Dell PowerEdge C8220X and VMware Horizon View

High performance graphics with the Dell PowerEdge C8220X in a VMware Horizon View 5.3 environment

Dell Wyse Solutions Engineering
February 2014

A Dell Technical White Paper

Revisions

Date	Description
February 2014	Initial release v.6.0
March 2014	Minor edits, PCoIP logo update v.6.1

Table of contents

Revisions 2

Executive summary 5

1 Solution architecture overview 6

1.1 Introduction 6

1.2 Dell Wyse Datacenter solution layers 7

1.3 Shared Tier 1 rack scaling guidance (iSCSI) 8

2 Hardware components 9

3 Dell Wyse Cloud Clients 11

3.1 Dell Wyse P25 11

3.2 Dell Wyse D10DP 11

3.3 Dell Wyse P45 11

3.4 Dell Wyse Z50D 12

3.5 Dell Wyse Z90D 12

3.6 Dell Chromebook 11 12

4 VDI density guidance 13

5 vDGA testing with NVIDIA GRID K2 cards 14

5.1 Graphics-specific performance analysis results 14

5.1.1 NVIDIA GRID K2 – Heaven Benchmark testing – Single VM 14

5.1.2 NVIDIA GRID K2 – Heaven Benchmark testing – with companion workload 15

5.1.3 NVIDIA GRID K2 – ViewPerf Benchmark testing – Single VM 18

5.1.4 NVIDIA GRID K2 – ViewPerf Benchmark testing with companion workload 19

5.1.5 Subjective tests 22

6 Conclusion 23

A Appendix – Configuration details 24

Executive summary

The Dell PowerEdge C8000 series is a space-efficient 4U chassis which houses compute, graphics processing units (GPU), and storage nodes for scale-out data center environments. The 4U chassis form factor allows for maximum flexibility of system configurations with the ability to adjust both sled and power options based on the customer's requirements.

The C8000 features three different sled types: C8220- Single Width Compute, C8220X- Double Width Compute, and C8000XD- Double Width Storage. You can power your scale-out environment with the density and versatility of the 2-socket C8220X compute GPU node powered by the Intel Xeon processor E5-2600v2 product family. Up to four C8220X compute GPU nodes can slide into the C8000 chassis mounted on specially-designed double-wide sleds, offering the intensive computing power of next-generation Intel processing plus enhanced I/O capabilities.

It is possible to install up to 2 NVIDIA GRID K2 cards in the C8220X sled for a total of 16 virtual dedicated graphics acceleration (vDGA) sessions per C8000 chassis (2 GRID K2 per sled x 4 sleds). vDGA is the technology which dedicates the full processing power of a single GPU to an individual VMware Horizon View virtual desktop thereby giving the user access to a desktop capable of performing intensive graphics workloads comparable to a high-end workstation in addition to providing native NVIDIA drivers for current and latest OpenGL and DirectX support.

The NVIDIA GRID K2 card contains two GPUs for a total of 8 GB of GDDR5 memory and 3072 Compute Unified Device Architecture (CUDA) cores.

This document addresses the architecture design, configuration, performance data, and implementation considerations for the key components of the architecture required to deliver virtual desktops via VMware Horizon View on the Dell PowerEdge C8000 chassis and C8220X sled platform using VMware vSphere 5.5.

1 Solution architecture overview

1.1 Introduction

The Dell Wyse Datacenter solution leverages a core set of hardware and software components consisting of 4 primary layers:

- Networking
- Compute server
- Management server
- Storage

These components have been integrated and tested to provide the optimal balance of high performance and lowest cost per user. Additionally, the Dell Wyse Datacenter solution includes an approved extended list of optional components in the same categories. These components give IT departments the flexibility to custom tailor the solution for environments with unique virtual desktop infrastructure (VDI) feature, scale, or performance needs.

In the Shared Tier 1 solution model, an additional high-performance shared storage array is added to handle the execution of the VDI sessions. All compute and management layer hosts in this model are diskless with the hypervisor being installed on a Micro SD card. The C8220X has a Micro SD slot located on the PCI Express riser for loading the ESXi hypervisor.

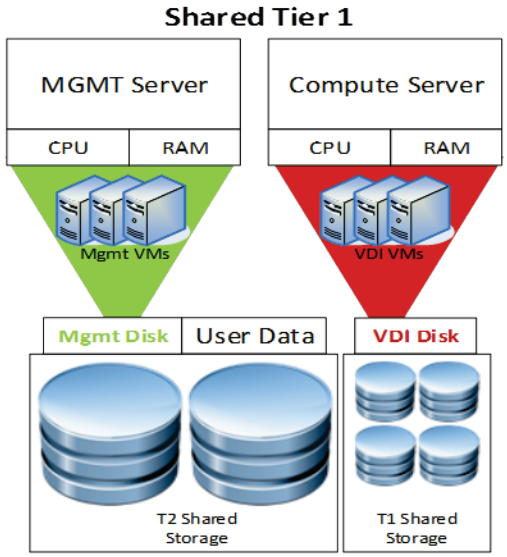

Figure 1 Shared Tier 1 solution model

1.2 Dell Wyse Datacenter solution layers

Each C8220X sled has two Intel Ethernet Controller i350 - x 1Gb Ethernet adaptors which can be uplinked to your existing network infrastructure. It is also possible to add the following extra Ethernet ports which can be used to connect to a high speed 10 Gb network infrastructure for access to shared storage such as the EqualLogic PS6210XS which is a 10Gb Tier 1 storage array validated configuration.

10 Gb Ethernet (options)

- Intel 82599 10Gb Ethernet controller dual port mezzanine card
- Intel X540 dual port 10 Gb Ethernet Base-T adapter
- Intel X520-DA dual port 10 Gb SFP+ adapter

In the Shared Tier 1 architecture model for rack servers, both management and compute servers connect to share storage. All top-of-rack (ToR) network traffic has been designed to be layer 2 (switched locally), with all layers 3 (routable) VLANs routed through a core or distribution switch. The following diagrams illustrate the server NIC to ToR switch connections, vSwitch assignments, as well as logical VLAN flow in relation to the core switch.

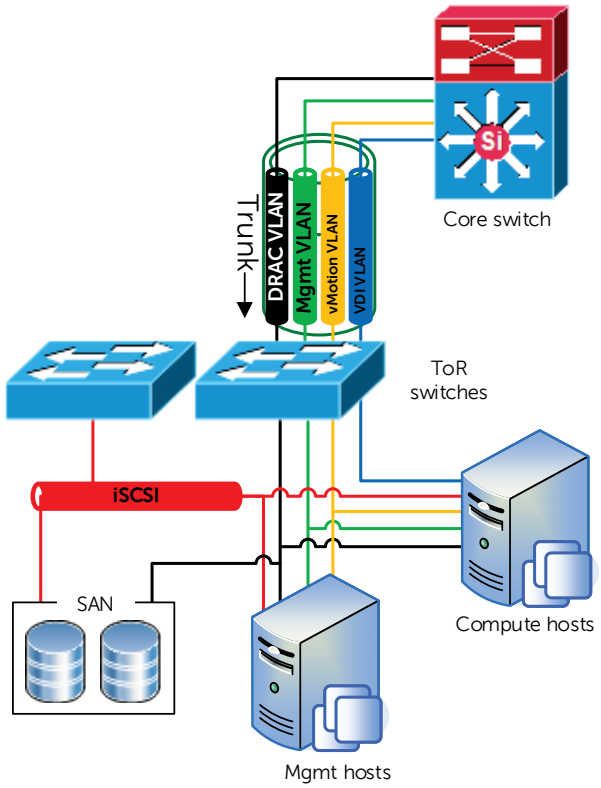

Figure 2 Top-of-rack switch connections and vSwitch assignments

1.3 Shared Tier 1 rack scaling guidance (iSCSI)

The following table shows a combination of ToR switches for LAN, iSCSI, and the various EqualLogic array options for using iSCSI storage with the C8220X

