Technical Report–Application Guide

NetApp HCI for Dassault Systèmes CATIA

3D Immersive Engineering Design Experience

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In partnership with

Abstract

This technical report describes the value of NetApp® HCI for the Dassault Systèmes 3DEXPERIENCE focused on CATIA. It also includes best practices to use with VMware Horizon or Citrix Virtual Apps and Desktops, test validation results from SPECViewPerf 13, and sizing guidelines for use with NetApp HCI.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Executive Summary

This NetApp® HCI Solution Application Guide describes the on-premises end-user compute (EUC) environment for Dassault CATIA (Computer Aided Three-Dimensional Interactive Application), which provides 3D product lifecycle management.

CATIA supports multiple stages of product development, from conceptualization through engineering (CAE), design (CAD), and manufacture (CAM), to service and manufactured products. NetApp HCI is the perfect infrastructure to preserve your CATIA V5 engineering environment and data while managing your design projects collaboratively with teams working remotely via powerful EUC solutions.

NetApp HCI virtual desktop infrastructure (VDI) and EUC solutions help to ensure your business growth, flexibility, and responsiveness to changing world and business conditions. As a Dassault CATIA V5 user, with NetApp HCI you have full connectivity to optimize the power user's 3D experience on premises with data connectivity to the cloud.

Today's automotive industry is digitizing yesterday's automation and design optimization to quickly develop a host of new technologies, from autonomous electric cars to beautiful new automotive styling. To compete in this new market landscape, auto manufacturers are using Dassault CATIA on virtual, remote high-end graphics systems for engineers to reimagine design and manufacturing methodologies. With NetApp EUC and VDI solutions for CATIA 3D modeling tools, mechanical engineers can use the power of 3D visualization to gain deeper insight into key factors of quality and performance early in the product development phase. With CATIA on NetApp HCI EUC and VDI, we provide the platform that enables automotive engineers to create any type of 3D assembly for a wide range of engineering processes.

Key benefits of Dassault CATIA on NetApp HCI with EUC and VDI include:

- Streamline design, production, distribution, and service for lower costs and improved time to market with a single infrastructure that addresses a wide range of roles and personas while scaling independently on demand.
- Real-time low latency 3D modeling and simulations, anywhere. Horizon or Citrix EUC makes it possible for 3D models to be shared in real time, anywhere from the board room to the shop floor.
- The NetApp HCI infrastructure delivers industry-leading price/performance at scale.

NetApp HCI EUC and VDI solutions enable the rich features available with Dassault CATIA V5, including:

- Improved information and intelligence with full product visualization
- Improved design-manufacturing communication between internal employees and external agencies and suppliers
- Insight into key factors of quality and performance early in the product development phase
- Digital prototyping, combined with digital analysis and simulation, allows product development teams to virtually create and analyze a mechanical product in its operating environment
- Smooth evolution from 2D- to 3D-based design methodologies
- Advanced technologies for mechanical surfacing, based on a powerful specification-driven modeling approach
- Addresses a wide range of roles and user personas

2 NetApp HCI for Digital Workspace Overview

Dassault 3DEXPERIENCE offers a seamless experience across and beyond the design environment with access-from-anywhere collaboration. NetApp HCI digital workspace solutions with Citrix and VMware provide flexibility to access desktop operating systems (OSs) running on virtual hardware (single session per machine). They can also provide access to desktop environments running on server OSs (multiple sessions per machine) and/or access to just the applications hosted on either server or desktop OSs for

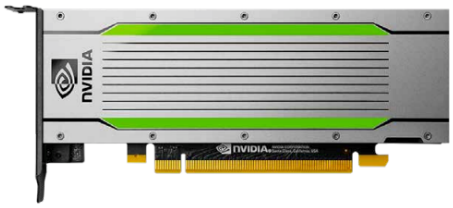
task workers. Now a single infrastructure can deliver applications to factory users, advanced office workers, and highly demanding engineering designers with guaranteed service and performance levels.

The value of NetApp virtual desktop infrastructure solutions is expanded in the digital workspace, which delivers single sign-on access from anywhere to enterprise apps, software-as-a-service (SaaS) based applications, and intranet applications.

