Dell Appliance for Wyse - vWorkspace™

Dell Engineering
September 2015

A Dell Appliance Architecture

Revisions

Date	Description
June 2015	Initial release with vWorkspace 8.5.
September 2015	Revision 1.1. Qualification of vWorkspace 8.6. Addition of a pilot configuration. Adjustments to appliance hardware configuration.

A Dell Appliance Architecture

Contents

A Dell Appliance Architecture

A Dell Appliance Architecture

1 Introduction

1.1 Purpose

This document addresses the architecture design, configuration and implementation considerations for the key components required to deliver virtual desktops and application virtualization using the Dell Appliance for Wyse. The underlying technology is Dell Wyse vWorkspace™ on Microsoft® Windows Server® Hyper-V® 2012 R2.

1.2 Scope

Relative to delivering the virtual desktop environment, the objectives of this document are to:

- Define the detailed technical design for the solution.
- Define the hardware requirements to support the design.
- Define the constraints which are relevant to the design.
- Define relevant risks, issues, assumptions and concessions – referencing existing ones where possible.
- Provide a breakdown of the design into key elements such that the reader receives an incremental or modular explanation of the design.
- Provide guidance on user density per appliance.

1.3 What's New

- Updated hardware configurations
- Updated application virtualization user density

2 Solution Architecture Overview

2.1 Introduction

The incredible versatility of the Dell Appliance for Wyse - vWorkspace delivers outstanding functionality in just 2U of rack space when using the PowerEdge R730 server. With the combination of powerful processors, large memory and versatile storage options, the R730 performs exceptionally well in a number of demanding environments. The appliance also provides a tower solution - the PowerEdge T630 2-socket tower server, a member of the 13th generation of PowerEdge servers accelerates demanding workloads while providing power and flexibility.

The Dell Appliance for Wyse via the R730 and T630 series delivers an out-of-the-box infrastructure solution for virtual desktops that eliminates the high cost, variable performance, and extensive risk of conventional solutions.

2.2 Large Density Appliance

The compute, management and storage layers are 'converged' into a single appliance, hosting Microsoft Hyper-V hypervisor and Dell Wyse vWorkspace. The appliance setup is simplified and automated using Dell's Quick Start Tool which deploys a complete, ready to use, virtualization environment on the appliance. Local storage is split in to volumes for the hypervisor management OS and for virtual machine storage. Either persistent (full clone) or non-persistent virtual desktop types can be chosen with ample storage space provided for the maximum number of desktops allowed per appliance.
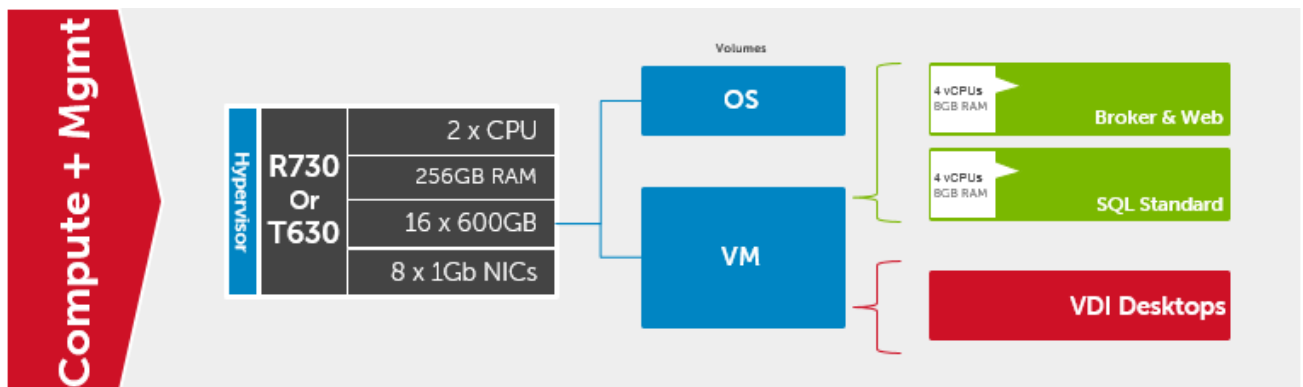
The appliance can also be used for application virtualization. In this configuration, storage capacity is reduced as only five Windows Server 2012 R2 RDSH VMs are required.

A Dell Appliance Architecture
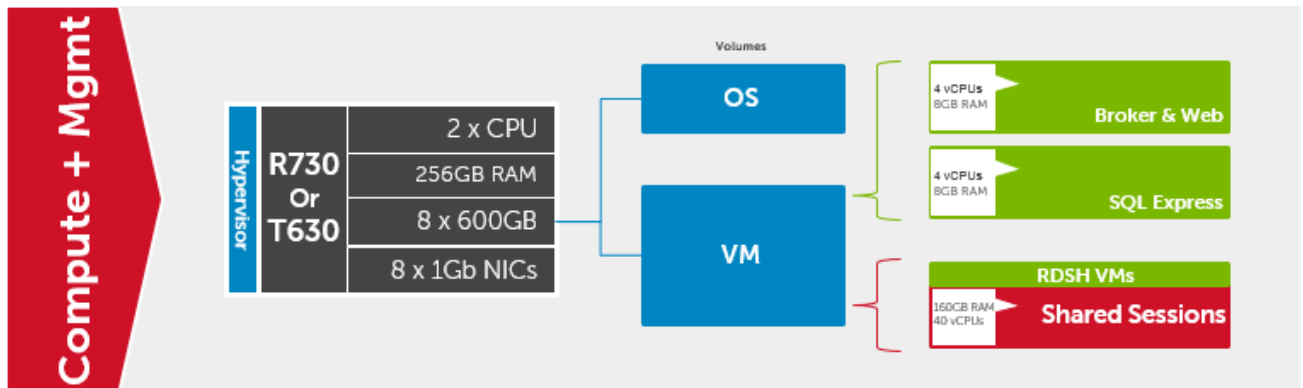
2.3　Pilot / Small Density Appliance

Dell offers an affordable pilot appliance capable of supporting up to 100 concurrent users for virtual desktops and up to 125 concurrent users for application virtualization. This architecture leverages an inexpensive single server platform intended to demonstrate the capabilities of VDI (or application virtualization) for a small environment or focused POC of Wyse vWorkspace.
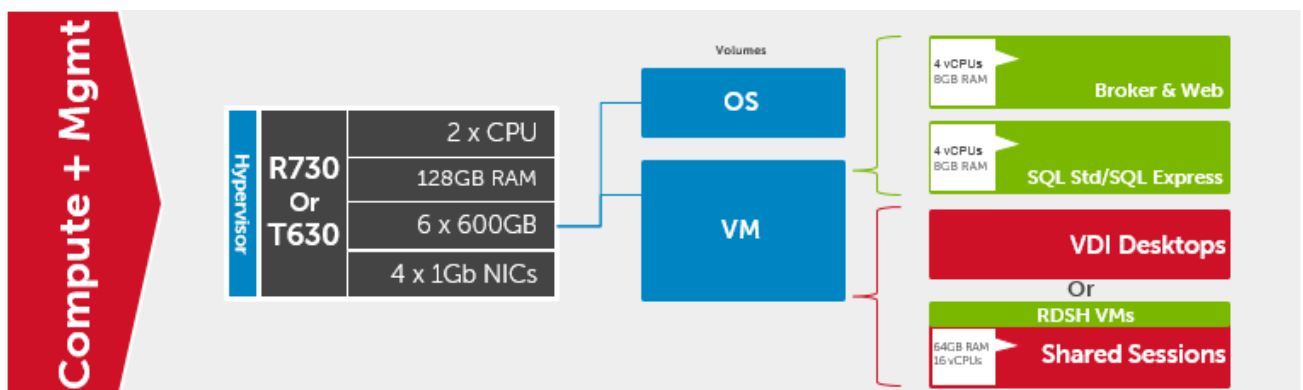
3 Hardware Components

3.1 Dell Appliance for Wyse

Dell offers the Dell Appliance for Wyse – vWorkspace in two optimized server platforms: the PowerEdge R730 (rack) and the PowerEdge T630 (tower).

Large RDSH

- Mid core CPUs
- Medium density RAM
- Local Storage
- vWorkspace & XenDesktop RDSH Hyper-V

PowerEdge R730/ T630

CPU	2 x E5-2680v3 (12C, 2.5GHz)
Memory	16 x 16GB 2133MHz RDIMMs Effective speed: 2133MHz @ 256GB
RAID Ctrls	H730P (2GB cache)
Storage	8 x 600GB 15K SAS 2.5" (RAID10)
Network	4 x 1Gb NDC, 4 x 1Gb NIC
iDRAC	iDRAC8 Ent w/ vFlash, 8GB SD
Power	2 x 750W PSUs

Large VDI

- Mid core CPUs
- Medium density RAM
- Local Storage
- vWorkspace & XenDesktop Hyper-V

PowerEdge R730/ T630

CPU	2 x E5-2680v3 (12C, 2.5GHz)
Memory	16 x 16GB 2133MHz RDIMMs Effective speed: 2133MHz @ 256GB
RAID Ctrls	H730P (2GB cache)
Storage	16 x 600GB 15K SAS 2.5" (RAID10)
Network	4 x 1Gb NDC, 4 x 1Gb NIC
iDRAC	iDRAC8 Ent w/ vFlash, 8GB SD
Power	2 x 750W PSUs

Pilot RDSH/VDI

- Low core CPUs
- Low density RAM
- Local Storage
- vWorkspace Hyper-V

PowerEdge R730/ T630

CPU	2 x E5-2620v3 (6C, 2.4GHz)
Memory	8 x 16GB 2133MHz RDIMMs Effective speed: 1866MHz @ 128GB
RAID Ctrls	H730P (2GB cache)
Storage	6 x 600GB 15K SAS 2.5" (RAID10)
Network	4 x 1Gb NDC
iDRAC	iDRAC8 Ent w/ vFlash, 8GB SD
Power	2 x 750W PSUs

3.1.1 PowerEdge R730

The rack server platform for the Dell Wyse Datacenter solution is the best-in-class Dell PowerEdge R730. This dual socket CPU platform runs the fastest Intel Xeon E5-2600 v3 family of processors, can host up to 768GB RAM and supports up to 16 2.5" SAS disks. The Dell PowerEdge R730 offers uncompromising performance and scalability in a 2U form factor. For more information, please visit: Link

A Dell Appliance Architecture

3.1.2   PowerEdge T630

3.2   Dell Wyse Cloud Clients

The following Dell Wyse clients will deliver a superior Microsoft and vWorkspace user experience and are the recommended choices for this solution.

3.2.1   Wyse 3020 Thin Client (ThinOS)

The Dell Wyse 3020 thin client runs Wyse ThinOS and handles everyday tasks with ease and also provides multimedia acceleration for task workers who need video. Users will enjoy integrated graphics processing and additional WMV9 & H264 video decoding capabilities from the Marvell ARMADA™ PXA2128 1.2 GHz Dual Core ARM System-on-Chip (SoC) processor. In addition, the Wyse 3020 is one of the only affordable thin clients to support dual monitors with monitor rotation, enabling increased productivity by providing an extensive view of task work. Designing smooth playback of high bit-rate HD video and graphics in such a small box hasn't been at the expense of energy consumption and heat emissions either. Using less than 7 watts of electricity, the Wyse 3020 small size enables discrete mounting options: under desks, to walls, and behind monitors, creating cool workspaces in every respect.

3.2.2　Wyse 5010 (ThinOS)

Designed for knowledge workers and power users, the Wyse 5010 (ThinOS) is a high-performance thin client based on Dell Wyse ThinOS, the virus-immune firmware base designed for optimal thin client security, performance, and ease-of-use. Highly secure, compact and powerful, the Wyse 5010 combines Dell Wyse ThinOS with a dual-core AMD 1.4 GHz processor and a revolutionary unified graphics engine for an outstanding user experience. The Wyse 5010 (ThinOS) addresses the performance challenges of processing-intensive applications like computer-aided design, multimedia, HD video and 3D modeling. Scalable enterprise-wide on-premise or cloud-based management provides simple deployment, patching and updates. Take a unit from box to productivity in minutes with auto configuration. Delivering outstanding processing speed and power, security and display performance, the Wyse 5010 (ThinOS) offers a unique combination of performance, efficiency, and affordability. The Wyse 5010 (ThinOS) is Citrix HDX, Microsoft® RemoteFX, and VMware® Horizon View certified. It also supports legacy peripherals via an optional USB adapter. For more information, please visit: Link

3.2.3　Wyse 5010 Thin Client (Windows Embedded Standard 8)

A strong, reliable thin client, the Dell Wyse 5010 thin client runs Windows Embedded Standard 8 and packs dual-core processing power into a compact form factor for knowledge workers who need performance for demanding virtual Windows® desktops and cloud applications. It's also great for kiosks, and multi-touch displays in a wide variety of environments, including manufacturing, hospitality, retail, and healthcare. It features dual-core processing power and an integrated graphics engine for a fulfilling Windows® 8 user experience. Knowledge workers will enjoy rich content creation and consumption as well as everyday multimedia. Kiosk displays will look great on a thin client that is Microsoft RemoteFX®, Citrix® HDX, VMware PCoIP, and HD video-enabled. Operating with less than 9 watts of energy, the Dell Wyse 5010 (Windows) offers cool, quiet operations, potentially lowering your overall carbon footprint.

