TECHNICAL WHITEPAPER

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HP ZCENTRAL AND NVIDIA OMNIVERSE™

CONCEPTS, CONFIGURATIONS, ARCHITECTURES AND DEPLOYMENTS

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1. SUMMARY

HP ZCentral Remote Boost[1] is an Emmy®-award-winning solution that allows Creators to remotely and securely connect powerful Z Workstations back in the office or data center from their laptop, desktop PC, thin client, or even Mac®. HP ZCentral Remote Boost is trusted by the top Media and Entertainment experts and is widely deployed across many segments including Product Design, Energy, Data Science, Architecture / Engineering and Construction and others. HP has been working closely with these industries to optimize functionality and performance for over 15 years.

NVIDIA Omniverse™[2] is a cloud-native, multi-GPU enabled open platform for virtual collaboration and real-time physically-accurate, photorealistic simulation. Creators, designers, and engineers can now unite their assets, libraries, and software applications, freely iterate on design concepts in real time, and instantly share, high-fidelity models to any device. Creators can accelerate any workflow with interoperability between content creation applications, and teams can experience seamless collaboration in an interactive, simulated world—even when using multiple software suites.

Together, HP's ZCentral remote computing solution and NVIDIA Omniverse™ enabled real-time remote work and virtual collaboration and is used by HP for internal projects and demonstrations for Customers.

2. SCOPE

This whitepaper will describe HP ZCentral and Omniverse Concepts, Applications and workflows supported, typical HP ZCentral-based configurations, and details for setting up an Omniverse deployment. The intended audience are Creators, Studios and their IT professionals.

3. HP ZCENTRAL AND NVIDIA OMNIVERSE™ CONCEPTS

HP ZCentral Remote Boost allows Creators to access remote resources in a seamless and highly-performant way. It is an excellent "front end" to the NVIDIA Omniverse™, as described below.

NVIDIA's Omniverse™ allows groups of collaborators, from 2 people to ten or more, to simultaneously edit project files using different content creation applications such as Autodesk® Maya®, 3ds Max®, Revit, Trimble SketchUp, Unreal® Engine 4 and many others. Individual assets are synchronized in real-time by Omniverse to provide a cohesive view of the overall project to all involved. Prior to Omniverse, Creators would typically edit their portion of the project, check those models into a file share somewhere, and then manually combine all the individual changes into a common model. This took a lot of time and was error prone - Omniverse helps eliminate many of those steps with no data preparation or model decimation. The five core components of Omniverse are shown below in **Figure 1**. This whitepaper currently does not directly address the Simulation or Kit components of NVIDIA Omniverse™.

Figure 1.

Nucleus	Connect	Kit	Simulation	RTX Renderer
Allows Creators to store, share, and collaborate on project data and provides the unique ability to collaborate live across multiple applications. Nucleus works on a local machine, on premises, or in the cloud.	Opens the portals that allow content creation tools to connect to the Omniverse platform and save USD and MDL content. With Omniverse, users continue to work in their favorite industry software applications.	The powerful toolkit for developers to create new Omniverse Apps and extensions. Kit Extensions are plugins to Omniverse Kit that extend its capabilities for developers to enhance their workflows and UI.	Powered by core NVIDIA® technologies that simulate the world including PhysX®, Flow, Blast, and Rigid Body Dynamics.	An advanced, multi-GPU renderer based on NVIDIA RTX™ that supports both real-time ray tracing and ultra-fast path tracing.

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A good example of such a project using Omniverse Create App is shown in **Figure 2**. In this illustration, one of the creators is using Unreal Engine 4 to generate the overall scene, another is using Adobe Substance Painter to paint a texture on the brick wall, and the third is modeling the countertop in Autodesk Maya. All of these are combined into one shared database and rendering that can shared back to the individual creators or to stakeholders using various approaches.