NetApp HCI is a cluster of nodes with independent scalability of compute and storage to optimize your resource utilization, performance, and cost. NetApp HCI storage optimization dramatically reduces storage costs with industry-leading thin provisioning, in-line deduplication, compression, and compaction features to reduce storage demand. NetApp HCI H610S contains NVMe storage, which supports 65,535 queues and 65,536 commands per queue per disk. And NetApp all-flash storage provides significantly better performance than traditional disk-based storage systems.

NetApp HCI compute is available on H410C, H610C, and H615C nodes. For CATIA V5 engineering applications, NetApp recommends the H615C, which is based on Intel's second-generation scalable processor family with Speed Select Technology and support for three NVIDIA T4 GPU cards for the most demanding 3D design flows. Figure 1 shows technical specifications of a single GPU on H615C.

Figure 1) NetApp HCI H615C single GPU specifications.



SPECIFICATIONS	
GPU Architecture	**NVIDIA Turing**
NVIDIA Turing Tensor Cores	**320**
NVIDIA CUDA® Cores	**2,560**
RT Cores	**40**
Memory Size	**16 GB GDDR6**
Memory BW	**Up to 320 GB/sec**
vGPU Profiles	**1 GB, 2 GB, 4 GB, 8 GB, 16 GB**
Form Factor	**PCIe 3.0 single slot (half height & length)**
Power	**70 W**
Thermal	**Passive**

A single H615C GPU has 40 RT cores that provide the computation needed to deliver real-time ray tracing. The same server model used by designers and engineers can now also be used by artists to create photorealistic imagery that features light bouncing off surfaces just as it would in real life. This RTX-capable GPU produces real-time ray tracing performance of up to 5 gigarays per second. When combined with Quadro Virtual Data Center Workstation software, the NetApp HCI H615C GPU enables artists to create photorealistic designs with accurate shadows, reflections, and refractions on any device from anywhere.

CATIA Live Rendering gives designers and engineers an intuitive means of creating images that rival photographs, in a fraction of the time previously required. Assemblies of every size can be interactively rendered directly in CATIA, due to the parallel processing architecture of NVIDIA GPUs.

CATIA can render complex models with realistic reflections and refractions to empower users with instant insight. A single H615C server supports up to 24 users who view the models, and up to 6 designers.

The minimum size of NetApp HCI is two storage nodes and two compute nodes. Additional storage or compute nodes can be easily added to expand the cluster. NetApp HCI does not need to be dedicated to single application; it is typically used for workload consolidations, and it supports mixing various nodes. Quality of service provides guaranteed performance with lower and upper limits. And NetApp HCI allows bursts of short duration if the workloads accumulate credit while running below the upper limits.

3 Digital Workspace with GPU

Many companies have employees and contractors around the globe who collaborate with subject matter experts via video conferencing and need to watch training videos. Applications like CATIA require GPU to enhance performance.

Citrix Hypervisor and VMware vSphere are the popular choices for running the virtual machines (VMs) required for the digital workspace.

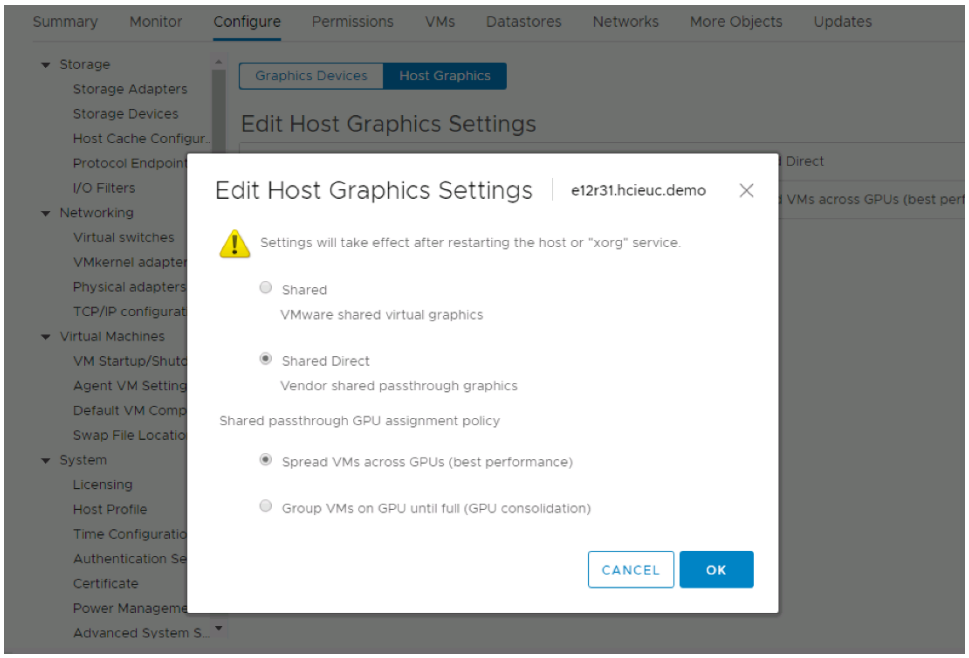
VMware vSphere supports GPU consumption with one of the following options:

