compatibility](https://www.khronos.org/registry/OpenCL/specs/3.0-unified/html/OpenCL_API.html#opencl-3.0-backwards-compatibility).

- ▶ The denormalized results for some math functions that were flushed to zero when cl-fast-relaxed-math is passed as a compiler option on OpenCL 1.2 drivers won't be flushed to zero with OpenCL 3.0 drivers.
- ▶ Shared virtual memory - the current implementation of shared virtual memory is limited to 64-bit platforms only.

### 2.1.5.3 Cross-adapter Clone Mode

Under Windows 10, clone mode across graphics processors is handled by the Windows OS, and not by the NVIDIA driver. Consequently, there are no controls for cross-adapter clone mode in the NVIDIA Control Panel under Windows 10.

Functionality of some display controls in the NVIDIA Control Panel may be affected if cross-adapter clone mode is enabled through the Windows Control Panel. In this case, use the Windows Control Panel to adjust display settings.

### 2.1.5.4 Optimus Systems

Because cross-adapter clone mode is handled by the Windows 10 OS, there are no display controls in the NVIDIA Control Panel if no display is connected to the NVIDIA GPU.

## 2.2 Changes in Version 516.59

The following sections list the important changes and the most common issues resolved in this driver version.

### 2.2.1 Fixed issues

- ▶ [Blender]: Blender Benchmark GUI version fails to properly open on Quadro/RTX products
- ▶ [Control Panel][Notebook]: Default value of "Preferred graphics processor" field is blank for some 3D profiles
- ▶ [Mosaic]: Unable to set displays as client when topology is configured with 2x Quadro Sync II cards
- ▶ [MultiDisplay]: HD video playback gets stuck with 12+ displays

### 2.2.2 Known issues

- ▶ Users may encounter an NVIDIA Display Driver Installation Error – "An unknown error has occurred." In the event this error occurs with the NVIDIA RTX Enterprise Driver Version 516.59, please download the NVIDIA RTX Enterprise Driver Version 516.25 first and then proceed to reinstall the NVIDIA RTX Enterprise Driver Version 516.59. [NVIDIA RTX Enterprise Driver Version 516.25](#) is available for download from the NVIDIA Driver Downloads page below:  
<https://www.nvidia.com/Download/Find.aspx?lang=en-us>
- ▶ Earlier versions of NVIDIA RTX Experience (i.e., prior to 1.4.1.11) may exhibit issues with new driver updates. In the event this behavior occurs, please download and install [NVIDIA RTX Experience Version 1.4.1.11](#) to resolve the issues.

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# Chapter 3. The Release 515 Driver

This chapter covers the following main topics:

- ▶ [Driver Security](#)
- ▶ [Advanced Driver Information](#)
- ▶ [Known Product Limitations](#)
- ▶ [Hardware and Software Support](#)

## 3.1 Driver Security

Follow these safe computing practices:

- ▶ Only download or execute content and programs from trusted third parties.
- ▶ Run your system and programs with the least privilege necessary. Users should run without administrator rights whenever possible.
- ▶ When running as administrator, do not elevate UAC privileges for activities or programs that don't need them.

This section describes additional actions to take to mitigate specific known security issues.

### 3.1.1 Restricting/Enabling Access to GPU Performance Counters

The NVIDIA graphics driver contains a vulnerability (CVE-2018-6260) that may allow access to application data processed on the GPU through a side channel exposed by the GPU performance counters. GPU performance counters are needed by developers in order to use NVIDIA developer tools such as CUPTI, Nsight Graphics, and Nsight Compute. In order to address CVE-2018-6260 the driver (starting with version 419.67) automatically disables access for non-admin users. For more information about CVE-2018-6260 visit the [NVIDIA Security Bulletin 4772](#).

#### 3.1.1.1 Enabling Access to GPU Performance Counters Using the NVIDIA Control Panel

Access to GPU performance counters can be enabled for non-admin users who need to use NVIDIA developer tools. Enabling access to GPU performance counters can be accomplished through the

NVIDIA Control Panel->Developer->Manage GPU Performance Counters page. Refer to the Developer->Manage GPU Performance Counters section of the NVIDIA Control Panel Help for instructions.



Note: Access to GPU performance counters should be kept disabled for non-admin users who do not need to use NVIDIA developer tools.

### 3.1.1.2 Restricting/Enabling Access to GPU Performance Counters Across an Enterprise Using Scripts

Enterprise administrators can use scripts to programmatically apply the settings. The scripts should incorporate the registry key information provided below to automate the deployment.