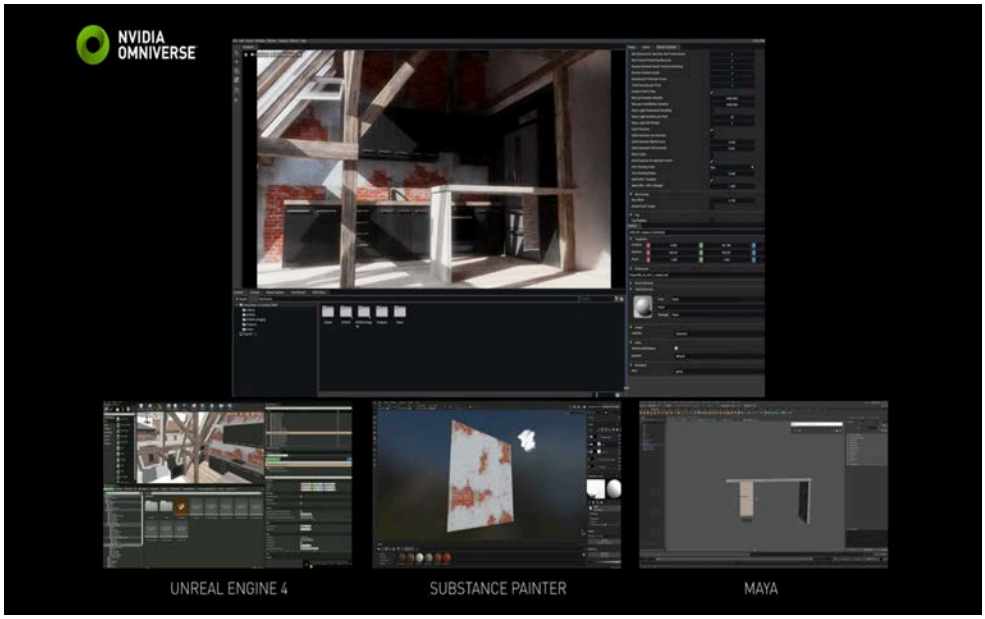

Figure 2.

There are many possible HP ZCentral and NVIDIA Omniverse™ architectures that would support this kind of interaction. One example is shown in **Figure 3.**

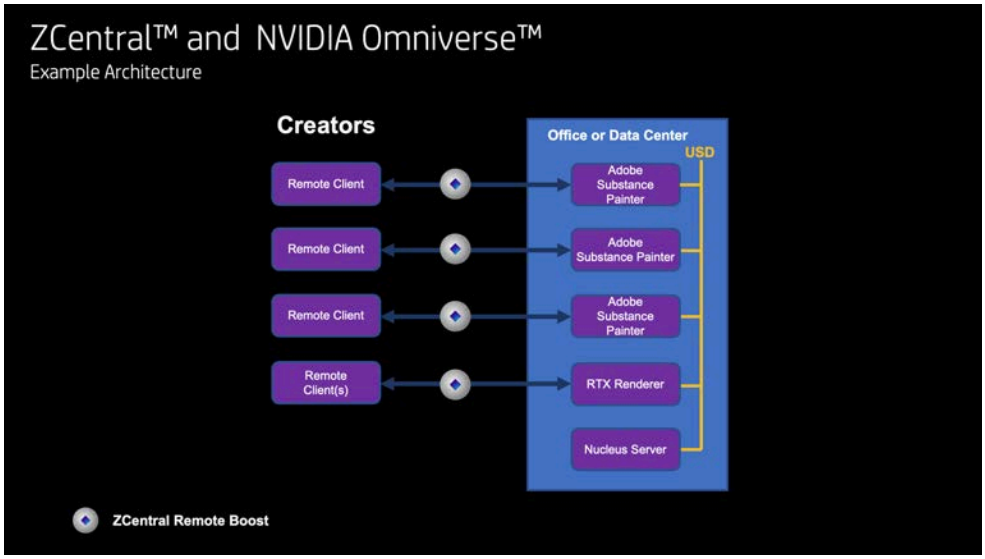

Figure 3.

In **Figure 3,** the remote Creators are accessing applications that are running on systems that are configured appropriately to run the apps in the Office or Data Center. In this example the apps are Epic Unreal Engine 4, Adobe Substance Painter and Autodesk® Maya®. In addition, the RTX Render node is dedicated to generating a high-quality rendering of the overall scene and can be accessed by ZCentral Remote Boost.

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This particular architecture would be useful if the Creators did not have local access to computers that were capable of running the desired applications or have the capacity for the 3D models they were using. The Creators are using **HP ZCentral Remote Boost** on their local clients to access the Data Center systems and applications. These local clients could range from entry level laptops to desktop PCs to Apple Macs. The key takeaway is that they don't have to be configured specifically to run the target applications - those are running on the systems in the Office or Data Center. In addition to being optimally configured for the target applications, the Data Center systems likely share a high-performance local network to optimize file and data transfer. Note that the Data Center could be owned by the Creators' company or it could be provided as a service from a 3rd party.

Note the yellow connections marked "**USD**" and the Nucleus Server in **Figure 3.** This is really the core of Omniverse ecosystem. Pixar's Universal Scene Description (USD) is a framework for interchange of 3D geometry, lights, materials, textures and other data that describe virtual worlds and their evolution through time. The open-source 3D scene description and file format is easily extensible, originally developed to simplify content creation and the interchange of assets between different industry software tools. Many 3D Creation applications are "USD Enabled" and with the right plugins can be brought into Omniverse.

NVIDIA Omniverse™ Nucleus stores the shared 3D model in USD format, and keeps all the applications synchronized in real-time as they individually make changes. In addition to creation apps, Omniverse can support renderers and microservices to do physics calculations, for example.

NVIDIA Omniverse **RTX™ Renderer** is shown at the bottom of the **Figure 3.** This function is an integral part of Omniverse. The RTX Renderer takes the synchronized USD data from the Nucleus server and generates renderings of the combined scene. These renderings can be of extremely high-quality using ray-traced or path-traced techniques and performance can be scaled using an arbitrary number of RTX GPUs. In addition to access via ZCentral Remote Boost, RTX Renderer can publish images in a WebRTC format so that the Creators or other stakeholders can see these high-quality renderings in a standard browser, running on almost any device.

