Integrate Cisco HyperFlex Systems and Cisco UCS M5 Servers with NVIDIA GRID 5.0 on VMware vSphere 6.5 and VMware Horizon 7.3.2

March 2018

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What you will learn

Cisco recently introduced the fifth-generation Cisco UCS® B-Series Blade Servers and C-Series Rack Servers and the Cisco HyperFlex™ hyperconverged servers, based on the Intel® Xeon® Scalable processor architecture. Nearly concurrently, NVIDIA launched new hardware and software designed specifically to use the new server architectures.

Using the increased processing power of these new B-Series Blade Servers and C-Series Rack Servers and Cisco HyperFlex hyperconverged servers, applications with demanding graphics requirements are now being virtualized. To enhance the capability to deliver these high-performance and graphics-intensive applications in virtual desktop infrastructure (VDI), Cisco offers support for the NVIDIA GRID P6, P40, P100, and M10 cards in the Cisco Unified Computing System™ (Cisco UCS) portfolio of PCI Express (PCIe) and mezzanine form-factor cards for the B-Series and C-Series servers.

With the addition of the new graphics processing capabilities, the engineering, design, imaging, and marketing departments of organizations can now experience the benefits that desktop virtualization brings to the applications they use. Users of Microsoft Windows 10 and Office 2016 or later versions can benefit from the new NVIDIA M10 high-density graphics card, deployable on Cisco UCS C240 M5 Rack Servers and Cisco HyperFlex hyperconverged servers.

This new graphics capability helps enable organizations to centralize their graphics workloads and data in the data center. This capability greatly benefits organizations that need to be able to shift work geographically. Until now, graphics files have been too large to move, and the files have had to be local to the person using them to be usable.

The PCIe graphics cards in the Cisco UCS servers offer these benefits:

- Support for full-length, full-power NVIDIA GRID cards in a 2-rack-unit (2RU) or 4RU form factor
- Support for a mezzanine form-factor adapter graphics processing unit (GPU) card in half-width and full-width blade servers
- Cisco UCS Manager integration for management of the servers and NVIDIA GRID cards
- End-to-end integration with Cisco UCS management solutions, including Cisco UCS Central Software and Cisco UCS Director
- More efficient use of rack space with Cisco UCS blade and rack servers with two NVIDIA GRID cards than with the 2-slot, 2.5-inch equivalent rack unit: the HP ProLiant WS460c Gen9 Graphics Server Blade with the GRID card in a second slot

The modular LAN-on-motherboard (mLOM) form-factor NVIDIA graphics card in the Cisco UCS B-Series servers offers these benefits:

- Cisco UCS Manager integration for management of the servers and the NVIDIA GRID GPU card
- End-to-end integration with Cisco UCS management solutions, including Cisco UCS Central Software and Cisco UCS Director

An important element of this document's design is VMware's support for the NVIDIA GRID virtual graphics processing unit (vGPU) feature in VMware vSphere 6.5. Prior to Release 6.0, vSphere supported only virtual direct graphics acceleration (vDGA) and virtual shared graphics acceleration (vSGA), so support for vGPU in vSphere 6.0 and later releases greatly expands the range of deployment scenarios using the most versatile and efficient configuration of the GRID cards.

The purpose of this document is to help our partners and customers integrate NVIDIA GRID 5.0 graphics processing cards, Cisco HyperFlex systems, Cisco UCS B200 M5 Blade Servers, Cisco UCS C240 M5 Rack Servers, VMware vSphere, and VMware Horizon 7.3.2 in vGPU mode.

Please contact our partners NVIDIA and VMware for lists of applications that are supported by the card, hypervisor, and desktop broker in each mode.

The objective here is to provide the reader with specific methods for integrating Cisco UCS servers with NVIDIA GRID P6, P40, and M10 cards on Cisco HyperFlex with VMware vSphere and VMware Horizon products so that the servers, hypervisor, and virtual desktops are ready for installation of graphics applications.

Why use NVIDIA GRID vGPU for graphic deployments on VMware Horizon

The NVIDIA GRID vGPU allows multiple virtual desktops to share a single physical GPU, and it allows multiple GPUs to reside on a single physical PCI card. All provide the 100 percent application compatibility of vDGA pass-through graphics, but with a lower cost because multiple desktops share a single graphics card. With VMware Horizon, you can centralize, pool, and more easily manage traditionally complex and expensive distributed workstations and desktops. Now all your user groups can take advantage of the benefits of virtualization.

The GRID vGPU capability brings the full benefits of NVIDIA hardware-accelerated graphics to virtualized solutions. This technology provides exceptional graphics performance for virtual desktops equivalent to PCs with an onboard graphics processor.

The GRID vGPU uses the industry's most advanced technology for sharing true GPU hardware acceleration among multiple virtual desktops—without compromising the graphics experience. Application features and compatibility are exactly the same as they would be at the user's desk.

With GRID vGPU technology, the graphics commands of each virtual machine are passed directly to the GPU, without translation by the hypervisor. By allowing multiple virtual machines to access the power of a single GPU in the virtualization server, enterprises can increase the number of users with access to true GPU-based graphics acceleration on virtual machines.

The physical GPU in the server can be configured with a specific vGPU profile. Organizations have a great deal of flexibility in how best to configure their servers to meet the needs of various types of end users.

vGPU support allows businesses to use the power of the NVIDIA GRID technology to create a whole new class of virtual machines designed to provide end users with a rich, interactive graphics experience.

vGPU profiles

In any given enterprise, the needs of individual users vary widely. One of the main benefits of the GRID vGPU is the flexibility to use various vGPU profiles designed to serve the needs of different classes of end users.

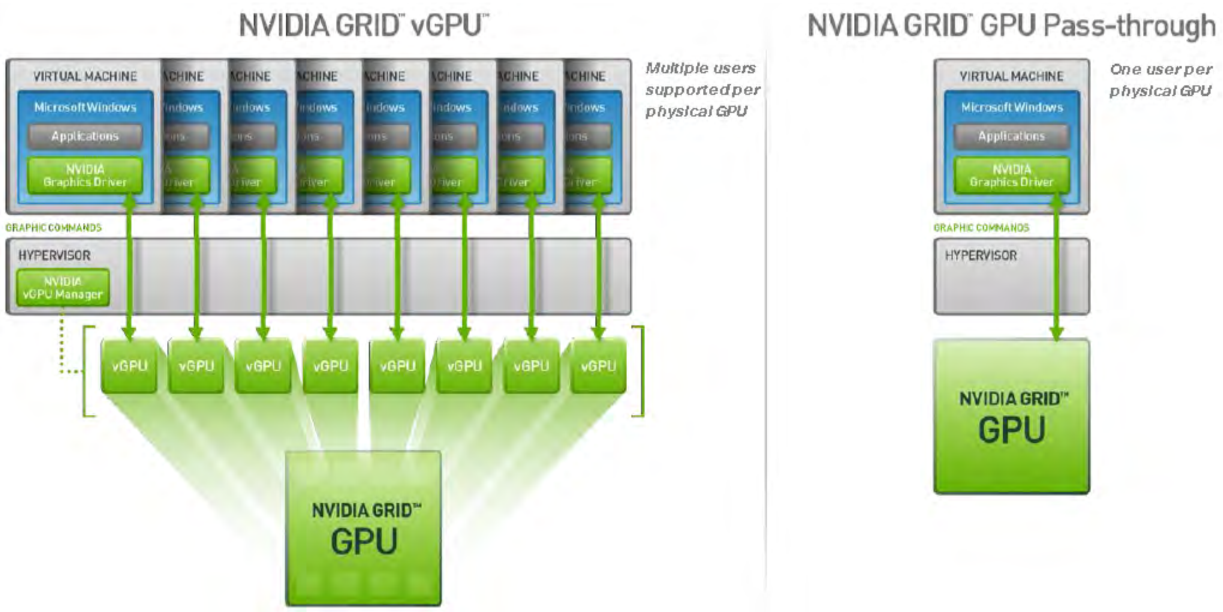
Although the needs of end users can be diverse, for simplicity users can be grouped into the following categories: knowledge workers, designers, and power users.

- For knowledge workers, the main areas of importance include office productivity applications, a robust web experience, and fluid video playback. Knowledge workers have the least-intensive graphics demands, but they expect the same smooth, fluid experience that exists natively on today’s graphics-accelerated devices such as desktop PCs, notebooks, tablets, and smartphones.
- Power users are users who need to run more demanding office applications, such as office productivity software, image editing software such as Adobe Photoshop, mainstream computer-aided design (CAD) software such as Autodesk AutoCAD, and product lifecycle management (PLM) applications. These applications are more demanding and require additional graphics resources with full support for APIs such as OpenGL and Direct3D.

- Designers are users in an organization who run demanding professional applications such as high-end CAD software and professional digital content creation (DCC) tools. Examples include Autodesk Inventor, PTC Creo, Autodesk Revit, and Adobe Premiere. Historically, designers have used desktop workstations and have been a difficult group to incorporate into virtual deployments because of their need for high-end graphics and the certification requirements of professional CAD and DCC software.

vGPU profiles allow the GPU hardware to be time-sliced to deliver exceptional shared virtualized graphics performance (Figure 1).

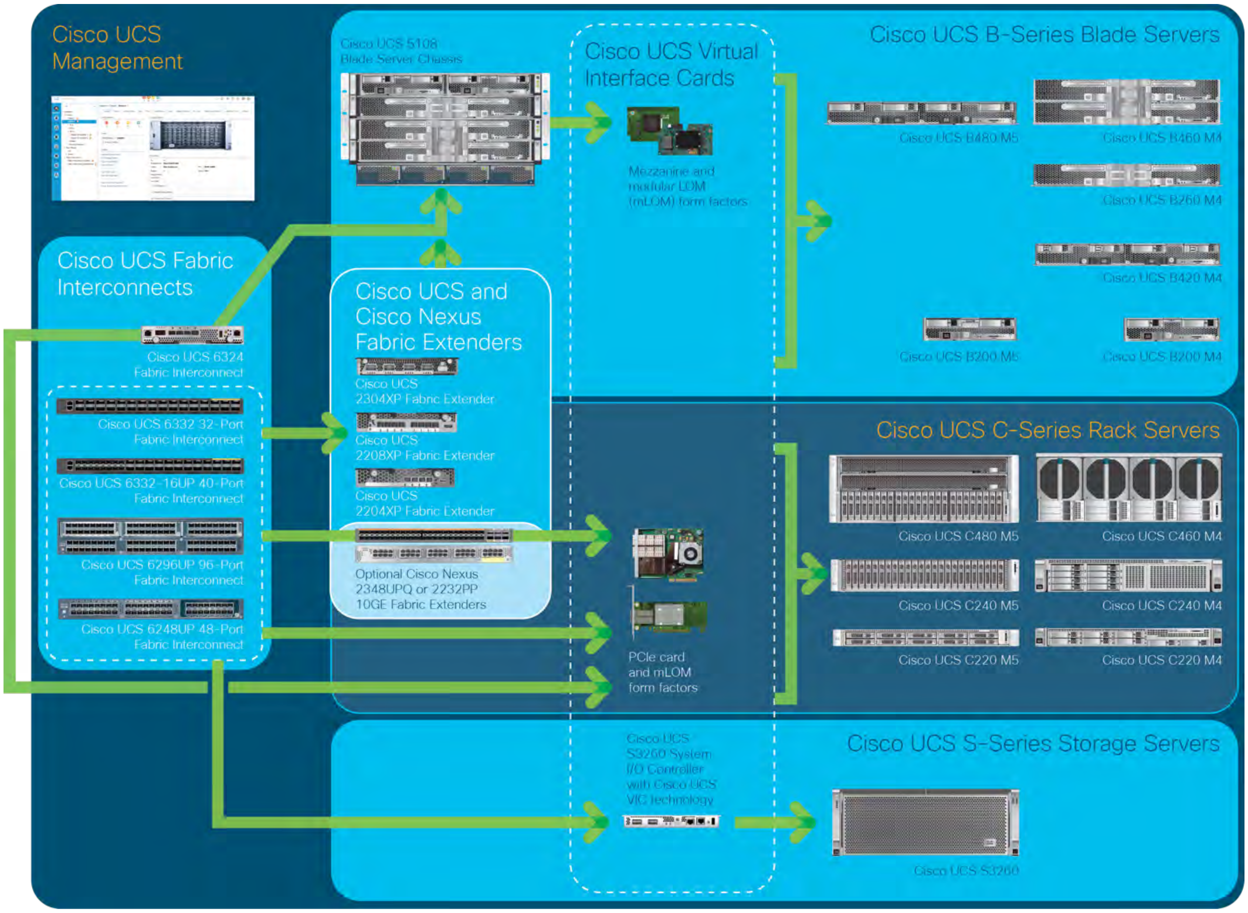
Figure 1. NVIDIA GRID vGPU system architecture



Cisco Unified Computing System

Cisco UCS is a next-generation data center platform that unites computing, networking, and storage access. The platform, optimized for virtual environments, is designed using open industry-standard technologies and aims to reduce total cost of ownership (TCO) and increase business agility. The system integrates a low-latency; lossless 40 Gigabit Ethernet unified network fabric with enterprise-class, x86-architecture servers. It is an integrated, scalable, multichassis platform in which all resources participate in a unified management domain (Figure 2).

Figure 2. Cisco UCS components


Cisco UCS Management
Cisco UCS 5108 Blade Server Chassis
Cisco UCS Virtual Interface Cards
Mezzanine and modular LOM (mLOM) form factors
Cisco UCS B-Series Blade Servers
Cisco UCS B480 M5
Cisco UCS B460 M4
Cisco UCS B260 M4
Cisco UCS B420 M4
Cisco UCS B200 M5
Cisco UCS B200 M4
Cisco UCS Fabric Interconnects
Cisco UCS 6324 Fabric Interconnect
Cisco UCS 6332 32-Port Fabric Interconnect
Cisco UCS 6332-16UP 40-Port Fabric Interconnect
Cisco UCS 6296UP 96-Port Fabric Interconnect
Cisco UCS 6248UP 48-Port Fabric Interconnect
Cisco UCS and Cisco Nexus Fabric Extenders
Cisco UCS 2304XP Fabric Extender
Cisco UCS 2208XP Fabric Extender
Cisco UCS 2204XP Fabric Extender
Optional Cisco Nexus 2348UPQ or 2232PP 10GE Fabric Extenders
PCIe card and mLOM form factors
Cisco UCS C-Series Rack Servers
Cisco UCS C480 M5
Cisco UCS C460 M4
Cisco UCS C240 M5
Cisco UCS C240 M4
Cisco UCS C220 M5
Cisco UCS C220 M4
Cisco UCS S3260 System I/O Controller with Cisco UCS VIC technology
Cisco UCS S-Series Storage Servers
Cisco UCS S3260

The main components of Cisco UCS are:

- **Computing:** The system is based on an entirely new class of computing system that incorporates blade servers and modular servers based on Intel processors.
- **Network:** The system is integrated onto a low-latency, lossless, 40-Gbps unified network fabric. This network foundation consolidates LANs, SANs, and high-performance computing (HPC) networks, which are separate networks today. The unified fabric lowers costs by reducing the number of network adapters, switches, and cables and by decreasing power and cooling requirements.
- **Virtualization:** The system unleashes the full potential of virtualization by enhancing the scalability, performance, and operational control of virtual environments. Cisco security, policy enforcement, and diagnostic features are now extended into virtualized environments to better support changing business and IT requirements.
- **Storage access:** The system provides consolidated access to local storage, SAN storage, and network-attached storage (NAS) over the unified fabric. With storage access unified, Cisco UCS can access storage over Ethernet, Fibre Channel, Fibre Channel over Ethernet (FCoE), and Small Computer System Interface over IP (iSCSI) protocols. This capability provides customers with a choice for storage access and investment protection. In addition, server administrators can

preassign storage-access policies for system connectivity to storage resources, simplifying storage connectivity and management and helping increase productivity.

- **Management:** Cisco UCS uniquely integrates all system components, enabling the entire solution to be managed as a single entity by Cisco UCS Manager. The manager has an intuitive GUI, a command-line interface (CLI), and a robust API for managing all system configuration processes and operations.

Cisco UCS is designed to deliver:

- Reduced TCO and increased business agility
- Increased IT staff productivity through just-in-time provisioning and mobility support
- A cohesive, integrated system that unifies the technology in the data center; the system is managed, serviced, and tested as a whole
- Scalability through a design for hundreds of discrete servers and thousands of virtual machines and the capability to scale I/O bandwidth to match demand
- Industry standards supported by a partner ecosystem of industry leaders

Cisco UCS Manager

Cisco UCS Manager provides unified, embedded management of all software and hardware components of Cisco UCS through an intuitive GUI, a CLI, and an XML API. The manager provides a unified management domain with centralized management capabilities and can control multiple chassis and thousands of virtual machines. Tightly integrated Cisco UCS manager and NVIDIA GPU cards provide better management of firmware and graphics card configuration.

Cisco UCS 6332 Fabric Interconnect

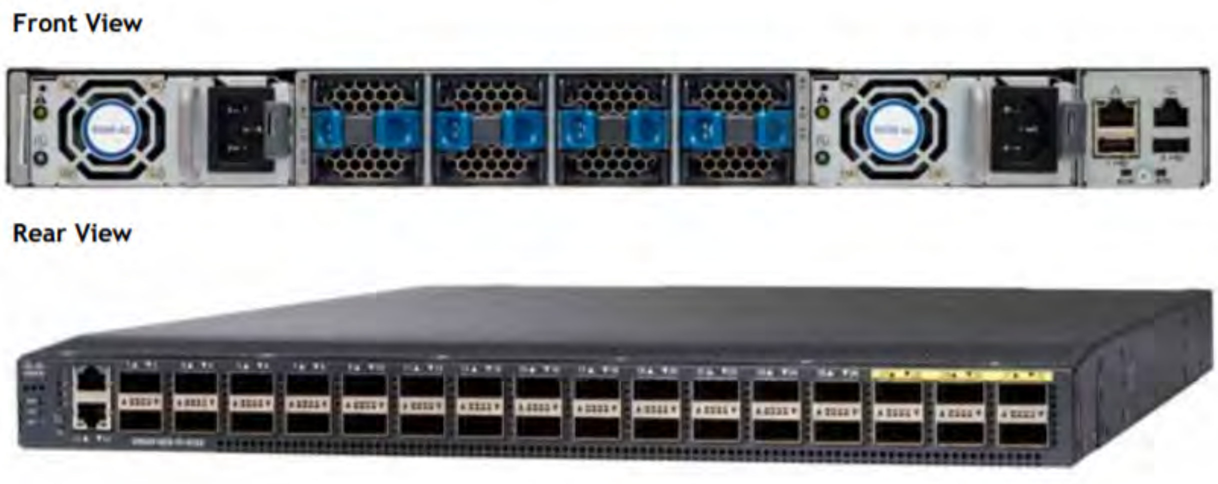
The Cisco UCS 6332 Fabric Interconnect (Figure 3) is the management and communication backbone for Cisco UCS B-Series Blade Servers, C-Series Rack Servers, and 5100 Series Blade Server Chassis. All servers attached to 6332 Fabric Interconnects become part of one highly available management domain.

Because they support unified fabric, Cisco UCS 6300 Series Fabric Interconnects provide both LAN and SAN connectivity for all servers within their domains. For more details see the Cisco UCS fabric interconnect specifications sheet.

The 6332 Fabric Interconnect provides these features and capabilities:

- Bandwidth of up to 2.56-Tbps full-duplex throughput
- Thirty-two 40-Gbps Enhanced Quad small Form-Factor Pluggable (QSFP+) ports in a 1RU form factor
- Support for four 10-Gbps breakout cables
- Ports capable of line-rate, low-latency, lossless 40 Gigabit Ethernet and FCoE
- Centralized unified management with Cisco UCS Manager
- Efficient cooling and serviceability

Figure 3. Cisco UCS 6332 Fabric Interconnect



Front View

Rear View

Cisco UCS C-Series Rack Servers

Cisco UCS C-Series Rack Servers keep pace with Intel Xeon processor innovation by offering the latest processors with increased processor frequency and improved security and availability features. With the increased performance provided by the Intel Xeon Scalable processors, C-Series servers offer an improved price-to-performance ratio. They also extend Cisco UCS innovations to an industry-standard rack-mount form factor, including standards-based unified network fabric, Cisco® VN-Link virtualization support, and Cisco Extended Memory Technology.

Designed to operate both in standalone environments and as part of a Cisco UCS managed configuration, these servers enable organizations to deploy systems incrementally—using as many or as few servers as needed—on a schedule that best meets the organization's timing and budget. C-Series servers offer investment protection through the capability to deploy them either as standalone servers or as part of Cisco UCS.

One compelling reason that many organizations prefer rack-mount servers is the wide range of I/O options available in the form of PCIe adapters. C-Series servers support a broad range of I/O options, including interfaces supported by Cisco as well as adapters from third parties.

Cisco UCS C240 M5 Rack Server

The Cisco UCS C240 M5 Rack Server (Figures 4 and 5 and Table 1) is designed for both performance and expandability over a wide range of storage-intensive infrastructure workloads, including big data and collaboration.

The C240 M5 small form-factor (SFF) server extends the capabilities of the Cisco UCS portfolio in a 2RU form factor with the addition of the Intel Xeon Scalable Processor, 24 DIMM slots for 2666-MHz DDR4 DIMMs, and up to 128-GB capacity points, up to 6 PCIe 3.0 slots, and up to 26 internal SFF drives. The C240 M5 SFF server also includes one dedicated internal slot for a 12-GB SAS storage controller card. The C240 M5 server includes a dedicated internal mLOM slot for installation of a Cisco VIC or third-party network interface card (NIC), without consuming a PCI slot, in addition to two 10GBASE-T Intel x550 LOM ports embedded on the motherboard.

In addition, the C240 M5 offers outstanding levels of internal memory and storage expandability with exceptional performance. It delivers:

- Up to 24 DDR4 DIMMs at speeds up to 2666 MHz for improved performance and lower power consumption
- One or 2 Intel Xeon Scalable CPUs
- Up to 6 PCIe 3.0 slots (4 full-height, full-length for GPU)
- Six hot-swappable fans for front-to-rear cooling
- Twenty-four SFF front-facing SAS/SATA hard-disk drives (HDDs) or SAS/SATA solid-state drives (SSDs)
- Optionally, up to two front-facing SFF Non-Volatile Memory Express (NVMe) PCIe SSDs (replacing SAS/SATA drives)
  - These drives must be placed in front drive bays 1 and 2 only and are controlled from Riser 2 option C.
- Optionally, up to two SFF, rear-facing SAS/SATA HDDs/SSDs or up to two rear-facing SFF NVMe PCIe SSDs
  - Rear-facing SFF NVMe drives connected from Riser 2, Option B or C, support 12-Gbps SAS drives
- Dedicated mLOM slot on the motherboard, which can flexibly accommodate the following cards:
  - Cisco VICs
  - Quad port Intel i350 1 Gigabit Ethernet RJ-45 mLOM NIC
  - Two 1 Gigabit Ethernet embedded LOM ports
- Support for up to two double-wide NVIDIA GPUs, providing a graphics-rich experience to more virtual users
- Excellent reliability, availability, and serviceability (RAS) features with tool-free CPU insertion, easy-to-use latching lid, and hot-swappable and hot-pluggable components
- One slot for a Micro SD card on PCIe Riser 1 (Option 1 and 1B)
  - The Micro SD card serves as a dedicated local resource for utilities such as the Cisco Host Upgrade Utility (HUU).
  - Images can be pulled from a file share (Network File System [NFS] or Common Internet File System [CIFS] and uploaded to the cards for future use.
- A mini-storage module connector on the motherboard, which supports either:
  - SD card module with two Secure Digital (SD) card slots (mixing of different capacity SD cards is not supported)
  - M.2 module with two SATA M.2 SSD slots (mixing of different-capacity M.2 modules is not supported)

Note: SD cards and M.2 modules cannot be mixed. M.2 modules do not support RAID 1 with VMware. Only Microsoft Windows and Linux are supported.

The C240 M5 also increases performance and customer choice over many types of storage-intensive applications, such as:

- Collaboration
- Small and medium-sized business (SMB) databases
- Big data infrastructure
- Virtualization and consolidation
- Storage servers
- High-performance appliances

The C240 M5 can be deployed as a standalone server or as part of a Cisco UCS managed domain. Cisco UCS unifies computing, networking, management, virtualization, and storage access into a single integrated architecture that enables end-to-end server visibility, management, and control in both bare-metal and virtualized environments. Within a Cisco UCS deployment, the C240 M5 takes advantage of Cisco's standards-based unified computing innovations, which significantly reduce customers' TCO and increase business agility.

For more information about the Cisco UCS C240 M5 Rack Server, see the specifications sheet.

Figure 4. Cisco UCS C240 M5 Rack Server

Figure 5. Cisco UCS C240 M5 Rack Server rear view

Table 1. Cisco UCS C240 M5 PCIe slots

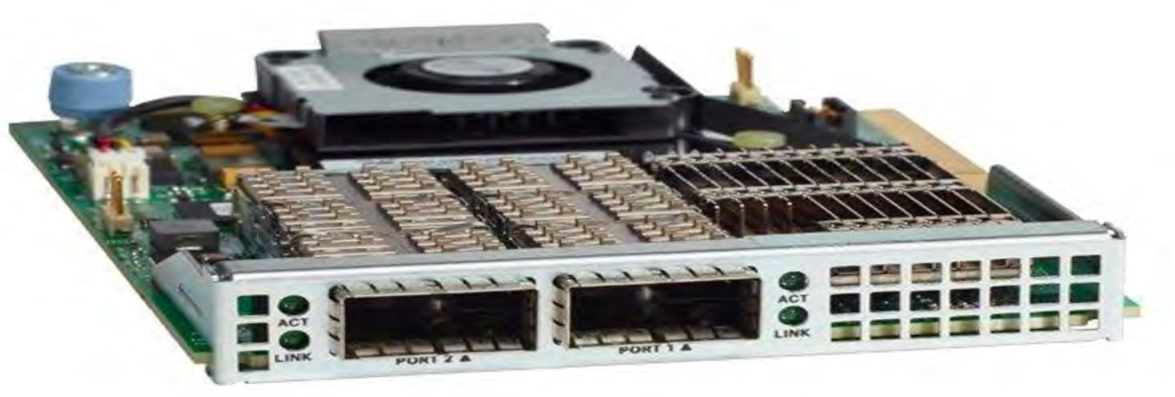
PCIe slot	Length	Lane
1	Half	x8
2	Full	x16
3	Half	x8
4	Half	x8
5	Full	x16
6	Full	x8

Cisco UCS Virtual Interface Card 1387

The Cisco UCS VIC 1387 (Figure 6) is a dual-port Enhanced Small Form-Factor Pluggable (SFP+) 40-Gbps Ethernet and FCoE-capable PCIe mLOM adapter installed in Cisco UCS C-Series Rack Servers. The mLOM slot can be used to install a Cisco VIC without consuming a PCIe slot, providing greater I/O expandability. It incorporates next-generation converged network adapter (CNA) technology from Cisco, providing investment protection for future feature releases. The card enables a policy-based, stateless, agile server infrastructure that can present more than 256 PCIe standards-compliant interfaces to the host that can be dynamically configured as either NICs or host bus adapters (HBAs). The personality of the card is determined dynamically at boot time using the service profile associated with the server. The number, type (NIC or HBA), identity (MAC address and World Wide Name [WWN]), failover policy, bandwidth, and quality-of-service (QoS) policies of the PCIe interfaces are all determined using the service profile.

For more information about the VIC, see the specifications sheet.

Figure 6. Cisco UCS VIC 1387 CNA



Cisco UCS B200 M5 Blade Server

Delivering performance, versatility, and density without compromise, the Cisco UCS B200 M5 Blade Server (Figure 7) addresses a broad set of workloads, from IT and web infrastructure through distributed database. The enterprise-class B200 M5 Blade Server extends the capabilities of the Cisco UCS portfolio in a half-width blade form factor. The B200 M5 harnesses the power of the latest Intel Xeon Scalable CPUs with up to 3072 GB of RAM (using 128-GB DIMMs), two SSDs or HDDs, and connectivity with throughput of up to 80 Gbps.

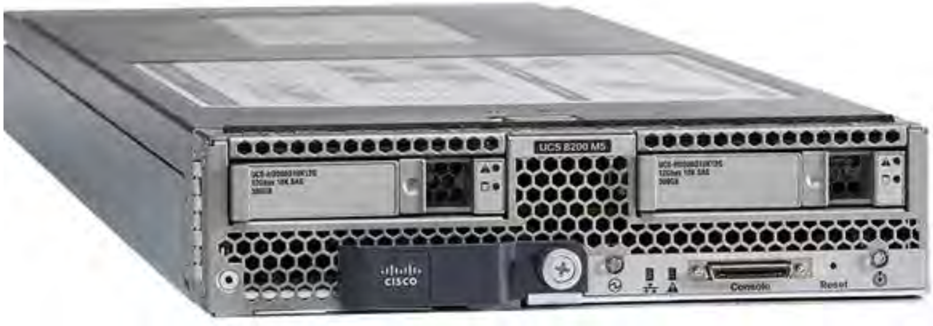
The B200 M5 server mounts in a Cisco UCS 5100 Series Blade Server Chassis or Cisco UCS Mini blade server chassis. It has 24 total slots for error-correcting code (ECC) registered DIMMs (RDIMMs) or load-reduced DIMMs (LR DIMMs). It supports one connector for the Cisco UCS VIC 1340 adapter, which provides Ethernet and FCoE.

The B200 M5 has one rear mezzanine adapter slot, which can be configured with a Cisco UCS port expander card for additional connectivity bandwidth or with an NVIDIA P6 GPU. These hardware options enable an additional four ports of the VIC 1340, bringing the total capability of the VIC 1340 to a dual native 40-Gbps interface or a dual 4 x 10 Gigabit Ethernet port-channel interface. Alternatively, the same rear mezzanine adapter slot can be configured with an NVIDIA P6 GPU.