Table 1 Top-of-rack switch combinations

Shared Tier 1 hardware scaling (rack – iSCSI)					
User scale	ToR LAN	ToR 10Gb iSCSI	EqualLogic T1	EqualLogic T2	EqualLogic NAS
0-500	S55	S4810	PS6210XS	-	-
500-1000	S55	S4810	PS6210XS	PS4110E	-
0-1000 (HA)	S55	S4810	PS6210XS	PS4110E	NX3300
0-3000	S55	S4810	PS6210XS	PS6210E	NX3300
3000-6000	S55	S4810	PS6210XS	PS6510E	NX3300
6000+	S60	S4810	PS6210XS	PS6510E	NX3300

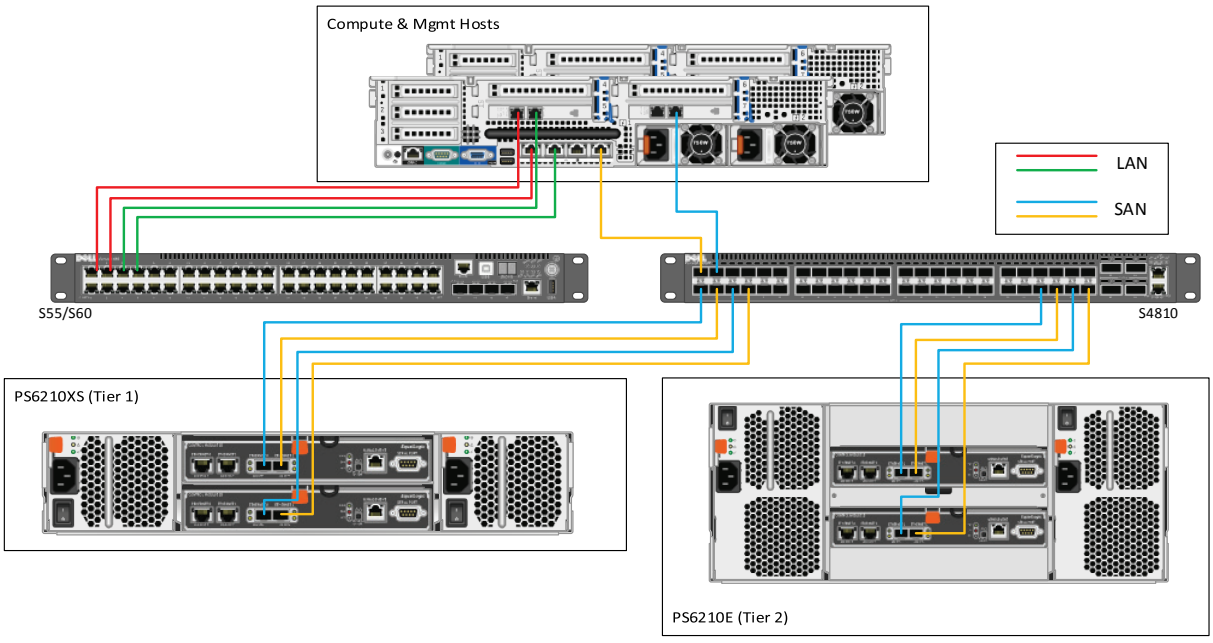

Figure 3 Shared Tier 1 cabling diagram (rack – EqualLogic)

2 Hardware components

Figure 4 PowerEdge C8000 chassis – Front panel view

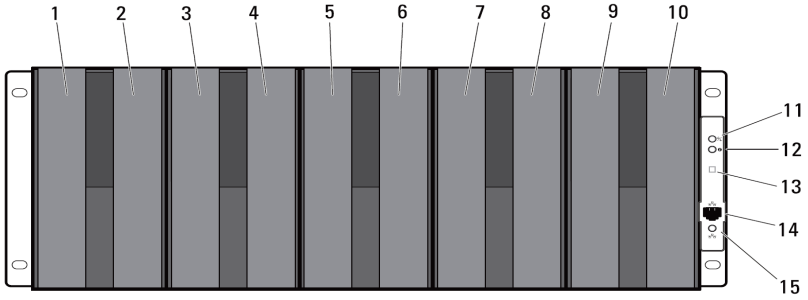

Figure 5 PowerEdge C8000 chassis – Front panel features

- 1, 2, 4, 7, 8, 9, 10 Sled bays (up to 5 C8220X sleds, 10 C8220 sleds, and 5 C8000XD sleds)
- 5, 6 Sled bays (up to 2 power sleds, 2 compute sleds, or combination of both)
- 11 Power event indicators
- 12 Chassis identification indicator
- 13 Thermal sensor
- 14 Ethernet port
- 15 Network link and activity indicators

Figure 6 Sled external and internal views

Shared Tier 1 compute host – PowerEdge C8220X
2 x Intel Xeon E5-2600v2 processors
256 GB Memory (16 x 16 GB DIMMs @ 1600MHz)
VMware vSphere in internal SD memory
2 USB external USB ports (front)
Embedded server management: BMC with IPMI 2.0 support and 1 x 10/100 Mbps RJ45 port
Network: Intel i350 2 x 1 Gb Ethernet
Hard drives: 2 x 2.5" hot-plug + 8 x 2.5" non-hot-plug, or only 2 x 2.5" non-hot-plug (when using GPUs)
Hard drive: 2 x 2.5" hot-plug + 4 x 3.5" option
Drive controller: Intel C600 SATA or SSD only, LSI 2008 6 GB SAS mezzanine (optional)

Table 2 Compute host configuration

3 Dell Wyse Cloud Clients

The following Dell Wyse end/ zero clients are the recommended choices for this solution.

3.1 Dell Wyse P25

Experience uncompromised computing with the benefits of secure, centralized management. The Dell Wyse P25 PCoIP zero client for VMware View is a secure, easily managed zero client that provides outstanding graphics performance for advanced applications such as CAD, 3D solids modeling, video editing and advanced worker-level office productivity applications. Smaller than a typical notebook, this dedicated zero client is designed specifically for VMware View. It features the latest processor technology from Teradici to process the PCoIP protocol in silicon, and includes client-side content caching to deliver the highest level of performance available over 2 HD displays in an extremely compact, energy-efficient form factor. The Dell Wyse P25 delivers a rich user experience while resolving the challenges of provisioning, managing, maintaining and securing enterprise desktops.

3.2 Dell Wyse D10DP

The Dell Wyse D10DP is a high-performance and secure ThinOS 8 thin client that is absolutely virus and malware immune. Combining the performance of a dual core AMD G-Series APU with an integrated graphics engine and ThinOS, the D10DP offers exceptional thin client PCoIP processing performance for VMware Horizon View environments that handles demanding multimedia apps with ease and delivers brilliant graphics. Powerful, compact and extremely energy efficient, the D10DP is a great VDI end point for organizations that need high-end performance but face potential budget limitations.

