SYSTEM	VIRTUAL GRAPHICS WORKSTATIONS
TITLE	**Proof of Concept for Virtual Graphics Workstations :** **Configuration and Usage**

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Electronics Instrumentation Group

Virtual Graphics Workstations

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SUMMARY

A Proof of Concept (PoC) setup for Virtual Graphics Workstation (VGW) has been implemented at Computer Division. The aim of this setup was to get the working knowledge and performance evaluation of VGW. This internal report explains the configuration and usage of the PoC setup.

Proof of Concept for Virtual Graphics Workstations: Configuration and Usage

1. Introduction

Physical workstations are used by scientists and engineers for 2D/ 3D modeling, simulation and analysis. They require high end graphics rendering capabilities and computing power than normal desktop PCs. Workstations are expensive and also require infrastructure investment in terms of AC and uninterrupted power supply. This results in lack of mobility of workstations, forcing users to visit centralized facility for using them. An alternative approach is to provide users with virtual workstations, where a shared, centralized computing environment provides a virtual machine to run interactive 3D graphical computing, which can be accessed from a zero client anywhere within the network.

In a virtual workstation approach, the remote server hosts a virtual representation of the machine that performs computation as well as graphics processing. To achieve this, the software transforms a physical GPU installed on the server to create virtual GPUs that can be shared across multiple virtual machines (VMs). Only the final displayed image (the pixel stream) traverses the network to the zero clients that display those pixels and capture user I/O.

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2. Hardware configuration for Virtual Graphics Workstations

The graphics virtualization setup consists of two virtualization servers and two management servers. The virtualization servers are equipped with Nvidia Grid GPU card and are used for hosting the vGPU enabled virtual workstations. Two management servers host the virtual machines required by the virtualization software (VMware) for authentication, management and connection brokering (infrastructure VMs). Table 1 lists the servers used for building the virtualization setup.

S.No	Server Type	Host Name	IP Address
1	Management Server	VGPU1	10.1.2.110
2	Management Server	VGPU2	10.1.2.111
3	Virtualization Server	VGPU3	10.1.2.112
4	Virtualization Server	VGPU4	10.1.2.113

Table 1: Physical servers with IP address and Host name

2.1. Hardware configuration of management servers

Processor : Intel Xeon E5-2697 V2

Clock Speed : 2.7GHz

No. of CPUs : 2

No. of Cores per CPU : 12

RAM : 128GB DDR3 Fully

HDD : 2 TB

2.2. Hardware configuration of virtualization servers

Processor : Intel Xeon CPU E5-2643 v4

Clock Speed : 3.40 GHz
No. of CPUs : 2
No. of Cores per CPU: 6
RAM : 128GB

HDD : 4 TB

Graphics Card : NVIDIA Tesla M60 with 16 GB GDDR5 Memory

The NVIDIA Tesla M60 GPU accelerator works with NVIDIA GRID software to provide the high-end graphics performance for virtualized workstations.

2.3 Hardware configuration of Thin Clients

Thin Clients are provided to users for connecting the VMs through network and they support graphics intensive applications with 4K resolution. The thin clients have dual core 2.4 GHz processor , 4GB RAM and 32 GB hard disk space.

3. Virtualization Software

The main software component used for virtualization is the hypervisor. It is the software that can virtualize hardware resources and manages the resources for every virtual machine. The VMware virtualization software stack and NVIDIA Virtual GPU Manager is used to achieve virtualization of graphics workstations.

3.1 VMware software stack

VMware ESXi is a bare-metal hypervisor, installed directly onto virtualization servers and management servers. The hypervisor partitions the hardware resources (CPU, Memory, HDD and GPU) to increase the effective utilization of the resources.

3.2 NVIDIA Virtual GPU Manager

Nvidia virtual GPU manager transforms a physical GPU installed on a server to create virtual GPUs that can be shared across multiple virtual machines. It runs along with the Vmware ESXI hypervisor in the virtualization servers. NVIDIA physical GPUs are capable of supporting multiple virtual GPU devices (vGPUs) that can be assigned directly to guest VMs. Guest VMs use NVIDIA vGPUs in the same manner as a physical GPU that has been passed through by the hypervisor: an NVIDIA driver loaded in the guest VM provides direct access to the GPU for graphics intensive applications and smooth rendering of graphics on the screen.