The B200 M5 also has one front mezzanine slot. The B200 M5 can be ordered with or without a front mezzanine card. The front mezzanine card can accommodate a storage controller or NVIDIA P6 GPU.

For more information, see the specifications sheet.

Figure 7. Cisco UCS B200 M5 Blade Server front view



Cisco UCS Virtual Interface Card 1340

The Cisco UCS VIC 1340 (Figure 8) is a 2-port 40-Gbps Ethernet or dual 4 x 10-Gbps Ethernet and FCoE-capable mLOM designed exclusively for the M5 generation of Cisco UCS B-Series Blade Servers. When used in combination with an optional port expander, the VIC 1340 offers two ports of 40-Gbps Ethernet. The VIC 1340 enables a policy-based, stateless, agile server infrastructure that can present more than 256 PCIe standards-compliant interfaces to the host that can be dynamically configured as either NICs or HBAs. In addition, the VIC 1340 supports Cisco Virtual Machine Fabric Extender (VM-FEX) technology, which extends the Cisco UCS fabric interconnect ports to virtual machines, simplifying server virtualization deployment and management.

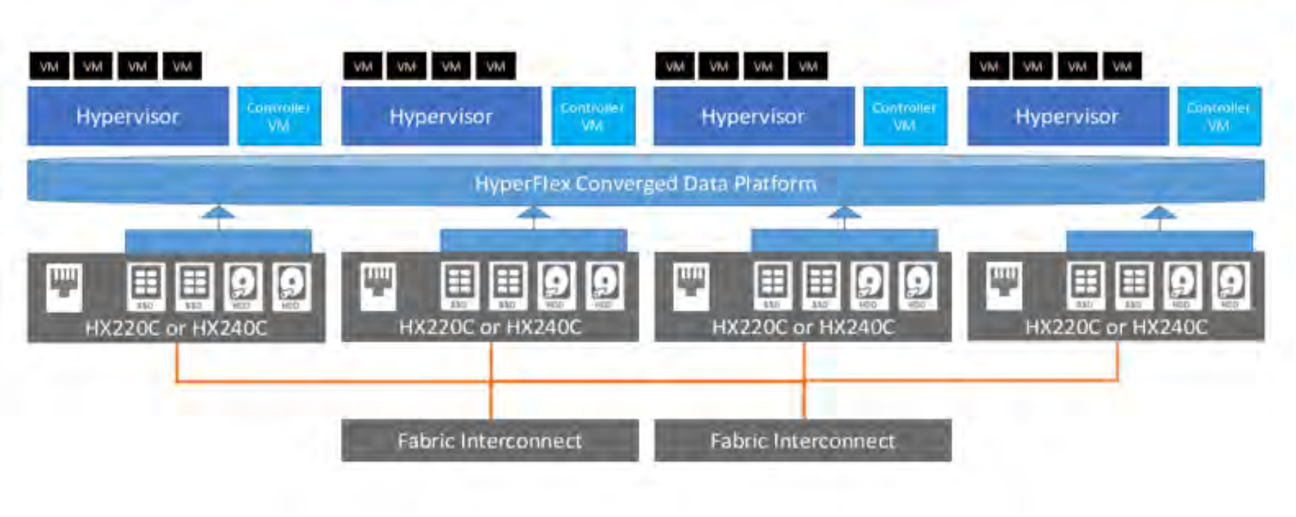
For more information, see the specifications sheet.

Figure 8. Cisco UCS VIC 1340

Cisco HyperFlex system

The Cisco HyperFlex system provides a fully contained virtual server platform. It includes computing and memory resources, integrated networking connectivity, a distributed high-performance log-structured file system for virtual machine storage, and hypervisor software for running the virtualized servers, all in a single Cisco UCS management domain (Figure 9).

Figure 9. Cisco HyperFlex system overview

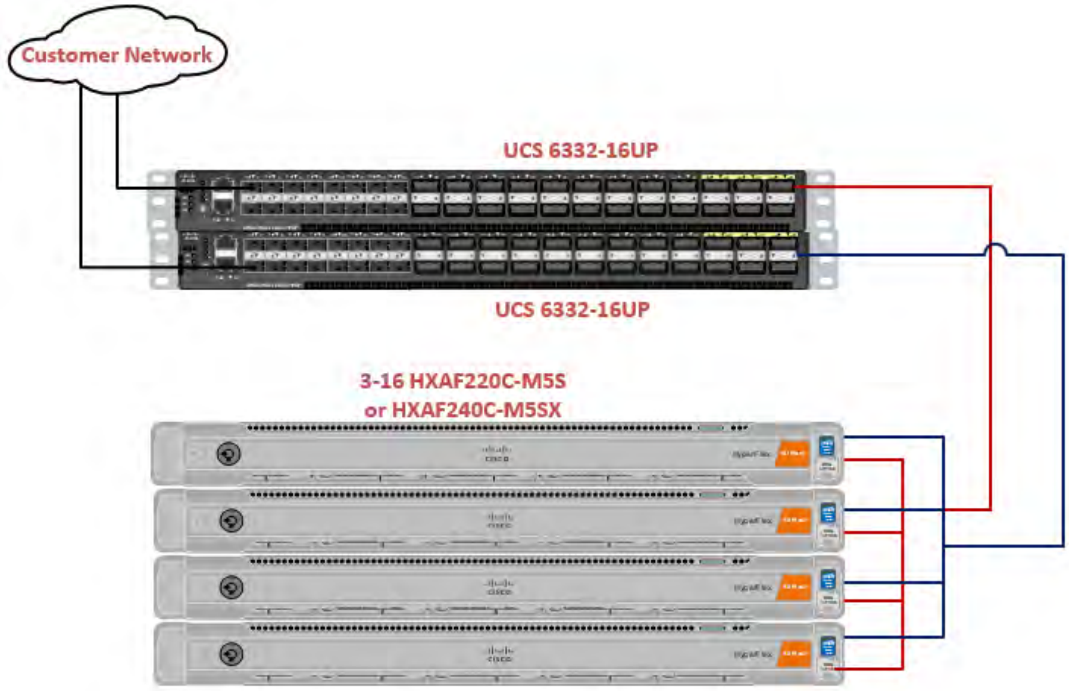


The Cisco HyperFlex system is composed of a pair of Cisco UCS 6200 or 6300 Series Fabric Interconnects, along with up to 16 Cisco HyperFlex HX-Series all-flash rack-mount servers per cluster. In addition, up to 16 computing-only servers can be added per cluster. Adding the Cisco UCS 5108 Blade Server Chassis allows the use of Cisco UCS B200 M5 Blade Servers for additional computing resources in a hybrid cluster design. Cisco UCS C240 and C220 servers can also be used for additional computing resources. Up to 8 separate HX-Series clusters can be installed under a single pair of fabric interconnects. The fabric interconnects connect both to every HX-Series rack mount server and to every Cisco UCS 5108 Blade Server Chassis. Upstream network connections, also referred to as northbound network connections, are made from the fabric interconnects to the customer data center network at the time of installation.

For the configuration used in this document, Cisco UCS 6332-16UP Fabric Interconnects are uplinked to Cisco Nexus® 9372PX Switches.

Figure 10 illustrates the hyperconverged topology used for this document.

Figure 10. Cisco HyperFlex standard topology



Additional graphics support for Cisco HyperFlex clusters can be achieved by adding Cisco UCS B200 M5 Blade Servers or Cisco UCS C240 M5 Rack Servers to the cluster as computing-only nodes.

To learn more about Cisco HyperFlex HX-Series servers, see the Hyperconverged Infrastructure webpage.

NVIDIA GRID

NVIDIA GRID is the industry's most advanced technology for sharing vGPUs across multiple virtual desktop and application instances. You can now use the full power of NVIDIA data center GPUs to deliver a superior virtual graphics experience to any device anywhere. The NVIDIA GRID platform offers the highest levels of performance, flexibility, manageability, and security–offering the right level of user experience for any virtual workflow.

For more information about NVIDIA GRID technology, see http://www.nvidia.com/object/nvidia-grid.html.

NVIDIA GRID 5.0 GPU

The NVIDIA GRID solution runs on top of award-winning, NVIDIA Maxwell and Pascal powered GPUs. These GPUs come in two server form factors: the NVIDIA Tesla P6 for blade servers and converged infrastructure, and the NVIDIA Tesla M10 and P40 for rack and tower servers.

NVIDIA GRID cards

For desktop virtualization applications, the NVIDIA Tesla P6, M10, and P40 cards are optimal choices for high-performance graphics (Table 2).

Table 2. Technical specifications for NVIDIA GRID cards

Number of GPUs	Single midrange Pascal	Quad midlevel Maxwell	Single high-end Pascal
NVIDIA Compute Unified Device Architecture (CUDA) cores	2048	2560 (640 per GPU)	3840
Memory size	16-GB GDDR5	32-GB GDDR5 (8 GB per GPU)	24-GB GDDR5
Maximum number of vGPU instances	16	64	24
Power	75W	225W	250W
Form factor	Mobile PCI Express Module (MXM) blade servers, with x16 lanes	PCIe 3.0 dual-slot rack servers, with x16 lanes	PCIe 3.0 dual-slot rack servers, with x16 lanes
Cooling solution	Bare board	Passive	Passive
H.264 1080p30 streams	24	28	24
Maximum number of users per board	16 (with 1-GB profile)	32 (with 1-GB profile)	24 (with 1-GB profile)
Virtualization use case	Blade optimized	User-density optimized	Performance optimized

NVIDIA GRID 5.0 license requirements

GRID 5.0 requires concurrent user licenses and an on-premises NVIDIA license server to manage the licenses. When the guest OS boots, it contacts the NVIDIA license server and consumes one concurrent license. When the guest OS shuts down, the license is returned to the pool.

GRID 5.0 also requires the purchase of a 1:1 ratio of concurrent licenses to NVIDIA Support, Update, and Maintenance Subscription (SUMS) instances.

The following NVIDIA GRID products are available as licensed products on NVIDIA Tesla GPUs:

- Virtual workstation
- Virtual PC
- Virtual applications

For complete details about GRID 5.0 license requirements, see https://images.nvidia.com/content/grid/pdf/GRID-Licensing-Guide.pdf.

VMware vSphere 6.5

VMware provides virtualization software. VMware's enterprise software hypervisors for servers—VMware vSphere ESX, vSphere ESXi, and vSphere—are bare-metal hypervisors that run directly on server hardware without requiring an additional underlying operating system. VMware vCenter Server for vSphere provides central management and complete control and visibility into clusters, hosts, virtual machines, storage, networking, and other critical elements of your virtual infrastructure.

vSphere 6.5 introduces many enhancements to vSphere Hypervisor, VMware virtual machines, vCenter Server, virtual storage, and virtual networking, further extending the core capabilities of the vSphere platform.

The vSphere 6.5 platform includes these features:

- Computing
  - **Increased scalability:** vSphere 6.5 supports larger maximum configuration sizes. Virtual machines support up to 128 virtual CPUs (vCPUs) and 6128 GB of virtual RAM (vRAM). Hosts support up to 576 CPUs and 12 TB of RAM, 1024 virtual machines per host, and 64 nodes per cluster.
  - **Expanded support:** Get expanded support for the latest x86 chip sets, devices, drivers, and guest operating systems. For a complete list of guest operating systems supported, see the VMware Compatibility Guide.
  - **Outstanding graphics:** The NVIDIA GRID vGPU delivers the full benefits of NVIDIA hardware-accelerated graphics to virtualized solutions.
  - **Instant cloning:** Technology built into vSphere 6.0 lays the foundation for rapid cloning and deployment of virtual machines—up to 10 times faster than what is possible today.
- Storage
  - **Transformation of virtual machine storage:** vSphere Virtual Volumes enable your external storage arrays to become virtual machine aware. Storage-policy-based management (SPBM) enables common management across storage tiers and dynamic storage class-of-service (CoS) automation. Together these features enable exact combinations of data services (such as clones and snapshots) to be instantiated more efficiently on a per–virtual machine basis.
- Network
  - **Network I/O control:** New support for per–virtual machine VMware distributed virtual switch (DVS) bandwidth reservation helps ensure isolation and enforce limits on bandwidth.
  - **Multicast snooping:** Support for Internet Group Management Protocol (IGMP) snooping for IPv4 packets and Multicast Listener Discovery (MLD) snooping for IPv6 packets in VDS improves performance and scalability with multicast traffic.
  - **Multiple TCP/IP stacks for VMware vMotion:** Implement a dedicated networking stack for vMotion traffic, simplifying IP address management with a dedicated default gateway for vMotion traffic.
- Availability
  - **vMotion enhancements:** Perform nondisruptive live migration of workloads across virtual switches and vCenter Servers and over distances with a round-trip time (RTT) of up to 100 milliseconds (ms). This support for dramatically longer RTT—a 10x increase in the supported time—for long-distance vMotion now enables data centers physically located in New York and London to migrate live workloads between one another.
  - **Replication-assisted vMotion:** Customers with active-active replication set up between two sites can perform more efficient vMotion migration, resulting in huge savings in time and resources, with up to 95 percent more efficient migration depending on the amount of data moved.

  - **Fault tolerance (up to four vCPUs):** Get expanded support for software-based fault tolerance for workloads with up to four vCPUs.
- Management
  - **Content library:** This centralized repository provides simple and effective management for content, including virtual machine templates, ISO images, and scripts. With VMware vSphere Content Library, you can now store and manage content from a central location and share content through a publish-and-subscribe model.
  - **Cloning and migration across vCenter:** Copy and move virtual machines between hosts on different vCenter Servers in a single action.
  - **Enhanced user interface:** VMware vSphere Web Client is more responsive, more intuitive, and simpler than ever before.

Graphics acceleration in VMware Horizon

To help ensure top performance for 3D graphics in VMware Horizon View, administrators can choose from three graphics-acceleration options: Soft 3D, vSGA, and vDGA. The vDGA option provides the highest availability for 3D graphics acceleration in Horizon.

Soft 3D, vSGA, and vDGA are distinguished by the following characteristics:

- **Soft 3D:** Introduced with View 5.0, the Software 3D Renderer (Soft 3D) uses the Soft 3D graphics driver, which is automatically installed with VMware Tools on Microsoft Windows 7 View virtual desktops. Soft 3D provides support for software-accelerated 3D graphics without the need for any physical GPUs to be installed in the ESXi virtual desktop host.
- **vSGA:** Introduced with View 5.2, virtual shared graphics acceleration, or vSGA, allows multiple virtual machines to share physical GPUs installed locally in the ESXi hosts. vSGA also uses the Soft 3D graphics driver, which is automatically installed on Microsoft Windows 7 View virtual desktops with VMware Tools.
- **vDGA:** Introduced with View 5.3, virtual dedicated graphics acceleration, or vDGA, uses the native graphics-card driver provided by the graphics-card vendor and allows a single virtual machine to be mapped to a single physical GPU installed in the ESXi host.

With these differences in mind, a hierarchy becomes clear: vDGA hardware 3D rendering provides the most powerful solution for 3D graphics acceleration in View, and Soft 3D software 3D rendering offers the most straightforward graphics-acceleration solution for virtual desktops with less-intensive workloads. The flexible and dynamic vSGA solution, which includes several different graphics-acceleration options, offers the highest availability for 3D graphics acceleration in View virtual desktops, without sacrificing performance, making it a uniquely appealing option. However, vSGA configuration demands a better understanding of the environment and technology, as discussed in the following sections.

vSGA overview

vSGA can provide higher availability for 3D graphics acceleration because the Soft 3D graphics driver allows administrators to set a vSGA-enabled virtual machine to Automatic, which allows it to dynamically switch between hardware and software 3D rendering, without the need for reconfiguration, depending on the availability of GPU resources. Additionally, by using the built-in Soft 3D graphics driver, vSGA allows a virtual machine to take advantage of vSphere vMotion, which enables the virtual machine to be migrated to an ESXi host that has available GPU resources.

You can configure vSGA from either of two locations: vSphere Client (or vSphere Web Client) or the pool settings for View.

Configuring vSGA with pool settings for VMware Horizon View

The pool settings for View allow administrators to configure graphics acceleration for aggregate pools of View desktops.

The options for vSGA 3D rendering in the pool settings for View are as follows:

- **Manage Using vSphere Client:** This setting enables individual virtual machines to be configured (with an Automatic, Software, Hardware, or Disabled setting) through vSphere Client or vSphere Web Client. With this setting, you can no longer configure aggregate pools of virtual desktops through the pool settings. Instead, you must configure each desktop one by one through vSphere Client of vSphere Web Client. This setting is most useful during testing or for manual desktop pools.
- **Automatic:** This setting uses hardware 3D rendering when hardware GPU resources are available, and it switches to software 3D rendering when they are not. This behavior allows virtual machines to be started on, or migrated to (through vSphere vMotion), any host (vSphere 5.0 or later) and to use the best solution (either hardware or software) available on that host.
- **Software:** This setting uses software 3D rendering even if hardware GPU resources are available. This setting both allows a virtual machine to run on any host (vSphere 5.0 or later) and allows you to block virtual machines from using a hardware GPU in a host.
- **Hardware:** This setting uses only hardware GPUs. Virtual machines set to this option will not start in (or be able to be migrated to) any host without an available hardware GPU. This setting can be used to help guarantee that a virtual machine will always use hardware 3D rendering when a GPU is available. However, this capability limits the virtual machine to hosts with hardware GPUs.
- **Disabled:** This setting uses neither hardware nor software 3D rendering. Use this setting to help ensure that a desktop pool with nongraphical workloads does not use resources unnecessarily.

Note: If you select the Manage Using vSphere Client option, VMware recommends that you use the vSphere Web Client to configure virtual machines, rather than the traditional vSphere Client. You should use this approach because the traditional vSphere Client does not display the various rendering options; it instead allows you only to enable or disable 3D support.

Configuring vSGA with the vSphere Client or vSphere Web Client

Use the vSphere Client or vSphere Web Client to configure virtual desktops one by one.

Note: Graphics acceleration in virtual machines with ESXi Version 9 or later hardware can be managed only through vSphere Web Client.

The options for vSGA 3D rendering in vSphere Client or vSphere Web Client are as follows:

- Automatic
- Software
- Hardware
- Disabled

Enhanced graphics with VMware Horizon 7 with Blast 3D

VMware Horizon with Blast 3D breaks the restraints of the physical workstation. Virtual desktops now deliver immersive 2D and 3D graphics smoothly rendered on any device, accessible from any location. Power users and designers can collaborate with global teams in real time, and organizations can increase workforce productivity, save costs, and expand user capabilities.

With a portfolio of solutions, including software- and hardware-based graphics acceleration technologies, Horizon provides a full-spectrum approach to enhancing the user experience and accelerating application responsiveness. Take advantage of Soft 3D, vSGA, vDGA, and NVIDIA GRID vGPU to deliver the right level of user experience and performance for every use case in your organization with secure, immersive 3D graphics from the cloud. Power users and designers get the same graphics experience that they expect from dedicated hardware, delivered securely and cost effectively and with improved collaboration workflow.

Enable dispersed teams to collaborate on large graphics data sets in real time from the cloud:

- Provide greater security for mission-critical data.
- Protect intellectual property and improve security by centralizing data files.
- Deploy with confidence. A growing portfolio of leading independent software vendor (ISV) certifications, including certifications from ESRI, PTC, and Siemens, helps ensure that users get the same graphics performance and experience as from their physical PCs and workstations.

Blast Extreme provides an enhanced remote-session experience introduced with Horizon for Linux desktops, Horizon 7, and Horizon Desktop as a Service (DaaS). In this case, the connection flow from Horizon Client differs from the flow for PC over IP (PCoIP). Figure 11 summarizes the process flow.

- Horizon Client sends authentication credentials using the XML API over HTTPS to the external URL on an access-point appliance or a security server. This process typically uses a load balancer virtual IP address.
- HTTPS authentication data is passed through from the access point to the tenant appliance (Horizon DaaS). In the case of a security server, the server uses Apache JServ Protocol 13 (AJP13) forwarded traffic, which is protected by IP Security (IPsec), from the security server to a paired connection server. Any entitled desktop pools are returned to the client.

Note: If multiple access-point appliances are used, which is often the case, a load-balancer virtual IP address will be used to load-balance the access-point appliances. Security servers use a different approach, with each security server paired with a connection server. No such pairing exists for access points.

- The user selects a desktop or application, and a session handshake occurs over HTTPS (TCP 443) to the access point or security server.
- A secure WebSocket connection is established (TCP 443) for the session data between Horizon Client and the access point or security server.
- The Blast Secure Gateway service (for the access point or security server) will attempt to establish a User Datagram Protocol (UDP) WebSocket connection on port 443. This approach is preferred, but if this fails because, for example, a firewall is blocking it, then the initial WebSocket TCP 443 connection will be used.

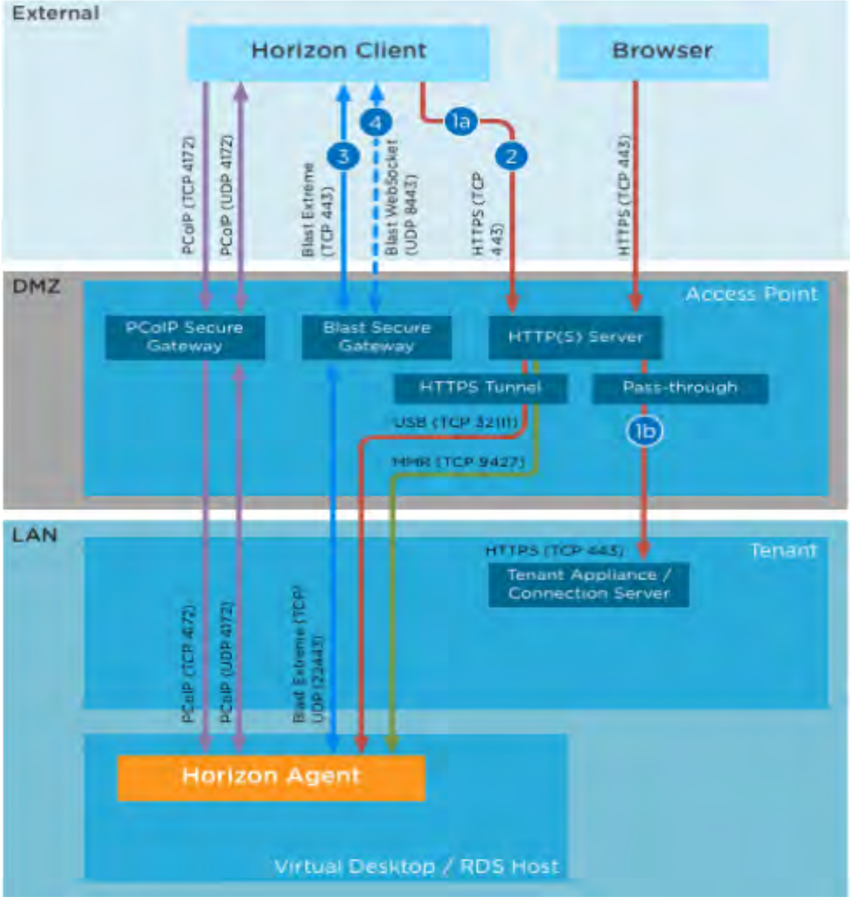
VMware recommends Blast Extreme for most use cases. It is required for connections to Linux desktops and for HTML access.

Linux desktops use the JPG or PNG codec, and HTML access uses the JPG or PNG codec except for Chrome browsers, which can be configured to use the H.264 codec. For a detailed description of these codecs, see Codecs Used by Blast Extreme.

The only end users who should continue to use PCoIP rather than Blast Extreme are users of zero-client devices that are specifically manufactured to support PCoIP. For a list of zero clients and thin clients that support Blast Extreme, see the VMware Compatibility Guide

Note: If you configure a pool to use Blast Extreme and do not allow users to choose a protocol, VMware View Connection Server automatically allows PCoIP connections from PCoIP zero clients and older Horizon Client releases (earlier than Release 4.0).

Figure 11. VMware Horizon Blast Extreme process flow



GPU acceleration for Microsoft Windows Server

VMware Blast Extreme allows graphics-intensive applications running in Microsoft Windows Server sessions to render on the server's GPU. By moving OpenGL, DirectX, Direct3D, and Windows Presentation Foundation (WPF) rendering to the server's GPU, the server's CPU is not slowed by graphics rendering. Additionally, the server can process more graphics because the workload is split between the CPU and the GPU.

GPU sharing for VMware Horizon Remote Desktop Services host workloads

Remote desktop services (RDS) GPU sharing enables GPU hardware rendering of OpenGL and Microsoft DirectX applications in remote desktop sessions.

- Sharing can be used on virtual machines to increase application scalability and performance.
- Sharing enables multiple concurrent sessions to share GPU resources (most users do not require the rendering performance of a dedicated GPU).
- Sharing requires no special settings.

For DirectX applications, only one GPU is used by default. That GPU is shared by multiple users. The allocation of sessions across multiple GPUs with DirectX is experimental and requires registry changes. Contact VMware Support for more information.

You can install multiple GPUs on a hypervisor and assign virtual machines to each of these GPUs on a one-to-one basis: either install a graphics card with more than one GPU, or install multiple graphics cards with one or more GPUs each. Mixing heterogeneous graphics cards on a server is not recommended. Virtual machines require direct pass-through access to a GPU, which is available with VMware vSphere 6. For RDS hosts, applications in application pools and applications running on RDS desktops both can display 3D graphics.

The following 3D graphics options are available:

- With vDGA, you allocate an entire GPU to a single machine for maximum performance. The RDS host must be in a manual farm.
- With NVIDIA GRID vGPU, each graphics card can support multiple RDS hosts. The RDS hosts must be in a manual farm. If a VMware ESXi host has multiple physical GPUs, you can also configure the way that the ESXi host assigns virtual machines to the GPUs. By default, the ESXi host assigns virtual machines to the physical GPU with the fewest virtual machines already assigned. This approach is called performance mode. You can also choose consolidation mode, in which the ESXi host assigns virtual machines to the same physical GPU until the maximum number of virtual machines is reached before placing virtual machines on the next physical GPU. To configure consolidation mode, edit the /etc/vmware/config file on the ESXi host and add the following entry: vGPU.consolidation = " true" .
- 3D graphics is supported only when you use the PCoIP or VMware Blast protocol. Therefore, the farm must use PCoIP or VMware Blast as the default protocol, and users must not be allowed to choose the protocol.
- Configuration of 3D graphics for RDS hosts in VMware View Administrator is not required. Selecting the option 3D RDS Host (RDSH) when you install Horizon Agent is sufficient. By default, this option is not selected, and 3D graphics is disabled.

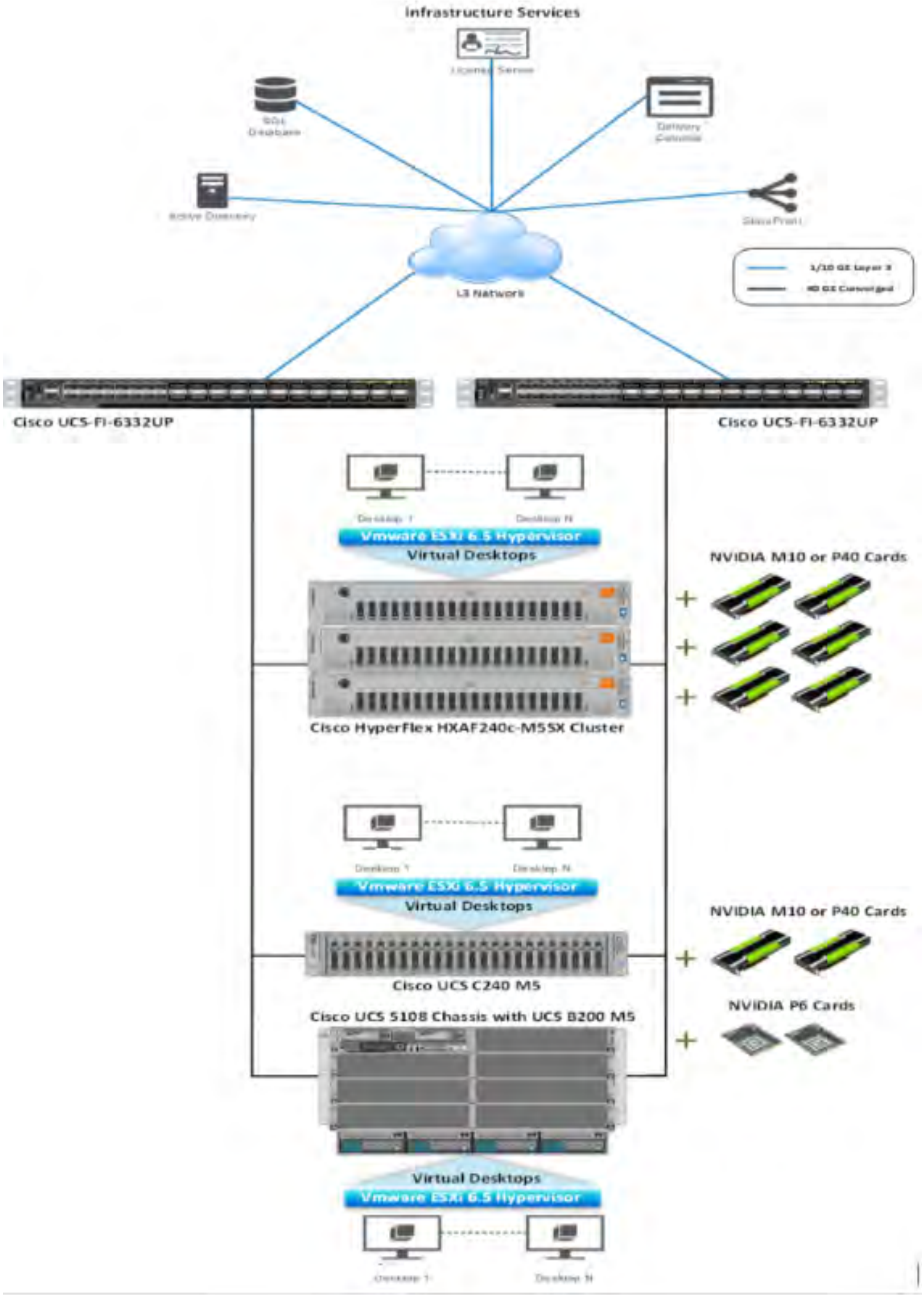
Scalability using RDS GPU sharing depends on several factors:

- The applications being run
- The amount of video RAM that the applications consume
- The graphics card's processing power

Some applications handle video RAM shortages better than others. If the hardware becomes extremely overloaded, the system may become unstable, or the graphics card driver may fail. Limit the number of concurrent users to avoid such problems. To confirm that GPU acceleration is occurring, use a third-party tool such as GPU-Z (http://www.techpowerup.com/gpuz/).