3.3 Dell Wyse P45

Experience uncompromised computing with the benefits of secure, centralized management. The Dell Wyse P45 PCoIP zero client for VMware View is a secure, easily managed zero client that provides outstanding graphics performance for advanced applications such as CAD, 3D solids modeling, video editing and advanced worker-level office productivity applications. About the size of a notebook, this dedicated zero client designed specifically for VMware View. It features the latest processor technology from Teradici to process the PCoIP protocol in silicon and includes client-side content caching to deliver the highest level of display performance available over 4 HD displays in a compact, energy-efficient form factor. The Dell Wyse P45 delivers a rich user experience while resolving the challenges of provisioning, managing, maintaining and securing enterprise desktops.

3.4 Dell Wyse Z50D

Designed for power users, the Dell Wyse X50D is the highest performing thin client on the market. Highly secure and ultra-powerful, the X50D combines Dell Wyse-enhanced SUSE Linux Enterprise with dual-core AMD 1.65 Ghz processor and a revolutionary unified engine for an unprecedented user experience. The Z50D eliminates performance constraints for high-end, processing-intensive applications like computer-aided design, multimedia, HD video and 3D modelling.

3.5 Dell Wyse Z90D

This is super high performance Windows Embedded Standard 7 thin client for virtual desktop environments. Featuring a dual core AMD processor and a revolutionary unified engine that eliminates performance constraints, the Z90D7 achieves incredible speed and power for the most demanding embedded windows applications, rich graphics and HD video. With touch screen capable displays, the Z90D7 adds the ease of an intuitive multi touch user experience and is an ideal thin client for the most demanding virtual desktop workload applications.

3.6 Dell Chromebook 11

chrome

With its slim design and high performance, the Dell Chromebook 11 features a 4th Generation Intel® Celeron 2955U processor, 11.6-inch screen, up to 10-hours of battery life and 16GB embedded Solid State Drive which allow it to book in seconds. The Dell Chromebook 11 is available in two models with either 2GB or 4GB of internal DDR3 RAM. This provides options for the education ecosystem, allowing students, teachers and administrators to access, create and collaborate throughout the day at a price point that makes widespread student computing initiatives affordable. The Dell Chromebook 11 features an 11.6-inch, edge-to-edge glass screen that produces exceptional viewing clarity at a maximum resolution of 1366x768 and is powered by Intel HD Graphics. The high-performing display coupled with a front-facing 720p webcam creates exciting opportunities for collaborative learning. The Dell Chromebook 11 is less than one inch in height and starts at 2.9lbs, making it highly portable. With two USB 3.0 ports, Bluetooth 4.0 and an HDMI port, end users have endless possibilities for collaborating, creating, consuming and displaying content. With battery life of up to 10-hours[i], the Chromebook is capable of powering end users throughout the day.

Finally with a fully compliant HTML5 browser, the Dell Chromebook11 is an excellent choice as an endpoint to a HTML5/BLAST connect Horizon View VDI desktop.

4 VDI density guidance

Density numbers given below are an extrapolation based on testing and validation work completed in the Dell Wyse Solutions Engineering labs on other PowerEdge Server platforms configured with identical CPU, memory, and hard drive configurations. It is meant to be an estimate of VM density on the C8000 platform for the non-graphics workloads described in the section below.

User Type	Max. User Density Per Host	vCPUs	vRAM Total (GB)	vRAM Reserve (GB)
Basic	185	1	2	1
Standard	130	2	3	1.5
Premium	115	2	4	2

Table 3 User density extrapolations for the PowerEdge C8000

Test Specifications
2 x Intel Xeon E5-2690v2 processors*
256 GB Memory (16 x 16 GB DIMMs @ 1600MHz)
Networking: 10 Gb
Desktop OS: Windows 7
Tier 1 Storage: Shared
*When using GPUs in the C8220X, CPUs must be E5-2680v2 (2.8 GHz, 10C) or E5-2695 (2.4 GHz, 12C)

Table 4 Test environment specifications

5 vDGA testing with NVIDIA GRID K2 cards

The capability for 3D graphics and video in VMware Horizon View further expands the use cases and target users that IT can deliver with virtual desktops. VDGA allows the IT department to deliver virtual desktops to users who traditionally would have required high performance workstations in order to get the graphics performance that they required for running applications like AutoCAD and Edrawings e.g. engineering and oil and gas sectors.

The critical difference between vDGA and vSGA is that when using vDGA the virtual machine has full control and usage of the assigned GPU, it is passed through the hypervisor to the VM and the driver is installed locally on the VM whereas in vSGA the GPU is shared amongst a pool of virtual machines, the natively installed NVIDIA drivers allows the VMs to have the latest OpenGL and DirectX functionality.

VDGA offers DirectX 9, 10 and 11 support and it can also support OpenGL 2.1 / 3.x / 4.1 x whereas vSGA can only support DirectX9 and Open GL2.1 (at this time)

The Dell PowerEdge C8000 series packs up to eight single-wide sleds, four double-wide (Compute/GPU) sleds or a variety of combinations to create the ideal mix for your workloads. It's possible to install 2 x NVIDIA GRID K2 cards in each of the four double-wide GPU sleds, giving us a total of eight K2 cards in the chassis.

Furthermore, each NVIDIA GRID K2 has two GPUs so this gives us a total of 16 GPUs per 4U chassis. Using this setup can support four high performance vDGA users per sled.

The following pages details tests and validation undertaken on one C8220X double-wide sled housing 1 x NVIDIA GRID K2 card. The validation is for workstation users and the GRID cards are operating in pass-through mode (i.e. a VM has direct access to a GPU on the K2 card). The GPU is not shared with any other VMs on the hypervisor. The results would linearly scale fully populating the chassis with 3 more sleds.

For the validation described here, the Dell Wyse P25 zero client endpoints were used, which is able to perform client side caching and can process PCoIP in embedded Teradici hardware . Also used, was the Dell Wyse D10DP endpoint which is a dual core thin client which includes an enhanced graphics engine.

1. Dell recommended guidelines to optimize solutions and/or products.
2. Industry related guidelines which are generally accepted by industry experts or recognized industry standards organizations.

5.1 Graphics-specific performance analysis results

5.1.1 NVIDIA GRID K2 – Heaven Benchmark testing – Single VM

Heaven Benchmark (HB) is a GPU-intensive benchmark that significantly stresses graphics cards. This benchmark tool can be effectively used to determine the stability of a GPU under extremely stressful conditions, as well as validating the characteristics of the card's thermal subsystems.