WE8S

3.2.4　Wyse 7010 Thin Client (Windows Embedded Standard 8)

The versatile Dell Wyse 7010 thin client runs Windows Embedded Standard 8 and gives people the freedom to mix and match a broad range of legacy and cutting edge peripheral devices. Ports for parallel, serial, and USB 3.0 offer fast, flexible connectivity. Like all Dell Wyse cloud clients, the new Dell Wyse 7010 (Windows) is one cool operator. Its energy efficient processor – which out-performs other more power-hungry alternatives – and silent fan-less design, all contribute to help lower an organization's carbon footprint through power requirements that are a fraction of traditional desktop PCs.

WE8S

A Dell Appliance Architecture

3.2.5   Wyse 5040 AIO

The Dell Wyse 5040 AIO all-in-one (AIO) offers versatile connectivity options for use in a wide range of industries. With four USB 2.0 ports, Gigabit Ethernet and integrated dual band Wi-Fi options, users can link to their peripherals and quickly connect to the network while working with processing-intensive, graphics-rich applications. Built-in speakers, a camera and a microphone make video conferencing and desktop communication simple and easy. It even supports a second attached display for those who need a dual monitor configuration. A simple one-cord design and out-of-box automatic setup makes deployment effortless while remote management from a simple file server, Wyse Device Manager (WDM), or Wyse Cloud Client Manager can help lower your total cost of ownership as you grow from just a few thin clients to tens of thousands.

3.2.6   Dell Wyse Cloud Connect

Designed to promote bring-your-own-device (BYOD) environments, Dell Wyse Cloud Connect allows you to securely access and share work and personal files, presentations, applications and other content from your business or your home. Managed through Dell Wyse Cloud Client Manager software-as-a-service (SaaS), IT managers can ensure that each Cloud Connect device is used by the appropriate person with the right permissions and access to the appropriate apps and content based on role, department and location. Slightly larger than a USB memory stick, Cloud Connect is an ultra-compact multimedia-capable device. Simply plug it into any available Mobile High-Definition Link (MHL) / HDMI port on a TV or monitor, attach a Bluetooth keyboard and mouse, and you're off and running. Easy to slip into your pocket or bag, it enables an HD-quality window to the cloud, great for meetings and presentations while on business travel, or for cruising the internet and checking email after a day of work. For more information, please visit: Link

3.2.7   Dell Venue 11 Pro

Meet the ultimate in productivity, connectivity and collaboration. Enjoy full laptop performance in an ultra-portable tablet that has unmatched flexibility for a business in motion. This dual purpose device works as a tablet when you're out in the field but also enables you to work on your desktop in the office thanks to an optional dock. For more information, please visit: Link

A Dell Appliance Architecture

3.2.8   Dell Chromebook 11

The lightweight, easy-to-use Dell Chromebook 11 helps turn education into exploration - without the worries of safety or security. Priced to make 1:1 computing affordable today, Chromebook 11 is backed by Dell support services to make the most of your budget for years to come. The Chrome OS and Chrome browser get students online in an instant and loads web pages in seconds. A high-density battery supported by a 4th Gen Intel® processor provides up to 10 hours of power. Encourage creativity with the Chromebook 11 and its multimedia features that include an 11.6" screen, stereo sound and webcam.

4 Software Components

4.1 Broker Technology

4.1.1 Dell Wyse vWorkspace

The solution is based on Wyse vWorkspace™ which provides a complete end-to-end solution delivering Microsoft Windows virtual desktops or server-based hosted shared sessions to users on a wide variety of endpoint devices. Virtual desktops are dynamically assembled on demand, providing users with pristine, yet personalized, desktops each time they log on.

Wyse vWorkspace provides a complete virtual desktop delivery system by integrating several distributed components with advanced configuration tools that simplify the creation and real-time management of the virtual desktop infrastructure.

Wyse vWorkspace is an enterprise class desktop virtualization management solution which enables blended deployment and support of virtual desktops, shared sessions and virtualized applications. The core components of vWorkspace are:

- **Connection Broker**: The vWorkspace Connection Broker helps users connect to their virtual desktops, applications, and other hosted resource sessions. The user's [endpoint?] sends a request to the connection broker to access their virtual environment. The connection broker processes the request by searching for available desktops, and then redirects the user to the available managed desktop or application.
- **Management Database**: The vWorkspace Management Database is required to perform administrative functions. The management database stores all the information relevant to a vWorkspace farm, such as configuration data, administrative tasks and results, and information regarding client connections to virtual desktops and RDSH environments.
- **Management Console**: The vWorkspace Management Console is an integrated graphical interface that helps you perform various management and administrative functions and can be installed on any workstation or server.
- **Data Collector Service**: The vWorkspace Data Collector service is a Windows service on RDSH servers, virtual desktops, and Hyper-V hosts in a vWorkspace farm that sends a heartbeat signal and other information to the connection broker.
- **Hyper-V Catalyst Components**: vWorkspace Hyper-V Catalyst Components increase the scalability and performance of virtual computers on Hyper-V Hosts. Hyper-V catalyst components consist of two components: HyperCache and HyperDeploy. HyperCache provides read IOPS savings and improves virtual desktop performance through selective RAM caching of parent VHDs. HyperDeploy manages parent VHD deployment to relevant Hyper-V hosts and enables instant cloning of Hyper-V virtual computers.
- **Diagnostics and Monitoring**: Built on Dell Software's Foglight platform, vWorkspace Diagnostics and Monitoring provides real-time and historical data for user experience, hypervisor performance,

RDSH servers/applications, virtual desktops, Connection Broker servers, Web Access servers, Secure Access servers, profile servers, and farm databases.

- **User Profile Management**: vWorkspace User Profile Management uses virtual user profiles as an alternative to roaming profiles in a Microsoft Windows environment including virtual desktops and RD Session Hosts. The virtual user profiles eliminate potential profile corruption and accelerate logon and logoff times by combining the use of a mandatory profile with a custom persistence layer designed to preserve user profile settings between sessions.
- **Web Access**: vWorkspace Web Access is a web application that acts as a web-based portal to a vWorkspace farm. It helps users to retrieve the list of available applications and desktops by using their web browser. After successful authentication, their published desktops and applications are displayed in the web browser.
- **Secure Access**: vWorkspace Secure Access is an SSL gateway that simplifies the deployment of applications over the Internet and can provide proxy connections to vWorkspace components such as RDP sessions, the Web Access client, and connection brokers.

vWorkspace 8.6 includes Windows connector improvements, internationalization and localization, Chrome OS support as well as provides several enhancements to Monitoring and Diagnostics, WSM and more.

For additional information about the enhancements in Wyse vWorkspace 8.6, please visit: LINK

## 4.2   Hypervisor Platforms

4.2.1   Microsoft Windows Server 2012 R2 Hyper-V

Windows Server 2012 R2 Hyper-V ™ is a powerful virtualization technology that enables businesses to leverage the benefits of virtualization. Hyper-V reduces costs, increases hardware utilization, optimizes business infrastructure, and improves server availability. Hyper-V works with virtualization-aware hardware to tightly control the resources available to each virtual machine. The latest generation of Dell servers includes virtualization-aware processors and network adapters.

From a network management standpoint, virtual machines are much easier to manage than physical computers. To this end, Hyper-V includes many management features designed to make managing virtual machines simple and familiar, while enabling easy access to powerful VM-specific management functions. The primary management platform within a Hyper-V based XenDesktop virtualization environment is Microsoft Systems Center Virtual Machine Manager 2012 R2 (SCVMM).

SCVMM provides centralized and powerful management, monitoring, and self-service provisioning for virtual machines. SCVMM host groups are a way to apply policies and to check for problems across several VMs at once. Groups are organized by owner, operating system, or by custom names such as
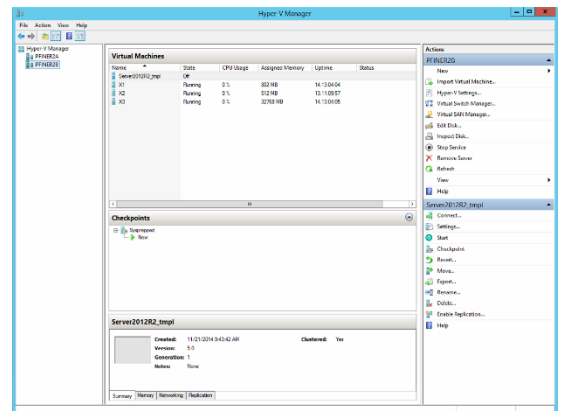
"Development" or "Production". The interface also incorporates Remote Desktop Protocol (RDP); double-click a VM to bring up the console for that VM—live and accessible from the management console.

4.3   Dell Quick Start Tool (QST)

The Dell Quick Start Tool or QST is a lightweight utility that helps immensely reduce complexity and time required to deploy the appliance. It takes a minute to install and then reduces the number of deployment steps from roughly 375 down to 35-37 which is a 90% reduction. The QST can only be executed on the appliance itself (Windows Server 2012 R2 host). Deployment time is down to between 2 to 4 hours depending on your environment and workflows-this is significantly less than the days it normally takes. The QST can be downloaded from here.
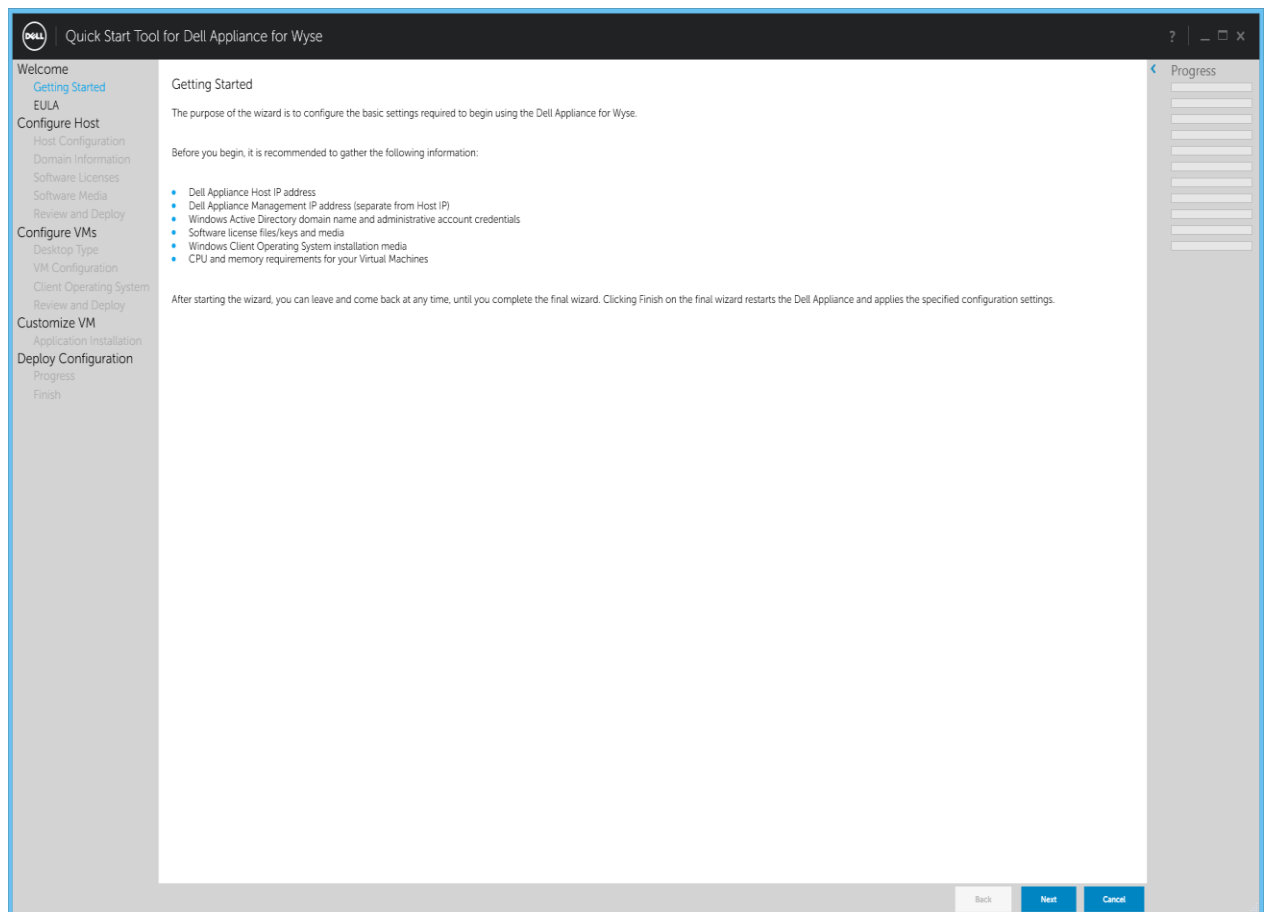
4.4 Operating Systems

4.4.1 Microsoft Windows Server 2012 R2

Microsoft Windows Server 2012 R2 is the latest iteration of the Windows Server operating system environment. This release introduces a host of new features and enhancements, including virtualization, storage, networking, management, security and applications. With this release also come the introduction of Microsoft Cloud OS and an update of products and services to further enable customers' shift to cloud enablement.

