STK: DEMYSTIFYING THE CLOUD AND VIRTUAL ENVIRONMENTS

CONTENTS

ABSTRACT

This paper serves to give insight into how Systems Took Kit (STK) functions and performs in virtual/cloud environments and offer guidance to users when selecting a virtual environment. We have documented the results of several common virtual environments frequently considered and explore the benefits and pitfalls of each, highlighting what to look for when selecting a virtual environment for enterprise use.

INTRODUCTION

Virtual environments provide flexibility and value across the enterprise. AGI has several product offerings that will run natively on localized hardware, as well as, in a virtual environment. One of our offerings, Systems Tool Kit (STK), has enhanced graphical capabilities that requires specific system requirements in order to take full advantage of our analytically-correct visualization of complex scenarios.

VIRTUAL ENVIRONMENT SYSTEM REQUIREMENTS

Let's begin with a review of the general system requirements of STK 11.1. This is the first place to start when considering any virtual environment because the system specifications will be exactly the same for local and virtual environments. The product system requirements can be found in the STK online Help at http://help.agi.com/.

CPU Speed	2+ GHz
Processor	Intel Core Duo, SSE2 (or greater) Pentium 4 or Xeon Processors
Memory / RAM	3+ GB
Disk Space	3+ GB See Supplemental STK Modules
Graphics Card	High-end OpenGL-compatible graphics card (512+ MB memory) that supports OpenGL 2.0+.	To determine whether the graphics card installed on your system is supported by STK, from the StartàAll Programs Menu, select STK <version number>àGraphics Card Information. **Notes**: For visualization with STK, your computer's graphics performance is a critical factor. Please carefully consider the following notes regarding graphics performance and STK. • Integrated motherboard graphics chipsets, such as Intel Integrated Graphics, should be avoided. Dedicated video cards based on chipsets from nVIDIA have shown excellent performance and compatibility with STK. • For optimal performance, it is critical that the drivers for the video card be kept up to date. A good practice to follow is to update video drivers whenever the version of STK is updated. • STK will automatically use OpenGL 1.1 with remote access applications (such as Microsoft Remote Desktop) and virtual PC applications (such as VMWare and Microsoft Virtual PC) that do not support OpenGL 1.2 extensions. Some capabilities will not be available. • If your computer has an integrated graphics chipset and a dedicated graphics card, ensure that the dedicated graphics card is enabled for use with STK (check the control panel for the graphics card).
Network Hardware	Network Card required.	

HARDWARE ACCELERATED GRAPHICS

When applications are run locally in a traditional desktop environment, they have direct access to the graphics hardware. This is not always the case for applications running in a virtual environment. Virtual

environments provide varying levels of graphical hardware support, which can result in a dramatically different user experience.

Some virtual environments do not provide any support for hardware accelerated graphics. In these situations, the application only has access to a very limited OpenGL 1.1 rendering context. STK is able to function under these constraints, but it must disable many of its graphical features including: 3D terrain, Bing high resolution imagery, COLLADA 3D model support, filled coverage graphics, solar panel tool, lighting on 2D maps, and text outlines. Other graphical features will continue to function, but at reduced performance and may have a different appearance. In addition to reduced functionality, the lack of Graphics Processing Unit (GPU) hardware acceleration means that the CPU is used to perform the task of rendering the graphics. The CPU is not designed for the task of rendering graphics, and the result is significantly reduced rendering performance.

Many of the virtual environments evaluated here do support hardware accelerated graphics. This allows STK to enable all of the graphical features users are accustomed to seeing in the traditional desktop environment. While all of the graphical features are supported, the overall rendering performance can still be impacted depending on the specific configuration of the virtual environment. The two most important factors are how much GPU memory and GPU processing power is available to each virtual user.

A final item to consider that can affect the graphical performance in virtual environments is the network bandwidth and latency between the remote user and the virtual server. All of the graphical processing and rendering are performed within the virtual environment. However, the final image that appears on the user's screen still must be transmitted across the network to the remote machine. If the network bandwidth is low or the latency is high, the transmission of the final images may not be able to keep up with the rate that the virtual environment is generating them. Virtual environments handle this situation by dropping frames that get backed up. The effect is that the user may experience an effective frame rate that is significantly lower than what the virtual environment is capable of producing. This problem becomes a greater factor as the screen sizes of the 2D and 3D windows are increased because larger images means more data that has to be transmitted across the network.

