Virtual GPU Software R525 for Red Hat Enterprise Linux with KVM

Release Notes

RN-08687-001 _v15.0 through 15.4 | October 2023

Table of Contents

Chapter 1. Release Notes

These *Release Notes* summarize current status, information on validated platforms, and known issues with NVIDIA vGPU software and associated hardware on Red Hat Enterprise Linux with KVM.

Note: The most current version of the documentation for this release of NVIDIA vGPU software can be found online at NVIDIA Virtual GPU Software Documentation.

1.1. NVIDIA vGPU Software Driver Versions

Each release in this release family of NVIDIA vGPU software includes a specific version of the NVIDIA Virtual GPU Manager, NVIDIA Windows driver, and NVIDIA Linux driver.

NVIDIA vGPU Software Version	NVIDIA Virtual GPU Manager Version	NVIDIA Windows Driver Version	NVIDIA Linux Driver Version
15.4	525.147.01	529.19	525.147.05
15.3	525.125.03	529.11	525.125.06
15.2	525.105.14	528.89	525.105.17
15.1	525.85.07	528.24	525.85.05
15.0	525.60.12	527.41	525.60.13

For details of which Red Hat Enterprise Linux with KVM releases are supported, see Hypervisor Software Releases.

1.2. Compatibility Requirements for the NVIDIA vGPU Manager and Guest VM Driver

The releases of the NVIDIA vGPU Manager and guest VM drivers that you install must be compatible. If you install an incompatible guest VM driver release for the release of the vGPU Manager that you are using, the NVIDIA vGPU fails to load.

See VM running an incompatible NVIDIA vGPU guest driver fails to initialize vGPU when booted.

Note: You must use NVIDIA License System with every release in this release family of NVIDIA vGPU software. All releases in this release family of NVIDIA vGPU software are **incompatible** with all releases of the NVIDIA vGPU software license server.

Compatible NVIDIA vGPU Manager and Guest VM Driver Releases

The following combinations of NVIDIA vGPU Manager and guest VM driver releases are compatible with each other.

- NVIDIA vGPU Manager with guest VM drivers from the same release
- NVIDIA vGPU Manager with guest VM drivers from different releases within the same major release branch
- NVIDIA vGPU Manager from a later major release branch with guest VM drivers from the previous branch

Note:

When NVIDIA vGPU Manager is used with guest VM drivers from a different release within the same branch or from the previous branch, the combination supports **only** the features, hardware, and software (including guest OSes) that are supported on both releases.

For example, if vGPU Manager from release 15.4 is used with guest drivers from release 13.1, the combination does **not** support Red Hat Enterprise Linux 8.1 because NVIDIA vGPU software release 15.4 does not support Red Hat Enterprise Linux 8.1.

The following table lists the specific software releases that are compatible with the components in the NVIDIA vGPU software 15 major release branch.

NVIDIA vGPU Software Component	Releases	Compatible Software Releases
NVIDIA vGPU Manager	15.0 through 15.4	▶ Guest VM driver releases 15.0 through 15.4 ▶ All guest VM driver 14.*x* releases
Guest VM drivers	15.0 through 15.4	NVIDIA vGPU Manager releases 15.0 through 15.4

Incompatible NVIDIA vGPU Manager and Guest VM Driver Releases

The following combinations of NVIDIA vGPU Manager and guest VM driver releases are incompatible with each other.

- NVIDIA vGPU Manager from a later major release branch with guest VM drivers from a production branch two or more major releases before the release of the vGPU Manager
- NVIDIA vGPU Manager from an earlier major release branch with guest VM drivers from a later branch

The following table lists the specific software releases that are incompatible with the components in the NVIDIA vGPU software 15 major release branch.

NVIDIA vGPU Software Component	Releases	Incompatible Software Releases
NVIDIA vGPU Manager	15.0 through 15.4	All guest VM driver releases 13.*x* and earlier
Guest VM drivers	15.0 through 15.4	All NVIDIA vGPU Manager releases 14.*x* and earlier

1.3. Updates in Release 15.4

New Features in Release 15.4

- Security updates - see *Security Bulletin: NVIDIA GPU Display Driver - October 2023*, which is posted shortly after the release date of this software and is listed on the NVIDIA Product Security page
- Miscellaneous bug fixes

1.4. Updates in Release 15.3

New Features in Release 15.3

- Security updates - see *Security Bulletin: NVIDIA GPU Display Driver - June 2023*, which is posted shortly after the release date of this software and is listed on the NVIDIA Product Security page
- Miscellaneous bug fixes

Hardware and Software Support Introduced in Release 15.3

- Support for Red Hat Enterprise Linux with KVM hypervisor 9.2 and 8.8
- Support for Red Hat Enterprise Linux 9.2 as a guest OS
- Support for Red Hat Enterprise Linux 8.8 as a guest OS

Feature Support Withdrawn in Release 15.3

- Red Hat Enterprise Linux with KVM hypervisor 9.1, 8.7, and 8.4 are no longer supported.
- Red Hat Enterprise Linux 9.1 is no longer supported as a guest OS.
- Red Hat Enterprise Linux 8.7 and 8.4 are no longer supported as a guest OS.

1.5. Updates in Release 15.2

New Features in Release 15.2

- Support for authenticated local proxy servers by licensed clients of a Cloud License Service (CLS) instance
- Security updates - see *Security Bulletin: NVIDIA GPU Display Driver - March 2023*, which is posted shortly after the release date of this software and is listed on the NVIDIA Product Security page
- Miscellaneous bug fixes

Hardware and Software Support Introduced in Release 15.2

- Support for the for the following GPUs:
  - NVIDIA H800 PCIe 80GB
  - NVIDIA L4
- Support for Rocky Linux as a guest OS

Features Deprecated in Release 15.2

The following table lists features that are deprecated in this release of NVIDIA vGPU software. Although the features remain available in this release, they might be withdrawn in a future release. In preparation for the possible removal of these features, use the preferred alternatives listed in the table.

Deprecated Feature	Preferred Alternatives
CentOS Linux as a guest OS The following CentOS Linux releases are the last releases to be supported by NVIDIA vGPU software: ▶ CentOS Linux 7.9 ▶ CentOS Linux 8 (2011)	Rocky Linux Rocky Linux releases that are compatible with supported Red Hat Enterprise Linux releases are supported.

1.6. Updates in Release 15.1

New Features in Release 15.1

- Support for GPU System Processor (GSP) in NVIDIA vGPU deployments on GPUs based on the NVIDIA Ada Lovelace architecture
- Options in the NVML API and the `nvidia-smi` command for getting information about the scheduling behavior of time-sliced vGPUs
- Support for independent operation of NVIDIA CUDA Toolkit profilers on MIG-backed vGPUs on GPUs based on the NVIDIA Hopper architecture
- Support for NVIDIA Virtual Applications (vApps) on Linux OSes
- Miscellaneous bug fixes

Hardware and Software Support Introduced in Release 15.1

- Support for the for the following GPUs:
  - NVIDIA L40
  - NVIDIA RTX 6000 Ada
- Support for Windows 10 2022 Update (22H2) as a guest OS

1.7. Updates in Release 15.0

New Features in Release 15.0

- Support for NVIDIA GPUDirect® Storage technology on MIG-backed vGPUs
- Assignment of multiple fractional vGPUs to a single VM

  A fractional vGPU is allocated only a fraction of the physical GPU's frame buffer.
- Support for NVIDIA Virtual Compute Server (vCS) in Windows guest VMs
- DCH packaging of the NVIDIA vGPU software graphics driver for Windows guest OSes

  Note: As a result of this change, the path to the registry key for configuring NVIDIA vGPU software licensing has changed. After an upgrade from a package that is not DCH compliant, license settings must be reconfigured in the registry key at the new path to ensure that a VM in which the driver has been upgraded can acquire a license.
- Support for a mixture of TCC and WDM operation for Windows VMs to which multiple vGPUs are assigned
- Unified memory support on the following GPUs:
  - NVIDIA A100 (all variants)
  - NVIDIA A30
- Support for non-transparent local proxy servers when NVIDIA vGPU software is served licenses by a Cloud License Service (CLS) instance
- Miscellaneous bug fixes

Hardware and Software Support Introduced in Release 15.0

- Support for the following GPUs:
  - NVIDIA A100 PCIe 80GB liquid cooled
  - NVIDIA A800 PCIe 80GB
  - NVIDIA A800 PCIe 80GB liquid cooled
  - NVIDIA A800 HGX 80GB
  - NVIDIA H100 PCIe 80GB
- Support for Red Hat Enterprise Linux with KVM hypervisor 9.1 and 8.7
- Support for Red Hat Enterprise Linux 9.1 and 8.7 as a guest OS
- Support for Red Hat CoreOS 4.11 as a guest OS

Feature Support Withdrawn in Release 15.0

- The legacy NVIDIA vGPU software license server is no longer supported.

> **Note:** If you are using the legacy NVIDIA vGPU software license server to serve licenses for an earlier vGPU software release, you **must** migrate your licenses to NVIDIA License System as part of your upgrade to NVIDIA vGPU software 15.0. Otherwise, your guest VMs will **not** be able to acquire a license for NVIDIA vGPU software. For more information, refer to Migrating Licenses from a Legacy NVIDIA vGPU Software License Server in the NVIDIA License System documentation.

- Red Hat CoreOS 4.7 is longer supported as a guest OS
- All versions of Microsoft Windows Server 2016 are no longer supported as a guest OS.

Chapter 2. Validated Platforms

This release family of NVIDIA vGPU software provides support for several NVIDIA GPUs on validated server hardware platforms, Red Hat Enterprise Linux with KVM hypervisor software versions, and guest operating systems. It also supports the version of NVIDIA CUDA Toolkit that is compatible with R525 drivers.

2.1. Supported NVIDIA GPUs and Validated Server Platforms

This release of NVIDIA vGPU software on Red Hat Enterprise Linux with KVM provides support for several NVIDIA GPUs running on validated server hardware platforms. For a list of validated server platforms, refer to NVIDIA GRID Certified Servers.

The supported products for each type of NVIDIA vGPU software deployment depend on the GPU.

Since 15.1: GPUs Based on the NVIDIA Ada Lovelace Architecture

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
NVIDIA L40	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Since 15.2: NVIDIA L4	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
NVIDIA RTX 6000 Ada	▶ vCS	N/A	▶ vCS

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
	▶ vWS ▶ vPC ▶ vApps		▶ vWS ▶ vApps

GPUs Based on the NVIDIA Hopper Architecture

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
Since 15.2: H800 PCIe 80GB	vCS	vCS	vCS
H100 PCIe 80GB	vCS	vCS	vCS

GPUs Based on the NVIDIA Ampere Architecture

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
NVIDIA A800 PCIe 80GB	vCS	vCS	vCS
NVIDIA A800 PCIe 80GB liquid cooled	vCS	vCS	vCS
NVIDIA A800 HGX 80GB	vCS	vCS	vCS
NVIDIA A100 PCIe 80GB	vCS	vCS	vCS
NVIDIA A100 PCIe 80GB liquid cooled	vCS	vCS	vCS
NVIDIA A100X	vCS	vCS	vCS
NVIDIA A100 HGX 80GB	vCS	vCS	vCS
NVIDIA A100 PCIe 40GB	vCS	vCS	vCS
NVIDIA A100 HGX 40GB	vCS	vCS	vCS

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
NVIDIA A40[4]	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
NVIDIA A30	vCS	vCS	vCS
NVIDIA A30X	vCS	vCS	vCS
NVIDIA A16	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
NVIDIA A10	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
NVIDIA A2	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
NVIDIA RTX A6000[4]	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
NVIDIA RTX A5500[4]	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
NVIDIA RTX A5000[4]	▶ vCS ▶ vWS ▶ vPC	N/A	▶ vCS ▶ vWS

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
	▶ vApps		▶ vApps

GPUs Based on the NVIDIA Turing Architecture

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
Tesla T4	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Quadro RTX 6000 [4]	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Quadro RTX 6000 passive[4]	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Quadro RTX 8000[4]	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Quadro RTX 8000 passive[4]	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps

GPUs Based on the NVIDIA Volta Architecture

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
Tesla V100 SXM2	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla V100 SXM2 32GB	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla V100 PCIe	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla V100 PCIe 32GB	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla V100S PCIe 32GB	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla V100 FHHL	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps

GPUs Based on the NVIDIA Pascal™ Architecture

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
Tesla P4	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla P6	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla P40	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla P100 PCIe 16 GB	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla P100 SXM2 16 GB	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps
Tesla P100 PCIe 12GB	▶ vCS ▶ vWS ▶ vPC ▶ vApps	N/A	▶ vCS ▶ vWS ▶ vApps

GPUs Based on the NVIDIA Maxwell Graphic Architecture

Note: NVIDIA Virtual Compute Server (vCS) is **not** supported on GPUs based on the NVIDIA Maxwell™ graphic architecture.

GPU	Supported NVIDIA vGPU Software Products[1,2,3]		
	Time-Sliced NVIDIA vGPU	MIG-Backed NVIDIA vGPU	GPU Pass Through
Tesla M6	▶ vWS ▶ vPC ▶ vApps	N/A	▶ vWS ▶ vApps
Tesla M10	▶ vWS ▶ vPC ▶ vApps	N/A	▶ vWS ▶ vApps
Tesla M60	▶ vWS ▶ vPC ▶ vApps	N/A	▶ vWS ▶ vApps

2.1.1. Switching the Mode of a GPU that Supports Multiple Display Modes

Some GPUs support display-off and display-enabled modes but must be used in NVIDIA vGPU software deployments in display-off mode.

The GPUs listed in the following table support multiple display modes. As shown in the table, some GPUs are supplied from the factory in display-off mode, but other GPUs are supplied in a display-enabled mode.

[1] The supported products are as follows:

- vCS: NVIDIA Virtual Compute Server
- vWS: NVIDIA RTX Virtual Workstation
- vPC: NVIDIA Virtual PC
- vApps: NVIDIA Virtual Applications

[2] N/A indicates that the deployment is not supported.
[3] vApps is supported only on Windows operating systems.
[4] This GPU is supported only in displayless mode. In displayless mode, local physical display connectors are disabled.

