



Dell Appliance for Wyse - Citrix®

Dell Engineering
September 2015

Revisions

Date	Description
June 2015	Initial release
September 2015	Revision 1.1. Qualification of latest hardware configurations.

THIS DOCUMENT IS FOR INFORMATIONAL PURPOSES ONLY, AND MAY CONTAIN TYPOGRAPHICAL ERRORS AND TECHNICAL INACCURACIES. THE CONTENT IS PROVIDED AS IS, HARDWARE SELECTIONS CONTAINED WITHIN ARE FROM THE BASIS OF BEST WITHOUT EXPRESS OR IMPLIED WARRANTIES OF ANY KIND.

Copyright © 2015 Dell Inc. All rights reserved. Reproduction of this material in any manner whatsoever without the express written permission of Dell Inc. is strictly forbidden. For more information, contact Dell.

Dell, the Dell logo, and the Dell badge are trademarks of Dell Inc. Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and/or other countries. VMware is a registered trademark of VMware, Inc. NVIDIA GRID™ and vGPU™ are registered trademarks of NVIDIA Corporation. Other trademarks and trade names may be used in this document to refer to either the entities claiming the marks and names or their products. Dell Inc. disclaims any proprietary interest in trademarks and trade names other than its own.

Contents

1	Introduction.....	5
1.1	Purpose.....	5
1.2	Scope.....	5
1.3	What's New.....	5
2	Solution Architecture Overview.....	6
2.1	Introduction.....	6
2.2	Large Density Appliance.....	6
3	Hardware Components.....	8
3.1	Dell Appliance for Wyse.....	8
3.1.1	PowerEdge R730.....	8
3.1.2	PowerEdge T630.....	9
3.2	Dell Wyse Cloud Clients.....	9
3.2.1	Wyse 3020 Thin Client (ThinOS).....	10
3.2.2	Wyse 5010 (ThinOS).....	10
3.2.3	Wyse 5010 Thin Client (Windows Embedded Standard 8).....	10
3.2.4	Wyse 7010 Thin Client (Windows Embedded Standard 8).....	11
3.2.5	Wyse 5040 AIO.....	11
3.2.6	Dell Wyse Cloud Connect.....	11
3.2.7	Dell Venue 11 Pro.....	12
3.2.8	Dell Chromebook 11.....	12
4	Software Components.....	13
4.1	Citrix.....	13
4.1.1	Citrix XenDesktop.....	13
4.1.2	Machine Creation Services (MCS).....	15
4.1.3	Citrix Profile Manager.....	16
4.1.4	Citrix XenApp.....	16
4.1.5	Citrix NetScaler.....	19
4.2	Hypervisor Platforms.....	21
4.2.1	Microsoft Windows Server 2012 R2 Hyper-V.....	21
4.3	Dell Quick Start Tool (QST).....	22

4.4	Operating Systems.....	22
4.4.1	Microsoft Windows Server 2012 R2.....	22
4.4.2	Microsoft Windows 8.1.....	23
5	Solution Architecture for XenDesktop 7.....	24
5.1	Management Role Configuration.....	24
5.1.1	Hyper-V Management Role Requirements.....	24
5.1.2	XenApp on Hyper-V.....	24
5.1.3	SQL Databases.....	25
5.1.4	DNS.....	25
5.2	Storage Architecture Overview.....	25
5.3	Virtual Networking.....	25
5.3.1	Hyper-V.....	25
5.4	Appliance Density.....	27
5.5	Dell Wyse Datacenter for XenDesktop Communication Flow.....	28
6	Solution Performance and Testing.....	29
6.1	Load Generation and Monitoring.....	29
6.1.1	Login VSI – Login Consultants.....	29
6.1.2	Microsoft Performance Monitor.....	29
6.2	Performance Analysis Methodology.....	29
6.2.1	Resource Utilization.....	30
6.2.2	Dell Wyse Datacenter Workloads and Profiles.....	30
6.2.3	Dell Wyse Datacenter Workloads.....	31
6.3	Testing and Validation.....	34
6.3.1	Testing Process.....	34
6.4	Citrix XenDesktop Test Results.....	34
6.4.1	Summary of Test Runs.....	35
6.4.2	Persistent Virtual Desktop, Standard Workload (180 Users).....	36
6.4.3	Persistent Virtual Desktop, Enhanced Workload (150 Users).....	37
6.4.4	Persistent Virtual Desktop, Professional Workload (100 Users).....	39
6.4.5	Shared Session (XenApp), Enhanced Workload (300 Users).....	41
	About the Authors.....	43

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 shared session desktops using the Dell Appliance for Wyse. The underlying technology is Citrix® XenDesktop® and XenApp® 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 shared session user density