For additional information about the enhancements in Microsoft Windows Server 2012 R2, please visit: LINK

4.4.2 Microsoft Windows 8.1

Microsoft Windows 8.1 is a Windows desktop operating system, providing several user centric features. With updates to the user interface, applications, online services, security and more, Windows 8.1 helps keeps a consistent user experience across virtual and physical instances.

For additional information about the enhancements in Microsoft Windows 8.1, please visit: LINK

4.5 Remote Desktop Session Host (RDSH)

The Remote Desktop Session Host role within Windows Server 2012 R2 enables a physical or virtual server to host RemoteApp programs or session-based desktops. Users can connect to RD Session Host servers in a session collection to run programs, save files, and use resources on those servers. RDSH provides a cost effective method for task or knowledge workers to access full desktop sessions or published applications on a shared host. RDSH is very effectively virtualized allowing several instances to be run in parallel on a single host providing access to hundreds of simultaneous users.

For additional information about Remote Desktop Services, please visit: LINK

4.5.1 NUMA Architecture Considerations

Best practices and testing has showed that aligning RDSH design to the physical Non-Uniform Memory Access (NUMA) architecture of the server CPUs results in increased and optimal performance. NUMA ensures that a CPU can access its own directly-connected RAM banks faster than those banks of the other processor which are accessed via the Quick Path Interconnect (QPI). Ensuring that your virtual RDSH servers do not span physical CPUs will ensure the greatest possible performance benefit.

### 4.5.2 Large Density Appliance NUMA Alignment

12 physical cores per CPU in both platforms, 24 logical with Hyperthreading active, gives us a total of 48 consumable cores per appliance and falls in line with a 2x oversubscription rate. The management VMs will receive their vCPU allotment from the first physical CPU and so configuring the RDSH VMs as shown below will ensure that no NUMA spanning occurs which could lower performance.
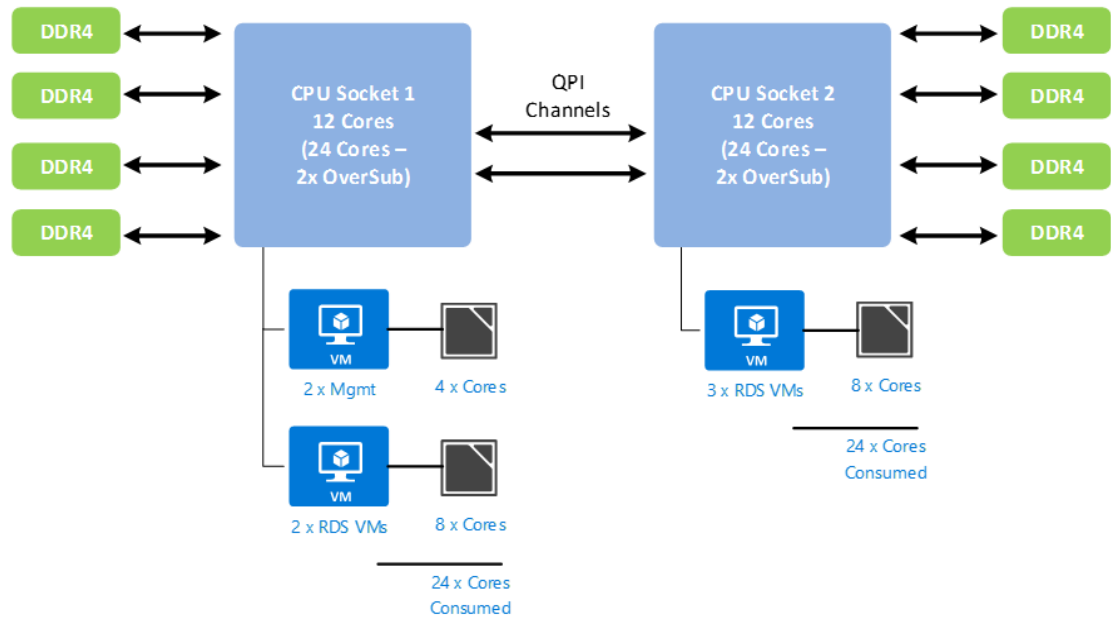
4.5.3   Pilot / Small Density Appliance NUMA Alignment

6 physical cores per CPU in both platforms, 12 logical with Hyperthreading active, gives us a total of 24 consumable cores per appliance and falls in line with a 2x oversubscription rate. The management VMs will receive their vCPU allotment from the first physical CPU and so configuring the RDSH VMs as shown below will ensure that no NUMA spanning occurs which could lower performance.

A Dell Appliance Architecture
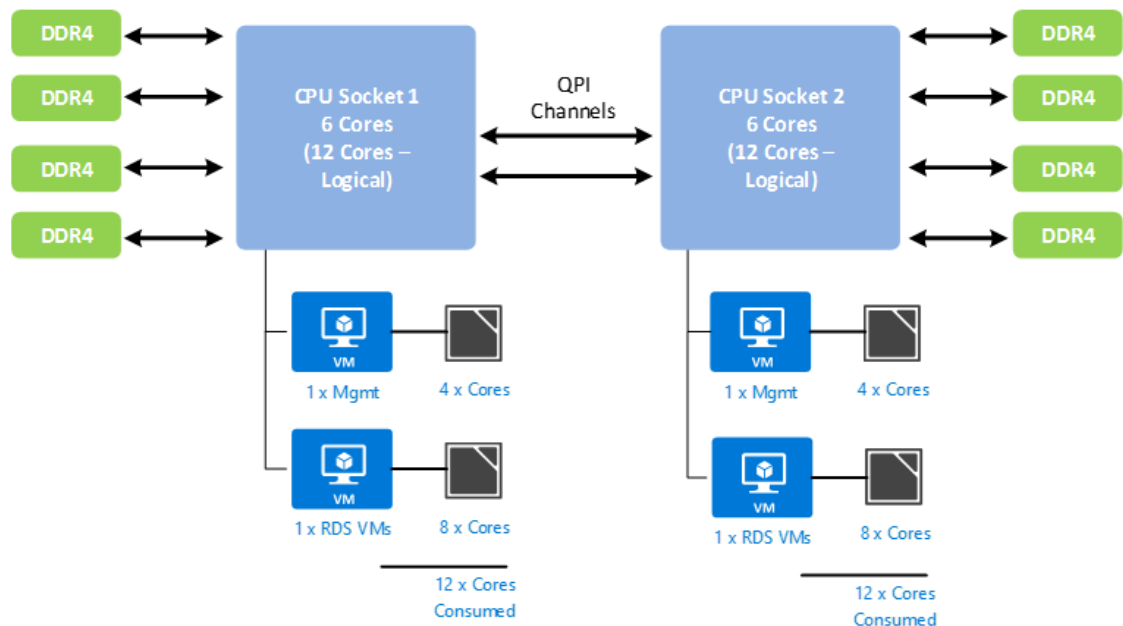
5 Solution Architecture for vWorkspace

5.1 Management Role Configuration

The Management role recommendations for the traditional virtual desktop and application virtualization configurations are summarized below.

5.1.1 Hyper-V Management Role Requirements

Role	vCPU	Startup RAM (GB)	Dynamic Memory			NIC	OS vDisk	
			Min|Max	Buffer	Weight		Size (GB)	Volume
Broker & Web Access	4	8	2GB|8GB	20%	Med	1	140	DATA
SQL	4	8	2GB|8GB	20%	Med	1	140	DATA
Total	**8**	**16**	**4GB|16Gb**	**-**	**-**	**2**	**280**	**-**

5.1.2 RDSH on Hyper-V

The recommended number of RDSH VMs for application virtualization and their configurations on Hyper-V are summarized below based on applicable hardware platform.

Role	HW Config	VMs per host	vCPUs per VM	RAM (GB)	NIC	OS vDisk	
						Size (GB)	Volume
RDSH VM	Large Density	5	8	32	1	140	DATA
RDSH VM	Pilot / Small	2	8	32	1	140	DATA

5.1.3 SQL Databases

The vWorkspace database is hosted by a single dedicated Windows Server 2012 R2 VM in the Management layer for the desktop configuration. The Quick Start Tool (QST) creates all the necessary databases for Dell Wyse vWorkspace.

A Dell Appliance Architecture

5.1.4 DNS

DNS plays a crucial role in the environment not only as the basis for Active Directory but is used to control access to the various vWorkspace and Microsoft software components. All hosts, VMs, and consumable software components need to have a presence in DNS, preferably via a dynamic and AD-integrated namespace. Microsoft best practices and organizational requirements are to be adhered to.

5.2 Storage Architecture Overview

The appliance comes with local storage that includes 15k SAS drives. These drives are shared for appliance operating system as well as virtual machine storage.

5.3 Virtual Networking

5.3.1 Hyper-V

As shown in the diagram below, native Windows Server 2012 R2 NIC Teaming is utilized to load balance and provide resiliency for network connections. Since the appliance performs both the compute and management roles, a single LBFO NIC team consisting of eight physical NICs is configured to connect to a Hyper-V virtual switch for external traffic. All vNICs associated with the Management OS connect directly to the external Hyper-V virtual switch. For ease of deployment and compatibility, VLANs are not configured on the vNICs by default but can be enabled if used in the environment.


A Dell Appliance Architecture
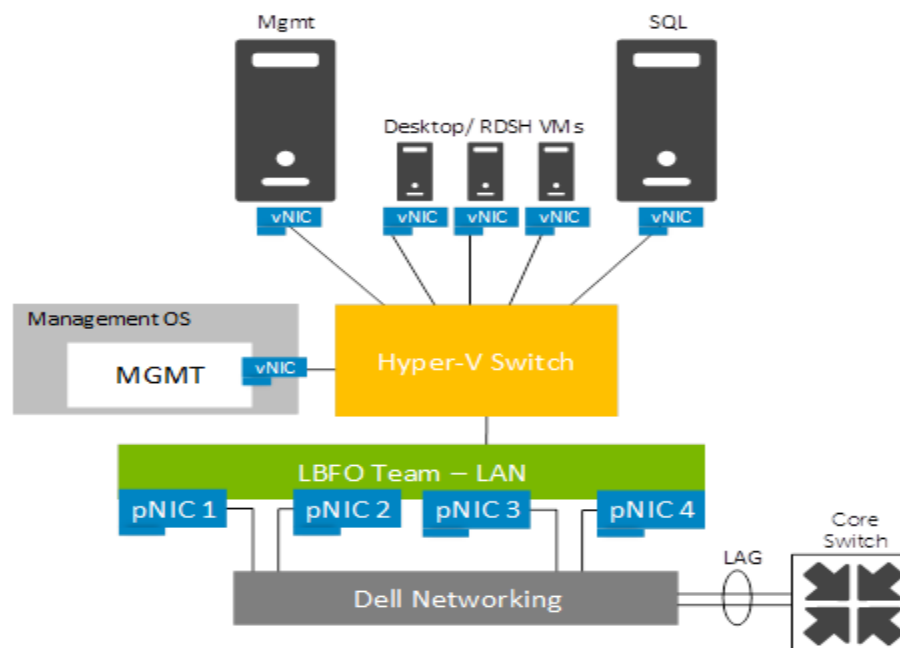
The NIC team for the Hyper-V switch is configured as switch independent, dynamic for the load balancing mode with all adapters set to active. This team is used exclusively by Hyper-V.
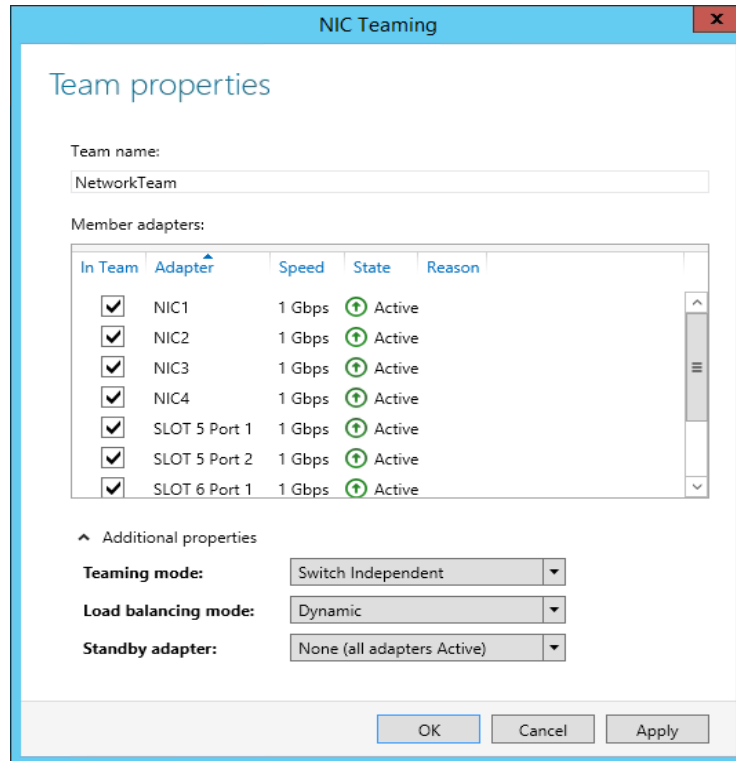
5.4   Appliance Density