Fig. 1 depicts the components of the graphics virtualization setup. The NVIDIA Tesla M60 GPU cards are installed on virtualization servers. A network switch is provided to interconnect all the servers. Network Attached Storage (NAS) is configured through iSCSI mount point to provide the additional storage space to user VMs.
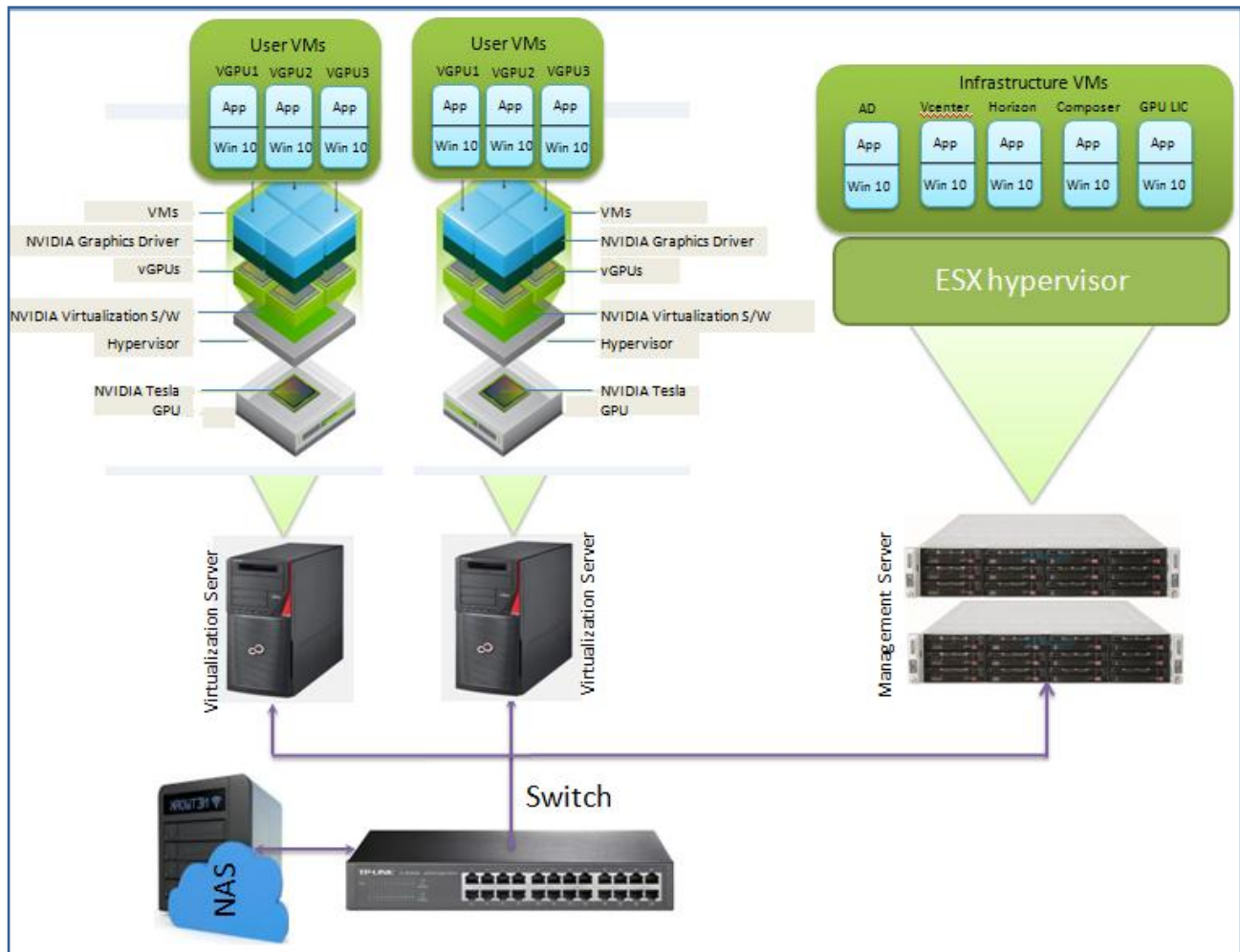
Fig. 1 Virtualized graphics workstations using VMware software stack

3.3 Infrastructure Services for Virtualization Software

The virtualization software requires separate services to be run for provisioning, managing, monitoring and authenticating user virtual machines. These services are running on virtual machines hosted in the management servers. Table 2 lists the details of such VMs and their functionalities.

S.No	VM Name	Host Name	IP Address	Functionality
1	Active Directory (AD) Server	VGPUAD	10.1.2.114	AD server verifies the user credentials when a user signs into a VM over a network and also controls which users have rights for accessing which VM.
2	Vcenter Server	VGPUVC	10.1.2.115	vCenter Server is used to configure ESX servers and VMs, as well as monitor performance of the entire infrastructure, using events and alerts.
3	Horizon Server	VGPUHS	10.1.2.116	Horizon server provides virtual desktops
4	Composer Server	VGPUCS	10.1.2.117	The Composer server is used to manage virtual desktops on the vCenter server. Its primary function is to track desktops and manage the state and configuration of desktops.
5	GPU LIC Server	VGPULIC	10.1.2.118	The NVIDIA vGPU software License Server is used to serve a pool of floating licenses to NVIDIA vGPU software licensed VMs.

Table 2: Infrastructure VMs with their functionalities

3.4 Configuration of user VMs

Six numbers of user VMs are provisioned on the two GPU enabled virtualization servers. Server1 hosts VGPU1 to VGPU3 and Server2 hosts VGPU4 to VGPU6. The detailed configuration of the user VMs are listed in Table 3. All the user VMs are loaded with 64 bit Windows 10 operating system. Software packages such as AutoCAD, SolidWorks, Ansys and Comsol are loaded in the VMs based on user requirements.

S.No	VM Name	Host Name	IP Address	Configuration of the VM
1	VGPUWIN10-1	VGPU1	10.1.2.121	8 vCPU, 4GB RAM with nvidia_vgpu_8q profile
2	VGPUWIN10-2	VGPU2	10.1.2.122	8 vCPU, 4GB RAM with nvidia_vgpu_4q profile
3	VGPUWIN10-3	VGPU3	10.1.2.123	8 vCPU, 3GB RAM with nvidia_vgpu_4q profile
4	VGPUWIN10-4	VGPU4	10.1.2.124	6 vCPU, 3GB RAM with nvidia_vgpu_8q profile
5	VGPUWIN10-5	VGPU5	10.1.2.125	6 vCPU, 4GB RAM with nvidia_vgpu_4q profile
6	VGPUWIN10-6	VGPU6	10.1.2.126	4 vCPU, 4GB RAM with nvidia_vgpu_4q profile

Table 3: User VMs with their configuration

3.5 VMware Blast protocol

Blast protocol is VMware's native display protocol used for desktop virtualization and remote application-delivery. This uses the H.264 codec as well as the JPG/PNG codec and automatically selects the most suitable codec for the conditions. The H.264 codec gives better performance in rendering smooth display. With H.264, the protocol can be encoded on the server using either hardware or software processing and decoded on the local endpoint using either hardware or software (hardware is the default unless the client is not H.264-capable). Servers with NVIDIA GRID graphics acceleration cards can offload H.264 encoding to the hardware in the NVIDIA GRID card.