It should be noted that RTX Renderer doesn't have to run on a dedicated system. It can run on any system that has RTX graphics that has a network connection to the Nucleus Server. That will be discussed in more detail later.

Figure 4 has a slight twist in that one of the remote Creators is running their application locally and the rest are using systems in the Office or Data Center. This would be the case when some remote Creators have local access to capable machines and some of the Creators do not.

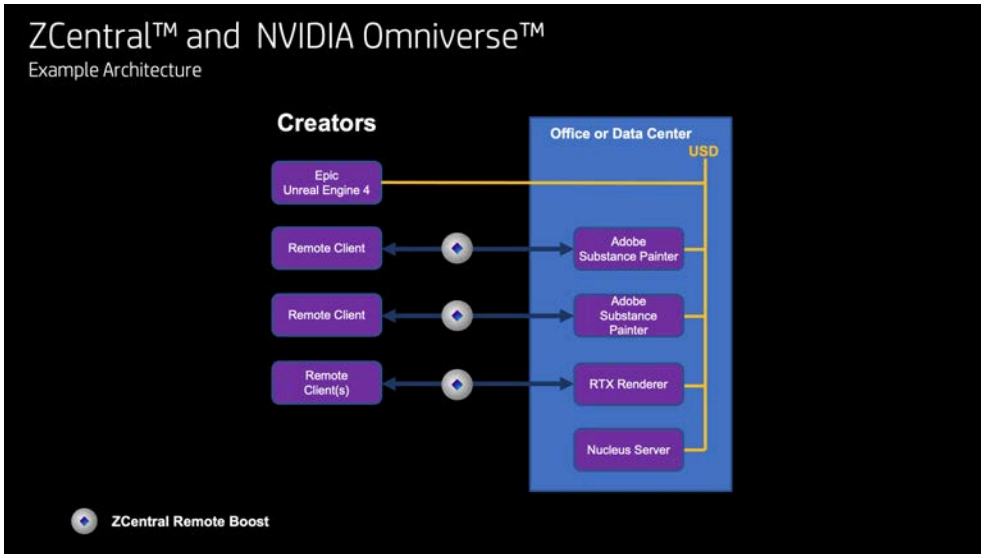

Figure 4.

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4. APPLICATIONS SUPPORTED

Table 1 lists the applications that currently or will soon be supported. This list of applications is expected to rapidly expand.

Application	Version	Supported OS's
Adobe Photoshop	CC	Windows
Autodesk 3ds Max	2018 or later	Windows
Autodesk Maya	2018 or later	Windows, Linux CentOS 7
Autodesk MotionBuilder (Coming Soon)	2018 or later	Windows
Autodesk Revit (export only)	2019 or later	Windows
Blender	TBD	TBD
DS Solidworks	TBD	TBD
Epic Games Unreal Engine 4	4.24 or later	Windows
Esri ArcGIS CityEngine (Coming Soon)	TBD	TBD
Graphisoft Archicad	Archicad 24	Windows
Kitware ParaView	ParaView 5.9	
Marvelous Designer (Coming Soon)	TBD	TBD
McNeel Rhino including Grasshopper	Rhino 6 or later	Windows, Linux
PTC OnShape (Coming Soon)	TBD	TBD
Reallusion Character Connector	3.41 or later	Windows
SideFX Houdini (Coming Soon)	18.5 or later	Windows
Substance Designer	2020 or later	Windows
Substance Painter	2018 or later	Windows
Substance Source (Coming Soon)	TBD	TBD
Trimble SketchUp	2019 or later	Windows

Table 1.

NVIDIA® has built extensions and additional software layers on top of the open-source USD distribution that allow DCC tools and compute services to communicate easily with each other through the Omnivers Nucleus Server. Those extensions and additions and the application plugins that make use of them are collectively known as NVIDIA Omniverse™ Connect.

The NVIDIA Omniverse™ Connect plugins for the various application are listed and described in detail here: https://docs.omniverse.nvidia.com/con_connect/con_connect/overview.html. The plugins can be downloaded and installed through the Omniverse Installer, which is described in section 6.

