NVIDIA AI Enterprise

Release Notes

RN-10616-001 _v5.1 | June 2024

Table of Contents

Chapter 1. What's New in NVIDIA AI Enterprise

NVIDIA AI Enterprise release 5.1 is an update release that introduces some new features and enhancements, and includes bug fixes and security updates.

Changes to Hardware and Software Supported in this Release

Newly supported graphics cards:

- NVIDIA L20 liquid-cooled

Newly supported hypervisor software:

- Red Hat Enterprise Linux with KVM hypervisor 9.4 and 8.10

Newly supported guest OS and bare-metal OS releases:

- Red Hat Enterprise Linux 9.4 and 8.10

Hypervisor software longer supported:

- Red Hat Enterprise Linux with KVM hypervisor 9.3, 9.0, 8.9, and 8.6

Guest OSes no longer supported:

- Red Hat Enterprise Linux 9.3, 9.0, 8.9, and 8.6

Changes to Infrastructure Software in this Release

- New releases of the following software:
  - NVIDIA vGPU software: 17.3:
    - Virtual GPU Manger: 550.90.05
    - NVIDIA vGPU Guest Driver for Windows: 552.74
    - NVIDIA vGPU Guest Driver for Linux: 550.90.07

    For details of the changes in this release of NVIDIA vGPU software since the last release that was a component of NVIDIA AI Enterprise, refer to the following NVIDIA vGPU software documentation:

        - For Red Hat Enterprise Linux KVM:
            - Updates in Release 17.3
            - Updates in Release 17.2
        - For Ubuntu:
            - Updates in Release 17.3
            - Updates in Release 17.2
        - For VMware vSphere:
            - Updates in Release 17.3
            - Updates in Release 17.2
    - NVIDIA Base Command™ Manager Essentials: 10.24.05
    - NVIDIA GPU Operator: 24.3.0
    - NVIDIA Network Operator: 24.4.0
- Addition of NVIDIA data center GPU drivers for bare-metal deployments to the NVIDIA AI Enterprise Infra Release 5 collection:
    - NVIDIA Data Center GPU Driver for Windows: 552.74
    - NVIDIA Data Center GPU Driver for Linux: 550.90.07
- Miscellaneous bug fixes

Chapter 2. Supported Hardware and Software

For more information, refer to the NVIDIA AI Enterprise Product Support Matrix.

Servers, NVIDIA GPUs, and Other Processing Units Supported

NVIDIA AI Enterprise is supported on NVIDIA® DGX™ servers in bare-metal deployments with the NVIDIA graphics driver for Linux that is included in the DGX OS software.

Note: NVIDIA vGPU software is **not** supported on NVIDIA DGX servers.

NVIDIA AI Enterprise is supported on the following NVIDIA GPUs with the compatible third-party servers that are listed on the NVIDIA-certified systems page.

- NVIDIA A800 PCIe 80GB
- NVIDIA A800 PCIe 80GB liquid cooled
- NVIDIA A800 HGX 80GB
- NVIDIA A800 40GB PCIe active cooled
- NVIDIA A100X
- NVIDIA A100 PCIe 40GB
- NVIDIA A100 HGX 40GB
- NVIDIA A100 PCIe 80GB
- NVIDIA A100 PCIe 80GB liquid cooled
- NVIDIA A100 HGX 80GB
- NVIDIA A40
- NVIDIA A30 liquid cooled
- NVIDIA A30X
- NVIDIA A30
- NVIDIA A10
- NVIDIA A16
- NVIDIA A2

- NVIDIA AX800[1]
- NVIDIA GH200 96GB (CG1) Grace Hopper™ Superchip[2]
- NVIDIA GH200 Grace Hopper 144GB (CG1) Superchip[2]
- NVIDIA H100 PCIe 94GB (H100 NVL)
- NVIDIA H100 PCIe 80GB
- NVIDIA H100 SXM5 94GB
- NVIDIA H100 SXM5 80GB[3]
- NVIDIA H100 SXM5 64GB
- NVIDIA H800 PCIe 94GB (H800 NVL)
- NVIDIA H800 PCIe 94GB
- NVIDIA H800 PCIe 80GB
- NVIDIA H800 SXM5 80GB[3]
- NVIDIA L2
- NVIDIA L4
- NVIDIA L20
- NVIDIA L20 liquid cooled
- NVIDIA L40
- NVIDIA L40S
- NVIDIA RTX A6000
- NVIDIA RTX A5500
- NVIDIA RTX A5000
- NVIDIA RTX 6000 passive
- NVIDIA RTX 8000 passive
- NVIDIA RTX 6000 Ada
- NVIDIA RTX 5880 Ada
- NVIDIA RTX 5000 Ada
- NVIDIA T4
- NVIDIA V100

Multi-node scaling requires an Ethernet NIC that supports RoCE. For best performance, NVIDIA recommends using an NVIDIA® Mellanox® ConnectX®-6 Dx and an NVIDIA A100 GPU in each VM used for multi-node scaling. Refer to the Sizing guide and the Multi-Node Training solution guide for further information.

[1] The NVIDIA AX800 GPU is supported only on Linux OSes. Windows is **not** supported.
[2] All variants of the NVIDIA GH200 Grace Hopper Superchip are supported only in bare-metal deployments on Red Hat Enterprise Linux, SUSE Linux Enterprise Server, and Ubuntu.
[3] When deployed on an NVIDIA HGX Hopper 8-GPU baseboard, this GPU is supported starting with VMware vSphere 8 update 2. Earlier VMware vSphere releases are **not** supported.

Hypervisor Software Supported

Note: Updates to a base release of a supported hypervisor are compatible with the base release and can also be used with this version of NVIDIA AI Enterprise unless expressly stated otherwise.

- Red Hat Enterprise Linux with KVM hypervisor 9.4, 9.2
- Red Hat Enterprise Linux with KVM hypervisor 8.10, 8.8
- VMware vSphere Hypervisor (ESXi) Enterprise Plus Edition 8.0
- VMware vCenter Server 8.0
- VMware vSphere Hypervisor (ESXi) Enterprise Plus Edition 7.0 Update 3
- VMware vCenter Server 7.0 Update 3

Supported Generic Linux with KVM Hypervisors

NVIDIA AI Enterprise is supported on generic Linux with KVM hypervisors **only** by specific hypervisor software vendors. For information about which NVIDIA AI Enterprise releases and hypervisor software releases are supported, consult the documentation from your hypervisor vendor.