Hypervisor	Provisioning	Workload	User Density (LARGE Appliance)	User Density (PILOT Appliance)
Hyper-V	vWorkspace	Standard	200	60
Hyper-V	vWorkspace	Enhanced	160	75
Hyper-V	vWorkspace	Professional	130	100
Hyper-V	RDSH	Enhanced	300	125

A Dell Appliance Architecture

5.5 Dell Wyse Datacenter for vWorkspace Communication Flow

A Dell Appliance Architecture
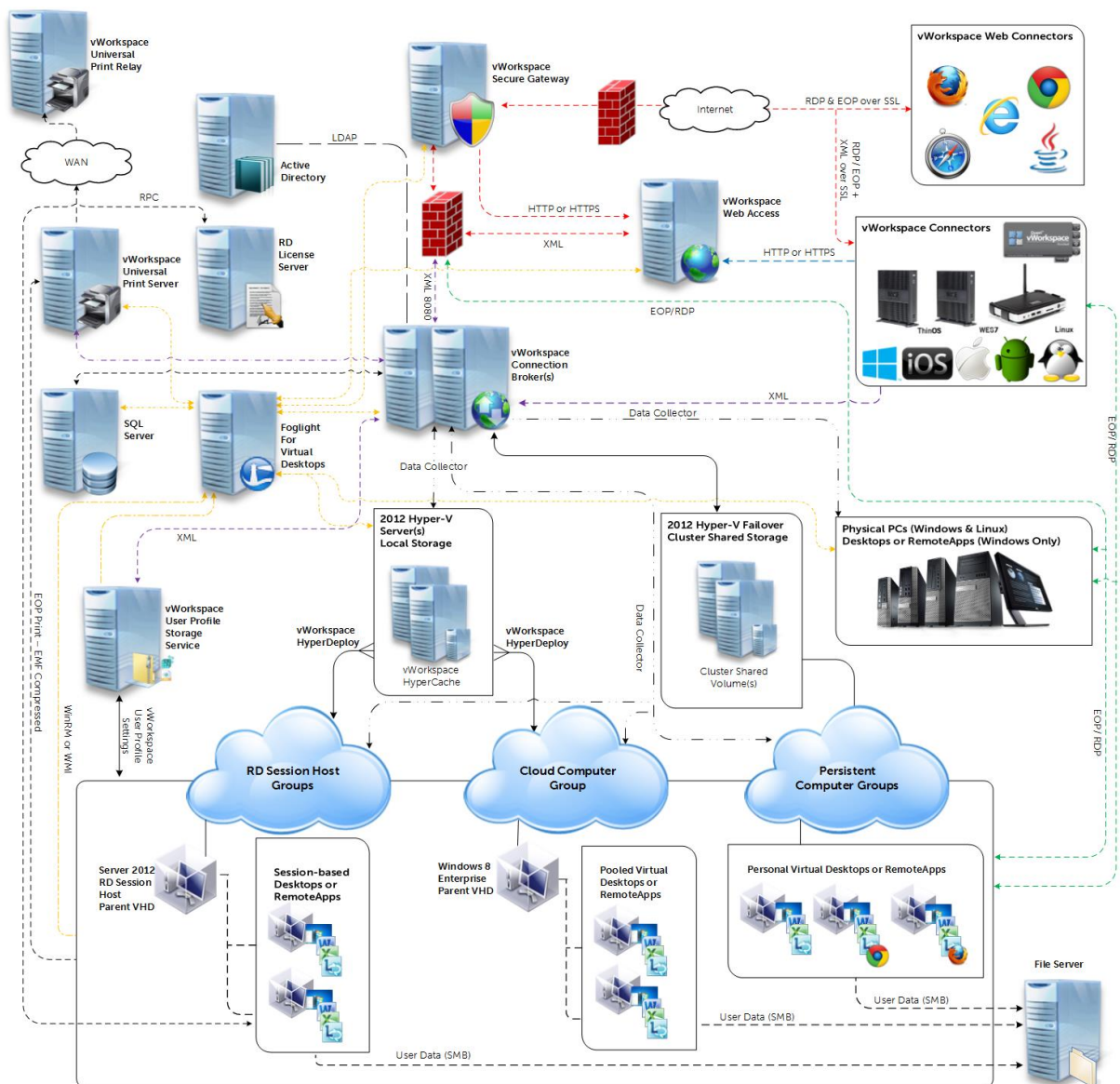
6 Solution Performance and Testing

6.1 Load Generation and Monitoring

### 6.1.1 Login VSI – Login Consultants

Login VSI is the de-facto industry standard tool for testing VDI environments and server-based computing or RDSH environments. It installs a standard collection of desktop application software (e.g. Microsoft Office, Adobe Acrobat Reader) on each VDI desktop; it then uses launcher systems to connect a specified number of users to available desktops within the environment. Once the user is connected the workload is started via a logon script which starts the test script once the user environment is configured by the login script. Each launcher system can launch connections to a number of 'target' machines (i.e. VDI desktops), with the launchers being managed by a centralized management console, which is used to configure and manage the Login VSI environment.

6.1.2 Microsoft Performance Monitor

Microsoft Performance Monitor was utilized to collect performance data for tests performed on the Hyper-V platform.

6.2 Performance Analysis Methodology

In order to ensure the optimal combination of end-user experience (EUE) and cost-per-user, performance analysis and characterization (PAAC) on Dell Wyse Datacenter solutions is carried out using a carefully designed, holistic methodology that monitors both hardware resource utilization parameters and EUE during load-testing. This methodology is based on the three pillars shown below. Login VSI is currently the load-testing tool used during PAAC of Dell Wyse Datacenter solutions; Login VSI is the de-facto industry standard for VDI and server-based computing (SBC) environments and is discussed in more detail below.
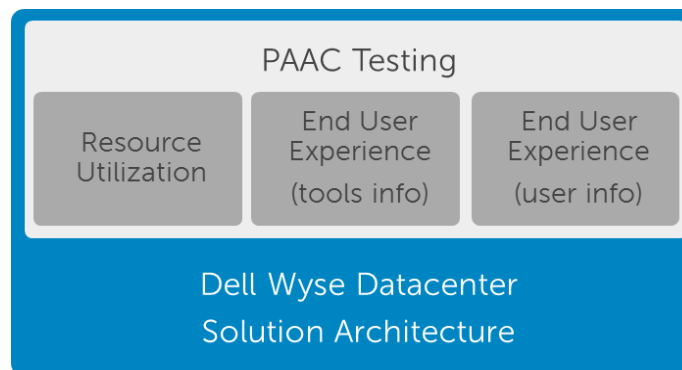
6.2.1 Resource Utilization

Poor end-user experience is one of the main risk factors when implementing desktop virtualization but the root cause for poor end-user experience is resource contention – hardware resources at some point in

A Dell Appliance Architecture

the solution have been exhausted, thus causing the poor end-user experience. In order to ensure that this has not happened (and that it is not close to happening), PAAC on Dell Wyse Datacenter solutions monitors the relevant resource utilization parameters and applies relatively conservative thresholds as shown in the table below. As discussed above, these thresholds are carefully selected to deliver an optimal combination of good end-user experience and cost-per-user, while also providing burst capacity for seasonal / intermittent spikes in usage. These thresholds are used to decide the number of virtual desktops (density) that are hosted by a specific hardware environment (i.e. combination of server, storage and networking) that forms the basis for a Dell Wyse Datacenter RA.

Resource Utilization Thresholds	
Parameter	Pass / Fail Threshold
Physical Host CPU Utilization	**85%**
Physical Host Memory Utilization	85%
Network Throughput	85%
Storage IO Latency	20ms

6.2.2   Dell Wyse Datacenter Workloads and Profiles

It's important to understand user workloads and profiles when designing a desktop virtualization solution in order to understand the density numbers that the solution can support. At Dell, we use four workload / profile levels, each of which is bound by specific metrics and capabilities. In addition, we use workloads and profiles that are targeted at graphics-intensive use cases. We present more detailed information in relation to these workloads and profiles below but first it is useful to define the terms "workload" and "profile" as they are used in this document.

- **Profile:** This is the configuration of the virtual desktop - number of vCPUs and amount of RAM configured on the desktop (i.e. available to the user).
- **Workload:** This is the set of applications used by performance analysis and characterization (PAAC) of Dell Wyse Datacenter solutions e.g. Microsoft Office applications, PDF Reader, Internet Explorer etc.

A Dell Appliance Architecture

User Profile	VM vCPU	VM Memory Startup	VM Memory Min/Max	Approx. IOPS	VDI Session Disk Space	OS Image Notes
Standard	1	1GB	512MB/2GB	2-3	2.1GB	This user workload leverages a shared desktop image emulates a task worker. Only two apps are open simultaneously and session idle time is approximately one hour and forty-five minutes.
Enhanced	2	1GB	512MB/3GB	7-8	3.75GB	This user workload leverages a shared desktop image emulates a medium knowledge worker. Up to 5 applications are open simultaneously and session idle time is approximately 2 minutes.
Pro	2	1GB	1GB/4GB	10-12	6GB	This user workload leverages a shared desktop image emulates a high level knowledge worker. Additional applications are opened simultaneously and session idle time is two minutes

6.2.3   Dell Wyse Datacenter Workloads

Load-testing on each of the profiles described in the above table is carried out using an appropriate workload that is representative of the relevant use case. In the case of the non-graphics workloads, these workloads are Login VSI workloads and in the case of graphics workloads, these are specially designed workloads that stress the VDI environment to a level that is appropriate for the relevant use case. This information is summarized in the table below:

Profile Name	Workload	OS Image
Standard	Login VSI Light	Shared
Enhanced	Login VSI Medium	Shared
Professional	Login VSI Heavy	Shared + Profile Virtualization

Further information for each of the workloads is given below. It is noted that for Login VSI testing, the following login and boot paradigm is used:

- For single-server / single-host testing (typically carried out to determine the virtual desktop capacity of a specific physical server), users are logged in every 30 seconds.

- For multi-host / full solution testing, users are logged in over a period of 1-hour, to replicate the normal login storm in an enterprise environment.
- All desktops are pre-booted in advance of logins commencing.
- For all testing, all virtual desktops run an industry-standard anti-virus solution (currently McAfee VirusScan Enterprise) in order to fully replicate a customer environment.

6.2.3.1 Standard Workload

The Standard workload consists of simple task worker workloads. Typically a repetitive application use profile with a non-personalized virtual desktop image. Sample use cases may be a kiosk or call-center use cases which do not require a personalized desktop environment and the application stack is static. In a virtual desktop environment the image is dynamically created from a template for each user and returned to the desktop pool for reuse by other users. The workload requirements for a basic user is the lowest in terms of CPU, memory, network and Disk I/O requirements and will allow the greatest density and scalability of the infrastructure.

6.2.3.2 Enhanced Workload

The Enhanced workload consists of email, typical office productivity applications and web browsing for research/training. There is minimal image personalization required in an Enhanced user profile. The workload requirement for an Enhanced user is moderate and most closely matches the majority of office worker profiles in terms of CPU, memory, network and Disk I/O. This will allow moderate density and scalability of the infrastructure.

6.2.3.3 Professional Workload

The Professional workload is an advanced knowledge worker. All office applications are configured and utilized. The user has moderate-to-large file size (access, save, transfer requirements). There is some graphics creation or editing done for presentations or content creation tasks. Web browsing use is typically research/training driven, similar to Enhanced Users. The Professional user requires extensive image personalization, for shortcuts, macros, menu layouts etc. The workload requirements for a Professional user are heavier than typical office workers in terms of CPU, memory, network and disk I/O. This will limit density and scalability of the infrastructure.

6.2.3.4 Workload Characterization Testing Details

User Profile/ Login VSI Workload	VM RAM	OS Image	Workload Description
Standard / Light	2GB	Shared	• The light workload is very light compared to medium. • Only two apps are open simultaneously. • Only apps used are Internet Explorer and Excel. • Idle time total is about 1 hour and 45 minutes
Enhanced / Medium	3GB	Shared	• Once a session has been started, the workload will repeat every 48 minutes. • The loop is divided in four segments, each consecutive Login VSI user logon will start a different segments. This ensures that all elements in the workload are equally used throughout the test. • During each loop the response time is measured every 3-4 minutes. • The medium workload opens up to five applications simultaneously. • The keyboard type rate is 160 ms for each character. • Approx 2 minutes of idle time is included to simulate real-world users. Each loop will open and use: • Outlook 2010, browse 10 messages. • Internet Explorer, browsing different webpages and a YouTube video (480p movie trailer) is opened 3 times. • Word 2010, one instance to measure response time, one instance to review and edit document. • Doro PDF Printer & Acrobat Reader, the word document is printed and reviewed to PDF. • Excel 2010, a very large randomized sheet is opened. • PowerPoint 2010, a presentation is reviewed and edited. • FreeMind, a Java based Mind Mapping application.

Professional / Heavy	4GB	Shared plus Profile Virt, *or,* Private	The heavy workload is based on the medium workload except that the heavy workload: - Begins by opening 4 instances of Internet Explorer. These instances stay open throughout the workload loop. - Begins by opening 2 instances of Adobe Reader. These instances stay open throughout the workload loop. - There are more PDF printer actions in the workload. - A 720p and a 1080p video are watched. - Increased the time the workload plays a flash game. - The idle time is reduced to 2 minutes.