CONFIGURATIONS TESTED

TEST SUMMARY

Configuration	Remote Access Method	Hardware Accelerated Graphics
Server 2012 R2 Base AMI	Remote Desktop Connection	No
Server 2012 R2 Base AMI	TightVNC	Yes
Scalable Graphics CGX AMI	Scalable Graphics CGX (custom) Client	Yes
Octane Cloud Workstation AMI	Web Browser (Chrome)	Yes
Vwmare EXSI 6.0 (vGPU, Profile - K260Q)	Remote Desktop Connection	Yes
Vmware EXSI 6.0 (vGPU, Profile - K220Q)	Remote Desktop Connection	Yes

. AMAZON EC2

1. SERVER 2012 R2 BASE AMI

System Specification: Server 2012 R2 Base AMI - g2.2xlarge with Virtual GPU (NVIDIA GRID K520)

### FUNCTIONALITY

A. REMOTE DESKTOP CONNECTION

STK functions in this environment with limited graphics capabilities.

- Full globe rendering requires that the graphics card have at least two texture units; only a single base texture will be rendered.
- Shaders are not supported with OpenGL v1.1
- Sun lighting and some imagery are not supported with OpenGL v1.1
- STK message viewer reports OpenGLv1.1 errors:

Message Viewer

| Message	Type	Date/Time
STK/CON: Initializing STK/CON module.	ⓘ Information	09-29-2016 04:13:11 PM
STK/CON: Accepting connection requests	ⓘ Information	09-29-2016 04:13:11 PM
Shaders not supported by current video driver. Sun lighting and some imagery types are not supported for all map projections.	ⓘ Information	09-29-2016 04:13:23 PM
Frame buffer objects not supported by current video driver. Imagery on perspective and orthographic projections are not supported.	ⓘ Information	09-29-2016 04:13:23 PM
Full globe rendering requires OpenGL version 1.2 or greater; current version is 1.1.0; upgrade graphics card driver or card; only a single base texture will be rendered	❌ Error	09-29-2016 04:13:23 PM
Full globe rendering requires that the graphics card have at least two texture units; only a single base texture will be rendered	❌ Error	09-29-2016 04:13:23 PM
Globe rendering is using OpenGL 1.1; unable to add http://twsusewebsvr02.agi.com/stk-terrain/v1/tilesets/world	ⓘ Information	09-29-2016 04:13:26 PM
Globe rendering is using OpenGL 1.1; unable to add non-base file virtual_earth://virtualearth.net/Aerial.ve	ⓘ Information	09-29-2016 04:13:26 PM
Globe rendering is using OpenGL 1.1; unable to add non-base file file:///C:/Program%20Files/AGI/STK%2011/STKData/VO/Textures/water.jp2	ⓘ Information	09-29-2016 04:13:26 PM
Model Space\satellite.dae for Satellite1 may cause performance issues due to an older video card.	ⓘ Information	09-29-2016 04:13:27 PM
Model Sea\ship.dae for Ship1 may cause performance issues due to an older video card.	ⓘ Information	09-29-2016 04:13:27 PM
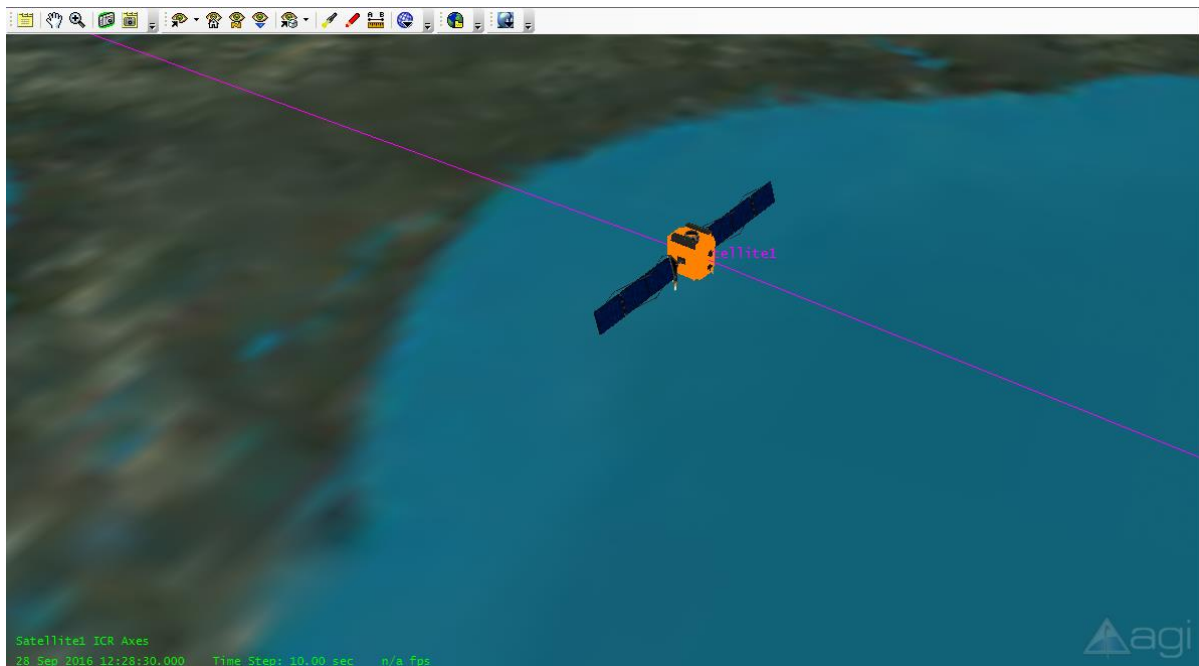
Limited Visualization is available with OpenGL 1.1; features including multi-texturing, programmable shaders, and COLLADA models are not available in this configuration.