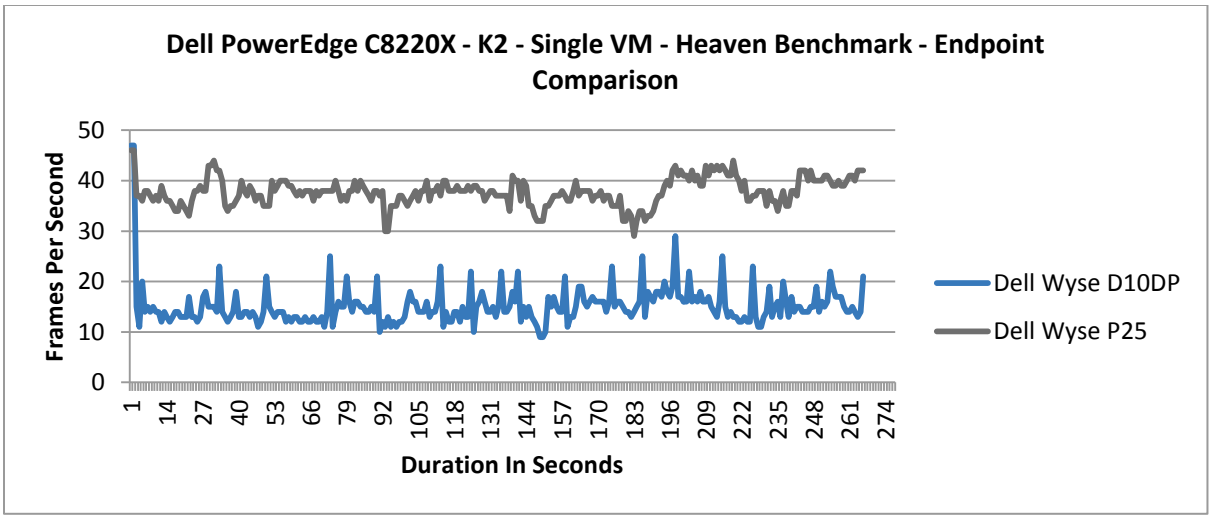

Figure 7 PowerEdge C8220X – K2 – Single VM – HB – Endpoint comparison

As we can see in the above graph, the Dell Wyse P25 Zero client is able to maintain a much higher frame rate than the Dell Wyse D10DP – highlighting the fact that zero clients are a better candidate for high – end graphics workloads as they are able to process PCoIP frames in hardware. The Dell Wyse D10DP, however, performs very well with lighter graphics workloads.

Note: Heaven benchmark produces a score after each benchmark test; however we found the scores to be unreliable so they are not included in this document

Note: Heaven benchmark was executed at high quality with a resolution of 1366 x 768 (not full screen)

5.1.2 NVIDIA GRID K2 – Heaven Benchmark testing – with companion workload

For the following test, we ran a companion workload on the other VMs on the host to establish whether or not it would have any negative impact on the test results of the benchmark VM. In theory, the companion workload should have little impact as each VM has access to its own dedicated GPU.

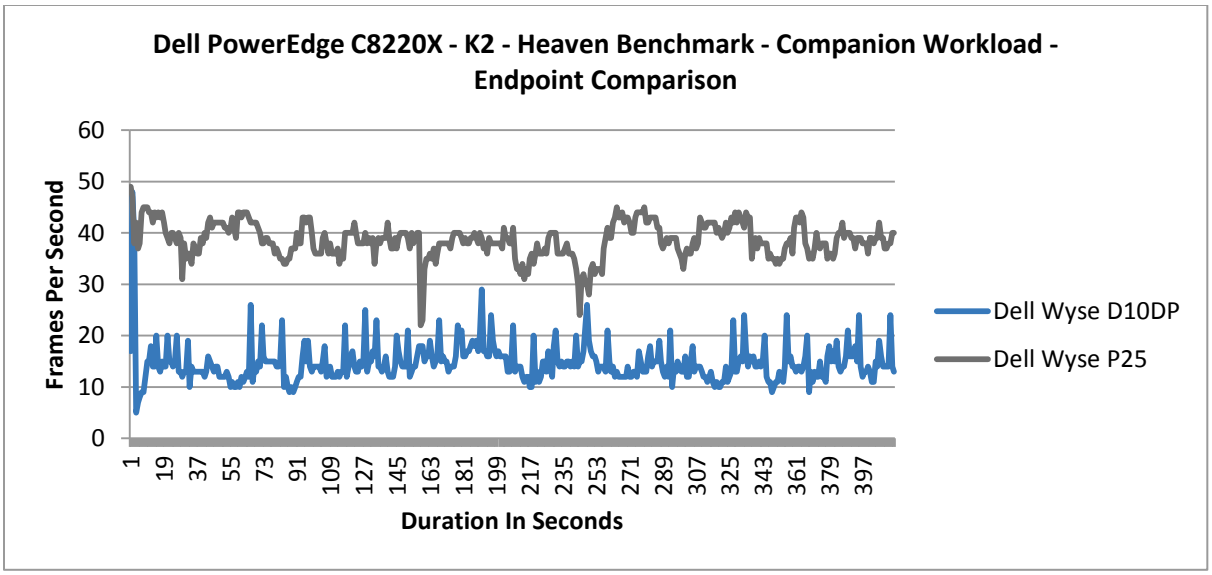

Figure 8 Dell PowerEdge C8220X – K2 – HB with companion workload

As you can see, the graph in Figure 8 is almost identical to the graph in Figure 7 when just a single VM was used. This confirms that companion workloads on the other VMs do not impact the benchmark VM because the GPUs are assigned to each VM directly and there is little or no contention for resources.

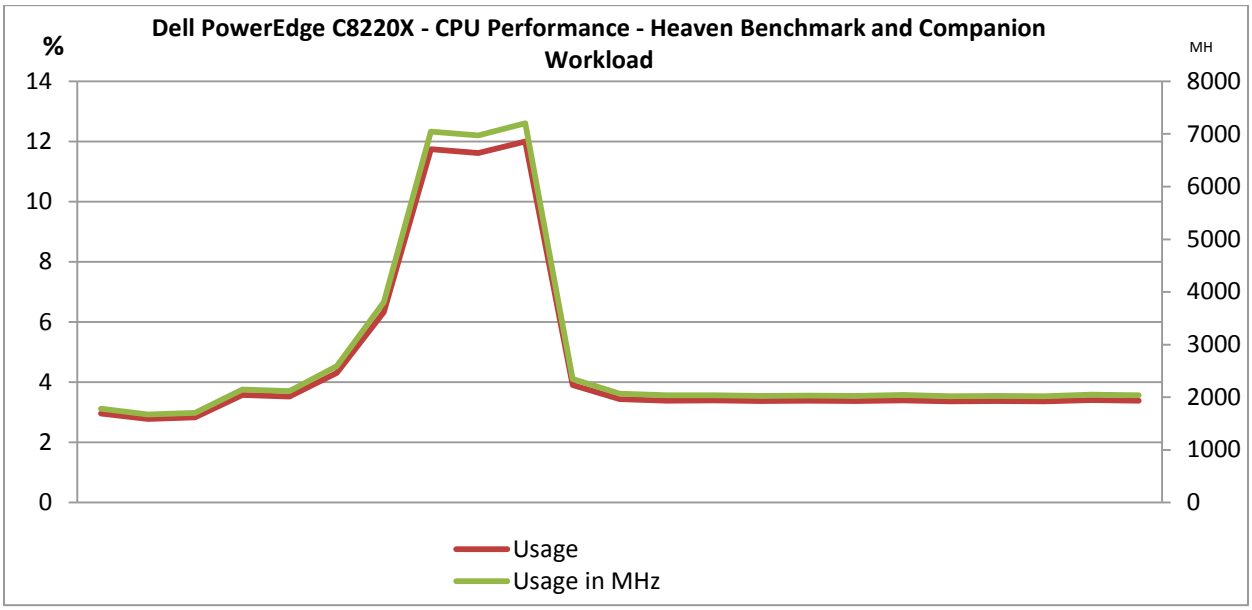

Figure 9 Dell PowerEdge C8220X – CPU usage. Here we see that the host CPU usage remained quite low while the HB and the companion workloads were running.