CAUTION: These instructions should be performed only by enterprise administrators. Changes to the registry must be made with care. System instability can result if performed incorrectly.

```
[HKLM\SYSTEM\CurrentControlSet\Services\nvlddmkm\Global\NVTweak]
Value: "RmProfilingAdminOnly"
Type: DWORD
Data: 00000001
```

The data value 1 restricts access to admin users, whereas data value 0 allows access to all users. A system reboot is required for the changes to take effect.

## 3.2 Advanced Driver Information

This section clarifies instructions for successfully accomplishing the following tasks:

- ▶ [Turning Off V-Sync to Boost Performance](#)
- ▶ [NVIDIA Application Configuration Engine \(ACE\)](#)
- ▶ [Using the WDDM Driver Model with Tesla GPU GOMs](#)
- ▶ [SLI Multi-OS – GPU Assignment in System Virtualization](#)

### 3.2.1 Turning Off V-Sync to Boost Performance

To get the best benchmark and application performance measurements, turn V-Sync off as follows:

1. Open the NVIDIA Control Panel and make sure that *Advanced Settings* is selected from the control panel tool bar.
2. From the *Select a Task* pane, under 3D Settings, click Manage 3D Settings, then click the Global Settings tab.
3. From the Global presets pull-down menu, select Base profile.
4. From the Settings list box, select Vertical sync and change its value to Force off, then click Apply.

5. From the Global presets pull-down menu, select 3D App - Default Global Settings (the driver's default profile) or use the application profile that matches the application you are testing, then click Apply.

Be sure to close the NVIDIA Control Panel completely —leaving it open will affect benchmark and application performance.

## 3.2.2 NVIDIA Application Configuration Engine (ACE)

This driver includes the NVIDIA Application Configuration Engine (ACE), which automatically detects the workstation application and configures the appropriate profile settings in the NVIDIA Control Panel.

See the *NVIDIA Quadro Professional Drivers: NVIDIA Control Panel Quick Start Guide* for more information about this feature.

## 3.2.3 Using the WDDM Driver Model with Tesla GPU GOMs

### 3.2.3.1 Tesla GPU Operation Modes

Tesla K20X and K20 GPU Accelerators offer the ability to specify the GPU operation mode using NV-SMI/NVML (refer to: <https://developer.nvidia.com/nvidia-management-library-nvml>).

By setting the GPU operation mode, developers can selectively turn off certain features in the GPU to get the best performance per watt for certain workloads.

The following are the supported GOMs:

- ▶ Compute-Only: For running compute tasks only.  
By default the Tesla K20X and K20 accelerator boards ship in this mode.
- ▶ Low-Double Precision: For graphics applications that don't require high bandwidth double precision.  
This is recommended for workloads that are not sensitive to double precision but at the same time need graphics capabilities.
- ▶ All On: This is recommended only when the workload needs full double precision as well as graphics capabilities.

### 3.2.3.2 WDDM and TCC Driver Models

Along with the GPU operation mode, the developer needs to select the compatible driver model for the Tesla K20X and K20.

- ▶ Tesla Compute Cluster (TCC): Optimized for running compute workloads.
- ▶ Windows Device Driver Model (WDDM): Designed for graphics application and not recommended for compute workloads.

### 3.2.3.3 Compatibility Between GOM and Driver Models

Table 1 shows which GPU operation modes are compatible with which driver models.

Table 1. GOM and Driver Model Compatibility

| GOM                  | TCC Driver Model | WDDM Driver Model | Use Case Support   |
|----------------------|------------------|-------------------|--|
| All On               | YES              | YES               | All use cases are supported.   |
| Compute-Only         | YES              | NO                | The following are unsupported:<br>X11 and those that require X11 (GLInterop, OCL conformance and VIPER)<br>32-bit Windows OS |
| Low Double Precision | YES              | YES               | All use cases supported.   |

The compute-only GOM is supported only on the TCC driver model, while the WDDM driver model supports only GOM modes that enable graphics.

The compute-only GOM and WDDM are incompatible and should not be used simultaneously.

*The Tesla K20 Active Accelerators for workstations ship in “compute-only” mode and cannot be modified. Therefore, use only the TCC driver model with these products.*

### 3.2.3.4 Using the WDDM Driver Model

To use the WDDM driver model with Tesla K20x and K20 GPU Accelerators for servers, first switch the GOM mode from compute-only to All On, then switch from TCC to WDDM.

*Do not attempt to specify the driver model by editing the registry.* Doing so can result in compute-only GOM and WDDM being configured simultaneously, which might require a clean installation of the driver to fix.