2 Solution Architecture Overview

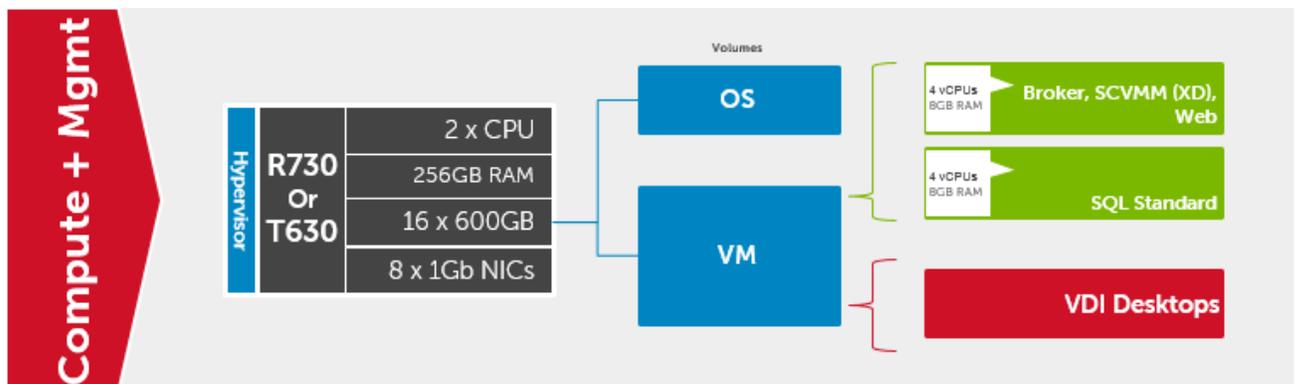
2.1 Introduction

The incredible versatility of the Dell Appliance for Wyse - Citrix 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.

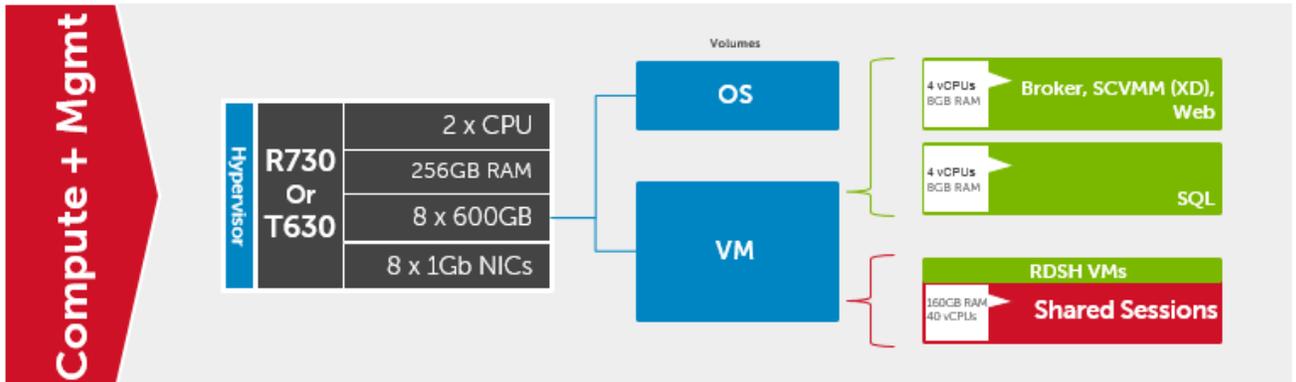
The Dell Appliance for Wyse via the R730 and T630 series delivers an out-of-the-box infrastructure solution for virtual desktops that eliminates the high cost, variable performance, and extensive risk of conventional solutions.

2.2 Large Density Appliance

The compute, management and storage layers are 'converged' into a single appliance, hosting Microsoft Hyper-V hypervisor and Citrix XenDesktop. 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.



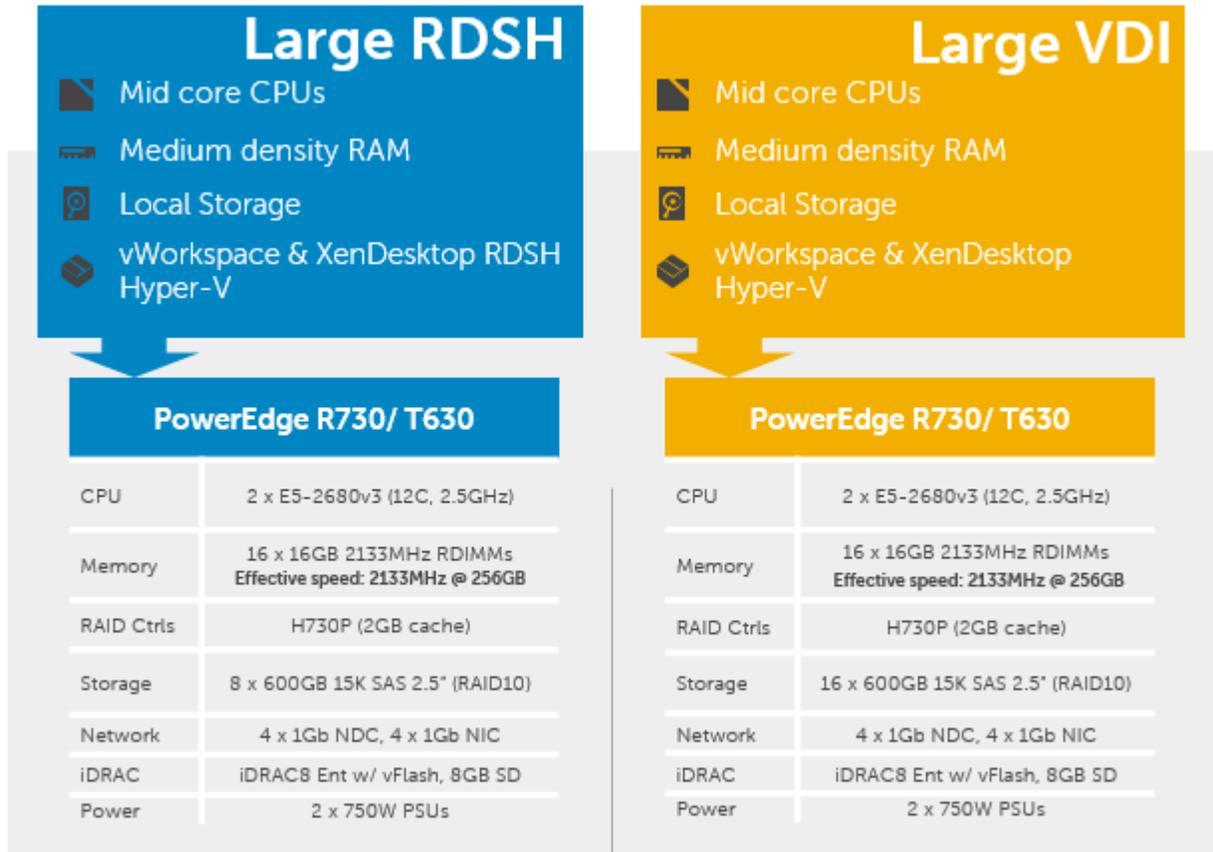
The appliance can also be used to host shared session desktops. In this configuration, storage capacity is reduced as only five Windows Server 2012 R2 RDSH VMs are required.