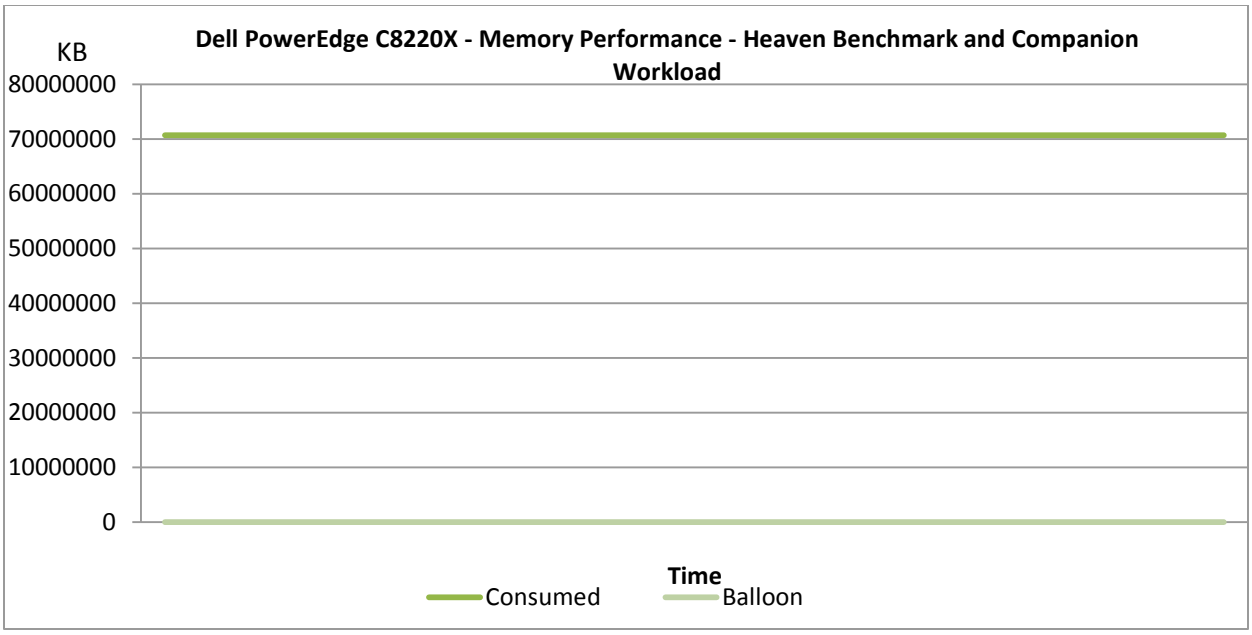

Figure 10 Dell PowerEdge C8220X – Memory performance. Here we see that the host memory usage during the HB while running the companion workloads showed no evidence of any memory ballooning.

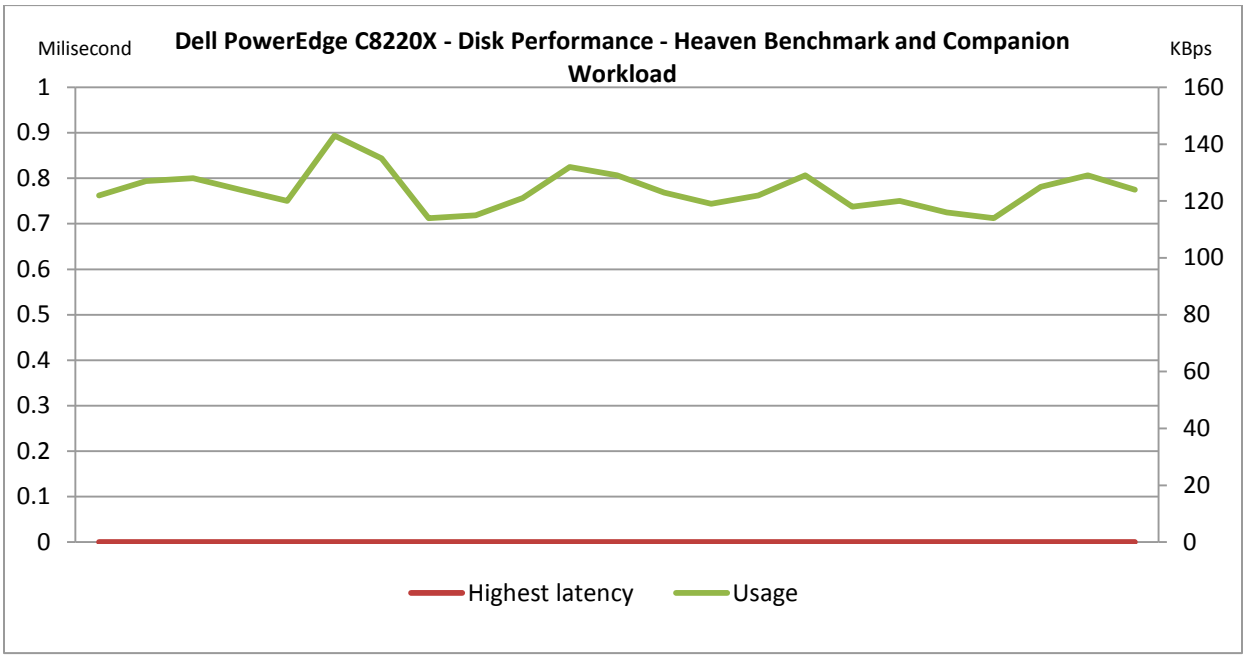

Figure 11 Host disk usage while the HB and companion workloads were running. Latency remained low at less than 1ms.

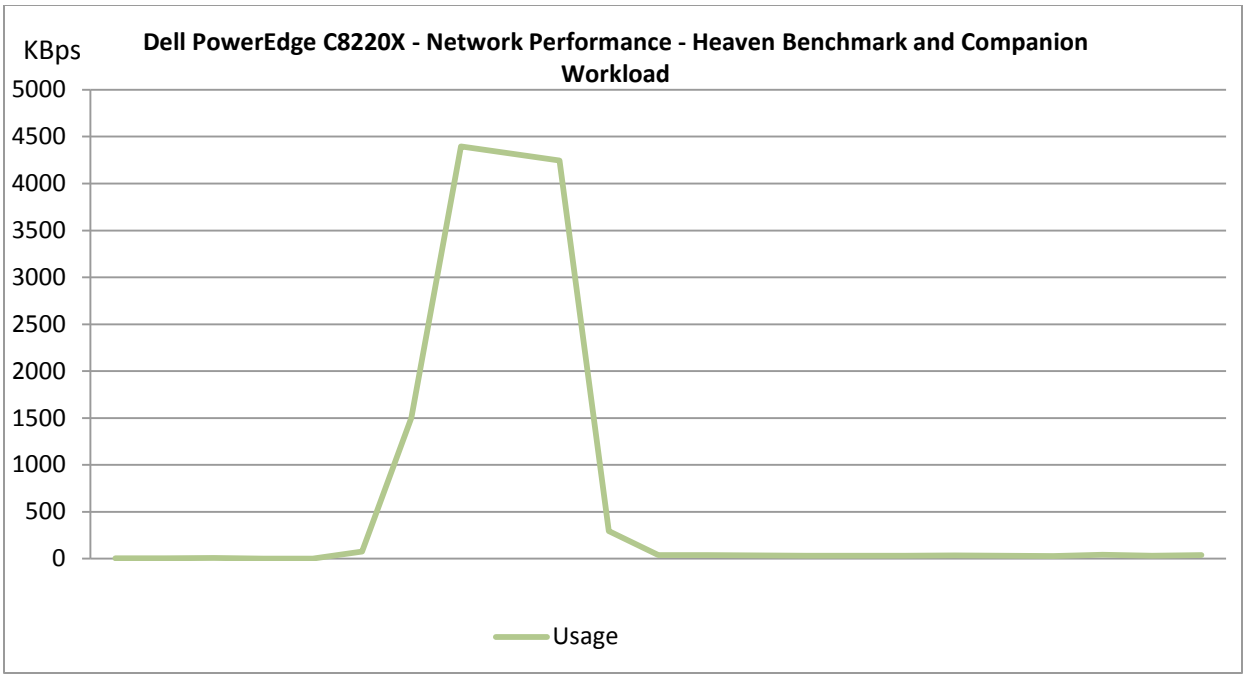

Figure 12 Host network usage metrics were well within acceptable thresholds while the HB and companion workloads were running