- Shared mode (vSGA)
- Shared Direct (NVIDIA vGPU)
- Dedicated (vDGA)

Shared mode supports most of the virtualization features, but it is limited in terms of application compatibility support. Dedicated mode offers performance similar to bare metal systems, but it has limited virtualization features.

Shared Direct mode is the preferred solution because it provides the flexibility of vSGA and performance similar to vDGA. This mode is not the default option, and the virtualization administrator needs to enable it on each GPU.

Figure 2) Shared Direct mode.



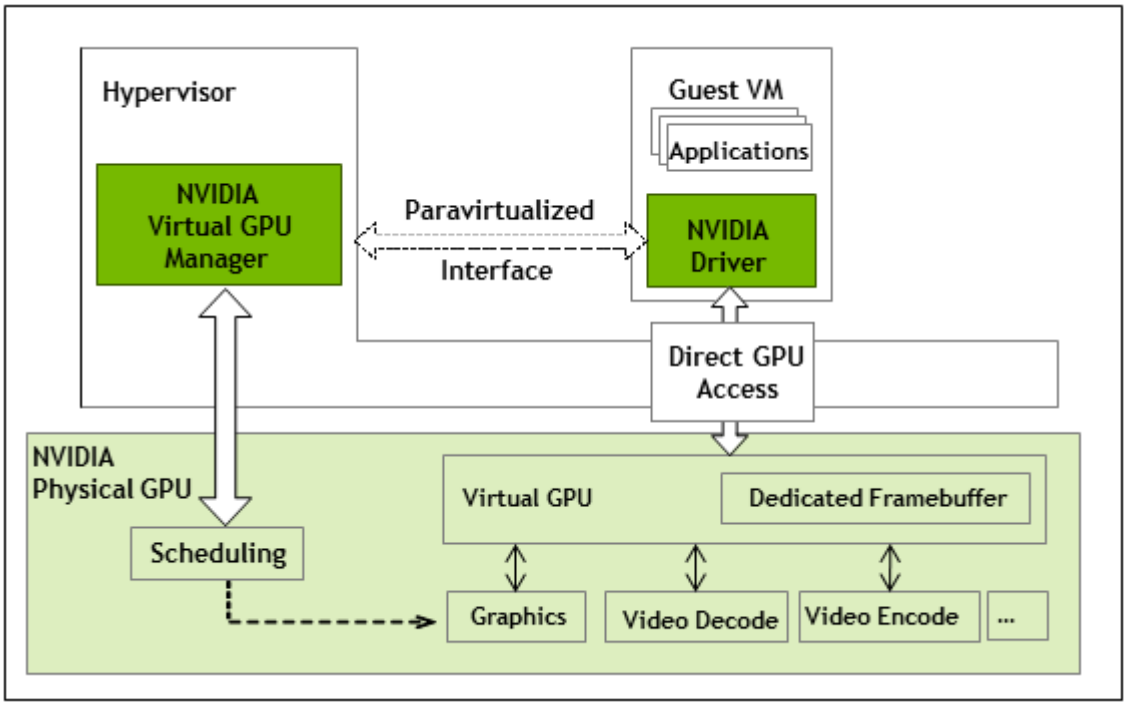
The vMotion feature of VMware vSphere adds high availability to VMs. With VMware vSphere 6.7 Update 1 and later, vMotion is supported even for the VMs that include NVIDIA vGPU.

Note: The vCenter Advanced `vgpu.hotmigrate.enabled` setting must be set to Enabled.