3 Hardware Components

3.1 Dell Appliance for Wyse

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



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 Citrix user experience and are the recommended choices for this solution.

A Dell Appliance Architecture

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.



ThinOS

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)



WE8S

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 5290-D90D8 offers cool, quiet operations, potentially lowering your overall carbon footprint.

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 7290-Z90D8 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.



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](#)

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.



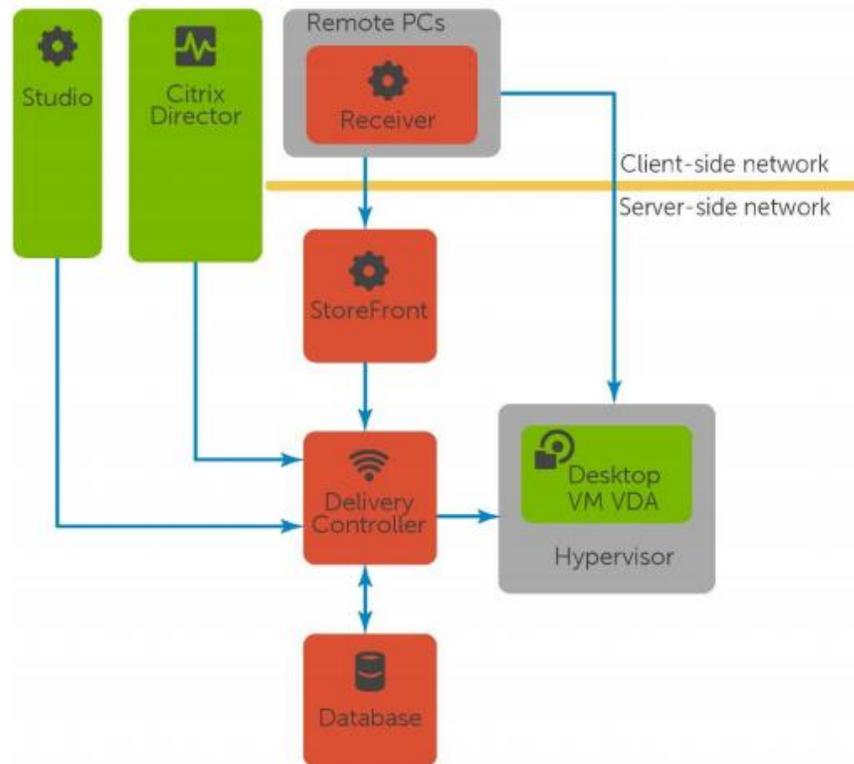
4 Software Components

4.1 Citrix

4.1.1 Citrix XenDesktop

The solution is based on Citrix XenDesktop 7.6 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.

Citrix XenDesktop 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.



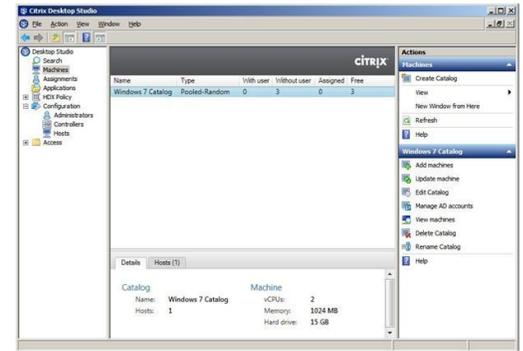
The core XenDesktop components include:

- **Studio:** Studio is the management console that enables you to configure and manage your deployment, eliminating the need for separate management consoles for managing delivery of applications and desktops. Studio provides various wizards to guide you through the process of setting up your environment, creating your workloads to host applications and desktops, and assigning applications and desktops to users.
- **Director:** Director is a web-based tool that enables IT support teams to monitor an environment, troubleshoot issues before they become system-critical, and perform support tasks for end users. You can also view and interact with a user's sessions using Microsoft Remote Assistance.
- **Receiver:** Installed on user devices, Citrix Receiver provides users with quick, secure, self-service access to documents, applications, and desktops from any of the user's devices including smartphones, tablets, and PCs. Receiver provides on-demand access to Windows, Web, and Software as a Service (SaaS) applications.
- **Delivery Controller (DC):** Installed on servers in the data center, the controller authenticates users, manages the assembly of users' virtual desktop environments, and brokers connections between users and their virtual desktops.
- **StoreFront:** StoreFront authenticates users to sites hosting resources and manages stores of desktops and applications that user's access.
- **License Server:** The Citrix License Server is an essential component at any Citrix-based solution. Every Citrix product environment must have at least one shared or dedicated license server. License servers are computers that are either partly or completely dedicated to storing and managing licenses. Citrix products request licenses from a license server when users attempt to connect.
- **Machine Creation Services (MCS):** A collection of services that work together to create virtual servers and desktops from a master image on demand; optimizing storage utilization and providing a pristine virtual machine to users every time they log on. Machine Creation Services is fully integrated and administrated in Citrix Studio.
- **Provisioning Services (PVS):** The Provisioning Services infrastructure is based on software-streaming technology. This technology allows computers to be provisioned and re-provisioned in real-time from a single shared-disk image.
- **Virtual Delivery Agent (VDA):** The Virtual Desktop Agent is a transparent plugin that is installed on every virtual desktop or XenApp host (RDSH) and enables the direct connection between the virtual desktop and users' endpoint devices.

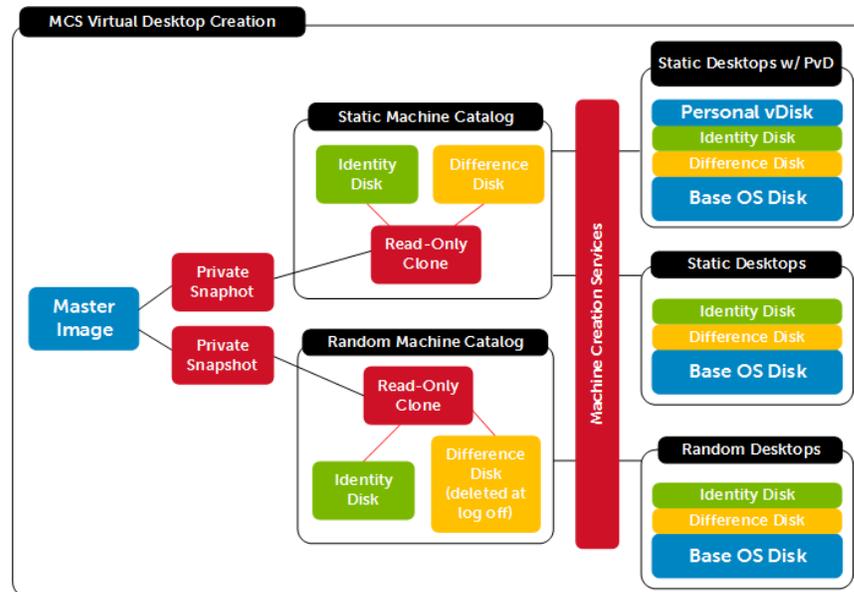
4.1.2 Machine Creation Services (MCS)

Citrix Machine Creation Services is the native provisioning mechanism within Citrix XenDesktop for virtual desktop image creation and management. Machine Creation Services uses the hypervisor APIs to create, start, stop, and delete virtual desktop images. Desktop images are organized in a Machine Catalog and within that catalog there are a number of options available to create and deploy virtual desktops:

- **Random:** Virtual desktops are assigned randomly as users connect. When they logoff, the desktop is reset to its original state and made free for another user to login and use. Any changes made by the user are discarded at log off.
- **Static:** Virtual desktops are assigned to the same user every time with three options for how to handle changes made to the desktop: Store on local vDisk, Personal vDisk, or discarded on user log off.



All the desktops in a random or static catalog are based off a master desktop template which is selected during the catalog creation process. MCS then takes snapshots of the master template and layers two additional virtual disks on top: an Identity vDisk and a Difference vDisk. The Identity vDisk includes all the specific desktop identity information such as host names and passwords. The Difference vDisk is where all the writes and changes to the desktop are stored. These Identity and Difference vDisks for each desktop are stored on the same data store as their related clone.



While traditionally used for small to medium sized XenDesktop deployments, MCS can bring along with it some substantial Tier 1 storage cost savings because of the snapshot/identity/difference disk

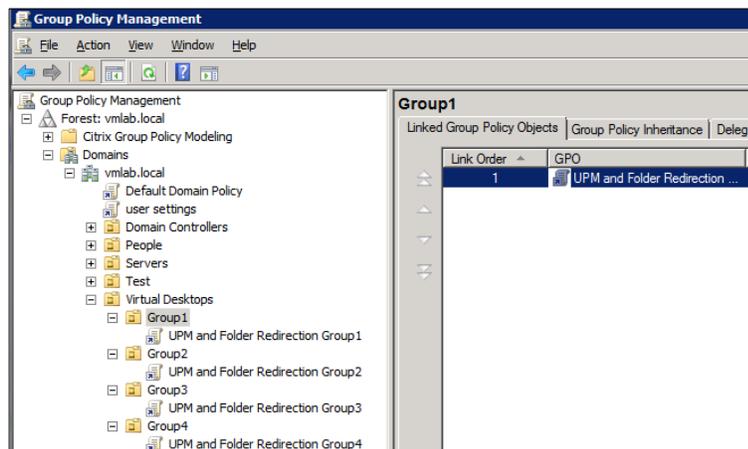
methodology. The Tier 1 disk space requirements of the identity and difference disks when layered on top of a master image snapshot, is far less than that of a dedicated desktop architecture.