GPU	Mode as Supplied from the Factory
NVIDIA A40	Display-off
NVIDIA L40	Display-off
NVIDIA RTX 6000 Ada	Display enabled
NVIDIA RTX A5000	Display enabled
NVIDIA RTX A5500	Display enabled
NVIDIA RTX A6000	Display enabled

A GPU that is supplied from the factory in display-off mode, such as the NVIDIA A40 GPU, might be in a display-enabled mode if its mode has previously been changed.

To change the mode of a GPU that supports multiple display modes, use the `displaymodeselector` tool, which you can request from the NVIDIA Display Mode Selector Tool page on the NVIDIA Developer website.

Note:

Only the following GPUs support the `displaymodeselector` tool:

- NVIDIA A40
- NVIDIA L40
- NVIDIA RTX A5000
- NVIDIA RTX 6000 Ada
- NVIDIA RTX A5500
- NVIDIA RTX A6000

Other GPUs that support NVIDIA vGPU software do not support the `displaymodeselector` tool and, unless otherwise stated, do not require display mode switching.

2.1.2. Switching the Mode of a Tesla M60 or M6 GPU

Tesla M60 and M6 GPUs support compute mode and graphics mode. NVIDIA vGPU requires GPUs that support both modes to operate in graphics mode.

Recent Tesla M60 GPUs and M6 GPUs are supplied in graphics mode. However, your GPU might be in compute mode if it is an older Tesla M60 GPU or M6 GPU or if its mode has previously been changed.

To configure the mode of Tesla M60 and M6 GPUs, use the `gpumodeswitch` tool provided with NVIDIA vGPU software releases. If you are unsure which mode your GPU is in, use the `gpumodeswitch` tool to find out the mode.

Note:

Only Tesla M60 and M6 GPUs support the `gpumodeswitch` tool. Other GPUs that support NVIDIA vGPU do not support the `gpumodeswitch` tool and, except as stated in Switching the Mode of a GPU that Supports Multiple Display Modes, do not require mode switching.

Even in compute mode, Tesla M60 and M6 GPUs do **not** support NVIDIA Virtual Compute Server vGPU types.

For more information, refer to *gpumodeswitch User Guide*.

2.2. Hypervisor Software Releases

This release supports **only** the hypervisor software releases listed in the table.

Note: If a specific release, even an update release, is not listed, it's **not** supported.

Software	Releases Supported	Notes
Since 15.3: Red Hat Enterprise Linux with KVM	9.2	All NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
15.0-15.2 only: Red Hat Enterprise Linux with KVM	9.1	All NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
Red Hat Enterprise Linux with KVM	9.0	All NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
Since 15.3: Red Hat Enterprise Linux with KVM	8.8	All NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
15.0-15.2 only: Red Hat Enterprise Linux with KVM	8.7	All NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
Red Hat Enterprise Linux with KVM	8.6	All NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
15.0-15.2 only: Red Hat Enterprise Linux with KVM	8.4	All NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
Red Hat Enterprise Linux with KVM	7.9	The following GPUs are supported in GPU pass through mode **only**: ▸ NVIDIA H800 PCIe 80GB ▸ NVIDIA H100 PCIe 80GB ▸ NVIDIA A800 PCIe 80GB ▸ NVIDIA A800 PCIe 80GB liquid cooled

Software	Releases Supported	Notes
		▶ NVIDIA A800 HGX 80GB ▶ NVIDIA A100 PCIe 80GB ▶ NVIDIA A100 PCIe 80GB liquid cooled ▶ NVIDIA A100X ▶ NVIDIA A100 HGX 80GB ▶ NVIDIA A100 PCIe 40GB ▶ NVIDIA A100 HGX 40GB ▶ NVIDIA A40 ▶ NVIDIA A30 ▶ NVIDIA A30X ▶ NVIDIA A16 ▶ NVIDIA A10 ▶ NVIDIA A2 ▶ NVIDIA RTX A6000 ▶ NVIDIA RTX A5500 ▶ NVIDIA RTX A5000 All other NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
Red Hat Virtualization (RHV)	4.4	All NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.
Red Hat Virtualization (RHV)	4.3, 4.2	Not supported on the following GPUs: ▶ NVIDIA RTX A6000 ▶ NVIDIA RTX A5500 ▶ NVIDIA RTX A5000 ▶ NVIDIA A40 ▶ NVIDIA A10 ▶ NVIDIA A16 ▶ NVIDIA A2 The following GPUs are supported in GPU pass through mode **only**: ▶ NVIDIA H800 PCIe 80GB ▶ NVIDIA H100 PCIe 80GB ▶ NVIDIA A800 PCIe 80GB

Software	Releases Supported	Notes
		▸ NVIDIA A800 PCIe 80GB liquid cooled ▸ NVIDIA A800 HGX 80GB ▸ NVIDIA A100 PCIe 80GB ▸ NVIDIA A100 PCIe 80GB liquid cooled ▸ NVIDIA A100X ▸ NVIDIA A100 HGX 80GB ▸ NVIDIA A100 PCIe 40GB ▸ NVIDIA A100 HGX 40GB ▸ NVIDIA A30 ▸ NVIDIA A30X All other NVIDIA GPUs that NVIDIA vGPU software supports are supported with vGPU and in pass-through mode.

2.3. Guest OS Support

NVIDIA vGPU software supports several Windows releases and Linux distributions as a guest OS. The supported guest operating systems depend on the hypervisor software version.

Note:

Use only a guest OS release that is listed as supported by NVIDIA vGPU software with your virtualization software. To be listed as supported, a guest OS release must be supported not only by NVIDIA vGPU software, but also by your virtualization software. NVIDIA **cannot** support guest OS releases that your virtualization software does not support.

NVIDIA vGPU software supports **only** 64-bit guest operating systems. No 32-bit guest operating systems are supported.

2.3.1. Windows Guest OS Support

Note: Red Hat Enterprise Linux with KVM and Red Hat Virtualization (RHV) support Windows guest operating systems only under specific Red Hat subscription programs. For details, see:

- Certified guest operating systems for Red Hat Enterprise Linux with KVM
- Certified Guest Operating Systems in Red Hat OpenStack Platform and Red Hat Enterprise Virtualization

NVIDIA vGPU software supports **only** the 64-bit Windows releases listed in the table as a guest OS on Red Hat Enterprise Linux with KVM. The releases of Red Hat Enterprise Linux with KVM for which a Windows release is supported depend on whether NVIDIA vGPU or pass-through GPU is used.

Note:

If a specific release, even an update release, is not listed, it's **not** supported.

Guest OS	NVIDIA vGPU - Red Hat Enterprise Linux with KVM Releases	Pass-Through GPU - Red Hat Enterprise Linux with KVM Releases
Windows Server 2019	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9 RHV 4.4, 4.3, 4.2	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9 RHV 4.4, 4.3, 4.2
Windows 10 2022 Update (22H2) and all Windows 10 releases supported by Microsoft up to and including this release See Note (1)	RHV 4.4, 4.3, 4.2	RHV 4.4, 4.3, 4.2

Note:

1. The hardware-accelerated GPU scheduling feature introduced in Windows 10 May 2020 Update (2004) is **not** supported on GPUs based on the Maxwell architecture and is supported only in pass-through mode on GPUs based on later architectures.

2.3.2. Linux Guest OS Support

NVIDIA vGPU software supports **only** the 64-bit Linux distributions listed in the table as a guest OS on Red Hat Enterprise Linux with KVM. The releases of Red Hat Enterprise Linux with KVM for which a Linux release is supported depend on whether NVIDIA vGPU or pass-through GPU is used.

Note:

If a specific release, even an update release, is not listed, it's **not** supported.

Guest OS	NVIDIA vGPU - Red Hat Enterprise Linux with KVM Releases	Pass-Through GPU - Red Hat Enterprise Linux with KVM Releases
Red Hat CoreOS 4.11	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6

Guest OS	NVIDIA vGPU - Red Hat Enterprise Linux with KVM Releases	Pass-Through GPU - Red Hat Enterprise Linux with KVM Releases
	15.0-15.2 only: RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4	**15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4
Since 15.3: Red Hat Enterprise Linux 9.2	RHEL KVM 9.2, 9.0	RHEL KVM 9.2, 9.0
15.0-15.2 only: Red Hat Enterprise Linux 9.1	RHEL KVM 9.1, 9.0	RHEL KVM 9.1, 9.0
Red Hat Enterprise Linux 9.0	**Since 15.3:** RHEL KVM 9.2, 9.0 **15.0-15.2 only:** RHEL KVM 9.1, 9.0	**Since 15.3:** RHEL KVM 9.2, 9.0 **15.0-15.2 only:** RHEL KVM 9.1, 9.0
Rocky Linux 9.0	**Since 15.3:** RHEL KVM 9.2, 9.0 **15.0-15.2 only:** RHEL KVM 9.1, 9.0	**Since 15.3:** RHEL KVM 9.2, 9.0 **15.0-15.2 only:** RHEL KVM 9.1, 9.0
Since 15.3: Red Hat Enterprise Linux 8.8	RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9	RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9
15.0-15.2 only: Red Hat Enterprise Linux 8.7	RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9	RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9
Red Hat Enterprise Linux 8.6	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9
15.0-15.2 only: Red Hat Enterprise Linux 8.4	RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9	RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9
Rocky Linux 8.4	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9
Deprecated: CentOS Linux 8 (2105)	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9
Red Hat Enterprise Linux 7.9	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9

Guest OS	NVIDIA vGPU - Red Hat Enterprise Linux with KVM Releases	Pass-Through GPU - Red Hat Enterprise Linux with KVM Releases
	15.0-15.2 only: RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9 RHV 4.4, 4.3, 4.2	**15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9 RHV 4.4, 4.3, 4.2
Deprecated: CentOS 7.6-7.8 See Note (1)	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9 RHV 4.4, 4.3, 4.2	**Since 15.3:** RHEL KVM 9.2, 9.0, 8.8, 8.6, 7.9 **15.0-15.2 only:** RHEL KVM 9.1, 9.0, 8.7, 8.6, 8.4, 7.9 RHV 4.4, 4.3, 4.2

Note:

1. CentOS is not a certified guest OS for Red Hat Enterprise Linux with KVM or RHV.

2.4. NVIDIA CUDA Toolkit Version Support

The releases in this release family of NVIDIA vGPU software support NVIDIA CUDA Toolkit 12.0.

To build a CUDA application, the system must have the NVIDIA CUDA Toolkit and the libraries required for linking. For details of the components of NVIDIA CUDA Toolkit, refer to *NVIDIA CUDA Toolkit Release Notes for CUDA 12.0*.

To run a CUDA application, the system must have a CUDA-enabled GPU and an NVIDIA display driver that is compatible with the NVIDIA CUDA Toolkit release that was used to build the application. If the application relies on dynamic linking for libraries, the system must also have the correct version of these libraries.

For more information about NVIDIA CUDA Toolkit, refer to CUDA Toolkit 12.0 Documentation.

Note:

If you are using NVIDIA vGPU software with CUDA on Linux, avoid conflicting installation methods by installing CUDA from a distribution-independent runfile package. Do not install CUDA from a distribution-specific RPM or Deb package.

To ensure that the NVIDIA vGPU software graphics driver is not overwritten when CUDA is installed, deselect the CUDA driver when selecting the CUDA components to install.

For more information, see *NVIDIA CUDA Installation Guide for Linux*.

2.5. Multiple vGPU Support

To support applications and workloads that are compute or graphics intensive, multiple vGPUs can be added to a single VM. The assignment of more than one vGPU to a VM is supported only on a subset of vGPUs and hypervisor software releases.

2.5.1. vGPUs that Support Multiple vGPUs Assigned to a VM

The supported vGPUs depend on the architecture of the GPU on which the vGPUs reside:

- For GPUs based on the NVIDIA Volta architecture and later GPU architectures, **all** Q-series and C-series vGPUs are supported. On GPUs that support the Multi-Instance GPU (MIG) feature, both time-sliced and MIG-backed vGPUs are supported.
- For GPUs based on the NVIDIA Pascal™ architecture, only Q-series and C-series vGPUs that are allocated all of the physical GPU's frame buffer are supported.
- For GPUs based on the NVIDIA NVIDIA Maxwell™ graphic architecture, only Q-series vGPUs that are allocated all of the physical GPU's frame buffer are supported.

You can assign multiple vGPUs with differing amounts of frame buffer to a single VM, provided the board type and the series of all the vGPUs is the same. For example, you can assign an A40-48C vGPU and an A40-16C vGPU to the same VM. However, you cannot assign an A30-8C vGPU and an A16-8C vGPU to the same VM.

Since 15.1: Multiple vGPU Support on the NVIDIA Ada Lovelace Architecture

Board	vGPU
NVIDIA L40	All Q-series vGPUs All C-series vGPUs
Since 15.2: NVIDIA L4	All Q-series vGPUs All C-series vGPUs
NVIDIA RTX 6000 Ada	All Q-series vGPUs All C-series vGPUs

Multiple vGPU Support on the NVIDIA Hopper GPU Architecture

Board	vGPU
Since 15.2: NVIDIA H800 PCIe 80GB	All C-series vGPUs

Board	vGPU
	See Note (1).
NVIDIA H100 PCIe 80GB	All C-series vGPUs See Note (1).

Multiple vGPU Support on the NVIDIA Ampere GPU Architecture

Board	vGPU
NVIDIA A800 PCIe 80GB NVIDIA A800 PCIe 80GB liquid cooled	All C-series vGPUs See Note (1).
NVIDIA A800 HGX 80GB	All C-series vGPUs See Note (1).
NVIDIA A100 PCIe 80GB NVIDIA A100 PCIe 80GB liquid cooled NVIDIA A100X	All C-series vGPUs See Note (1).
NVIDIA A100 HGX 80GB	All C-series vGPUs See Note (1).
NVIDIA A100 PCIe 40GB	All C-series vGPUs See Note (1).
NVIDIA A100 HGX 40GB	All C-series vGPUs See Note (1).
NVIDIA A40	All Q-series vGPUs All C-series vGPUs See Note (1).
NVIDIA A30 NVIDIA A30X	All C-series vGPUs See Note (1).
NVIDIA A16	All Q-series vGPUs

Board	vGPU
	All C-series vGPUs See Note (1).
NVIDIA A10	All Q-series vGPUs All C-series vGPUs See Note (1).
NVIDIA A2	All Q-series vGPUs All C-series vGPUs See Note (1).
NVIDIA RTX A6000	All Q-series vGPUs All C-series vGPUs See Note (1).
NVIDIA RTX A5500	All Q-series vGPUs All C-series vGPUs See Note (1).
NVIDIA RTX A5000	All Q-series vGPUs All C-series vGPUs See Note (1).