*Always use NVIDIA-provided tools to specify a processing mode or to switch between driver models.*

Such tools include nvidia-smi or the NVIDIA Control Panel->Manage Maximus Settings page. These tools provide warnings in the case of a conflict.

## 3.2.4 SLI Multi-OS – GPU Assignment in System Virtualization

On systems with two or more graphics cards installed, this driver supports a hypervisor's ability to directly assign GPUs to guest virtual machines (VMs). This direct assignment allows each guest VM to run on their own operating system with their own GPU and driver. The assignment allows full GPU performance and functionality in the guest VM.

### 3.2.4.1 Hardware Platform Requirements

To make use of GPU passthrough with virtual machines running Windows and Linux, the hardware platform must support the following features:

- ▶ A CPU with hardware-assisted instruction set virtualization: Intel VT-x or AMD-V.
- ▶ Platform support for I/O DMA remapping.

On Intel platforms the DMA remapper technology is called Intel VT-d. On AMD platforms it is called AMD IOMMU.

Support for these features varies by processor family, product, and system, and should be verified at the manufacturer's website.

### 3.2.4.2 Supported Hypervisors

The following hypervisors are supported:

| Hypervisor                    | Notes                  |
|-------------------------------|------------------------|
| Citrix XenServer              | Version 6.0 and later. |
| VMware vSphere (ESX / ESXi)   | Version 5.1 and later. |
| Parallels Workstation Extreme | Version 4 and later    |

### 3.2.4.3 Supported Graphics Cards

The following GPUs are supported for device passthrough:

| GPU Family    | Boards supported   |
|---------------|--|
| NVIDIA Ampere | NVIDIA Data Center: A100, A40, A30, A16, A10, A2<br>NVIDIA RTX: A6000, A5500, A5000, A4000H, A4000 |
| Turing        | Quadro: RTX 8000, RTX 6000, RTX 5000, RTX 4000<br>NVIDIA Data Center: T4                           |



| GPU Family | Boards supported   |
|------------|--|
| Volta      | <u>Quadro</u> : GV100<br>NVIDIA Data Center: V100  |
| Pascal     | <u>Quadro</u> : P2000, P4000, P5000, P6000, GP100 <u>Tesla</u> : P100, P40, P4   |
| Maxwell    | <u>Quadro</u> : K2200, M2000, M4000, M5000, M6000, M6000 24GB<br><u>Tesla</u> : M60, M10, M6   |
| Kepler     | <u>Quadro</u> : K2000, K4000, K4200, K5000, K5200, K6000<br><u>Tesla</u> : K10, K20, K20x, K20Xm, K20c, K20s, K40m, K40c, K40s, K40st, K40t, K80 |

### 3.2.4.4 Notes and Known Issues

#### 3.2.4.4.1 VMware

- ▶ PCI I/O hole may need to be changed for Windows 64-bit VMs.

Windows 64-bit VMs may require that you edit the VM configuration file to configure a larger PCI I/O hole for the GPU.

- ▶ Access Control Services is required on some switches.

Starting with ESX 5.0 Update 1, Access Control Services (ACS) is required on any switches in the PCIe hierarchy above a PCIe device that is to be used for passthrough. If ACS is not present, ESX will not allow the device to be assigned directly to a VM.

- ▶ To allow assignment of devices below switches that do not support ACS, you can disable the ACS check as follows:

```
esxcfg-advcfg -k true disableACScheck
```

- ▶ Configuring passthrough to a Windows Server 2008R2 VM.

The VMware WDDM driver must be manually installed on Windows Server 2008 R2. Follow the steps provided at: <http://communities.vmware.com/message/1423263#1425288>.

- ▶ MSI translation must be disabled for ESXi 5.1 and 5.5.

Blue-screen crashes may occur on VMs with assigned GPUs if MSI is initially enabled for passthrough devices.

To avoid this issue, disable MSI translation by setting *pciPassthru0.msiEnabled* = "FALSE" in the VM's VMX file.

Disabling MSI translation is not needed for ESXi 6.0 and later.

#### 3.2.4.4.2 Citrix XenServer

- ▶ XenServer 6.1 workaround for 64-bit MMIO failures on PCI passthrough.

Dom0 kernel may relocate GPU BARs to an invalid location immediately beyond the end of physical RAM. There are two workaround options to address this condition:

Workaround option #1: Add 'pci=use\_crs' to the kernel parameters by running the following command in Dom0:

```
/opt/xensource/libexec/xen-cmdline --set-dom0 pci=use_crs
```

Workaround option #2: Install the hotfix provided by Citrix at <http://support.citrix.com/article/CTX137645>).