Hypervisor Vendor	Platform	Additional Information
Nutanix	AHV	Obtain the NVIDIA Virtual GPU Manager software directly from Nutanix through the My Nutanix portal (My Nutanix account required). **Note:** If the NVIDIA AI Enterprise release that you need is not available from the My Nutanix portal, contact Nutanix. Then follow the instructions on the My Nutanix portal to obtain the correct NVIDIA AI Enterprise graphics drivers from the NVIDIA Licensing Portal.
Red Hat	OpenStack Platform	Product Documentation for Red Hat OpenStack Platform

Microsoft Windows Guest Operating Systems Supported

Note:

- NVIDIA AI Enterprise supports **only** the Tesla Compute Cluster (TCC) driver model for Windows guest drivers.

- Windows guest OS support is limited to running applications natively in Windows VMs **without** containers. NVIDIA AI Enterprise features that depend on containerization of applications are not supported on Windows guest operating systems.
- If you are using a supported generic Linux with KVM hypervisor, consult the documentation from your hypervisor vendor for information about Windows releases supported as a guest OS.

Guest OS	Red Hat Enterprise Linux KVM	Ubuntu	VMware vSphere
Microsoft Windows Server 2022	9.4, 9.2 8.10, 8.8	Not supported	8.0 7.0 Update 3
Microsoft Windows 11	Not supported	22.04 LTS, 20.04 LTS	8.0 7.0 Update 3
Microsoft Windows 10	Not supported	22.04 LTS, 20.04 LTS	8.0 7.0 Update 3

Linux Guest Operating Systems Supported

Note: If you are using a supported generic Linux with KVM hypervisor, consult the documentation from your hypervisor vendor for information about Linux distributions supported as a guest OS.

Guest OS	Red Hat Enterprise Linux KVM	Ubuntu	VMware vSphere
Red Hat Enterprise Linux 9.4, 9.2	9.4, 9.2 8.10, 8.8	Not supported	8.0 7.0 Update 3
Red Hat Enterprise Linux 8.10, 8.8	9.4, 9.2 8.10, 8.8	Not supported	8.0 7.0 Update 3
Red Hat OpenShift 4.12 through 4.15 using Red Hat Linux CoreOS (RHCOS)	9.4, 9.2 8.10, 8.8	Not supported	8.0 7.0 Update 3
SUSE Linux Enterprise Server 15 SP2+	Not supported	Not supported	8.0 7.0 Update 3

Guest OS	Red Hat Enterprise Linux KVM	Ubuntu	VMware vSphere
Ubuntu 22.04 LTS	Not supported	22.04 LTS, 20.04 LTS	8.0 7.0 Update 3
Ubuntu 20.04 LTS	Not supported	22.04 LTS, 20.04 LTS	8.0 7.0 Update 3

NVIDIA Data Center GPU Driver Support

In bare-metal deployments, NVIDIA AI Enterprise supports NVIDIA data center GPU drivers as alternative to the NVIDIA virtual GPU software guest drivers. When NVIDIA data center GPU drivers are used, licensing is enforced through the End-User License Agreement (EULA) only.

The NVIDIA data center GPU drivers are available from the NVIDIA AI Enterprise Infra Release 5 collection. For more information about these drivers, refer to NVIDIA Data Center Drivers.

Slurm Workload Manager Releases Supported

NVIDIA AI Enterprise supports Slurm workload manager 23.02.

2.1. NVIDIA AI Enterprise Software Components

Infrastructure and Workload Management Components

Software Component	NVIDIA Release
NVIDIA virtual GPU software	17.3: ▶ Virtual GPU Manger: 550.90.05 ▶ NVIDIA vGPU Guest Driver for Windows: 552.74 ▶ NVIDIA vGPU Guest Driver for Linux: 550.90.07
NVIDIA Data Center Drivers	▶ NVIDIA Data Center GPU Driver for Windows: 552.74 ▶ NVIDIA Data Center GPU Driver for Linux: 550.90.07

Software Component	NVIDIA Release
NVIDIA GPU Operator	24.3.0
NVIDIA Network Operator	24.4.0
NVIDIA Base Command™ Manager Essentials	10.24.05

NVIDIA AI Enterprise Infra Release 5 is compatible with the tools for AI development and use cases in the following Production Branch (PB) and Feature Branch (FB) collection versions:

- **PB collection version:** Production Branch October 2023
- **FB collection version:** Top of Tree (ToT)

Tools for AI Development and Use Cases

The PB and FB collections that are compatible with NVIDIA AI Enterprise Infra Release 5 contain the following tools for AI development and use cases:

- NVIDIA Clara Parabricks
- NVIDIA DeepStream
- NVIDIA DGL
- NVIDIA Maxine
- NVIDIA Modulus
- MONAI (Medical Open Network for Artificial Intelligence) Enterprise
- NVIDIA NeMo™
- NVIDIA NIM
- PyTorch
- NVIDIA RAPIDS
- NVIDIA RAPIDS Accelerator for Apache Spark
- NVIDIA Riva
- TAO Toolkit
- NVIDIA TensorRT
- TensorFlow
- NVIDIA Triton Inference Server
- NVIDIA Triton Management Service

NVIDIA NIM Collection

The NVIDIA NIM collection is available on NVIDIA NGC. NVIDIA NIM is a set of easy-to-use microservices for accelerating deployment of generative AI at scale in the cloud, in the data center, and on workstations.

2.2. 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 AI Enterprise 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.

GPU	Mode as Supplied from the Factory
NVIDIA A40	Display-off
NVIDIA L40	Display-off
NVIDIA L40S	Display-off
NVIDIA L20	Display-off
NVIDIA L20 liquid cooled	Display-off
NVIDIA RTX 5000 Ada	Display enabled
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 GPUs listed in the table support the `displaymodeselector` tool. Other GPUs that support NVIDIA AI Enterprise do not support the `displaymodeselector` tool and, unless otherwise stated, do not require display mode switching.

2.3. Requirements for Using C-Series vGPUs

Because C-Series vGPUs have large BAR memory settings, using these vGPUs has some restrictions on VMware ESXi.

- The guest OS must be a 64-bit OS.
- 64-bit MMIO and EFI boot must be enabled for the VM.
- The guest OS must be able to be installed in EFI boot mode.

- The VM's MMIO space must be increased to 64 GB as explained in VMware Knowledge Base Article: VMware vSphere VMDirectPath I/O: Requirements for Platforms and Devices (2142307).