Multiple vGPU Support on the NVIDIA Turing GPU Architecture

Board	vGPU
Tesla T4	All Q-series vGPUs All C-series vGPUs
Quadro RTX 6000	All Q-series vGPUs All C-series vGPUs
Quadro RTX 6000 passive	All Q-series vGPUs

Board	vGPU
	All C-series vGPUs
Quadro RTX 8000	All Q-series vGPUs All C-series vGPUs
Quadro RTX 8000 passive	All Q-series vGPUs All C-series vGPUs

Multiple vGPU Support on the NVIDIA Volta GPU Architecture

Board	vGPU
Tesla V100 SXM2 32GB	All Q-series vGPUs All C-series vGPUs
Tesla V100 PCIe 32GB	All Q-series vGPUs All C-series vGPUs
Tesla V100S PCIe 32GB	All Q-series vGPUs All C-series vGPUs
Tesla V100 SXM2	All Q-series vGPUs All C-series vGPUs
Tesla V100 PCIe	All Q-series vGPUs All C-series vGPUs
Tesla V100 FHHL	All Q-series vGPUs All C-series vGPUs

Multiple vGPU Support on the NVIDIA Pascal GPU Architecture

Board	vGPU
Tesla P100 SXM2	P100X-16Q P100X-16C
Tesla P100 PCIe 16GB	P100-16Q P100-16C

Board	vGPU
Tesla P100 PCIe 12GB	P100C-12Q P100C-12C
Tesla P40	P40-24Q P40-24C
Tesla P6	P6-16Q P6-16C
Tesla P4	P4-8Q P4-8C

Multiple vGPU Support on the NVIDIA Maxwell GPU Architecture

Board	vGPU
Tesla M60	M60-8Q
Tesla M10	M10-8Q
Tesla M6	M6-8Q

Note:

1. This type of vGPU cannot be assigned with other types of vGPU to the same VM.

2.5.2. Maximum Number of vGPUs Supported per VM

NVIDIA vGPU software supports up to a maximum of 16 vGPUs per VM.

2.5.3. Hypervisor Releases that Support Multiple vGPUs Assigned to a VM

All hypervisor releases that support NVIDIA vGPU software are supported.

2.6. Peer-to-Peer CUDA Transfers over NVLink Support

Peer-to-peer CUDA transfers enable device memory between vGPUs on different GPUs that are assigned to the same VM to be accessed from within the CUDA kernels. NVLink

is a high-bandwidth interconnect that enables fast communication between such vGPUs. Peer-to-Peer CUDA transfers over NVLink are supported only on a subset of vGPUs, Red Hat Enterprise Linux with KVM releases, and guest OS releases.

2.6.1. vGPUs that Support Peer-to-Peer CUDA Transfers

Only Q-series and C-series time-sliced vGPUs that are allocated all of the physical GPU's frame buffer on physical GPUs that support NVLink are supported.

Peer-to-Peer CUDA Transfer Support on the NVIDIA Hopper GPU Architecture

Board	vGPU
Since 15.2: NVIDIA H800 PCIe 80GB	H800-80C
NVIDIA H100 PCIe 80GB	H100-80C

Peer-to-Peer CUDA Transfer Support on the NVIDIA Ampere GPU Architecture

Board	vGPU
NVIDIA A800 PCIe 80GB NVIDIA A800 PCIe 80GB liquid cooled	A800D-80C
NVIDIA A800 HGX 80GB	A800DX-80C See Note (1).
NVIDIA A100 PCIe 80GB NVIDIA A100 PCIe 80GB liquid cooled NVIDIA A100X	A100D-80C
NVIDIA A100 HGX 80GB	A100DX-80C See Note (1).
NVIDIA A100 PCIe 40GB	A100-40C
NVIDIA A100 HGX 40GB	A100X-40C See Note (1).
NVIDIA A40	A40-48Q

Board	vGPU
	A40-48C
NVIDIA A30 NVIDIA A30X	A30-24C
NVIDIA A10	A10-24Q A10-24C
NVIDIA RTX A6000	A6000-48Q A6000-48C
NVIDIA RTX A5500	A5500-24Q A5500-24C
NVIDIA RTX A5000	A5000-24Q A5000-24C

Peer-to-Peer CUDA Transfer Support on the NVIDIA Turing GPU Architecture

Board	vGPU
Quadro RTX 6000	RTX6000-24Q RTX6000-24C
Quadro RTX 6000 passive	RTX6000P-24Q RTX6000P-24C
Quadro RTX 8000	RTX8000-48Q RTX8000-48C
Quadro RTX 8000 passive	RTX8000P-48Q RTX8000P-48C

Peer-to-Peer CUDA Transfer Support on the NVIDIA Volta GPU Architecture

Board	vGPU
Tesla V100 SXM2 32GB	V100DX-32Q

Board	vGPU
	V100DX-32C
Tesla V100 SXM2	V100X-16Q V100X-16C

Peer-to-Peer CUDA Transfer Support on the NVIDIA Pascal GPU Architecture

Board	vGPU
Tesla P100 SXM2	P100X-16Q P100X-16C

Note:

1. Supported only on the following hardware:
   - NVIDIA HGX™ A100 4-GPU baseboard with four fully connected GPUs
   - NVIDIA HGX A100 8-GPU baseboards with eight fully connected GPUs

   Fully connected means that each GPU is connected to every other GPU on the baseboard.

2.6.2. Hypervisor Releases that Support Peer-to-Peer CUDA Transfers

Peer-to-Peer CUDA transfers over NVLink are supported on all hypervisor releases that support the assignment of more than one vGPU to a VM. For details, see Multiple vGPU Support.

2.6.3. Guest OS Releases that Support Peer-to-Peer CUDA Transfers

Linux only. Peer-to-Peer CUDA transfers over NVLink are **not** supported on Windows.

2.6.4. Limitations on Support for Peer-to-Peer CUDA Transfers

- NVIDIA NVSwitch is supported only on the hardware platforms, vGPUs, and hypervisor software releases listed in NVIDIA NVSwitch On-Chip Memory Fabric Support. Otherwise, only direct connections are supported.
- Only time-sliced vGPUs are supported. MIG-backed vGPUs are **not** supported.

- PCIe is not supported.
- SLI is not supported.

2.7. GPUDirect Technology Support

NVIDIA GPUDirect® Remote Direct Memory Access (RDMA) technology enables network devices to directly access vGPU frame buffer, bypassing CPU host memory altogether. GPUDirect Storage technology enables a direct data path for direct memory access (DMA) transfers between GPU memory and storage. GPUDirect technology is supported only on a subset of vGPUs and guest OS releases.

Supported vGPUs

GPUDirect RDMA and GPUDirect Storage technology are supported on all time-sliced and MIG-backed C-series vGPUs on physical GPUs that support single root I/O virtualization (SR-IOV).

- **Since 15.1:** GPUs based on the NVIDIA Ada Lovelace GPU architecture:
  - NVIDIA L40
  - **Since 15.2:** NVIDIA L4
  - NVIDIA RTX 6000 Ada
- GPUs based on the NVIDIA Hopper GPU architecture:
  - **Since 15.2:** NVIDIA H800 PCIe 80GB
  - NVIDIA H100 PCIe 80GB
- GPUs based on the NVIDIA Ampere GPU architecture:
  - NVIDIA A800 PCIe 80GB
  - NVIDIA A800 PCIe 80GB liquid cooled
  - NVIDIA A800 HGX 80GB
  - NVIDIA A100 PCIe 80GB
  - NVIDIA A100 PCIe 80GB liquid cooled
  - NVIDIA A100 HGX 80GB
  - NVIDIA A100 PCIe 40GB
  - NVIDIA A100 HGX 40GB
  - NVIDIA A100X
  - NVIDIA A30
  - NVIDIA A30X
  - NVIDIA A40
  - NVIDIA A16
  - NVIDIA A10

- NVIDIA A2
- NVIDIA RTX A6000
- NVIDIA RTX A5500
- NVIDIA RTX A5000

Supported Guest OS Releases

Linux only. GPUDirect technology is **not** supported on Windows.

Supported Network Interface Cards

GPUDirect technology is supported on the following network interface cards:

- NVIDIA ®ConnectX®- 7 SmartNIC
- Mellanox Connect-X 6 SmartNIC
- Mellanox Connect-X 5 Ethernet adapter card

Limitations

GPUDirect Storage technology is supported only on the following guest OS releases:

- Red Hat Enterprise Linux 8.4

2.8. NVIDIA NVSwitch On-Chip Memory Fabric Support

NVIDIA® NVSwitch™ on-chip memory fabric enables peer-to-peer vGPU communication within a single node over the NVLink fabric. NVSwitch on-chip memory fabric is supported only on a subset of hardware platforms, vGPUs, hypervisor software releases, and guest OS releases.

For information about how to use the NVSwitch on-chip memory fabric, see *Fabric Manager for NVIDIA NVSwitch Systems User Guide* (PDF).

2.8.1. Hardware Platforms that Support NVIDIA NVSwitch On-Chip Memory Fabric

- NVIDIA HGX A100 8-GPU baseboard

2.8.2. vGPUs that Support NVIDIA NVSwitch On-Chip Memory Fabric

Only C-series time-sliced vGPUs that are allocated all of the physical GPU's frame buffer on NVIDIA A800 and NVIDIA A100 HGX physical GPUs are supported.

NVIDIA NVSwitch On-Chip Memory Fabric Support on the NVIDIA Ampere GPU Architecture

Board	vGPU
NVIDIA A800 HGX 80GB	A800DX-80C
NVIDIA A100 HGX 80GB	A100DX-80C
NVIDIA A100 HGX 40GB	A100X-40C

2.8.3. Hypervisor Releases that Support NVIDIA NVSwitch On-Chip Memory Fabric

8.2 only.

2.8.4. Guest OS Releases that Support NVIDIA NVSwitch On-Chip Memory Fabric

Linux only. NVIDIA NVSwitch on-chip memory fabric is **not** supported on Windows.

2.8.5. Limitations on Support for NVIDIA NVSwitch On-Chip Memory Fabric

- Only time-sliced vGPUs are supported. MIG-backed vGPUs are **not** supported.
- PCIe is not supported.
- SLI is not supported.
- All vGPUs that are communicating peer-to-peer must be assigned to the same VM.

2.9. Unified Memory Support

Unified memory is a single memory address space that is accessible from any CPU or GPU in a system. It creates a pool of managed memory that is shared between the CPU and GPU to provide a simple way to allocate and access data that can be used by code running on any CPU or GPU in the system. Unified memory is supported only on a subset of vGPUs and guest OS releases.

Note: Unified memory is disabled by default. If used, you must enable unified memory individually for each vGPU that requires it by setting a vGPU plugin parameter. NVIDIA CUDA Toolkit profilers are supported and can be enabled on a VM for which unified memory is enabled.

2.9.1. vGPUs that Support Unified Memory

On GPUs that support the Multi-Instance GPU (MIG) feature, **all** MIG-backed vGPUs are supported.Only time-sliced Q-series and C-series vGPUs that are allocated all of the physical GPU's frame buffer on physical GPUs that support unified memory are supported.

Since 15.1: Unified Memory Support on the NVIDIA Ada Lovelace GPU Architecture

Board	vGPU
NVIDIA L40	L40-48Q L40-48C
Since 15.2: NVIDIA L4	L4-24Q L4-24C
NVIDIA RTX 6000 Ada	RTX 6000 Ada-48Q RTX 6000 Ada-48C

Unified Memory Support on the NVIDIA Hopper GPU Architecture

Board	vGPU
NVIDIA H800 PCIe 80GB	H800-80C **All** MIG-backed vGPUs
NVIDIA H100 PCIe 80GB	H100-80C **All** MIG-backed vGPUs

Unified Memory Support on the NVIDIA Ampere GPU Architecture

Board	vGPU
NVIDIA A800 PCIe 80GB NVIDIA A800 PCIe 80GB liquid cooled	A800D-80C **All** MIG-backed vGPUs
NVIDIA A800 HGX 80GB	A800DX-80C **All** MIG-backed vGPUs
NVIDIA A100 PCIe 80GB	A100D-80C

Board	vGPU
NVIDIA A100 PCIe 80GB liquid cooled NVIDIA A100X	**All** MIG-backed vGPUs
NVIDIA A100 HGX 80GB	A100DX-80C **All** MIG-backed vGPUs
NVIDIA A100 PCIe 40GB	A100-40C **All** MIG-backed vGPUs
NVIDIA A100 HGX 40GB	A100X-40C **All** MIG-backed vGPUs
NVIDIA A40	A40-48Q A40-48C
NVIDIA A30	A30-24C **All** MIG-backed vGPUs
NVIDIA A16	A16-16Q A16-16C
NVIDIA A10	A10-24Q A10-24C
NVIDIA A2	A2-16Q A2-16C
NVIDIA RTX A6000	A6000-48Q A6000-48C
NVIDIA RTX A5500	A5500-24Q A5500-24C
NVIDIA RTX A5000	A5000-24Q A5000-24C

2.9.2. Guest OS Releases that Support Unified Memory

Linux only. Unified memory is **not** supported on Windows.

2.9.3. Limitations on Support for Unified Memory

- Only time-sliced Q-series and C-series vGPUs that are allocated all of the physical GPU's frame buffer on physical GPUs that support unified memory are supported. Fractional time-sliced vGPUs are **not** supported.

2.10. NVIDIA GPU Operator Support

NVIDIA GPU Operator simplifies the deployment of NVIDIA vGPU software with software container platforms on immutable operating systems. An immutable operating system does not allow the installation of the NVIDIA vGPU software graphics driver directly on the operating system. NVIDIA GPU Operator is supported only on specific combinations of hypervisor software release, container platform, and guest OS release.