6.3   Testing and Validation

6.3.1   Testing Process

The purpose of the single server testing is to validate the architectural assumptions made around the server stack. Each user load is tested against four runs. First, a pilot run to validate that the infrastructure is functioning and valid data can be captured, and then, three subsequent runs allowing correlation of data.

At different stages of the testing the testing team will complete some manual "User Experience" Testing while the environment is under load. This will involve a team member logging into a session during the run and completing tasks similar to the User Workload description. While this experience will be subjective, it will help provide a better understanding of the end user experience of the desktop sessions, particularly under high load, and ensure that the data gathered is reliable.

For all workloads, the performance analysis scenario will be to launch a user session every 30 seconds. Once all users have logged in, all will run workload activities at steady-state for 48-60 minutes and then logoffs will commence.

6.4   Dell Wyse vWorkspace Test Results

This validation was designed to evaluate the capabilities and performance of the components of the solution:

- Microsoft Windows Server 2012 R2 (appliance and RDSH VM OS)
- Microsoft Windows 8.1 (virtual desktop OS)
- Microsoft Office 2010 (for application testing)
- Dell Wyse vWorkspace 8.6

Pilot / Small Density appliance hardware test configuration:

Platform	CPU	Memory (RDIMMs)	RAID Controller	HD Config	Network
VDI (R730)	2 x E5-2620v3 (6C, 2.4GHz)	8 x 16GB 2133MHz **Effective speed: 1866MHz @ 128GB**	H730P (2GB cache) Raid 1+0	6 x 600GB 15k SAS 2.5" **(Compute / Management)**	4 x 1Gb Teamed
RDSH (R730)	2 x E5-2620v3 (6C, 2.4GHz)	8 x 16GB 2133MHz **Effective speed: 1866MHz @ 128GB**	H730P (2GB cache) Raid 1+0	6 x 300GB 15k SAS 2.5" **(Compute / management)**	4 x 1Gb Teamed

Large Density appliance hardware test configuration:

Platform	CPU	Memory (RDIMMs)	RAID Controller	HD Config	Network
VDI (R730)	2 x E5-2680v3 (12C, 2.5GHz)	16 x 16GB 2133MHz **Effective speed: 2133MHz @ 256GB**	H730P (2GB cache) Raid 1+0	16 x 600GB 15k SAS 2.5" **(Compute / Management)**	4 x 1Gb Teamed
RDSH (R730)	2 x E5-2620v3 (6C, 2.4GHz)	16 x 16GB 2133MHz **Effective speed: 2133MHz @ 256GB**	H730P (2GB cache) Raid 1+0	16 x 600GB 15k SAS 2.5" **(Compute / Management)**	4 x 1Gb Teamed

6.4.1   Summary of Test Runs

6.4.1.1   Pilot / Small Density Appliance

The tables below summarize the resource utilizations and user densities that were obtained while remaining in acceptable limits (typically around 85% of available resources) for the appliance hardware platforms. For all platforms, Memory was the limiting resource.

	Workload	Users / Sessions	Peak CPU%	Peak Memory Consumed (GB)	Avg IOPS / User	Avg Network Usage Kbps / User
Virtual Desktops	Standard	100	45	101	2.73	84
	Enhanced	75	70	99	6.36	195
	Professional	60	82	101	9.49	414
RD Sessions	Enhanced	130	68	75	1.84	113

* All average values are during steady state period and represent the host values.

- **CPU Utilization**: The values shown in the table is the Compute host steady state peak CPU Usage.
- **Memory utilization**: The figure shown in the table above is the average memory consumed per host over the recorded test period (Compute and Management are on the same machine).
- **The IOPS**: Results are calculated from the average Disk IOPS figure over the test period divided by the number of users.
- **Network Utilization**: The figure shown in the table is the average Kilobits/sec/User per host over the recorded test period.

6.4.1.2   Large Density Appliance

The tables below summarize the resource utilizations and user densities that were obtained while remaining in acceptable limits (typically around 85% of available resources) for the appliance hardware platforms. For all platforms, Memory was the limiting resource.

NOTE: User sessions tested are higher than the recommended density limits due to small template image disk size. Dell recommends limiting user density to 130|160|200 users for Professional | Enhanced | Standard profiles respectively especially when using persistent desktops.

	Workload	Users / Sessions	Peak CPU%	Peak Memory Consumed (GB)	Avg IOPS / User	Avg Network Usage Kbps / User
Virtual Desktops	Standard	230	42	221	3.16	77
	Enhanced	180	63	215	5.02	135
	Professional	140	76	217	4.92	245
RD Sessions	Enhanced	300	84	177	3.04	161

* All average values are during steady state period and represent the host values.

- **CPU Utilization**: The values shown in the table is the Compute host steady state peak CPU Usage.
- **Memory utilization**: The figure shown in the table above is the average memory consumed per host over the recorded test period (Compute and Management are on the same machine).
- **The IOPS**: Results are calculated from the average Disk IOPS figure over the test period divided by the number of users.
- **Network Utilization**: The figure shown in the table is the average Kilobits/sec/User per host over the recorded test period.

6.4.2   Pilot Appliance Test Results

6.4.2.1   Non-Persistent Virtual Desktop, Standard Workload (100 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Express 2014, and vWorkspace 8.6 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 100 users successfully logged on, executed the test workload, and logged off.

Performance Monitor Host Metrics

CPU utilization did not spiked above our 85% limit at various times on each host but on average, remained at or below the limit. Memory utilization is below the 108GB (85% of 128GB) threshold however there is no additional capacity as dynamic memory has been allocation. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.
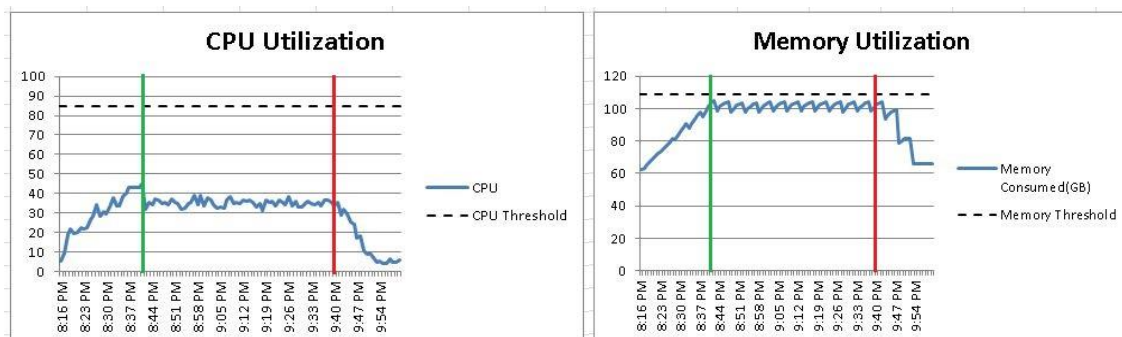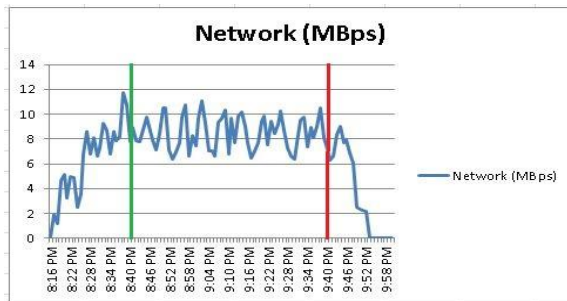
The charts above begin at the start of the logon period at 8:16PM which lasts until 10:00PM. The green vertical line indicates the beginning of the steady state period at 8:40PM which lasts until 9:40PM. The red vertical line indicates the beginning of the logoff period at 9:41PM which lasts until 10:00PM.

Appliance IOPS

The IOPS spiked to 866 during the logon period while users were logging in every 15 seconds. During steady state there was another peak at 866, all users are executing the test workload and IOPS averaged 273 yielding about 2.73 IOPS/user. During the logoff period, IOPS peaked at 370. The chart below graphs the IOPS broken out by host.
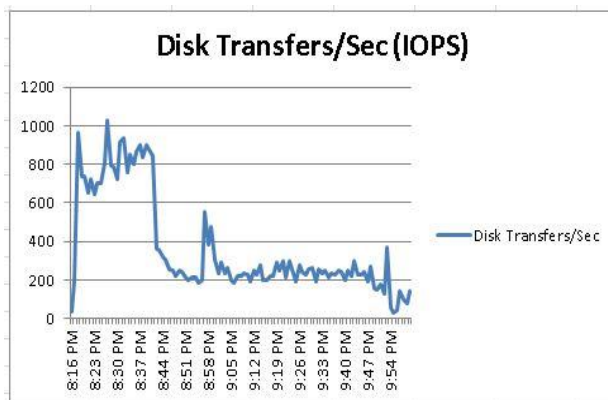
          Disk IOPS by Host   **R/W Disk IOPS (Reads = Blue Line, Writes = Red Line)**
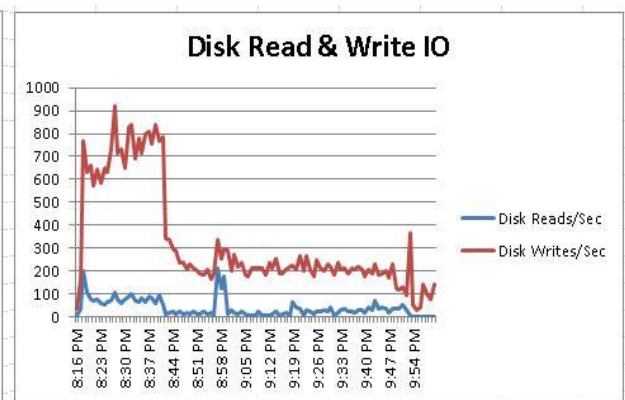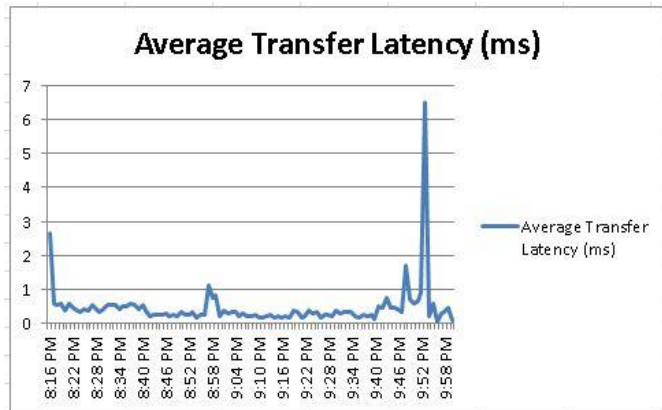
Disk Latency

Disk latency peaked around 6.48ms but remained below our 20ms threshold.

6.4.2.2   Non-Persistent Virtual Desktop, Enhanced Workload (75 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Express and vWorkspace 8.6 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 75 users successfully logged on, executed the test workload, and logged off.

Performance Monitor Host Metrics

CPU utilization did not spiked above our 85% limit at various times on each host but on average, remained below the limit. Memory utilization is below the 108GB (85% of 128GB) threshold however there is no additional capacity as dynamic memory has been allocation. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.
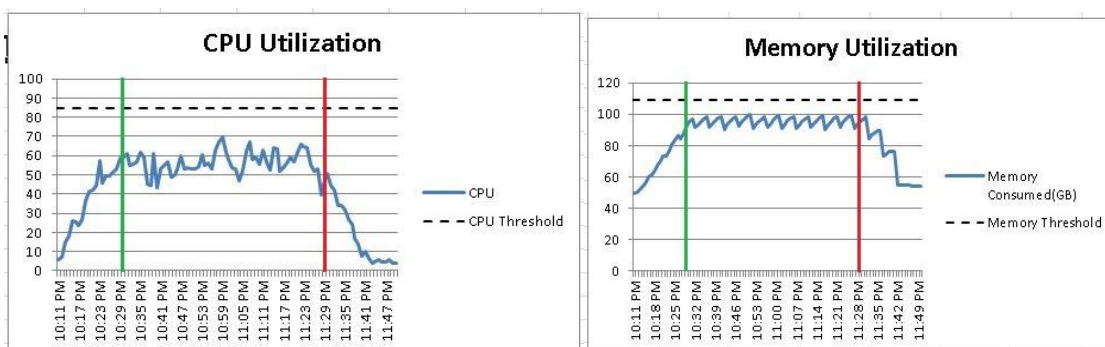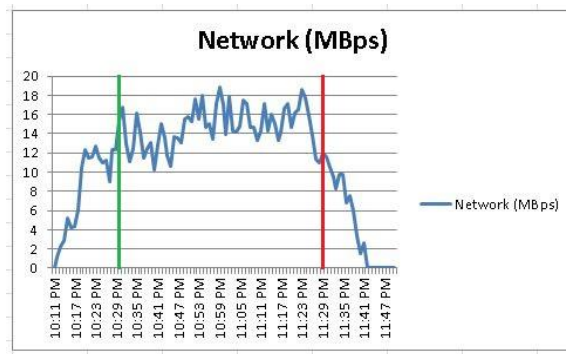
The charts above begin at the start of the logon period at 11:11PM which lasts until 11:50PM. The green vertical line indicates the beginning of the steady state period at 10:29PM which lasts until 11:29PM. The red vertical line indicates the beginning of the logoff period at 11:30PM which lasts until 11:50PM.