3.6 Access methodology

The virtualization and management servers are hosted at computer Division. The users from the various groups are accessing their assigned VMs through campus backbone network using thin clients. VMware Horizon Client is installed on each endpoint device /thin client. Client software has the provision to provide the IP address of the connection server and username / password. By

providing the username and password of the user VM, the authentication takes place through connection server (Horizon server). The horizon server internally contacts the AD server for verifying user credentials. After successful login the respective VM is loaded into the thin client. Fig. 2 explains the network connectivity from the user end to the server.
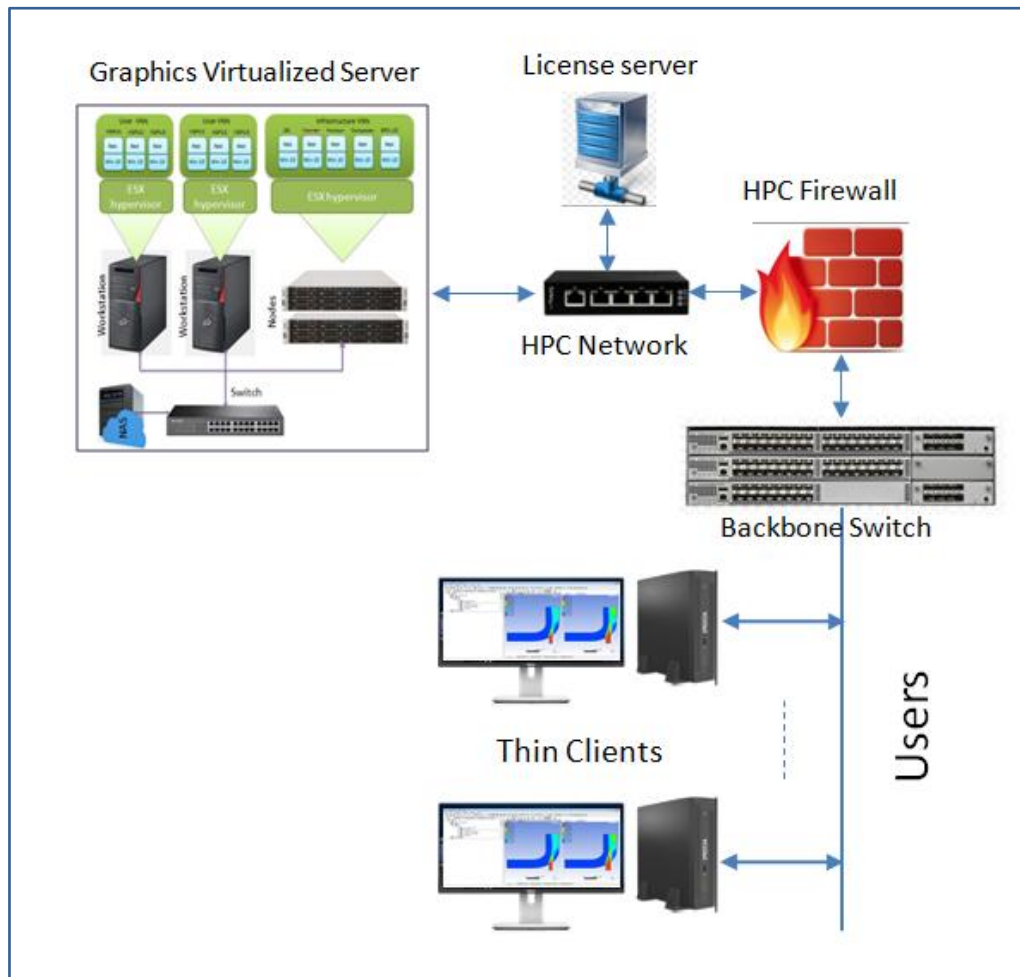

Fig. 2 accessing the user VMs through thin clients

## 4. User Guide for Accessing Virtual Machines through Thin Clients

For accessing the user virtual machines through the thin clients, following steps are involved:

1. Setting up an IP address for the thin client.
2. Connecting to the virtual machine from thin client.
3. Working on the virtual machine
4. Disconnecting from the virtual machine

4.1 Setting up IP Address for the Thin Client

To start using virtual graphics workstation, you have to assign an IP Address to the thin client. For this, get an IP address and gateway IP address from your network administrator.