2.4. Requirements for Using vGPU on GPUs Requiring 64 GB or More of MMIO Space with Large-Memory VMs

Some GPUs require 64 GB or more of MMIO space. When a vGPU on a GPU that requires 64 GB or more of MMIO space is assigned to a VM with 32 GB or more of memory on ESXi , the VM's MMIO space must be increased to the amount of MMIO space that the GPU requires.

For more information, refer to VMware Knowledge Base Article: VMware vSphere VMDirectPath I/O: Requirements for Platforms and Devices (2142307).

No extra configuration is needed.

The following table lists the GPUs that require 64 GB or more of MMIO space and the amount of MMIO space that each GPU requires.

GPU	MMIO Space Required
NVIDIA A10	64 GB
NVIDIA A30	64 GB
NVIDIA A40	128 GB
NVIDIA A100 40GB (all variants)	128 GB
NVIDIA A100 80GB (all variants)	256 GB
NVIDIA RTX A5000	64 GB
NVIDIA RTX A5500	64 GB
NVIDIA RTX A6000	128 GB
Quadro RTX 6000 Passive	64 GB
Quadro RTX 8000 Passive	64 GB
Tesla V100 (all variants)	64 GB

2.5. Linux Only: Error Messages for Misconfigured GPUs Requiring Large MMIO Space

In a Linux VM, if the requirements for using C-Series vCS vGPUs or GPUs requiring large MMIO space in pass-through mode are not met, the following error messages are written to the VM's `dmesg` log during installation of the NVIDIA AI Enterprise graphics driver:

```
NVRM: BAR1 is 0M @ 0x0 (PCI:0000:02:02.0)
[  90.823015] NVRM: The system BIOS may have misconfigured your GPU.
[  90.823019] nvidia: probe of 0000:02:02.0 failed with error -1
[  90.823031] NVRM: The NVIDIA probe routine failed for 1 device(s).
```

2.6. NVIDIA CUDA Toolkit Version Support

The releases in this release family of NVIDIA AI Enterprise support NVIDIA CUDA Toolkit 12.4.

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 12.3*.

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 12.4 Documentation.

2.7. vGPU Migration Support

vGPU Migration, which includes vMotion and suspend-resume, is supported for both time-sliced and MIG-backed vGPUs on all supported GPUs and guest operating systems but only on a subset of supported hypervisor software releases.

Limitations with vGPU Migration Support

Red Hat Enterprise Linux with KVM: Migration between hosts that are running different versions of the NVIDIA Virtual GPU Manager driver is not supported, even within the same NVIDIA Virtual GPU Manager driver branch.

vGPU migration is disabled for a VM for which any of the following NVIDIA CUDA Toolkit features is enabled:

- Unified memory
- Debuggers
- Profilers

Supported Hypervisor Software Releases

Since Red Hat Enterprise Linux with KVM 9.4

Not supported on Ubuntu

All supported releases of VMware vSphere

Known Issues with vGPU Migration Support

Use Case	Affected GPUs	Issue
Migration between hosts with different ECC memory configuration	All GPUs that support vGPU Migration	Migration of VMs configured with vGPU stops before the migration is complete

2.8. 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.

2.8.1. vGPUs that Support Multiple vGPUs Assigned to a VM

The supported vGPUs depend on the hypervisor:

- For generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu, **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 VMware vSphere, the supported vGPUs depend on the hypervisor release:
  - **Since VMware vSphere 8.0: 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.
  - **VMware vSphere 7.x releases:** Only Q-series and C-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 or an A40-48C vGPU and an A40-16C vGPU to the same VM. However, you cannot assign an or an A30-8C vGPU and an A16-8C vGPU to the same VM.

Multiple vGPU Support on the NVIDIA Ada Lovelace Architecture

Board	vGPU
NVIDIA L40S	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ L40S-48C ▶ L40S-48Q
NVIDIA L40	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ L40-48C ▶ L40-48Q
NVIDIA L20 NVIDIA L20 liquid cooled	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs

Board	vGPU
	VMware vSphere 7.x releases: ▶ L20-48C ▶ L20-48Q
NVIDIA L4	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ L4-24C ▶ L4-24Q
NVIDIA L2	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ L2-24C ▶ L2-24Q
NVIDIA RTX 6000 Ada	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs

Board	vGPU
	VMware vSphere 7.x releases: ▶ RTX 6000 Ada-48C ▶ RTX 6000 Ada-48Q
NVIDIA RTX 5880 Ada	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ RTX 5880 Ada-48C ▶ RTX 5880 Ada-48Q
NVIDIA RTX 5000 Ada	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ RTX 5000 Ada-32C ▶ RTX 5000 Ada-32Q

Multiple vGPU Support on the NVIDIA Hopper GPU Architecture

Board	vGPU
NVIDIA H800 PCIe 94GB	All C-series vGPUs See Note (1).
NVIDIA H800 PCIe 80GB	All C-series vGPUs See Note (1).

Board	vGPU
NVIDIA H800 SXM5 80GB	All C-series vGPUs See Note (1).
NVIDIA H100 PCIe 94GB (H100 NVL)	All C-series vGPUs See Note (1).
NVIDIA H100 SXM5 94GB	All C-series vGPUs See Note (1).
NVIDIA H100 PCIe 80GB	All C-series vGPUs See Note (1).
NVIDIA H100 SXM5 80GB	All C-series vGPUs See Note (1).
NVIDIA H100 SXM5 64GB	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 NVIDIA AX800	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** All C-series vGPUs **Since VMware vSphere 8.0: All** C-series vGPUs **VMware vSphere 7.x releases:** A800D-80C See Note (1).
NVIDIA A800 HGX 80GB	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** All C-series vGPUs **Since VMware vSphere 8.0: All** C-series vGPUs **VMware vSphere 7.x releases:** A800DX-80C See Note (1).