## 3.3 Known Product Limitations

This section describes problems that will not be fixed. Usually, the source of the problem is beyond the control of NVIDIA. Following is the list of problems and where they are discussed in this document:

- ▶ [Issues Installing the NVIDIA Control Panel from the Windows Store](#)
- ▶ [Some APIs do not Report Total Available Graphics Memory Correctly](#)
- ▶ [Using HDMI/DisplayPort Audio with Displays that have a High Native Resolution](#)
- ▶ [Using HDMI/DisplayPort Audio in Dualview or Clone Mode Configurations](#)
- ▶ [GPU Runs at a High Performance Level in Multi-display Modes](#)
- ▶ [SLI Connector Requirement on NVIDIA Quadro SLI Cards](#)
- ▶ [Applying Workstation Application Profiles](#)

### 3.3.1 Issues Installing the NVIDIA Control Panel from the Windows Store

You may encounter issues when attempting to install the NVIDIA Control Panel from the Windows Store under Windows 10, such as:

- ▶ The download process from the Windows Store freezes at the "Starting download ..." stage.
- ▶ The NVIDIA Control Panel fails to download after initiating the download from the notification popup that appears upon installing the driver.

For assistance with installing the NVIDIA Control Panel from the Microsoft Windows Store, see the NVIDIA Knowledge Base Article, [NVIDIA Control Panel Windows Store App](#).

For information about the DCH vs Standard drivers for Windows 10, see the NVIDIA Knowledge Base Article, [NVIDIA DCH/Standard Display Drivers for Windows 10 FAQ](#).

### 3.3.2 Some APIs Do Not Report Total Available Graphics Memory Correctly

#### 3.3.2.1 Background—TAG Memory

In the Windows Display Driver Model (WDDM), Total Available Graphics (TAG) memory is reported as the sum of

- ▶ Dedicated Video Memory (video memory dedicated for graphics use)
- ▶ Dedicated System Memory (system memory dedicated for graphics use), and
- ▶ Shared System Memory (system memory shared between the graphics subsystem and the CPU).

The values for each of these components are computed according to WDDM guidelines when the NVIDIA Display Driver is loaded.

### 3.3.2.2 Issue

NVIDIA has found that some TAG-reporting APIs represent video memory using 32-bits instead of 64-bits, and consequently do not properly report available graphics memory when the TAG would otherwise exceed 4 gigabytes (GB). This results in under reporting of available memory and potentially undesirable behavior of applications that rely on these APIs to report available memory.

The reported memory can be severely reduced. For example, 6 GB might be reported as 454 MB, and 8 GB might be reported as 1259 MB.

### 3.3.2.3 NVIDIA Action for Some GeForce-based Systems

For GeForce GPUs with 2.75 GB or less of video memory, the NVIDIA display driver constrains TAG memory to just below 4 GB<sup>1</sup>. In this scenario, the Shared System Memory component of TAG is limited first, before limiting Dedicated Video Memory.

This is a policy decision within the driver, and results in reliable reporting of sub-4 GB TAG memory.

- 
1. The WDDM guidelines dictate minimum and maximum values for the components, but the display driver may further constrain the values that are reported (within the allowed minimum and maximum)

### 3.3.2.4 When TAG Reporting Would Not Be Limited

For GeForce-based GPUs with more than 2.75 GB of video memory, as well as all Quadro and Tesla GPUs, the NVIDIA display driver does not constrain TAG memory reporting.

The disadvantage of constraining TAG on systems with larger amounts of video and system memory is that memory which otherwise would be available for graphics use is no longer available. Since shared system memory is limited first, driver components and algorithms utilizing shared system memory may suffer performance degradation when TAG is constrained.

Since these and similar scenarios are prevalent in many Workstation applications, the NVIDIA driver avoids constraining TAG on all Quadro and Tesla-based systems. Likewise, the driver does not constrain TAG for GeForce-based systems with more than 2.75 GB of video memory.

## 3.3.3 Using HDMI/DisplayPort Audio with Displays that have a High Native Resolution

*To use HDMI/DisplayPort audio with some displays that have a native resolution higher than 1920x1080, you must set the display to a lower HD resolution.*

Some HDMI TVs have a native resolution that exceeds the maximum supported HD mode. For example, TVs with a native resolution of 1920x1200 exceed the maximum supported HD mode of 1920x1080.

Applying this native mode results in display overscan which cannot be resized using the NVIDIA Control Panel since the mode is not an HD mode.

To avoid this situation and provide a better user experience, the driver treats certain TVs— such as the Viewsonic VX2835wm and the Westinghouse LVM- 37w3—as a DVI monitor when applying the native mode. Because the driver does not treat the TV as an HDMI in this case, the HDMI audio is not used.