4.1.3 Citrix Profile Manager

Citrix Profile Management is a component of the XenDesktop suite which is used to manage user profiles and minimize many of the issues associated with traditional Windows roaming profiles in an environment where users may have their user profile open on multiple devices at the same time. The profile management toolset has two components: the profile management agent, installed on any device where the user profiles is managed, and a Group Policy Administrative Template, which is imported to a group policy.

In order to further optimize, the profile management folders within the user profile is redirected the users' home drive. The folder redirection is managed via group policy objects within Active Directory. The following folders are redirected:

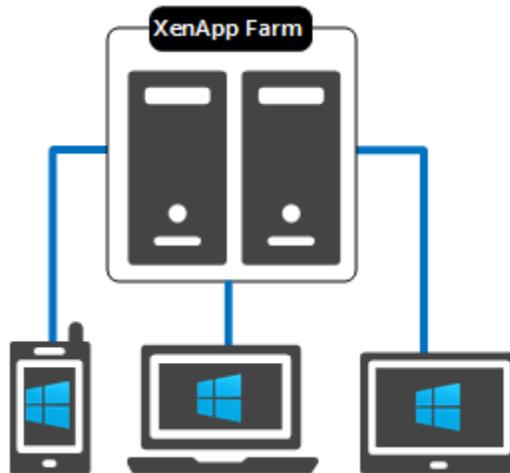
- **Contacts**
- **Downloads**
- **Favorites**
- **Links**
- **My Documents**
- **Searches**
- **Start Menu**
- **Windows**
- **My Music**
- **My Pictures**
- **My Videos**
- **Desktop**



4.1.4 Citrix XenApp

Citrix XenApp 7.6 includes enhancements in the areas of faster access to virtual apps with higher connection resiliency, improved graphics rendering, and new app-usage reporting and monitoring tools.

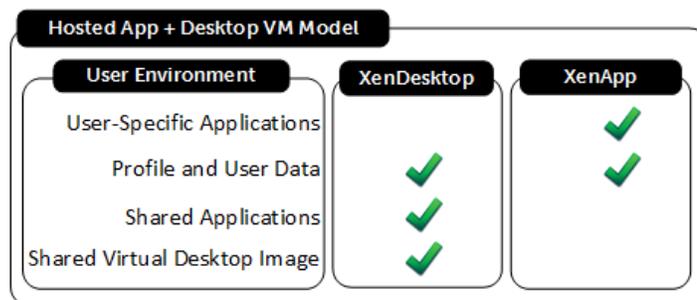
Citrix XenApp delivers Windows apps as secure mobile services. With XenApp, IT can mobilize the business - increasing user productivity, while reducing costs by centralizing control and security of intellectual property. XenApp delivers high-performance apps to any PC, Mac, laptop, tablet or smartphone that enable the delivery of a native experience that is optimized for the type of device, as well as the network. XenApp is built on a 3rd generation FlexCast Management Architecture (FMA) and is the only hybrid cloud-ready platform that separates the management plane from the workload to enable IT to securely deliver published apps on-premises, and manage workers and mobile workspaces either on-premises or in the cloud.



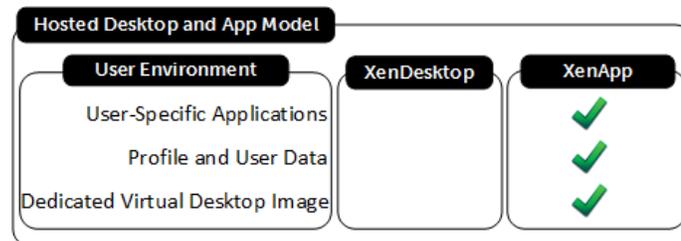
Benefits of hosted desktop sessions and applications:

- Management of applications (single instance)
- Management of simple desktop images (no applications installed)
- PVS to stream XenApp servers as well as user desktops
- Scalability of XenDesktop compute hosts: CPU and IOPS reduction via application offload
- Shared storage scalability: less IOPS = more room to grow

Citrix XenDesktop with XenApp integration can effectively deliver a desktop/application hybrid solution as well. Specifically where a single or small number of shared VDI desktop images are deployed via XenDesktop, each with common shared applications installed within the golden image. A user-specific application set is then deployed and made accessible via the hosted application compute infrastructure, accessible from within the virtual desktop.



Alternatively, XenApp provides a platform for delivering Windows server-based sessions to users who may not need a full desktop VM. Hosted desktops increase infrastructure resource utilization while reducing complexity as all applications and sessions are centrally managed.



4.1.4.1 XenApp Integration into Dell Wyse Datacenter Architecture

The XenApp servers can exist as physical or virtualized instances of Windows Server 2012 R2. A minimum of one (1), up to a maximum of eight (8) virtual servers are installed per physical compute host. Since XenApp instances are easily added to an existing XenDesktop stack, the only additional components required are:

- One or more Windows Server OS instances running the Citrix VDA added to the XenDesktop site

The total number of required virtual XenApp servers is dependent on application type, quantity and user load. Deploying XenApp virtually and in a multi-server farm configuration increases overall farm performance, application load balancing as well as farm redundancy and resiliency.