Solution configuration

Figure 12. Reference architecture



The hardware components in the solution are:

- Cisco UCS C240 M5 Rack Server (two Intel Xeon Gold 5120 CPUs at 2.20 GHz) with 768 GB of memory (64 GB x 12 DIMMs at 2666 MHz)
- Cisco UCS B200 M5 Blade Server (two Intel Xeon Gold 5120 CPUs at 2.20 GHz) with 768 GB of memory (64 GB x 12 DIMMs at 2666 MHz)
- Cisco HyperFlex HX240c M5SX All Flash hyperconverged server (two Intel Xeon Gold 5120 CPUs at 2.20 GHz) with 768 GB of memory (64 GB x 12 DIMMs at 2666 MHz)
- Cisco UCS VIC 1387 mLOM (Cisco UCS C240 M5 Rack Server and Cisco HyperFlex HX240c M5S All Flash Node)
- Cisco UCS VIC 1340 mLOM (Cisco UCS B200 M5 Blade Server)
- Two Cisco UCS 6332 Fabric Interconnects (third-generation fabric interconnects)
- NVIDIA Tesla M10, P40, and P6 cards
- Two Cisco Nexus 9372 switches (optional access switches)

Note: For high-performance graphics applications, Intel Xeon processor 6154 CPUs at 3.0 GHz paired with NIVDIA Tesla P40 or P6 cards are recommended.

The software components of the solution are:

- Cisco UCS Firmware Release 3.2(2c)
- Cisco HyperFlex HX Data Platform Release 2.6(1a)
- VMware ESXi 6.5 (5969303) for VDI hosts
- VMware Horizon 7.3.2
- Microsoft Windows 10 64-bit
- Microsoft Server 2016
- Microsoft Office 2016
- NVIDIA GRID software and licenses:
  - NVIDIA-VMware_ESXi_6.5_Host_Driver_384.99-1OEM.650.0.0.4598673
  - 385.90_grid_win10_server2016_64bit_international
  - vGPU License Server Version 5.0.0.22575570 with Quadro-Virtual-DWS licenses

Configure Cisco UCS

This section describes the Cisco UCS configuration.

Install NVIDIA Tesla GPU card on Cisco UCS C240 M5 and Cisco HyperFlex HX 240c M5 All Flash server

Install the M10 or P40 GPU card on the Cisco UCS C240 M5 Rack Server and Cisco HyperFlex HX 240c M5 All Flash Node.

Table 3 lists the minimum firmware required for the supported GPU cards.

Table 3. Minimum server firmware versions required for GPU cards

Cisco Integrated Management Controller (IMC)	BIOS minimum version
NVIDIA Tesla M10	Release 3.1(1)
NVIDIA Tesla P40	Release 3.1(1)

Mixing of different brands or models of GPU cards in the server is not supported.

The rules for configuring the server with GPUs differ, depending on the server version and other factors. Table 4 lists rules for populating the Cisco UCS C240 M5 with NVIDIA GPUs.

Table 4. NVIDIA GPU population rules for Cisco UCS C240 M5 Rack Server

Single GPU	Dual GPU
Riser 1, slot 2 or Riser 2, slot 5 supported in all riser options	Riser 1, slot 2 and Riser 2A/2B, slot 5

Figure 13. One-GPU scenario

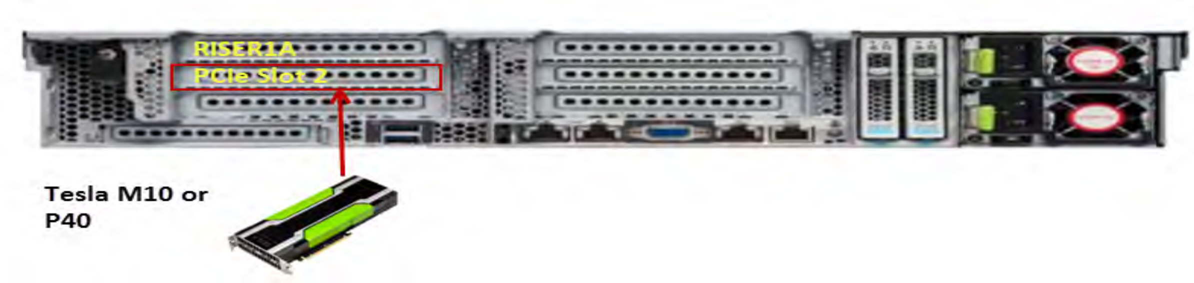
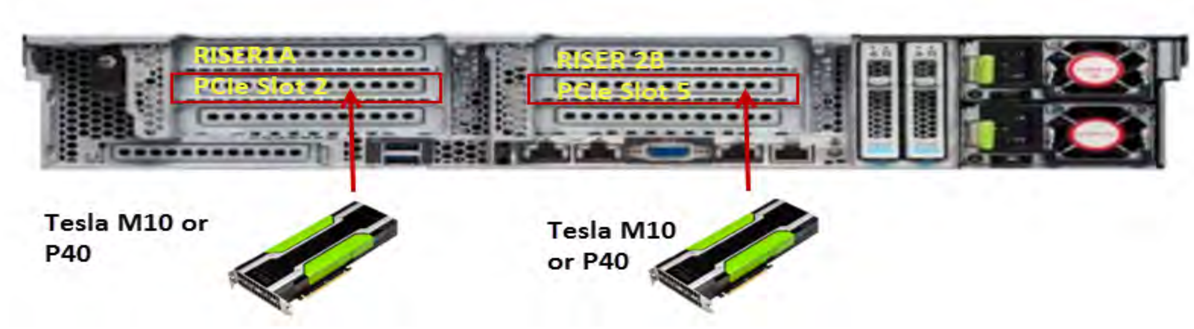


Figure 14. Two-GPU scenario



For more information refer to the following configuration documents:

- https://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/c/hw/C240M5/install/C240M5.pdf
- https://www.cisco.com/c/dam/en/us/products/collateral/hyperconverged-infrastructure/hyperflex-hx-series/hxaf-240c-m5-specsheet.pdf

Install NVIDIA Tesla GPU card on Cisco UCS B200 M5

Install the P6 GPU card on the Cisco UCS B200 M5 server.

Table 5 lists the minimum firmware required for the GPU card. Figure 15 shows the card in the server.

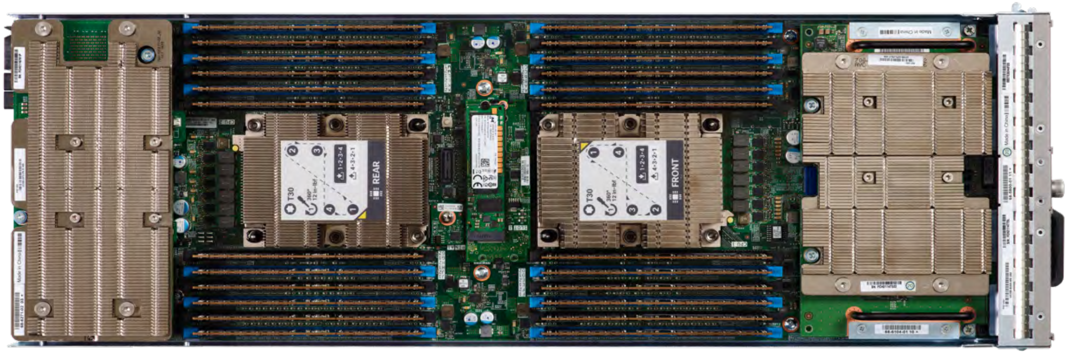
Table 5. Minimum server firmware versions required for GPU card

Cisco Integrated Management Controller (IMC)	BIOS minimum version
NVIDIA Tesla M6	Release 3.2(1d)

Before installing the NVIDIA P6 GPU, do the following:

- Remove any adapter card, such as a Cisco UCS VIC 1380 or 1280 or a port extender card, from mLOM slot 2. You cannot use any other card in slot 2 when the NVIDIA P6 GPU is installed.
- Upgrade your Cisco UCS system to a version of Cisco UCS Manager that supports this card. Refer to the latest version of the release notes for Cisco UCS software at the following URL for information about supported hardware: http://www.cisco.com/c/en/us/support/servers-unified-computing/ucs-manager/products-release-notes-list.html.

Figure 15. Cisco UCS B200 M5 Blade Server with two NVIDIA GRID P6 GPU cards.



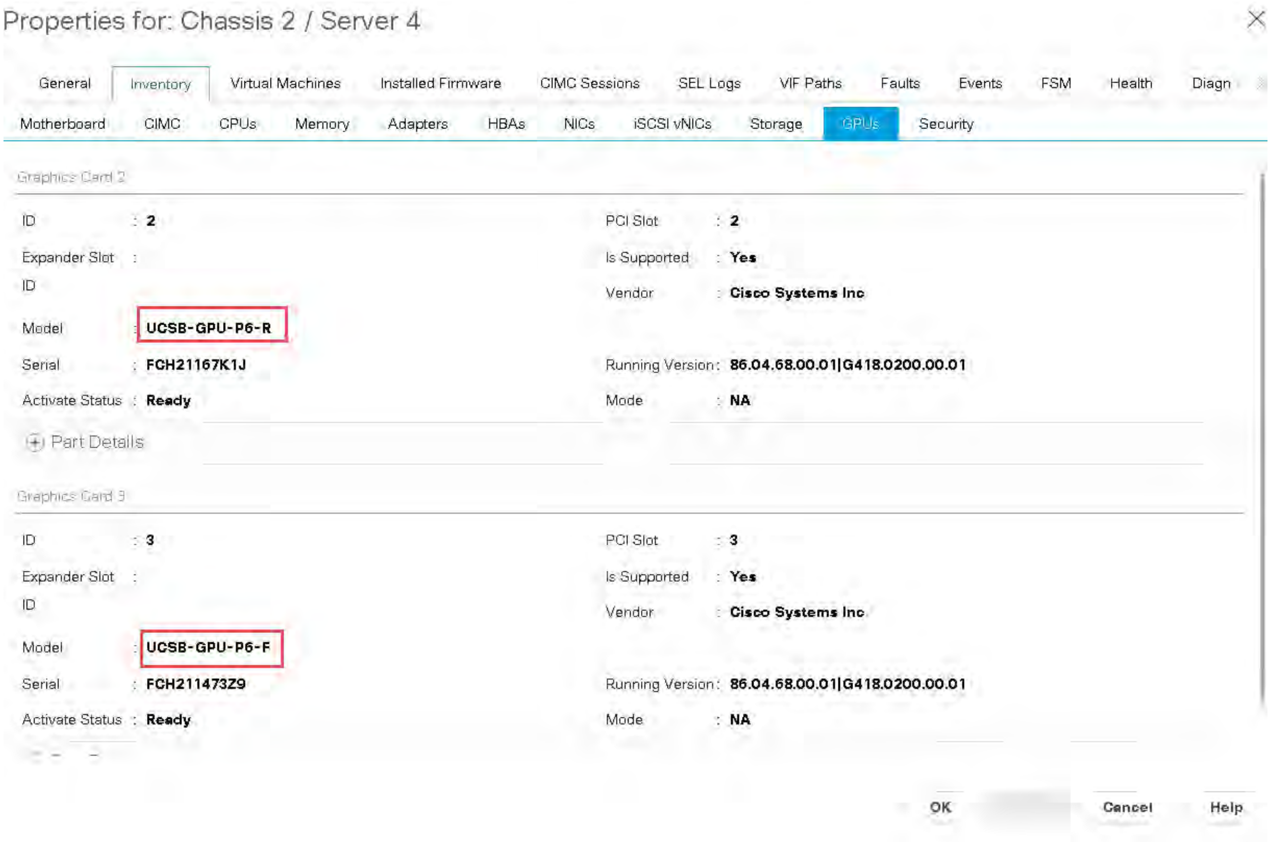
For more information refer to this configuration document: https://www.cisco.com/c/en/us/td/docs/unified_computing/ucs/hw/blade-servers/B200M5.pdf.

Configure the GPU card

Follow these steps to configure the GPU card.

1. After the NVIDIA P6 GPU cards are physically installed and the Cisco UCS B200 M5 Blade Server is discovered in Cisco UCS Manager, select the server and choose Inventory > GPUs. As shown in Figure 16, PCIe slots 2 and 3 are used with the two GRID P6 cards.

Figure 16. NVIDIA GRID P6 card inventory displayed in Cisco UCS Manager



Graphics Card 2

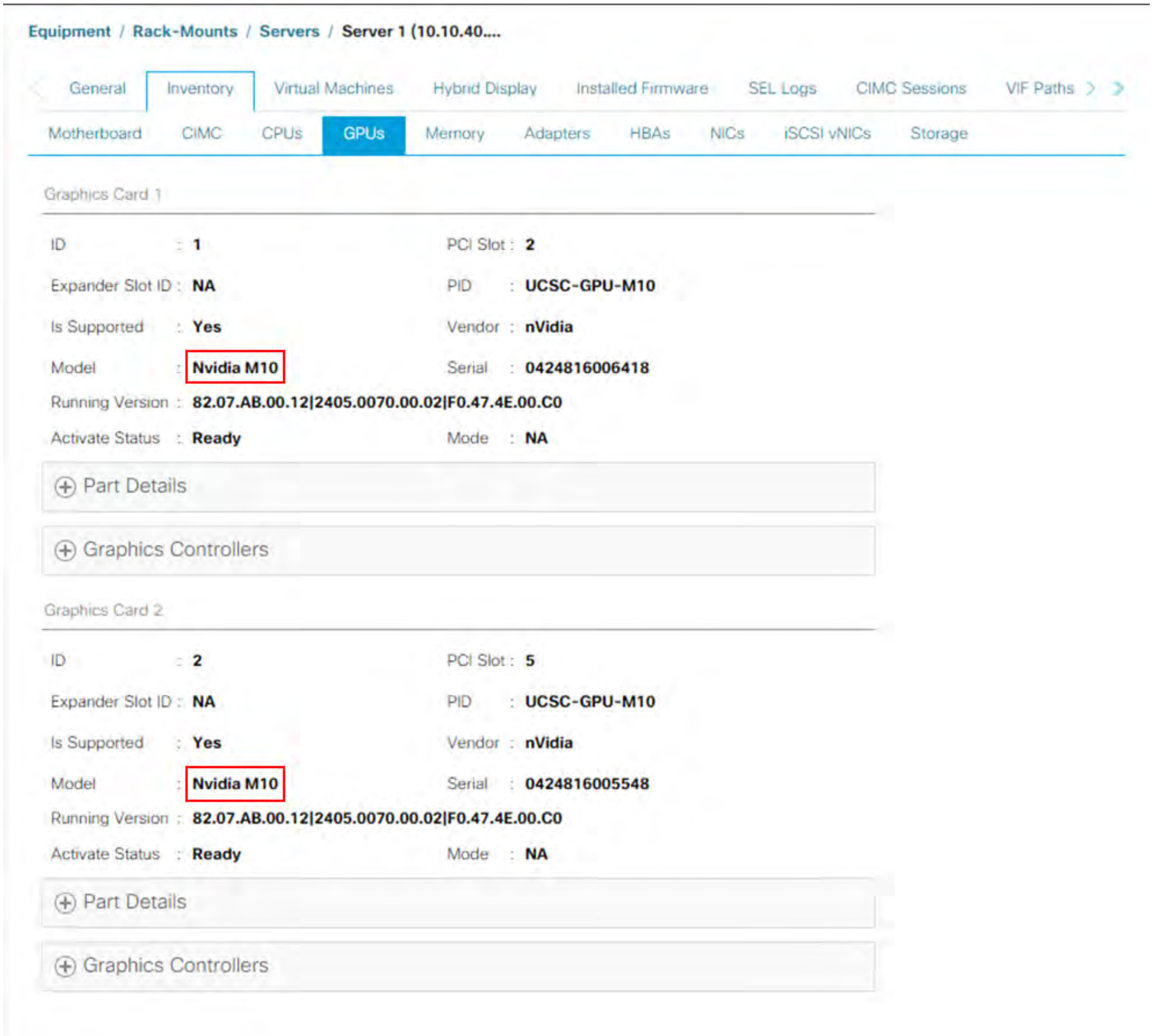
ID : 2
Expander Slot ID :
Model : UCSB-GPU-P6-R
Serial : FCH21167K1J
Activate Status : Ready
PCI Slot : 2
Is Supported : Yes
Vendor : Cisco Systems Inc
Running Version : 86.04.68.00.01|G418.0200.00.01
Mode : NA

Graphics Card 3

ID : 3
Expander Slot ID :
Model : UCSB-GPU-P6-F
Serial : FCH211473Z9
Activate Status : Ready
PCI Slot : 3
Is Supported : Yes
Vendor : Cisco Systems Inc
Running Version : 86.04.68.00.01|G418.0200.00.01
Mode : NA

2. After the NVIDIA M10 GPU cards are physically installed and the Cisco UCS C240 M5 and Cisco HyperFlex HX240c M5 All Flash server is discovered in Cisco UCS Manager, select the server and choose Inventory > GPUs. As shown in Figure 17, PCIe slots 2 and 5 are used with the two GRID M10 cards.

Figure 17. NVIDIA GRID M10 card inventory displayed in Cisco UCS Manager



Graphics Card 1

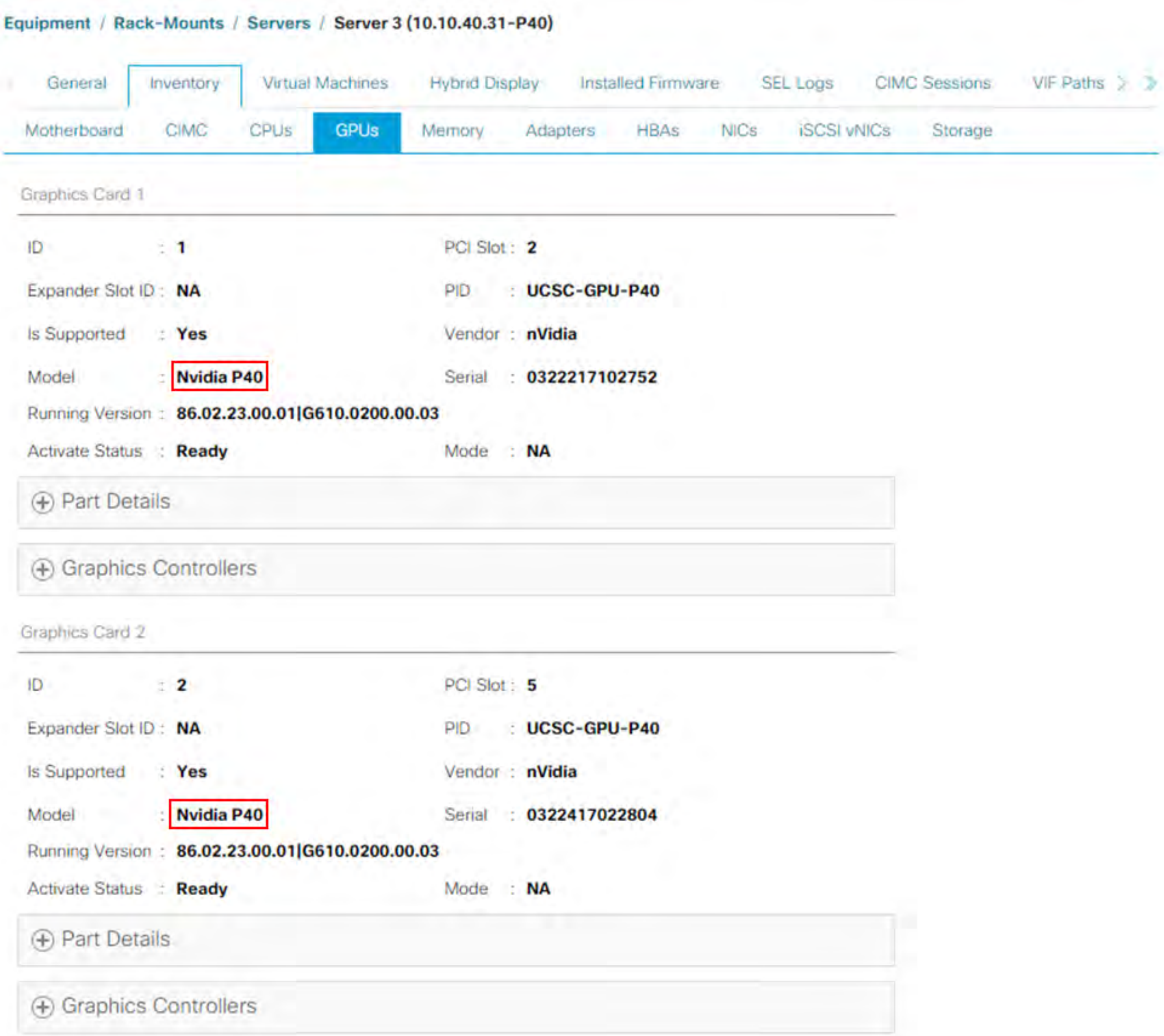
ID : 1 PCI Slot : 2
Expander Slot ID : NA PID : UCSC-GPU-M10
Is Supported : Yes Vendor : nVidia
Model : Nvidia M10 Serial : 0424816006418
Running Version : 82.07.AB.00.12|2405.0070.00.02|F0.47.4E.00.C0
Activate Status : Ready Mode : NA

Graphics Card 2

ID : 2 PCI Slot : 5
Expander Slot ID : NA PID : UCSC-GPU-M10
Is Supported : Yes Vendor : nVidia
Model : Nvidia M10 Serial : 0424816005548
Running Version : 82.07.AB.00.12|2405.0070.00.02|F0.47.4E.00.C0
Activate Status : Ready Mode : NA

3. After the NVIDIA P40 GPU card is physically installed and the Cisco UCS C240 and Cisco HyperFlex HX240 M5 All Flash rack server is discovered in Cisco UCS Manager, select the server and choose Inventory > GPUs. As shown in Figure 18, PCIe slots 2 and 5 are used with the two GRID P40 cards.

Figure 18. NVIDIA GRID P40 card inventory displayed in Cisco UCS Manager



Graphics Card 1

ID : 1
PCI Slot : 2
Expander Slot ID : NA
PID : UCSC-GPU-P40
Is Supported : Yes
Vendor : nVidia
Model : Nvidia P40
Serial : 0322217102752
Running Version : 86.02.23.00.01|G610.0200.00.03
Activate Status : Ready
Mode : NA

⊕ Part Details

⊕ Graphics Controllers

Graphics Card 2

ID : 2
PCI Slot : 5
Expander Slot ID : NA
PID : UCSC-GPU-P40
Is Supported : Yes
Vendor : nVidia
Model : Nvidia P40
Serial : 0322417022804
Running Version : 86.02.23.00.01|G610.0200.00.03
Activate Status : Ready
Mode : NA

⊕ Part Details

⊕ Graphics Controllers

You can use Cisco UCS Manager to perform firmware upgrades to the NVIDIA GPU cards in managed Cisco UCS C240 M5 and Cisco HyperFlex HX240c M5 and HX240c M5 All Flash servers.

Note: VMware ESXi virtual machine hardware Version 9 or later is required for vGPU and vDGA configuration. Virtual machines with hardware Version 9 or later should have their settings managed through VMware vSphere Web Client.

Install the NVIDIA GRID license server

This section summarizes the installation and configuration process for the GRID 5.0 license server.

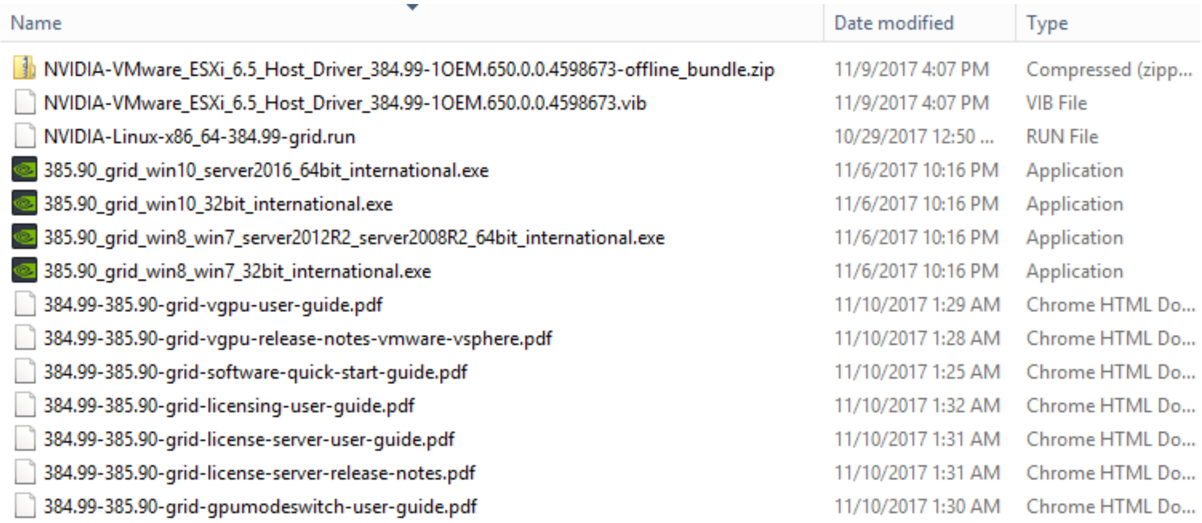
The NVIDIA GRID vGPU is a licensed feature on Tesla P6, P40, and M10. A software license card is required to use the full vGPU feature sets on a guest virtual machine. An NVIDIA license server with the appropriate licenses is required.

To get an evaluation license code and download the software, register at http://www.nvidia.com/object/grid-evaluation.html#utm_source=shorturl&utm_medium=referrer&utm_campaign=grideval.

Three packages are required for VMware ESXi host setup, as shown in Figure 19:

- The GRID license server installer
- The NVIDIA GRID Manager software, which is installed on VMware vSphere ESXi; the NVIDIA drivers and software that are installed in Microsoft Windows are also in this folder
- The GPU Mode Switch utility, which changes the cards from the default Compute mode to Graphics mode

Figure 19. Software required for NVIDIA GRID 5.0 setup on the VMware ESXi host



Name	Date modified	Type
NVIDIA-VMware_ESXi_6.5_Host_Driver_384.99-1OEM.650.0.0.4598673-offline_bundle.zip	11/9/2017 4:07 PM	Compressed (zipp...
NVIDIA-VMware_ESXi_6.5_Host_Driver_384.99-1OEM.650.0.0.4598673.vib	11/9/2017 4:07 PM	VIB File
NVIDIA-Linux-x86_64-384.99-grid.run	10/29/2017 12:50 ...	RUN File
385.90_grid_win10_server2016_64bit_international.exe	11/6/2017 10:16 PM	Application
385.90_grid_win10_32bit_international.exe	11/6/2017 10:16 PM	Application
385.90_grid_win8_win7_server2012R2_server2008R2_64bit_international.exe	11/6/2017 10:16 PM	Application
385.90_grid_win8_win7_32bit_international.exe	11/6/2017 10:16 PM	Application
384.99-385.90-grid-vgpu-user-guide.pdf	11/10/2017 1:29 AM	Chrome HTML Do...
384.99-385.90-grid-vgpu-release-notes-vmware-vsphere.pdf	11/10/2017 1:28 AM	Chrome HTML Do...
384.99-385.90-grid-software-quick-start-guide.pdf	11/10/2017 1:25 AM	Chrome HTML Do...
384.99-385.90-grid-licensing-user-guide.pdf	11/10/2017 1:32 AM	Chrome HTML Do...
384.99-385.90-grid-license-server-user-guide.pdf	11/10/2017 1:31 AM	Chrome HTML Do...
384.99-385.90-grid-license-server-release-notes.pdf	11/10/2017 1:31 AM	Chrome HTML Do...
384.99-385.90-grid-gpumodeswitch-user-guide.pdf	11/10/2017 1:30 AM	Chrome HTML Do...

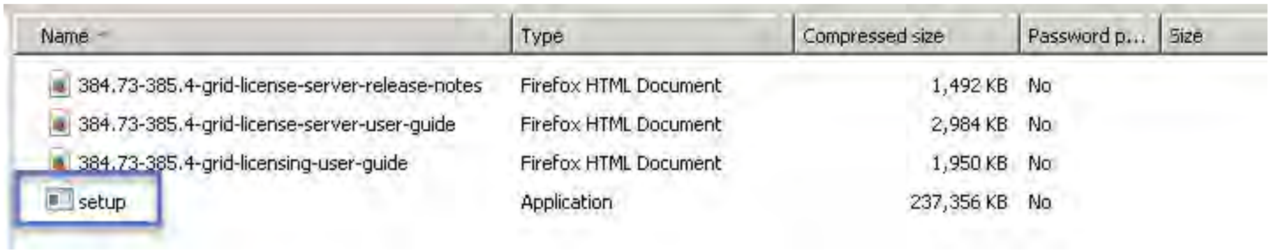
Install the GRID 5.0 license server

The steps shown here use the Microsoft Windows version of the license server installed on Windows Server 2016. A Linux version of the license server is also available.

