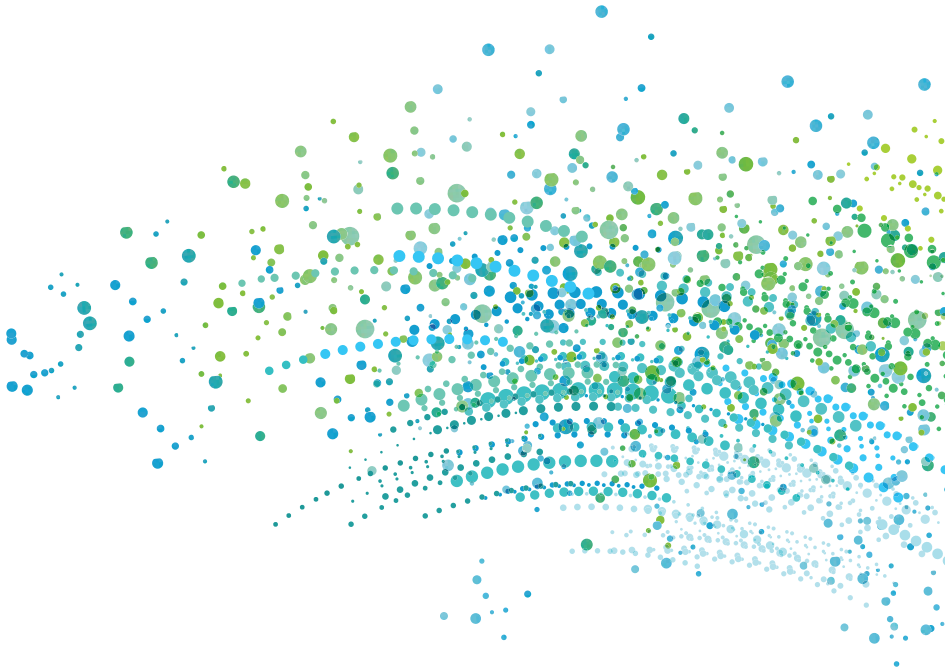

Exploring Remote and Virtual Solutions for Autodesk® Maya®

WHITEPAPER

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Introduction

Autodesk Maya is an industry-leading 3D computer graphics application with powerful modeling, rendering, simulation, texturing and animation tools for VFX artists, modelers, and animators. The software is used to create graphics and visual effects in films, video games, television and in other diverse application areas such as architecture design and computer-aided manufacturing. Due to the computation and graphics requirements, Maya has typically been run on high-end, dedicated workstations located on or under the artist's desk. This presents several challenges for typical workflows:

- Model sizes have become very large and take a long time to transfer to a local workstation even with a gigabit network, thus impacting productivity.
- More and more projects involve teams that are not at the same physical location, which makes sharing and collaborating even more cumbersome.
- Moving physical workstations around to accommodate the constant location changes of individuals as they shift between different project groups is expensive and time consuming.
- No convenient or secure way to enable artists or reviewers to evaluate and approve content from home or on-the-go.
- The heat and noise generated by high-end workstations negatively impacts the work environment.

In this whitepaper, we are exploring two technology options that can enable the use of Maya while addressing these challenges and providing for a happier and more productive work environment. The two options are:

a. A Teradici PCoIP® Remote Workstation Card that provides uncompromised access to any workstation located remotely using standard IP networks for connections.

b. The Teradici PCoIP Workstation Access Software that enables remote access to virtualized workstations in which more than one Maya artist is sharing the same physical workstation using either physical Graphics Processing Units (GPUs) assigned individually to each user or sharing a physical GPU between Maya users leveraging Virtual GPU (vGPU) technology.

Using experimental results, we show that both of the above are viable options for Maya application users, without having to sacrifice their experience.

This whitepaper covers the technology options for working remotely and describes how the Maya application can be used with a virtual machine with dedicated or shared access to any GPU. Next, the Maya workload being benchmarked is described, followed by a high-level description of the test configuration. Measurement results for both options are then presented and explained, comparing them to running Maya in a local workstation. The final section contains our conclusions, followed by an Appendix with specific details of the test environment.