## 3.3.4 Using HDMI/DisplayPort Audio in Dualview or Clone Mode Configurations

### 3.3.4.1 Two Audio-enabled Ports

In a multi-display configuration where both HDMI/DisplayPort audio ports are enabled, only the primary display will provide the audio.

### 3.3.4.2 One Audio-enabled Port

In a multi-display configuration where only one audio port is enabled, such as when one display is a DVI display, then the HDMI/DisplayPort display can provide the audio whether is it the primary or secondary display.

## 3.3.5 GPU Runs at a High Performance Level in Multi-display Modes

This is a hardware limitation and not a software bug. Even when no 3D programs are running, the driver will operate the GPU at a high performance level in order to efficiently drive multiple displays. In the case of SLI or multi-GPU PCs, the second GPU will always operate with full clock speeds; again, in order to efficiently drive multiple displays. Today, all hardware from all GPU vendors have this limitation.

## 3.3.6 SLI Connector Requirement on NVIDIA Quadro SLI Cards

The SLI connector that links two SLI cards is needed for proper SLI operation. However, the connector can be removed if you do not intend to enable SLI mode. If you remove the connector, then you must make sure that SLI mode is disabled from the NVIDIA control panel. Enabling SLI mode without the SLI connector installed will result in video corruption.

## 3.3.7 Applying Workstation Application Profiles

### ► Background

The workstation application profiles are software settings used by the NVIDIA Display Drivers to provide optimum performance when using a selected application. The profile also works around known application issues and bugs.

If there is an available setting for an application, it should be used, otherwise incorrect behavior or reduced performance is likely to occur.

► Issues

Configuration changes require that you restart the application.

Once an application is running, it does not receive notification of configuration changes. Therefore, if you change the configuration while the application is running, you must exit and restart the application for the configuration changes to take effect.

---

## Chapter 4. Hardware and Software Support

This chapter covers the following main topics:

- [Supported Operating Systems](#)
- [Supported NVIDIA Workstation GPUs](#)
- [Supported NVIDIA Notebook GPUs](#)
- [Supported Languages](#)

## 4.1.1 Supported Operating Systems

The Release 515 driver, version 516.59, has been tested with

- ▶ Microsoft Windows® 11
- ▶ Microsoft Windows® 10, 64-bit (versions 1909 and later)

## 4.1.2 Supported NVIDIA Workstation GPUs

The following tables list the NVIDIA products supported by the Release 515 driver, version 516.59.

### 4.1.2.1 NVIDIA Quadro, NVS, & RTX Product

Table 2. Supported NVIDIA Quadro & NVS Products

| Product                | GPU Architecture |
|------------------------|------------------|
| NVIDIA RTX A6000       | NVIDIA Ampere    |
| NVIDIA RTX A5500       | NVIDIA Ampere    |
| NVIDIA RTX A5000       | NVIDIA Ampere    |
| NVIDIA RTX A4500       | NVIDIA Ampere    |
| NVIDIA RTX A4000H      | NVIDIA Ampere    |
| NVIDIA RTX A4000       | NVIDIA Ampere    |
| NVIDIA RTX A2000 12GB  | NVIDIA Ampere    |
| NVIDIA RTX A2000       | NVIDIA Ampere    |
| NVIDIA Quadro RTX 8000 | Turing           |
| NVIDIA Quadro RTX 6000 | Turing           |
| NVIDIA Quadro RTX 5000 | Turing           |
| NVIDIA Quadro RTX 4000 | Turing           |
| NVIDIA Quadro RTX 3000 | Turing           |
| NVIDIA T1000 8GB       | Turing           |
| NVIDIA T1000           | Turing           |
| NVIDIA T600            | Turing           |
| NVIDIA T400 4GB        | Turing           |
| NVIDIA T400            | Turing           |

| Product                  | GPU Architecture |
|--------------------------|------------------|
| NVIDIA Quadro GV100      | Volta            |
| NVIDIA Quadro GP100      | Pascal           |
| NVIDIA Quadro P6000      | Pascal           |
| NVIDIA Quadro P5000      | Pascal           |
| NVIDIA Quadro P4000      | Pascal           |
| NVIDIA Quadro P2200      | Pascal           |
| NVIDIA Quadro P2000      | Pascal           |
| NVIDIA Quadro P1000      | Pascal           |
| NVIDIA Quadro P600       | Pascal           |
| NVIDIA Quadro P400       | Pascal           |
| NVIDIA Quadro M6000 24GB | Maxwell          |
| NVIDIA Quadro M6000      | Maxwell          |
| NVIDIA Quadro M5000      | Maxwell          |
| NVIDIA Quadro M4000      | Maxwell          |
| NVIDIA Quadro M2000      | Maxwell          |
| NVIDIA Quadro K2200      | Maxwell          |
| NVIDIA Quadro K1200      | Maxwell          |
| NVIDIA Quadro K620       | Maxwell          |
| NVIDIA NVS 810           | Maxwell          |