Omniverse Apps

In addition to the 3rd party applications in Table 1, Creators can take advantage of Omniverse Apps – purpose-built for specific industries or workflows. Details about some of the key applications are below:

- NVIDIA Omniverse™ **Create** – Allows Creators users to assemble, light, simulate and render large scale scenes. https://docs.omniverse.nvidia.com/app_create/app_create/overview.html
- NVIDIA Omniverse™ **View** – Powerful toolkit designed to visualize architectural and engineering projects https://docs.omniverse.nvidia.com/app_view/app_view/overview.html
- NVIDIA Omniverse™ **Audio2Face** - AI based technologies that generate facial motion and lip sync https://docs.omniverse.nvidia.com/app_audio2face/app_audio2face/overview.html
- NVIDIA Omniverse™ **Kaolin** - Accelerates 3D Deep Learning research https://developer.nvidia.com/graphics-research-tools
- NVIDIA Omniverse™ **Isaac Sim** (Coming soon) https://developer.nvidia.com/isaac-sim (developer access needed to view)
- NVIDIA Omniverse™ **Machinima** (Coming soon) https://www.nvidia.com/en-us/geforce/machinima/

This list is being updated and the current list and details about these can be found here: https://docs.omniverse.nvidia.com/index.html

5. CONFIGURATIONS

Given the broad set of capabilities and architectures of the NVIDIA Omniverse™ platform, there are a myriad of potential configurations – too many to fully describe here. That said, here are a few configurations that might be useful. An "Individual User" single system configuration is shown in **Figure 5** and a "Small Workgroup" is shown in **Figure 6.**

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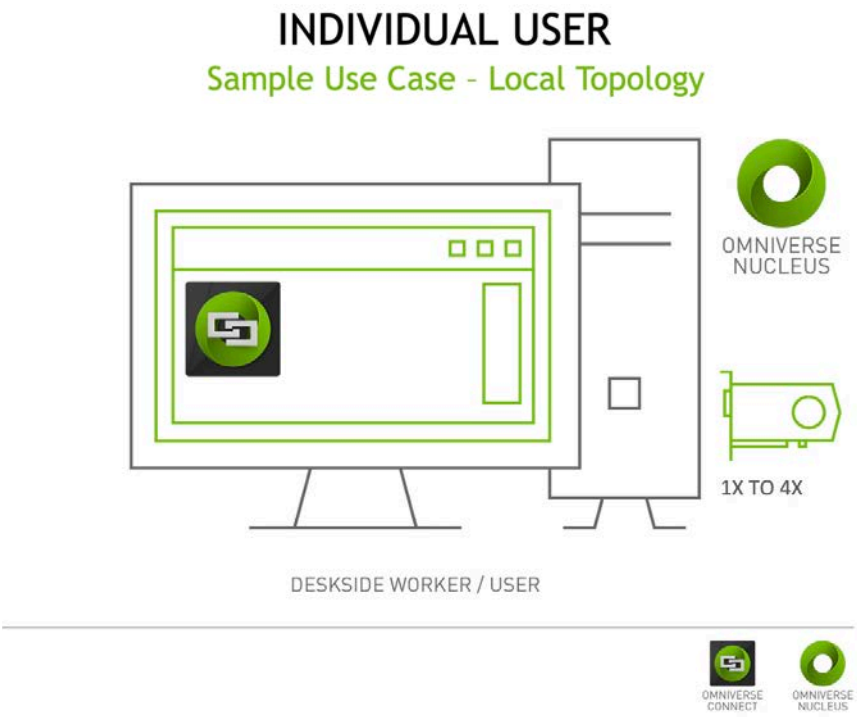

Figure 5. Individual User

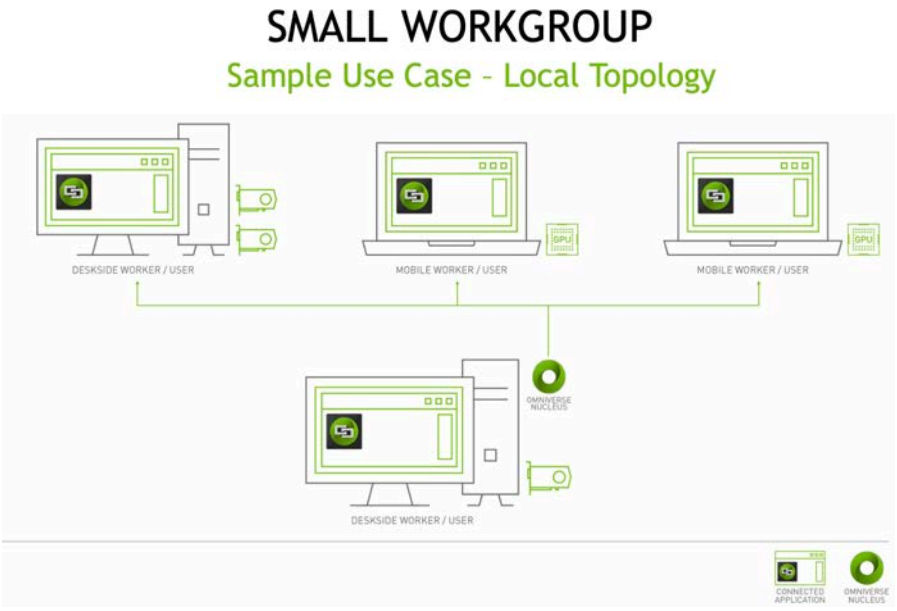

Figure 6. Small Workgroup

The functional components that make up those configurations are discussed below.

Functional Components

As described in the Concepts section, a basic Omniverse deployment contains the following components. "Good" and "Better" recommendations are indicated where it makes sense.