The NetApp HCI graphics adapter can be consumed by the VM with one of the following options:

- **Fraction of GPU.** Share the GPU resources among VMs (one to many).
- **Whole single GPU.** Dedicated access to GPU for a single VM (one to one).
- **Multiple GPU.** Multiple GPUs presented to a single VM (many to one).

Figure 3) NVIDIA vGPU internal architecture.



NVIDIA GRID software installed on a hypervisor manages the scheduling of GPU resources among various VMs. Each VM has its own dedicated frame buffers based on allocation. The GPU and the video encoder and decoder are shared resources that are controlled by the scheduling policy.

The time slicing of resources allows users to get the same level of performance even when sharing the resources. This is due to user "think time," which includes any time the user is not actually interacting with the application. Adding up all the time away from the application (meetings, lunch, out of office, and so on) means even more benefits from the shared resources. These benefits equate to more resources for the user's session and typically a more responsive application, thus a better experience for the end user.

The vGPU scheduling policies are:

- **Best Effort (default option).** Consistent performance at higher scale reduces TCO per user.
- **Equal Share.** Fair share of GPU resources for running VMs.
- **Fixed Share.** Guarantees the same dedicated quality of service at all times.

In the Best Effort scheduling policy, the GPU is shared among running VMs using the round robin method. The GPU idle time is shared among the running VMs. The downside is that one heavily loaded VM can affect the performance of other lightly loaded VMs on that GPU.

Equal Share scheduling allocates GPU resources equally to all running VMs. vGPU performance depends on the number of VMs running on that GPU.

Fixed Share scheduling assigns the share of resources based on the vGPU profile (frame buffer memory size). A VM with T4-4Q profile gets 25% of resources, and T4-8Q gets 50%. vGPU performance is not affected by the number of VMs that are powered on.

For low-latency requirements, a shorter time slice is preferred when using with Equal Share or Fixed Share scheduling policy. For more information, see the NVIDIA Virtual GPU Software Documentation site.

Users consume VMs running CATIA using Quadro Virtual Data Center Workstation hosted on VMware Horizon or Citrix Virtual Apps and Desktops. Task workers who use CATIA predominately for their work might be presented with a hosted application that is similar to the mobile application.

With Quadro Virtual Data Center Workstation, users have the native experience, including the use of nView Desktop Manager, which allows CATIA users to organize the desktop view based on their preferences and quickly change to other views by using keyboard shortcuts.

VMware Horizon Client and Citrix Workspace support client USB redirection, which enables CATIA users to use any supported accessories, such as 3DConnexion SpacePilot Pro Mouse.

Citrix HDX and VMware Blast Extreme display protocol support both H.264 and High Efficiency Video Coding (H.265), even on low-bandwidth and high-latency networks.

4 Sizing Guidelines for Virtual Workstations

Engineers and designers in industries ranging from automotive and aerospace to consumer-packaged goods can fully leverage the power of the Dassault Systèmes 3DExperience platform with NetApp HCI VDI with NVIDIA for professional graphics solutions.

The Quadro Virtual Data Center Workstation provides the flexibility to adapt new technologies with very little interruption to work. The growing demands of 4K displays push the need for large frame buffers on GPU.

Because user behavior varies based on role, and usage of tools impacts the usage of GPU and its resources, the user types are divided into three categories, as shown in Table 1.

Table 1) CATIA user types.

User Type	Description	Number of Users per H615C
Light	• View only or full application • Accessing individual parts or assemblies	12 or 24
Medium	• View only and full application • Accessing medium assemblies	6 or 12
Heavy	• Full application • Accessing large assemblies or full model	3

For performance-oriented goals, choose the lower recommended number per server. For TCO goals, choose the higher recommended number per server. If you're not sure which one to choose, you can perform a proof of concept to identify the frame buffer requirements. Table 2 shows sizing information based on frame buffer as well as display resolution requirements.