1. Click on the 'Network' Icon at the bottom right corner of your thin client. In the Menu, select 'Edit Connections'.
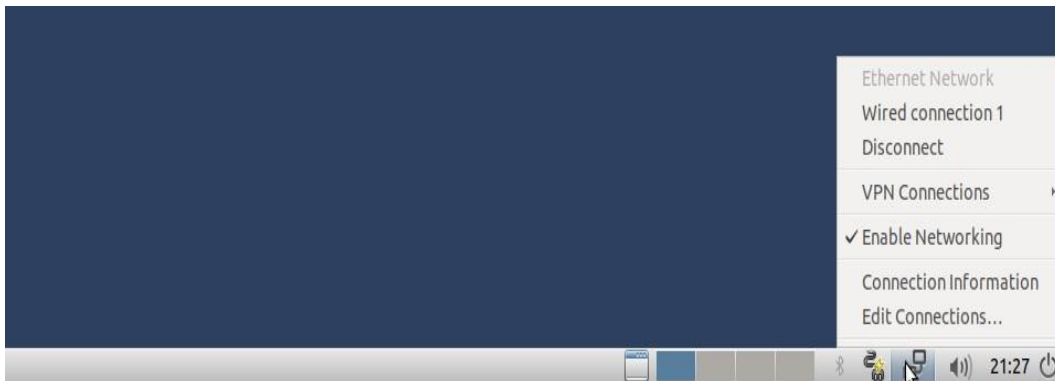
2. A screen named 'Network Connections' will pop up. Double click on 'Wired Connection 1'.
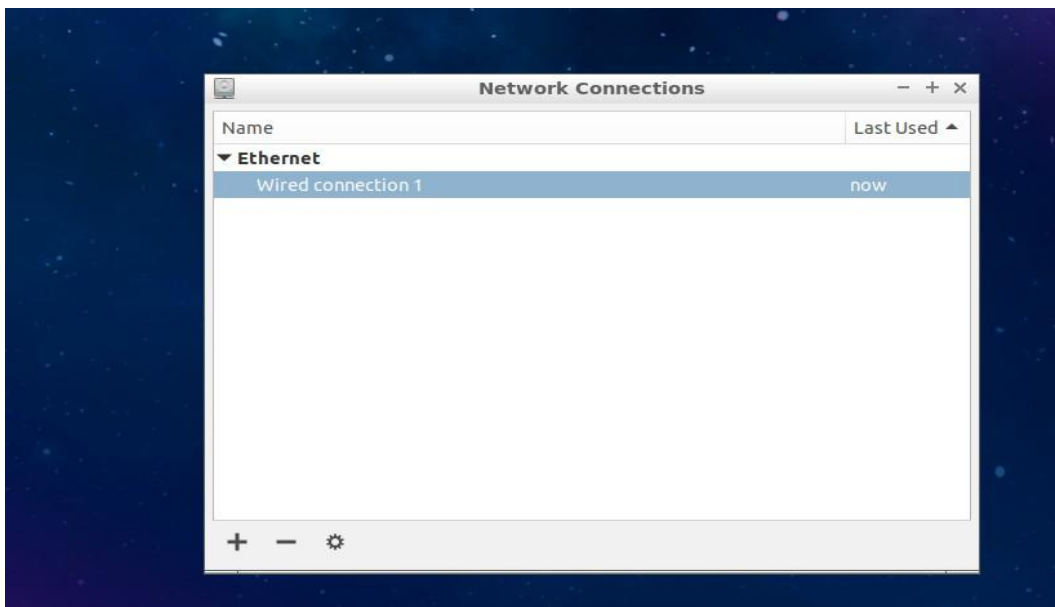
3. A screen named 'Editing Wired Connection 1' will pop up. Select 'IPV4 Settings' tab in the screen.
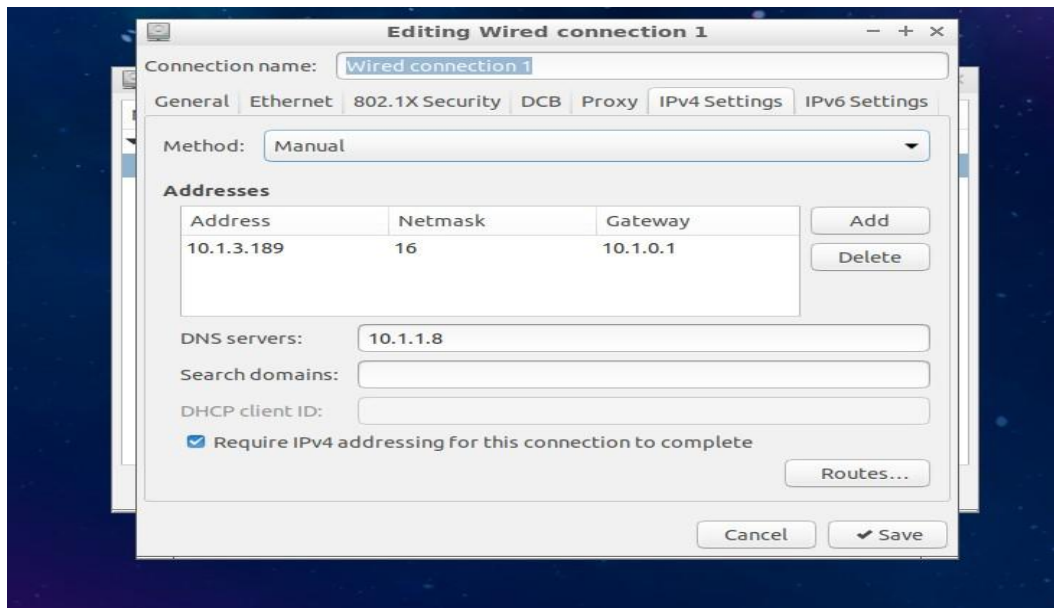
4. Select Method as 'Manual' from the drop down list. Under 'Address', click on the current IP address and change it to the new IP Address. Also click on the gateway and change it to the new gateway IP Address. Finally click on 'Save' Button.
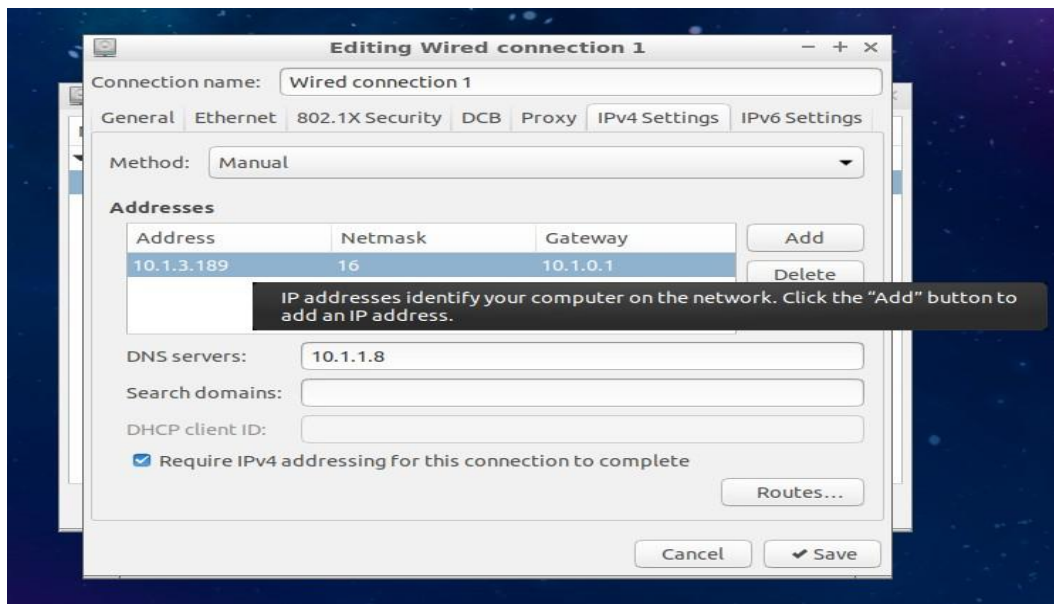
5. For the IP address change to be effective, reboot your thin client by selecting 'Reboot' after clicking 'Power' Button on the bottom right corner of your thin client.
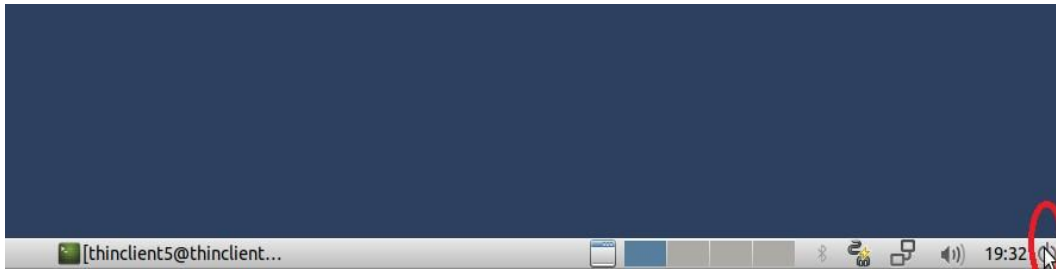
4.2 Connecting to the Virtual Machines