- Remote Clients
- Application nodes
- Nucleus Server™
- Omniverse RTX™ Renderer node or nodes

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These components are arranged in a particular architecture in **Figure 7** below, but many alternate arrangements are possible, as mentioned. Z Central Remote Boost Sender and Receiver and NVIDIA Omniverse™ Connect are shown separately and have specific considerations for the nodes on which they run.

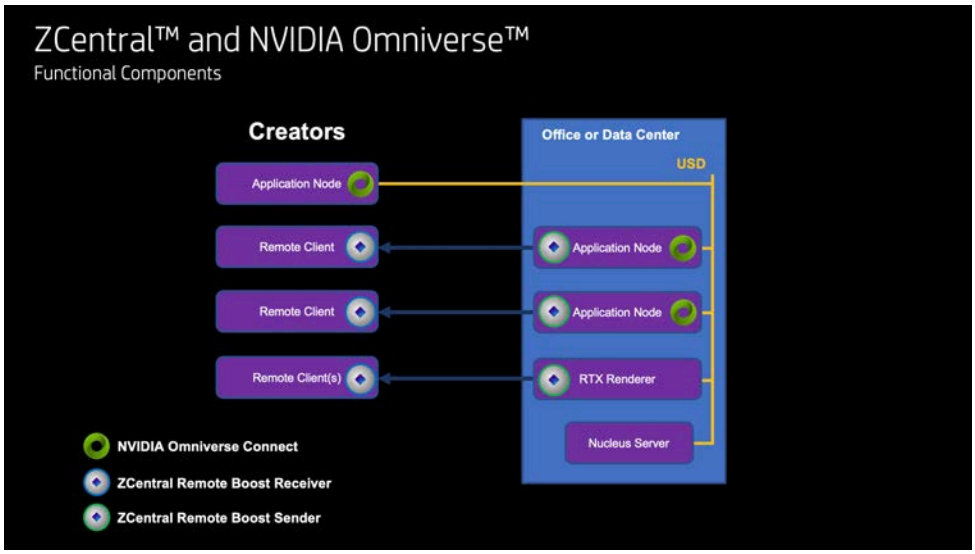

Figure 7.

There are some **general considerations** for all these systems:

- If a system will be out of reach of the Creator or it needs to be remotely managed for other reasons, make sure to select a Workstation configuration that supports Intel® **vPro® / AMT**. All HP Z4R and all HP Z8 configurations support vPro and AMT. Other HP Z workstation platforms do as well, but that varies by SKU.
- For central, shared functions like Nucleus Server, **uptime is important**. System components such as ECC memory, redundant power supplies and RAID disk configurations are recommended.
- **Networking should be optimized** for component communication where possible. That can mean isolating the Omniverse network traffic from other Datacenter traffic and/or using 10GbE networking where possible. The HP Z4R has built in 10GbE and this is an option for HP Z8, Z6 and Z4 systems.
- For specific configuration options for HP Z Workstations, **QuickSpecs** are available for the various HP Z workstations.

Remote Clients

These can be any system which supports the **HP ZCentral Remote Boost Receiver**. The current list of supported operating environments for the Remote Boost Receiver includes Windows 10, RHEL 6.10, 7.7 and 8, Ubuntu 18.04, macOS 10.13 and HP ThinPro 7.01. HP maintains an actively updated list in the Remote Boost QuickSpecs here: http://h20195.www2.hp.com/v2/GetDocument.aspx?docname=4AA7-7185ENW.

Note that there is a very large variety of potential Remote Clients, from traditional HP thin clients to very powerful Z Workstations. The performance of these various Remote Clients can significantly affect the Creator's experience in terms of frames-per-second and the supported size and number of the remoted "screens". Given this variety, it is difficult to present a flowchart leading to a specific Remote Client suggestion for a given use case. However, there are some considerations:

- Standalone thin clients such as the HP t740 provide turn-key and secure access but give the creator limited ability to execute applications locally.
- For Creators accessing 3D graphics content via Remote Boost at FHD (1920 x 1080) resolution, the minimum configuration would be 4 cores with hyperthreading, an entry GPU, and 8 GB of free memory. Any other application or system requirements would be additive.
- For Creators accessing 3D graphics content at higher resolution such as UHD (3840 x 2160), more cores and graphics are necessary.

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Table 2 consolidates Remote Client configuration rules of thumb for CPU cores and GPU class.

	REMOTE CLIENT CONFIGURATION			
< 4 cores	**4 Core Entry GPU**	**4 Core Midrange GPU**	**6-8 Core Entry GPU**	**6-8 Core Midrange GPU**
Not Recommended	Good FHD Not recommended for UHD	Best FHD Good UHD	Best FHD Good UHD	Best FHD and UHD multi-monitor

Table 2.

Note that a HP ZBook or Z Workstation desktop as a Remote Client, configured with NVIDIA RTX™ graphics will allow the RTX Renderer function to run locally. This will allow the Creator to see the common rendered scene in real-time on their system. Examples would be HP ZBook Create or HP ZBook Fury configurations for notebooks and HP Z4, Z6, Z8 with Quadro RTX™ 5000, Quadro RTX™ 6000, Quadro RTX™ 8000 for desktops.