NVIDIA GRID drivers introduced a change in build 340. Earlier NVIDIA drivers enabled OpenGL sharing, but later versions do not. NVIDIA reports that the AWS behavior is as intended. NVIDIA OpenGL over RDP/ RDSH is only supported on workstation (Quadro) / NVS products. The GRID K520 card that is on Amazon's G2 instances is not a workstation product unlike GRID K1/K2. Prior to build 340 NVIDIA did not block the use of OpenGL and the GPU, although it was never officially supported.

B. TIGHTVNC

STK is fully functional, as OpenGL is fully supported in this configuration.

Although this is a successful means of connecting to a remote host there may be security concerns that should be considered before using this configuration.
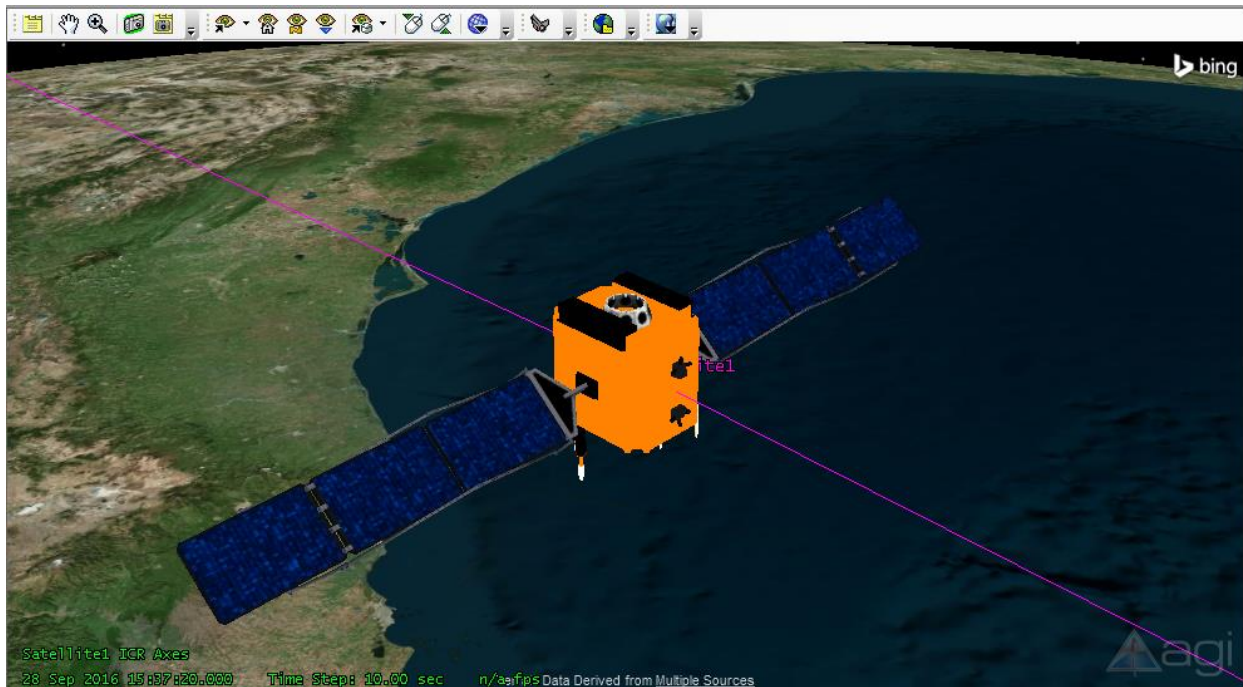
Multitexturing, programmable shaders, and COLLADA as shown here are available when the system environment has access to the GPU device.

CONFIGURATION

It is necessary in some environments to adjust local firewalls. It was our experience that we needed to open the following:

- Remote Desktop Access Method: TCP for RDP and T.120
- TightVNC Access Method: VNC and VNC-HTTP
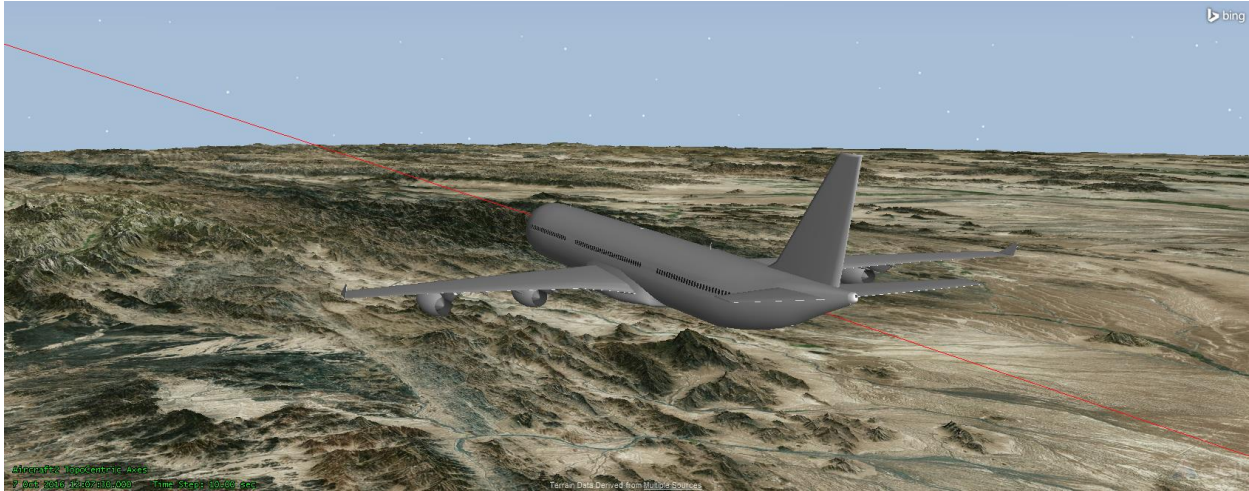- VNC had to be allowed out from the Amazon instance.

2. SCALABLE GRAPHICS CGX AMI

System Specification: Scalable Graphics CGX AMI - g2.2xlarge with Virtual GPU (NVIDIA GRID K520)

FUNCTIONALITY
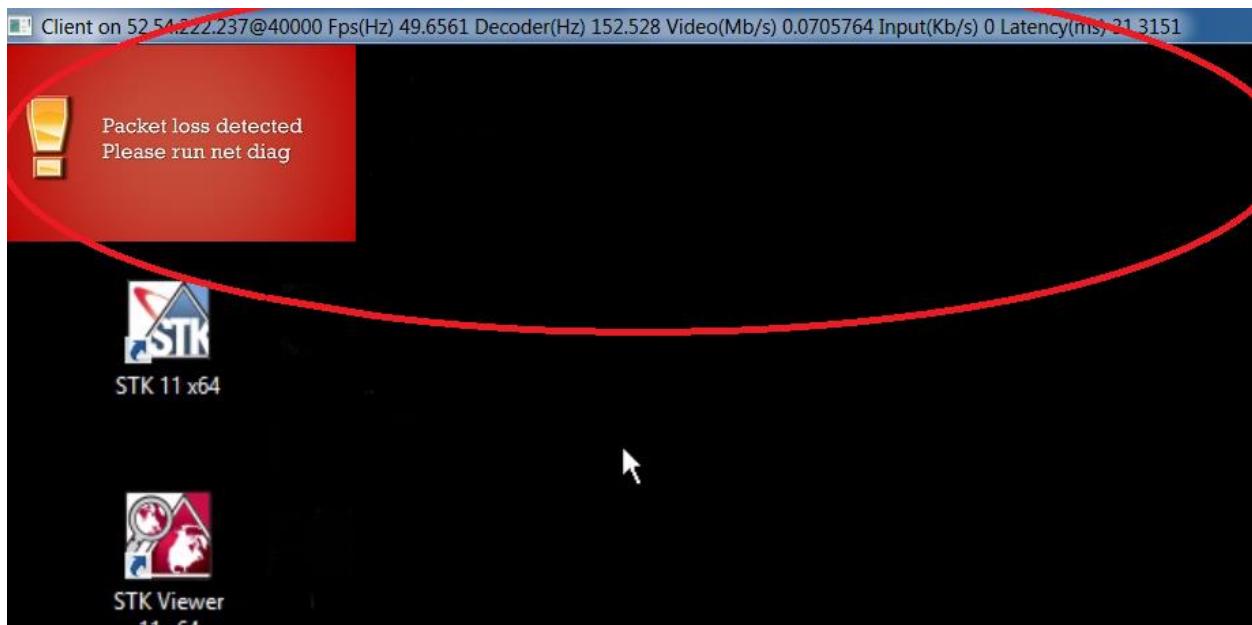
SCALABLE GRAPHICS CGX (CUSTOM) CLIENT

STK is fully functional, as OpenGL is fully supported in this configuration.