The GRID 5.0 license server requires Java Version 7 or later. Go to Java.com and install the latest version.

1. Extract and open the NVIDIA-ls-windows-2017.08-0001 folder. Run setup.exe (Figure 20).

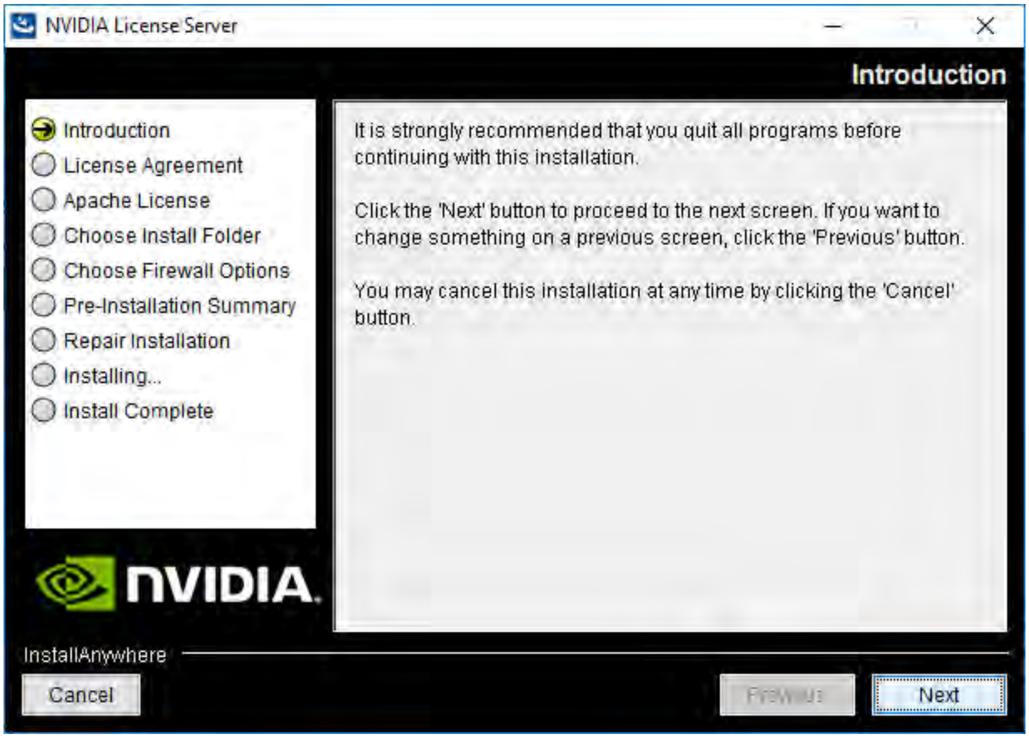
Figure 20. Run setup.exe



Name	Type	Compressed size	Password p...	Size
384.73-385.4-grid-license-server-release-notes	Firefox HTML Document	1,492 KB	No	
384.73-385.4-grid-license-server-user-guide	Firefox HTML Document	2,984 KB	No	
384.73-385.4-grid-licensing-user-guide	Firefox HTML Document	1,950 KB	No	
setup	Application	237,356 KB	No	

2. Click Next (Figure 21).

Figure 21. NVIDIA License Server page



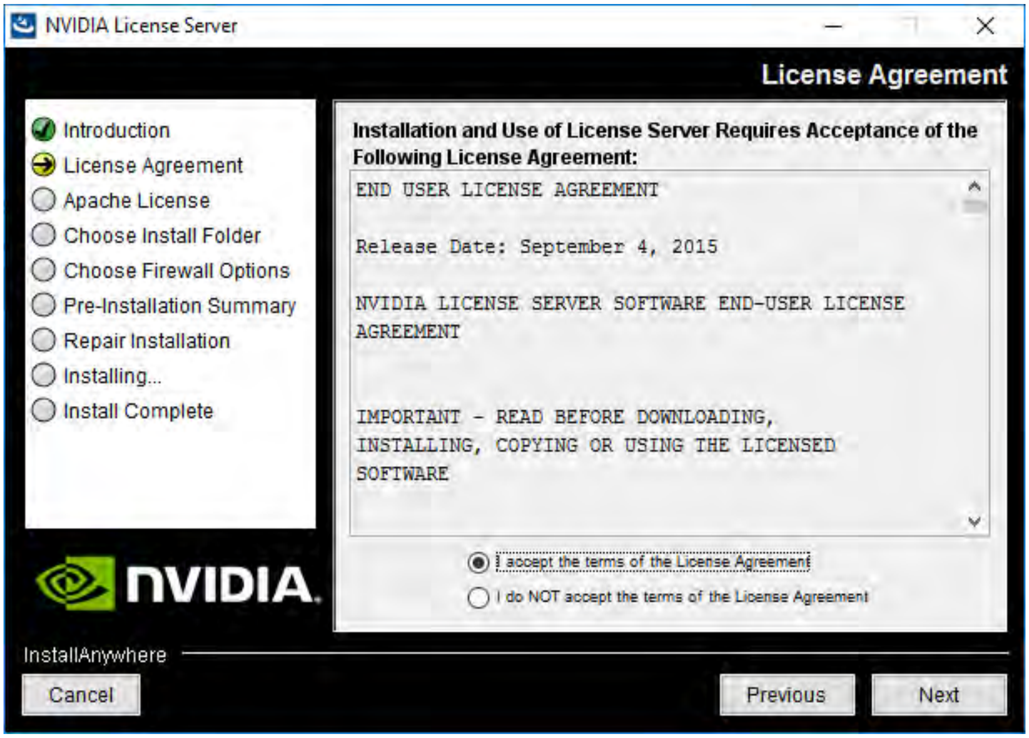
It is strongly recommended that you quit all programs before continuing with this installation.

Click the 'Next' button to proceed to the next screen. If you want to change something on a previous screen, click the 'Previous' button.

You may cancel this installation at any time by clicking the 'Cancel' button.

3. Accept the license agreement and click Next (Figure 22).

Figure 22. NVIDIA License Agreement page



Installation and Use of License Server Requires Acceptance of the Following License Agreement:

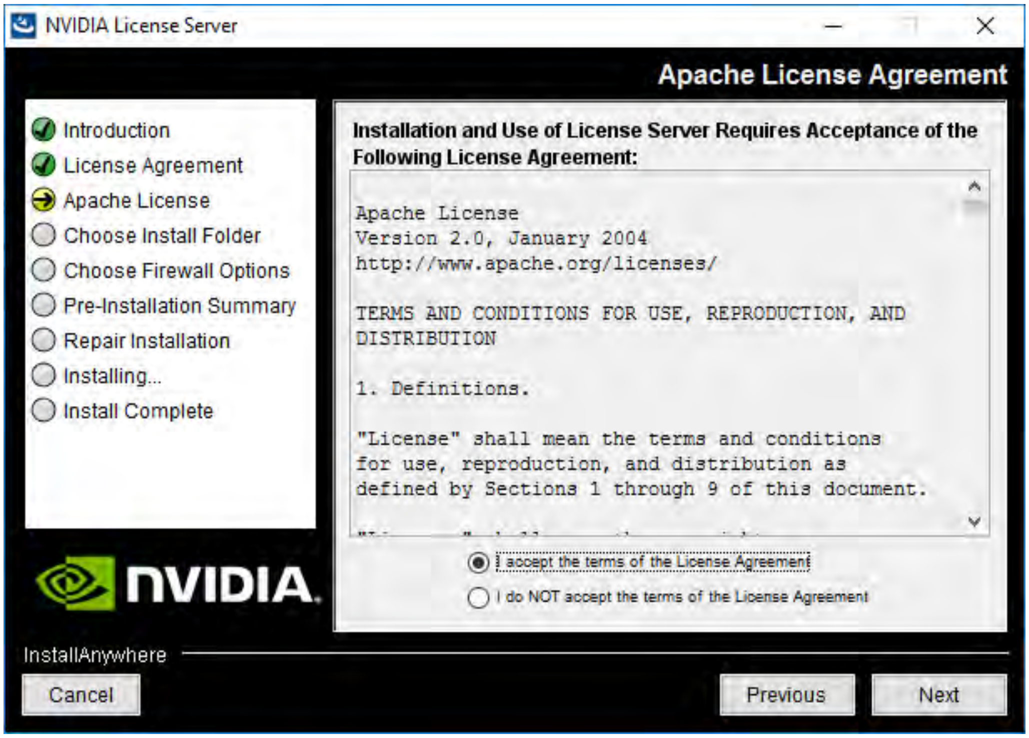
```
END USER LICENSE AGREEMENT

Release Date: September 4, 2015

NVIDIA LICENSE SERVER SOFTWARE END-USER LICENSE
AGREEMENT


IMPORTANT - READ BEFORE DOWNLOADING,
INSTALLING, COPYING OR USING THE LICENSED
SOFTWARE
```

● I accept the terms of the License Agreement

○ I do NOT accept the terms of the License Agreement

4. Accept the Apache license agreement and click Next (Figure 23).

Figure 23. Apache License Agreement page



Installation and Use of License Server Requires Acceptance of the Following License Agreement:

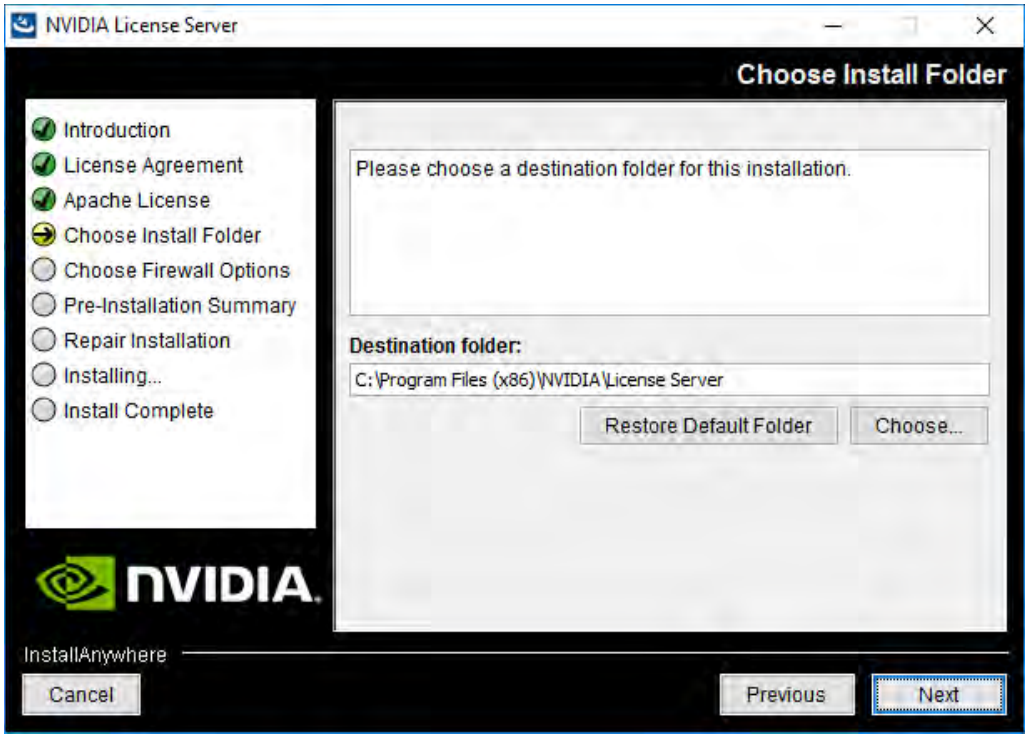
```
Apache License
Version 2.0, January 2004
http://www.apache.org/licenses/

TERMS AND CONDITIONS FOR USE, REPRODUCTION, AND
DISTRIBUTION

1. Definitions.

"License" shall mean the terms and conditions
for use, reproduction, and distribution as
defined by Sections 1 through 9 of this document.
```

● I accept the terms of the License Agreement

○ I do NOT accept the terms of the License Agreement

5. Choose the desired installation folder and click Next (Figure 24).

Figure 24. Choosing a destination folder

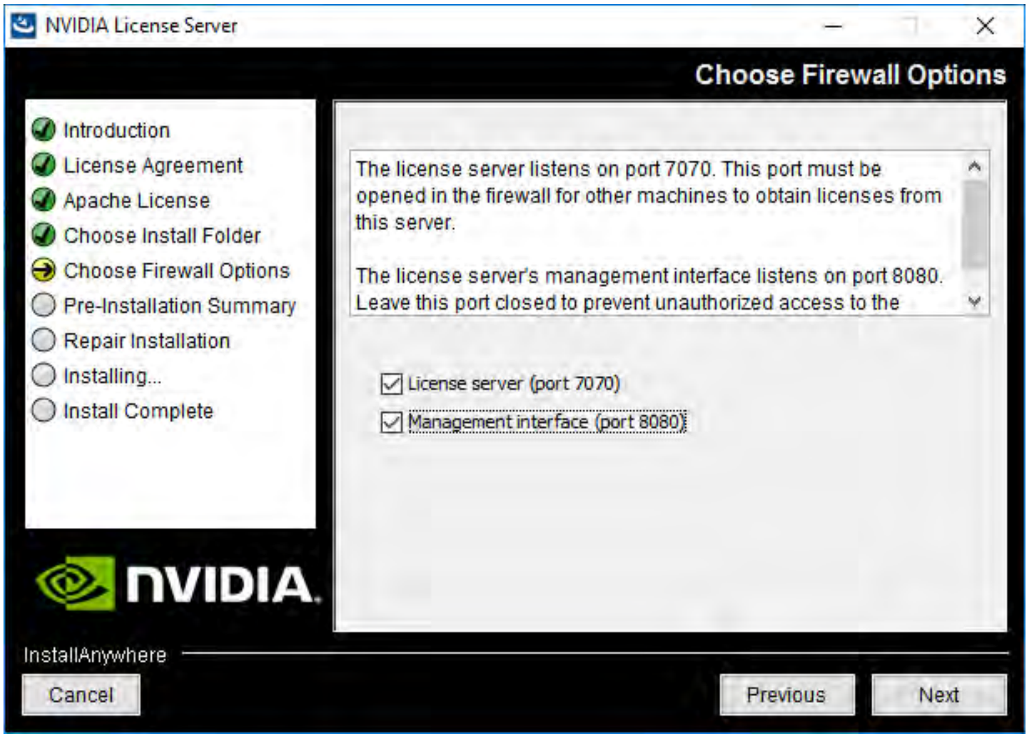


Please choose a destination folder for this installation.

Destination folder: C:\Program Files (x86)\NVIDIA\License Server

6. The license server listens on port 7070. This port must be opened in the firewall for other machines to obtain licenses from this server. Select the “License server (port 7070)” option.
7. The license server’s management interface listens on port 8080. If you want the administration page accessible from other machines, you will need to open up port 8080. Select the “Management interface (port 8080)” option.
8. Click Next (Figure 25).

Figure 25. Setting firewall options



NVIDIA License Server

Choose Firewall Options

The license server listens on port 7070. This port must be opened in the firewall for other machines to obtain licenses from this server.

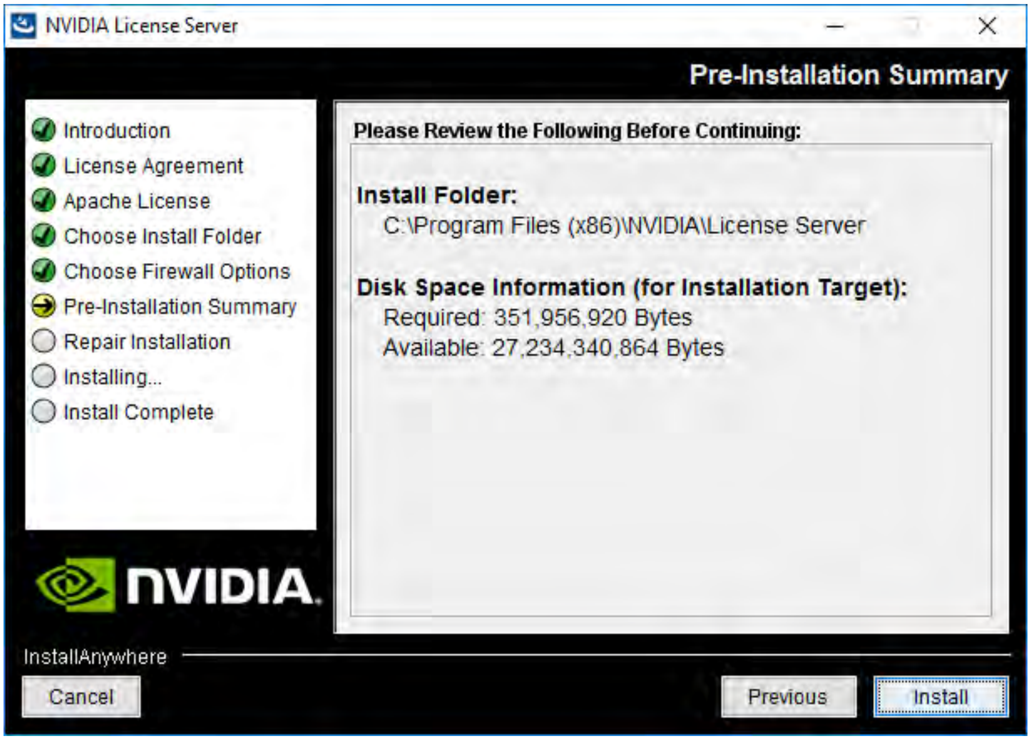
The license server's management interface listens on port 8080. Leave this port closed to prevent unauthorized access to the

☑ License server (port 7070)

☑ Management interface (port 8080)

9. On the Pre-installation Summary page, click install (Figure 26). The installation process will automatically progress without user input (Figure 27).

Figure 26. Pre-Installation Summary page

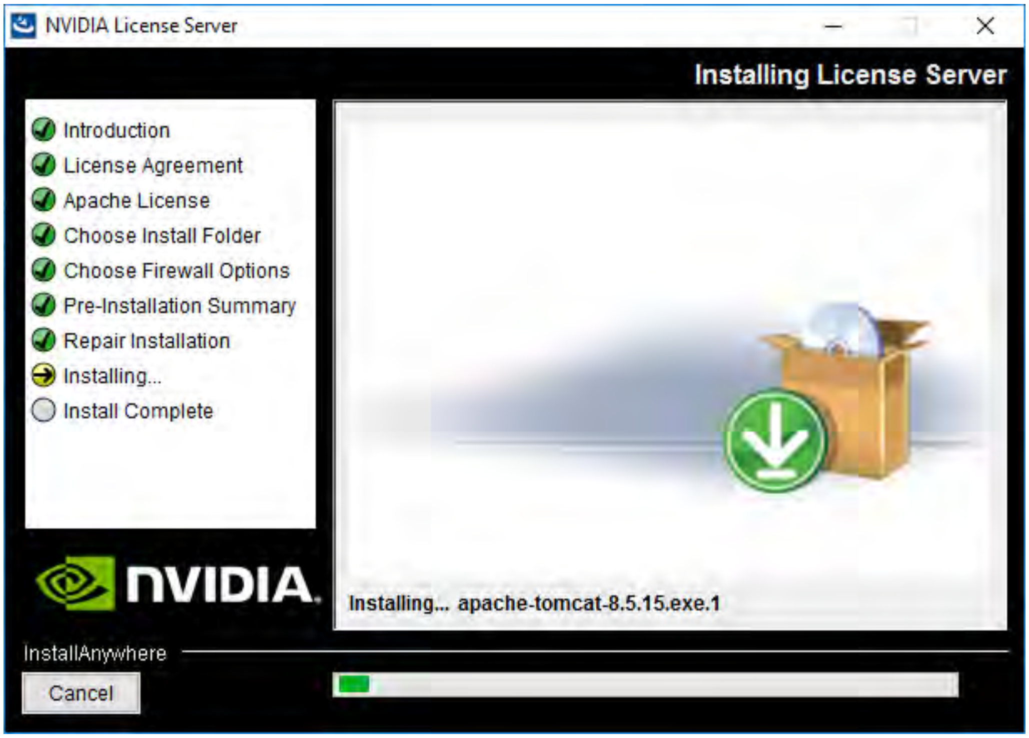


Please Review the Following Before Continuing:

Install Folder:
C:\Program Files (x86)\NVIDIA\License Server

Disk Space Information (for Installation Target):
Required: 351,956,920 Bytes
Available: 27,234,340,864 Bytes

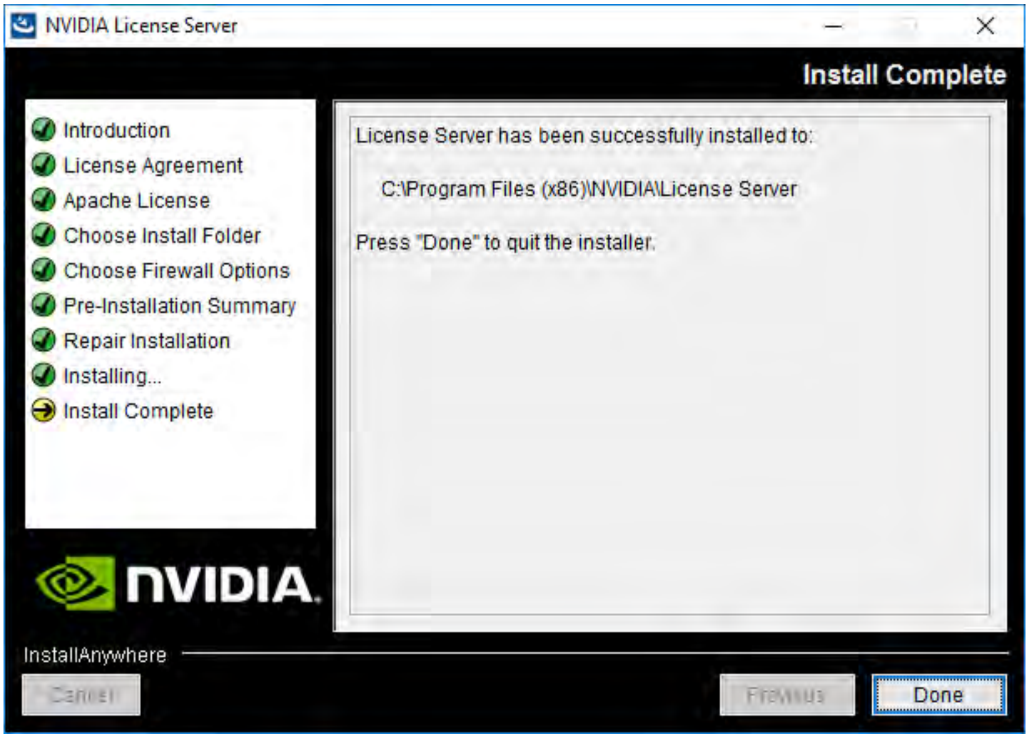
Figure 27. Installing the license server



Installing... apache-tomcat-8.5.15.exe.1

10. When the installation process is complete, click Done (Figure 28).

Figure 28. Install complete page



License Server has been successfully installed to:

C:\Program Files (x86)\NVIDIA\License Server

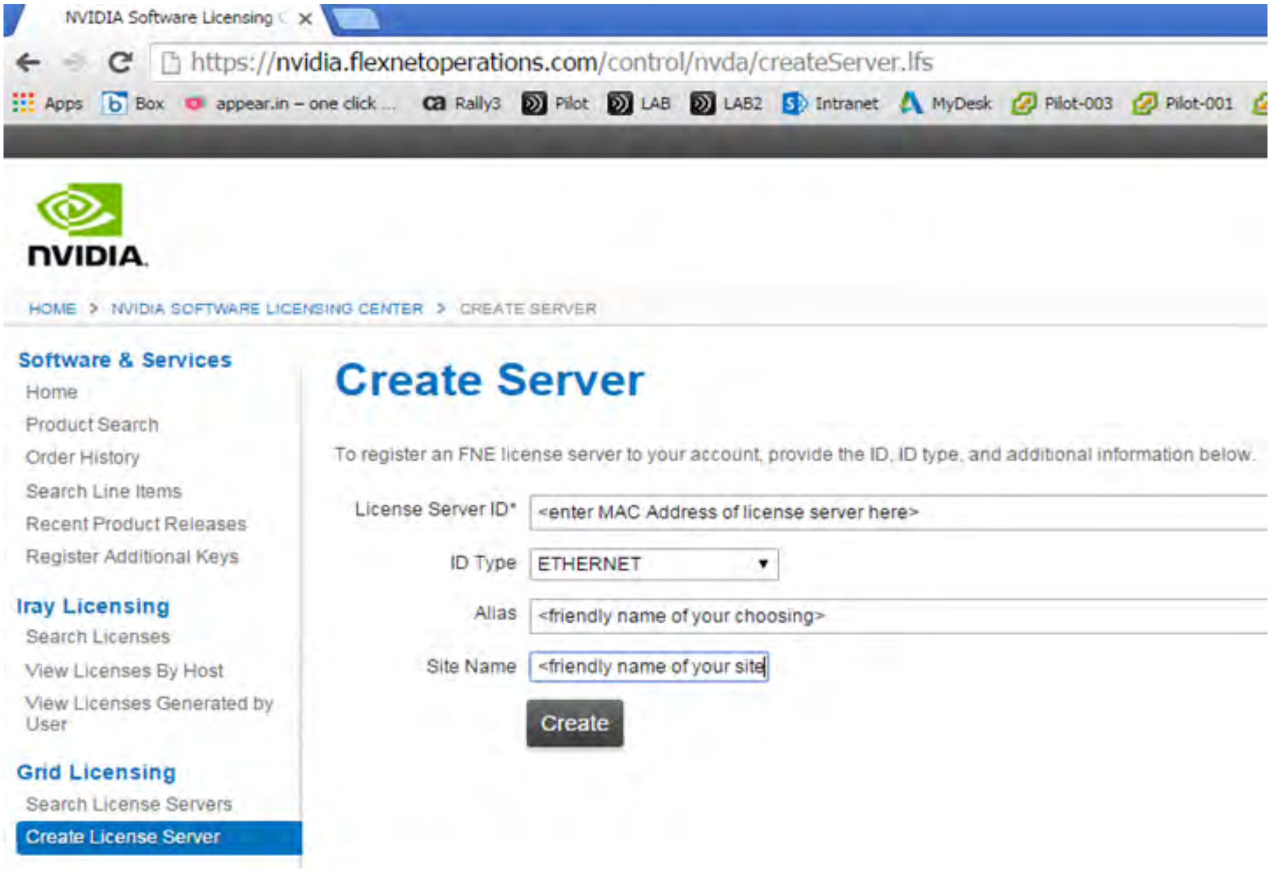
Press "Done" to quit the installer.

Configure the NVIDIA GRID 5.0 license server

Now configure the NVIDIA GRID license server.

1. Log in to the license server site with the credentials set up during the registration process at nvidia.com/grideval. A license file is generated from https://nvidia.flexnetoperations.com.
2. After you are logged in, click Create License Server.
3. Specify the fields as shown in Figure 29. In the License Server ID field, enter the MAC address of your local license server's NIC. Leave ID Type set to Ethernet. For Alias and Site Name, choose user-friendly names. Then click Create.

Figure 29. Creating the license server



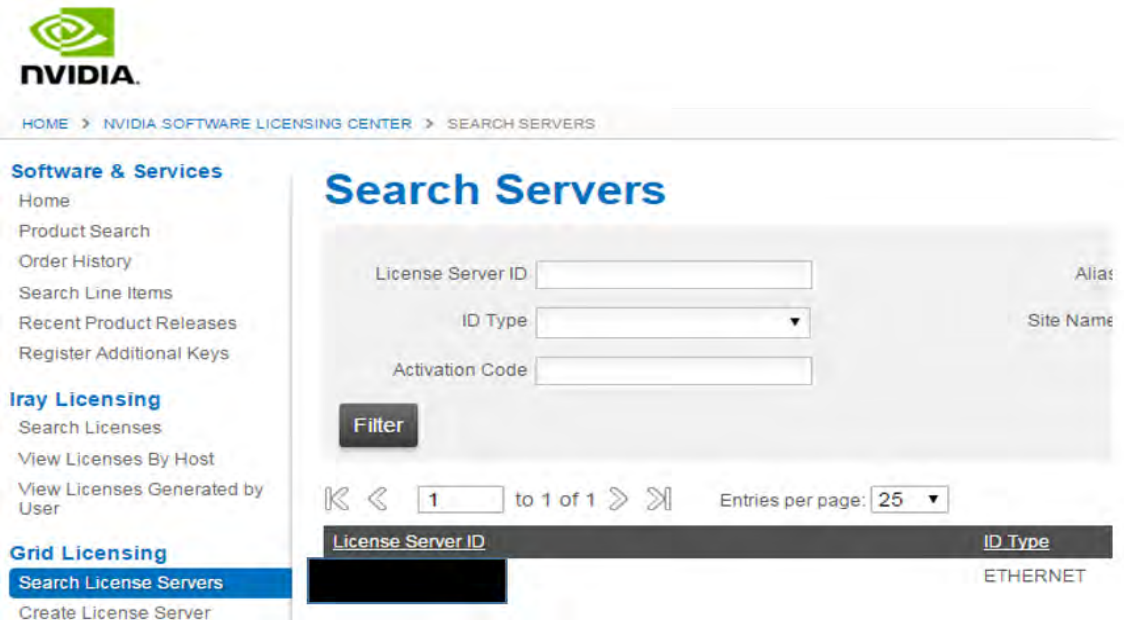
Create Server

To register an FNE license server to your account, provide the ID, ID type, and additional information below.