Application Nodes

These are defined by the requirements of the applications and the size of the models with which the Creators will work. As these nodes may be used to run different applications and workloads over time, they should be sized for the most demanding case.

To help select the correct system, HP provides an online system selector and configurator that gives suggestions for desktop and mobile Workstations:

https://www8.hp.com/us/en/workstations/overview.html#modal=overlay-zfinder

For example, if the Creator's main application is Autodesk® Maya®, being remoted by using HP ZCentral Remote Boost Sender, the configurator currently recommends an HP Z4 with the following configuration:

Processor: Intel® Core™ i9-10920X 3.5 - 4.6GHz 12 core
Memory: 64 GB
Storage: 512 GB SSD + 1 TB M.2 + 4 TB SATA
Graphics: NVIDIA® Quadro RTX™ 5000
Operating System: Windows 10 Pro

For those already familiar with HP Z workstation configuration there are two special / additional requirements for these nodes:

- An NVIDIA RTX™ GPU is needed to run in NVIDIA Omniverse™, by definition.
- If the Application node is located in the "Office or Data Center", it will be running HP Z Central Remote Boost Sender in addition to the application itself. Depending on the resolution and number of the displays to be remoted to the Remote Client, additional load can be placed on this system. As a rule of thumb the Remote Boost Sender generally requires an additional 2 to 4 CPU cores to perform its function, depending on resolution and number of screens.

Figure 8 has some suggested mobile Good / Better / Best Mobile Workstation configurations.

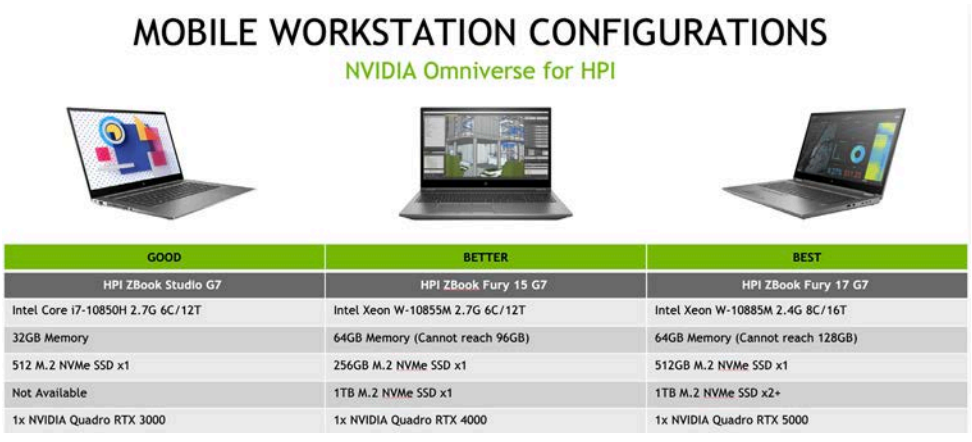

Figure 8.

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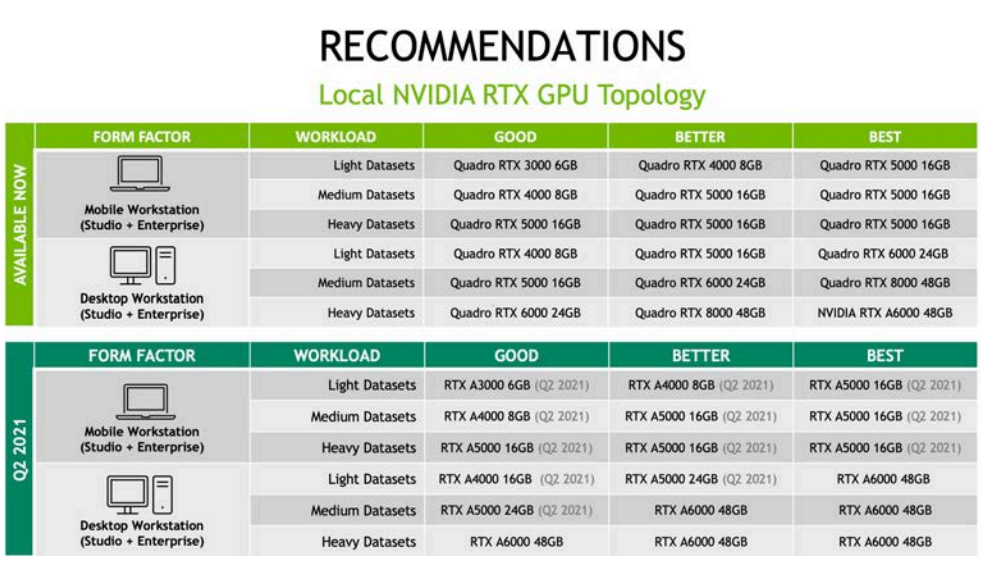
Figure 9 shows several examples of Good / Better / Best desktop Workstation configurations.