Remotely working with Autodesk Maya

Working remotely allows users to run the Maya application without being physically present in front of their workstation. This enables a user to work from various locations including at work, home or on-the-go with the ability to share, review and edit their designs with team members in different locations to more efficiently collaborate on a project.

Figure 1 shows how a Teradici PCoIP Remote Workstation Card installed in a physical workstation running the Maya application using PCoIP Zero Clients or PCoIP Software Clients, OS X, and Windows as the end-points from many different locations. PCoIP Zero Clients simply receive and decode encrypted image information, and are immune to attack from computer viruses. PCoIP Zero Clients do not store any application data only the pixels being displayed. Even when the PCoIP Zero Client devices are geographically distributed, the workstations can be collocated with all the storage for the project. This collocation makes it easier to use 10 Gigabit or higher connections between the workstations and the project data dramatically improving performance. Having all of the project data in one location also greatly simplifies the job of keeping that data secure. Replicating or transferring large Maya files or datasets across multiple locations is not required since the remote workstations can all access the same shared file systems. By only transmitting encrypted pixels via the PCoIP protocol, intellectual property is protected and remains safe in the data center.

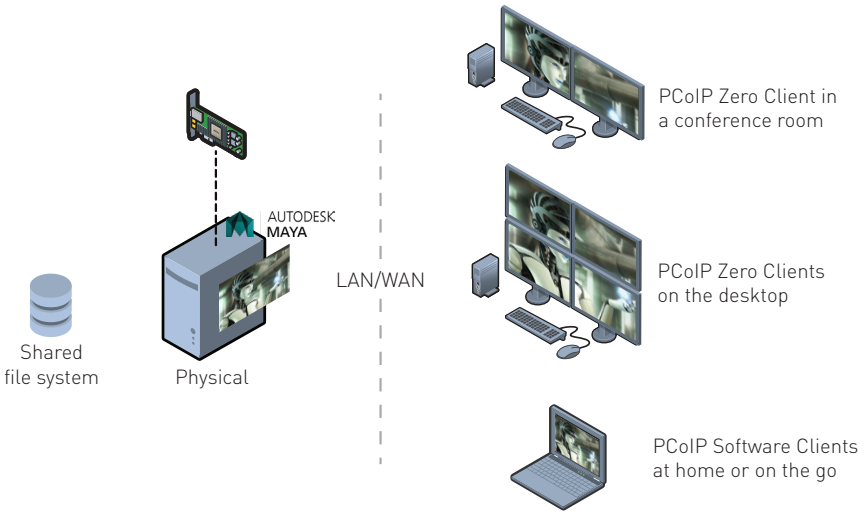

Figure 1: High-performance remote access from any location with the Teradici PCoIP Remote Workstation Card

Using Maya app with a virtualized GPU

Maya and other graphically-intense applications need a workstation with a GPU to ensure an acceptable user experience. Having dedicated workstations with GPUs for each individual user is an expensive solution. With advances in virtualization and GPU technology in recent years, Virtual Machines (VMs) can have dedicated one-to-one access to a physical GPU in a server or, a physical GPU can be shared by multiple VMs. Either can provide a more cost-effective solution for Maya application users, especially when the shared workstations can be repurposed for rendering computations when the artists are not using them.

Figure 2 depicts how Teradici PCoIP Workstation Access Software installed on a VM allows access to a GPU in a server running hypervisor software, such as VMware ESXi. Using PCoIP Zero Clients or PCoIP Software Clients (including Android, ChromeOS, and iOS) in dispersed locations, users can run the Maya application on a VM that has a dedicated GPU (one-to-one) or shared access to physical GPU resources (vGPU).