License Server ID*	<enter MAC Address of license server here>
ID Type	ETHERNET
Alias	<friendly name of your choosing>
Site Name	<friendly name of your site

4. Click the Search License Servers node.
5. Click your license server ID (Figure 30).

Figure 30. Selecting the license server ID



Search Servers

License Server ID

ID Type

Activation Code

Alias

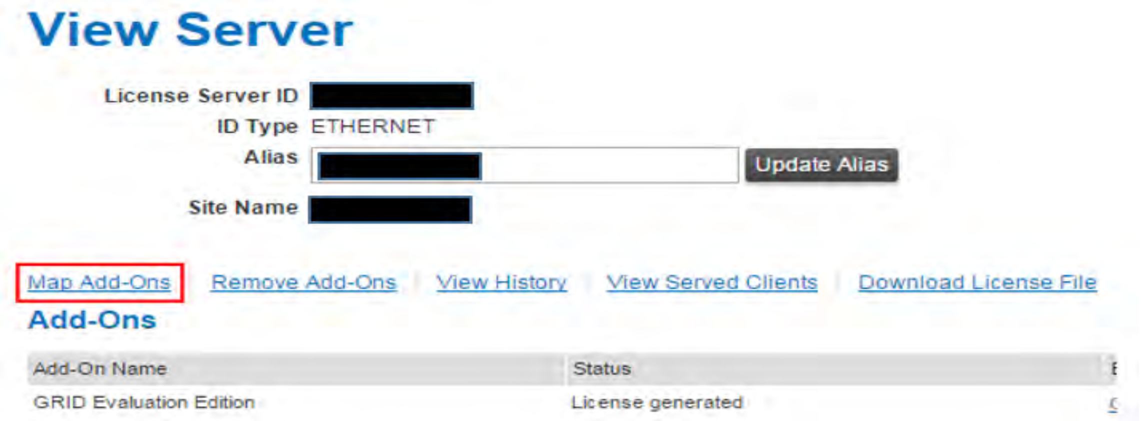
Site Name

1 to 1 of 1 Entries per page: 25

License Server ID	ID Type
[redacted]	ETHERNET

6. Click Map Add-Ons and choose the number of license units from your total pool to allocate to this license server (Figure 31).

Figure 31. Choosing the number of license units from the pool



View Server

License Server ID [redacted]

ID Type ETHERNET

Alias [redacted]

Site Name [redacted]

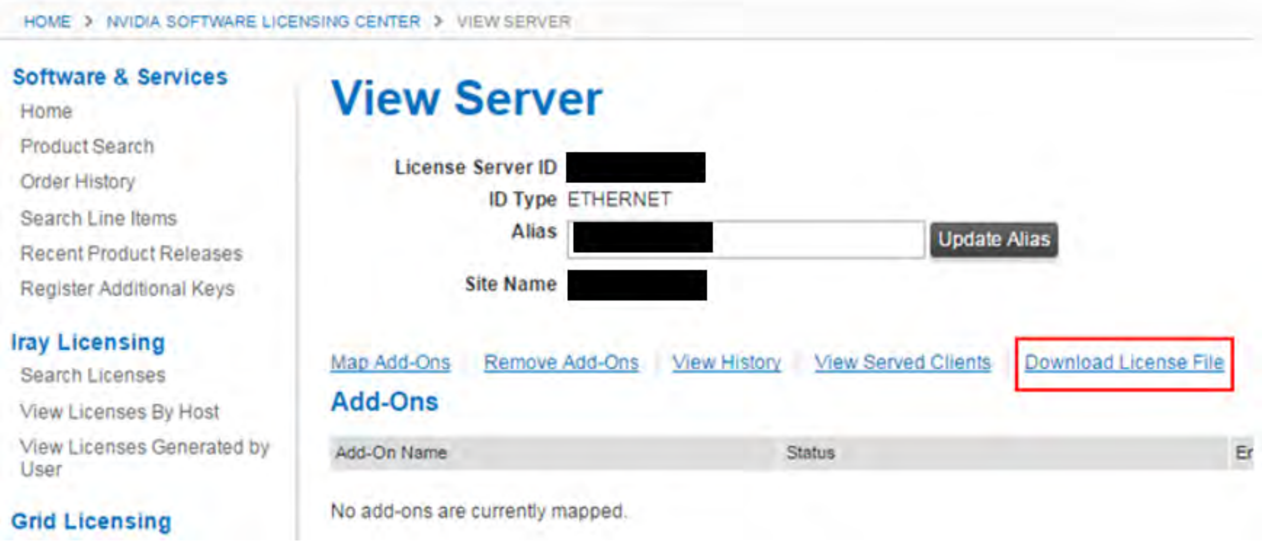
Add-Ons

Add-On Name	Status
GRID Evaluation Edition	License generated

7. View Server page after the add-ons are mapped
8. Click Download License File and save the .bin file to your license server (Figure 33).

Note: The .bin file must be uploaded to your local license server within 24 hours of its generation. Otherwise, you will need to generate a new .bin file.

Figure 32. Saving the .bin file



View Server

License Server ID [redacted]

ID Type ETHERNET

Alias [redacted]

Site Name [redacted]

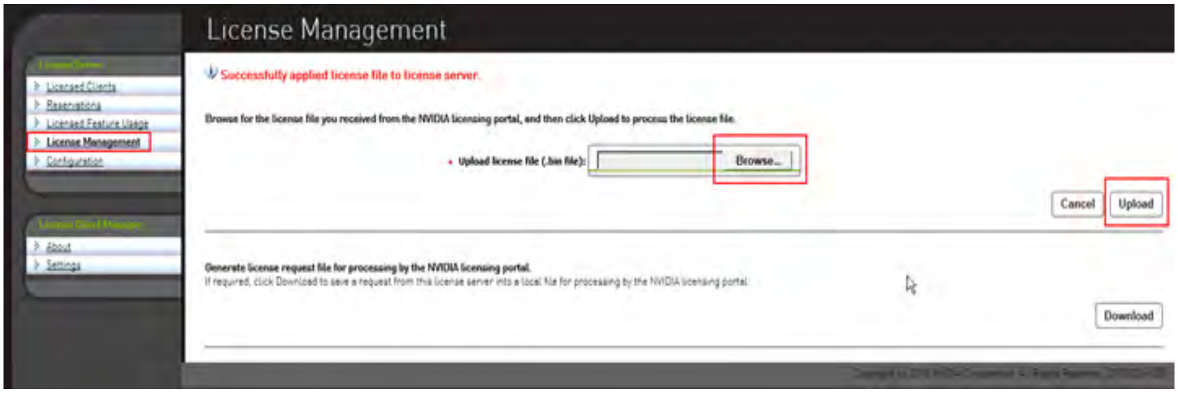
Add-Ons

Add-On Name	Status	Er

No add-ons are currently mapped.

9. On the local license server, browse to http://<FQDN>:8080/licserver to display the License Server Configuration page.
10. Click License Management in the left pane.
11. Click Browse to locate your recently download .bin license file. Select the .bin file and click OK.
12. Click Upload. The message “Successfully applied license file to license server” should appear on the screen (Figure 34). The features are available (Figure 35).

Figure 33. License file successfully applied



License Management

Successfully applied license file to license server.

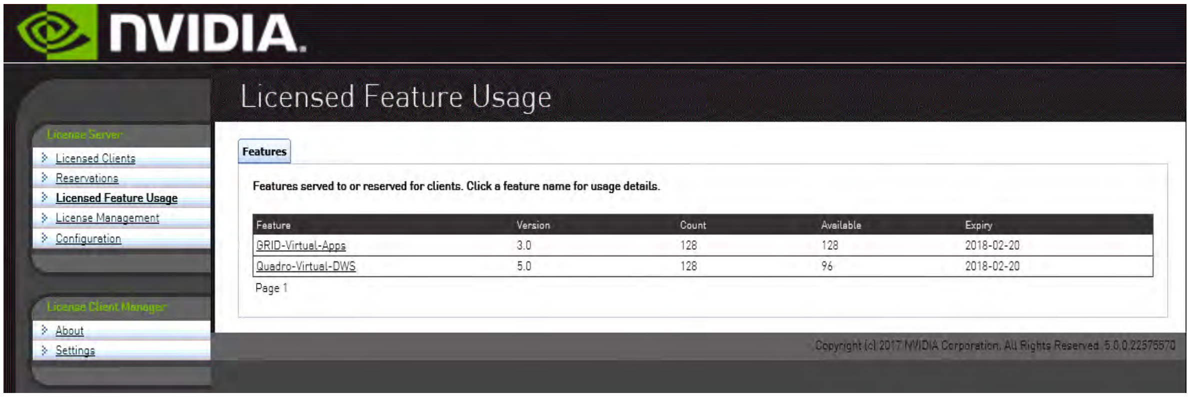
Browse for the license file you received from the NVIDIA licensing portal, and then click Upload to process the license file.

• Upload license file (.bin file):

Generate license request file for processing by the NVIDIA licensing portal.

If required, click Download to save a request from this license server into a local file for processing by the NVIDIA licensing portal.

Figure 34. NVIDIA license server



Licensed Feature Usage

Features served to or reserved for clients. Click a feature name for usage details.

Feature	Version	Count	Available	Expiry
GRID-Virtual-Apps	3.0	128	128	2018-02-20
Quadro-Virtual-DWS	5.0	128	96	2018-02-20

Page 1

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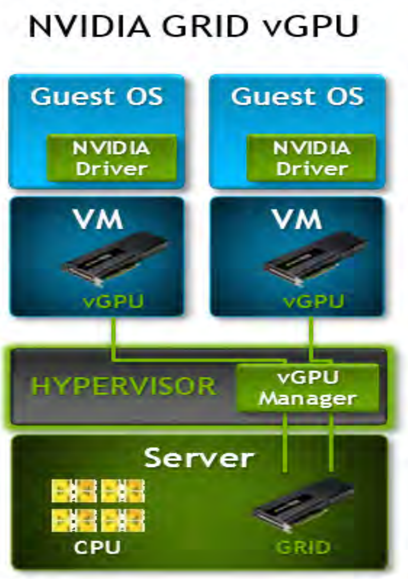
Install NVIDIA GRID software on the VMware ESX host and Microsoft Windows virtual machine

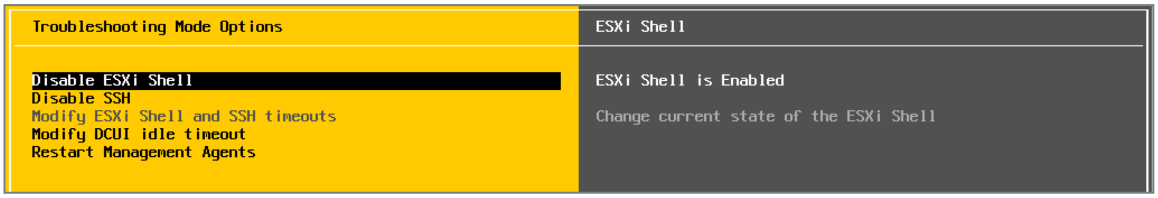
This section summarizes the installation process for configuring an ESXi host and virtual machine for vGPU support. Figure 35 shows the components used for vGPU support.

Figure 35. NVIDIA GRID vGPU components



1. Download the NVIDIA GRID GPU driver pack for VMware vSphere ESXi 6.5.
2. Enable the ESXi shell and the Secure Shell (SSH) protocol on the vSphere host from the Troubleshooting Mode Options menu of the vSphere ESXi Configuration Console (Figure 36).

Figure 36. VMware vSphere ESXi Configuration Console



```
Troubleshooting Mode Options                ESXi Shell

Disable ESXi Shell                          ESXi Shell is Enabled
Disable SSH
Modify ESXi Shell and SSH timeouts          Change current state of the ESXi Shell
Modify DCUI idle timeout
Restart Management Agents
```

3. Upload the NVIDIA driver (vSphere Installation Bundle [VIB] file) to the /tmp directory on the ESXi host using a tool such as WinSCP. (Shared storage is preferred if you are installing drivers on multiple servers or using the VMware Update Manager.)
4. Log in as root to the vSphere console through SSH using a tool such as Putty.

The ESXi host must be in maintenance mode for you to install the VIB module. To place the host in maintenance mode, use the command **esxcli system maintenanceMode set -enable true**.

5. Enter the following command to install the NVIDIA vGPU drivers:

   esxcli software vib install --no-sig-check -v /<path>/<filename>.VIB

The command should return output similar to that shown here:

```
# esxcli software vib install --no-sig-check -v /tmp/NVIDIA-VMware_ESXi_6.5_Host_Driver_384.99-1OEM.650.0.0.4598673.vib

Installation Result

   Message: Operation finished successfully.

   Reboot Required: false

   VIBs Installed: NVIDIA_bootbank_NVIDIA-VMware_ESXi_6.5_Host_Driver_384.99-1OEM.650.0.0.4598673

   VIBs Removed:

   VIBs Skipped:
```

Note: Although the display shows “Reboot Required: false,” a reboot is necessary for the VIB file to load and for xorg to start.

6. Exit the ESXi host from maintenance mode and reboot the host by using vSphere Web Client or by entering the following commands:

   ```
   #esxcli system maintenanceMode set -e false

   #reboot
   ```

7. After the host reboots successfully, verify that the kernel module has loaded successfully using the following command:

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

   The command should return output similar to that shown here:

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

   NVIDIA-VMware_ESXi_6.5_Host_Driver 384.99-1OEM.650.0.0.4598673          NVIDIA
   VMwareAccepted    2017-11-27
   ```

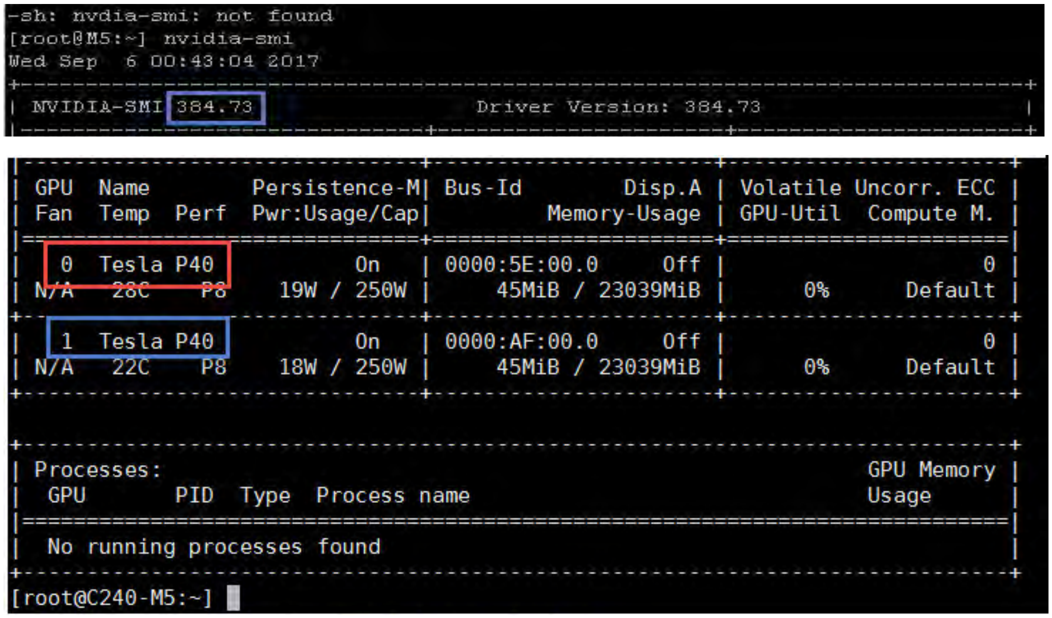
Note: See the VMware knowledge base article for information about removing any existing NVIDIA drivers before installing new drivers: http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=2033434.

8. Confirm GRID GPU detection on the ESXi host. To determine the status of the GPU card’s CPU, the card’s memory, and the amount of disk space remaining on the card, enter the following command:

   ```
   nvidia-smi
   ```

   The command should return output similar to that shown in Figures 37, 38, or 39, depending on the cards used in your environment.

Figure 37. VMware ESX SSH console report for GPU P40 card detection on Cisco UCS C240 M5 Rack Server

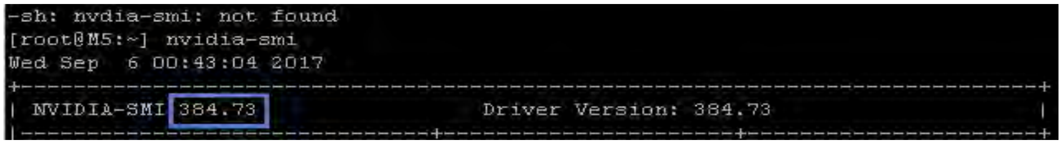


```
-sh: nvdia-smi: not found
[root@M5:~] nvidia-smi
Wed Sep  6 00:43:04 2017
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 384.73                 Driver Version: 384.73                    |
|-------------------------------+----------------------+----------------------+
```

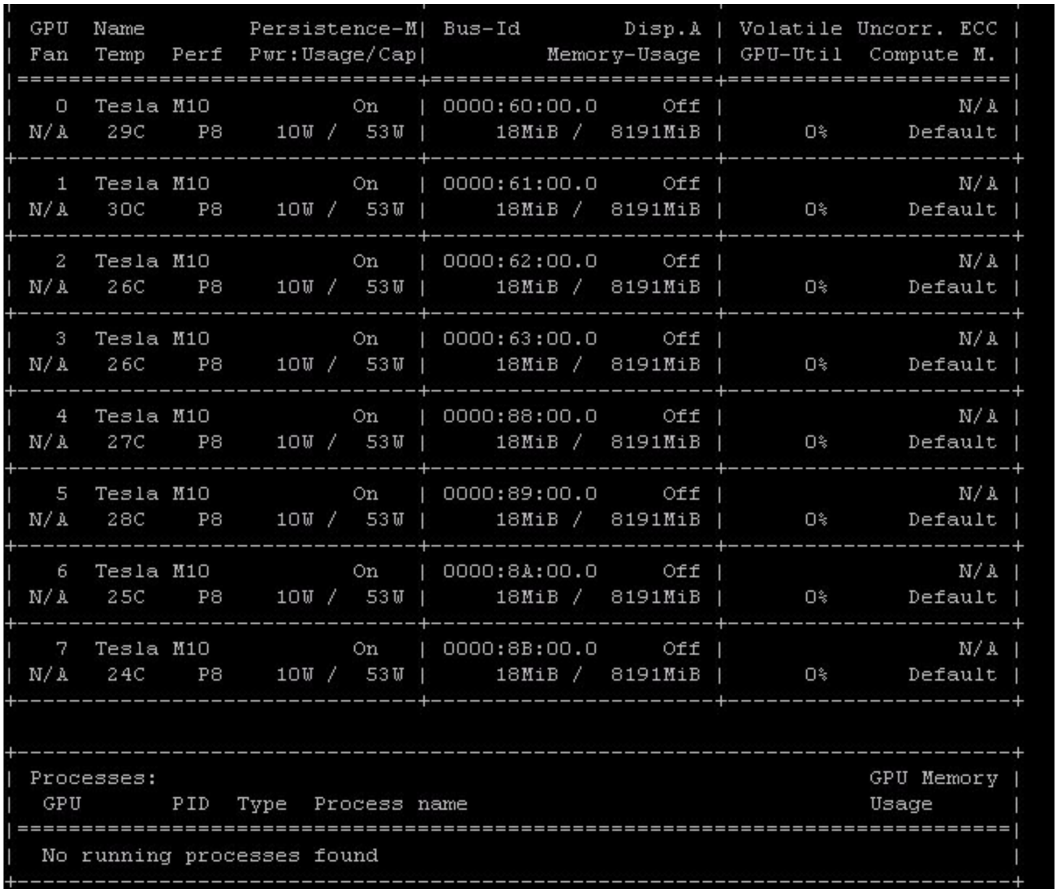
```
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  Tesla P40           On   | 0000:5E:00.0     Off |                    0 |
| N/A   28C    P8    19W / 250W |     45MiB / 23039MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   1  Tesla P40           On   | 0000:AF:00.0     Off |                    0 |
| N/A   22C    P8    18W / 250W |     45MiB / 23039MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                       GPU Memory |
|  GPU       PID   Type   Process name                             Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
[root@C240-M5:~]
```

Figure 38. VMware ESX SSH console report for GPU M10 card detection on Cisco UCS C240 M5 Rack Server



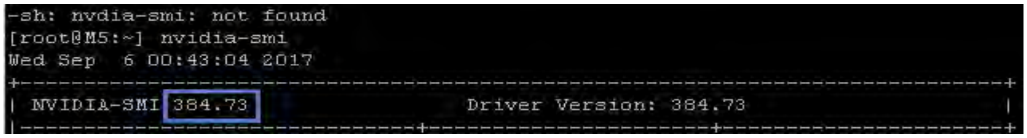
```
-sh: nvdia-smi: not found
[root@M5:~] nvidia-smi
Wed Sep  6 00:43:04 2017
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 384.73                 Driver Version: 384.73                    |
|-------------------------------+----------------------+----------------------+
```



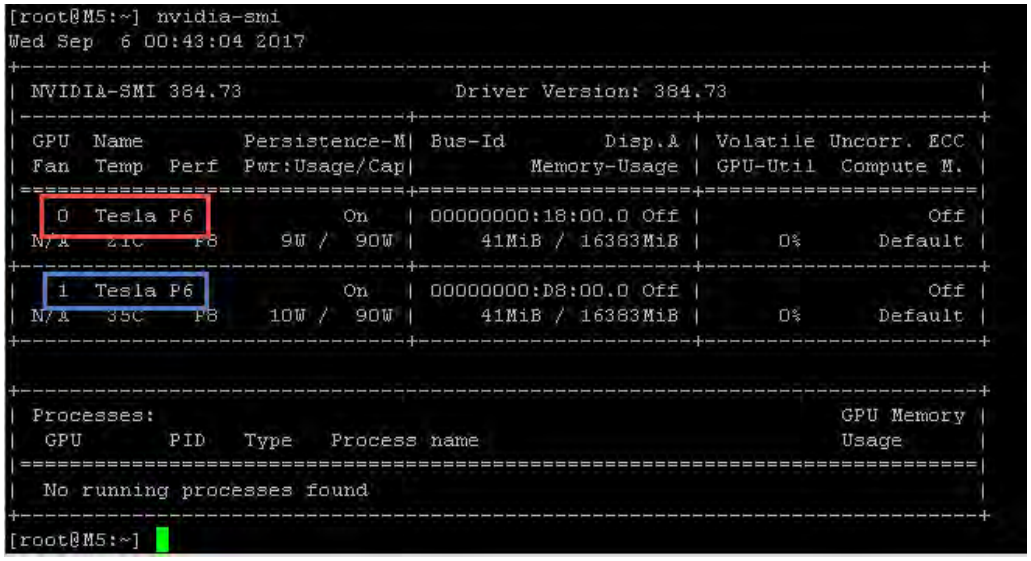
```
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  Tesla M10           On   | 0000:60:00.0     Off |                  N/A |
| N/A   29C    P8    10W /  53W |     18MiB /  8191MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   1  Tesla M10           On   | 0000:61:00.0     Off |                  N/A |
| N/A   30C    P8    10W /  53W |     18MiB /  8191MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   2  Tesla M10           On   | 0000:62:00.0     Off |                  N/A |
| N/A   26C    P8    10W /  53W |     18MiB /  8191MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   3  Tesla M10           On   | 0000:63:00.0     Off |                  N/A |
| N/A   26C    P8    10W /  53W |     18MiB /  8191MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   4  Tesla M10           On   | 0000:88:00.0     Off |                  N/A |
| N/A   27C    P8    10W /  53W |     18MiB /  8191MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   5  Tesla M10           On   | 0000:89:00.0     Off |                  N/A |
| N/A   28C    P8    10W /  53W |     18MiB /  8191MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   6  Tesla M10           On   | 0000:8A:00.0     Off |                  N/A |
| N/A   25C    P8    10W /  53W |     18MiB /  8191MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   7  Tesla M10           On   | 0000:8B:00.0     Off |                  N/A |
| N/A   24C    P8    10W /  53W |     18MiB /  8191MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+


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

Figure 39. VMware ESX SSH console report for GPU P6 card detection on Cisco UCS B200 M5 Blade Server



```
-sh: nvdia-smi: not found
[root@M5:~] nvidia-smi
Wed Sep  6 00:43:04 2017
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 384.73                 Driver Version: 384.73                    |
|-------------------------------+----------------------+----------------------+
```



```
[root@M5:~] nvidia-smi
Wed Sep  6 00:43:04 2017
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 384.73                 Driver Version: 384.73                    |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  Tesla P6            On   | 00000000:18:00.0 Off |                  Off |
| N/A   21C    P8     9W /  90W |     41MiB / 16383MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   1  Tesla P6            On   | 00000000:D8:00.0 Off |                  Off |
| N/A   35C    P8    10W /  90W |     41MiB / 16383MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                       GPU Memory |
|  GPU       PID   Type   Process name                             Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
[root@M5:~]
```

Note: The NVIDIA system management interface (SMI) also allows GPU monitoring using the following command: **nvidia-smi l**. This command adds a loop, automatically refreshing the display.

NVIDIA Tesla P6, P40, and M10 profile specifications

The Tesla P6 and P40 cards each have a single physical GPU and the Tesla M10 card has multiple physical GPUs. Each physical GPU can support several different types of vGPU. Each type of vGPU has a fixed amount of frame buffer space, a fixed number of supported display heads, and a fixed maximum resolution, and each is targeted at a different class of workload. Table 6 lists the vGPU types supported by GRID GPUs.

For more information, see http://www.nvidia.com/object/grid-enterprise-resources.html.

Table 6. User profile specifications for NVIDIA Tesla cards

End-user profile	GRID virtual application profiles	GRID virtual PC profiles	GRID virtual workstation profiles
1 GB	P6-1A M10-1A P40-1A	P6-1B M10-1B P40-1B	P6-1Q M10-1Q P40-1Q
2 GB	P6-2A M10-2A P40-2A	–	P6-2Q M10-2Q P40-2Q
3 GB	P40-3A	–	P40-3Q
4 GB	P6-4A M10-4A P40-4A	–	P6-4Q M10-4Q P40-4Q

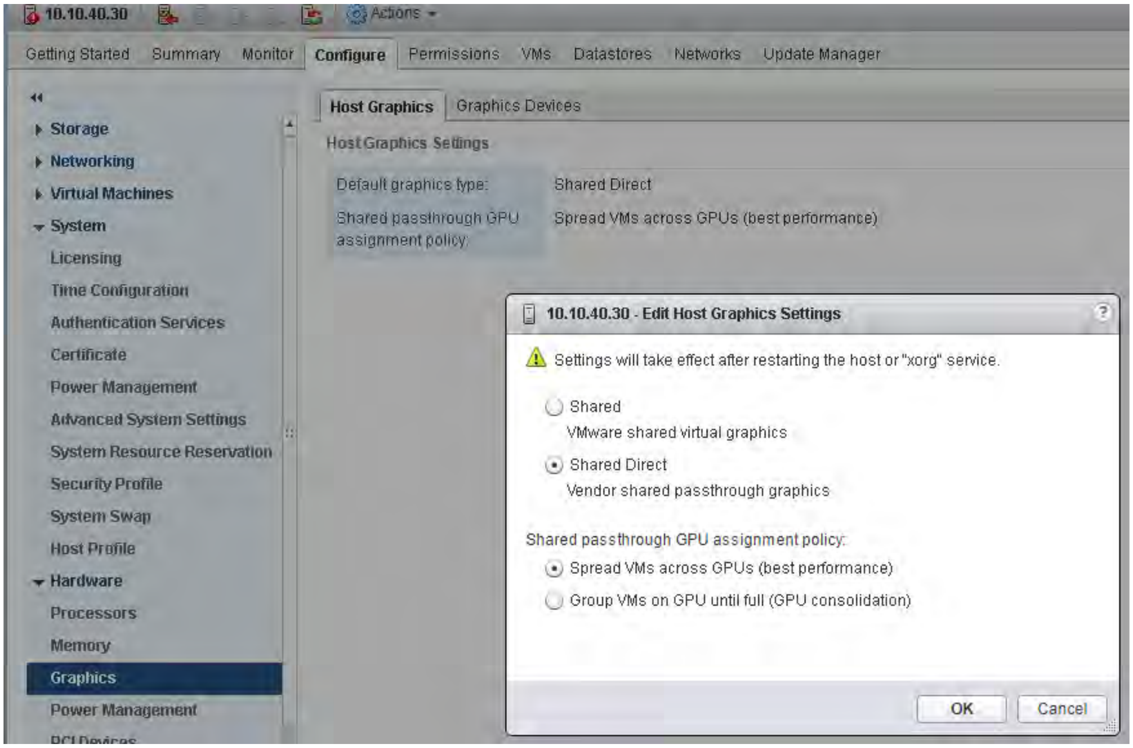
End-user profile	GRID virtual application profiles	GRID virtual PC profiles	GRID virtual workstation profiles
6GB	P40-6A	–	P40-6Q
8 GB	P6-8A M10-8A P40-8A	–	P6-8Q M10-8Q P40-8Q
12 GB	P40-12A	–	P40-12Q
16 GB	P6-16A	–	P6-16Q
24 GB	P40-24A	–	P40-24Q
Pass-through	–	–	–

Prepare a virtual machine for vGPU support

Use the following procedure to create the virtual machine that will later be used as the VDI base image.

1. Select the ESXi host and click the Configure tab. From the list of options at the left, choose Graphics >Edit Host Graphics Settings. Select Shared Direct “Vendor shared passthrough graphics” (Figure 41). Reboot the system to make the changes effective.

Figure 40. Edit Host Graphics Settings window



Default graphics type: Shared Direct

Shared passthrough GPU assignment policy: Spread VMs across GPUs (best performance)

10.10.40.30 - Edit Host Graphics Settings

Settings will take effect after restarting the host or "xorg" service.