Table 2) vGPU profiles.

vGPU Profile	Frame Buffer (GB)	Maximum vGPU per T4 GPU	Maximum vGPU per H615C server	Display Resolution	Virtual Displays per vGPU
T4-16Q/T4-16A	16	1	3	7680x4320	2
				5120x2880 or lower	4
T4-8Q/T4-8A	8	2	6	7680x4320	2
				5120x2880 or lower	4
T4-4Q/T4-4A	4	4	12	7680x4320	1
				5120x2880 or lower	4
T4-2Q/T4-2A	2	8	24	7680x4320	1
				5120x2880	2
				4096x2160 or lower	4
T4-1Q/T4-1A	1	16	48	5120x2880	1
				4096x2160	2
				3840x2160	2
				2560x1600 or lower	4

Based on the number of VMs per server, select the appropriate Speed Select setting for CPU cores. For heavy users, the number of VMs per server is low, so the 8-core option can be selected to achieve higher CPU frequency, which improves performance.

With NetApp HCI, the storage system is flash-based and has 25GbE connectivity to the storage system to provide high bandwidth while working on large datasets.

As users change roles, the VM configuration needs to be monitored and adjusted for high demands. The use of the compute engine, the frame buffer, and the encoder and decoder can all be monitored and logged through a CLI called the NVIDIA System Management Interface (nvidia-smi), accessed on the hypervisor or within the VM.

In addition, NVIDIA vGPU metrics are integrated with Windows Performance Monitor (PerfMon) and through management packs like VMware vRealize Operations. Updated versions of Windows 10 include GPU metrics in the Performance tab on Task Manager.

To identify bottlenecks of individual end users or of the physical GPU serving multiple end users, execute the following nvidia-smi commands on the hypervisor.

VM frame buffer utilization:

```
nvidia-smi vgpu -q -l 5 | grep -e "VM ID" -e "VM Name" -e "Total" -e "Used" -e "Free"
```

VM GPU, encoder and decoder utilization:

```
nvidia-smi vgpu -q -l 5 | grep -e "VM ID" -e "VM Name" -e "Utilization" -e "Gpu" -e "Encoder" -e
"Decoder"
```

Third-party monitoring solutions such as ControlUp, Lakeside SysTrack, Liquidware Stratusphere UX, and eG Innovations eG Enterprise can provide better operational experience.

5 Validation

We validated the solution using the SPECViewPerf 13 tool along with NVIDIA nVector Toolset to automate the provisioning and performance measurements across all VMs. We tested for the worst-case scenario by simulating simultaneous workload operations across all GPUs while maximizing the performance demands for all vGPUs.

Our testing verified the following values with NetApp HCI VDI solutions for Dassault CATIA users:

- High user density with low graphic demands. NetApp HCI delivers strong resource utilization and scalability for knowledge workers while offering expansion to address high-graphics-demand users. This scalability enhances the value of engineering systems to service the full range of users from the same platform.
- Excellent linear scalability with consistent performance and user experience when scaling for CATIA designers.
- Real-time user experience. Testing produced data verifying that user experiences for graphics users extends to high-end engineering CATIA design users. This test data further verifies the following NetApp HCI VDI values for CATIA engineering design users:
  - High-resolution quality for all users as verified with tests for multiple 4K monitors
  - Excellent user visualization and color consistency across all vGPUs as verified with tests for color accuracy
  - Excellent frame rates delivering optimal motion smoothness for CATIA user images across all vGPUs
  - Low latency for high-end users
- Excellent GPU utilization options for CATIA that offloads CPU utilization for effective resource utilization that scales. The test data covers two configuration variations. The first variation, tested with Citrix Virtual Apps and Desktops, includes multiple server loads for high-end graphics users distributed across three vGPUs per physical GPU. The second variation, tested with Horizon 7, includes workloads for high-end graphics users with full physical GPU utilization.

We included two test cases. One test maxed out the complete frame buffer on a single GPU for the designer use case, and the other used 25% of frame buffer, which is 4GB for typical CATIA users who use monitors at 4K resolution.

The catio-05 viewset was created from the traces of the graphics workload generated by the CATIA V6 R2012 application from Dassault Systèmes. Model sizes range from 5.1 to 21 million vertices.

The viewset includes numerous rendering modes supported by the application, including wireframe, anti-aliasing, shaded, shaded with edges, depth of field, and ambient occlusion.