Appliance IOPS

The IOPS spiked to 1718 during the logon period while users were logging in every 15 seconds. During steady state there was another spike at 1531, all users are executing the test workload and IOPS averaged 477 yielding about 6.36 IOPS/user. During the logoff period, IOPS peaked did not peak above 416. The chart below graphs the IOPS broken out by host.
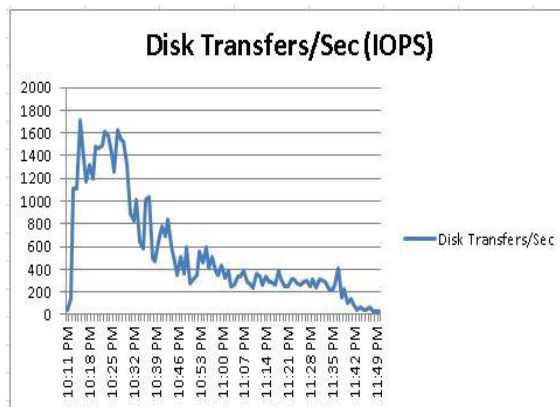
Disk IOPS by Host
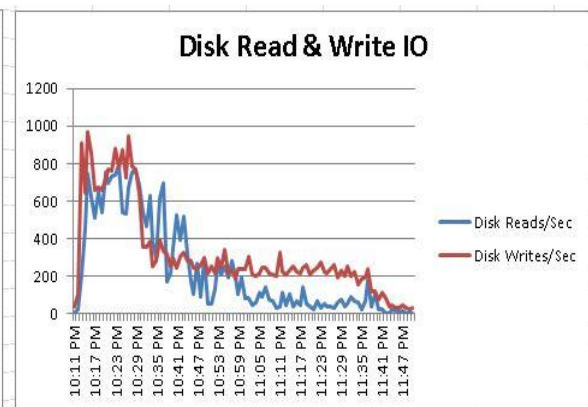
R/W Disk IOPS % (Reads = Blue Line, Writes = Red Line)
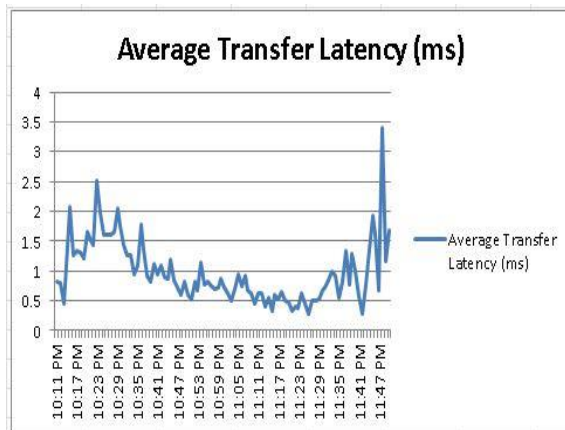
Disk Latency

The latency peaked around 3.41ms but remained below our 20ms threshold.

6.4.2.3   Non-Persistent Virtual Desktop, Professional Workload (60 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Express 2014 and vWorkspace 8.6 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 60 users successfully logged on, executed the test workload, and logged off.

Performance Monitor Host Metrics

CPU utilization did not spiked above our 85% limit at various times on each host but on average, remained below the limit. Memory utilization is close to the 108GB (85% of 128GB) threshold however there is no additional capacity as dynamic memory has been allocation. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.

A Dell Appliance Architecture

Network (MBps)
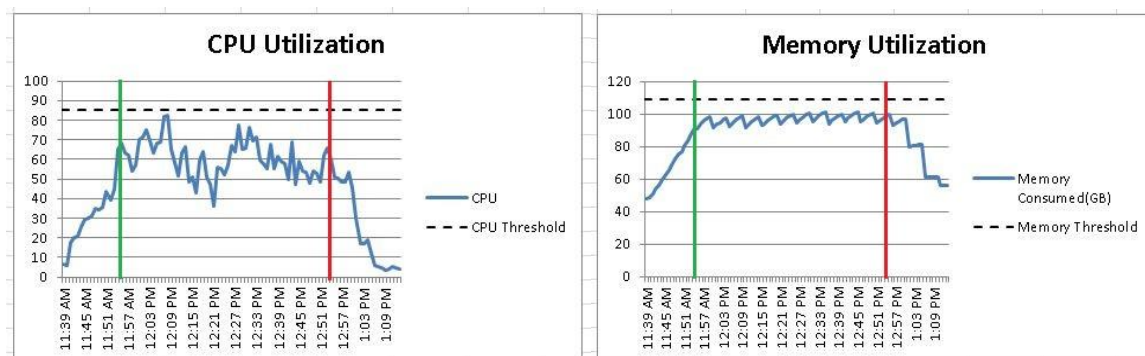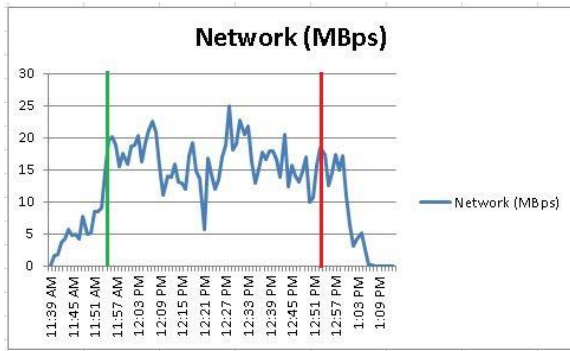
The charts above begin at the start of the logon period at 11:39AM which lasts until 1:13PM. The green vertical line indicates the beginning of the steady state period at 11:53AM which lasts until 12:53PM. The red vertical line indicates the beginning of the logoff period at 12:54PM which lasts until 1:13PM.
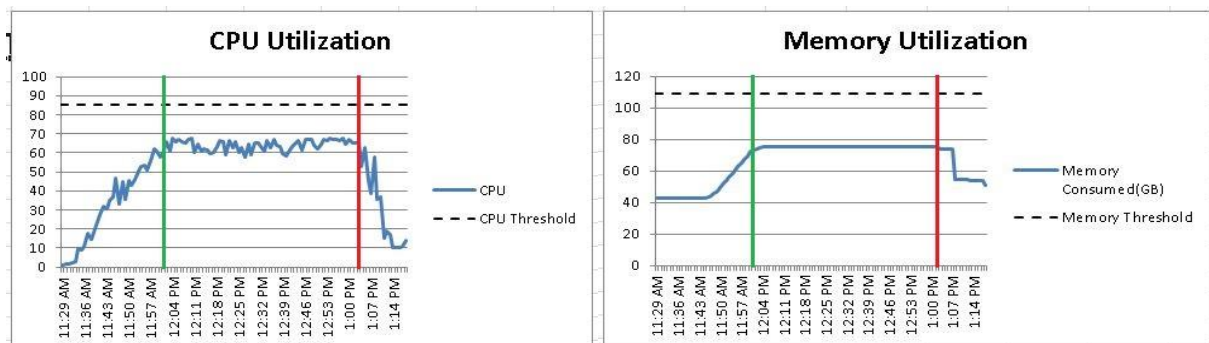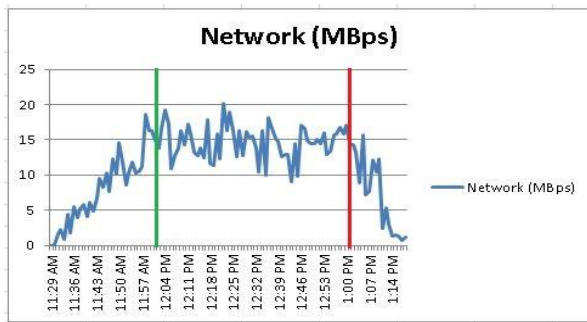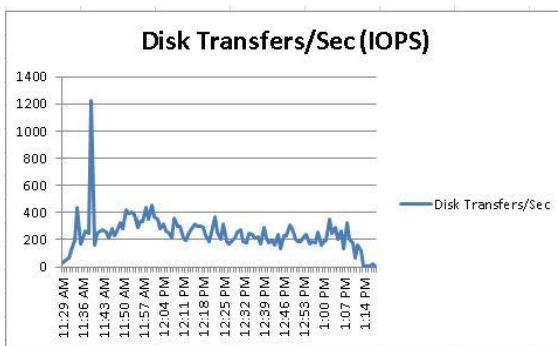
Appliance IOPS

The IOPS spiked to 2101 during the logon period while users were logging in every 15 seconds. During steady state spike at 2532, all users are executing the test workload and IOPS averaged 569 yielding about 9.49 IOPS/user. During the logoff period, IOPS peaked at 523. The chart below graphs the IOPS broken out by host.
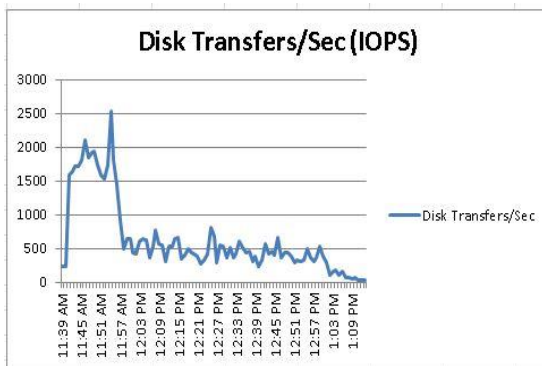
Disk IOPS on Host

R/W Disk IOPS (Read = Blue Line, Write = Red Line)

A Dell Appliance Architecture
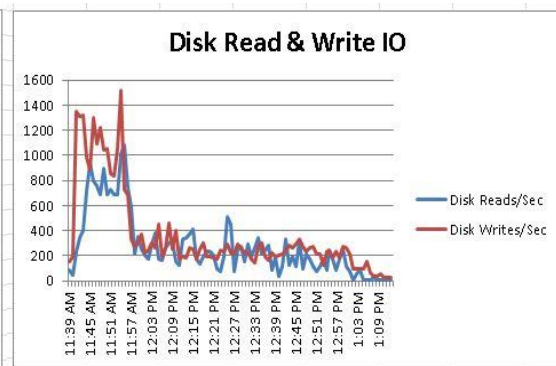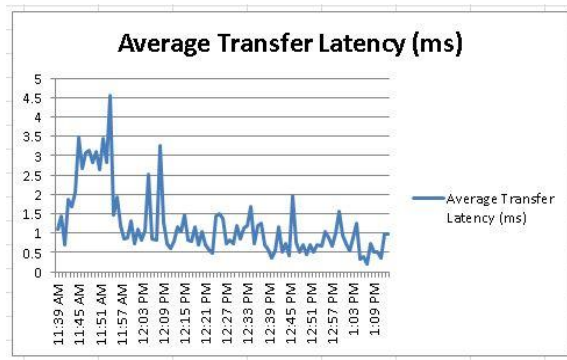
Disk Latency

The latency peaked around 4.56ms but remained below our 20ms threshold.

6.4.2.4 Application Virtualization (RDSH), Enhanced Workload (130 Users)

The results below were obtained from the host and management virtual machines with Hyper‑V, SQL Express 2014 and vWorkspace 8.6 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 130 users successfully logged on, executed the test workload, and logged off.

Performance Monitor Host Metrics

CPU utilization remained at or below the threshold for all hosts during steady state. Memory utilization is well below the 108GB (85% of 128GB) threshold. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.

The charts above begin at the start of the logon period at 11:29AM which lasts until 1:18PM. The green vertical line indicates the beginning of the steady state period at 12:01PM which lasts until 1:01PM. The red vertical line indicates the beginning of the logoff period at 1:02PM which lasts until 1:18PM.
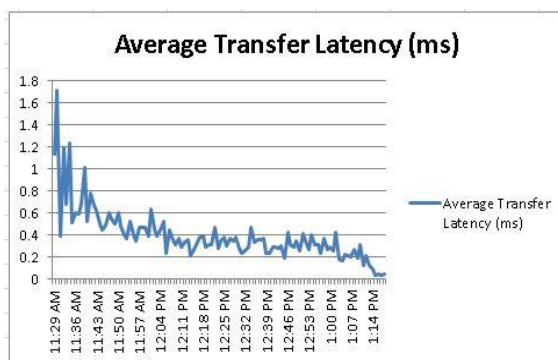
Appliance IOPS

The IOPS spiked to 1220 during the logon period while users were logging in every 15 seconds. During steady state, all users are executing the modified test workload and IOPS averaged 239 yielding about 1.84 IOPS/user. During the logoff period, IOPS peaked at 348. The chart below graphs the IOPS broken out by host.

Disk IOPS on Host

R/W Disk IOPS (Read = Blue Line, Write = Red Line)

Disk Latency

A Dell Appliance Architecture
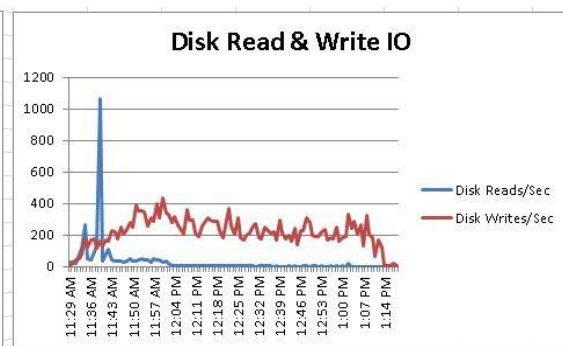
The Disk latency peaked around 1.71ms at logoff but remained below our 20ms threshold.