Board	vGPU
NVIDIA A800 PCIe 40GB active cooled	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** All C-series vGPUs **Since VMware vSphere 8.0: All** C-series vGPUs **VMware vSphere 7.x releases:** A800-40C See Note (1).
NVIDIA A100 PCIe 80GB NVIDIA A100 PCIe 80GB liquid cooled	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** All C-series vGPUs **Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu: All** C-series vGPUs **VMware vSphere 7.x releases:** A100D-80C See Note (1).
NVIDIA A100 HGX 80GB	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** All C-series vGPUs **Since VMware vSphere 8.0: All** C-series vGPUs **VMware vSphere 7.x releases:** A100DX-80C See Note (1).
NVIDIA A100 PCIe 40GB	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** All C-series vGPUs **Since VMware vSphere 8.0: All** C-series vGPUs **VMware vSphere 7.x releases:** A100-40C See Note (1).
NVIDIA A100 HGX 40GB	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** All C-series vGPUs

Board	vGPU
	Since VMware vSphere 8.0: All C-series vGPUs **VMware vSphere 7.x releases:** A100X-40C See Note (1).
NVIDIA A40	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ A40-48C ▶ A40-48Q See Note (1).
NVIDIA A30 NVIDIA A30X NVIDIA A30 liquid cooled	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** All C-series vGPUs **Since VMware vSphere 8.0: All** C-series vGPUs **VMware vSphere 7.x releases:** A30-24C See Note (1).
NVIDIA A16	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:**

Board	vGPU
	▶ A16-16C ▶ A16-16Q See Note (1).
NVIDIA A10	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0: All** C-series vGPUs **VMware vSphere 7.x releases:** A10-24C See Note (1).
NVIDIA RTX A6000	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ A6000-48C ▶ A6000-48Q See Note (1).
NVIDIA RTX A5500	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ A5500-24C

Board	vGPU
	▶ A5500-24Q See Note (1).
NVIDIA RTX A5000	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **VMware vSphere 7.x releases:** ▶ A5000-24C ▶ A5000-24Q See Note (1).

Multiple vGPU Support on the NVIDIA Turing GPU Architecture

Board	vGPU
Tesla T4	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs ▶ All Q-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs **VMware vSphere 7.x releases:** ▶ T4-16C
Quadro RTX 6000 passive	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs **VMware vSphere 7.x releases:**

Board	vGPU
	▶ RTX6000P-24C
Quadro RTX 8000 passive	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs **VMware vSphere 7.x releases:** ▶ RTX8000P-48C

Multiple vGPU Support on the NVIDIA Volta GPU Architecture

Board	vGPU
Tesla V100 SXM2 32GB	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs **VMware vSphere 7.x releases:** ▶ V100D-32C
Tesla V100 PCIe 32GB	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs **VMware vSphere 7.x releases:** ▶ V100D-32C
Tesla V100S PCIe 32GB	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs **Since VMware vSphere 8.0:**

Board	vGPU
	▶ All C-series vGPUs **VMware vSphere 7.x releases:** ▶ V100S-32C
Tesla V100 SXM2	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs **VMware vSphere 7.x releases:** ▶ V100X-16C
Tesla V100 PCIe	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs **VMware vSphere 7.x releases:** ▶ V100-16C
Tesla V100 FHHL	**Generic Linux with KVM hypervisors, Red Hat Enterprise Linux KVM, and Ubuntu:** ▶ All C-series vGPUs **Since VMware vSphere 8.0:** ▶ All C-series vGPUs **VMware vSphere 7.x releases:** ▶ V100L-16C

Note:

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

2.8.2. Maximum Number of vGPUs Supported per VM

For Red Hat Enterprise Linux KVM and Ubuntu, NVIDIA AI Enterprise supports up to a maximum of 16 vGPUs per VM.

For VMware vSphere, the maximum number of vGPUs per VM supported depends on the hypervisor release:

Hypervisor Release	Maximum Number of vGPUs per VM
Since VMware vSphere 8.0 Update 2	16
VMware vSphere 8.0 and 8.0 Update 1	8
VMware vSphere 7.*x* releases:	4

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

All hypervisor releases that support NVIDIA AI Enterprise are supported.

For information about which generic Linux with KVM hypervisor software releases support the assignment of more than one vGPU device to a VM, consult the documentation from your hypervisor vendor.

2.9. 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, VMware vSphere Hypervisor (ESXi) releases, and guest OS releases.

2.9.1. 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
NVIDIA H800 PCIe 94GB	H800L-94C

Board	vGPU
NVIDIA H800 PCIe 80GB	H800-80C
NVIDIA H100 PCIe 94GB (H100 NVL)	H100L-94C
NVIDIA H100 SXM5 94GB	H100XL-94C
NVIDIA H100 PCIe 80GB	H100-80C
NVIDIA H100 SXM5 80GB	H100XM-80C
NVIDIA H100 SXM5 64GB	H100XS-64C

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

Board	vGPU
NVIDIA A800 PCIe 80GB NVIDIA A800 PCIe 80GB liquid cooled NVIDIA AX800	A800D-80C
NVIDIA A800 HGX 80GB	A800DX-80C See Note (1).
NVIDIA A800 PCIe 40GB active cooled	A800-40C
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 A40-48C
NVIDIA A30 NVIDIA A30X	A30-24C

Board	vGPU
NVIDIA A30 liquid cooled	
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 passive	RTX6000P-24Q RTX6000P-24C
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 V100DX-32C
Tesla V100 SXM2	V100X-16Q V100X-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.

2.9.2. 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.

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

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

2.9.4. 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.
- On the Ubuntu hypervisor, NVSwitch is not supported. Only direct connections are supported.
- Only time-sliced vGPUs are supported. MIG-backed vGPUs are **not** supported.
- If unified memory is enabled, peer-to-peer CUDA transfers are not supported on GPUs based on the NVIDIA Ampere GPU architecture that also support MIG-backed vGPUs.
- PCIe is not supported.
- SLI is not supported.

2.10. 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).

- GPUs based on the NVIDIA Ada Lovelace GPU architecture:
  - NVIDIA L40
  - NVIDIA L40S
  - NVIDIA L20
  - NVIDIA L20 liquid cooled
  - NVIDIA L4
  - NVIDIA L2
  - NVIDIA RTX 6000 Ada
  - NVIDIA RTX 5880 Ada
  - NVIDIA RTX 5000 Ada
- GPUs based on the NVIDIA Hopper GPU architecture:
  - NVIDIA H800 PCIe 94GB
  - NVIDIA H800 PCIe 80GB
  - NVIDIA H800 SXM5 80GB
  - NVIDIA H100 PCIe 94GB (H100 NVL)
  - NVIDIA H100 SXM5 94GB
  - NVIDIA H100 PCIe 80GB
  - NVIDIA H100 SXM5 80GB
  - NVIDIA H100 SXM5 64GB
- GPUs based on the NVIDIA Ampere GPU architecture:
  - NVIDIA A800 PCIe 80GB
  - NVIDIA A800 PCIe 80GB liquid cooled
  - NVIDIA A800 HGX 80GB
  - NVIDIA AX800
  - NVIDIA A800 PCIe 40GB active cooled
  - 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 A30 liquid cooled
- 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

Starting with GPUDirect Storage technology release 1.7.2, the following limitations apply:

- GPUDirect Storage technology is **not** supported on GPUs based on the NVIDIA Ampere GPU architecture.
- On GPUs based on the NVIDIA Hopper GPU architecture and the NVIDIA Ada Lovelace GPU architecture, GPUDirect Storage technology is supported only with the guest driver for Linux that is based on NVIDIA Linux open GPU kernel modules

GPUDirect Storage technology releases before 1.7.2 are supported only with guest drivers with Linux kernel versions earlier than 6.6.