#### 4.1.2.2 NVIDIA Quadro Sync II

Table 3. Supported NVIDIA Quadro Sync II Products

| Product           | GPU Architecture |
|-------------------|------------------|
| NVIDIA RTX A6000  | NVIDIA Ampere    |
| NVIDIA RTX A5500  | NVIDIA Ampere    |
| NVIDIA RTX A5000  | NVIDIA Ampere    |
| NVIDIA RTX A4500  | NVIDIA Ampere    |
| NVIDIA RTX A4000H | NVIDIA Ampere    |

| Product                | GPU Architecture |
|------------------------|------------------|
| NVIDIA RTX A4000       | NVIDIA Ampere    |
| NVIDIA RTX A2000       | NVIDIA Ampere    |
| NVIDIA Quadro RTX 8000 | Turing           |
| NVIDIA Quadro RTX 6000 | Turing           |
| NVIDIA Quadro RTX 5000 | Turing           |
| NVIDIA Quadro RTX 4000 | Turing           |
| NVIDIA Quadro RTX 3000 | Turing           |
| NVIDIA T1000 8GB       | Turing           |
| NVIDIA T1000           | Turing           |
| NVIDIA T600            | Turing           |
| NVIDIA T400 4GB        | Turing           |
| NVIDIA T400            | Turing           |
| NVIDIA Quadro GV100    | Volta            |
| NVIDIA Quadro GP100    | Pascal           |
| NVIDIA Quadro P6000    | Pascal           |
| NVIDIA Quadro P5000    | Pascal           |
| NVIDIA Quadro P4000    | Pascal           |

### 4.1.2.3 NVIDIA Quadro Sync Products

Table 4. Supported NVIDIA Quadro Sync Products

| Product                  | GPU Architecture |
|--------------------------|------------------|
| NVIDIA Quadro M6000 24GB | Maxwell          |
| NVIDIA Quadro M6000      | Maxwell          |
| NVIDIA Quadro M5000      | Maxwell          |
| NVIDIA Quadro M4000      | Maxwell          |

### 4.1.2.4 NVIDIA Quadro Blade/Embedded Graphics Board

Table 5. Supported NVIDIA Quadro Blade/Embedded Graphics Board Series



| Product                | GPU Architecture |
|------------------------|------------------|
| NVIDIA Quadro RTX 5000 | Turing           |
| NVIDIA Quadro RTX 3000 | Turing           |
| NVIDIA Quadro T1000    | Turing           |
| NVIDIA Quadro P5000    | Pascal           |
| NVIDIA Quadro P3000    | Pascal           |
| NVIDIA Quadro P2000    | Pascal           |
| NVIDIA Quadro P1000    | Pascal           |
| NVIDIA Quadro M5000 SE | Maxwell          |
| NVIDIA Quadro M3000 SE | Maxwell          |

#### 4.1.2.5 NVIDIA Data Center Products

The driver package is designed for systems that have one or more NVIDIA Data Center products installed.

- ▶ Only one GHIC can be connected to the server in a system.
- ▶ This release of the Tesla driver supports CUDA C/C++ applications and libraries that rely on the CUDA C Runtime and/or CUDA Driver API.

Table 6. Supported NVIDIA Data Center Products

| Product                  | GPU Architecture |
|--------------------------|------------------|
| NVIDIA A-Series Products |                  |
| NVIDIA A100              | NVIDIA Ampere    |
| NVIDIA A40               | NVIDIA Ampere    |
| NVIDIA A30               | NVIDIA Ampere    |
| NVIDIA A16               | NVIDIA Ampere    |
| NVIDIA A10               | NVIDIA Ampere    |
| NVIDIA A2                | NVIDIA Ampere    |
| NVIDIA T-Series Products |                  |
| NVIDIA T4                | Turing           |
| NVIDIA V-Series Products |                  |

| Product                 | GPU Architecture |
|-------------------------|------------------|
| NVIDIA V100             | Volta            |
| Tesla P-Series Products |                  |
| NVIDIA Tesla P100       | Pascal           |
| NVIDIA Tesla P40        | Pascal           |
| NVIDIA Tesla P4         | Pascal           |
| Tesla M-Series Products |                  |
| NVIDIA Tesla M60        | Maxwell          |
| NVIDIA Tesla M6         | Maxwell          |

### 4.1.3 Supported NVIDIA Notebook GPUs

The notebook driver is part of the NVIDIA Verde Notebook Driver Program, and can be installed on supported NVIDIA notebook GPUs. However, please note that your notebook original equipment manufacturer (OEM) provides certified drivers for your specific notebook on their website. NVIDIA recommends that you check with your notebook OEM about recommended software updates for your notebook. OEMs may not provide technical support for issues that arise from the use of this driver.