Hypervisor Software Release	Container Platform	Guest OS
Red Hat Enterprise Linux with KVM 8.2	Red Hat Openshift 4.9 with Red Hat Enterprise Linux CoreOS and the CRI-O container runtime	Red Hat CoreOS 4.9
Red Hat Enterprise Linux with KVM 8.2	Red Hat Openshift 4.8 with Red Hat Enterprise Linux CoreOS and the CRI-O container runtime	Red Hat CoreOS 4.8

2.11. NVIDIA Deep Learning Super Sampling (DLSS) Support

NVIDIA vGPU software supports NVIDIA DLSS on NVIDIA RTX Virtual Workstation.

Supported DLSS versions: 2.0. Version 1.0 is **not** supported.

Supported GPUs:

- **Since 15.1:** NVIDIA L40
- **Since 15.2:** NVIDIA L4
- **Since 15.1:** NVIDIA RTX 6000 Ada
- NVIDIA A40

- NVIDIA A16
- NVIDIA A2
- NVIDIA A10
- NVIDIA RTX A6000
- NVIDIA RTX A5500
- NVIDIA RTX A5000
- Tesla T4
- Quadro RTX 8000
- Quadro RTX 8000 passive
- Quadro RTX 6000
- Quadro RTX 6000 passive

Note: NVIDIA graphics driver components that DLSS requires are installed only if a supported GPU is detected during installation of the driver. Therefore, if the creation of VM templates includes driver installation, the template should be created from a VM that is configured with a supported GPU while the driver is being installed.

Supported applications: only applications that use `nvngx_dlss.dll` version 2.0.18 or newer

Chapter 3. Known Product Limitations

Known product limitations for this release of NVIDIA vGPU software are described in the following sections.

3.1. NVENC does not support resolutions greater than 4096×4096

Description

The NVIDIA hardware-based H.264 video encoder (NVENC) does not support resolutions greater than 4096×4096. This restriction applies to all NVIDIA GPU architectures and is imposed by the GPU encoder hardware itself, not by NVIDIA vGPU software. The maximum supported resolution for each encoding scheme is listed in the documentation for NVIDIA Video Codec SDK. This limitation affects any remoting tool where H.264 encoding is used with a resolution greater than 4096×4096. Most supported remoting tools fall back to software encoding in such scenarios.

Workaround

If your GPU is based on a GPU architecture later than the NVIDIA Maxwell® architecture, use H.265 encoding. H.265 is more efficient than H.264 encoding and has a maximum resolution of 8192×8192. On GPUs based on the NVIDIA Maxwell architecture, H.265 has the same maximum resolution as H.264, namely 4096×4096.

Note: Resolutions greater than 4096×4096 are supported only by the H.265 decoder that 64-bit client applications use. The H.265 decoder that 32-bit applications use supports a maximum resolution of 4096×4096.

3.2. Nested Virtualization Is Not Supported by NVIDIA vGPU

NVIDIA vGPU deployments do not support nested virtualization, that is, running a hypervisor in a guest VM. For example, enabling the Hyper-V role in a guest VM running the Windows Server OS is **not** supported because it entails enabling nested virtualization. Similarly, enabling Windows Hypervisor Platform is not supported because it requires the Hyper-V role to be enabled.

3.3. Issues occur when the channels allocated to a vGPU are exhausted

Description

Issues occur when the channels allocated to a vGPU are exhausted and the guest VM to which the vGPU is assigned fails to allocate a channel to the vGPU. A physical GPU has a fixed number of channels and the number of channels allocated to each vGPU is inversely proportional to the maximum number of vGPUs allowed on the physical GPU.

When the channels allocated to a vGPU are exhausted and the guest VM fails to allocate a channel, the following errors are reported on the hypervisor host or in an NVIDIA bug report:

```
Jun 26 08:01:25 srvxen06f vgpu-3[14276]: error: vmiop_log: (0x0): Guest attempted to
 allocate channel above its max channel limit 0xfb
Jun 26 08:01:25 srvxen06f vgpu-3[14276]: error: vmiop_log: (0x0): VGPU message 6
 failed, result code: 0x1a
Jun 26 08:01:25 srvxen06f vgpu-3[14276]: error: vmiop_log: (0x0):
 0xc1d004a1, 0xff0e0000, 0xff0400fb, 0xc36f,
Jun 26 08:01:25 srvxen06f vgpu-3[14276]: error: vmiop_log: (0x0):         0x1,
 0xff1fe314, 0xff1fe038, 0x100b6f000, 0x1000,
Jun 26 08:01:25 srvxen06f vgpu-3[14276]: error: vmiop_log: (0x0):
 0x80000000, 0xff0e0200, 0x0, 0x0, (Not logged),
Jun 26 08:01:25 srvxen06f vgpu-3[14276]: error: vmiop_log: (0x0):         0x1, 0x0
Jun 26 08:01:25 srvxen06f vgpu-3[14276]: error: vmiop_log: (0x0): , 0x0
```

Workaround

Use a vGPU type with more frame buffer, thereby reducing the maximum number of vGPUs allowed on the physical GPU. As a result, the number of channels allocated to each vGPU is increased.

3.4. Virtual GPU hot plugging is not supported

NVIDIA vGPU software does not support the addition of virtual function I/O (VFIO) mediated device (`mdev`) devices after the VM has been started by QEMU. All `mdev` devices must be added before the VM is started.

3.5. Total frame buffer for vGPUs is less than the total frame buffer on the physical GPU

Some of the physical GPU's frame buffer is used by the hypervisor on behalf of the VM for allocations that the guest OS would otherwise have made in its own frame buffer. The frame buffer used by the hypervisor is not available for vGPUs on the physical GPU. In NVIDIA vGPU deployments, frame buffer for the guest OS is reserved in advance, whereas in bare-metal deployments, frame buffer for the guest OS is reserved on the basis of the runtime needs of applications.

If error-correcting code (ECC) memory is enabled on a physical GPU that does not have HBM2 memory, the amount of frame buffer that is usable by vGPUs is further reduced. All types of vGPU are affected, not just vGPUs that support ECC memory.

On all GPUs that support ECC memory and, therefore, dynamic page retirement, additional frame buffer is allocated for dynamic page retirement. The amount that is allocated is inversely proportional to the maximum number of vGPUs per physical GPU. All GPUs that support ECC memory are affected, even GPUs that have HBM2 memory or for which ECC memory is disabled.

The approximate amount of frame buffer that NVIDIA vGPU software reserves can be calculated from the following formula:

max-reserved-fb = *vgpu-profile-size-in-mb*÷16 + 16 + *ecc-adjustments* + *page-retirement-allocation* + *compression-adjustment*

max-reserved-fb
: The maximum total amount of reserved frame buffer in Mbytes that is not available for vGPUs.

vgpu-profile-size-in-mb
: The amount of frame buffer in Mbytes allocated to a single vGPU. This amount depends on the vGPU type. For example, for the T4-16Q vGPU type, *vgpu-profile-size-in-mb* is 16384.

ecc-adjustments
: The amount of frame buffer in Mbytes that is not usable by vGPUs when ECC is enabled on a physical GPU that does not have HBM2 memory.

- If ECC is enabled on a physical GPU that does not have HBM2 memory *ecc-adjustments* is *fb-without-ecc*/16, which is equivalent to 64 Mbytes for every Gbyte of frame buffer assigned to the vGPU. *fb-without-ecc* is total amount of frame buffer with ECC disabled.
- If ECC is disabled or the GPU has HBM2 memory, *ecc-adjustments* is 0.

page-retirement-allocation

The amount of frame buffer in Mbytes that is reserved for dynamic page retirement.

- On GPUs based on the NVIDIA Maxwell GPU architecture, *page-retirement-allocation* = 4÷*max-vgpus-per-gpu*.
- On GPUs based on NVIDIA GPU architectures **after** the Maxwell architecture, *page-retirement-allocation* = 128÷*max-vgpus-per-gpu*

max-vgpus-per-gpu

The maximum number of vGPUs that can be created simultaneously on a physical GPU. This number varies according to the vGPU type. For example, for the T4-16Q vGPU type, *max-vgpus-per-gpu* is 1.

compression-adjustment

The amount of frame buffer in Mbytes that is reserved for the higher compression overhead in vGPU types with 12 Gbytes or more of frame buffer on GPUs based on the Turing architecture.

compression-adjustment depends on the vGPU type as shown in the following table.

vGPU Type	Compression Adjustment (MB)
T4-16Q T4-16C T4-16A	28
RTX6000-12Q RTX6000-12C RTX6000-12A	32
RTX6000-24Q RTX6000-24C RTX6000-24A	104
RTX6000P-12Q RTX6000P-12C RTX6000P-12A	32
RTX6000P-24Q RTX6000P-24C RTX6000P-24A	104
RTX8000-12Q	32

vGPU Type	Compression Adjustment (MB)
RTX8000-12C RTX8000-12A	
RTX8000-16Q RTX8000-16C RTX8000-16A	64
RTX8000-24Q RTX8000-24C RTX8000-24A	96
RTX8000-48Q RTX8000-48C RTX8000-48A	238
RTX8000P-12Q RTX8000P-12C RTX8000P-12A	32
RTX8000P-16Q RTX8000P-16C RTX8000P-16A	64
RTX8000P-24Q RTX8000P-24C RTX8000P-24A	96
RTX8000P-48Q RTX8000P-48C RTX8000P-48A	238

For all other vGPU types, *compression-adjustment* is 0.

Note: In VMs running Windows Server 2012 R2, which supports Windows Display Driver Model (WDDM) 1.*x*, an additional 48 Mbytes of frame buffer are reserved and not available for vGPUs.

3.6. Issues may occur with graphics-intensive OpenCL applications on vGPU types with limited frame buffer

Description

Issues may occur when graphics-intensive OpenCL applications are used with vGPU types that have limited frame buffer. These issues occur when the applications demand more frame buffer than is allocated to the vGPU.

For example, these issues may occur with the Adobe Photoshop and LuxMark OpenCL Benchmark applications:

- When the image resolution and size are changed in Adobe Photoshop, a program error may occur or Photoshop may display a message about a problem with the graphics hardware and a suggestion to disable OpenCL.
- When the LuxMark OpenCL Benchmark application is run, XID error 31 may occur.

Workaround

For graphics-intensive OpenCL applications, use a vGPU type with more frame buffer.

3.7. In pass through mode, all GPUs connected to each other through NVLink must be assigned to the same VM

Description

In pass through mode, all GPUs connected to each other through NVLink must be assigned to the same VM. If a subset of GPUs connected to each other through NVLink is passed through to a VM, unrecoverable error `XID 74` occurs when the VM is booted. This error corrupts the NVLink state on the physical GPUs and, as a result, the NVLink bridge between the GPUs is unusable.

Workaround

Restore the NVLink state on the physical GPUs by resetting the GPUs or rebooting the hypervisor host.

3.8. vGPU profiles with 512 Mbytes or less of frame buffer support only 1 virtual display head on Windows 10

Description

To reduce the possibility of memory exhaustion, vGPU profiles with 512 Mbytes or less of frame buffer support only 1 virtual display head on a Windows 10 guest OS.

The following vGPU profiles have 512 Mbytes or less of frame buffer:

- Tesla M6-0B, M6-0Q
- Tesla M10-0B, M10-0Q
- Tesla M60-0B, M60-0Q

Workaround

Use a profile that supports more than 1 virtual display head and has at least 1 Gbyte of frame buffer.

3.9. NVENC requires at least 1 Gbyte of frame buffer

Description

Using the frame buffer for the NVIDIA hardware-based H.264/HEVC video encoder (NVENC) may cause memory exhaustion with vGPU profiles that have 512 Mbytes or less of frame buffer. To reduce the possibility of memory exhaustion, NVENC is disabled on profiles that have 512 Mbytes or less of frame buffer. Application GPU acceleration remains fully supported and available for all profiles, including profiles with 512 MBytes or less of frame buffer. NVENC support from both Citrix and VMware is a recent feature and, if you are using an older version, you should experience no change in functionality.

The following vGPU profiles have 512 Mbytes or less of frame buffer:

- Tesla M6-0B, M6-0Q

- Tesla M10-0B, M10-0Q
- Tesla M60-0B, M60-0Q

Workaround

If you require NVENC to be enabled, use a profile that has at least 1 Gbyte of frame buffer.

3.10. VM running an incompatible NVIDIA vGPU guest driver fails to initialize vGPU when booted

Description

A VM running a version of the NVIDIA guest VM driver that is incompatible with the current release of Virtual GPU Manager will fail to initialize vGPU when booted on a Red Hat Enterprise Linux with KVM platform running that release of Virtual GPU Manager.

A guest VM driver is incompatible with the current release of Virtual GPU Manager in either of the following situations:

- The guest driver is from a release in a branch two or more major releases before the current release, for example release 9.4.

  In this situation, the Red Hat Enterprise Linux with KVM VM's `/var/log/messages` log file reports the following error:

  ```
  vmiop_log: (0x0): Incompatible Guest/Host drivers: Guest VGX version is older
   than the minimum version supported by the Host. Disabling vGPU.
  ```

- The guest driver is from a later release than the Virtual GPU Manager.

  In this situation, the Red Hat Enterprise Linux with KVM VM's `/var/log/messages` log file reports the following error:

  ```
  vmiop_log: (0x0): Incompatible Guest/Host drivers: Guest VGX version is newer
   than the maximum version supported by the Host. Disabling vGPU.
  ```

In either situation, the VM boots in standard VGA mode with reduced resolution and color depth. The NVIDIA virtual GPU is present in **Windows Device Manager** but displays a warning sign, and the following device status:

```
Windows has stopped this device because it has reported problems. (Code 43)
```

Resolution

Install a release of the NVIDIA guest VM driver that is compatible with current release of Virtual GPU Manager.

3.11. Single vGPU benchmark scores are lower than pass-through GPU

Description

A single vGPU configured on a physical GPU produces lower benchmark scores than the physical GPU run in pass-through mode.