Scalable Graphics CGX AMI exposes a fully capable GPU for STK Visualization

AGI noticed some packet loss while using the Scalable Graphics custom client. Scalable graphics has a network diagnostic tool that when run reported the following:

> Last network diagnostic: Network diagnostic done: Ping = 12 ms, packet loss = 0.118518 %, jitter over limit = 0 % for 8 Mb/s

Connecting with scalable graphics custom client shows packet loss warning

CONFIGURATION

It is necessary in some environments to adjust local firewalls. It was our experience that we needed to open the following:

Scalable Graphics Custom Client: TCP ports 40000, 40001, 40002, 40003, and 40004 for the application type of "Unknown-TCP"

> Ports used by the CGX client can be customized from within the client itself if there is a desire to connect through alternate ports.

AGI recommends reviewing the specific AMI's documentation before the deployment. Following the AMI's documentation is critical to a successful deployment. The instructions for setting up this AMI can be found: http://www.scalablegraphics.com/aws/

3. OCTANE CLOUD WORKSTATION AMI

System Specification: Octane Cloud Workstation - g2.2xlarge with Virtual GPU (NVIDIA GRID K520)

FUNCTIONALITY

WEB BROWSER (CHROME)

STK is fully functional, as OpenGL is fully supported in this configuration.

In this configuration, Chrome required the user to load scripts from unauthenticated sources. After review, it appeared that traffic between the Amazon instance and the client was being sent over both HTTP and HTTPS which caused issue.
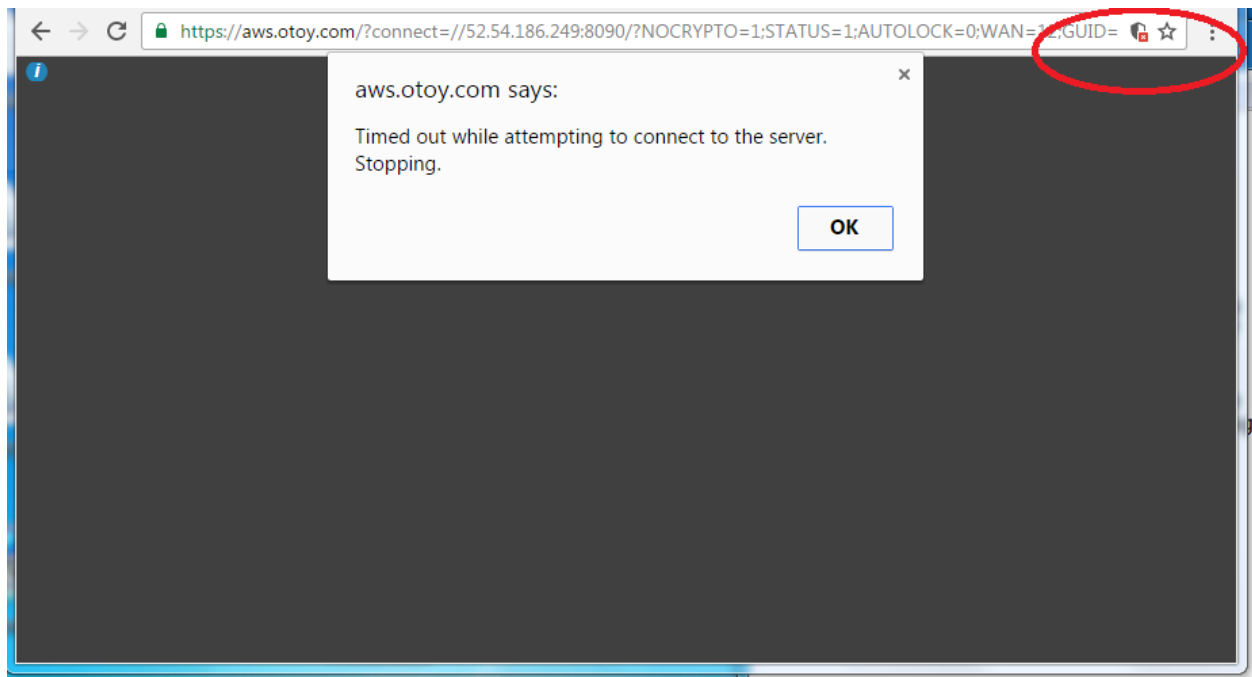
Warning the user to allow running scripts from unauthenticated sources