The following tables list the NVIDIA notebook products supported by the Release 515 driver, version 516.59:

Table 7. NVIDIA Quadro Notebook GPU Support

| Notebook Products   | GPU Architecture |
|---|------------------|
| NVIDIA RTX A5500 Laptop GPU NVIDIA RTX A5000 Laptop GPU NVIDIA RTX A4500 Laptop GPU NVIDIA RTX A4000 Laptop GPU NVIDIA RTX A3000 12GB Laptop GPU NVIDIA RTX A3000 Laptop GPU NVIDIA RTX A2000 8GB Laptop GPU NVIDIA RTX A2000 Laptop GPU NVIDIA RTX A1000 Laptop GPU NVIDIA RTX A500 Laptop GPU | NVIDIA Ampere    |
| NVIDIA T1200 Laptop GPU<br>NVIDIA T600 Laptop GPU<br>NVIDIA RTX T550 Laptop GPU   | Turing           |

| Notebook Products | GPU Architecture |
|-------------------|------------------|
| Quadro RTX 6000   | Turing           |
| Quadro RTX 5000   | Turing           |
| Quadro RTX 4000   | Turing           |
| Quadro RTX 3000   | Turing           |
| Quadro T2000      | Turing           |
| Quadro T1000      | Turing           |
| Quadro P5200      | Pascal           |
| Quadro P5000      | Pascal           |
| Quadro P4200      | Pascal           |
| Quadro P4000      | Pascal           |
| Quadro P3200      | Pascal           |
| Quadro P3000      | Pascal           |
| Quadro P620       | Pascal           |
| Quadro P520       | Pascal           |
| Quadro P600       | Pascal           |
| Quadro P500       | Pascal           |
| Quadro M5500      | Maxwell          |
| Quadro M5000M     | Maxwell          |
| Quadro M4000M     | Maxwell          |
| Quadro M3000M     | Maxwell          |
| Quadro M2000M     | Maxwell          |
| Quadro M1000M     | Maxwell          |
| Quadro M600M      | Maxwell          |
| Quadro M500M      | Maxwell          |
| Quadro K2200M     | Maxwell          |
| Quadro K620M      | Maxwell          |

## 4.2 Supported Languages

The Release 515 Graphics Drivers supports the following languages in the main driver Control Panel:

|                       |           |                           |
|-----------------------|-----------|---------------------------|
| English (USA)         | German    | Portuguese (Euro/Iberian) |
| English (UK)          | Greek     | Russian                   |
| Arabic                | Hebrew    | Slovak                    |
| Chinese (Simplified)  | Hungarian | Slovenian                 |
| Chinese (Traditional) | Italian   | Spanish                   |

|         |                     |                         |
|---------|---------------------|-------------------------|
| Czech   | Japanese            | Spanish (Latin America) |
| Danish  | Korean              | Swedish                 |
| Dutch   | Norwegian           | Thai                    |
| Finnish | Polish              | Turkish                 |
| French  | Portuguese (Brazil) |                         |

## 4.3 Driver Installation

### 4.3.1 Minimum Hard Disk Space

The hard disk space requirement is approximately 1.5x the size of the installation download to accommodate extracted and temporary files.

### 4.3.2 Before You Begin

#### 4.3.2.1 nTune

If you have previously installed NVIDIA nTune, NVIDIA recommends that you uninstall nTune before installing this driver. After the driver install is complete, you can reinstall NVIDIA nTune.

#### 4.3.2.2 Notebooks

- ▶ Check to make sure that your notebook has a supported GPU (see [Supported NVIDIA Notebook GPUs.](#))
- ▶ It is recommended that you back up your current system configuration.
- ▶ If you own a Dell Inspiron 1420, Dell XPS M1330, or Dell XPS M1530, or Dell LatitudeD630 or D630c, it is highly recommended that you first install the latest software updates from Dell.