Aside from performance differences that may be attributed to a vGPU's smaller frame buffer size, vGPU incorporates a performance balancing feature known as Frame Rate Limiter (FRL). On vGPUs that use the best-effort scheduler, FRL is enabled. On vGPUs that use the fixed share or equal share scheduler, FRL is disabled.

FRL is used to ensure balanced performance across multiple vGPUs that are resident on the same physical GPU. The FRL setting is designed to give good interactive remote graphics experience but may reduce scores in benchmarks that depend on measuring frame rendering rates, as compared to the same benchmarks running on a pass-through GPU.

Resolution

FRL is controlled by an internal vGPU setting. On vGPUs that use the best-effort scheduler, NVIDIA does not validate vGPU with FRL disabled, but for validation of benchmark performance, FRL can be temporarily disabled by setting `frame_rate_limiter=0` in the vGPU configuration file.

```
# echo "frame_rate_limiter=0" > /sys/bus/mdev/devices/vgpu-id/nvidia/vgpu_params
```

For example:

```
# echo "frame_rate_limiter=0" > /sys/bus/mdev/devices/aa618089-8b16-4d01-a136-25a0f3c73123/
nvidia/vgpu_params
```

The setting takes effect the next time any VM using the given vGPU type is started.

With this setting in place, the VM's vGPU will run without any frame rate limit.

The FRL can be reverted back to its default setting as follows:

1. Clear all parameter settings in the vGPU configuration file.

   ```
   # echo " " > /sys/bus/mdev/devices/vgpu-id/nvidia/vgpu_params
   ```

   > **Note:** You cannot clear specific parameter settings. If your vGPU configuration file contains other parameter settings that you want to keep, you must reinstate them in the next step.

2. Set `frame_rate_limiter=1` in the vGPU configuration file.

   ```
   # echo "frame_rate_limiter=1" > /sys/bus/mdev/devices/vgpu-id/nvidia/vgpu_params
   ```

If you need to reinstate other parameter settings, include them in the command to set `frame_rate_limiter=1`. For example:

```
# echo "frame_rate_limiter=1 disable_vnc=1" > /sys/bus/mdev/devices/aa618089-8b16-4d01-a136-25a0f3c73123/nvidia/vgpu_params
```

3.12. `nvidia-smi` fails to operate when all GPUs are assigned to GPU pass-through mode

Description

If all GPUs in the platform are assigned to VMs in pass-through mode, `nvidia-smi` will return an error:

```
[root@vgx-test ~]# nvidia-smi
Failed to initialize NVML: Unknown Error
```

This is because GPUs operating in pass-through mode are not visible to `nvidia-smi` and the NVIDIA kernel driver operating in the Red Hat Enterprise Linux with KVM host.

To confirm that all GPUs are operating in pass-through mode, confirm that the `vfio-pci` kernel driver is handling each device.

```
# lspci -s 05:00.0 -k
05:00.0 VGA compatible controller: NVIDIA Corporation GM204GL [Tesla M60] (rev a1)
                Subsystem: NVIDIA Corporation Device 113a
                Kernel driver in use: vfio-pci
```

Resolution

N/A

Chapter 4. Resolved Issues

Only resolved issues that have been previously noted as known issues or had a noticeable user impact are listed. The summary and description for each resolved issue indicate the effect of the issue on NVIDIA vGPU software **before the issue was resolved**.

Issues Resolved in Release 15.4

Bug ID	Summary and Description
4253360	**5.0-15.3 Only: vCS license acquisition from CLS fails for general-purpose GPUs in pass-through mode on Windows** A request to a Cloud License Service (CLS) instance for a vCS license from a Windows VM fails. This issue affects only Windows guest VMs that are configured with a general-purpose GPU in pass-through mode. A general-purpose GPU supports graphics acceleration in addition to compute workloads. When this issue occurs, NVIDIA License System (NLS) hangs after it is initialized.

Issues Resolved in Release 15.3

Bug ID	Summary and Description
4101021	**15.0-15.2 Only: NVIDIA vGPU software graphics driver fails to load on vGPUs based on the NVIDIA Ada Lovelace architecture** The NVIDIA vGPU software graphics driver fails to load on vGPUs based on the NVIDIA Ada Lovelace architecture if the physical GPU is behind a PCIe switch operating in synthetic mode. This issue affects both Linux and Windows guest VMs but is specific to GPUs based on the NVIDIA Ada Lovelace architecture.
4059416	**15.0-15.2 Only: Applications crash after migrations of VMs configured with vGPUs based on the NVIDIA Hopper architecture** After a VM configured with one or more vGPUs based on the NVIDIA Hopper architecture is migrated, applications on the destination host might crash immediately after the migration. This issue affects only MIG-backed vGPUs on GPUs based on the NVIDIA Hopper architecture

Bug ID	Summary and Description
	and does not affect all migrations. When this issue occurs, the following messages might be written to the log files on the hypervisor host: ▶ `VGPU message 108 failed` ▶ `VGPU message 111 failed`
3896627	**15.0-15.2 Only: NVWMI floods Windows application logs with Pipe operation failed messages** The NVIDIA Enterprise Management Toolkit (NVWMI) floods Windows application logs with `Pipe operation failed` messages. This issue affects only Windows guest VMs and has no functional impact other than the flooding of the Windows application logs.
3936030	**15.1, 15.2 Only: CUDA applications fail on any VM configured with multiple vGPUs when unified memory is enabled** CUDA applications fail on any VM configured with multiple vGPUs based on the NVIDIA Ada Lovelace GPU architecture when unified memory is enabled for the VM. Whenever a CUDA application fails, the following message is observed on the hypervisor host: `VGPU message 2 failed, result code: 0xff100004`
3596327	**15.0-15.2 Only: Remote desktop connection is lost and the NVIDIA vGPU software graphics driver is unloaded** The remote desktop connection is lost and the NVIDIA vGPU software graphics driver is unloaded after an attempt to access a VM over RDP and VMware Horizon agent direct connect. After an attempt to log in again, a black screen is displayed.

Issues Resolved in Release 15.2

Bug ID	Summary and Description
3334310	**15.0, 15.1 Only: NVIDIA Control Panel is started only for the RDP user that logs on first** On all supported Windows Server guest OS releases, **NVIDIA Control Panel** is started only for the RDP user that logs on first. Other users cannot start **NVIDIA Control Panel**. If more than one RDP user is logged on when **NVIDIA Control Panel** is started, it always opens in the session of the RDP user that logged on first, irrespective of which user started **NVIDIA Control Panel**. Furthermore, on Windows Server 2016, **NVIDIA Control Panel** crashes if a user session is disconnected and then reconnected while **NVIDIA Control Panel** is open.

Bug ID	Summary and Description
3835855	**15.0, 15.1 Only: Windows VMs fail to acquire a license in environments with multiple active desktop sessions** A race condition in the NVIDIA vGPU softwaregraphics driver for Windows can cause Windows VMs to fail to acquire a license. This issue occurs in environments where multiple active desktop sessions are trying to acquire a license simultaneously. When this issue occurs, the following error message is written to licensing event log on the client: `Mismatch between client and server with respect to licenses held. Returning the licenses`
3941622	**15.0, 15.1 Only: NVIDIA Control Panel is not found notification appears after a user logs in** After a user logs in to a remote desktop session, the `NVIDIA Control Panel is not found` notification pop-up window appears.
3956112	**15.0, 15.1 Only: The NVIDIA vGPU software graphics driver for Windows cannot drive the display** After a remoting session has been reconnected to several times or the screen has been resized several times, the NVIDIA vGPU software graphics driver can be randomly left in a state where it cannot drive the display. This issue affects only Windows guest VMs. Linux guest VMs are **not** affected.
3985036	**15.0, 15.1 Only: NVIDIA RTX Desktop Manager fails to start with B-series vGPUs on Windows VMs** **NVIDIA RTX Desktop Manager** fails to start with B-series vGPUs on Windows VMs. This issue occurs with Citrix and VMware remoting tools. It does not occur over Remote Desktop Protocol (RDP) connections.

Issues Resolved in Release 15.1

No resolved issues are reported in this release for Red Hat Enterprise Linux with KVM.

Issues Resolved in Release 15.0

No resolved issues are reported in this release for Red Hat Enterprise Linux with KVM.

Chapter 5. Known Issues

5.1. NVIDIA Control Panel is not available in multiuser environments

Description

After the NVIDIA vGPU software graphics driver for Windows is installed, the **NVIDIA Control Panel** app might be missing from the system. This issue typically occurs when multiple users connect to virtual machines by using remote desktop applications such as Microsoft RDP, VMware Horizon , and Citrix Virtual Apps and Desktops.

This issue occurs because the **NVIDIA Control Panel** app is now distributed through the **Microsoft Store**. The **NVIDIA Control Panel** app might fail to be installed when the NVIDIA vGPU software graphics driver for Windows is installed if the **Microsoft Store** app is disabled, the system is not connected to the Internet, or installation of apps from the **Microsoft Store** is blocked by your system settings.

To determine whether the **NVIDIA Control Panel** app is installed on your system, use the **Windows Settings** app or the `Get-AppxPackage` Windows PowerShell command.

- To use the **Windows Settings** app:
  1. From the Windows **Start** menu, choose **Settings** > **Apps** > **Apps & feautures** .
  2. In the **Apps & features** window, type **`nvidia control panel`** in the search box and confirm that the **NVIDIA Control Panel** app is found.
- To use the `Get-AppxPackage`Windows PowerShell command:
  1. Run **Windows PowerShell** as Administrator.
  2. Determine whether the **NVIDIA Control Panel** app is installed for the current user.
     ```
     PS C:\> Get-AppxPackage -Name NVIDIACorp.NVIDIAControlPanel
     ```
  3. Determine whether the **NVIDIA Control Panel** app is installed for all users.
     ```
     PS C:\> Get-AppxPackage -AllUsers -Name NVIDIACorp.NVIDIAControlPanel
     ```
     This example shows that the **NVIDIA Control Panel** app is installed for the users `Administrator`, `pliny`, and `trajan`.

```
PS C:\> Get-AppxPackage -AllUsers -Name NVIDIACorp.NVIDIAControlPanel

Name                   : NVIDIACorp.NVIDIAControlPanel
Publisher              : CN=D6816951-877F-493B-B4EE-41AB9419C326
Architecture           : X64
ResourceId             :
Version                : 8.1.964.0
PackageFullName        :
 NVIDIACorp.NVIDIAControlPanel_8.1.964.0_x64__56jybvy8sckqj
InstallLocation        : C:\Program Files\WindowsApps
\NVIDIACorp.NVIDIAControlPanel_8.1.964.0_x64__56jybvy8sckqj
IsFramework            : False
PackageFamilyName      : NVIDIACorp.NVIDIAControlPanel_56jybvy8sckqj
PublisherId            : 56jybvy8sckqj
PackageUserInformation :
 {S-1-12-1-530092550-1307989247-1105462437-500 [Administrator]: Installed,

 S-1-12-1-530092550-1307989247-1105462437-1002 [pliny]: Installed,

 S-1-12-1-530092550-1307989247-1105462437-1003 [trajan]: Installed}
IsResourcePackage      : False
IsBundle               : False
IsDevelopmentMode      : False
NonRemovable           : False
IsPartiallyStaged      : False
SignatureKind          : Store
Status                 : Ok
```

Preventing this Issue

To prevent this issue from occurring, ensure that:

- The Microsoft Store app is enabled.
- Installation of Microsoft Store apps is not blocked by your system settings.
- No local or group policies are set to block Microsoft Store apps.

Workaround

If the **NVIDIA Control Panel** app is missing from a system that is running Windows 11 or a modern version of Windows 10, you can install the **NVIDIA Control Panel** app by using the `winget` command-line tool of **Windows Package Manager**.

Note: The `winget` command-line tool is not available on the Windows Server OS.

Before using the `winget` command-line tool to install the **NVIDIA Control Panel** app, ensure that the following prerequisites are met:

- Your system is connected to the Internet.
- The Microsoft Store app is enabled.
- Packages on which `winget` depends, such as `Microsoft.UI.Xaml` and `Microsoft.VCLibs.x64`, are installed.

To use the `winget` command-line tool to install the **NVIDIA Control Panel** app, run the following command:

```
PS C:\> winget install "NVIDIA Control Panel" --id 9NF8H0H7WMLT -s msstore
```

```
--accept-package-agreements --accept-source-agreements
```

For information about how to download and use the latest `winget` version, refer to Use the winget tool to install and manage applications on the Microsoft documentation site.

If the issue persists, contact NVIDIA Enterprise Support for further assistance.

Status

Open

Ref.

3999308

5.2. Pixelation occurs on a Windows VM configured with a vGPU based on the NVIDIA Turing architecture

Description

Users might experience poor graphics quality on a Windows VM that is configured with a vGPU on a GPU that is based on the NVIDIA Turing architecture. This issue can cause random pixelation on the entire screen, or only on some patches of the screen. No errors are reported or written to the log files when this issue occurs.

Workaround

Contact NVIDIA Enterprise Support for assistance with a workaround for this issue.

Status

Open

Ref.

3973158

5.3. 5.0-15.3 Only: vCS license acquisition from CLS fails for general-purpose GPUs in pass-through mode on Windows

Description

A request to a Cloud License Service (CLS) instance for a vCS license from a Windows VM fails. This issue affects only Windows guest VMs that are configured with a general-purpose GPU in pass-through mode. A general-purpose GPU supports graphics acceleration in addition to compute workloads. When this issue occurs, NVIDIA License System (NLS) hangs after it is initialized.

Status

Resolved in NVIDIA vGPU software15.4

Ref.

4253360

5.4. 15.0-15.2 Only: NVIDIA vGPU software graphics driver fails to load on vGPUs based on the NVIDIA Ada Lovelace architecture

Description

The NVIDIA vGPU software graphics driver fails to load on vGPUs based on the NVIDIA Ada Lovelace architecture if the physical GPU is behind a PCIe switch operating in synthetic mode. This issue affects both Linux and Windows guest VMs but is specific to GPUs based on the NVIDIA Ada Lovelace architecture.

Status

Resolved in NVIDIA vGPU software 15.3

Ref.