AGI tested this instance using the Automatic Token Generation method. These methods are described in the documentation for the instance (link provided below).
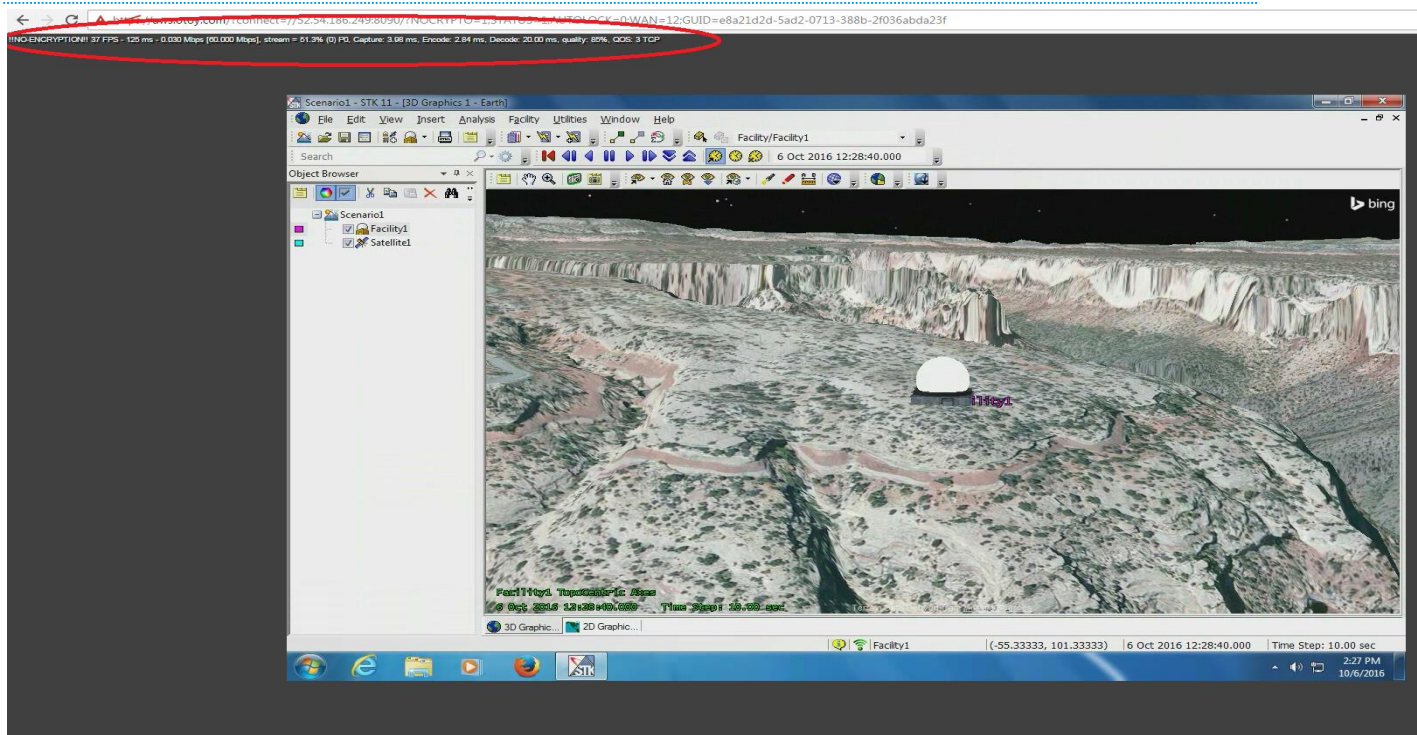
STK running in OTOY instance, performance characteristics highlighted in red

AGI experienced some trouble with leaving this instance up overnight and trying to reconnect the next morning. AGI had to remote desktop into the instance and reboot it to regain connectivity. AGI has no information on what caused this behavior.

> Note – When rebooting the instance, the GUID used to connect will change. If you attempt to connect using the old GUID you will receive an authentication error.

CONFIGURATION

AGI recommends reviewing the specific AMI's documentation before the deployment. Following the AMI's documentation is critical to a successful deployment. The instructions for setting up this AMI can be found: https://aws.otoy.com/docs/

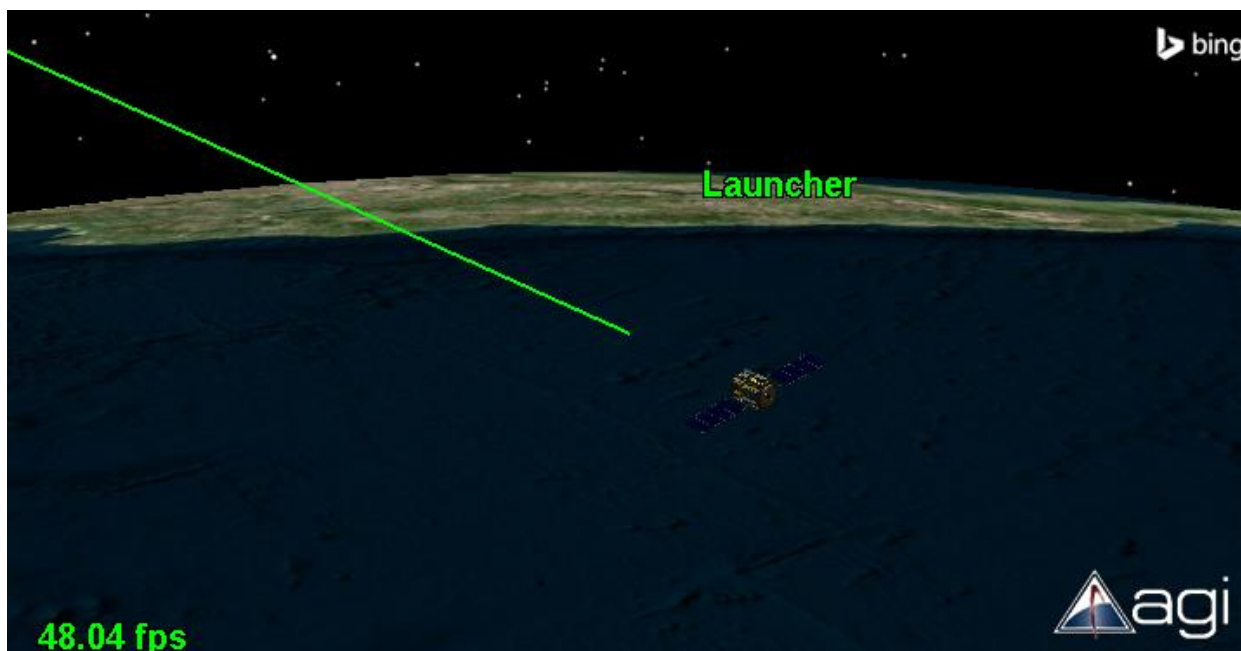## VMWARE EXSI 6.0 (ON PREMISE/PRIVATE CLOUD)