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

- Ubuntu 22.04 LTS
- Ubuntu 20.04 LTS

2.11. 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).

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

- NVIDIA HGX H800 8-GPU baseboard
- NVIDIA HGX H100 8-GPU baseboard
- NVIDIA HGX A100 8-GPU baseboard

2.11.2. 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 H800 and NVIDIA H100 SXM5 physical GPUs, and NVIDIA A800 and NVIDIA A100 HGX physical GPUs are supported.

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

Board	vGPU
NVIDIA H800 SXM5 80GB	H800XM-80C
NVIDIA H100 SXM5 80GB	H100XM-80C

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

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

For information about which generic Linux with KVM hypervisor software releases support NVIDIA NVSwitch on-chip memory fabric, consult the documentation from your hypervisor vendor.

All supported Red Hat Enterprise Linux KVM releases support NVIDIA NVSwitch on-chip memory fabric.

On the Ubuntu hypervisor, NVSwitch is not supported.

The earliest VMware vSphere Hypervisor (ESXi) release that supports NVIDIA NVSwitch on-chip memory fabric depends on the GPU architecture.

GPU Architecture	Earliest Supported VMware vSphere Hypervisor (ESXi) Release
NVIDIA Hopper	VMware vSphere Hypervisor (ESXi) 8 update 2
NVIDIA Ampere	VMware vSphere Hypervisor (ESXi) 8 update 1

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

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

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

- Only time-sliced vGPUs are supported. MIG-backed vGPUs are **not** supported.
- On the Ubuntu hypervisor, NVSwitch is not supported.
- GPU pass through is **not** supported.
- SLI is not supported.
- All vGPUs that are communicating peer-to-peer must be assigned to the same VM.
- On GPUs that are based on the NVIDIA Hopper GPU architecture, multicast is **not** supported..

2.12. 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.

2.12.1. 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.

Unified Memory Support on the NVIDIA Ada Lovelace GPU Architecture

Board	vGPU
NVIDIA L40	L40-48Q L40-48C
NVIDIA L40S	L40S-48Q L40S-48C
NVIDIA L20 NVIDIA L20 liquid cooled	L20-48Q L20-48C
NVIDIA L4	L4-24Q L4-24C
NVIDIA L2	L2-24Q L2-24C
NVIDIA RTX 6000 Ada	RTX 6000 Ada-48Q RTX 6000 Ada-48C
NVIDIA RTX 5880 Ada	RTX 5880 Ada-48Q RTX 5880 Ada-48C
NVIDIA RTX 5000 Ada	RTX 5000 Ada-32Q RTX 6000 Ada-32C

Unified Memory Support on the NVIDIA Hopper GPU Architecture

Board	vGPU
NVIDIA H800 PCIe 94GB	H800L-94C **All** MIG-backed vGPUs
NVIDIA H800 PCIe 80GB	H800-80C **All** MIG-backed vGPUs
NVIDIA H800 SXM5 80GB	H800XM-80C **All** MIG-backed vGPUs
NVIDIA H100 PCIe 94GB (H100 NVL)	H100L-94C **All** MIG-backed vGPUs
NVIDIA H100 SXM5 94GB	H100XL-94C **All** MIG-backed vGPUs
NVIDIA H100 PCIe 80GB	H100-80C **All** MIG-backed vGPUs
NVIDIA H100 SXM5 80GB	H100XM-80C **All** MIG-backed vGPUs
NVIDIA H100 SXM5 64GB	H100XS-64C **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 NVIDIA AX800	A800D-80C **All** MIG-backed vGPUs
NVIDIA A800 HGX 80GB	A800DX-80C **All** MIG-backed vGPUs
NVIDIA A800 PCIe 40GB active cooled	A800-40C

Board	vGPU
	All MIG-backed vGPUs
NVIDIA A100 PCIe 80GB NVIDIA A100 PCIe 80GB liquid cooled NVIDIA A100X	A100D-80C **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	A40-48C
NVIDIA A30 NVIDIA A30X NVIDIA A30 liquid cooled	A30-24C **All** MIG-backed vGPUs
NVIDIA A16	A16-16Q A16-16C
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

2.12.2. Guest OS Releases that Support Unified Memory

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

2.12.3. 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.
- When unified memory is enabled for a VM, vGPU migration is disabled for the VM.

2.13. NVIDIA GPU Operator Support

NVIDIA GPU Operator simplifies the deployment of NVIDIA AI Enterprise with software container platforms. 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 KVM 9.3, 9.2, 9.0	Red Hat OpenShift 4.12 through 4.15 using Red Hat Linux CoreOS (RHCOS) and the CRI-O container runtime	Red Hat OpenShift 4.12 through 4.15 using RHCOS
Red Hat Enterprise Linux KVM 8.9, 8.8, 8.6	Red Hat OpenShift 4.12 through 4.15 using RHCOS and the CRI-O container runtime	Red Hat OpenShift 4.12 through 4.15 using RHCOS
VMware vSphere Hypervisor (ESXi) 8.0	Red Hat OpenShift 4.12 through 4.15 using Red Hat Linux CoreOS (RHCOS) and the CRI-O container runtime	Red Hat OpenShift 4.12 through 4.15 using RHCOS
	Upstream Kubernetes 1.22 through 1.29	Red Hat Enterprise Linux 8.9, 8.8, 8.6
		Ubuntu 22.04 LTS
		Ubuntu 20.04 LTS
	Charmed Kubernetes 1.28	Ubuntu 22.04 LTS
	HPE Ezmeral Runtime Enterprise 5.5	Red Hat Enterprise Linux 8.9, 8.8, 8.6
VMware vSphere Hypervisor (ESXi) 7.0 Update 2, Update 3	Red Hat OpenShift 4.12 through 4.15 using RHCOS and the CRI-O container runtime	Red Hat OpenShift 4.12 through 4.15 using RHCOS
	Upstream Kubernetes 1.22 through 1.29	Red Hat Enterprise Linux 8.9, 8.8, 8.6
		Ubuntu 22.04 LTS

Hypervisor Software Release	Container Platform	Guest OS
		Ubuntu 20.04 LTS
	VMware vSphere with Tanzu 7.0 U3c	Ubuntu 20.04 LTS
	HPE Ezmeral Runtime Enterprise 5.5	Red Hat Enterprise Linux 8.9, 8.8, 8.6

2.14. NVIDIA RAPIDS Accelerator for Apache Spark Support

NVIDIA RAPIDS Accelerator for Apache Spark is a software component of NVIDIA AI Enterprise. It uses NVIDIA GPUs to accelerate Spark data frame workloads transparently, that is, without code changes.