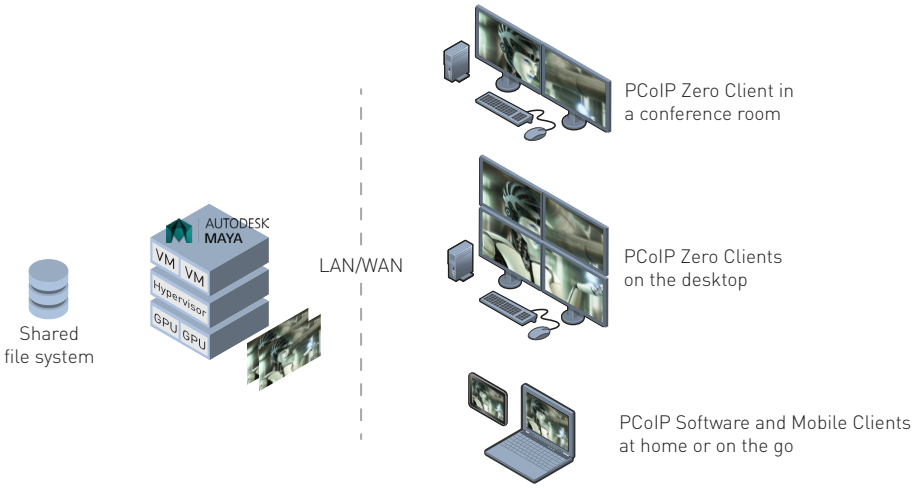

Figure 2: Running Maya on with a Virtualized GPU using Teradici PCoIP Workstation Access Software

Maya artists will expect the quality of user experience for remote solutions to be perceptually the same as the experience of a local workstation. Three factors are critical to meeting that requirement:

1. **Image quality** – the remoted image needs to be perceived by the Maya artist to be the same as the image would be on a local workstation; otherwise they will not be able to easily determine whether an artifact on the screen is in their content or due to the remote display protocol.

2. **Frame rate** – the rate of display updates happening per second on the remote client device (typically called the client frame rate) needs to be as close to the frame rate that a locally attached monitor would receive as possible. Note that a locally attached monitor will deliver the full frame rate the application is generating; whereas a remote display protocol may not send every frame due to bandwidth or client computational constraints,. As such, measuring the frame

rate at the remote client is what is important to the artist.

3. **Interactive latency** – the delay measured from a user input, such as a mouse click, until the time the response is seen by the artist on the remote display screen needs to be as low as possible. Humans can typically detect latency increases of 100ms or more.

The PCoIP protocol used by both of these solutions and also products like VMware® Horizon View were designed to deliver the highest possible image quality for computer applications, especially those with 3D graphics.

The PCoIP protocol achieves this by using the concept of multiple codecs. The idea behind multiple codecs is that your display is rarely doing just one thing at a time. Your desktop is dynamic, with some areas devoted to text, some to video or animation, some to simple apps, and others with intense graphics needs. A single-codec solution would treat your whole desktop as one thing, so a codec optimized for text would be sluggish with video; while a codec optimized for video streaming would be running a more complex algorithm and consuming more bandwidth for text than is necessary. Either scenario is pretty inefficient, causing unnecessary delays and sub-optimal image quality. Read this blog post about PCoIP multiple codecs to learn more.

Furthermore, the PCoIP codecs are optimized for truly lossless support. Most text and simple graphics are sent in a lossless form immediately. For more complex images, the PCoIP codecs are designed to be completely reversible on the client enabling a quick and efficient ability to build to a fully lossless state. In contrast, most video codecs (e.g. H.264) are built on algorithms that are not reversible and deliberately throw away color information for the sake of bandwidth efficiency. This can result in compression artifacts on the screen and inaccurate color representation that is unacceptable in applications such as Maya. Check out our blog post about lossless support to learn more. The figure below provides an illustration of the image distortion that video codecs can introduce in computer graphics compared to PCoIP