1. Power on the thin client by pressing the power button on the device. (The button will turn green when powered on)

2. Login to the thin client using the user name and password provided by CD for thin client.

3. Double Click on the 'VMWare Horizon Client' Icon on Desktop. This will open the Horizon application.
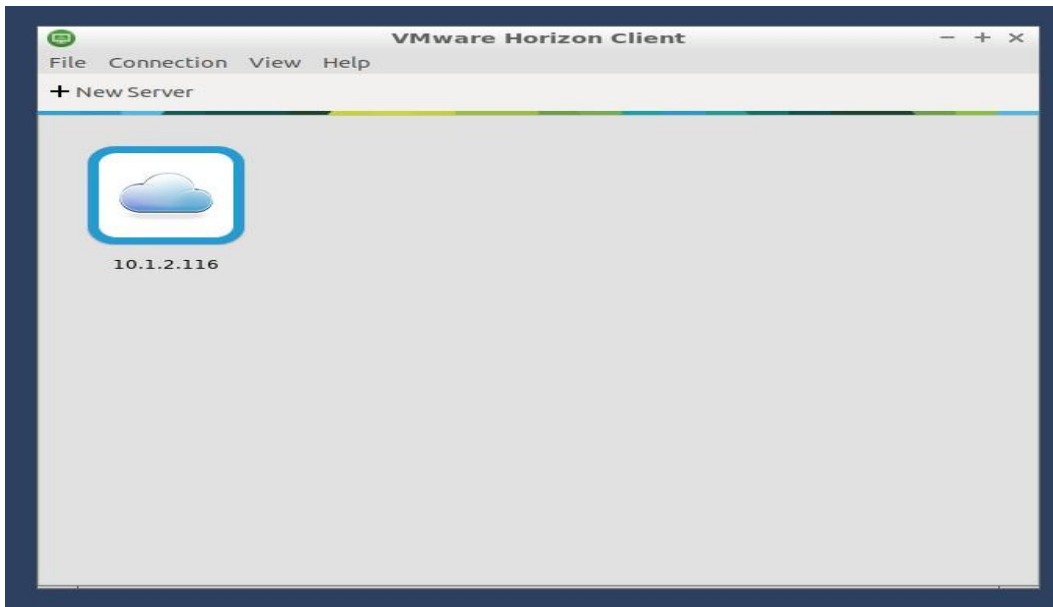
4. Click on the 'New Server' button. A popup box saying 'Enter the name of connection server' will come up.
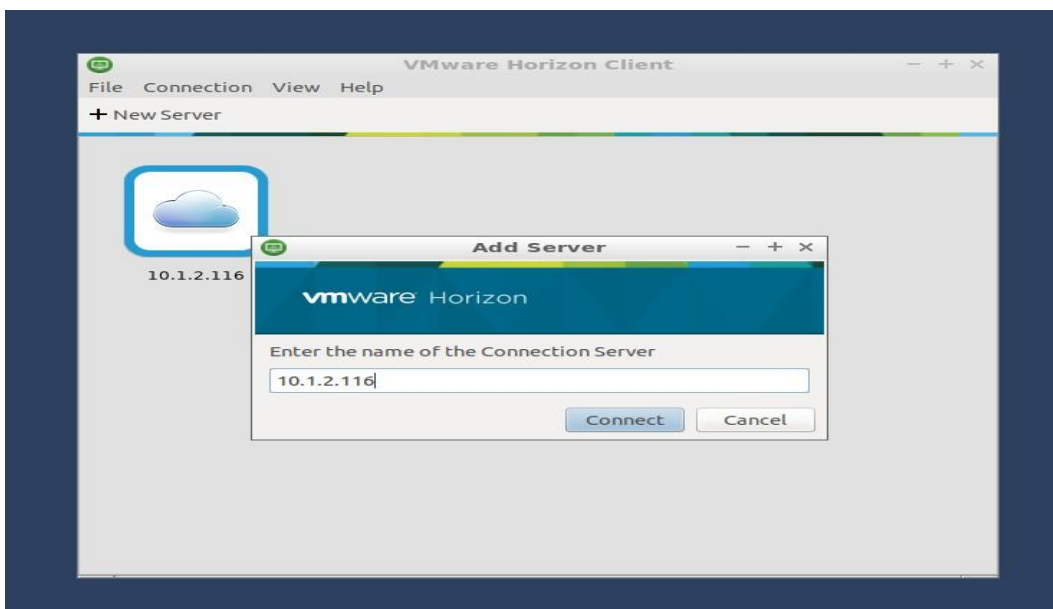
5. Enter 10.1.2.116 as the name of connection server and press connect.