NVIDIA AI Enterprise supports RAPIDS Accelerator for Apache Spark on the following platforms:

- Google Cloud Dataproc
- Databricks on the following cloud services:
  - Amazon Web Services (AWS)
  - Microsoft Azure
- Amazon EMR (formerly “Amazon Elastic MapReduce”)

Chapter 3. NVIDIA AI Enterprise Supported Cloud Services

NVIDIA AI Enterprise is supported on several cloud services with bring-your-own-license (BYOL) licensing. Pay-as-you-go licensing is also available with some cloud services.

- Alibaba
- Amazon Web Services Elastic Compute Cloud (AWS EC2)
- Google Cloud Platform (GCP)
- Microsoft Azure
- Oracle Cloud Infrastructure
- Tencent Cloud
- Volcano Engine

3.1. Alibaba

GPU	Supported Alibaba Instances	Certified Container Orchestration Platforms	Supported Guest Operating Systems
NVIDIA V100	gn6e gn6v	Upstream Kubernetes	▸ Ubuntu 22.04 ▸ Ubuntu 20.04
NVIDIA A10	gn7e gn7i		

3.2. Amazon Web Services Elastic Compute Cloud (AWS EC2)

Note: Pay-as-you-go licensing is also available for all supported AWS EC2 instances.

GPU	Supported AWS EC2 Instances	Certified Container Orchestration Platforms	Supported Guest Operating Systems
NVIDIA T4	All G4 series instances	Amazon Elastic Kubernetes Service (EKS) Red Hat OpenShift Upstream Kubernetes	Red Hat Enterprise Linux 8.9, 8.8, 8.6 Red Hat Enterprise Linux 7.9 Red Hat OpenShift 4.12 through 4.15 using Red Hat Linux CoreOS (RHCOS) Ubuntu 22.04 Ubuntu 20.04
NVIDIA V100	All P3 series instances		
NVIDIA A10G	All G5 series instances		
NVIDIA A100	All P4d and P4de series instances		
NVIDIA H100	All P5 series instances		

3.3. Google Cloud Platform (GCP)

Note: Pay-as-you-go licensing is also available for all supported GCP instances.

GPU	Supported GCP Instances	Certified Container Orchestration Platforms	Supported Guest Operating Systems
NVIDIA A100	All A2 series instances	Google Kubernetes Engine (GKE) Red Hat OpenShift Upstream Kubernetes	Red Hat Enterprise Linux 8.9, 8.8, 8.6 Red Hat Enterprise Linux 7.9 Red Hat OpenShift 4.12 through 15 using Red Hat Linux CoreOS (RHCOS) Ubuntu 22.04 Ubuntu 20.04
NVIDIA H100	All A3 series instances		
NVIDIA L4	All G2 series instances		
NVIDIA T4	Any predefined machine type. Any custom machine type that can be created in a zone.		
NVIDIA V100			

3.4. Microsoft Azure

Note: Pay-as-you-go licensing is also available for all supported Microsoft Azure instances, **except** NV_A10_v5 instances.

GPU	Supported Azure Instances	Certified Container Orchestration Platforms	Supported Guest Operating Systems
NVIDIA V100	All NC v3 and ND v2 instances	Azure Kubernetes Service (AKS) Red Hat OpenShift Upstream Kubernetes	Red Hat Enterprise Linux 8.4 Red Hat Enterprise Linux 7.9 Red Hat OpenShift 4.10 using Red Hat Linux CoreOS (RHCOS) Red Hat OpenShift 4.9 using Red Hat Linux CoreOS (RHCOS) Ubuntu 22.04 Ubuntu 20.04
NVIDIA T4	All NC T4_v3 instances		
NVIDIA H100	All ND H100_v5instances		
NVIDIA A100	All NC A100_v4 instances All ND A100_v4 instances		
NVIDIA A10	All NV A10_v5 instances		

3.5. Oracle Cloud Infrastructure

Note: Pay-as-you-go licensing is also available for all supported Oracle Cloud Infrastructure instances.

GPU	Oracle Cloud Infrastructure Shapes	Certified Container Orchestration Platforms	Supported Guest Operating Systems
NVIDIA V100	All VM.GPU3 shapes	Upstream Kubernetes	Linux: ▶ Ubuntu 22.04 ▶ Ubuntu 20.04 Windows: ▶ Microsoft Windows Server 2022
NVIDIA H100	BM.GPU.H100.8		
NVIDIA A100	All BM.GPU4 shapes All BM.GPU.A100-v2 shapes		
NVIDIA A10	All VM.GPU.A10 shapes		

3.6. Tencent Cloud

GPU	Supported Tencent Cloud Instances	Certified Container Orchestration Platforms	Supported Guest Operating Systems
NVIDIA V100	GN10Xp	Upstream Kubernetes	▶ Ubuntu 22.04
NVIDIA A10	PNV4		

GPU	Supported Tencent Cloud Instances	Certified Container Orchestration Platforms	Supported Guest Operating Systems
			▶ Ubuntu 20.04

3.7. Volcano Engine

GPU	Volcano Engine Instances	Certified Container Orchestration Platforms	Supported Guest Operating Systems
NVIDIA A10	ecs.gni2	Upstream Kubernetes	▶ Ubuntu 22.04 ▶ Ubuntu 20.04

3.8. NVIDIA GPU Optimized VMI on CSP Marketplace

For ease of use in the cloud, NVIDIA provides compute optimized and validated base Virtual Machine Instances (VMI) through CSP marketplaces. Each VMI includes key technologies and software from NVIDIA for rapid deployment, management, and scaling of AI workloads in the modern hybrid cloud.

Each VMI has the following software pre-installed:

- Ubuntu Server 20.04
- NVIDIA driver 525 TRD - 525.60.13
- Docker-ce 20.10.12
- NVIDIA Container Toolkit 1.8.1
- NVIDIA Container Runtime 3.8.1

Chapter 4. CPU Only Server Support

NVIDIA AI Enterprise supports deployments on CPU only servers that are part of the NVIDIA Certified Systems list. Customers can deploy both GPU and CPU Only systems with VMware vSphere or Red Hat Enterprise Linux.