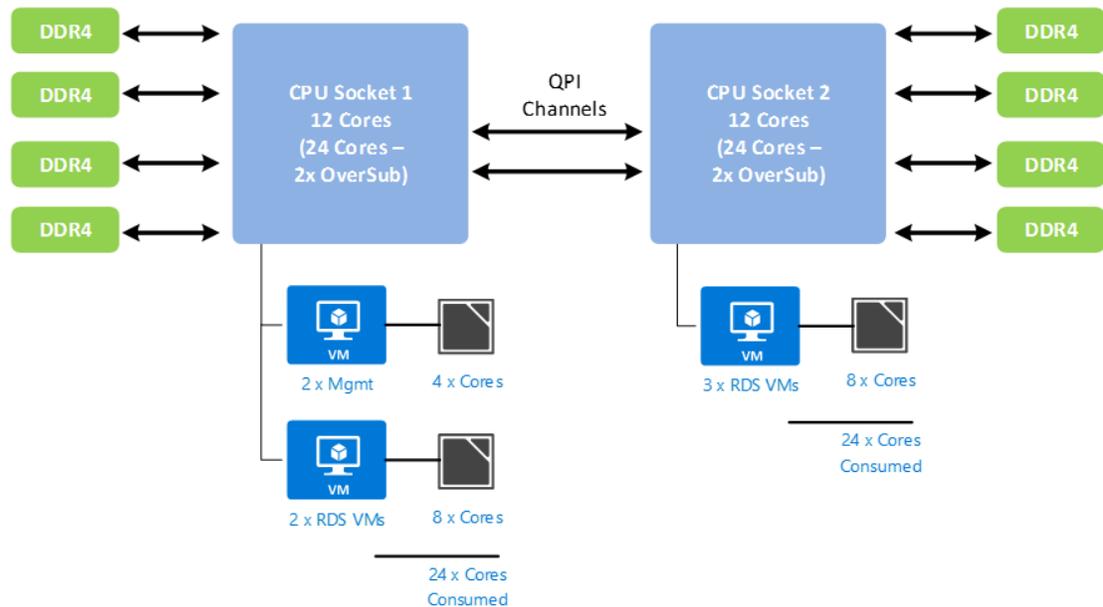
4.1.4.2 NUMA Architecture Considerations

Best practices and testing has showed that aligning XenApp design to the physical Non-Uniform Memory Access (NUMA) architecture of the server CPUs results in increased and optimal performance. NUMA alignment ensures that a CPU can access its own directly-connected RAM banks faster than those banks of the adjacent processor which are accessed via the Quick Path Interconnect (QPI). The same is true of VMs with large vCPU assignments, best performance will be achieved if your VMs receive their vCPU allotment from a single physical NUMA node. Ensuring that your virtual XenApp servers do not span physical NUMA nodes will ensure the greatest possible performance benefit.

The general guidance for XenApp NUMA-alignment on the Dell Appliance for Wyse is as follows:

4.1.4.3 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 XenApp VMs as shown below will ensure that no NUMA spanning occurs which could lower performance.

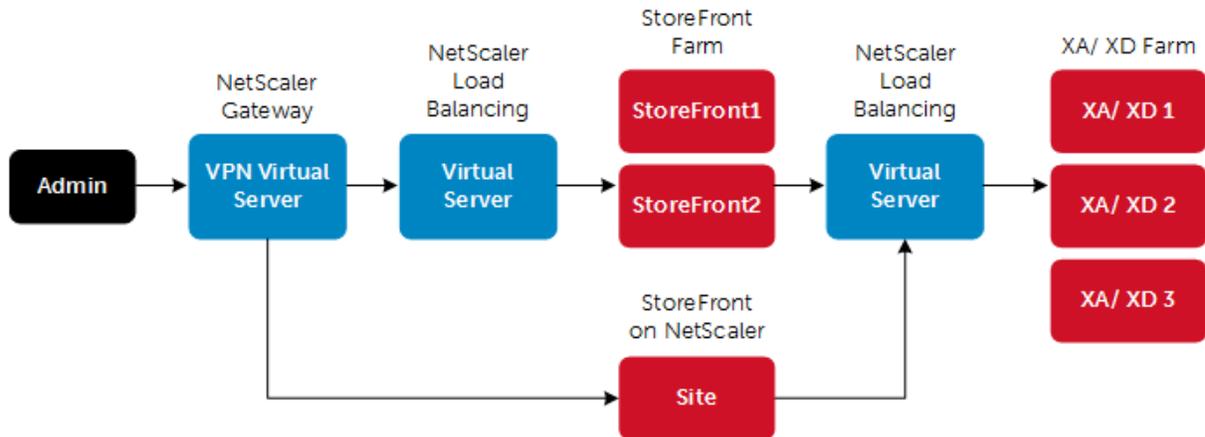


4.1.5 Citrix NetScaler

Citrix NetScaler is an all-in-one web [application delivery controller](#) that makes applications run five times better, reduces web application ownership costs, optimizes the user experience, and makes sure that applications are always available by using:

- Proven application acceleration such as [HTTP compression](#) and [caching](#)
- High application availability through advanced L4-7 [load balancer](#)
- Application security with an integrated [Application Firewall](#)
- Server offloading to significantly reduce costs and consolidate servers

A NetScaler appliance resides between the clients and the servers, so that client requests and server responses pass through it. In a typical installation, virtual servers (vservers) configured on the NetScaler provide connection points that clients use to access the applications behind the NetScaler. In this case, the NetScaler owns public IP addresses that are associated with its vservers, while the real servers are isolated in a private network. It is also possible to operate the NetScaler in a transparent mode as an L2 bridge or L3 router, or even to combine aspects of these and other modes. NetScaler can also be used to host the StoreFront function eliminating complexity from the environment.