GOOD	GOOD	BETTER	BEST
HPI Z4 G4	HPI ZCentral 4R	HPI Z6 G4	HPI Z8
Intel Xeon W-2235 3.8G 6C/12T	Intel Xeon W-2235 3.8G 6C/12T	Intel Xeon Gold 6234 3.3Ghz 8C/16T	2X Intel Xeon Gold 6234 3.3Ghz 8C/16T
32GB Memory	32GB Memory (additional DIMMS but 2x populated by 8GB)	96GB Memory	256GB Memory
256 M.2 NVMe SSD x1	512GB HP Z Turbo Drive TLC SSD	512 M.2 NVMe SSD x1	512 M.2 NVMe SSD x1
1TB SSD Storage x1	Not available	2TB SSD Storage x1	2TB SSD Storage x2
10GbE NIC	10GbE NIC	10GbE NIC	10GbE NIC
1x NVIDIA RTX A5000 (Using RTX 5000 as comparison)	1x NVIDIA RTX A5000 (Not available today)	1x NVIDIA RTX A6000 (Using RTX 8000 as comparison)	2x NVIDIA RTX A6000 (Using RTX 8000 as comparison)

Figure 9.

Looking solely at the graphics cards for a given configuration, NVIDIA® makes the following recommendations, in **Figure 10:**



	FORM FACTOR	WORKLOAD	GOOD	BETTER	BEST
AVAILABLE NOW	Mobile Workstation (Studio + Enterprise)	Light Datasets	Quadro RTX 3000 6GB	Quadro RTX 4000 8GB	Quadro RTX 5000 16GB
		Medium Datasets	Quadro RTX 4000 8GB	Quadro RTX 5000 16GB	Quadro RTX 5000 16GB
		Heavy Datasets	Quadro RTX 5000 16GB	Quadro RTX 5000 16GB	Quadro RTX 5000 16GB
	Desktop Workstation (Studio + Enterprise)	Light Datasets	Quadro RTX 4000 8GB	Quadro RTX 5000 16GB	Quadro RTX 6000 24GB
		Medium Datasets	Quadro RTX 5000 16GB	Quadro RTX 6000 24GB	Quadro RTX 8000 48GB
		Heavy Datasets	Quadro RTX 6000 24GB	Quadro RTX 8000 48GB	NVIDIA RTX A6000 48GB

	FORM FACTOR	WORKLOAD	GOOD	BETTER	BEST
Q2 2021	Mobile Workstation (Studio + Enterprise)	Light Datasets	RTX A3000 6GB (Q2 2021)	RTX A4000 8GB (Q2 2021)	RTX A5000 16GB (Q2 2021)
		Medium Datasets	RTX A4000 8GB (Q2 2021)	RTX A5000 16GB (Q2 2021)	RTX A5000 16GB (Q2 2021)
		Heavy Datasets	RTX A5000 16GB (Q2 2021)	RTX A5000 16GB (Q2 2021)	RTX A5000 16GB (Q2 2021)
	Desktop Workstation (Studio + Enterprise)	Light Datasets	RTX A4000 16GB (Q2 2021)	RTX A5000 24GB (Q2 2021)	RTX A6000 48GB
		Medium Datasets	RTX A5000 24GB (Q2 2021)	RTX A6000 48GB	RTX A6000 48GB
		Heavy Datasets	RTX A6000 48GB	RTX A6000 48GB	RTX A6000 48GB

Figure 10.

Nucleus Server

The NVIDIA Omniverse Nucleus™ server is the core of the Omniverse solution. Its function is to maintain the USD model of the overall project and keep it synchronized with the changes that are being made on the Application Nodes. This function is not graphics intensive. Nucleus can be deployed as standalone system or locally, within a design workstation.

Example **"Good"** configuration:

System: Z4 (rack-mountable, on its side. 4U.)
Processor: Intel® Core™ i7. Minimum Cores = 4
Memory: 16 GB, but recommend more, based on maximum model size
Storage: 512 GB minimum, SSD preferred
Networking: 1Gbe or dual, teamed 1Gbe
Graphics: Integrated / entry
Operating System: Windows 10 Pro

Example **"Better"** configuration:

System: Z4R 1U rackmount system with redundant power supplies and 10GbE nic
Processor: Intel® Core™ i9. Recommended cores = 8
Memory: 32 GB – 128 GB, determined by maximum model size
Storage: 1 TB minimum, SSD in RAID 0/... configuration
Networking: 10Gbe
Graphics: Integrated / entry
Operating System: Windows 10 Pro

Omniverse RTX™ Renderer

The RTX™ Renderer can be a standalone node or the render function can be installed on an Application Node if that node is performant enough (see above).