NVIDIA AI Enterprise will support the following CPU enabled frameworks:

- TensorFlow
- PyTorch
- Triton Inference Server with FIL backend
- NVIDIA RAPIDS with XGBoost and Dask

Chapter 5. Known Product Limitations

Known product limitations for this release of NVIDIA AI Enterprise are described in the following sections.

5.1. `nvidia-smi` cannot report GPU utilization for MIG instances

When Multi-Instance GPU (MIG) mode is enabled for a GPU, the `nvidia-smi` command cannot report any GPU engine utilization for MIG instances. To monitor GPU engine utilization for MIG instances, run the `nvidia-smi vgpu` command with the `--gpm-metrics` *ID-list* option.

For information about how to monitor GPU engine utilization for MIG instances, refer to *NVIDIA AI Enterprise User Guide*.

The following example shows the output from the `nvidia-smi` for a GPU for which MIG mode is enabled.

```
[root@host ~]# nvidia-smi
Fri Jun 14 11:45:28 2024
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 550.90.05    Driver Version: 550.90.05   CUDA Version:  12.4      |
|-------------------------------+----------------------+----------------------+
|-------------------------------+----------------------+----------------------+
| 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 GRID A100-2-10C On          | 00000000:02:02.0 Off | On                   |
| N/A N/A P0 N/A / N/A          | 2556MiB / 10235MiB   | N/A Default          |
|                               |                      | Enabled              |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| MIG devices:                                                                |
+------------------+----------------------+-----------+-----------------------+
| GPU GI CI MIG    | Memory-Usage         | Vol       | Shared                |
| ID ID Dev        | BAR1-Usage           | SM Unc    | CE ENC DEC OFA JPG    |
|                  |                      | ECC       |                       |
|==================+======================+===========+=======================|
| 0 0 0 0          | 2556MiB / 10235MiB   | 28 0      | 2 0 1 0 0             |
|                  | 5MiB / 4096MiB       |           |                       |
+------------------+----------------------+-----------+-----------------------+
```

```
+-----------------------------------------------------------------------------+
| Processes:                                                                  |
| GPU GI CI PID Type Process name GPU Memory                                  |
| ID ID Usage                                                                 |
|=============================================================================|
| 0 0 0 2843 C python3 1516MiB |
```

5.2. 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.

5.3. 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 AI Enterprise 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 RTX8000-12C RTX8000-12A	32
RTX8000-16Q RTX8000-16C RTX8000-16A	64
RTX8000-24Q RTX8000-24C RTX8000-24A	96
RTX8000-48Q RTX8000-48C RTX8000-48A	238
RTX8000P-12Q	32

vGPU Type	Compression Adjustment (MB)
RTX8000P-12C RTX8000P-12A	
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.

5.4. 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.

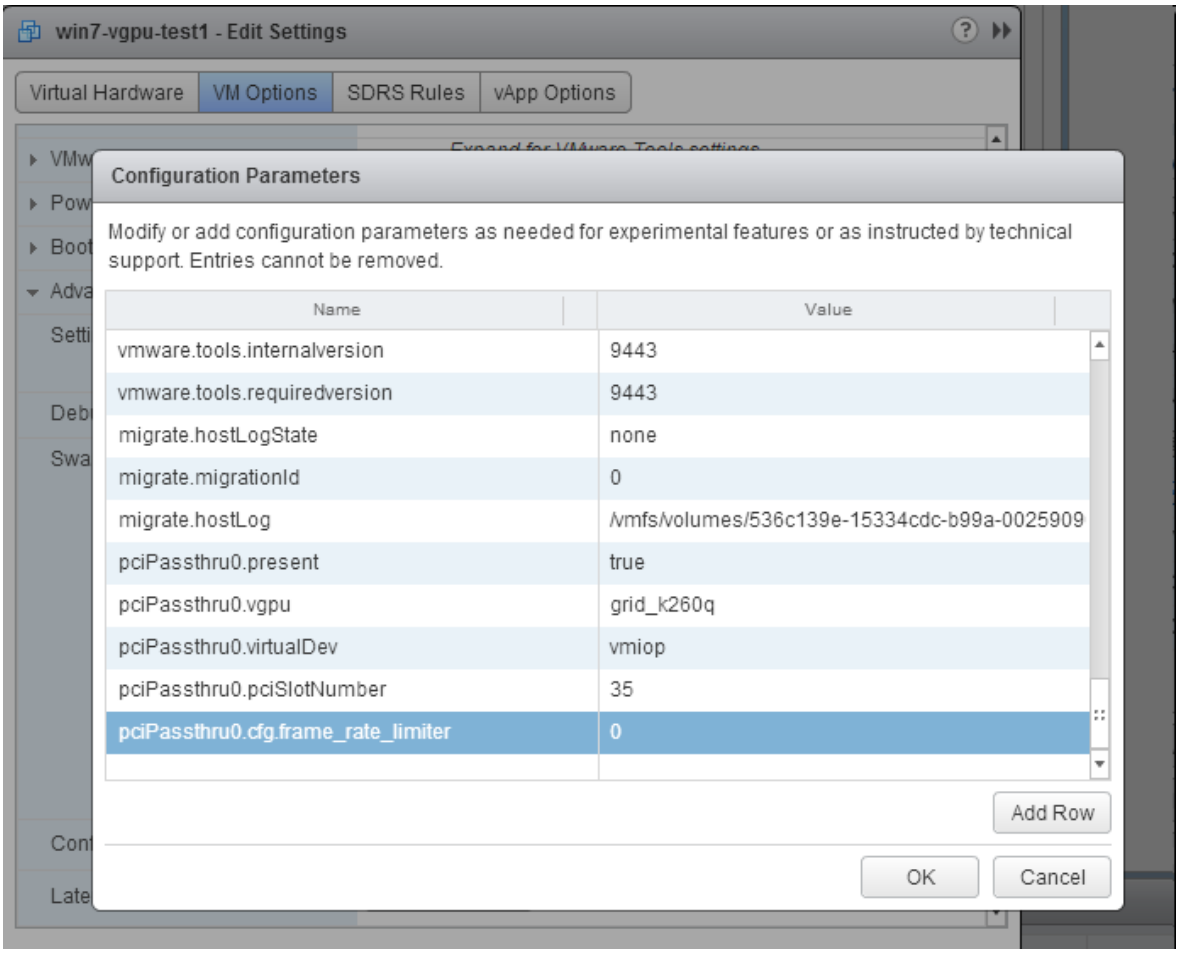
Resolution

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 adding the configuration

parameter `pciPassthru0.cfg.frame_rate_limiter` in the VM's advanced configuration options.