6. Another screen will popup asking for username/password. Give the username and password provided by CD for virtual machine.
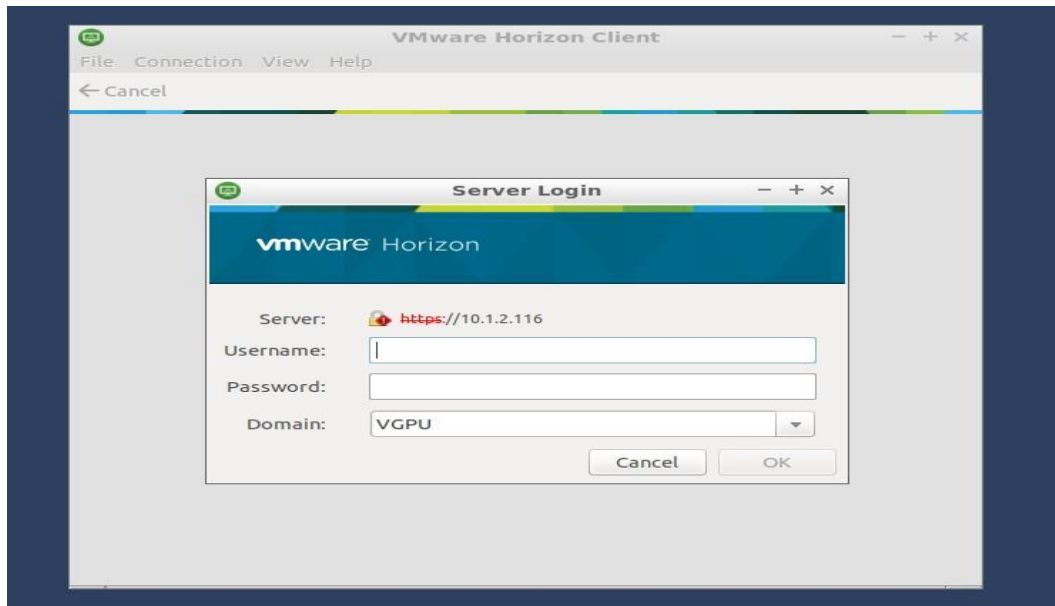
7. A screen will appear with the name of your virtual machine. Double click on it to connect to your VM.
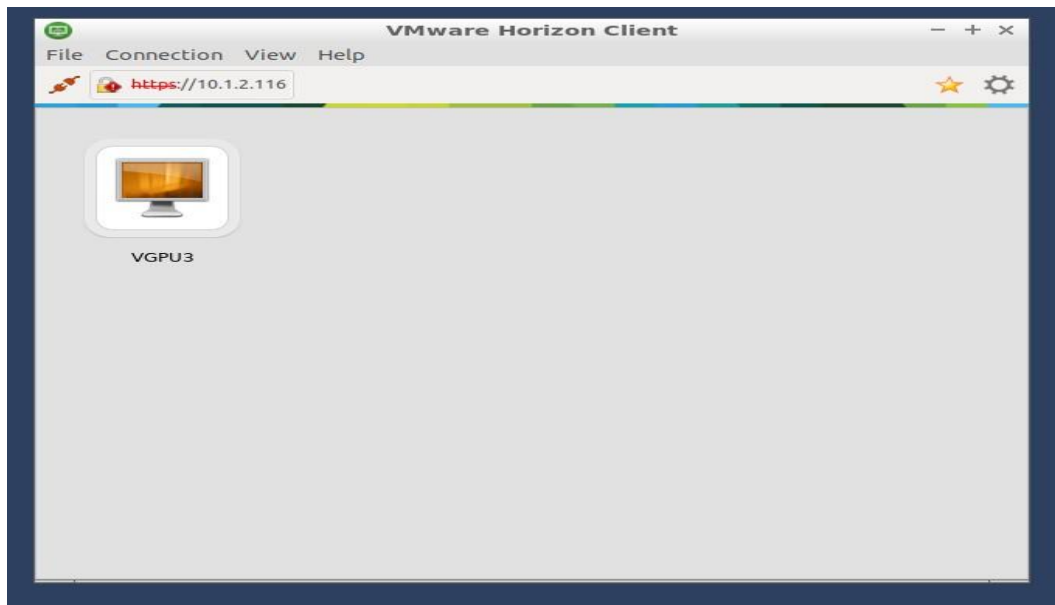
4.3 Working on the Virtual Machine

1. The virtual machine is having Windows 10 Operating System.

2. 300 GB disk space is provided in C: Drive and another 300 GB in E: Drive. These spaces can be used for installing applications and storing files you are currently working on. Another 1 TB space is available in NAS Volume. This space can be used for storing backup/ older files.

3. The administrator password for virtual machines is currently not provided to users. In case you want to install any applications/ do any actions requiring admin privilege, contact Computer Division.

4. For opening Task Manager/ ending any hanging tasks, press the 'Send Ctrl-Alt-Delete' button under 'Connection' Tab which appear on top of the virtual machine screen.
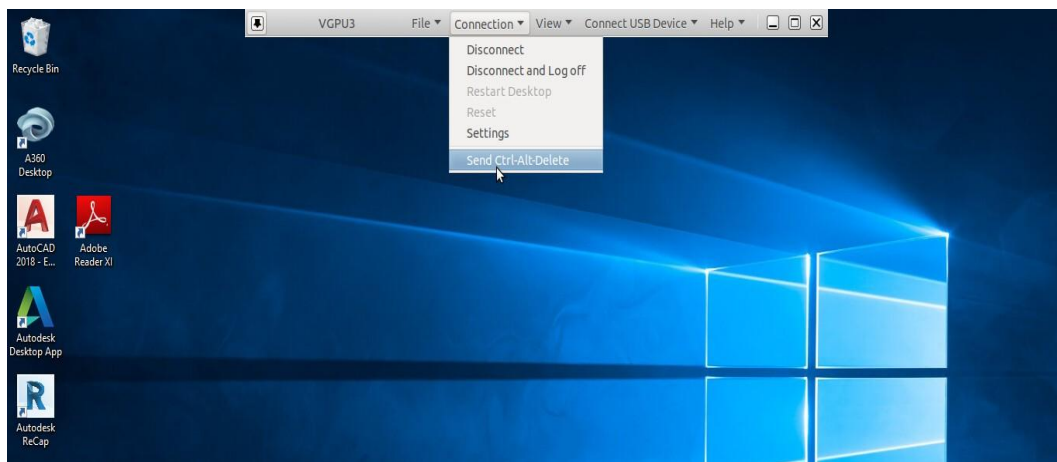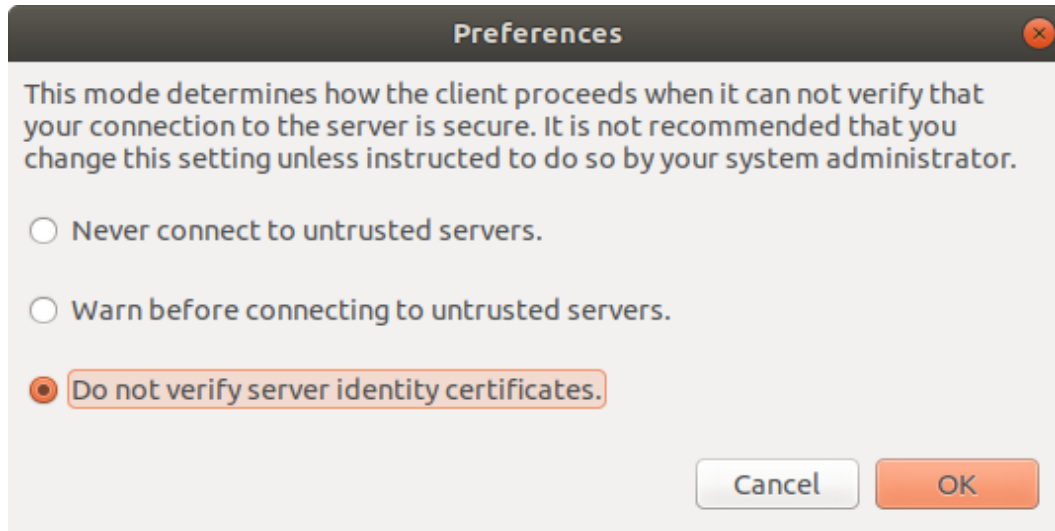