5.1.3 NVIDIA GRID K2 – ViewPerf Benchmark testing – Single VM

ViewPerf is a portable OpenGL performance benchmark program. It runs on most implementations of Linux and Windows. ViewPerf provides a vast amount of flexibility in benchmarking OpenGL performance and is a widely used graphics benchmarking tool. It is made up of eight different view sets and each one provides a score at the end of the test.

The following graph shows the ViewPerf scores for both the Dell Wyse P25 and the Dell Wyse D10DP using the NVIDIA GRID K2 card and a single VM test.

As you can see in Figure 13, the Dell Wyse P25 zero client achieves better scores than the Dell Wyse D10DP thin client, again due to the fact that zero end points process PCoIP in hardware. This represents the 'presentation' part of the graphics workloads as rendering of the graphics is done by the GPUs on the server.

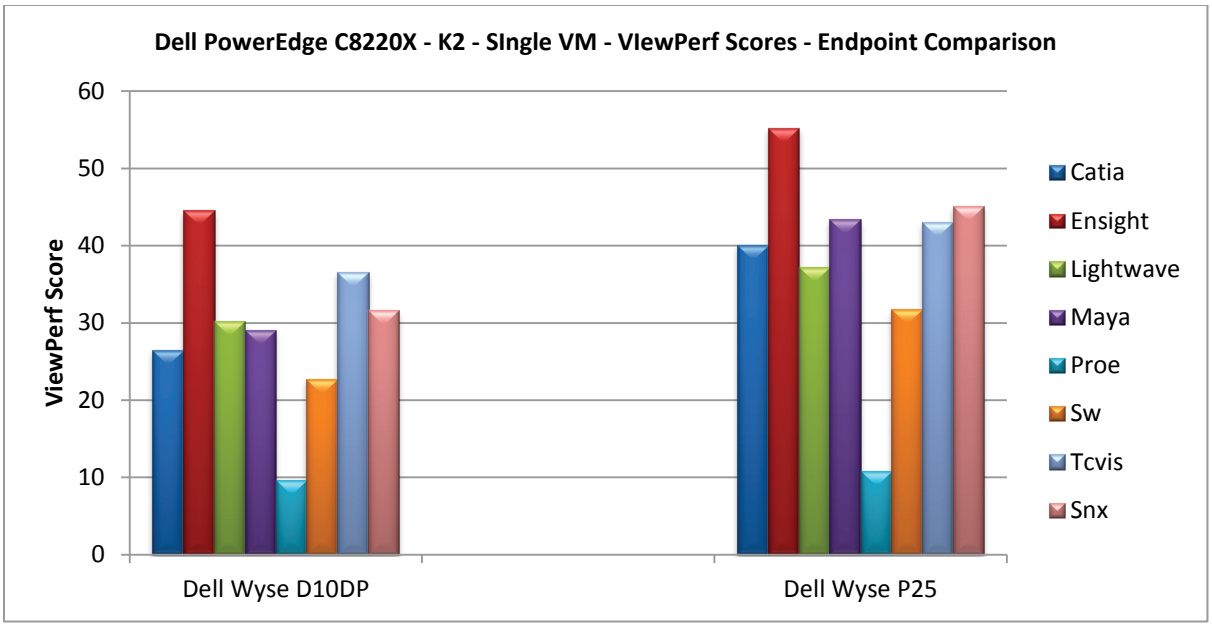

Figure 13 Dell PowerEdge C8220X – K2 – Single VM – ViewPerf scores – Endpoint comparison

5.1.4 NVIDIA GRID K2 – ViewPerf Benchmark testing with companion workload

The following graphs show the ViewPerf scores of the Dell Wyse P25 and the Dell Wyse D10DP while a companion workload is running on a second virtual machine.