Viewset tests:

- Race car shaded with ambient occlusion and depth of field effect
- Race car shaded with pencil effect
- Race car shaded with ambient occlusion
- Airplane shaded with ambient occlusion and depth of field effect
- Airplane shaded with pencil effect
- Airplane shaded

- Airplane shaded with edges
- Airplane shaded with ambient occlusion
- SUV1 vehicle shaded with ground reflection and ambient occlusion
- SUV2 vehicle shaded with ground shadow
- SUV2 vehicle shaded with ground reflection and ambient occlusion
- Jet plane shaded with ground reflection and ambient occlusion
- Jet plane shaded with edges with ground reflection and ambient occlusion

We validated with VMware Horizon 7 and Citrix Virtual Apps and Desktops 1909 edition environments. In the case of VMware Horizon, the NVIDIA nVector tool used Direct Connection Agent. For full information about environment details, see NVA-1140 and TR-4792.

Figure 4) CATIA composite score for VMware Horizon environment.

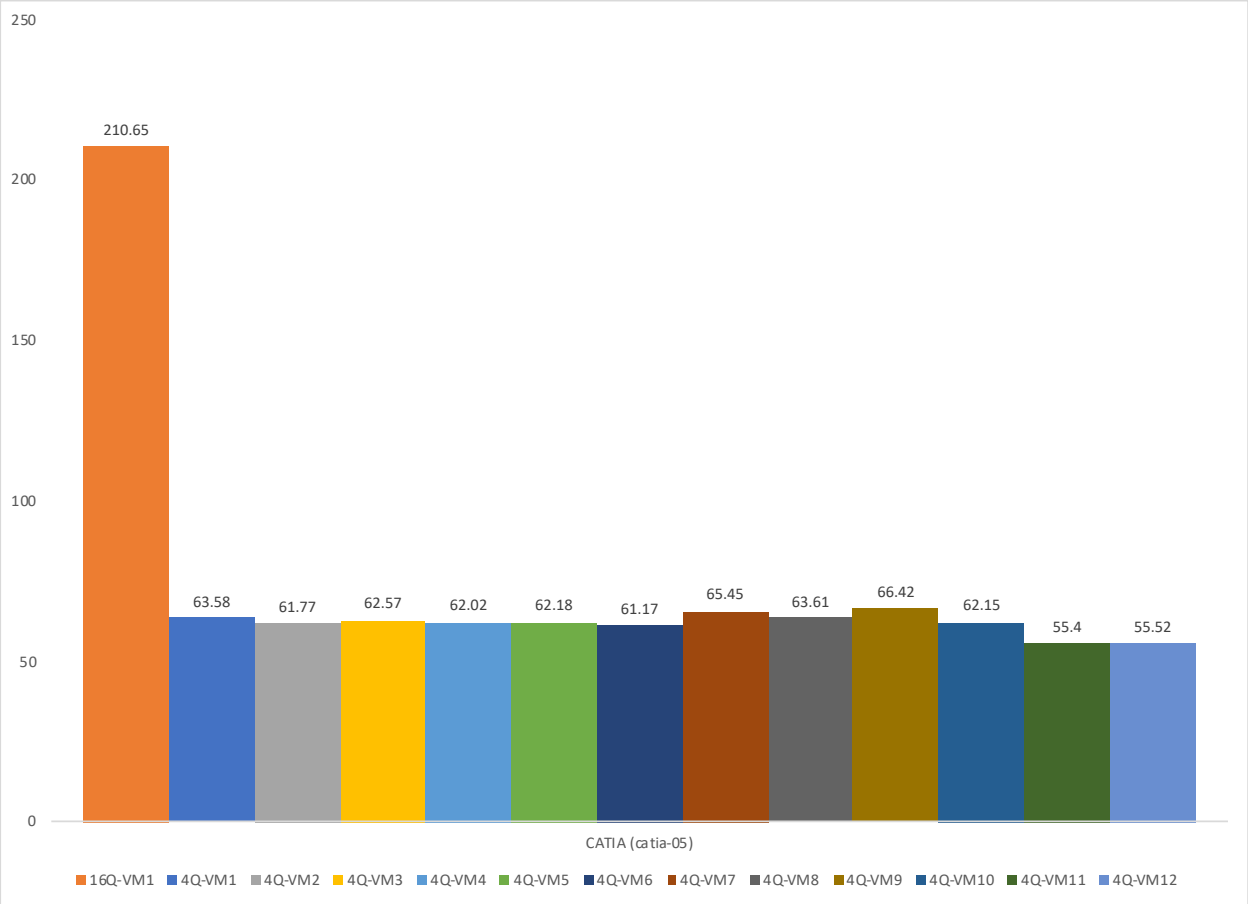
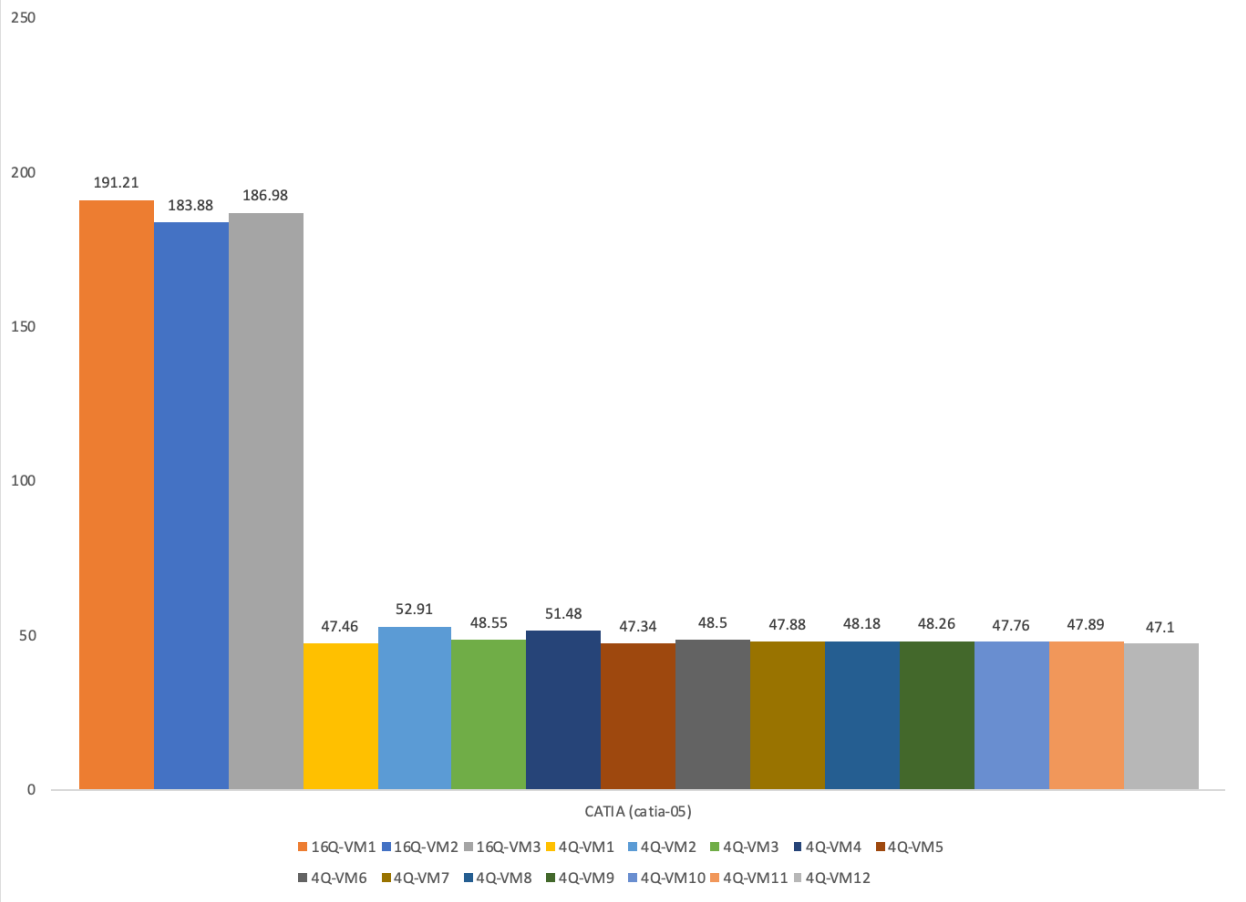