4101021

5.5. 15.0-15.2 Only: Applications crash after migrations of VMs configured with vGPUs based on the NVIDIA Hopper architecture

Description

After a VM configured with one or more vGPUs based on the NVIDIA Hopper architecture is migrated, applications on the destination host might crash immediately after the migration. This issue affects only MIG-backed vGPUs on GPUs based on the NVIDIA Hopper architecture and does not affect all migrations. When this issue occurs, the following messages might be written to the log files on the hypervisor host:

- `VGPU message 108 failed`
- `VGPU message 111 failed`

Status

Resolved in NVIDIA vGPU software 15.3

Note: To avoid this issue, the Virtual GPU Manager from NVIDIA vGPU software 15.3 to be running on the source host and the destination host.

Ref.

4059416

5.6. 15.0-15.2 Only: NVWMI floods Windows application logs with `Pipe operation failed` messages

Description

The NVIDIA Enterprise Management Toolkit (NVWMI) floods Windows application logs with `Pipe operation failed` messages. This issue affects only Windows guest VMs and has no functional impact other than the flooding of the Windows application logs.

Status

Resolved in NVIDIA vGPU software 15.3

Ref.

3896627

5.7. Optical Flow object allocation fails on VMs configured with vGPUs based on the NVIDIA Ampere architecture

Description

Optical Flow object allocation fails on VMs configured with vGPUs that reside on GPUs based on the NVIDIA Ampere GPU architecture. This issue has been observed as the failure of the Omniverse Kit container on a VM configured with NVIDIA vGPU.

Status

Open

Ref.

4096848

5.8. **NVIDIA Control Panel** crashes if a user session is disconnected and reconnected

Description

On all supported Windows Server guest OS releases, **NVIDIA Control Panel** crashes if a user session is disconnected and then reconnected while **NVIDIA Control Panel** is open.

Version

This issue affects all supported Windows Server guest OS releases.

Status

Open

Ref.

4086605

5.9. Graphics applications are corrupted on some Windows vGPU VMs

Description

Graphics applications are corrupted on Windows VMs that are configured with one or more vGPUs that are based on the NVIDIA Ampere or NVIDIA Ada Lovelace GPU architecture.

Status

Open

Ref.

3641947

5.10. 15.1, 15.2 Only: CUDA applications fail on any VM configured with multiple vGPUs when unified memory is enabled

Description

CUDA applications fail on any VM configured with multiple vGPUs based on the NVIDIA Ada Lovelace GPU architecture when unified memory is enabled for the VM. Whenever a CUDA application fails, the following message is observed on the hypervisor host:

```
VGPU message 2 failed, result code: 0xff100004
```

Status

Resolved in NVIDIA vGPU software 15.3

Ref.

3936030

5.11. 15.0-15.2 Only: Remote desktop connection is lost and the NVIDIA vGPU software graphics driver is unloaded

Description

The remote desktop connection is lost and the NVIDIA vGPU software graphics driver is unloaded after an attempt to access a VM over RDP and VMware Horizon agent direct connect. After an attempt to log in again, a black screen is displayed.

When this issue occurs, the following errors are written to the log files on the guest VM:

- A timeout detection and recovery (TDR) error:

  ```
  vmiop_log: (0x0): Timeout occurred, reset initiated.
  vmiop_log: (0x0): TDR_DUMP:0x52445456 0x006907d0 0x000001cc 0x00000001
  ```

- XID error 43:

  ```
  vmiop_log: (0x0): XID 43 detected on physical_chid
  ```

- vGPU error 22:

```
vmiop_log: (0x0): VGPU message 22 failed
```

- Guest driver unloaded error:

```
vmiop_log: (0x0): Guest driver unloaded!
```

Workaround

To recover from this issue, reboot the VM.

Since 15. 2: To prevent this issue from occurring, disable translation lookaside buffer (TLB) invalidation by setting the vGPU plugin parameter `tlb_invalidate_enabled` to 0.

Status

Resolved in NVIDIA vGPU software 15.3

Ref.

3596327

5.12. VM assigned multiple fractional vGPUs from the same GPU hangs

Description

A VM that has been assigned multiple fractional vGPUs from the same physical GPU hangs or becomes inaccessible during installation of the NVIDIA vGPU software graphics driver in the VM. This issue affects only GPUs based on the NVIDIA Turing and NVIDIA Volta GPU architectures. This issue does not occur if the VM has been assigned multiple fractional vGPUs from different physical GPUs.

Version

This issue affects only GPUs based on the NVIDIA Turing and NVIDIA Volta GPU architectures.

Status

Open

Ref.

4020171

5.13. Since 15.2: CUDA profilers cannot gather hardware metrics on NVIDIA vGPU

Description

NVIDIA CUDA Toolkit profilers cannot gather hardware metrics on NVIDIA vGPU. This issue affects only traces that gather hardware metrics. Other traces are not affected by this issue and work normally.

Version

This issue affects NVIDIA vGPU software releases starting with 15.2.

Status

Open

Ref.

4041169

5.14. NVIDIA vGPU software graphics driver for Windows sends a remote call to `ngx.download.nvidia.com`

Description

After the NVIDIA vGPU software graphics for windows has been installed in the guest VM, the driver sends a remote call to `ngx.download.nvidia.com` to download and install additional components. Such a remote call might be a security issue.

Workaround

Before running the NVIDIA vGPU software graphics driver installer, disable the remote call to `ngx.download.nvidia.com` by setting the following Windows registry key:

```
[HKEY_LOCAL_MACHINE\SOFTWARE\NVIDIA Corporation\Global\NGXCore]
```

```
"EnableOTA"=dword:00000000
```

Note: If this Windows registry key is set to 1 or deleted, the remote call to `ngx.download.nvidia.com` is enabled again.

Status

Open

Ref.

4031840

5.15. 15.0, 15.1 Only: Windows VMs fail to acquire a license in environments with multiple active desktop sessions

Description

A race condition in the NVIDIA vGPU softwaregraphics driver for Windows can cause Windows VMs to fail to acquire a license. This issue occurs in environments where multiple active desktop sessions are trying to acquire a license simultaneously. When this issue occurs, the following error message is written to licensing event log on the client:

```
Mismatch between client and server with respect to licenses held. Returning the
 licenses
```

Version

This issue affects only Windows guest VMs.

Status

Resolved in NVIDIA vGPU software 15.2

Ref.

3835855

5.16. 15.0, 15.1 Only: **NVIDIA RTX Desktop Manager** fails to start with B-series vGPUs on Windows VMs

Description

NVIDIA RTX Desktop Manager fails to start with B-series vGPUs on Windows VMs. This issue occurs with Citrix and VMware remoting tools. It does not occur over Remote Desktop Protocol (RDP) connections.

Status

Resolved in NVIDIA vGPU software 15.2

Ref.

3985036

5.17. 15.0, 15.1 Only: The NVIDIA vGPU software graphics driver for Windows cannot drive the display

Description

After a remoting session has been reconnected to several times or the screen has been resized several times, the NVIDIA vGPU software graphics driver can be randomly left in a state where it cannot drive the display. This issue affects only Windows guest VMs. Linux guest VMs are **not** affected.

Because the NVIDIA vGPU software graphics driver is not driving the display, this issue can cause visible performance degradation.

Status

Resolved in NVIDIA vGPU software 15.2

Ref.

3956112

5.18. 15.0, 15.1 Only: `NVIDIA Control Panel is not found` notification appears after a user logs in

Description

After a user logs in to a remote desktop session, the `NVIDIA Control Panel is not found` notification pop-up window appears.

In some situations, the notification pop-up window appears erroneously: It appears even if **NVIDIA Control Panel** is installed and available to the user. However, in other situations, the notification pop-up window correctly warns the user that **NVIDIA Control Panel** is not installed.

Workaround

Note: This workaround only prevents the notification pop-up window from appearing. It does **not** address the failure of **NVIDIA Control Panel** to be installed. Furthermore, if you apply this workaround, the notification pop-up window does **not** appear even if **NVIDIA Control Panel** is not installed.

In the Windows registry key `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\nvlddmkm\Global\NVTweak`, set the `DisableStoreNvCplNotifications` DWord (`REG_DWORD`) registry value to `1`.

Status

Resolved in NVIDIA vGPU software 15.2

Ref.

3941622

5.19. On NVIDIA H100, creation of multiple compute instances after deletion of existing compute instances fails

Description

After compute instances are created and deleted on an NVIDIA H100 GPU, creation of multiple instances in a single `nvidia-smi` command fails. For example, the command `nvidia-smi mig -cci 0,1,2` fails with the following error message:

```
Unable to create a compute instance on GPU  0 GPU instance ID  0 using profile 0:
 Invalid Argument
Failed to create compute instances: Invalid Argument
```

Workaround

Create each compute instance in a separate `nvidia-smi` command, for example:

```
$ nvidia-smi mig -cci 0
$ nvidia-smi mig -cci 1
$ nvidia-smi mig cci 2
```

Status

Open

Ref.

3829786

5.20. NLS client fails to acquire a license with the error `The allowed time to process response has expired`

Description

A licensed client of NVIDIA License System (NLS) fails to acquire a license with the error `The allowed time to process response has expired`. This error can affect clients of a Cloud License Service (CLS) instance or a Delegated License Service (DLS) instance.

This error occurs when the time difference between the system clocks on the client and the server that hosts the CLS or DLS instance is greater than 10 minutes. A common cause of this error is the failure of either the client or the server to adjust its system clock when daylight savings time begins or ends. The failure to acquire a license is expected to prevent clock windback from causing licensing errors.

Workaround

Ensure that system clock time of the client and any server that hosts a DLS instance match the current time in the time zone where they are located.

To prevent this error from occurring when daylight savings time begins or ends, enable the option to automatically adjust the system clock for daylight savings time:

- **Windows:** Set the **Adjust for daylight saving time automatically** option.
- **Linux:** Use the `hwclock` command.

Status

Not a bug

Ref.

3859889

5.21. NVIDIA vGPU software graphics driver fails to load on KVM-based hypervsiors

Description

The NVIDIA vGPU software graphics driver fails to load on hypervsiors based on Linux with KVM. This issue affects UEFI VMs configured with a vGPU or pass-through GPU that requires a large BAR address space. This issue does not affect VMs that are booted in legacy BIOS mode. The issue occurs because BAR resources are not mapped into the VM.

On a Windows VM, error code 12 is reported in **Device Manager** for the vGPU or pass-through GPU.

Workaround

1. In `virsh`, open for editing the XML document of the VM to which the vGPU or GPU is assigned.

```
# virsh edit vm-name
```

vm-name
The name of the VM to which the vGPU or GPU is assigned.

2. Declare the custom `libvirt` XML namespace that supports command-line pass through of QEMU arguments.

   Declare this namesapce by modifying the start tag of the top-level `domain` element in the first line of the XML document.

```
<domain type='kvm' xmlns:qemu='http://libvirt.org/schemas/domain/qemu/1.0'>
```

3. At the end of the XML document, between the `</devices>` end tag and the `</domain>` end tag, add the highlighted `qemu` elements.

   These elements pass the QEMU arguments for mapping the required BAR resources into the VM.

```
</devices>
  <qemu:commandline>
    <qemu:arg value='-fw_cfg'/>
    <qemu:arg value='opt/ovmf/X-PciMmio64Mb,string=262144'/>
  </qemu:commandline>
</domain>
```

4. Start the VM to which the vGPU or GPU is assigned.

```
# virsh start vm-name
```

vm-name
The name of the VM to which the vGPU or GPU is assigned.

Status

Not an NVIDIA bug

Ref.

200719557

5.22. With multiple active sessions, **NVIDIA Control Panel** incorrectly shows that the system is unlicensed

Description

In an environment with multiple active desktop sessions, the **Manage License** page of **NVIDIA Control Panel** shows that a licensed system is unlicensed. However, the `nvidia-smi` command and the management interface of the NVIDIA vGPU software license server correctly show that the system is licensed. When an active session is disconnected and reconnected, the **NVIDIA Display Container** service crashes.

The **Manage License** page incorrectly shows that the system is unlicensed because of stale data in **NVIDIA Control Panel** in an environment with multiple sessions. The data is stale because **NVIDIA Control Panel** fails to get and update the settings for remote sessions when multiple sessions or no sessions are active in the VM. The **NVIDIA Display Container** service crashes when a session is reconnected because the session is not active at the moment of reconnection.

Status

Open

Ref.

3761243

5.23. VP9 and AV1 decoding with web browsers are not supported on Microsoft Windows Server 2019

Description

VP9 and AV1 decoding with web browsers are not supported on Microsoft Windows Server 2019 and later supported releases. This issue occurs because starting with Windows Server 2019, the required codecs are not included with the OS and are not available through the **Microsoft Store** app. As a result, hardware decoding is not available for viewing YouTube videos or using collaboration tools such as Google Meet in a web browser.

Version

This issue affects Microsoft Windows Server releases starting with Windows Server 2019.

Status

Not an NVIDIA bug

Ref.

200756564

5.24. 15.0, 15.1 Only: NVIDIA Control Panel is started only for the RDP user that logs on first

Description

On all supported Windows Server guest OS releases, **NVIDIA Control Panel** is started only for the RDP user that logs on first. Other users cannot start **NVIDIA Control Panel**. If more than one RDP user is logged on when **NVIDIA Control Panel** is started, it always opens in the session of the RDP user that logged on first, irrespective of which user started **NVIDIA Control Panel**. Furthermore, on Windows Server 2016, **NVIDIA Control Panel** crashes if a user session is disconnected and then reconnected while **NVIDIA Control Panel** is open.

Version

This issue affects all supported Windows Server guest OS releases.

Status

Resolved in NVIDIA vGPU software 15.2

Ref.

3334310

5.25. `nvidia-smi` ignores the second NVIDIA vGPU device added to a Microsoft Windows Server 2016 VM

Description

After a second NVIDIA vGPU device is added to a Microsoft Windows Server 2016 VM, the device does not appear in the output from the `nvidia-smi` command. This issue occurs only if the VM is already running NVIDIA vGPU software for the existing NVIDIA vGPU device when the second device is added to the VM.