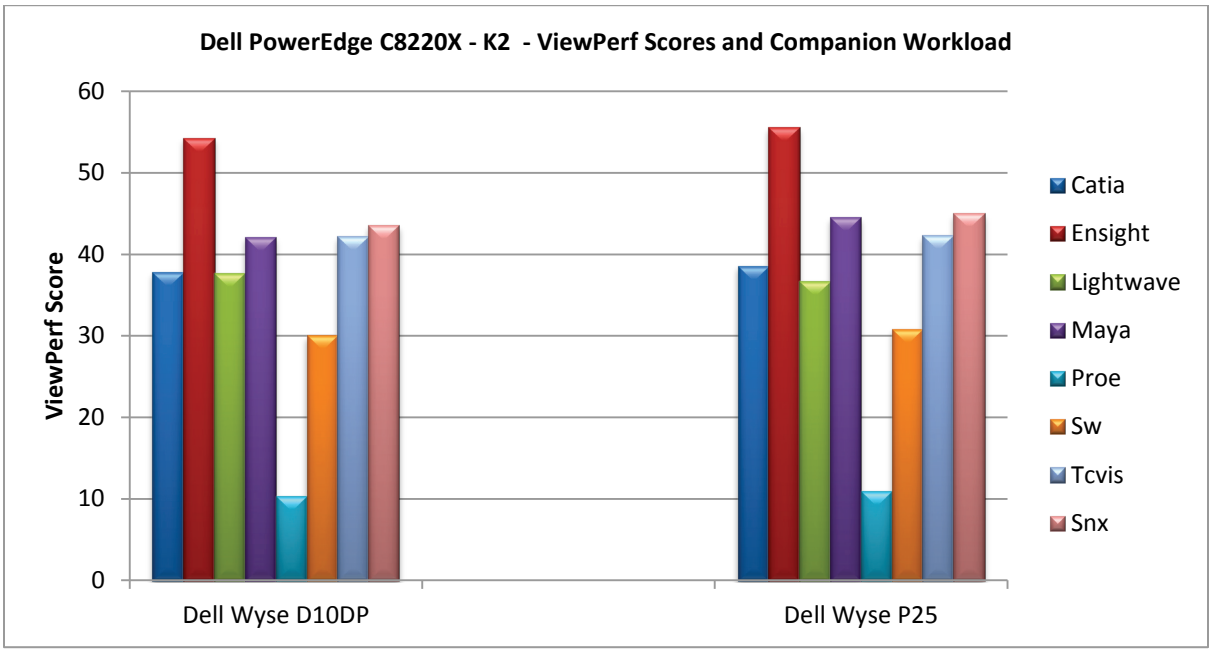

Figure 14 ViewPerf scores with companion workload

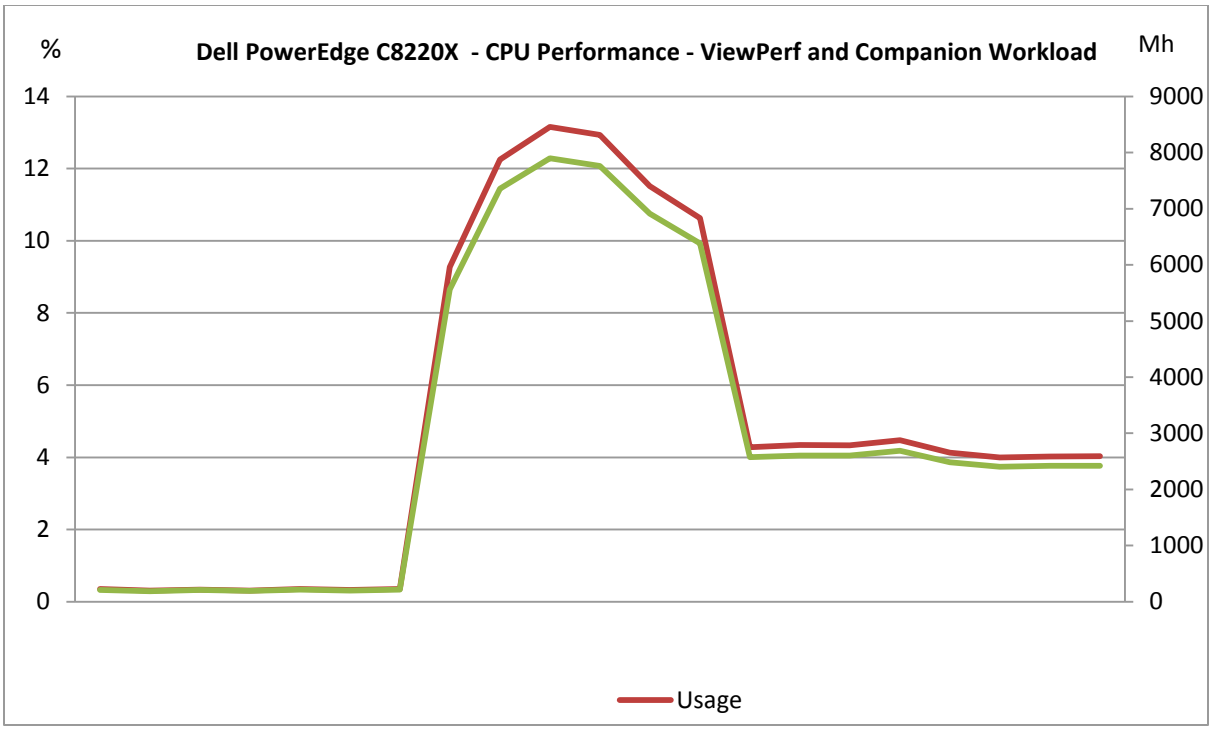

Figure 15 Host CPU usage remained quite low while the HB and the companion workloads were running.

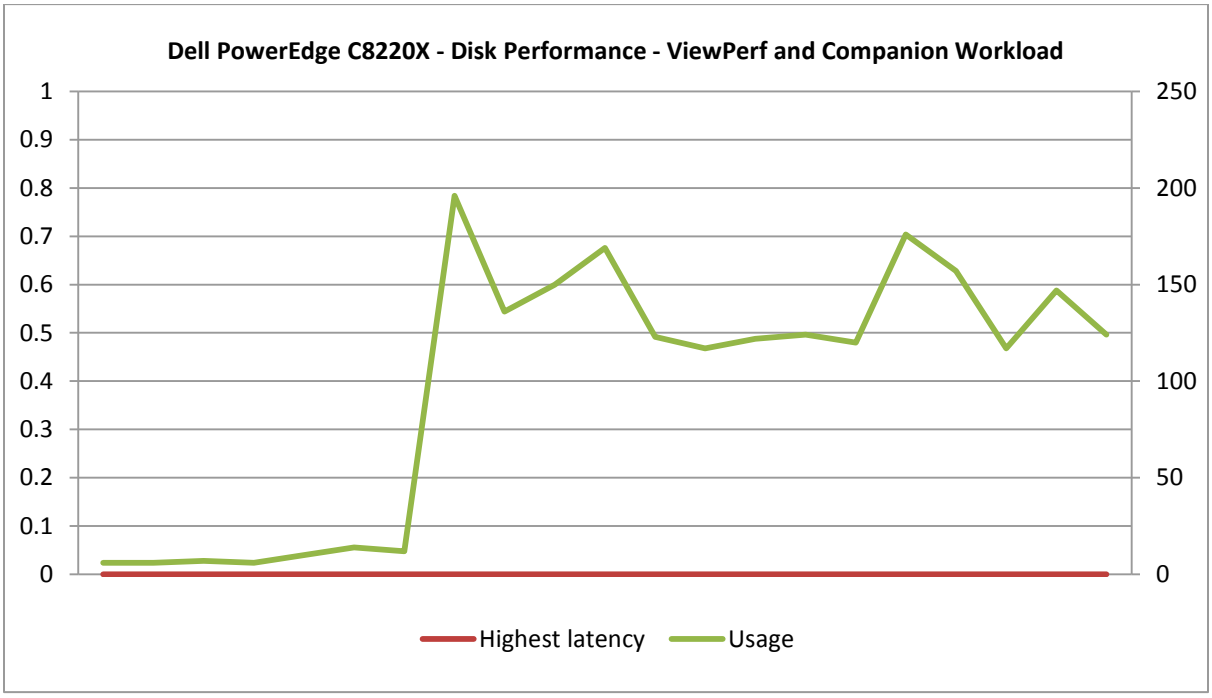

Figure 16 Host disk usage while the HB and the companion workloads were running. Latency remained below 1ms.