○ Shared
VMware shared virtual graphics

● Shared Direct
Vendor shared passthrough graphics

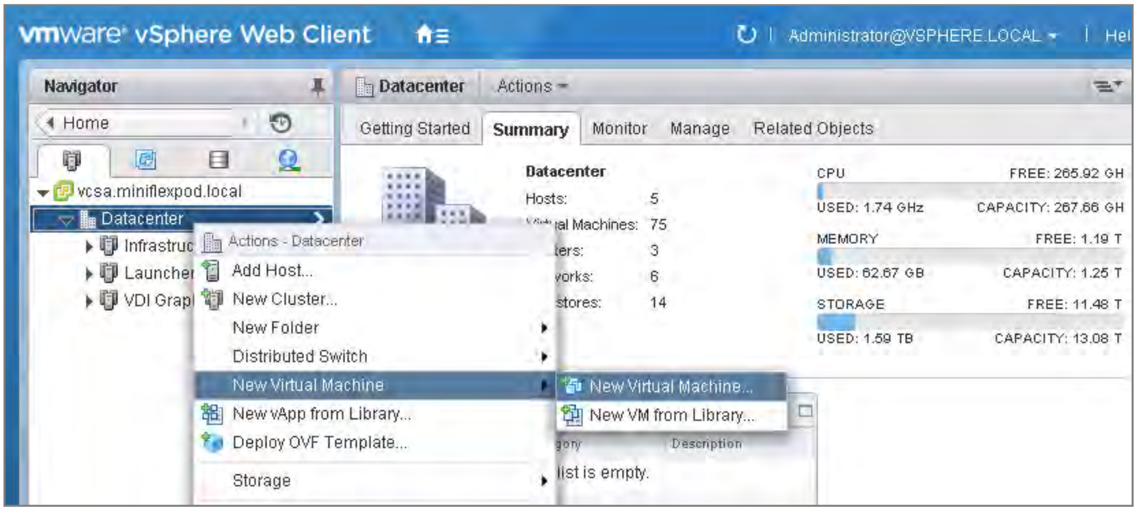
Shared passthrough GPU assignment policy:

● Spread VMs across GPUs (best performance)

○ Group VMs on GPU until full (GPU consolidation)

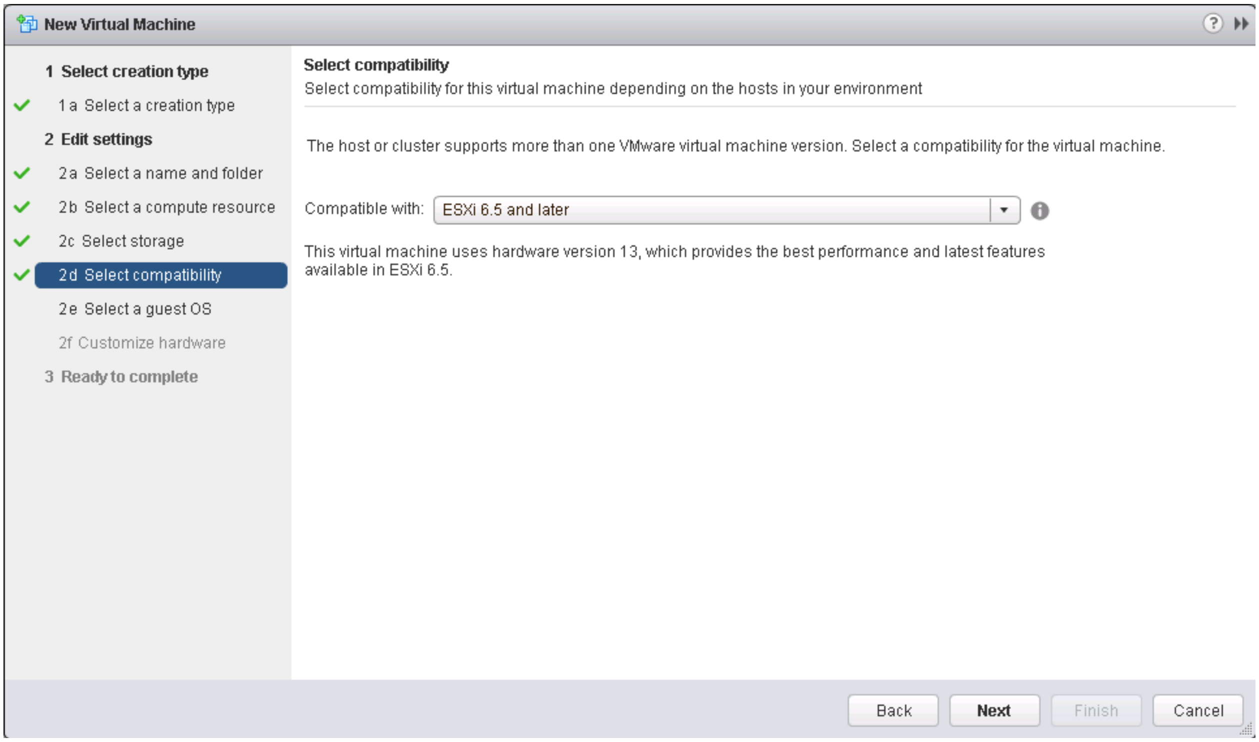
2. Using vSphere Web Client, create a new virtual machine. To do this, right-click a host or cluster and choose New Virtual Machine. Work through the New Virtual Machine wizard. Unless another configuration is specified, select the configuration settings appropriate for your environment (Figure 41).

Figure 41. Creating a new virtual machine in VMware vSphere Web Client



3. Choose “ESXi 6.0 and later” from the “Compatible with” drop-down menu to use the latest features, including the mapping of shared PCI devices, which is required for the vGPU feature (Figure 42). This document uses “ESXi 6.5 and later,” which provides the latest features available in ESXi 6.5 and virtual machine hardware Version 13.

Figure 42. Selecting virtual machine hardware Version 11 or later


New Virtual Machine

1 Select creation type
✓ 1a Select a creation type
2 Edit settings
✓ 2a Select a name and folder
✓ 2b Select a compute resource
✓ 2c Select storage
✓ 2d Select compatibility
2e Select a guest OS
2f Customize hardware
3 Ready to complete

Select compatibility
Select compatibility for this virtual machine depending on the hosts in your environment

The host or cluster supports more than one VMware virtual machine version. Select a compatibility for the virtual machine.

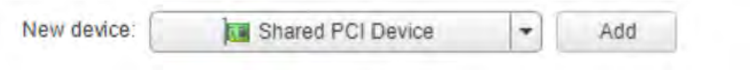
Compatible with: ESXi 6.5 and later

This virtual machine uses hardware version 13, which provides the best performance and latest features available in ESXi 6.5.

4. To customize the hardware of the new virtual machine, add a new shared PCI device, select the appropriate GPU profile, and reserve all virtual machine memory (Figures 44 and 45).

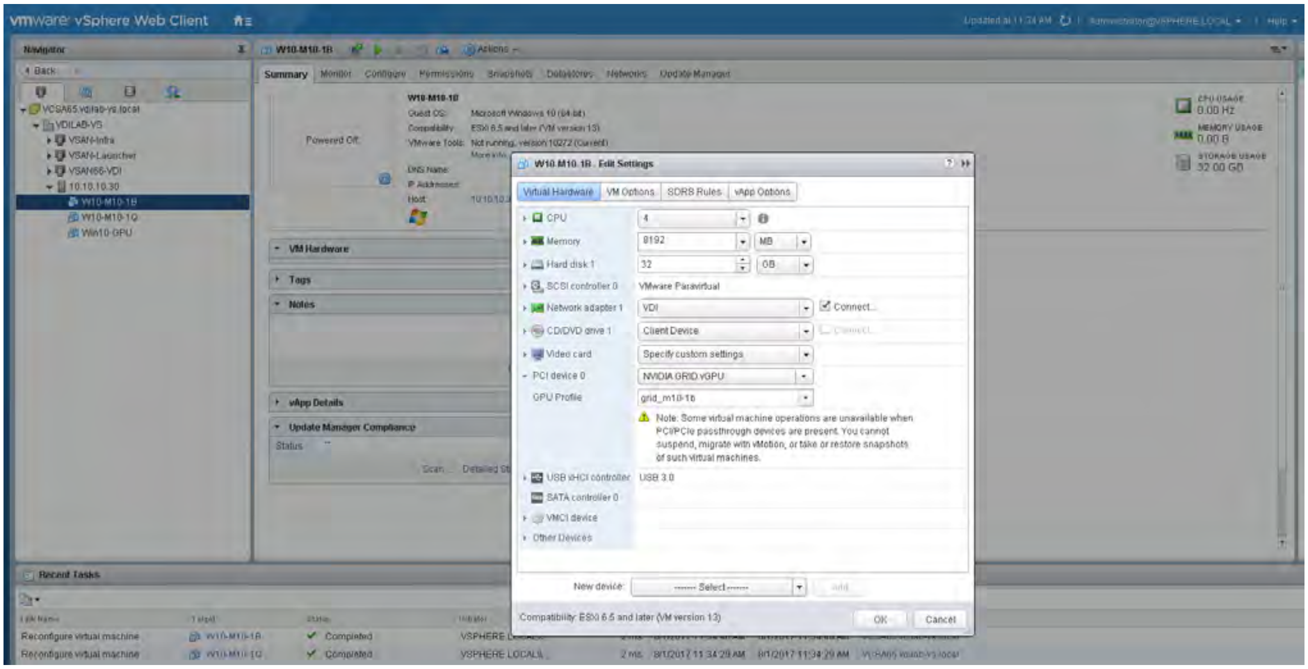
Note: If you are creating a new virtual machine and using the vSphere Web Client's virtual machine console functions, the mouse will not be usable in the virtual machine until after both the operating system and VMware Tools have been installed. If you cannot use the traditional vSphere Web Client to connect to the virtual machine, do not enable the NVIDIA GRID vGPU at this time.

Figure 43. Adding a shared PCI device to the virtual machine to attach the GPU profile



New device: Shared PCI Device

Figure 44. Attaching the GPU profile to a shared PCI device.



W10.M10.1B . Edit Settings

CPU	4
Memory	8192 MB
Hard disk 1	32 GB
SCSI controller 0	VMware Paravirtual
Network adapter 1	VDI ☑ Connect...
CD/DVD drive 1	Client Device □ Connect...
Video card	Specify custom settings
PCI device 0	NVIDIA GRID vGPU
GPU Profile	grid_m10-1b
USB xHCI controller	USB 3.0
SATA controller 0	
VMCI device	
Other Devices	

Note: Some virtual machine operations are unavailable when PCI/PCIe passthrough devices are present. You cannot suspend, migrate with vMotion, or take or restore snapshots of such virtual machines.

New device: ------- Select -------

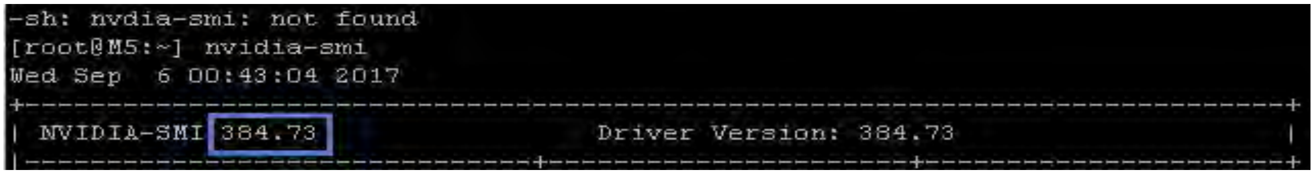
Compatibility: ESXi 6.5 and later (VM version 13)

Note: A virtual machine with a vGPU assigned will not start if ECC is enabled. If this is the case, as a workaround, disable ECC by entering the following commands (Figure 45):

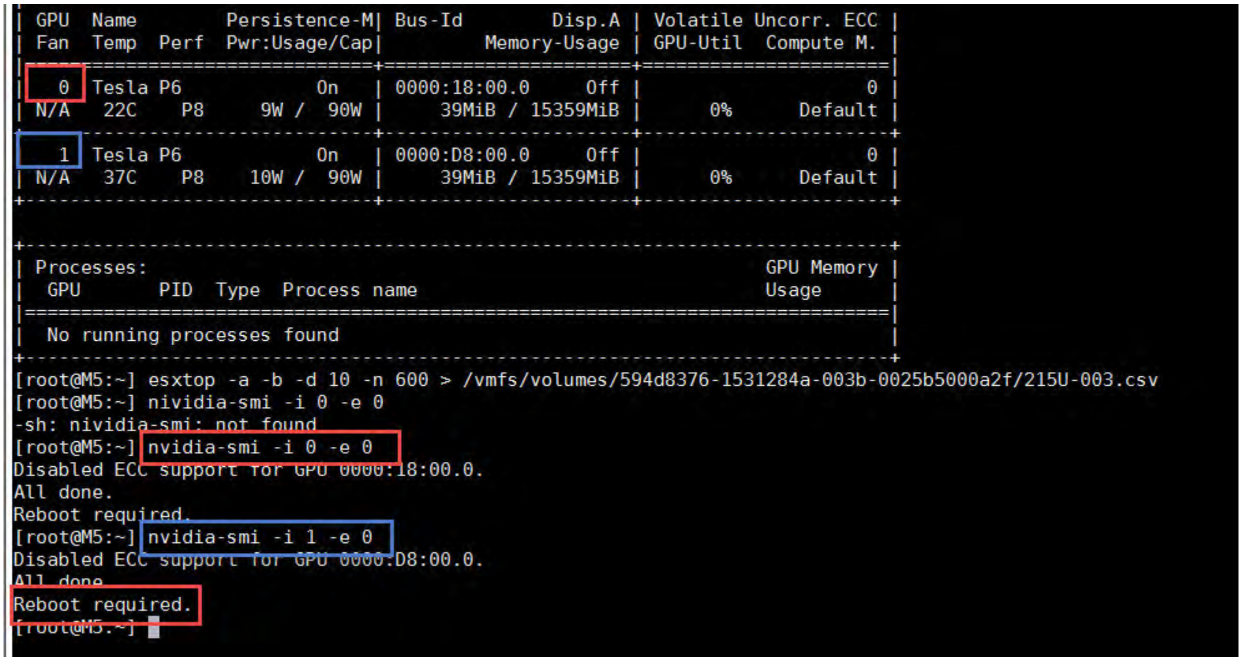
```
# nvidia-smi -i 0 -e 0
# nvidia-smi -i 1 -e 0
```

Note: Use **-i** to target a specific GPU. If two cards are installed in a server, run command twice as shown in the preceding example, where 0 and 1 each represent a different GPU card.

Figure 45. Disabling ECC



```
-sh: nvdia-smi: not found
[root@M5:~] nvidia-smi
Wed Sep  6 00:43:04 2017
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 384.73                 Driver Version: 384.73                    |
|-------------------------------+----------------------+----------------------+
```

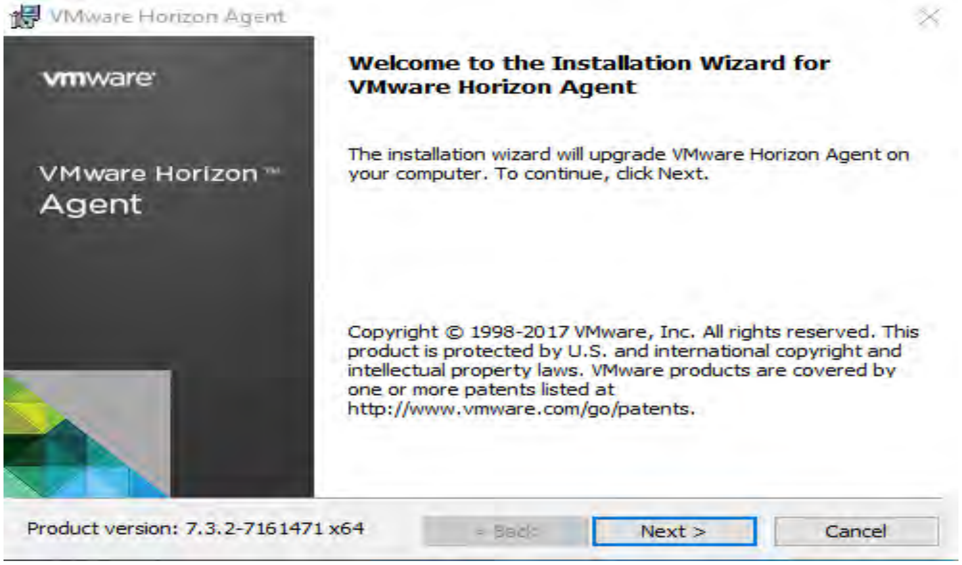


```
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  Tesla P6            On   | 0000:18:00.0     Off |                    0 |
| N/A   22C    P8     9W /  90W |     39MiB / 15359MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   1  Tesla P6            On   | 0000:D8:00.0     Off |                    0 |
| N/A   37C    P8    10W /  90W |     39MiB / 15359MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                       GPU Memory |
|  GPU       PID   Type   Process name                             Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
[root@M5:~] esxtop -a -b -d 10 -n 600 > /vmfs/volumes/594d8376-1531284a-003b-0025b5000a2f/215U-003.csv
[root@M5:~] nividia-smi -i 0 -e 0
-sh: nividia-smi: not found
[root@M5:~] nvidia-smi -i 0 -e 0
Disabled ECC support for GPU 0000:18:00.0.
All done.
Reboot required.
[root@M5:~] nvidia-smi -i 1 -e 0
Disabled ECC support for GPU 0000:D8:00.0.
All done.
Reboot required.
[root@M5:~]
```

5. Install and configure Microsoft Windows on the virtual machine:
   a) Configure the virtual machine with the appropriate amount of vCPU and RAM according to the GPU profile selected.
   b) Install VMware Tools.
   c) Join the virtual machine to the Microsoft Active Directory domain.
   d) Install VMware View Agent.
      - When you use the installer's GUI to install VMware Horizon Agent for a Windows desktop, click Next and complete the installation steps (Figure 46).

Figure 46. Selecting VMware Horizon Agent installation



Welcome to the Installation Wizard for VMware Horizon Agent

The installation wizard will upgrade VMware Horizon Agent on your computer. To continue, click Next.

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Product version: 7.3.2-7161471 x64

e) Optimize the Windows OS. VMware OSOT, the optimization tool, includes customizable templates to enable or disable Windows system services and features using LoginVSI recommendations and best practices across multiple systems. Because most Windows system services are enabled by default, the optimization tool can be used to easily disable unnecessary services and features to improve performance.

Note: VMware OSOT b1090 with the Windows 10 – LoginVSI template was used for the purposes of the tests described here. Table 7 shows difference in applied optimizations in the master image used for vGPU enabled desktops.

Table 7. Optimization differences

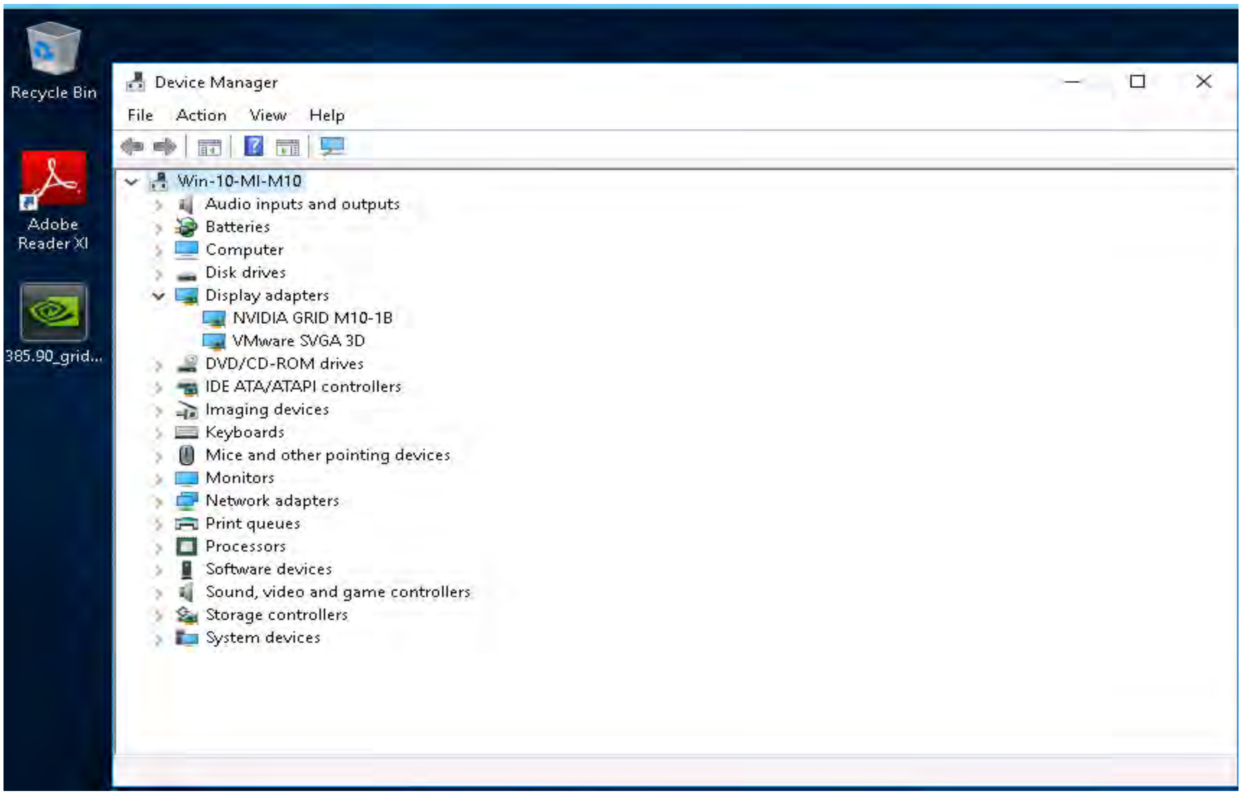
Optimization	Description	NoGPU	vGPU
Software Rendering Internet Explorer	Uses software rendering instead of hardware rendering. Enable this option if no vGPU is present.	Applied	Not applied
Disable Hardware Acceleration Office_14	Uses software rendering instead of hardware rendering. Enable this option if no vGPU is present.	Applied	Not applied
Disable Hardware Acceleration Office_15	Uses software rendering instead of hardware rendering. Enable this option if no vGPU is present.	Applied	Not applied
Disable Animations Office_15	Uses software rendering instead of hardware rendering. Enable this option if no vGPU is present.	Applied	Not applied
Disable Hardware Acceleration Office_16	Uses software rendering instead of hardware rendering. Enable this option if no vGPU is present.	Applied	Not applied
Disable Animations Office_16	Uses software rendering instead of hardware rendering. Enable this option if no vGPU is present.	Applied	Not applied

Install the NVIDIA vGPU software driver

Use the following procedure to install the NVIDIA GRID vGPU drivers on the desktop virtual machine. To fully enable vGPU operation, the NVIDIA driver must be installed.

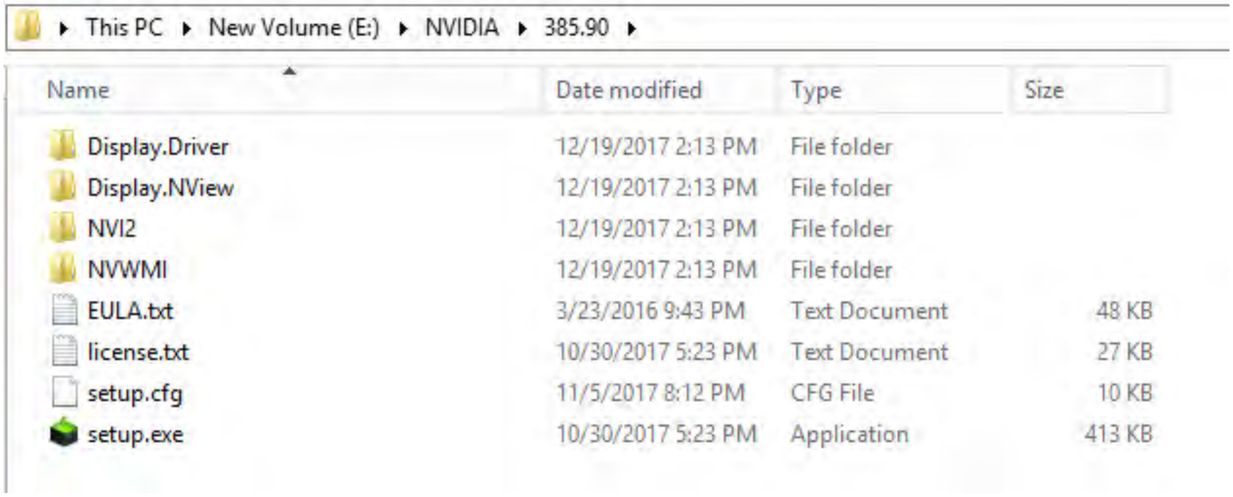
Before the NVIDIA driver is installed on the guest virtual machine, the Device Manager shows the standard VGA graphics adapter (Figure 47).

Figure 47. Device Manager before the NVIDIA driver is installed



1. Copy the Microsoft Windows drivers from the NVIDIA GRID vGPU driver pack downloaded earlier to the master virtual machine.
2. Copy the 32-bit or 64-bit NVIDIA Windows driver from the vGPU driver pack to the desktop virtual machine and run setup.exe (Figure 48).

Figure 48. NVIDIA driver pack



This PC ▸ New Volume (E:) ▸ NVIDIA ▸ 385.90 ▸

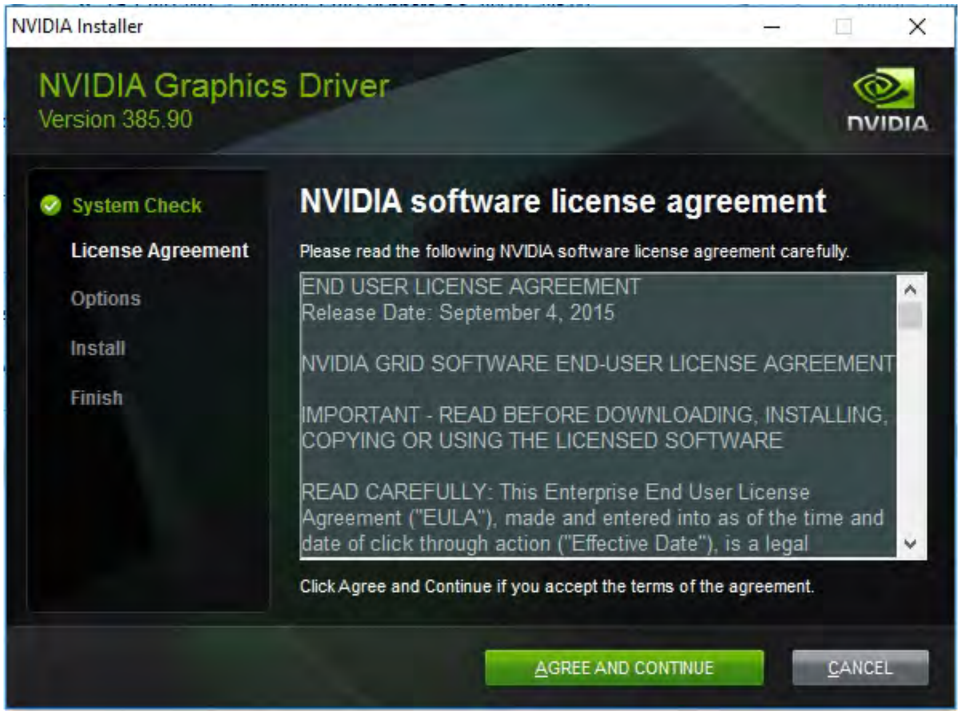
Name	Date modified	Type	Size
Display.Driver	12/19/2017 2:13 PM	File folder	
Display.NView	12/19/2017 2:13 PM	File folder	
NVI2	12/19/2017 2:13 PM	File folder	
NVWMI	12/19/2017 2:13 PM	File folder	
EULA.txt	3/23/2016 9:43 PM	Text Document	48 KB
license.txt	10/30/2017 5:23 PM	Text Document	27 KB
setup.cfg	11/5/2017 8:12 PM	CFG File	10 KB
setup.exe	10/30/2017 5:23 PM	Application	413 KB

Note: The vGPU host driver and guest driver versions need to match. Do not attempt to use a newer guest driver with an older vGPU host driver or an older guest driver with a newer vGPU host driver. In addition, the vGPU driver from NVIDIA is a different driver than the GPU pass-through driver.

3. Accept the NVIDIA software license (Figure 49).

Note: Be sure that remote desktop connections are enabled. After this step, console access may not be available for the virtual machine when you connect from a vSphere Client.

Figure 49. Agreeing to the NVIDIA software license



NVIDIA software license agreement

Please read the following NVIDIA software license agreement carefully.