The `nvidia-smi` command cannot retrieve the guest driver version, license status, and accounting mode of the second NVIDIA vGPU device.

```
nvidia-smi vgpu --query
GPU 00000000:37:00.0
    Active vGPUs                      : 1
    vGPU ID                           : 3251695793
        VM ID                         : 3575923
        VM Name                       : SVR-Reg-W(P)-KuIn
        vGPU Name                     : GRID V100D-32Q
        vGPU Type                     : 185
        vGPU UUID                     : 29097249-2359-11b2-8a5b-8e896866496b
        Guest Driver Version          : 528.24
        License Status                : Licensed
        Accounting Mode               : Disabled
...
GPU 00000000:86:00.0
    Active vGPUs                      : 1
    vGPU ID                           : 3251695797
        VM ID                         : 3575923
        VM Name                       : SVR-Reg-W(P)-KuIn
        vGPU Name                     : GRID V100D-32Q
        vGPU Type                     : 185
        vGPU UUID                     : 2926dd83-2359-11b2-8b13-5f22f0f74801
        Guest Driver Version          : Not Available
        License Status                : N/A
        Accounting Mode               : N/A
```

Version

This issue affects only VMs that are running Microsoft Windows Server 2016 as a guest OS.

Workaround

To avoid this issue, configure the guest VM with both NVIDIA vGPU devices **before** installing the NVIDIA vGPU software graphics driver.

If you encounter this issue after the VM is configured, use one of the following workarounds:

- Reinstall the NVIDIA vGPU software graphics driver.
- Forcibly uninstall the Microsoft Basic Display Adapter and reboot the VM.
- Upgrade the guest OS on the VM to Microsoft Windows Server 2019.

Status

Not an NVIDIA bug

Ref.

3562801

5.26. After an upgrade of the Linux graphics driver from an RPM package in a licensed VM, licensing fails

Description

After the NVIDIA vGPU software graphics driver for Linux is upgraded from an RPM package in a licensed VM, licensing fails. The `nvidia-smi vgpu -q` command shows the driver version and license status as N/A. Restarting the `nvidia-gridd` service fails with a `Unit not found` error.

Workaround

Perform a clean installation of the NVIDIA vGPU software graphics driver for Linux from an RPM package.

1. Remove the currently installed driver.
2. Install the new version of the driver.

```
$ rpm -iv nvidia-linux-grid-525_525.147.05_amd64.rpm
```

Status

Open

Ref.

3512766

5.27. The reported NVENC frame rate is double the actual frame rate

Description

The frame rate in frames per second (FPS) for the NVIDIA hardware-based H.264/HEVC video encoder (NVENC) reported by the `nvidia-smi encodersessions` command and NVWMI is double the actual frame rate. Only the reported frame rate is incorrect. The actual encoding of frames is **not** affected.

This issue affects only Windows VMs that are configured with NVIDIA vGPU.

Status

Open

Ref.

2997564

5.28. NVENC does not work with Teradici Cloud Access Software on Windows

Description

The NVIDIA hardware-based H.264/HEVC video encoder (NVENC) does not work with Teradici Cloud Access Software on Windows. This issue affects NVIDIA vGPU and GPU pass through deployments.

This issue occurs because the check that Teradici Cloud Access Software performs on the DLL signer name is case sensitive and NVIDIA recently changed the case of the company name in the signature certificate.

Status

Not an NVIDIA bug

This issue is resolved in the latest 21.07 and 21.03 Teradici Cloud Access Software releases.

Ref.

200749065

5.29. A licensed client might fail to acquire a license if a proxy is set

Description

If a proxy is set with a system environment variable such as `HTTP_PROXY` or `HTTPS_PROXY`, a licensed client might fail to acquire a license.

Workaround

Perform this workaround on each affected licensed client.

1. Add the address of the NVIDIA vGPU software license server to the system environment variable `NO_PROXY`.

   The address must be specified exactly as it is specified in the client's license server settings either as a fully-qualified domain name or an IP address. If the `NO_PROXY` environment variable contains multiple entries, separate the entries with a comma (`,`).

   If high availability is configured for the license server, add the addresses of the primary license server and the secondary license server to the system environment variable `NO_PROXY`.
2. Restart the NVIDIA driver service that runs the core NVIDIA vGPU software logic.
   - On Windows, restart the **NVIDIA Display Container** service.
   - On Linux, restart the `nvidia-gridd` service.

Status

Closed

Ref.

200704733

5.30. Session connection fails with four 4K displays and NVENC enabled on a 2Q, 3Q, or 4Q vGPU

Description

Desktop session connections fail for a 2Q, 3Q, or 4Q vGPU that is configured with four 4K displays and for which the NVIDIA hardware-based H.264/HEVC video encoder (NVENC) is enabled. This issue affects only Teradici Cloud Access Software sessions on Linux guest VMs.

This issue is accompanied by the following error message:

```
This Desktop has no resources available or it has timed out
```

This issue is caused by insufficient frame buffer.

Workaround

Ensure that sufficient frame buffer is available for all the virtual displays that are connected to a vGPU by changing the configuration in one of the following ways:

- Reducing the number of virtual displays. The number of 4K displays supported with NVENC enabled depends on the vGPU.

vGPU	4K Displays Supported with NVENC Enabled
2Q	1
3Q	2
4Q	3

- Disabling NVENC. The number of 4K displays supported with NVENC disabled depends on the vGPU.

vGPU	4K Displays Supported with NVENC Disabled
2Q	2
3Q	2
4Q	4

- Using a vGPU type with more frame buffer. Four 4K displays with NVENC enabled on any Q-series vGPU with at least 6144 MB of frame buffer are supported.

Status

Not an NVIDIA bug

Ref.

200701959

5.31. NVIDIA A100 HGX 80GB vGPU names shown as `Graphics Device` by `nvidia-smi`

Description

The names of vGPUs that reside on the NVIDIA A100 80GB GPU are incorrectly shown as `Graphics Device` by the `nvidia-smi` command. The correct names indicate the vGPU type, for example, `A100DX-40C`.

```
$ nvidia-smi
Mon Jan 25 02:52:57 2021
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 460.32.04    Driver Version: 460.32.04    CUDA Version: 11.2     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  Graphics Device     On   | 00000000:07:00.0 Off |                    0 |
| N/A   N/A    P0    N/A /  N/A |   6053MiB / 81915MiB |      0%      Default |
|                               |                      |             Disabled |
+-------------------------------+----------------------+----------------------+
```

```
|   1  Graphics Device     On   | 00000000:08:00.0 Off |                    0 |
| N/A   N/A    P0    N/A /  N/A |   6053MiB / 81915MiB |      0%      Default |
|                               |                      |             Disabled |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```

Status

Open

Ref.

200691204

5.32. Idle Teradici Cloud Access Software session disconnects from Linux VM

Description

After a Teradici Cloud Access Software session has been idle for a short period of time, the session disconnects from the VM. When this issue occurs, the error messages `NVOS status 0x19` and `vGPU Message 21 failed` are written to the log files on the hypervisor host. This issue affects only Linux guest VMs.

Status

Open

Ref.

200689126

5.33. GPU Operator doesn't support vGPU on GPUs based on architectures before NVIDIA Turing

Description

NVIDIA GPU Operator doesn't support vGPU deployments on GPUs based on architectures before the NVIDIA Turing™ architecture. This issue is caused by the omission of version information for the vGPU manager from the configuration information that GPU Operator requires. Without this information, GPU Operator does not deploy the NVIDIA driver container because the container cannot determine if the driver is compatible with the vGPU manager.

Status

Open

Ref.

3227576

5.34. Idle NVIDIA A100, NVIDIA A40, and NVIDIA A10 GPUs show 100% GPU utilization

Description

The `nvidia-smi` command shows 100% GPU utilization for NVIDIA A100, NVIDIA A40, and NVIDIA A10 GPUs even if no vGPUs have been configured or no VMs are running. A GPU is affected by this issue only if the `sriov-manage` script has **not** been run to enable the virtual function for the GPU in the `sysfs` file system.

```
[root@host ~]# nvidia-smi
Fri Nov 10 11:45:28 2023
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 525.147.01   Driver Version: 525.147.01   CUDA Version:  12.0     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  A100-PCIE-40GB      On   | 00000000:5E:00.0 Off |                    0 |
| N/A   50C    P0    97W / 250W |      0MiB / 40537MiB |     100%      Default |
|                               |                      |             Disabled |
```

```
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```

Workaround

Run the `sriov-manage` script to enable the virtual function for the GPU in the `sysfs` file system as explained in *Virtual GPU Software User Guide*.

After this workaround has been completed, the `nvidia-smi` command shows 0% GPU utilization for affected GPUs when they are idle.

```
root@host ~]# nvidia-smi
Fri Nov 10 11:47:38 2023
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 525.147.01   Driver Version: 525.147.01   CUDA Version:  12.0     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|                               |                      |               MIG M. |
|===============================+======================+======================|
|   0  A100-PCIE-40GB      On   | 00000000:5E:00.0 Off |                    0 |
| N/A   50C    P0    97W / 250W |      0MiB / 40537MiB |      0%      Default |
|                               |                      |             Disabled |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                                  |
|  GPU   GI   CI        PID   Type   Process name                  GPU Memory |
|        ID   ID                                                   Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```

Status

Open

Ref.

200605527

5.35. Guest VM frame buffer listed by `nvidia-smi` for vGPUs on GPUs that support SRIOV is incorrect

Description

The amount of frame buffer listed in a guest VM by the `nvidia-smi` command for vGPUs on GPUs that support Single Root I/O Virtualization (SR-IOV) is incorrect. Specifically, the amount of frame buffer listed is the amount of frame buffer allocated for the vGPU type minus the size of the VMMU segment (`vmmu_page_size`). Examples of GPUs that support SRIOV are GPUs based on the NIVIDIA Ampere architecture, such as NVIDA A100 PCIe 40GB or NVIDA A100 HGX 40GB.

For example, frame buffer for -4C and -20C vGPU types is listed as follows:

- For -4C vGPU types, frame buffer is listed as 3963 MB instead of 4096 MB.
- For -20C vGPU types, frame buffer is listed as 20347 MB instead of 20480 MB.

Status

Open

Ref.

200524749

5.36. VMs fail to boot on RHV 4.4

Description

On RHV 4.4, VMs fail to boot with the error `Host doesn't support passthru of host PCI device`. This issue affects GPU pass through deployments with all supported GPUs and NVIDIA vGPU deployments with GPUs based on the NVIDIA Ampere architecture. This issue occurs because the `intel_iommu` parameter and the `nouveau.modeset` parameter are not set correctly.

Version

This issue affects RHV 4.4.

Workaround

Perform this workaround on the hypervisor host. This workaround requires root user privileges on the hypervisor host.

1. In a plain-text editor, edit the file `/boot/loader/entries/rhvh-4.4.1.1-0.20200722.0+1-4.18.0-193.13.2.el8_2.x86_64.conf` to add the following options to the boot options.
   - `nouveau.modeset=0`
   - `intel_iommu=on`

   Note: Line breaks have been added to this example to enhance readability.