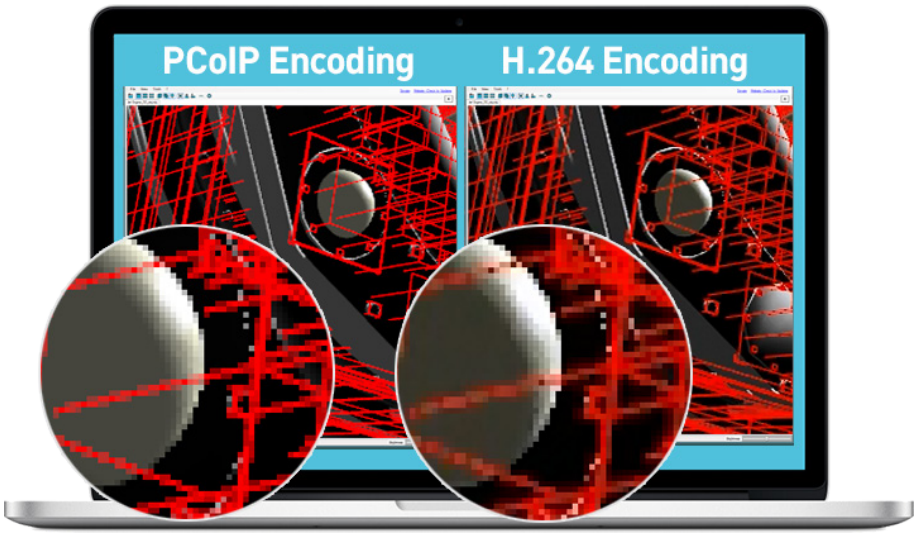

Figure 3: Build-to-lossless capability provides higher quality computer-generated images

For testing purposes, both frame rate and interactive latency will be measured using a representative Maya animator's workload. These two metrics will further demonstrate that Maya users can expect a satisfactory user experience with these two remoting solutions.

Workload Description

The workload used for the measurements was developed using Maya 2016 to simulate the playing back of an animated portion of a film and to provide a realistic, but graphically intense workload. The animation consisted of two jets flying through a textured mountain terrain, one chasing the other (refer to Figure 4 for two screen captures during the workload). Playback of the whole sequence lasts approximately three minutes and was repeated twice to make the total workload duration approximately seven minutes.