### 4.3.3 Installation Instructions

1. Follow the instructions on the [NVIDIA.com website driver download page](#) to locate the appropriate driver to download, based on your hardware and operating system.
2. Click the **driver download** link.
3. The license agreement dialog box appears.
4. Click **Accept** if you accept the terms of the agreement, then either open the file or save the file to your PC and open it later.
5. Open the NVIDIA driver installation .EXE file to launch the **NVIDIA InstallShield Wizard**.
6. Follow the instructions in the NVIDIA InstallShield Wizard to complete the installation.



Note: If you are over-installing the driver (installing over a previous driver without first removing the previous driver), then you must reboot your computer in order to complete the installation.

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# Chapter 5. NVIDIA Tesla Compute Cluster Mode

This chapter describes the Tesla Compute Cluster (TCC) mode.

- ▶ [About Tesla Compute Cluster Mode](#)
- ▶ [Operating on Systems with non-TCC NVIDIA GPUs](#)
- ▶ [Setting TCC Mode](#)

## 5.1 About Tesla Compute Cluster Mode

### 5.1.1 TCC Overview

Tesla Compute Cluster (TCC) mode is designed for compute cluster nodes that have one or more Tesla or supported Quadro products installed.

#### 5.1.1.1 Benefits

- ▶ TCC drivers make it possible to use NVIDIA GPUs in nodes with non-NVIDIA integrated graphics.
- ▶ NVIDIA GPUs on systems running the TCC drivers will be available via Remote Desktop, both directly and via cluster management systems that rely on Remote Desktop.
- ▶ NVIDIA GPUs will be available to applications running as a Windows service (i.e. in Session 0) on systems running the Tesla driver in TCC mode.

#### 5.1.1.2 TCC Does not Support Graphics Acceleration

- ▶ TCC mode does not provide CUDA–DirectX/OpenGL interoperability.  
It is a “non-display” driver, and NVIDIA GPUs using this driver will not support DirectX or OpenGL hardware acceleration.

### 5.1.2 Running CUDA Applications

- ▶ This release of the Tesla/Quadro driver supports CUDA C/C++ applications and libraries that rely on the CUDA C Runtime and/or CUDA Driver API.

- ▶ NVIDIA GPUs running the Tesla/Quadro driver in TCC mode will be available for CUDA applications running via services or Remote Desktop.
- ▶ In this release, all GPUs will be in compute exclusive mode. As a result, only one CUDA context may exist on a particular device at a time.
- ▶ SDK applications that use graphics will not run properly under TCC mode. The following are examples of CUDA SDK applications that are not supported:

|                    |                    |                 |                |
|--------------------|--------------------|-----------------|----------------|
| bicubicTexture     | boxFilter          | cudaDecodeD3D9  | smokeParticles |
| cudaDecodeGL       | fluidsD3D9         | fluidsGL        | SobelFilter    |
| imageDenoising     | Mandelbrot         | marchingCubes   | volumeRender   |
| nbody              | oceanFFT           | particles       |                |
| postProcessGL      | recursiveGaussian  | simpleD3D10     |                |
| simpleD3D10Texture | simpleD3D11Texture | simpleD3D9      |                |
| simpleD3D9Texture  | simpleGL           | simpleTexture3D |                |

## 5.2 Operating on Systems with non-TCC NVIDIA GPUs

- ▶ NVIDIA GPUs running under TCC mode may coexist with other display devices.
- ▶ The Tesla/Quadro driver is overinstalled over any NVIDIA display driver in the system—the NVIDIA Tesla driver then becomes the only driver for all NVIDIA GPUs in the system.  
If the Tesla/Quadro driver is uninstalled at a later time, the previous driver is not restored.
- ▶ NVIDIA GPUs that do not support TCC mode will appear as “VGA adapters” in the Windows Device Manager and can be used to drive displays.  
Non-supported NVIDIA GPUs can still function as CUDA devices, but the GPU’s graphics functionality is not available to applications.

## 5.3 Setting TCC Mode

To change the TCC mode, use the NVIDIA **smi** utility as follows:

```
nvidia-smi -g (GPU ID) -dm (0 for WDDM, 1 for TCC)
```

The following table shows the default TCC/non-TCC mode for supported products.

Table 8. Default TCC Mode

| Product | Default Mode |
|---------|--------------|
| K20Xm/c | TCC          |

|                                |         |
|--------------------------------|---------|
| K20m                           | TCC Off |
| C2075                          | TCC     |
| C2050                          | TCC Off |
| C2070                          | TCC Off |
| S2050                          | TCC     |
| M2050                          | TCC     |
| M2070                          | TCC     |
| M2075                          | TCC     |
| M2070-Q                        | TCC Off |
| M2090                          | TCC     |
| Quadro (Kepler/Maxwell/Pascal) | TCC Off |

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