5. For changing password of your virtual machine, click on 'Send Ctrl-Alt-Delete' button under 'Connection' Tab and select 'Change a Password' option.
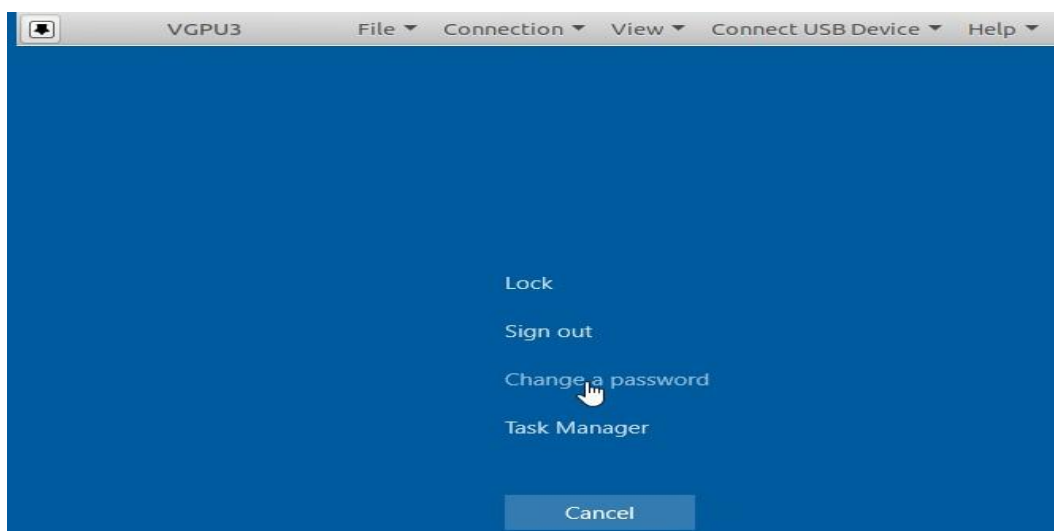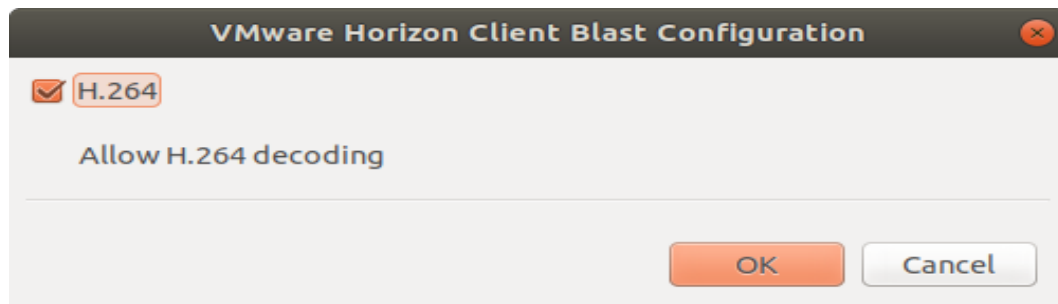
6. Please do not change the following settings in your Vmware Horizon client:

a. Under File → Preferences, 'Do not verify server identity certificates' must be selected.


b. Under File → Configure VMWare Blast, Allow H264 encoding must be selected.

c. Under 'Connect USB Device', 'Automatically Connect at Startup' and 'Automatically Connect when inserted' should be checked. By doing this, any USB device you are attaching to the thin client will automatically appear in your Windows Virtual Machine, under 'This PC' .
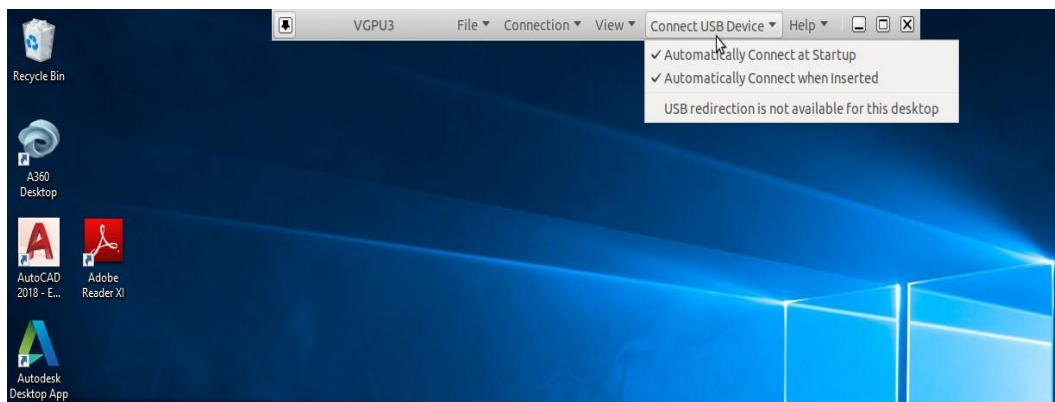
d. Under 'View' Menu, 'Full Screen – This Monitor' should be selected.
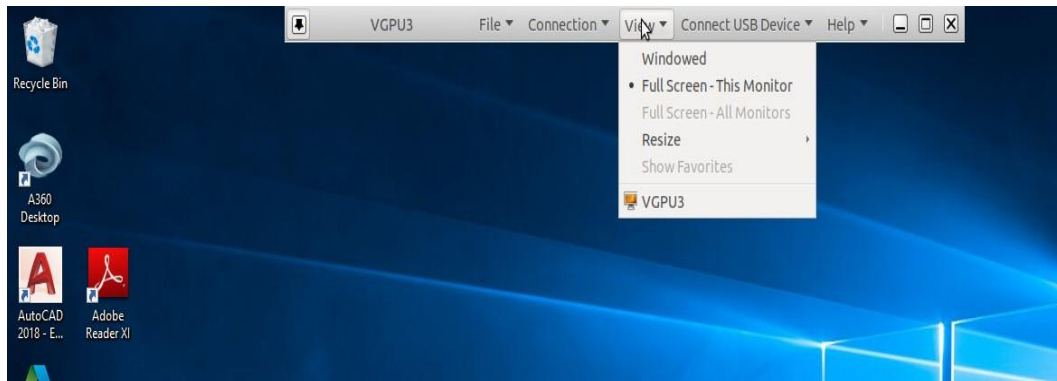
Important: Please remember that your thin client is to be used only as a device for connecting to the Virtual Machine. Please do not try to install/uninstall any programs or change configurations in it.