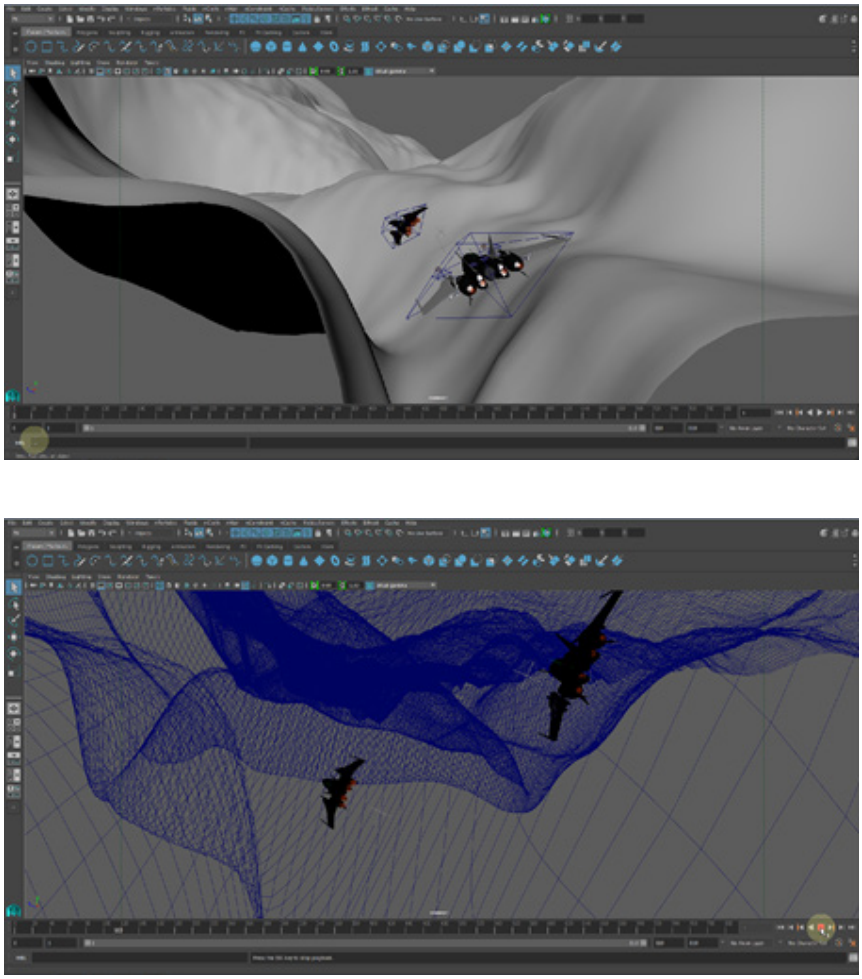

Figure 4: Screenshot from the Maya 2016 animation playback workload

Test Configuration

For measurements with the PCoIP Remote Workstation Card, the test configuration was a Dell Precision R7910 workstation with a PCoIP Remote Workstation Card and an NVIDIA K4200 GPU with the display ports of the GPU connected to the PCoIP Remote Workstation Card. Measurements for the PCoIP Workstation Access Software were done with a test configuration similar to Figure 2 using an ESXi 6.0 on a Dell Precision R7910 workstation.

For measuring the latency, a PC with a capture card was used, together with hardware that emulates the keyboard and mouse input from the client side. The measured latency was the time duration between a keyboard input from the client side until the expected change was detected on the client display. The average of many latency measurements taken during the workload was used as the measured latency. Figure 5 illustrates the high-level test configuration showing both the network emulator and the latency measurement tool. All tests were done with a single display with a resolution of 1920x1080.

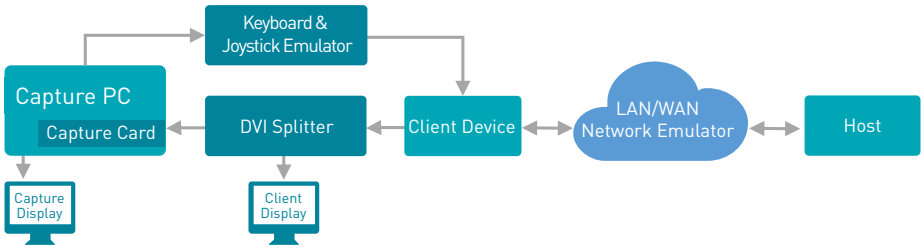

Figure 5: Latency measurement from the client side

The statistics provided by the PCoIP Zero Client were used for measuring and extracting the client frame rate every one second. Refer to the Appendix on page 9 for more specific details of the test configuration.

Measurement Results

Client frame rate and round-trip latency are two metrics that are indicative of end user experience when working with an interactive application. Figures 6 and 7 compare these metrics for the PCoIP Remote Workstation Card and the Teradici PCoIP Workstation Access Software with the base case values being a user running Maya locally on a workstation.

As seen from the results in Figure 6, the average client frame rate with the PCoIP Remote Workstation Card is essentially the same as using the Maya application on a local workstation adjusting for the slight differences in the two configurations and any measurement error. Even though the client frame rate with Teradici PCoIP Workstation Access Software is lower than the local workstation and the PCoIP Remote Workstation Card, it still provides a satisfactory average frame rate above 15 fps to the end user.