1. VWMARE EXSI 6.0 (VGPU, PROFILE - K260Q)

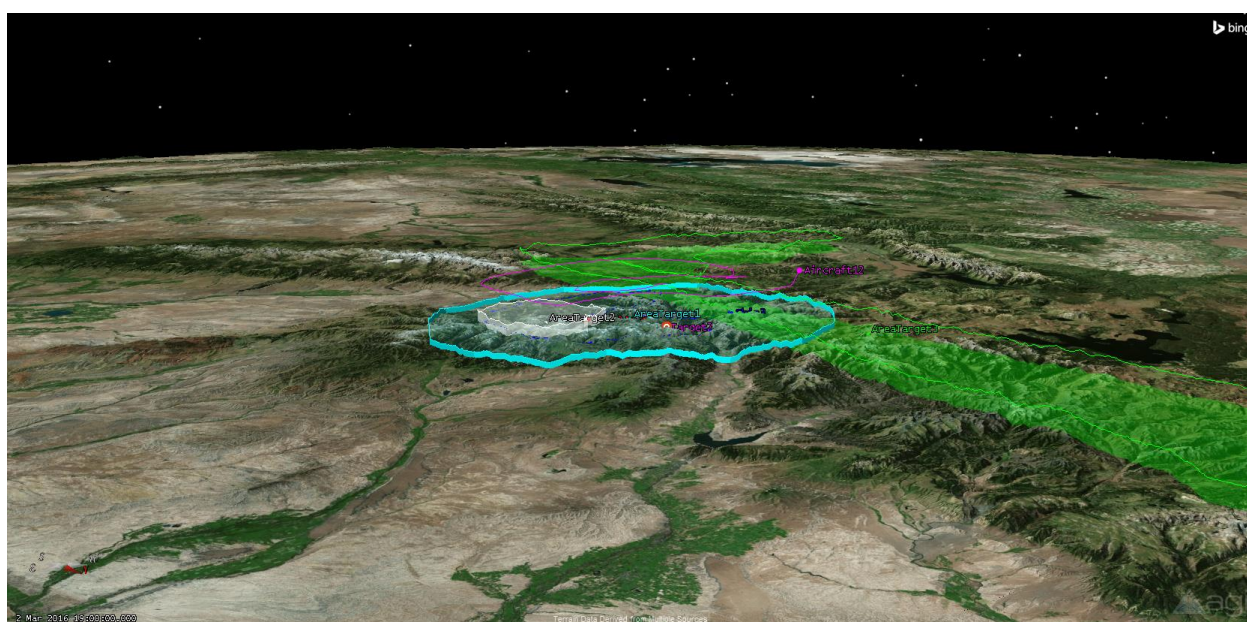**System Specification**: T7500 24 GB RAM, VMWare Exsi 6.0 NVIDIA K2 Graphics Card (vGPU testing)

FUNCTIONALITY

REMOTE DESKTOP CONNECTION

NVIDIA K1 and K2 cards are based on Quadro technology accelerated 3D graphics is available through remote desktop.

Animating a satellite at 48.04 Frames Per Second

Scenes rendered over RDP with Quadro card utilize complete GPU feature set.

CONFIGURATION

AGI tested using the k260Q profile documentation for different profiles can be found along with the drivers link below. AGI setup four remote virtual machines hosted on a T7500 Dell Precision Workstation with one (1) NVIDIA K2 Graphics Card, AGI connected to these remote systems

simultaneously and had positive results. We experienced frame rates as fast as 60 fps and an overall average of 30 – 45 fps based on the scenarios we tested against.

This configuration is well suited for power users of STK who need high end graphics with higher frame rates. This configuration can support four users simultaneously with positive results.