Note: This setting can only be changed when the VM is powered off.

1. Select **Edit Settings**.
2. In **Edit Settings** window, select the **VM Options** tab.
3. From the **Advanced** drop-down list, select **Edit Configuration**.
4. In the **Configuration Parameters** dialog box, click **Add Row**.
5. In the **Name** field, type the parameter name `pciPassthru0.cfg.frame_rate_limiter`, in the **Value** field type 0, and click **OK**.



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 by setting `pciPassthru0.cfg.frame_rate_limiter` to 1 or by removing the parameter from the advanced settings.

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
   ```

5.5. VMs configured with large memory fail to initialize vGPU when booted

Description

When starting multiple VMs configured with large amounts of RAM (typically more than 32GB per VM), a VM may fail to initialize vGPU. In this scenario, the VM boots in VMware SVGA mode and doesn't load the NVIDIA driver. The NVIDIA AI Enterprise 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)
```

When this error occurs, `VGPU message failed` messages and XID error messages are written to the VMware vSphere VM's log file.

Resolution

vGPU reserves a portion of the VM's framebuffer for use in GPU mapping of VM system memory. The reservation is sufficient to support up to 32GB of system memory, and may be increased to accommodate up to 64GB by adding the configuration parameter `pciPassthru0.cfg.enable_large_sys_mem` in the VM's advanced configuration options

Note: This setting can only be changed when the VM is powered off.

1. Select **Edit Settings**.
2. In **Edit Settings** window, select the **VM Options** tab.
3. From the **Advanced** drop-down list, select **Edit Configuration**.
4. In the **Configuration Parameters** dialog box, click **Add Row**.
5. In the **Name** field, type the parameter name `pciPassthru0.cfg.enable_large_sys_mem`, in the **Value** field type 1, and click **OK**.

With this setting in place, less GPU framebuffer is available to applications running in the VM. To accommodate system memory larger than 64GB, the reservation can be further increased by adding `pciPassthru0.cfg.extra_fb_reservation` in the VM's advanced configuration options, and setting its value to the desired reservation size in megabytes. The default value of 64M is sufficient to support 64 GB of RAM. We recommend adding 2 M of reservation for each additional 1 GB of system memory. For example, to support 96 GB of RAM, set `pciPassthru0.cfg.extra_fb_reservation` to 128.

The reservation can be reverted back to its default setting by setting `pciPassthru0.cfg.enable_large_sys_mem` to 0, or by removing the parameter from the advanced settings.

Chapter 6. Known Issues

6.1. MIG mode cannot be changed on a single NVIDIA H100 or H800 in a multi-GPU system

Description

MIG mode cannot be enabled or disabled on a single NVIDIA H100 or NVIDIA H800 GPU in a multi-GPU system. When this issue occurs, the following error message is displayed:

```
NVML: Unable to get MIG mode: Invalid Argument
```

This issue occurs **only** in response to running the **`nvidia-smi -mig -i gpu-index`** command to change the MIG mode of a single NVIDIA H100 or H800 GPU in a multi-GPU system.

This issue does not occur in any of the following situations:

- The command is run to change the MIG mode of any other GPU that supports the MIG feature, such as any variant of the NVIDIA A100 and NVIDIA A800 GPUs.
- The system contains only one NVIDIA H100 or NVIDIA H800 GPU.
- The **`-i gpu-index`** is omitted from the command to change the MIG mode.

Status

Open

Ref.

4008029

6.2. 17.0, 17.1 Only: Desktop is corrupted with XID errors 13 and 31 after vGPU VM is migrated or suspended and resumed

Description

When a vGPU VM is migrated or suspended and resumed, the remote desktop session window is corrupted. XID error 13, XID error 31, or both errors might also occur.

When this issue occurs, error messages similar to the following examples are written to the log file on the hypervisor host:

```
Apr  8 11:27:28 smc220-0008 kernel: NVRM: Xid (PCI:0000:4b:00): 31, pid=6327,
 name=nvidia-vgpu-mgr, Ch 00000701
...
Apr  8 11:27:29 smc220-0008 nvidia-vgpu-mgr[6327]: error: vmiop_log: (0x0): XID 31
 detected on physical_chid:0x701, guest_chid:0x1
Apr  8 11:27:29 smc220-0008 nvidia-vgpu-mgr[6327]: error: vmiop_log: (0x0): MMU
 Exception data for XID 31: addrLo 0x0, addHi 0x0, faultType 0 engineId 1
```

Status

Resolved in NVIDIA AI Enterprise 17.2

Ref.

3964376

6.3. Virtual GPU Manager upgrade fails on VMware vSphere Hypervisor (ESXi)

Description

Upgrading the Virtual GPU Manager from an earlier NVIDIA AI Enterprise release branch to the current release fails on VMware vSphere Hypervisor (ESXi). The installation result contains the message `Host is not changed`.

Version

This issue affects upgrades of the Virtual GPU Manager from an earlier NVIDIA AI Enterprise release branch to the current release.

Workaround

Uninstall the Virtual GPU Manager from the earlier NVIDIA AI Enterprise release branch before installing the current release of the Virtual GPU Manager.

Status

Open

Ref.

3913505

6.4. The NVIDIA MOFED driver container fails to install the driver if Network Operator is installed

Description

The NVIDIA MOFED driver container fails to install the driver if Network Operator is installed. The installation fails because the container fails to unload the `ib_core` module. The `rdma-core` package is installed as part of the Red Hat CoreOS installation. This package loads the `ib_core` module if the system has Mellanox network interface cards (NICs).

Status

Open

Ref.

3565857

6.5. Migration of VMs configured with vGPU stops before the migration is complete

Description

When a VM configured with vGPU is migrated to another host, the migration stops before it is complete.

This issue occurs if the ECC memory configuration (enabled or disabled) on the source and destination hosts are different. The ECC memory configuration on both the source and destination hosts must be identical.

Workaround

Before attempting to migrate the VM again, ensure that the ECC memory configuration on both the source and destination hosts are identical.

Status

Not an NVIDIA bug

Ref.

200520027

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 Maxwell, NVIDIA Pascal, NVIDIA Turing, NVIDIA Volta, 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