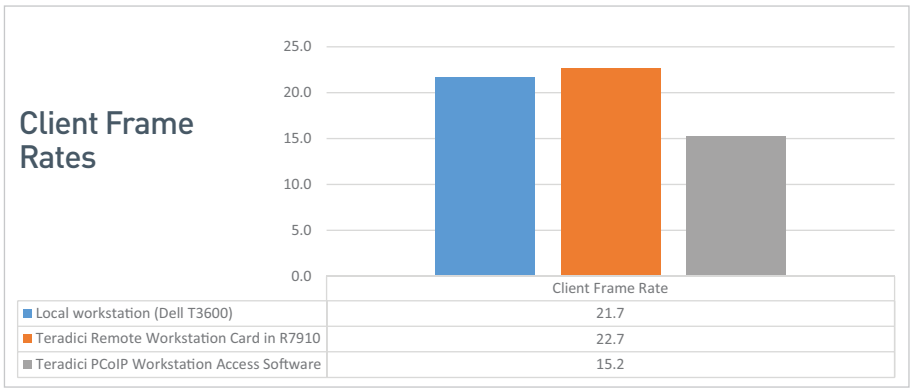

Figure 6: Comparison of client frame rates with Maya workload

Round-trip latency results in Figure 7 shows the latency in the base case of a local workstation at about 80ms. Compared to this, the Teradici Remote Workstation Card adds about 23ms of extra latency and the Teradici Pervasive Computing Platform Graphics Software adds about 50ms of extra latency. This additional latency for the software can be attributed to the impact on the GPU from accessing the GPU frame buffer, the copying of the frame buffer to the CPU, and the additional delay of software encoding versus hardware encoding in the PCoIP Remote Workstation Card. In both cases, the added latency above the local workstation is well below the 100ms threshold of human perception; however, these measurements are all on a LAN without any network latency. As such, the PCoIP Remote Workstation Card can be used with ~25ms more network latency than the Graphics Agent.

Figure 7: Comparison of round-trip Latency with Maya workload

Conclusions

In this whitepaper, we have explored two technology options that Autodesk Maya users could use to realize the benefits of working remotely, as well as leveraging a virtualized GPU for more cost-effective use of Maya. We've described how a PCoIP Remote Workstation Card installed in a workstation running Maya using PCoIP Zero Clients or PCoIP Software Clients from many different locations works. For more cost effective deployment, the Teradici PCoIP Workstation Access Software leverages virtualized workstations taking advantage of GPU pass-through a virtual GPU technology to reduce costs per workstation.

A typical Maya user working on a dedicated, local workstation might be concerned about the degradation of performance using these technology options; however, the PCoIP protocol has been designed to deliver outstanding image quality demanded by computer applications like Maya. Furthermore, using the representative metrics of the end user's display update rate (typically known as the client frame rate) and the interactive latency experienced by a user, we have presented experimental results that show both technology options provide satisfactory end user experience for Maya users.

Other Resources

- Learn more about Teradici's Remote Workstation solutions at teradici.com/remote-workstation
- Read ILM's case study at teradici.com/case-study/ILM
- Watch the on-demand ILM webinar at teradici.com/webinar/ILM
- teradici.com/blog

Appendix: Details of the Test Configuration

	Local workstation	Host for Teradici PCoIP Remote Workstation Card	Host VM for Teradici PCoIP Workstation Access Software
Hardware/Model	Dell T3600	Dell Precision R7910	Dell Precision R7910
Processor	Intel Xeon E5-1620	Intel Xeon E5-2637 v3	Intel Xeon E5-2637 v3
Clock Speed	3.6 GHz	3.5 GHz	3.5 GHz
Processor sockets	1	2 (8 Physical cores)	2 (8 Physical cores)
Cores per session	4 physical cores	4 virtual cores (HW v11)	4 virtual cores (HW v11)
Hyperthreading	Enabled	Enabled	Enabled
Memory per system/VM	8 GB	4 GB	4 GB
ESXi Version	Not Applicable	6.0.0 U1, 3620759	6.0.0 U1, 3620759
Windows version	Windows 7 64 Professional SP1	Windows 7 64 Professional SP1	Windows 7 64 Professional SP1
NVIDIA GPU	K4200	K4200	K4200
NVIDIA Graphics Driver	354.13	353.82	353.82
PCoIP Remote Workstation Card	Not applicable	TERA2220 FW 4.7.2	Not applicable
Graphics Agent Version	Not applicable	Not applicable	v2.3-RC
PCoIP Zero Client	Not applicable	TERA2321 FW 4.8.0	TERA2321 FW 4.8.0
Display	1920x1080	1920x1080	1920x1080