END USER LICENSE AGREEMENT
Release Date: September 4, 2015

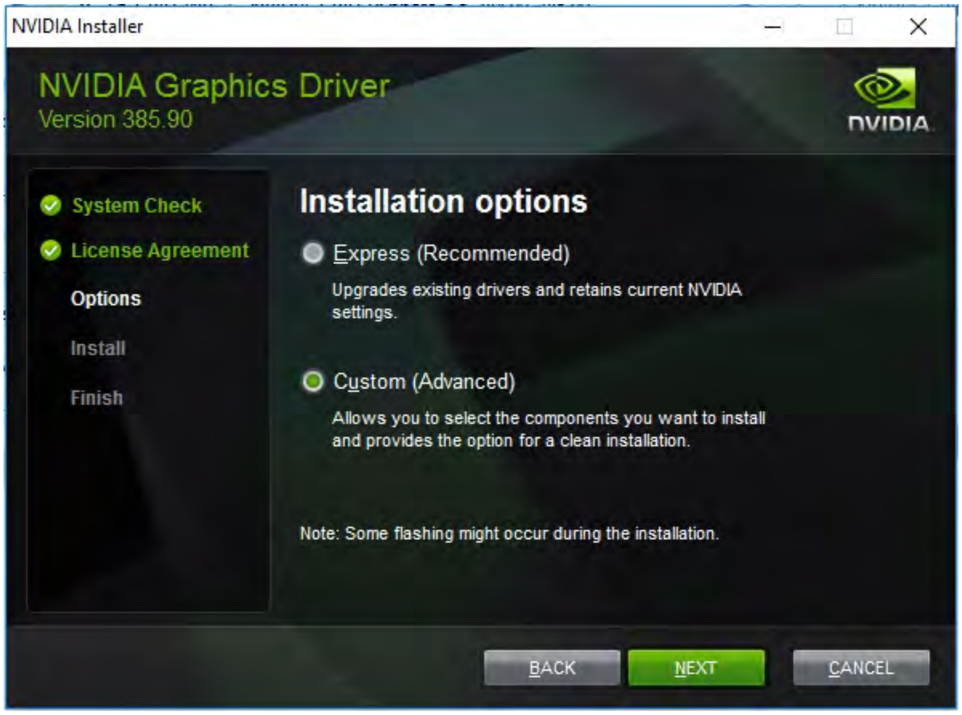
NVIDIA GRID SOFTWARE END-USER LICENSE AGREEMENT

IMPORTANT - READ BEFORE DOWNLOADING, INSTALLING, COPYING OR USING THE LICENSED SOFTWARE

READ CAREFULLY: This Enterprise End User License Agreement ("EULA"), made and entered into as of the time and date of click through action ("Effective Date"), is a legal

Click Agree and Continue if you accept the terms of the agreement.

Figure 50. Install the graphics drivers using the Express or the Custom option (Figures 50 and 51). Selecting the Express or Custom installation option



Installation options

○ Express (Recommended)

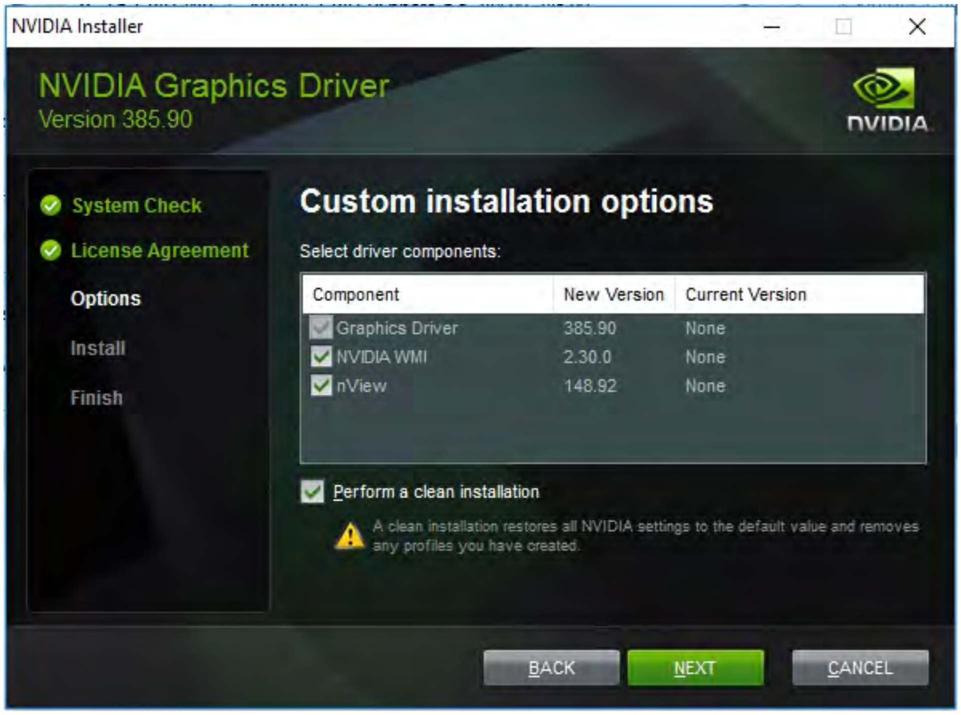
Upgrades existing drivers and retains current NVIDIA settings.

● Custom (Advanced)

Allows you to select the components you want to install and provides the option for a clean installation.

Note: Some flashing might occur during the installation.

Figure 51. Components to be installed during NVIDIA graphics driver custom installation process.



NVIDIA Installer

NVIDIA Graphics Driver
Version 385.90

Custom installation options

Select driver components:

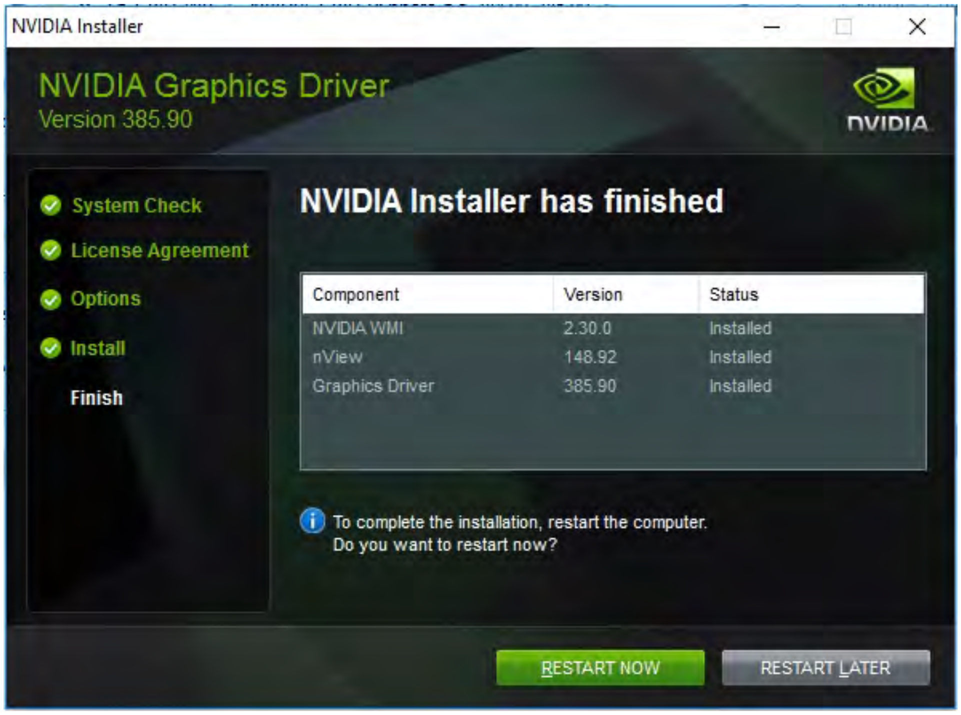
Component	New Version	Current Version
☑ Graphics Driver	385.90	None
☑ NVIDIA WMI	2.30.0	None
☑ nView	148.92	None

☑ Perform a clean installation

A clean installation restores all NVIDIA settings to the default value and removes any profiles you have created.

4. After the installation has completed successfully, restart the virtual machine (Figure 52).

Figure 52. Resarting the virtual machine



NVIDIA Installer has finished

Component	Version	Status
NVIDIA WMI	2.30.0	Installed
nView	148.92	Installed
Graphics Driver	385.90	Installed

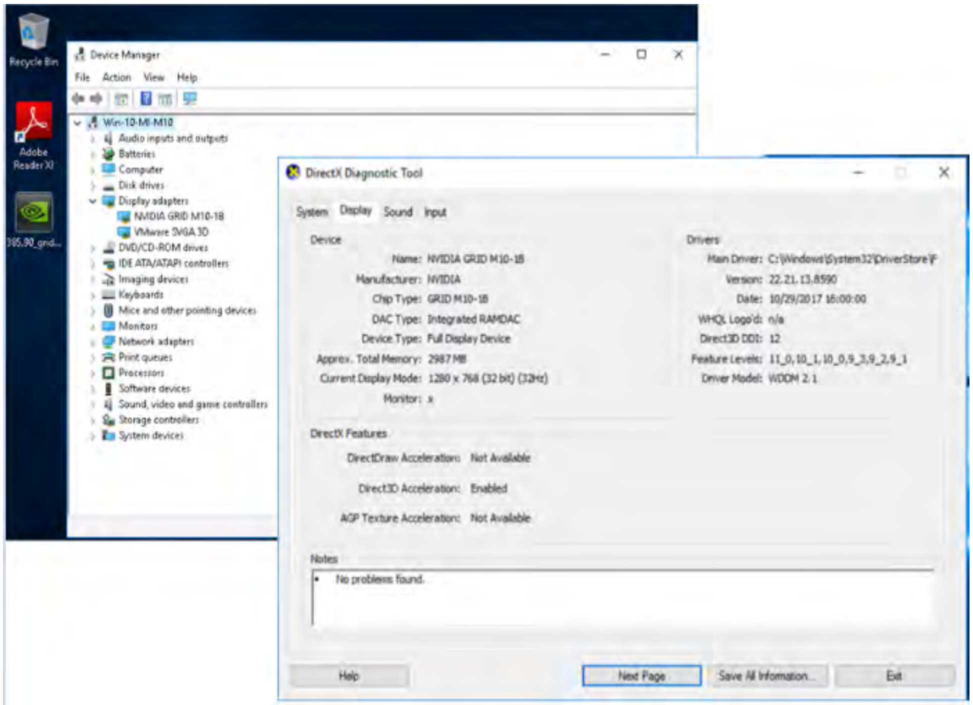
To complete the installation, restart the computer.
Do you want to restart now?

Verify that applications are ready to support the vGPU

Validate the successful installation of the graphics drivers and the vGPU device.

Open Windows Device Manager and expand the Display Adapter section. The device will reflect your chosen profile (Figure 53).

Figure 53. Validating the driver installation



```
Win-10-MI-M10
  Audio inputs and outputs
  Batteries
  Computer
  Disk drives
  Display adapters
    NVIDIA GRID M10-1B
    VMware SVGA 3D
  DVD/CD-ROM drives
  IDE ATA/ATAPI controllers
  Imaging devices
  Keyboards
  Mice and other pointing devices
  Monitors
  Network adapters
  Print queues
  Processors
  Software devices
  Sound, video and game controllers
  Storage controllers
  System devices
```

Device

Name: NVIDIA GRID M10-1B
Manufacturer: NVIDIA
Chip Type: GRID M10-1B
DAC Type: Integrated RAMDAC
Device Type: Full Display Device
Approx. Total Memory: 2987 MB
Current Display Mode: 1280 x 768 (32 bit) (32Hz)
Monitor: x

Drivers

Main Driver: C:\Windows\System32\DriverStore\F
Version: 22.21.13.8590
Date: 10/29/2017 16:00:00
WHQL Logo'd: n/a
Direct3D DDI: 12
Feature Levels: 11_0,10_1,10_0,9_3,9_2,9_1
Driver Model: WDDM 2.1

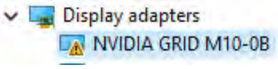
DirectX Features

DirectDraw Acceleration: Not Available
Direct3D Acceleration: Enabled
AGP Texture Acceleration: Not Available

Notes

- No problems found.

Note: If you see an exclamation point as shown here, a problem has occurred.



```
Display adapters
  NVIDIA GRID M10-0B
```

The following are the most likely the reasons:

- The GPU driver service is not running.
- The GPU driver is incompatible.

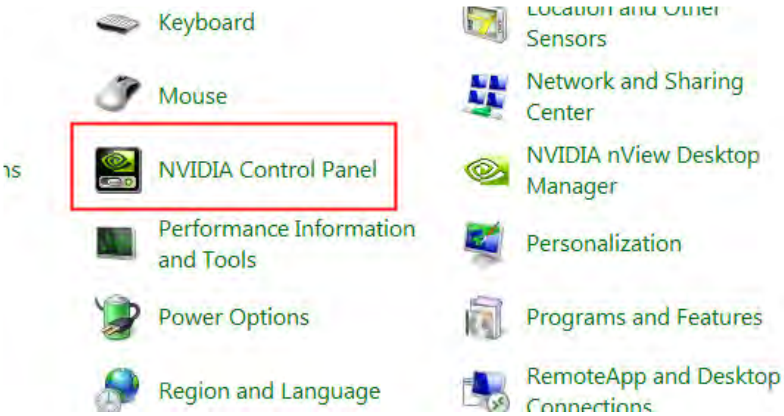
Configure the virtual machine for an NVIDIA GRID vGPU license

You need to point the master image to the license server so that the virtual machines with vGPUs can obtain licenses.

Note: The license settings persist across reboots. These settings can also be preloaded through registry keys.

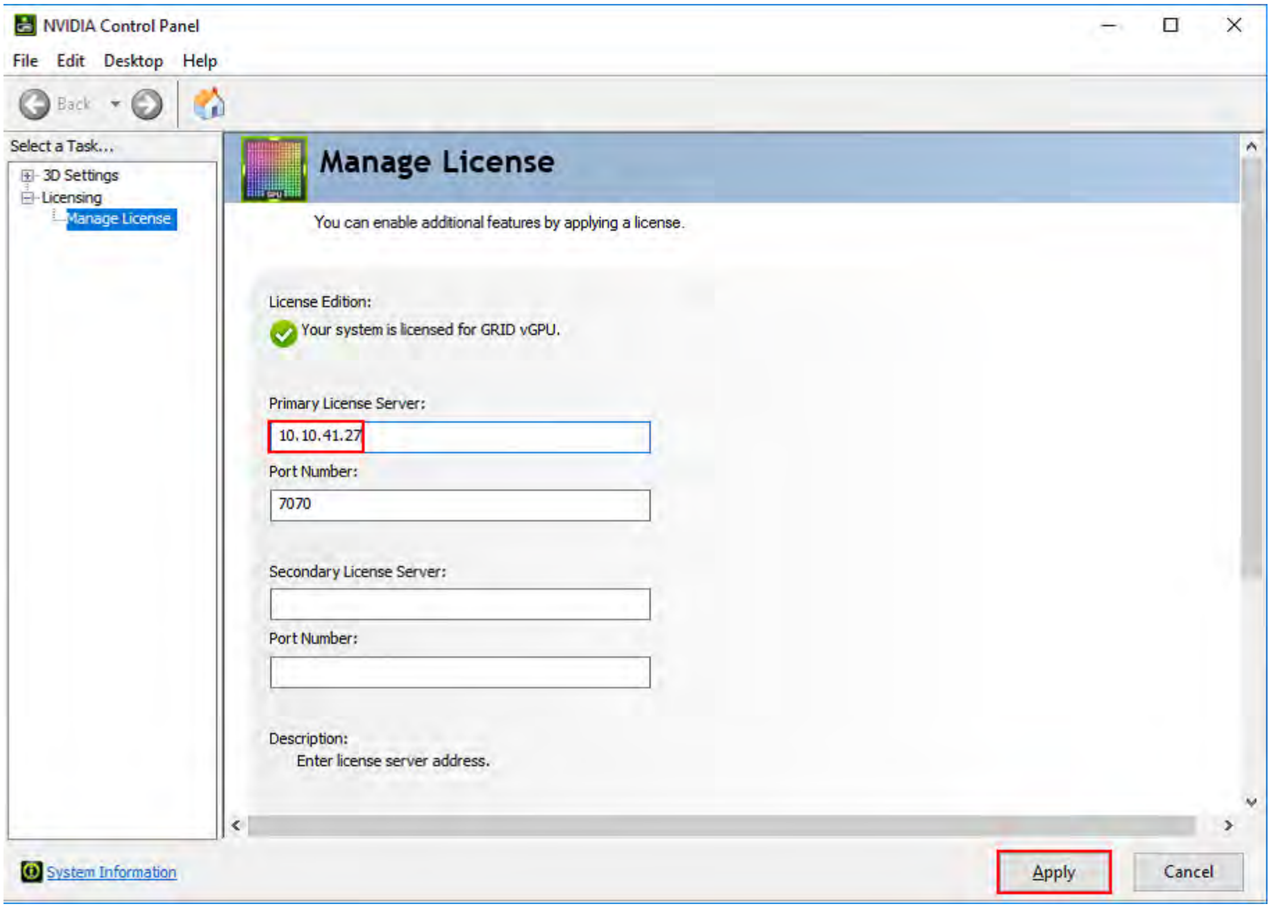
1. In the Microsoft Windows Control Panel, double-click NVIDIA Control Panel (Figure 54).

Figure 54. Choosing the NVIDIA Control Panel


Keyboard
Location and Other Sensors
Mouse
Network and Sharing Center
ns
NVIDIA Control Panel
NVIDIA nView Desktop Manager
Performance Information and Tools
Personalization
Power Options
Programs and Features
Region and Language
RemoteApp and Desktop Connections

2. Select Manage License from the left pane and enter your license server address and port. Click Apply (Figure 55).

Figure 55. Managing your license



You can enable additional features by applying a license.

License Edition:
✓ Your system is licensed for GRID vGPU.

Primary License Server: 10.10.41.27

Port Number: 7070

Secondary License Server:

Port Number:

Description:
Enter license server address.

Verify vGPU deployment

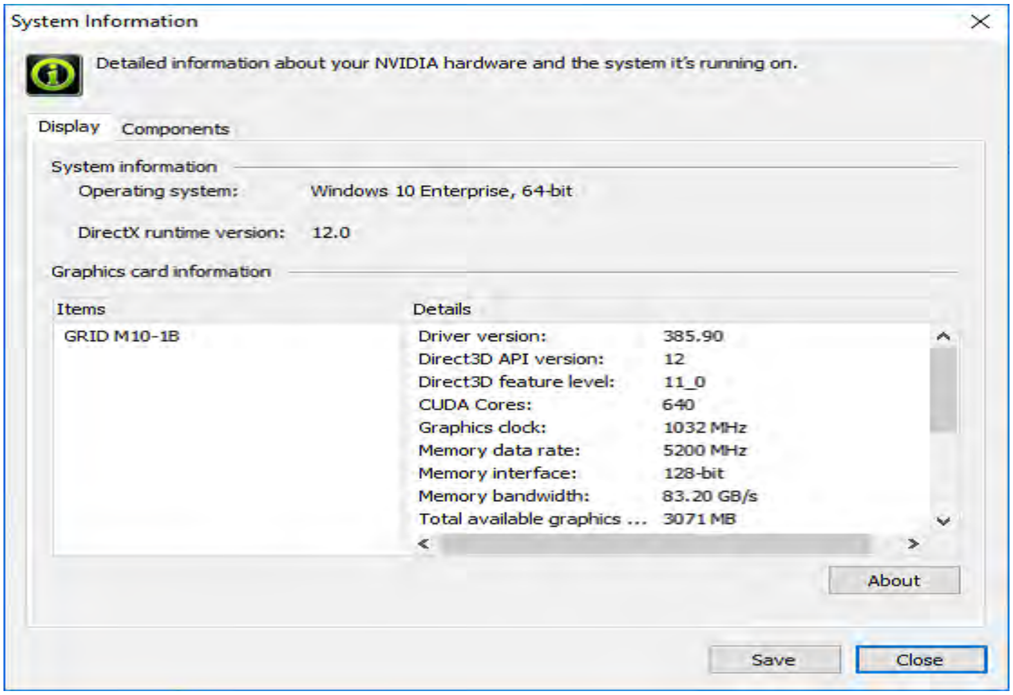
After the desktops are provisioned, use the following steps to verify vGPU deployment in the VMware desktop environment.

Verify that the NVIDIA driver is running on the desktop

Follow these steps to verify that the NVIDIA driver is running on the desktop:

1. Right-click the desktop. In the menu, choose NVIDIA Control Panel to open the control panel.
2. In the control panel, select System Information to see the vGPU that the virtual machine is using, the vGPU's capabilities, and the NVIDIA driver version that is loaded (Figure 56).

Figure 56. NVIDIA Control Panel System Information window



System Information

Detailed information about your NVIDIA hardware and the system it's running on.

System information

Operating system: Windows 10 Enterprise, 64-bit

DirectX runtime version: 12.0

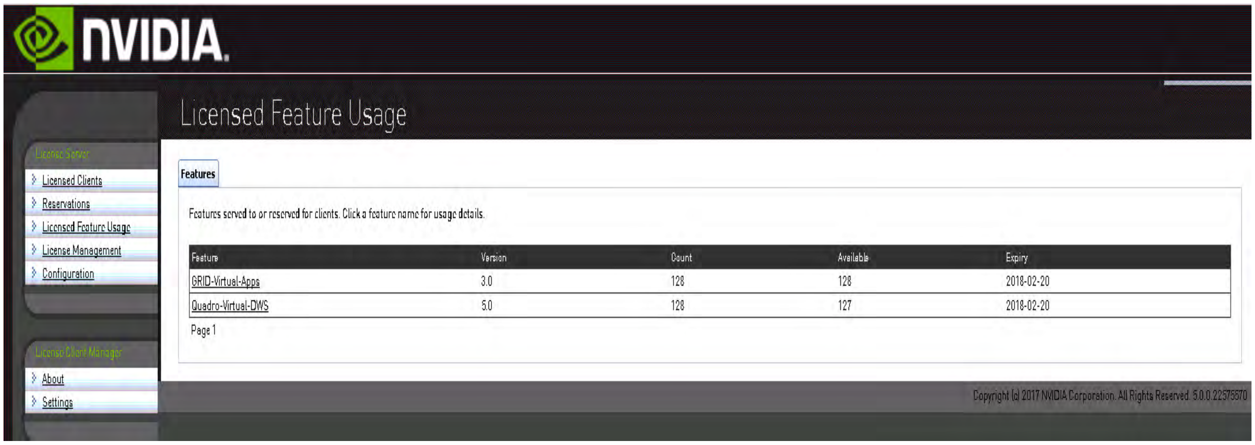
Graphics card information

Items	Details	
GRID M10-1B	Driver version:	385.90
	Direct3D API version:	12
	Direct3D feature level:	11_0
	CUDA Cores:	640
	Graphics clock:	1032 MHz
	Memory data rate:	5200 MHz
	Memory interface:	128-bit
	Memory bandwidth:	83.20 GB/s
	Total available graphics ...	3071 MB

Verify NVIDIA license acquisition by desktops

A license is obtained before the user logs on to the virtual machine after the virtual machine is fully booted (Figure 57).

Figure 57. NVIDIA License Server: Licensed Feature Usage window



Licensed Feature Usage

Features served to or reserved for clients. Click a feature name for usage details.

Feature	Version	Count	Available	Expiry
GRID-Virtual-Apps	3.0	128	128	2018-02-20
Quadro-Virtual-DWS	5.0	128	127	2018-02-20

Page 1

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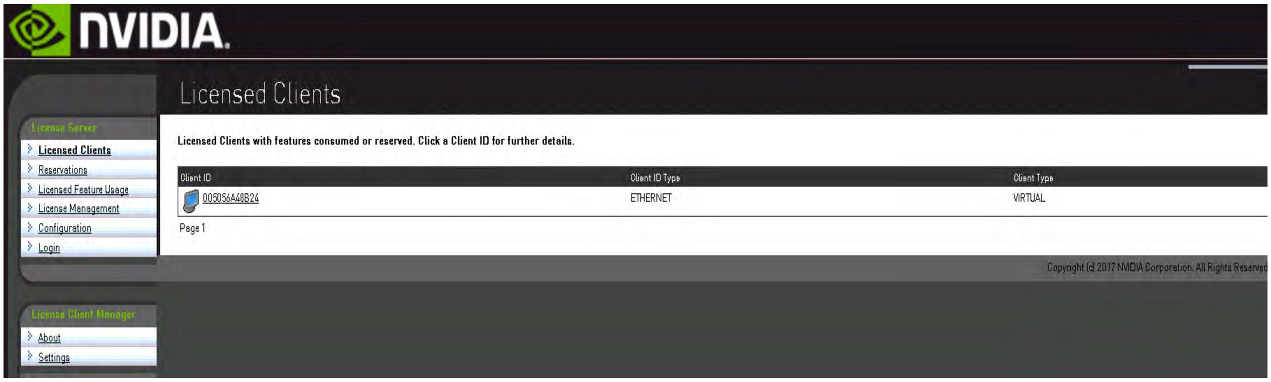
To view the details, select Licensed Clients in the left pane (Figure 58).

Figure 58. NVIDIA License Server: Licensed Clients window



Licensed Clients

Licensed Clients with features consumed or reserved. Click a Client ID for further details.

Client ID	Client ID Type	Client Type
005056A48B24	ETHERNET	VIRTUAL

Page 1

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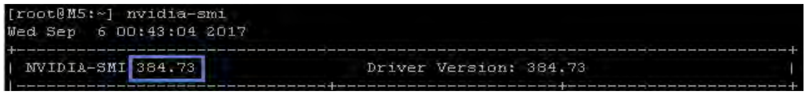
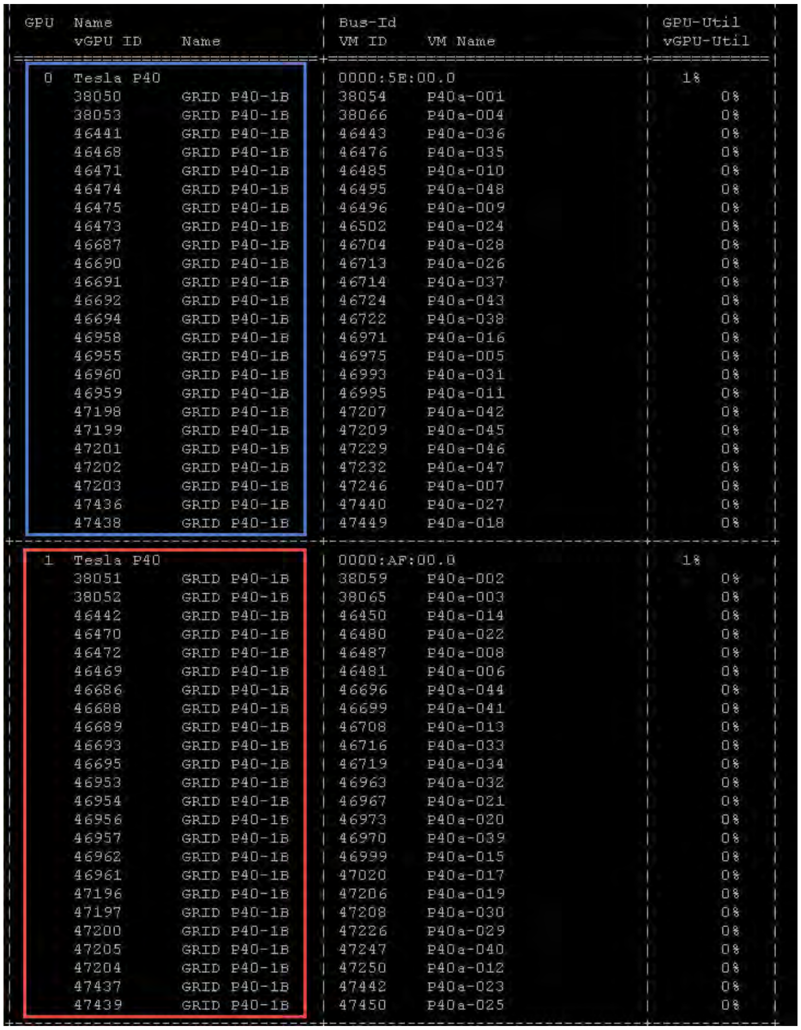
Verify the NVIDIA configuration on the host

To obtain a hostwide overview of the NVIDIA GPUs, enter the **nvidia-smi** command without any arguments (Figures 59, 60, and 61).