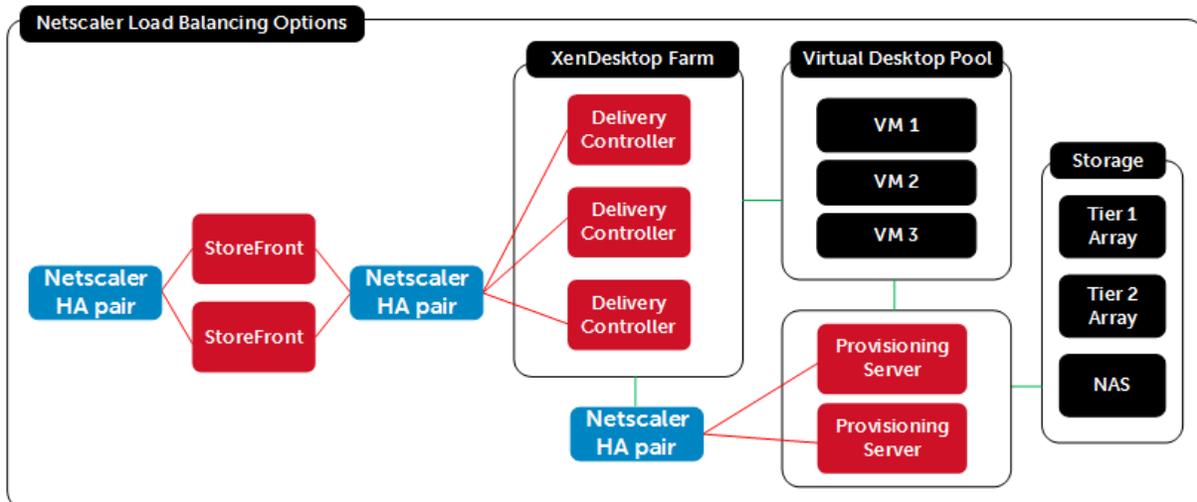
Global Server Load Balancing

GSLB is an industry standard function. It is in widespread use to provide automatic distribution of user requests to an instance of an application hosted in the appropriate data center where multiple processing facilities exist. The intent is to seamlessly redistribute load on an as required basis, transparent to the user community. These distributions are used on a localized or worldwide basis. Many companies use GSLB in its simplest form. They use the technology to automatically redirect traffic to Disaster Recovery (DR) sites on an exception basis. That is, GSLB is configured to simply route user load to the DR site on a temporary basis only in the event of a catastrophic failure or only during extended planned data center maintenance. GSLB is also used to distribute load across data centers on a continuous load balancing basis as part of normal processing.

XenDesktop HA with NetScaler White Paper: [Link](#)

Several of the management components of the XenDesktop stack are made highly-available using NetScaler to load balance traffic. The following management components require the use of a load balancer to function in a high availability mode:

- StoreFront Servers
- Licensing Server
- XenDesktop XML Service
- XenDesktop Desktop Director
- Provisioning Services TFTP Service

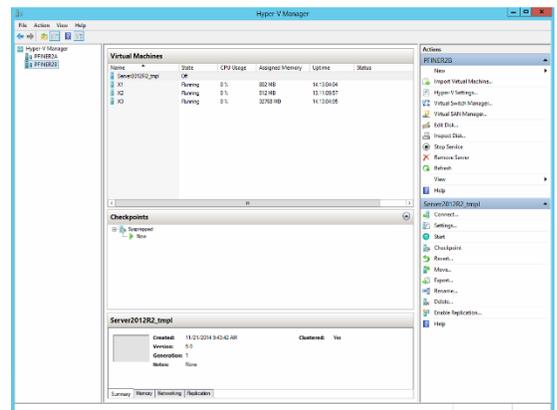


4.2 Hypervisor Platforms

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.