6.4.3　Large Density Appliance Test Results

6.4.3.1　Persistent Virtual Desktop, Standard Workload (230 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Server 2014, and vWorkspace 8.6 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 230 users successfully logged on, executed the test workload, and logged off.

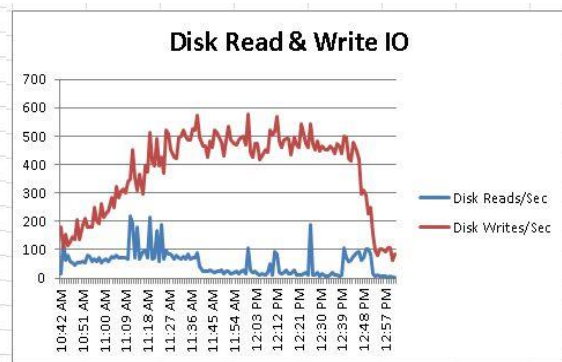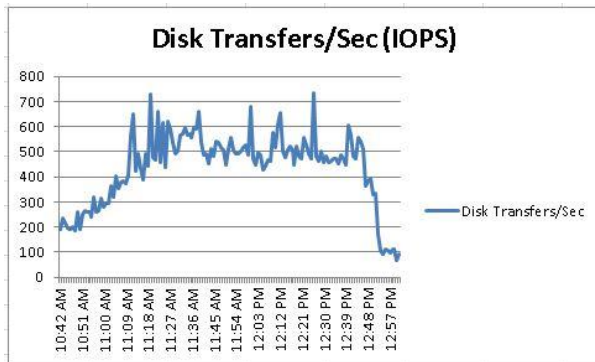**Performance Monitor Host Metrics**

CPU utilization did not spiked above our 85% limit at various times on each host but on average, remained at or below the limit. Memory utilization is below the 218GB (85% of 256GB) threshold however there is no additional capacity as dynamic memory has been allocation. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.
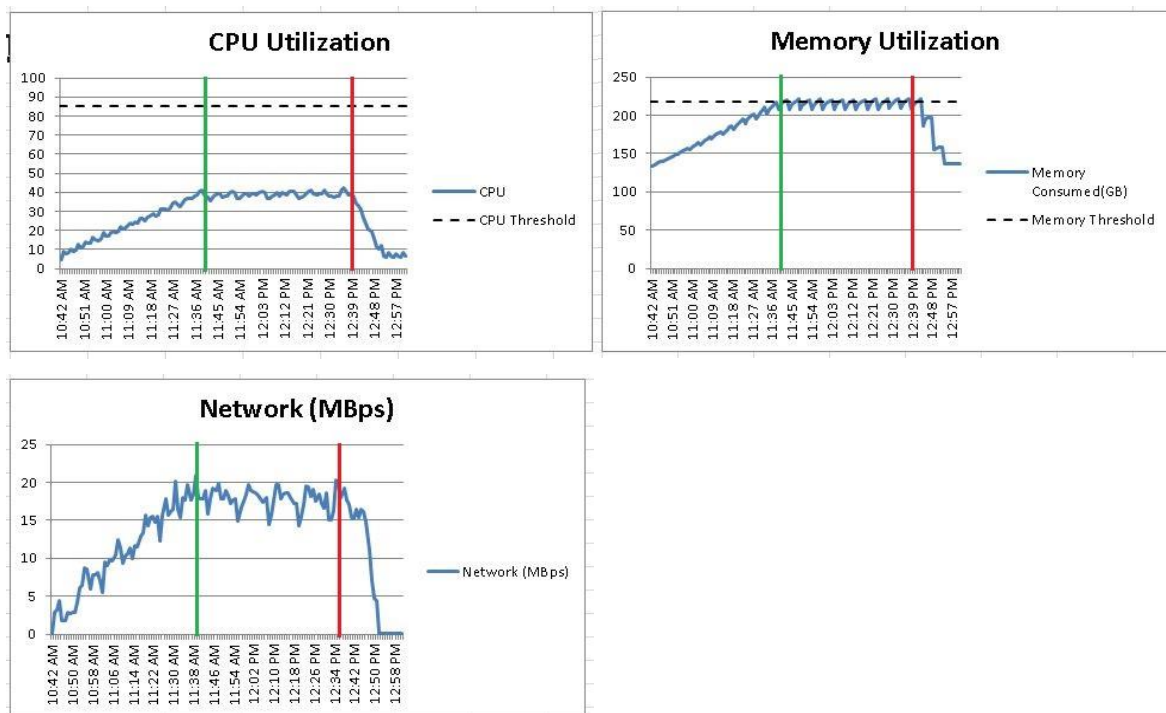
The charts above begin at the start of the logon period at 10:42AM which lasts until 1:01PM. The green vertical line indicates the beginning of the steady state period at 11:39AM which lasts until 12:39PM. The red vertical line indicates the beginning of the logoff period at 12:40PM which lasts until 1:01PM.

Appliance IOPS

The IOPS spiked to 728 during the logon period while users were logging in every 15 seconds. During steady state spiked to 733, all users are executing the test workload and IOPS averaged 505 yielding about 3.16 IOPS/user. During the logoff period, IOPS peaked at 605. The chart below graphs the IOPS broken out by host.

Disk IOPS by Host

R/W Disk IOPS (Reads = Blue Line, Writes = Red Line)
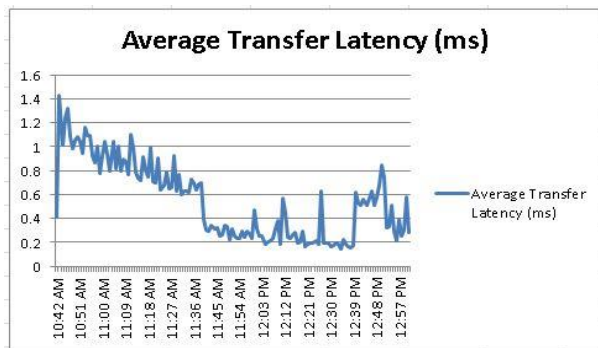
Disk Latency

Disk latency peaked around 1.42ms but remained below our 20ms threshold.

6.4.3.2   Persistent Virtual Desktop, Enhanced Workload (180 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Server and vWorkspace 8.6 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 180 users successfully logged on, executed the test workload, and logged off.

A Dell Appliance Architecture

Performance Monitor Host Metrics

CPU utilization did not spiked above our 85% limit at various times on each host but on average, remained below the limit. Memory utilization is below the 218GB (85% of 256GB) threshold however there is no additional capacity as dynamic memory has been allocation. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.
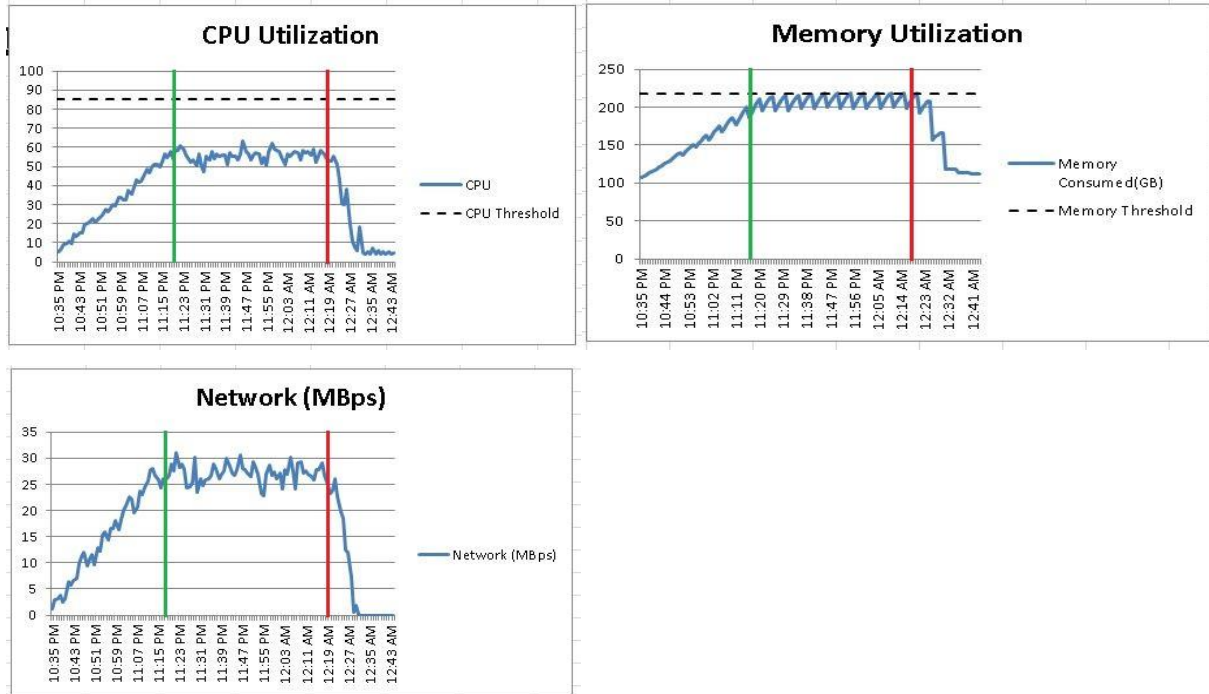

The charts above begin at the start of the logon period at 10:35PM which lasts until 12:44AM. The green vertical line indicates the beginning of the steady state period at 11:19PM which lasts until 12:19AM. The red vertical line indicates the beginning of the logoff period at 12:20AM which lasts until 12:44AM.

Appliance IOPS

The IOPS spiked to 2155 during the logon period while users were logging in every 15 seconds. During steady state spiked to 2669, all users are executing the test workload and IOPS averaged 642 yielding about 3.57 IOPS/user. During the logoff period, IOPS peaked did not peak above 1991. The chart below graphs the IOPS broken out by host.
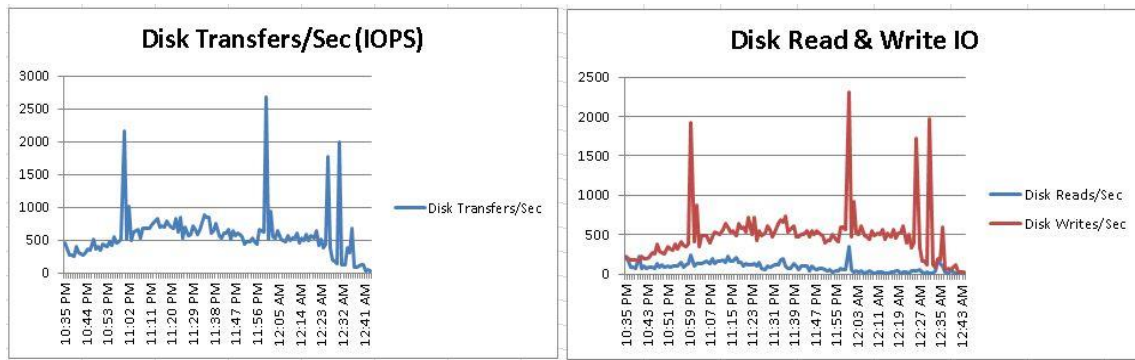
A Dell Appliance Architecture

Disk IOPS by Host

**R/W Disk IOPS % (Reads = Blue Line, Writes = Red Line)**
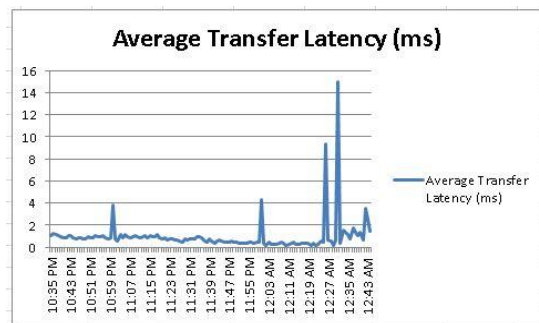
Disk Latency

The latency peaked around 15ms but remained below our 20ms threshold.

6.4.3.3 Persistent Virtual Desktop, Professional Workload (140 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Server 2014 and vWorkspace 8.6 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 140 users successfully logged on, executed the test workload, and logged off.

Performance Monitor Host Metrics

CPU utilization did not spiked above our 85% limit at various times on each host but on average, remained below the limit. Memory utilization is close to the 218GB (85% of 256GB) threshold however there is no additional capacity as dynamic memory has been allocation. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.