```
title rhvh-4.4.1.1-0.20200722.0 (4.18.0-193.13.2.el8_2.x86_64)
version 4.18.0-193.13.2.el8_2.x86_64
linux //rhvh-4.4.1.1-0.20200722.0+1/vmlinuz-4.18.0-193.13.2.el8_2.x86_64
initrd //rhvh-4.4.1.1-0.20200722.0+1/initramfs-4.18.0-193.13.2.el8_2.x86_64.img
options crashkernel=auto resume=/dev/mapper/rhvh00-swap \
rd.lvm.lv=rhvh00/rhvh-4.4.1.1-0.20200722.0+1 rd.lvm.lv=rhvh00/swap \
root=/dev/rhvh00/rhvh-4.4.1.1-0.20200722.0+1 \
boot=UUID=38ff2175-b761-403d-8a91-d7ec9f7ec2f7 rootflags=discard \
img.bootid=rhvh-4.4.1.1-0.20200722.0+1 intel_iommu=on nouveau.modeset=0
id rhel-20200825140238-4.18.0-193.13.2.el8_2.x86_64
grub_users $grub_users
grub_arg --unrestricted
grub_class kernel
```

2. Reboot the hypervisor host machine.

Status

Not an NVIDIA bug

Ref.

200653675

5.37. Driver upgrade in a Linux guest VM with multiple vGPUs might fail

Description

Upgrading the NVIDIA vGPU software graphics driver in a Linux guest VM with multiple vGPUs might fail. This issue occurs if the driver is upgraded by overinstalling the new release of the driver on the current release of the driver while the `nvidia-gridd` service is running in the VM.

Workaround

1. Stop the `nvidia-gridd` service.
2. Try again to upgrade the driver.

Status

Open

Ref.

200633548

5.38. **NVIDIA Control Panel** fails to start if launched too soon from a VM without licensing information

Description

If NVIDIA licensing information is not configured on the system, any attempt to start **NVIDIA Control Panel** by right-clicking on the desktop within 30 seconds of the VM being started fails.

Workaround

Restart the VM and wait at least 30 seconds before trying to launch **NVIDIA Control Panel**.

Status

Open

Ref.

200623179

5.39. On Linux, the frame rate might drop to 1 after several minutes

Description

On Linux, the frame rate might drop to 1 frame per second (FPS) after NVIDIA vGPU software has been running for several minutes. Only some applications are affected, for example, `glxgears`. Other applications, such as Unigine Heaven, are not affected. This behavior occurs because Display Power Management Signaling (DPMS) for the Xorg server is enabled by default and the display is detected to be inactive even when the application is running. When DPMS is enabled, it enables power saving behavior of the display after several minutes of inactivity by setting the frame rate to 1 FPS.

Workaround

1. If necessary, stop the Xorg server.

   ```
   # /etc/init.d/xorg stop
   ```

2. In a plain text editor, edit the `/etc/X11/xorg.conf file` to set the options to disable DPMS and disable the screen saver.

   a). In the `Monitor` section, set the `DPMS` option to `false`.

   ```
   Option "DPMS" "false"
   ```

   b). At the end of the file, add a `ServerFlags` section that contains option to disable the screen saver.

   ```
   Section "ServerFlags"
       Option "BlankTime" "0"
     EndSection
   ```

   c). Save your changes to `/etc/X11/xorg.conf file` and quit the editor.

3. Start the Xorg server.

   ```
   # etc/init.d/xorg start
   ```

Status

Open

Ref.

200605900

5.40. DWM crashes randomly occur in Windows VMs

Description

Desktop Windows Manager (DWM) crashes randomly occur in Windows VMs, causing a blue-screen crash and the bug check `CRITICAL_PROCESS_DIED`. Computer Management shows problems with the primary display device.

Version

This issue affects Windows 10 1809, 1903 and 1909 VMs.

Status

Not an NVIDIA bug

Ref.

2730037

5.41. ECC memory settings for a vGPU cannot be changed by using **NVIDIA X Server Settings**

Description

The ECC memory settings for a vGPU cannot be changed from a Linux guest VM by using **NVIDIA X Server Settings**. After the ECC memory state has been changed on the **ECC Settings** page and the VM has been rebooted, the ECC memory state remains unchanged.

Workaround

Use the `nvidia-smi` command in the guest VM to enable or disable ECC memory for the vGPU as explained in *Virtual GPU Software User Guide*.

If the ECC memory state remains unchanged even after you use the `nvidia-smi` command to change it, use the workaround in Changes to ECC memory settings for a Linux vGPU VM by nvidia-smi might be ignored.

Status

Open

Ref.

200523086

5.42. Changes to ECC memory settings for a Linux vGPU VM by `nvidia-smi` might be ignored

Description

After the ECC memory state for a Linux vGPU VM has been changed by using the `nvidia-smi` command and the VM has been rebooted, the ECC memory state might remain unchanged.

This issue occurs when multiple NVIDIA configuration files in the system cause the kernel module option for setting the ECC memory state `RMGuestECCState` in `/etc/modprobe.d/nvidia.conf` to be ignored.

When the `nvidia-smi` command is used to enable ECC memory, the file `/etc/modprobe.d/nvidia.conf` is created or updated to set the kernel module option `RMGuestECCState`. Another configuration file in `/etc/modprobe.d/` that contains the keyword `NVreg_RegistryDwordsPerDevice` might cause the kernel module option `RMGuestECCState` to be ignored.

Workaround

This workaround requires administrator privileges.

1. Move the entry containing the keyword `NVreg_RegistryDwordsPerDevice` from the other configuration file to `/etc/modprobe.d/nvidia.conf`.
2. Reboot the VM.

Status

Open

Ref.

200505777

5.43. Host core CPU utilization is higher than expected for moderate workloads

Description

When GPU performance is being monitored, host core CPU utilization is higher than expected for moderate workloads. For example, host CPU utilization when only a small number of VMs are running is as high as when several times as many VMs are running.

Workaround

Disable monitoring of the following GPU performance statistics:

- vGPU engine usage by applications across multiple vGPUs
- Encoder session statistics
- Frame buffer capture (FBC) session statistics
- Statistics gathered by performance counters in guest VMs

Status

Open

Ref.

2414897

5.44. Frame capture while the interactive logon message is displayed returns blank screen

Description

Because of a known limitation with NvFBC, a frame capture while the interactive logon message is displayed returns a blank screen.

An NvFBC session can capture screen updates that occur after the session is created. Before the logon message appears, there is no screen update after the message is shown and, therefore, a black screen is returned instead. If the NvFBC session is created after this update has occurred, NvFBC cannot get a frame to capture.

Workaround

Press **Enter** or wait for the screen to update for NvFBC to capture the frame.

Status

Not a bug

Ref.

2115733

5.45. RDS sessions do not use the GPU with some Microsoft Windows Server releases

Description

When some releases of Windows Server are used as a guest OS, Remote Desktop Services (RDS) sessions do not use the GPU. With these releases, the RDS sessions by default use the Microsoft Basic Render Driver instead of the GPU. This default setting enables 2D DirectX applications such as Microsoft Office to use software rendering, which can be more efficient than using the GPU for rendering. However, as a result, 3D applications that use DirectX are prevented from using the GPU.

Version

- Windows Server 2019
- Windows Server 2016
- Windows Server 2012

Solution

Change the local computer policy to use the hardware graphics adapter for all RDS sessions.

1. Choose **Local Computer Policy** > **Computer Configuration** > **Administrative Templates** > **Windows Components** > **Remote Desktop Services** > **Remote Desktop Session Host** > **Remote Session Environment** .
2. Set the **Use the hardware default graphics adapter for all Remote Desktop Services sessions** option.

5.46. When the scheduling policy is fixed share, GPU utilization is reported as higher than expected

Description

When the scheduling policy is fixed share, GPU engine utilization can be reported as higher than expected for a vGPU.

For example, GPU engine usage for six P40-4Q vGPUs on a Tesla P40 GPU might be reported as follows:

```
[root@localhost:~] nvidia-smi vgpu
Mon Aug 20 10:33:18 2018
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 390.42                 Driver Version: 390.42                    |
|-------------------------------+----------------------------------+----------+
| GPU  Name                     | Bus-Id                           | GPU-Util |
|      vGPU ID    Name          | VM ID    VM Name                 | vGPU-Util |
|===============================+==================================+==========|
|   0  Tesla P40                | 00000000:81:00.0                 |  99%     |
|      85109      GRID P40-4Q   | 85110    win7-xmpl-146048-1      |      32% |
|      87195      GRID P40-4Q   | 87196    win7-xmpl-146048-2      |      39% |
|      88095      GRID P40-4Q   | 88096    win7-xmpl-146048-3      |      26% |
|      89170      GRID P40-4Q   | 89171    win7-xmpl-146048-4      |       0% |
|      90475      GRID P40-4Q   | 90476    win7-xmpl-146048-5      |       0% |
|      93363      GRID P40-4Q   | 93364    win7-xmpl-146048-6      |       0% |
+-------------------------------+----------------------------------+----------+
|   1  Tesla P40                | 00000000:85:00.0                 |   0%     |
+-------------------------------+----------------------------------+----------+
```

The vGPU utilization of vGPU 85109 is reported as 32%. For vGPU 87195, vGPU utilization is reported as 39%. And for 88095, it is reported as 26%. However, the expected vGPU utilization of any vGPU should not exceed approximately 16.7%.

This behavior is a result of the mechanism that is used to measure GPU engine utilization.

Status

Open

Ref.

2227591

5.47. License is not acquired in Windows VMs

Description

When a windows VM configured with a licensed vGPU is started, the VM fails to acquire a license.

Error messages in the following format are written to the NVIDIA service logs:

```
[000000020.860152600 sec] - [Logging.lib]   ERROR: [nvGridLicensing.FlexUtility]
 353@FlexUtility::LogFneError : Error: Failed to add trusted storage. Server
 URL : license-server-url -
[1,7E2,2,1[7000003F,0,9B00A7]]

System machine type does not match expected machine type..
```

Workaround

This workaround requires administrator privileges.

1. Stop the **NVIDIA Display Container LS** service.
2. Delete the contents of the folder `%SystemDrive%:\Program Files\NVIDIA Corporation\Grid Licensing`.
3. Start the **NVIDIA Display Container LS** service.

Status

Closed

Ref.

200407287

5.48. `nvidia-smi` reports that vGPU migration is supported on all hypervisors

Description

The command `nvidia-smi vgpu -m` shows that vGPU migration is supported on all hypervisors, even hypervisors or hypervisor versions that do not support vGPU migration.

Status

Closed

Ref.

200407230

5.49. Hot plugging and unplugging vCPUs causes a blue-screen crash in Windows VMs

Description

Hot plugging or unplugging vCPUs causes a blue-screen crash in Windows VMs that are running NVIDIA vGPU software graphics drivers.

When the blue-screen crash occurs, one of the following error messages may also be seen:

- `SYSTEM_SERVICE_EXCEPTION(nvlddmkm.sys)`
- `DRIVER_IRQL_NOT_LESS_OR_EQUAL(nvlddmkm.sys)`

NVIDIA vGPU software graphics drivers do not support hot plugging and unplugging of vCPUs.

Status

Closed

Ref.

2101499

5.50. Luxmark causes a segmentation fault on an unlicensed Linux client

Description

If the Luxmark application is run on a Linux guest VM configured with NVIDIA vGPU that is booted without acquiring a license, a segmentation fault occurs and the application core dumps. The fault occurs when the application cannot allocate a CUDA object on

NVIDIA vGPUs where CUDA is disabled. On NVIDIA vGPUs that can support CUDA, CUDA is disabled in unlicensed mode.

Status

Not an NVIDIA bug.

Ref.

200330956

5.51. A segmentation fault in DBus code causes `nvidia-gridd` to exit on Red Hat Enterprise Linux and CentOS

Description

On Red Hat Enterprise Linux 6.8 and 6.9, and CentOS 6.8 and 6.9, a segmentation fault in DBus code causes the `nvidia-gridd` service to exit.

The `nvidia-gridd` service uses DBus for communication with **NVIDIA X Server Settings** to display licensing information through the **Manage License** page. Disabling the GUI for licensing resolves this issue.

To prevent this issue, the GUI for licensing is disabled by default. You might encounter this issue if you have enabled the GUI for licensing and are using Red Hat Enterprise Linux 6.8 or 6.9, or CentOS 6.8 and 6.9.

Version

Red Hat Enterprise Linux 6.8 and 6.9

CentOS 6.8 and 6.9

Status

Open

Ref.

- 200358191
- 200319854
- 1895945

5.52. No **Manage License** option available in **NVIDIA X Server Settings** by default

Description

By default, the **Manage License** option is not available in **NVIDIA X Server Settings**. This option is missing because the GUI for licensing on Linux is disabled by default to work around the issue that is described in A segmentation fault in DBus code causes nvidia-gridd to exit on Red Hat Enterprise Linux and CentOS.

Workaround

This workaround requires `sudo` privileges.

Note: Do **not** use this workaround with Red Hat Enterprise Linux 6.8 and 6.9 or CentOS 6.8 and 6.9. To prevent a segmentation fault in DBus code from causing the `nvidia-gridd` service from exiting, the GUI for licensing must be disabled with these OS versions.

If you are licensing a physical GPU for vCS, you **must** use the configuration file `/etc/nvidia/gridd.conf`.

1. If **NVIDIA X Server Settings** is running, shut it down.
2. If the `/etc/nvidia/gridd.conf` file does not already exist, create it by copying the supplied template file `/etc/nvidia/gridd.conf.template`.
3. As root, edit the `/etc/nvidia/gridd.conf` file to set the `EnableUI` option to `TRUE`.
4. Start the `nvidia-gridd` service.

```
# sudo service nvidia-gridd start
```

When **NVIDIA X Server Settings** is restarted, the **Manage License** option is now available.

Status

Open

5.53. Licenses remain checked out when VMs are forcibly powered off

Description

NVIDIA vGPU software licenses remain checked out on the license server when non-persistent VMs are forcibly powered off.

The NVIDIA service running in a VM returns checked out licenses when the VM is shut down. In environments where non-persistent licensed VMs are not cleanly shut down, licenses on the license server can become exhausted. For example, this issue can occur in automated test environments where VMs are frequently changing and are not guaranteed to be cleanly shut down. The licenses from such VMs remain checked out against their MAC address for seven days before they time out and become available to other VMs.

Resolution

If VMs are routinely being powered off without clean shutdown in your environment, you can avoid this issue by shortening the license borrow period. To shorten the license borrow period, set the `LicenseInterval` configuration setting in your VM image. For details, refer to *Virtual GPU Client Licensing User Guide*.

Status

Closed

Ref.

1694975

5.54. VM bug checks after the guest VM driver for Windows 10 RS2 is installed

Description

When the VM is rebooted after the guest VM driver for Windows 10 RS2 is installed, the VM bug checks. When Windows boots, it selects one of the standard supported video modes. If Windows is booted directly with a display that is driven by an NVIDIA driver, for example a vGPU on Citrix Hypervisor, a blue screen crash occurs.

This issue occurs when the screen resolution is switched from VGA mode to a resolution that is higher than 1920×1200.

Fix

Download and install Microsoft Windows Update KB4020102 from the Microsoft Update Catalog.

Workaround

If you have applied the fix, ignore this workaround.

Otherwise, you can work around this issue until you are able to apply the fix by not using resolutions higher than 1920×1200.

1. Choose a GPU profile in Citrix XenCenter that does not allow resolutions higher than 1920×1200.
2. Before rebooting the VM, set the display resolution to 1920×1200 or lower.

Status

Not an NVIDIA bug

Ref.

200310861

5.55. GNOME Display Manager (GDM) fails to start on Red Hat Enterprise Linux 7.2 and CentOS 7.0

Description

GDM fails to start on Red Hat Enterprise Linux 7.2 and CentOS 7.0 with the following error:

```
Oh no! Something has gone wrong!
```

Workaround

Permanently enable permissive mode for Security Enhanced Linux (SELinux).

1. As root, edit the `/etc/selinux/config` file to set `SELINUX` to `permissive`.
   ```
   SELINUX=permissive
   ```
2. Reboot the system.
   ```
   ~]# reboot
   ```

For more information, see Permissive Mode in *Red Hat Enterprise Linux 7 SELinux User's and Administrator's Guide*.

Status

Not an NVIDIA bug

Ref.

200167868

Notice

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

NVIDIA reserves the right to make corrections, modifications, enhancements, improvements, and any other changes to this document, at any time without notice.

Customer should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

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

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

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

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

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

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

VESA DisplayPort

DisplayPort and DisplayPort Compliance Logo, DisplayPort Compliance Logo for Dual-mode Sources, and DisplayPort Compliance Logo for Active Cables are trademarks owned by the Video Electronics Standards Association in the United States and other countries.

HDMI

HDMI, the HDMI logo, and High-Definition Multimedia Interface are trademarks or registered trademarks of HDMI Licensing LLC.

OpenCL

OpenCL is a trademark of Apple Inc. used under license to the Khronos Group Inc.

Trademarks

NVIDIA, the NVIDIA logo, NVIDIA GRID, NVIDIA GRID vGPU, NVIDIA Maxwell, NVIDIA Pascal, NVIDIA Turing, NVIDIA Volta, GPUDirect, Quadro, and Tesla are trademarks or registered trademarks of NVIDIA Corporation in the U.S. and other countries. Other company and product names may be trademarks of the respective companies with which they are associated.

Copyright

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