4.4 Disconnecting / logging off from user VM

1. Do not shut down or restart your virtual machine.

2. Once your work is over, you can disconnect from your VM by: Click 'Connection' button on top of VMWare Horizon Client Menu and use 'Disconnect' option. By doing this, you will not be logged out from your virtual machine and your job running in VM will continue
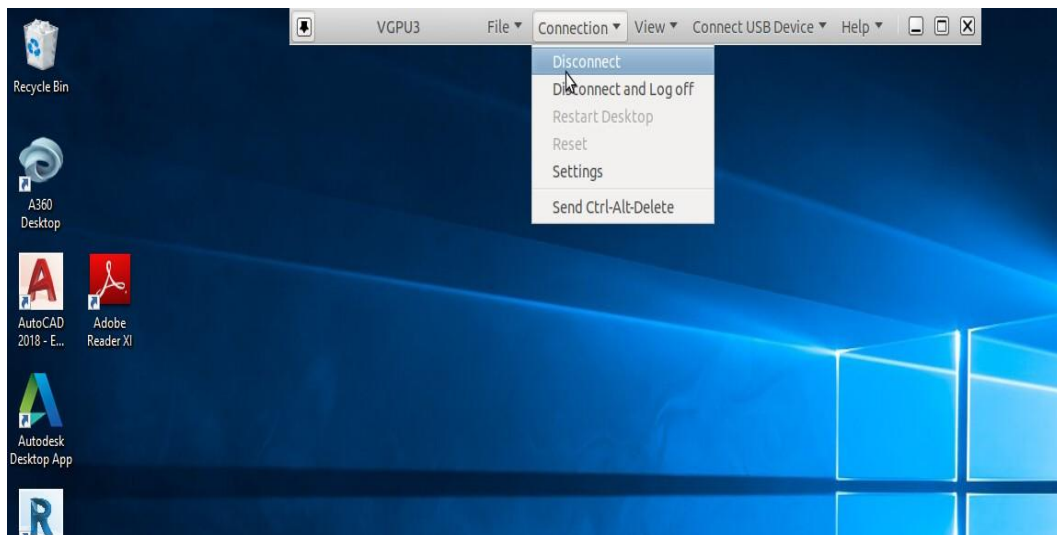
3. After that click on the 'Disconnect from Server' option on the top left corner of Horizon client. When it asks for a confirmation, select 'Disconnect'. After this, you can close Horizon client.
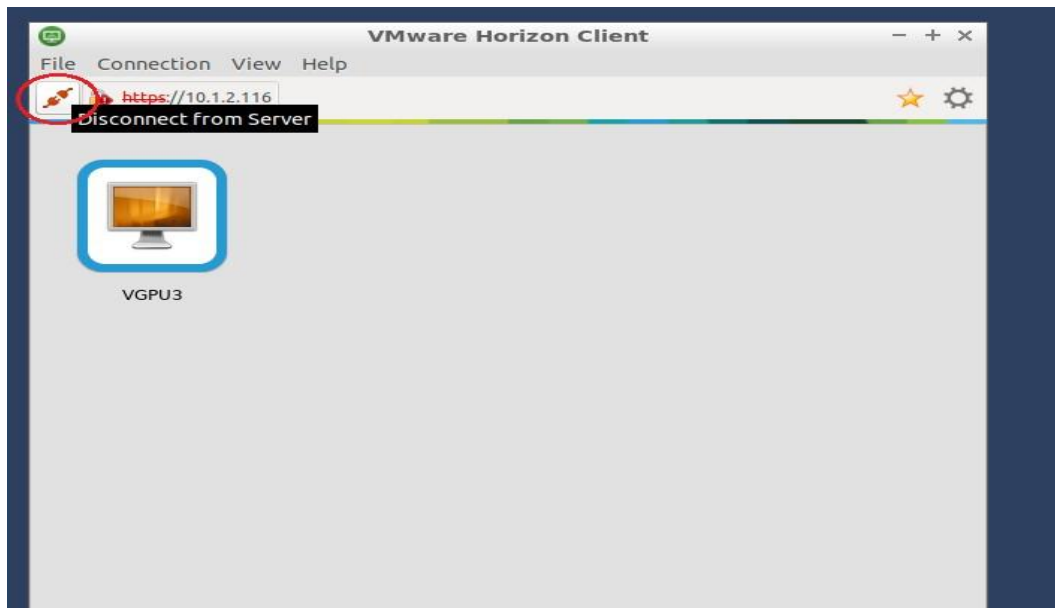
3. To shut down thin client, click power button at the bottom right corner of thin client and choose 'Shut Down'

5 Summary

A Proof of Concept for Virtual Graphics Workstations was successfully installed, configured and tested at IGCAR. It was established that VGWs provide high definition graphics rendering capabilities and computing power to scientists and engineers, with the benefits of centralized control, enhanced security and anywhere access.