CPU Utilization

**Memory Utilization**

Network (MBps)
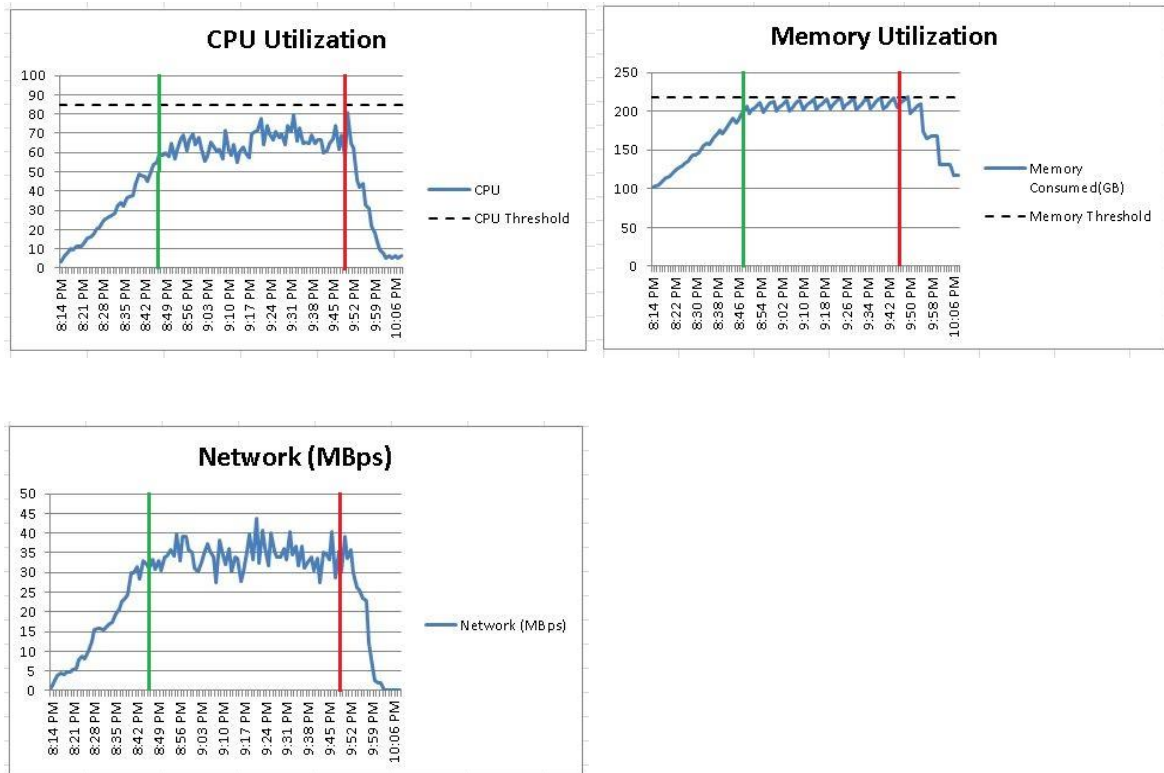
The charts above begin at the start of the logon period at 8:14AM which lasts until 10:08AM. The green vertical line indicates the beginning of the steady state period at 8:48AM which lasts until 9:48AM. The red vertical line indicates the beginning of the logoff period at 9:49AM which lasts until 10:08AM.

Appliance IOPS

The IOPS spiked to 1002 during the logon period while users were logging in every 15 seconds. During steady state spiked to 1010, all users are executing the test workload and IOPS averaged 688 yielding about 4.92 IOPS/user. During the logoff period, IOPS peaked at 1031. The chart below graphs the IOPS broken out by host.
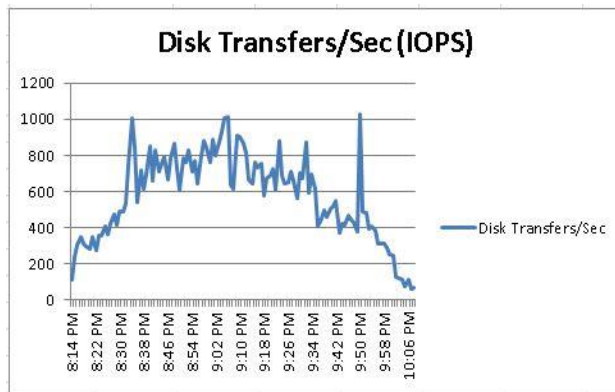
A Dell Appliance Architecture

Disk IOPS on Host
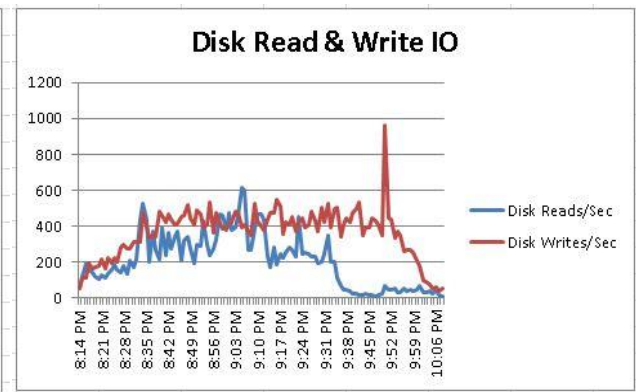
**R/W Disk IOPS (Read = Blue Line, Write = Red Line)**
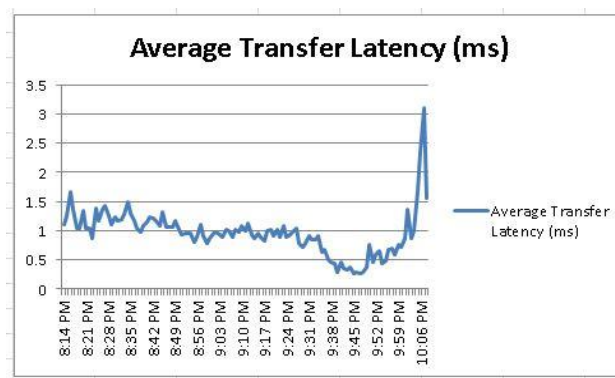
Disk Latency

The latency peaked around 3.1ms but remained below our 20ms threshold.

6.4.3.4   Application Virtualization (RDSH), Enhanced Workload (300 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Server 2014 and vWorkspace 8.6 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 300 users successfully logged on, executed the test workload, and logged off.
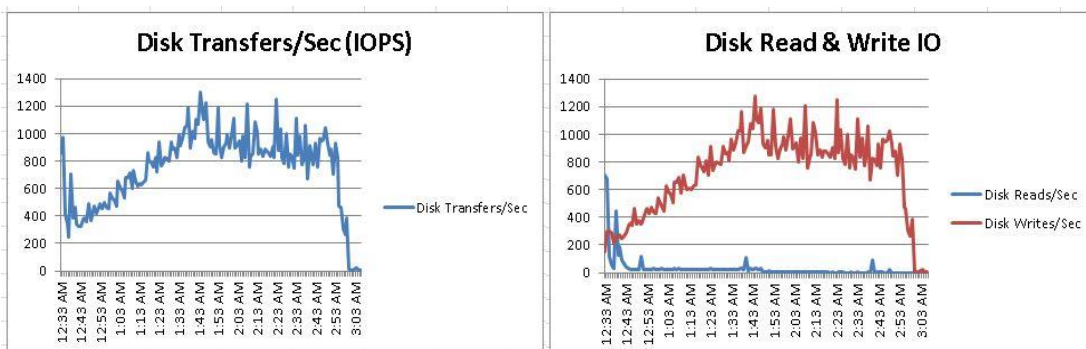
Performance Monitor Host Metrics

CPU utilization remained at or below the threshold for all hosts during steady state. Memory utilization is well below the 218GB (85% of 256GB) threshold. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.

A Dell Appliance Architecture

CPU Utilization

Memory Utilization

Network (MBps)
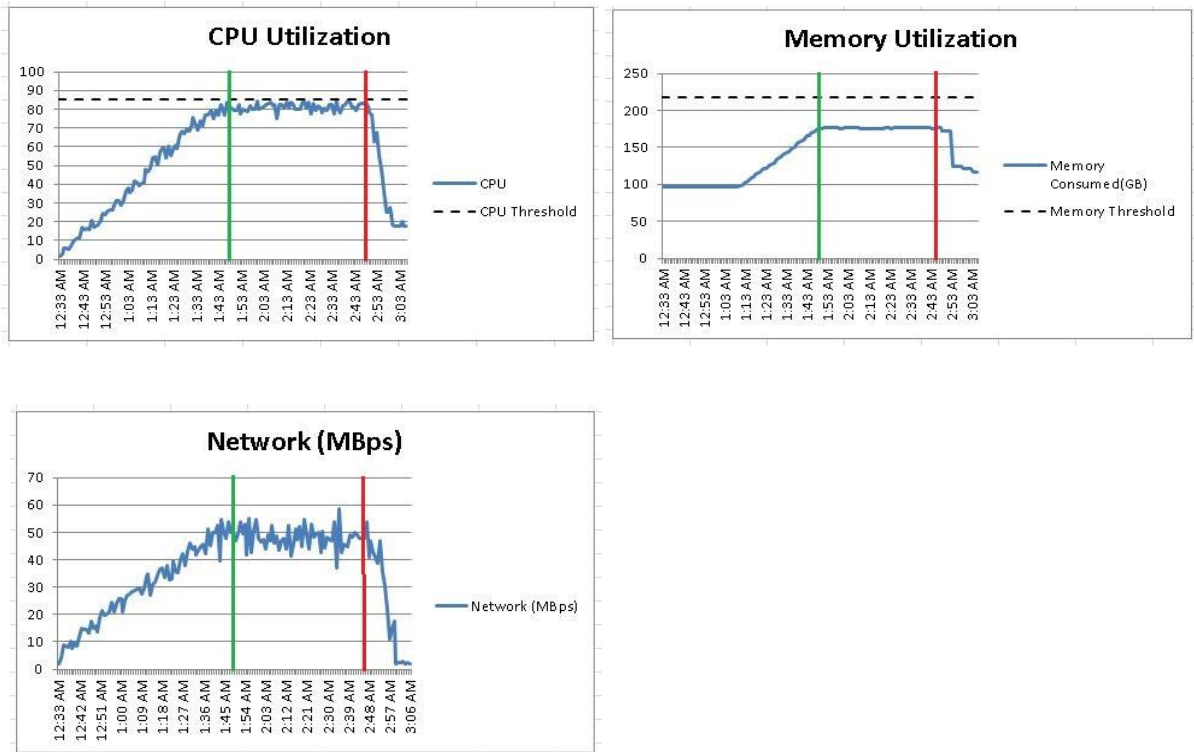
The charts above begin at the start of the logon period at 12:33AM which lasts until 3:06AM. The green vertical line indicates the beginning of the steady state period at 1:47AM which lasts until 2:47AM. The red vertical line indicates the beginning of the logoff period at 2:48AM which lasts until 3:06AM.
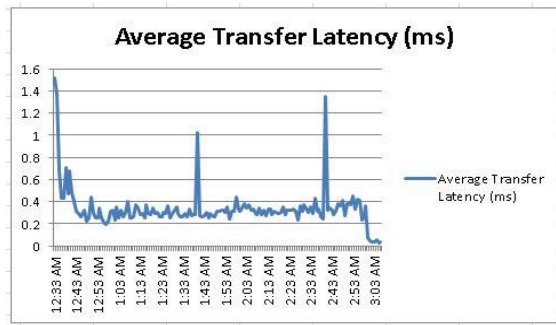
Appliance IOPS

The IOPS spiked to 1304 during the logon period while users were logging in every 15 seconds. During steady state spiked to 1250, all users are executing the modified test workload and IOPS averaged 913 yielding about 3.04 IOPS/user. During the logoff period, IOPS peaked at 1045. The chart below graphs the IOPS broken out by host.

Disk Transfers/Sec (IOPS)

Disk Read & Write IO

A Dell Appliance Architecture

Disk IOPS on Host   **R/W Disk IOPS (Read = Blue Line, Write = Red Line)**

Average Transfer Latency (ms)

Disk Latency

The Disk latency peaked around 1.69ms at logoff but remained below our 20ms threshold.

About the Authors

Peter Fine is the Sr. Principal Solutions Architect for enterprise VDI solutions at Dell. Peter has extensive experience and expertise on the broader Microsoft, Citrix and VMware solutions software stacks as well as in enterprise virtualization, storage, networking and enterprise data center design.

Andrew McDaniel is the Solutions Development Manager for VMware solutions at Dell, managing the development and delivery of enterprise-class desktop virtualization solutions based on Dell Data center components and core virtualization platforms.

Jerry Van Blaricom is a Systems Principal Engineer in the Cloud Client Solutions Engineering Group at Dell. Jerry has extensive experience with the design and implementation of a broad range of enterprise systems and is focused on making Dell's virtualization offerings consistently best in class.

John Waldron is a Sr. Systems Engineer in the Cloud Client Solutions Engineering Group at Dell. John has years of deep operational experience in IT and holds a Bachelor's degree in Computer Engineering from the University of Limerick.

Geoff Dillon is a Solutions Engineer in the Cloud Client Solutions Engineering Group at Dell. Geoff is experienced in enterprise system deployment and administration and is working on making Dell's VDI solutions stand out in the market.

David Pfahler is a Senior Software Engineer for Cloud Client Solutions Engineering Group at Dell. David has extensive experience in enterprise software design and development for automated deployments that exceed customer expectations.

Manish Chacko is the Sr. Technical Marketing Advisor for enterprise VDI solutions at Dell. Before writing about technology, Manish spent time designing, implementing and supporting technology- in IT, Systems Engineering & Network Performance & Monitoring. Manish was a long-time Dell customer and advocate before becoming a Dell employee.