The renderer will synchronize with the Nucleus Server to keep its own copy of the USD for the project and will render based on that local copy. Generally, this node will need at least one high-end RTX card such as a Quadro RTX™ 4000, Quadro RTX™ 5000, Quadro RTX™ 6000, Quadro RTX™ 8000 or NVIDIA RTX™ A6000. More than one GPU is preferable for better performance.

Example **"Good"** configuration:

System: Z4R
Processor: Intel® Core™ i7
Memory: 32 GB, but determined by maximum model size
Storage: 1 TB minimum, SSD
Networking: 1Gbe or dual, teamed 1Gbe
Graphics: Quadro RTX™ 5000
Operating System: Windows 10 Pro

Example **"Better"** configuration:

System: Z8
Processor: Intel® Core™ i9
Memory: 64 GB – 128 GB, but determined by maximum model size
Storage: 1 TB minimum, SSD in RAID 0 configuration
Networking: 10Gbe
Graphics: Dual NVIDIA RTX™ 8000
Operating System: Windows 10 Pro

6. INSTALLATION AND CONFIGURATION

Once the various systems have been received, physically placed an had basic OS software and application installed and updated, the HP ZCentral Remote Boost and NVIDIA Omniverse™ components can be downloaded and installed.

Installing HP ZCentral Remote Boost

The HP ZCentral Remote Boost User Guide provides detailed instructions for installing both the Receiver and the Sender. Generally Application Nodes located in a datacenter would run the Sender and Remote clients would run the Receiver. The guide is located here: http://h20195.www2.hp.com/v2/GetDocument.aspx?docname=4AA7-7173ENW

Installing NVIDIA Omniverse ™

NVIDIA Omniverse™ is only available directly from NVIDIA.com at www.nvidia.com/omniverse. In depth installation instructions are provided here: https://docs.omniverse.nvidia.com/plat_omniverse/plat_omniverse/workstation_installation.html

The initial step is to download the Omniverse Launcher from www.nvidia.com/omniverse. The Omniverse Launcher provides the essential backbone and interface tools for working with the Omniverse. All available Omniverse Apps, Extensions, and Connector "plugins" can be found within the launcher.

Further support for the Omniverse platform, Apps, and Connectors can be found at https://docs.omniverse.nvidia.com

Firewall Port Requirements

Application nodes, RTX Renderer nodes and other functions communicate with the Nucleus Server over the following ports. Please consult your security professional to make sure these pathways are enabled in accordance with your organizational guidelines.

- Nucleus API
  - Nucleus API: 3009
  - Service: 3006
  - Admin: 3008
  - IFT: 3007
  - Metrics: 3010
- Nucleus LFT API: 3030
- Discovery Service API: 3333
- Auth Service: 3100
- Asset Converter API: 3420
- Cache Service
  - API: 8891
  - Control: 8892
- System Monitor API: 3085

Connecting the Applications

Once the systems are physically in place and the application and NVIDIA Omniverse™ software is loaded, the systems must be logically connected to allow the USD traffic to flow between the Nucleus Server and the other nodes.

Note that while all Connect plug-ins give their respective applications similar functionality, they are not identical. Thus it's important to read through this material in detail for the applications of interest: https://docs.omniverse.nvidia.com/con_connect/con_connect/overview.html.

There are step-by-step instructions (text and video) and sections describing:

- Supported Features
- Loading the plug-in
- Signing in to the Omniverse Server
- Main Menu functions
- USD Menu
- USD File Export Browser
- USD File Import Browser
- Help Menu
- Omniverse Connectivity, including Live Sync
- File Information
- The Omniverse Shelf (when applicable)
- Omniverse Settings
- Application-specific settings and capabilities
- Missing Features and Release Notes
- Potential Future Roadmaps

Sharing via WebRTC

The high-quality images produced by RTX Renderer can be viewed in a standard browser on a multitude of platforms, using WebRTC protocol. This can be a very useful function and will be described in detail in a future update to this whitepaper.

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7. RESOURCES

- HP ZCentral Remote Boost: https://www8.hp.com/us/en/workstations/zcentral-remote-boost.html
- HP ZCentral Overview: https://h20195.www2.hp.com/v2/GetDocument.aspx?docname=4AA7-4470ENW
- HP Workstations: https://www8.hp.com/us/en/workstations/overview.html
- NVIDIA Ominverse™: www.nvidia.com/omniverse
- NVIDIA Omniverse™ Support: https://docs.omniverse.nvidia.com

8. FOOTNOTES

[1]HP ZCentral Remote Boost does not come preinstalled on Z Workstations but can be downloaded and run on all Z desktop and laptops without license purchase. With non-Z sender devices, purchase of perpetual individual license or perpetual floating license per simultaneously executing versions and purchase of ZCentral Remote Boost Software Support is required. ZCentral Remote Boost requires Windows, RHEL (7 or 8), UBUNTU 18.04 LTS, or HP ThinPro 7 operating systems. MacOS (10.13 or newer) operating system is only supported on the receiver side. Requires network access. The software is available for download at hp.com/Z Central Remote Boost.

[2]NVIDIA Omniverse™ is sold separately, from NVIDIA®.

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