AGI used the NVIDIA driver set of **NVIDIA GRID VGPU SOFTWARE RELEASE 367.43/369.17** for our testing.

> **Note**: It was AGI's experience that you have to use the matching pair of drivers for Windows Display Driver as well as the GRID vGPU Manager. When this set did not match, we experienced issues with the guest machine recognizing the graphics card.
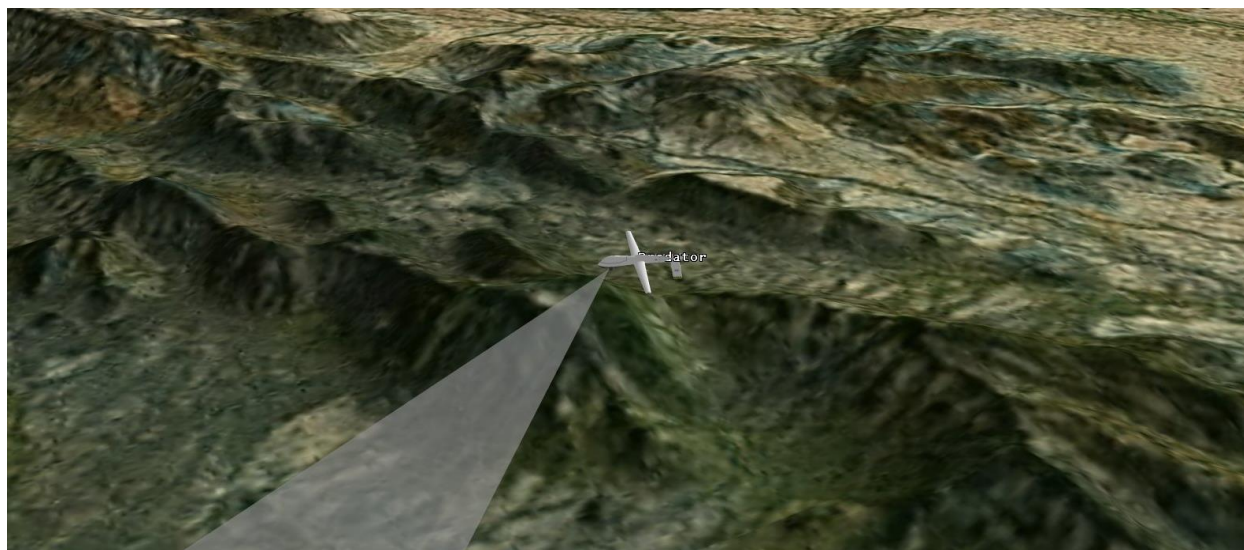
AGI recommends reviewing NVIDIA's users guide for proper system setup. The user guide and the release notes are contained in the bundled download in the link provided above.

2. VMWARE EXSI 6.0 (VGPU, PROFILE - K220Q)

System Specification: T7500 24 GB RAM, VMWare Exsi 6.0 NVIDIA K2 Graphics Card (vGPU testing)

FUNCTIONALITY

REMOTE DESKTOP CONNECTION

Scenes rendered over RDP with Quadro card utilize complete GPU feature set.

CONFIGURATION

AGI tested using the k220Q profile documentation for different profiles can be found along with the drivers link below. AGI setup eight virtual machines hosted on a T7500 Dell Precision Workstation with one (1) NVIDIA K2 Graphics Card, AGI connected to these remote systems simultaneously and had

positive results. We experienced frame rates as fast as 35 fps and an average of 20 -30 fps based on the scenarios we tested against.

This configuration is well suited for standard users of STK. This configuration can support eight users simultaneously with positive results. It was AGI's experience that users did not benefit from fewer users accessing the virtual machine. GPU resources per user (GPU memory and GPU processing power) are static. Having fewer users does not mean that the remaining users get more resources.

AGI used the NVIDIA driver set of **NVIDIA GRID VGPU SOFTWARE RELEASE 367.43/369.17** for our testing.

> **Note**: It was AGI's experience that you have to use the matching pair of drivers for Windows Display Driver as well as the GRID vGPU Manager. When this set did not match, we experienced issues with the guest machine recognizing the graphics card.

AGI recommends reviewing NVIDIA's users guide for proper system setup. The user guide as well as release notes are contained in the bundled download in the link provided above.

OVERALL PERFORMANCE

Naturally, performance of the application can vary based on available network bandwidth and CPU configuration. AGI has experienced frame rates as high as 60 frames per second and as low as four to five frames per second under ideal and heavily congested network conditions respectively.

AGI conducted this testing over AGI's 100 Mbps network.

CONCLUSION

Systems Tool Kit, as well as other AGI offerings, operate as expected in cloud and virtual environments. Depending on your specific need and environment, when you adhere to the general system requirements of the product, AGI's software will behave as expected in a virtual/cloud environment as well as a local environment.