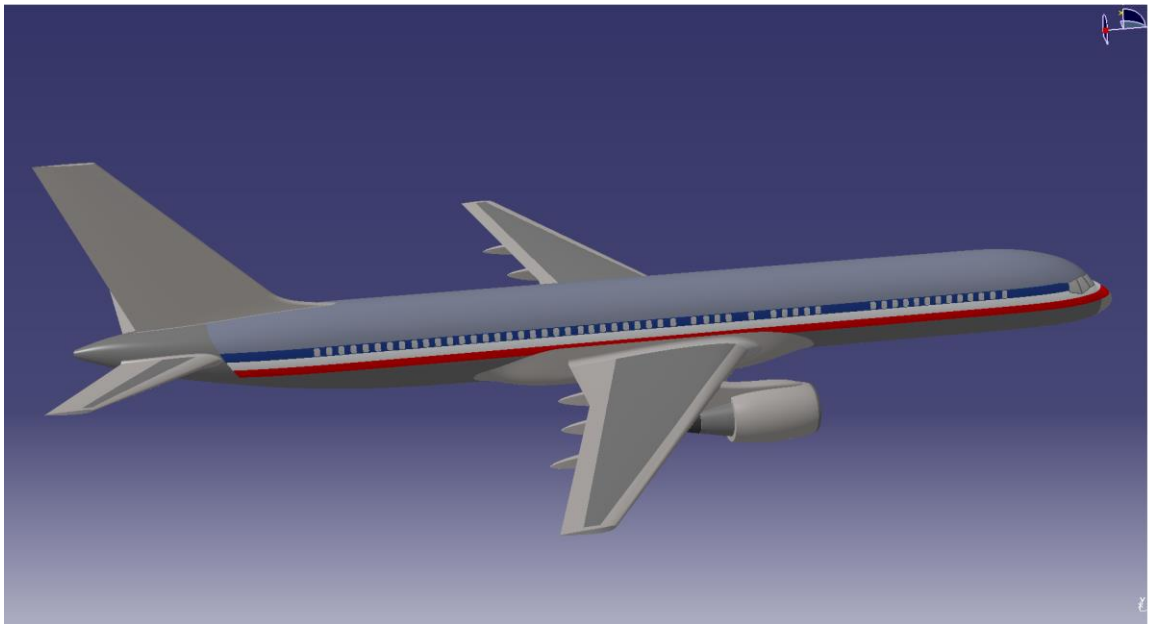
Figure 5) CATIA composite score for Citrix Virtual Apps and Desktops environment.



We noticed that the designer VM that has a 16GB frame buffer produced more than three times the performance of a typical CATIA users who is using a 4GB frame buffer.

Figure 6 shows a sample screenshot of workload taken during the test.

Figure 6) Viewset sample.



Where to Find Additional Information

To learn more about the information that is described in this document, review the following documents and/or websites:

- NetApp HCI Datasheet
  https://www.netapp.com/us/media/ds-3881.pdf
- NVA-1140 NetApp HCI for Citrix Virtual Apps and Desktops
  https://www.netapp.com/us/media/nva-1140-design.pdf
- NetApp HCI for Virtual Desktop Infrastructure for VMware Horizon 7
  https://www.netapp.com/us/media/tr-4792.pdf
- NetApp HCI for End-User Computing with VMware and NVIDIA GPUs
  https://www.netapp.com/us/media/nva-1129-deploy.pdf
- 3DS Certified Configurations for VDI
  https://www.3ds.com/support/hardware-and-software/certified-configurations-for-vdi/
- NVIDIA vGPU Software Documentation
  https://docs.nvidia.com/grid/index.html
- NVIDIA Quadro Virtual Workstation Documentation
  https://docs.nvidia.com/grid/qvws/latest/index.html
- NVIDIA Grid 3DS Catia v5/v6 Scalability Guide
  https://www.nvidia.com/content/dam/en-zz/Solutions/design-visualization/solutions/resources/documents1/161107-vGPU-Scale-Guide-CATIA.pdf
- NVIDIA Management and Monitoring
  https://www.nvidia.com/en-us/data-center/virtualization/it-management/
- Dassault Systèmes CATIA
  https://www.3ds.com/products-services/catia/
- SPECviewperf 13 benchmark
  https://www.spec.org/gwpg/gpc.static/vp13info.html

- NVIDIA nView Desktop Management
  https://www.nvidia.com/en-us/design-visualization/solutions/nview-display/

Version History

Version	Date	Document Version History
Version 1.0	May 2020	Initial release.

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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