Figure 59. The nvidia-smi command output from the host with two NVIDIA P40 cards and 48 Microsoft Windows 10 desktops with P40-1B vGPU profile

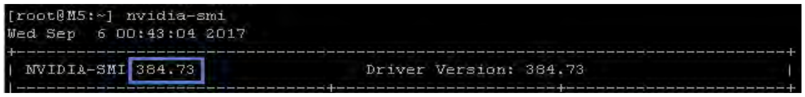


```
[root@M5:~] nvidia-smi
Wed Sep  6 00:43:04 2017
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 384.73                 Driver Version: 384.73                    |
|-------------------------------+----------------------+----------------------+
```

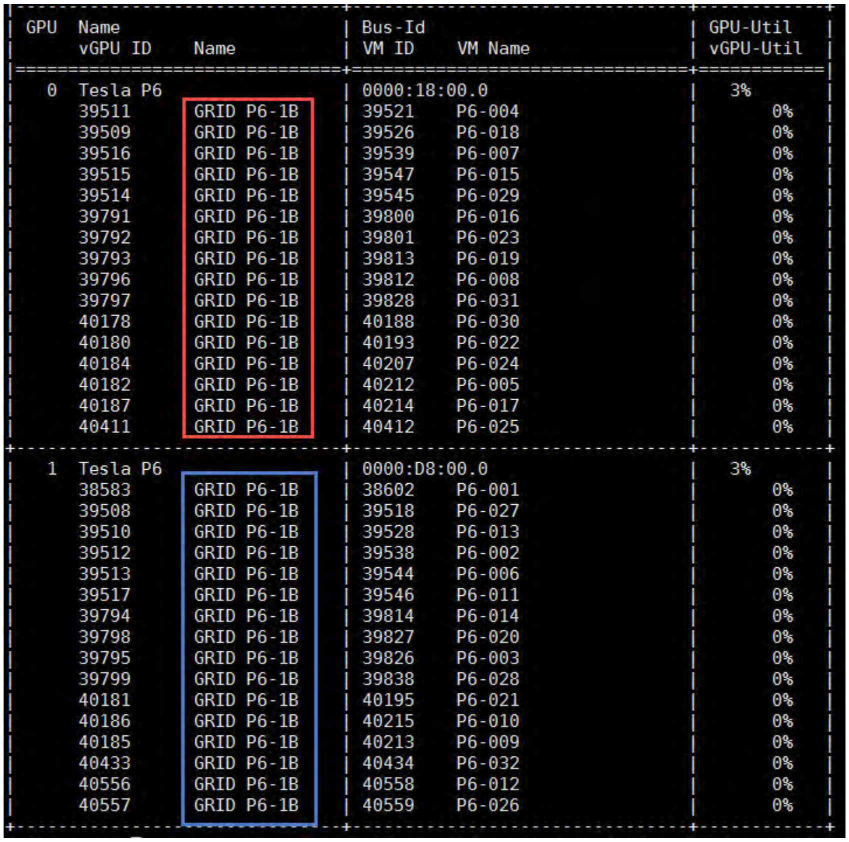


```
| GPU  Name                          | Bus-Id                           | GPU-Util   |
|      vGPU ID     Name              | VM ID     VM Name                | vGPU-Util  |
|==============================+=================================+============|
|   0  Tesla P40                     | 0000:5E:00.0                     |   1%       |
|      38050       GRID P40-1B       | 38054     P40a-001               |       0%   |
|      38053       GRID P40-1B       | 38066     P40a-004               |       0%   |
|      46441       GRID P40-1B       | 46443     P40a-036               |       0%   |
|      46468       GRID P40-1B       | 46476     P40a-035               |       0%   |
|      46471       GRID P40-1B       | 46485     P40a-010               |       0%   |
|      46474       GRID P40-1B       | 46495     P40a-048               |       0%   |
|      46475       GRID P40-1B       | 46496     P40a-009               |       0%   |
|      46473       GRID P40-1B       | 46502     P40a-024               |       0%   |
|      46687       GRID P40-1B       | 46704     P40a-028               |       0%   |
|      46690       GRID P40-1B       | 46713     P40a-026               |       0%   |
|      46691       GRID P40-1B       | 46714     P40a-037               |       0%   |
|      46692       GRID P40-1B       | 46724     P40a-043               |       0%   |
|      46694       GRID P40-1B       | 46722     P40a-038               |       0%   |
|      46958       GRID P40-1B       | 46971     P40a-016               |       0%   |
|      46955       GRID P40-1B       | 46975     P40a-005               |       0%   |
|      46960       GRID P40-1B       | 46993     P40a-031               |       0%   |
|      46959       GRID P40-1B       | 46995     P40a-011               |       0%   |
|      47198       GRID P40-1B       | 47207     P40a-042               |       0%   |
|      47199       GRID P40-1B       | 47209     P40a-045               |       0%   |
|      47201       GRID P40-1B       | 47229     P40a-046               |       0%   |
|      47202       GRID P40-1B       | 47232     P40a-047               |       0%   |
|      47203       GRID P40-1B       | 47246     P40a-007               |       0%   |
|      47436       GRID P40-1B       | 47440     P40a-027               |       0%   |
|      47438       GRID P40-1B       | 47449     P40a-018               |       0%   |
+------------------------------+---------------------------------+------------+
|   1  Tesla P40                     | 0000:AF:00.0                     |   1%       |
|      38051       GRID P40-1B       | 38059     P40a-002               |       0%   |
|      38052       GRID P40-1B       | 38065     P40a-003               |       0%   |
|      46442       GRID P40-1B       | 46450     P40a-014               |       0%   |
|      46470       GRID P40-1B       | 46480     P40a-022               |       0%   |
|      46472       GRID P40-1B       | 46487     P40a-008               |       0%   |
|      46469       GRID P40-1B       | 46481     P40a-006               |       0%   |
|      46686       GRID P40-1B       | 46696     P40a-044               |       0%   |
|      46688       GRID P40-1B       | 46699     P40a-041               |       0%   |
|      46689       GRID P40-1B       | 46708     P40a-013               |       0%   |
|      46693       GRID P40-1B       | 46716     P40a-033               |       0%   |
|      46695       GRID P40-1B       | 46719     P40a-034               |       0%   |
|      46953       GRID P40-1B       | 46963     P40a-032               |       0%   |
|      46954       GRID P40-1B       | 46967     P40a-021               |       0%   |
|      46956       GRID P40-1B       | 46973     P40a-020               |       0%   |
|      46957       GRID P40-1B       | 46970     P40a-039               |       0%   |
|      46962       GRID P40-1B       | 46999     P40a-015               |       0%   |
|      46961       GRID P40-1B       | 47020     P40a-017               |       0%   |
|      47196       GRID P40-1B       | 47206     P40a-019               |       0%   |
|      47197       GRID P40-1B       | 47208     P40a-030               |       0%   |
|      47200       GRID P40-1B       | 47226     P40a-029               |       0%   |
|      47205       GRID P40-1B       | 47247     P40a-040               |       0%   |
|      47204       GRID P40-1B       | 47250     P40a-012               |       0%   |
|      47437       GRID P40-1B       | 47442     P40a-023               |       0%   |
|      47439       GRID P40-1B       | 47450     P40a-025               |       0%   |
+------------------------------+---------------------------------+------------+
```

Figure 60. The nvidia-smi command output from the host with two NVIDIA P6 cards and 32 Microsoft Windows 10 desktops with P6-1B vGPU profile

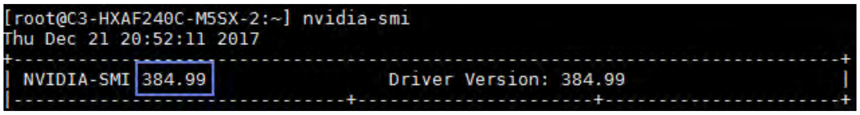


```
[root@M5:~] nvidia-smi
Wed Sep  6 00:43:04 2017
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 384.73                 Driver Version: 384.73                    |
|-------------------------------+----------------------+----------------------+
```

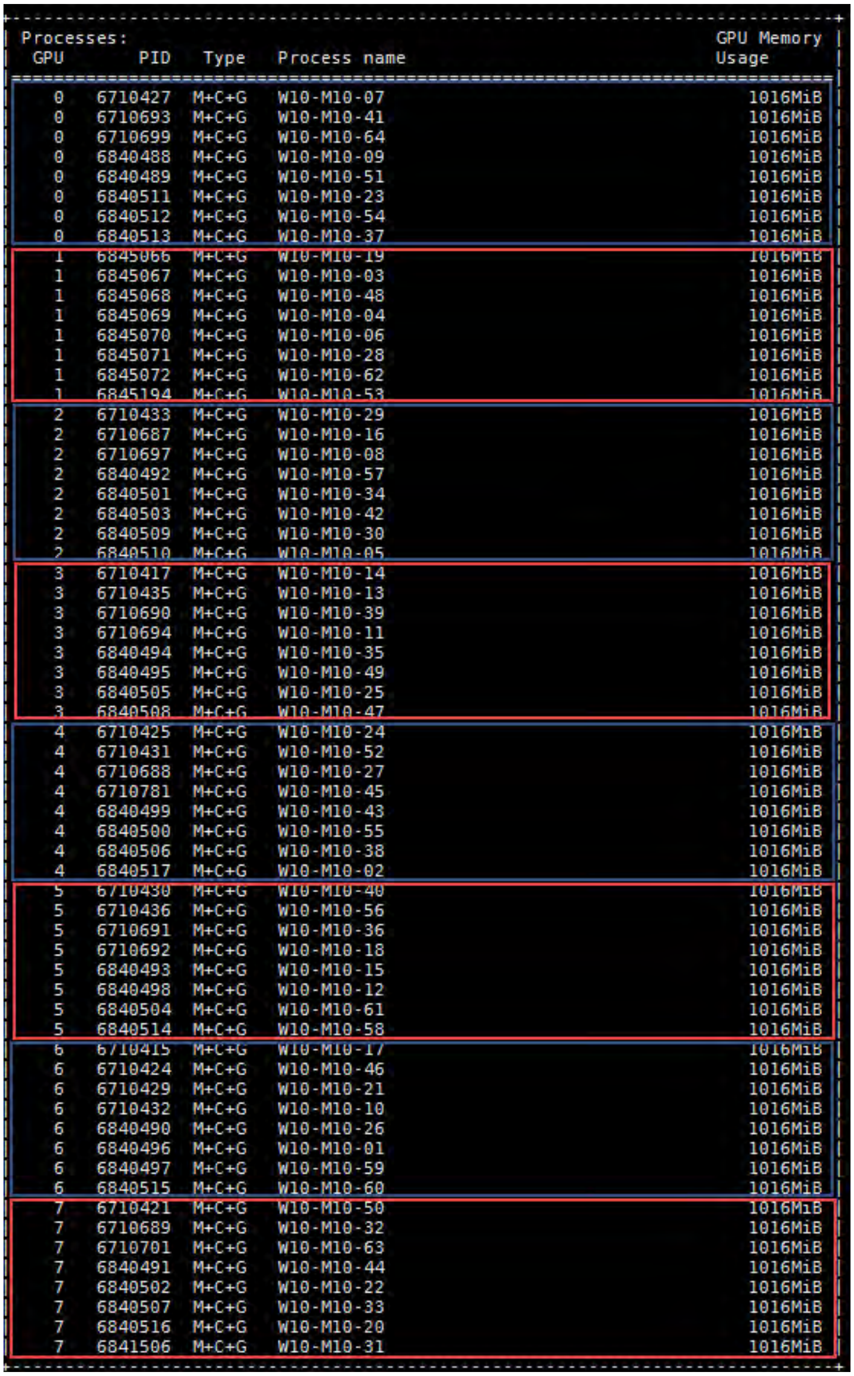


```
+-----------------------------------+-------------------------------------+------------+
| GPU  Name                         | Bus-Id                              | GPU-Util   |
|      vGPU ID     Name             | VM ID     VM Name                   | vGPU-Util  |
|===================================+=====================================+============|
|   0  Tesla P6                     | 0000:18:00.0                        |    3%      |
|      39511      GRID P6-1B        | 39521     P6-004                    |        0%  |
|      39509      GRID P6-1B        | 39526     P6-018                    |        0%  |
|      39516      GRID P6-1B        | 39539     P6-007                    |        0%  |
|      39515      GRID P6-1B        | 39547     P6-015                    |        0%  |
|      39514      GRID P6-1B        | 39545     P6-029                    |        0%  |
|      39791      GRID P6-1B        | 39800     P6-016                    |        0%  |
|      39792      GRID P6-1B        | 39801     P6-023                    |        0%  |
|      39793      GRID P6-1B        | 39813     P6-019                    |        0%  |
|      39796      GRID P6-1B        | 39812     P6-008                    |        0%  |
|      39797      GRID P6-1B        | 39828     P6-031                    |        0%  |
|      40178      GRID P6-1B        | 40188     P6-030                    |        0%  |
|      40180      GRID P6-1B        | 40193     P6-022                    |        0%  |
|      40184      GRID P6-1B        | 40207     P6-024                    |        0%  |
|      40182      GRID P6-1B        | 40212     P6-005                    |        0%  |
|      40187      GRID P6-1B        | 40214     P6-017                    |        0%  |
|      40411      GRID P6-1B        | 40412     P6-025                    |        0%  |
+-----------------------------------+-------------------------------------+------------+
|   1  Tesla P6                     | 0000:D8:00.0                        |    3%      |
|      38583      GRID P6-1B        | 38602     P6-001                    |        0%  |
|      39508      GRID P6-1B        | 39518     P6-027                    |        0%  |
|      39510      GRID P6-1B        | 39528     P6-013                    |        0%  |
|      39512      GRID P6-1B        | 39538     P6-002                    |        0%  |
|      39513      GRID P6-1B        | 39544     P6-006                    |        0%  |
|      39517      GRID P6-1B        | 39546     P6-011                    |        0%  |
|      39794      GRID P6-1B        | 39814     P6-014                    |        0%  |
|      39798      GRID P6-1B        | 39827     P6-020                    |        0%  |
|      39795      GRID P6-1B        | 39826     P6-003                    |        0%  |
|      39799      GRID P6-1B        | 39838     P6-028                    |        0%  |
|      40181      GRID P6-1B        | 40195     P6-021                    |        0%  |
|      40186      GRID P6-1B        | 40215     P6-010                    |        0%  |
|      40185      GRID P6-1B        | 40213     P6-009                    |        0%  |
|      40433      GRID P6-1B        | 40434     P6-032                    |        0%  |
|      40556      GRID P6-1B        | 40558     P6-012                    |        0%  |
|      40557      GRID P6-1B        | 40559     P6-026                    |        0%  |
+-----------------------------------+-------------------------------------+------------+
```

Figure 61. The nvidia-smi command output from the host with two NVIDIA M10 Cards and 64 Microsoft Windows 10 desktops with M10-1B vGPU profile



```
[root@C3-HXAF240C-M5SX-2:~] nvidia-smi
Thu Dec 21 20:52:11 2017
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 384.99                 Driver Version: 384.99                    |
|-------------------------------+----------------------+----------------------+
```



```
+-----------------------------------------------------------------------------+
| Processes:                                                       GPU Memory |
|  GPU       PID   Type   Process name                             Usage      |
|=============================================================================|
|    0   6710427  M+C+G   W10-M10-07                                 1016MiB |
|    0   6710693  M+C+G   W10-M10-41                                 1016MiB |
|    0   6710699  M+C+G   W10-M10-64                                 1016MiB |
|    0   6840488  M+C+G   W10-M10-09                                 1016MiB |
|    0   6840489  M+C+G   W10-M10-51                                 1016MiB |
|    0   6840511  M+C+G   W10-M10-23                                 1016MiB |
|    0   6840512  M+C+G   W10-M10-54                                 1016MiB |
|    0   6840513  M+C+G   W10-M10-37                                 1016MiB |
|    1   6845066  M+C+G   W10-M10-19                                 1016MiB |
|    1   6845067  M+C+G   W10-M10-03                                 1016MiB |
|    1   6845068  M+C+G   W10-M10-48                                 1016MiB |
|    1   6845069  M+C+G   W10-M10-04                                 1016MiB |
|    1   6845070  M+C+G   W10-M10-06                                 1016MiB |
|    1   6845071  M+C+G   W10-M10-28                                 1016MiB |
|    1   6845072  M+C+G   W10-M10-62                                 1016MiB |
|    1   6845194  M+C+G   W10-M10-53                                 1016MiB |
|    2   6710433  M+C+G   W10-M10-29                                 1016MiB |
|    2   6710687  M+C+G   W10-M10-16                                 1016MiB |
|    2   6710697  M+C+G   W10-M10-08                                 1016MiB |
|    2   6840492  M+C+G   W10-M10-57                                 1016MiB |
|    2   6840501  M+C+G   W10-M10-34                                 1016MiB |
|    2   6840503  M+C+G   W10-M10-42                                 1016MiB |
|    2   6840509  M+C+G   W10-M10-30                                 1016MiB |
|    2   6840510  M+C+G   W10-M10-05                                 1016MiB |
|    3   6710417  M+C+G   W10-M10-14                                 1016MiB |
|    3   6710435  M+C+G   W10-M10-13                                 1016MiB |
|    3   6710690  M+C+G   W10-M10-39                                 1016MiB |
|    3   6710694  M+C+G   W10-M10-11                                 1016MiB |
|    3   6840494  M+C+G   W10-M10-35                                 1016MiB |
|    3   6840495  M+C+G   W10-M10-49                                 1016MiB |
|    3   6840505  M+C+G   W10-M10-25                                 1016MiB |
|    3   6840508  M+C+G   W10-M10-47                                 1016MiB |
|    4   6710425  M+C+G   W10-M10-24                                 1016MiB |
|    4   6710431  M+C+G   W10-M10-52                                 1016MiB |
|    4   6710688  M+C+G   W10-M10-27                                 1016MiB |
|    4   6710781  M+C+G   W10-M10-45                                 1016MiB |
|    4   6840499  M+C+G   W10-M10-43                                 1016MiB |
|    4   6840500  M+C+G   W10-M10-55                                 1016MiB |
|    4   6840506  M+C+G   W10-M10-38                                 1016MiB |
|    4   6840517  M+C+G   W10-M10-02                                 1016MiB |
|    5   6710430  M+C+G   W10-M10-40                                 1016MiB |
|    5   6710436  M+C+G   W10-M10-56                                 1016MiB |
|    5   6710691  M+C+G   W10-M10-36                                 1016MiB |
|    5   6710692  M+C+G   W10-M10-18                                 1016MiB |
|    5   6840493  M+C+G   W10-M10-15                                 1016MiB |
|    5   6840498  M+C+G   W10-M10-12                                 1016MiB |
|    5   6840504  M+C+G   W10-M10-61                                 1016MiB |
|    5   6840514  M+C+G   W10-M10-58                                 1016MiB |
|    6   6710415  M+C+G   W10-M10-17                                 1016MiB |
|    6   6710424  M+C+G   W10-M10-46                                 1016MiB |
|    6   6710429  M+C+G   W10-M10-21                                 1016MiB |
|    6   6710432  M+C+G   W10-M10-10                                 1016MiB |
|    6   6840490  M+C+G   W10-M10-26                                 1016MiB |
|    6   6840496  M+C+G   W10-M10-01                                 1016MiB |
|    6   6840497  M+C+G   W10-M10-59                                 1016MiB |
|    6   6840515  M+C+G   W10-M10-60                                 1016MiB |
|    7   6710421  M+C+G   W10-M10-50                                 1016MiB |
|    7   6710689  M+C+G   W10-M10-32                                 1016MiB |
|    7   6710701  M+C+G   W10-M10-63                                 1016MiB |
|    7   6840491  M+C+G   W10-M10-44                                 1016MiB |
|    7   6840502  M+C+G   W10-M10-22                                 1016MiB |
|    7   6840507  M+C+G   W10-M10-33                                 1016MiB |
|    7   6840516  M+C+G   W10-M10-20                                 1016MiB |
|    7   6841506  M+C+G   W10-M10-31                                 1016MiB |
+-----------------------------------------------------------------------------+
```

Additional configurations

This section presents additional configuration options.

Install and upgrade NVIDIA drivers

The NVIDIA GRID API provides direct access to the frame buffer of the GPU, providing the fastest possible frame rate for a smooth and interactive user experience.

Use GPU acceleration for Microsoft Windows Server DirectX, Direct3D, and WPF rendering

DirectX, Direct3D, and WPF rendering are available only on servers with a GPU that supports display driver interface (DDI) Version 9ex, 10, or 11.

Use the OpenGL Software Accelerator

The OpenGL Software Accelerator is a software rasterizer for OpenGL applications such as ArcGIS, Google Earth, NeHe, Maya, Blender, Voxler, CAD, and CAM. In some cases, the OpenGL Software Accelerator can eliminate the need to use graphics cards to deliver a good user experience with OpenGL applications.

Note: OpenGL Software Accelerator is provided as is and must be tested with all applications. It may not work with some applications and is intended as a solution to try if the Windows OpenGL rasterizer does not provide adequate performance. If OpenGL Software Accelerator works with your applications, you can use it to avoid the cost of GPU hardware.

OpenGL Software Accelerator is provided in the Support folder on the installation media, and it is supported on all valid VDA platforms.

Try OpenGL Software Accelerator in the following cases:

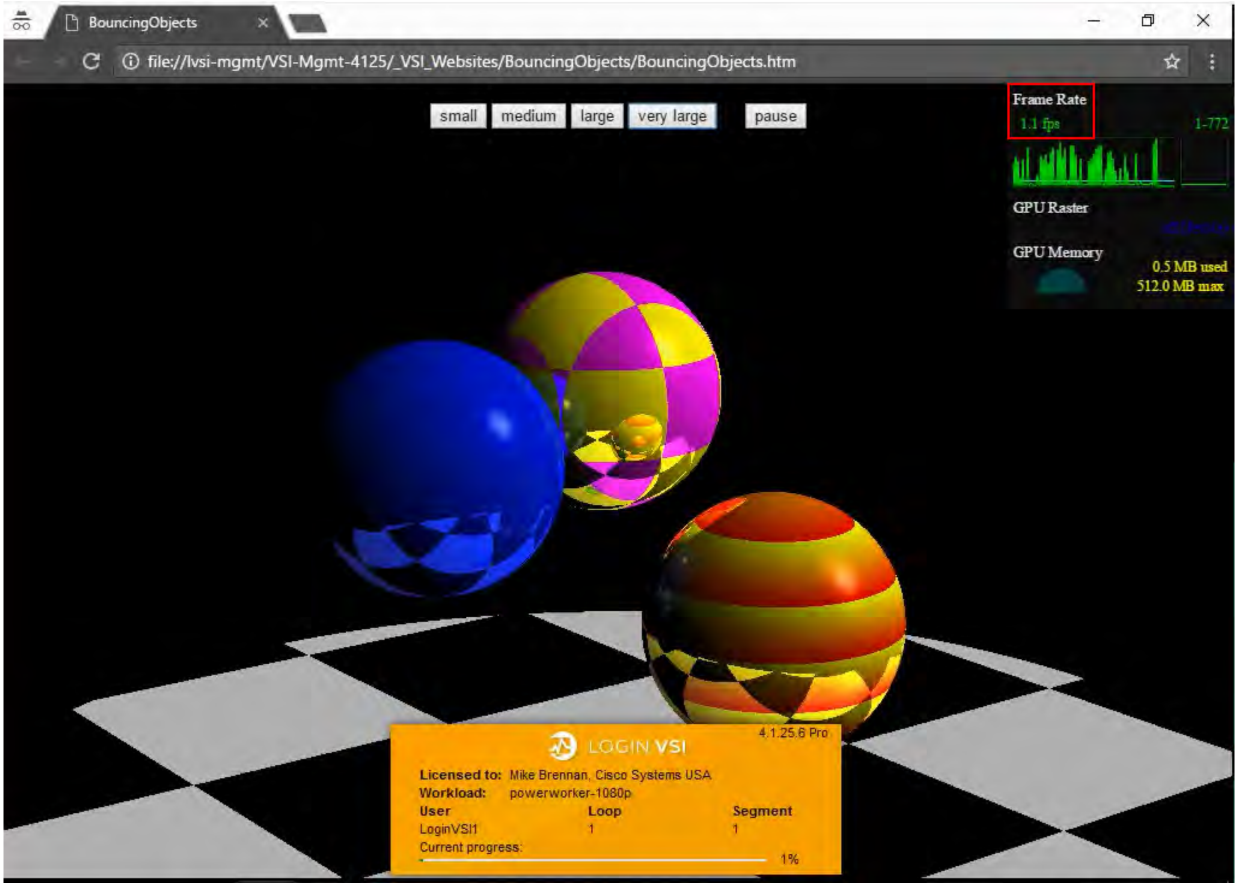
- If the performance of OpenGL applications running on virtual machines is a concern, try using the OpenGL accelerator. For some applications, the accelerator outperforms the Microsoft OpenGL software rasterizer that is included with Windows because the OpenGL accelerator uses SSE4.1 and AVX. The OpenGL accelerator also supports applications using OpenGL versions up to Version 2.1.
- For applications running on a workstation, first try the default version of OpenGL support provided by the workstation's graphics adapter. If the graphics card is the latest version, in most cases it will deliver the best performance. If the graphics card is an earlier version or does not deliver satisfactory performance, then try OpenGL Software Accelerator.
- 3D OpenGL applications that are not adequately delivered using CPU-based software rasterization may benefit from OpenGL GPU hardware acceleration. This feature can be used on bare-metal devices and virtual machines.

Sample test

The LoginVSI test framework with a custom power-user workload was used to simulate users running a graphics-intensive workload and high-definition video content.

Figures 62 and 63 show differences in frame-per-second (FPS) rates during tests between desktops configured with and without a vGPU.

Figure 62. BouncingObjects.htm FPS on desktop without vGPU


BouncingObjects
file://lvsi-mgmt/VSI-Mgmt-4125/_VSI_Websites/BouncingObjects/BouncingObjects.htm
small
medium
large
very large
pause
GPU Raster
LOGIN VSI
4.1.25.6 Pro

Frame Rate
1.1 fps
1-772

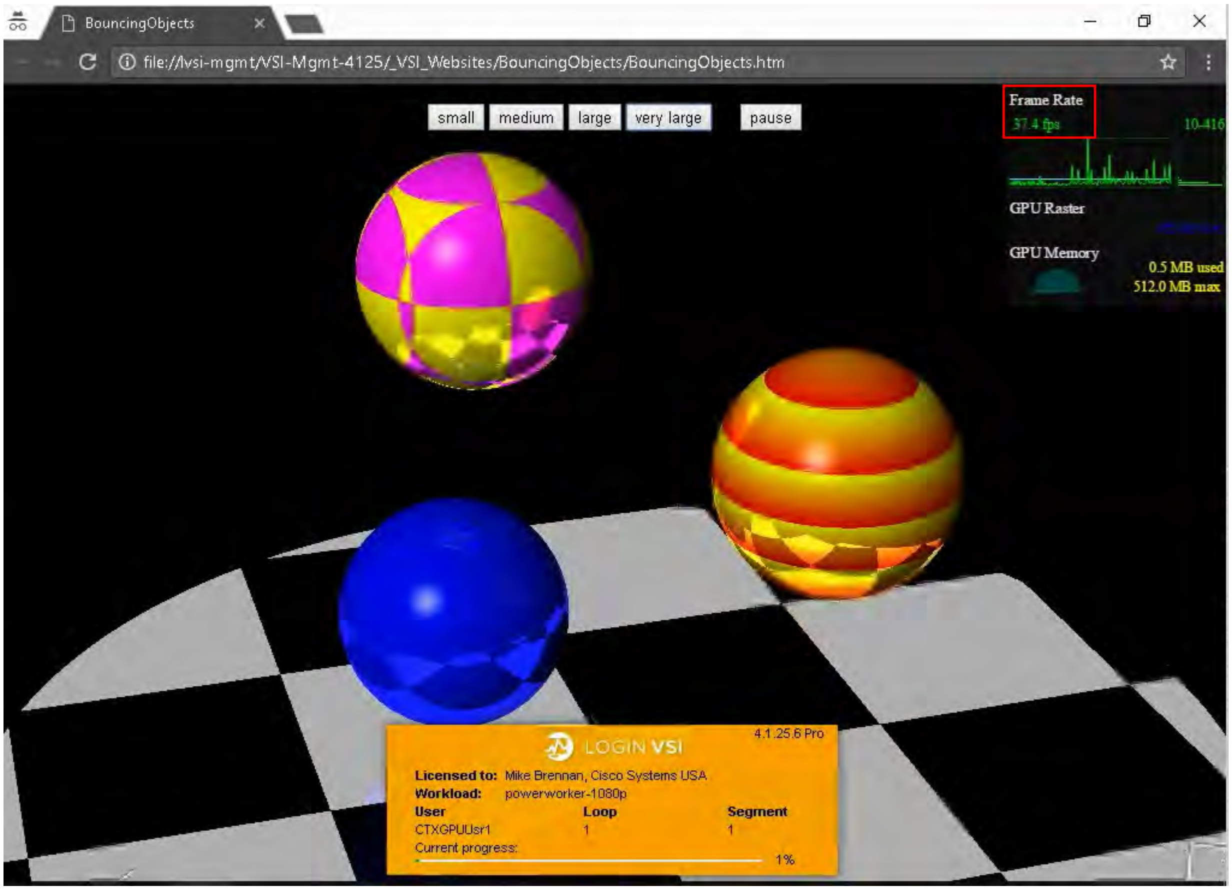
GPU Memory
0.5 MB used
512.0 MB max

Licensed to: Mike Brennan, Cisco Systems USA
Workload: powerworker-1080p

User	Loop	Segment
LoginVSI1	1	1

Current progress:
1%

Figure 63. BouncingObjects.htm FPS on desktop with vGPU



Licensed to: Mike Brennan, Cisco Systems USA
Workload: powerworker-1080p

User	Loop	Segment
CTXGPUUsr1	1	1

Current progress: 1%

Conclusion

The combination of Cisco UCS Manager, Cisco HyperFlex Data Platform 2.6, Cisco HyperFlex HX240 M5 and HX240 M5 All Flash hyperconverged nodes, Cisco UCS C240 M5 Rack Servers and B200 M5 Blade Servers, and NVIDIA Tesla cards running VMware vSphere 6.5 and VMware Horizon 7.3.2 provides a high-performance platform for virtualizing graphics-intensive workloads.

By following the configuration guidance in this document, our customers and partners can be assured that they are ready to host the growing list of graphics applications that are supported by our partners.

For more information

- Cisco UCS C-Series Rack Servers and B-Series Blade Servers:
  - http://www.cisco.com/en/US/products/ps10265/
- Cisco HyperFlex hyperconverged servers:
  - https://www.cisco.com/c/en/us/products/hyperconverged-infrastructure/hyperflex-hx-series/index.html
- NVIDIA:
  - http://www.nvidia.com/object/grid-technology.html
  - http://docs.nvidia.com/grid/latest/pdf/grid-software-quick-start-guide.pdf
  - http://docs.nvidia.com/grid/latest/pdf/grid-vgpu-release-notes-vmware-vsphere.pdf

- VMware Horizon 7.3.2:
  - https://my.vmware.com/web/vmware/info/slug/desktop_end_user_computing/vmware_horizon/7_3
  - https://my.vmware.com/web/vmware/details?downloadGroup=VIEW-732-ENT-1&productId=681&rPId=21360
  - https://www.vmware.com/content/dam/digitalmarketing/vmware/en/pdf/techpaper/vmware-horizon-view-graphics-acceleration-deployment.pdf
  - https://www.vmware.com/resources/compatibility/pdf/vi_vsga_guide.pdf
- Microsoft Windows and VMware Horizon optimization guides for virtual desktops:
  - https://labs.vmware.com/flings/vmware-os-optimization-tool
- VMware vSphere ESXi and vCenter Server 6.5:
  - http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=2033434http://pubs.vmware.com/vsphere-6-5/index.jsp
  - https://docs.vmware.com/en/VMware-vSphere/index.html

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