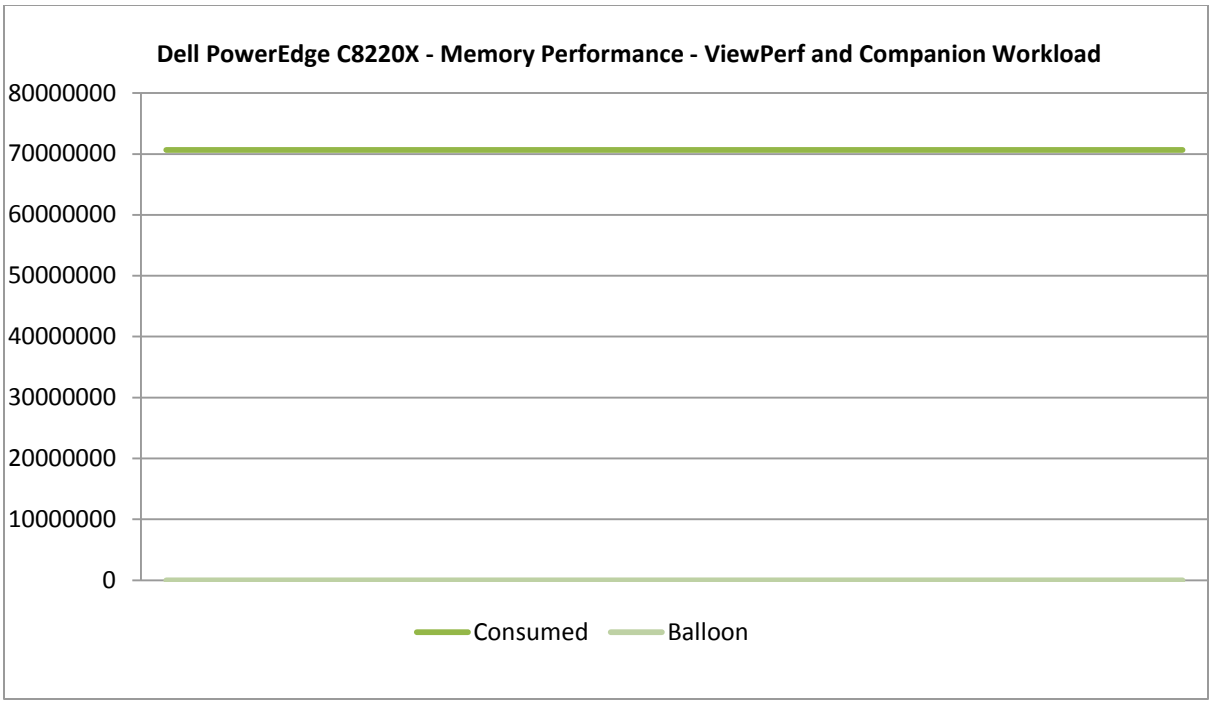

Figure 17 Host memory usage while the HB and the companion workloads were running showed no evidence of any memory ballooning.

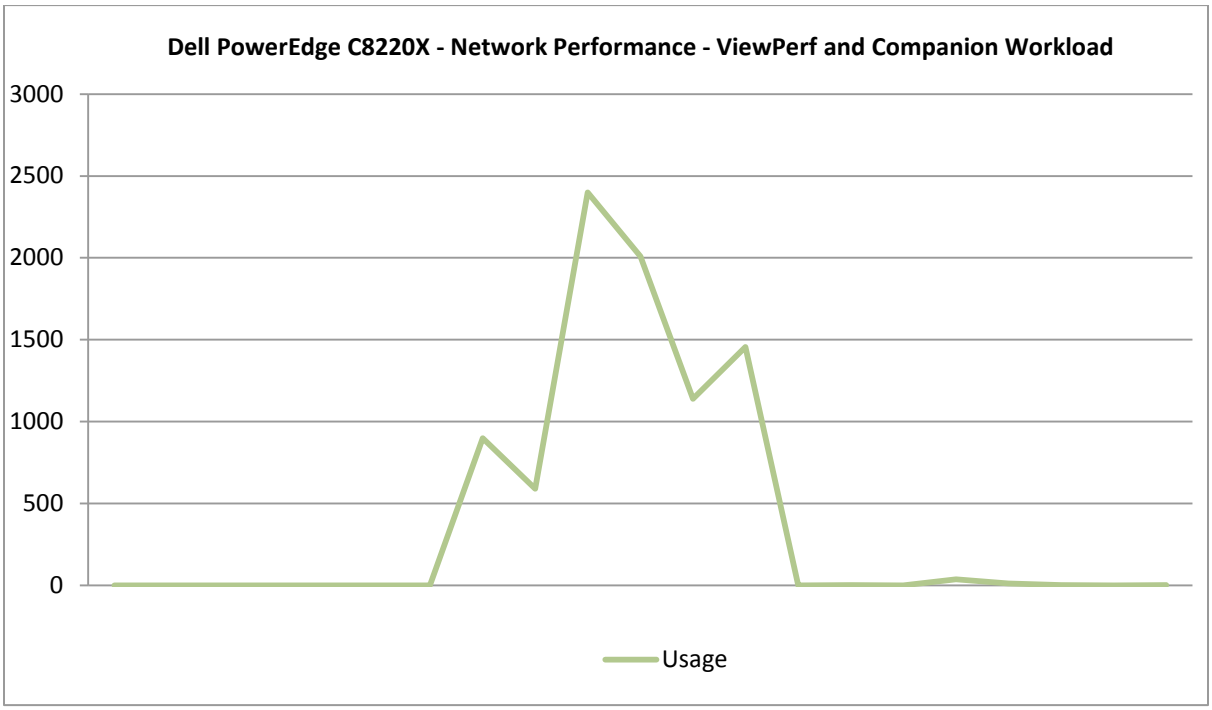

Figure 18 Host network utilization remained well within acceptable thresholds.

5.1.5 Subjective tests

As part of the validation work performed in the Dell Wyse Solutions Engineering labs, our technicians were able to login to the Dell Wyse D10DP and Dell Wyse P25 successfully and execute many subjective tests while the companion workloads were running on the host.

They performed multiple concurrent activities while the workloads were running on the desktops. Examples include opening Microsoft Office applications, Adobe Reader documents, Internet Explorer and browsing through folders using Windows Explorer.

Subjective user experience on both endpoints was satisfactory.

6 Conclusion

The C8000 4U chassis with 4 double wide C8220X GPU hot swappable sleds can offer a compelling solution to your high performance graphics desktop needs. It can accommodate 16 vDGA users per chassis delivering excellent performance to your users. This solution has the combined benefits of excellent performance and good density. Additional information on the PowerEdge C Series and C8220X can be found here:

http://www.dell.com/ie/business/p/poweredge-c8220x/pd

The NVIDIA GRID K2 card has two Kepler based GPUs , giving a total of 3072 CUDA cores and 8 GB of GDDR5 memory. The K2 is aimed at intensive graphical workloads and users who work with rich 3D graphics in a virtualized environment. Learn more about NVIDIA GRID cards here:

http://www.nvidia.com/object/grid-boards.html

Endpoint selection is very important when designing an infrastructure for heavy graphics workloads. The endpoint needs to be capable of decoding the PCoIP frames quick enough in order to display smooth, graphically rich images. This is why we selected the Dell Wyse P25 and Dell Wyse D10DP for our testing as both are capable of delivering a great graphical experience to the end user. Learn more about these and other Dell Wyse endpoints here:

http://www.wyse.com/products/cloud-clients/zero-clients/P25

http://www.wyse.com/products/cloud-clients/thin-clients/D10DP

A Appendix – Configuration details

Hardware components

- Virtual desktops
  - Windows 7 64-bit
  - 4 x CPU
  - 32 GB RAM
- VMware compute host
  - Dell PowerEdge C8000 chassis
  - 1 x Dell PowerEdge C8220X sled
    - ESXi 5.5 (installed on an 8 GB microSD card)
    - Intel Xeon CPU E5-2680 v2 2.8 GHz
    - 196 GB RAM 1600 MHz
    - 1 x NVIDIA GRID K2
- VMware management host
  - Dell PowerEdge R720
    - ESXi 5.5
    - Intel Xeon CPU E5-2690 2.7 GHz
    - 128 GB RAM 1600 MHz
    - 10 x 146 GB 15K SAS HDD (RAID-10)
    - Broadcom BCM5720 1 Gb NIC
    - PERC H710P RAID controller
- Network
  - 1 x Dell PowerConnect 6248 1 Gb Ethernet switch
- Performance monitoring
  - VMware vSphere Virtual Center 5.5
  - NVIDIA SMI Utility

Software components

- VMware vCenter Server 5.5 build 1312298
- VMware Horizon View 5.3 build 1354012
- VMware ESXi 5.5 build 1331820
- Microsoft SQL Server 2008 Enterprise Edition (64-bit)
- Windows Server 2008 R2 SP1

Other configuration notes

- PCoIP GPO was applied to enable 120 maximum FPS
- Build to lossless was disabled
- Heaven Benchmark was not run in full screen mode
- Monitor used for endpoint testing was a Dell U2713 set to a display resolution of 1920 x 1200