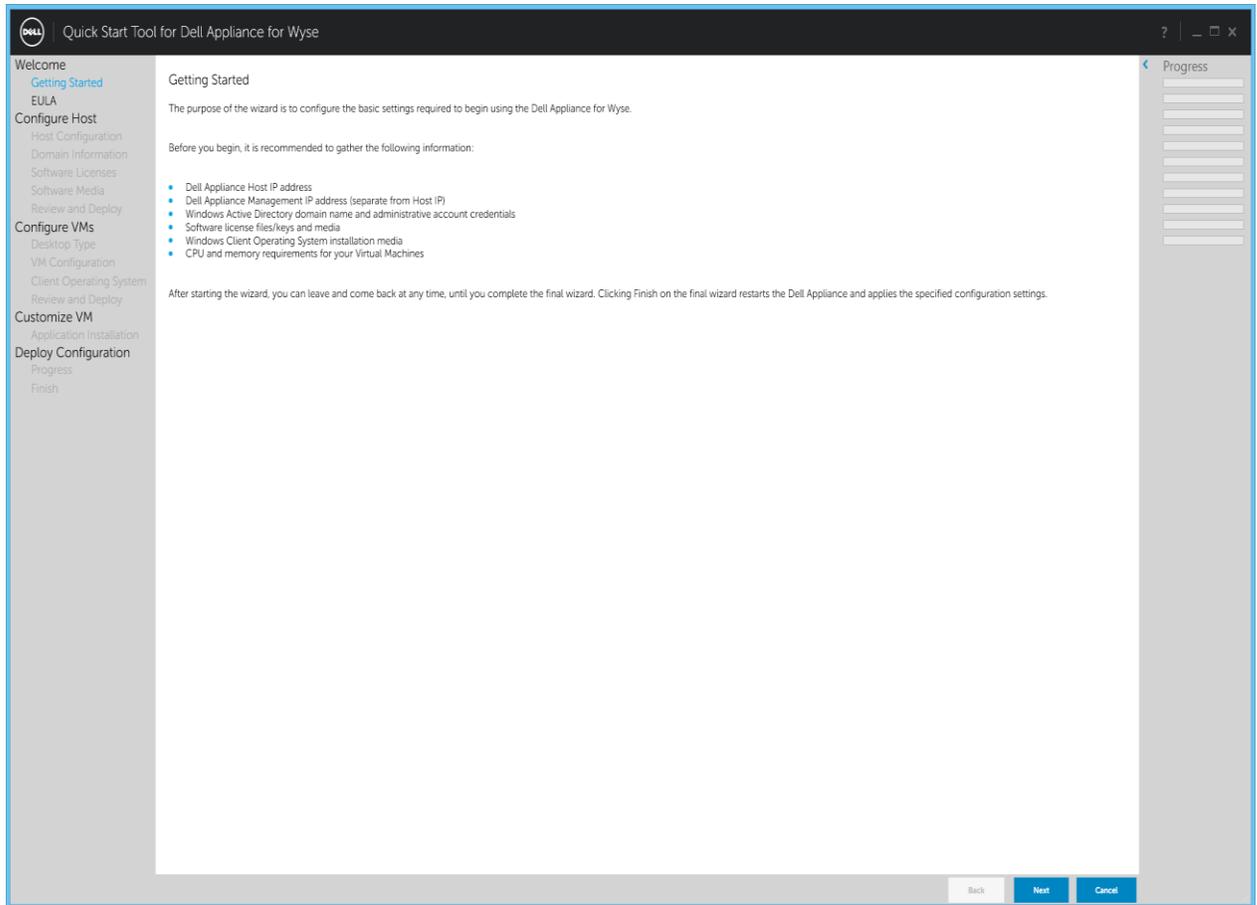
From a network management standpoint, virtual machines are much easier to manage than physical computers. To this end, Hyper-V includes many management features designed to make managing virtual machines simple and familiar, while enabling easy access to powerful VM-specific management functions. The 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](#)

5 Solution Architecture for XenDesktop 7

5.1 Management Role Configuration

The Management role recommendations for the traditional virtual desktop and shared session desktop (XenApp) 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, Storefront, & SCVMM	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 XenApp on Hyper-V

The recommended number of XenApp (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

5.1.3 SQL Databases

The Citrix and Microsoft databases are hosted by a single dedicated Windows Server 2012 R2 VM in the Management layer. The Quick Start Tool (QST) creates all the necessary databases for:

- Citrix XenDesktop
- SCVMM

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 Citrix 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.

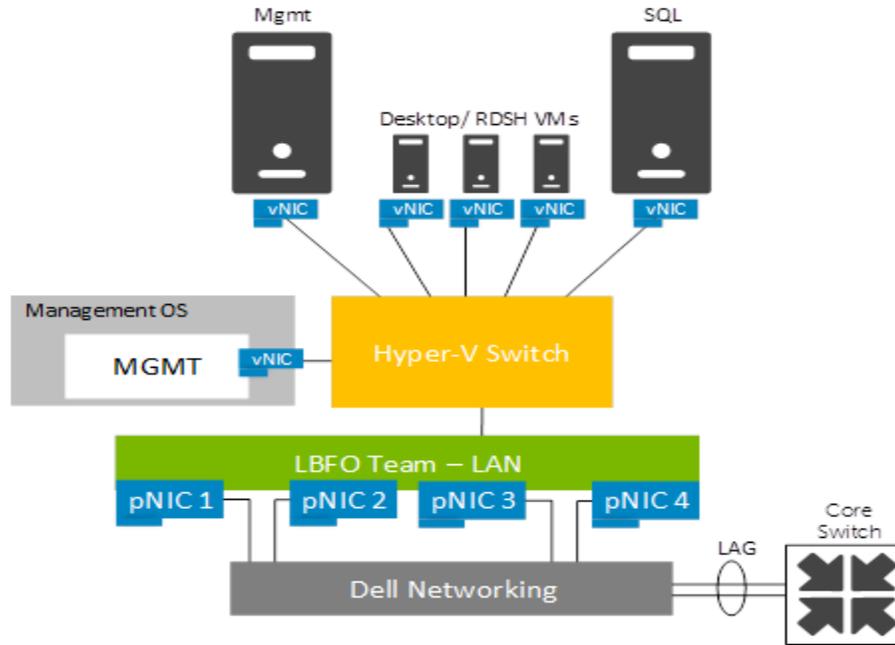
5.2 Storage Architecture Overview

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.

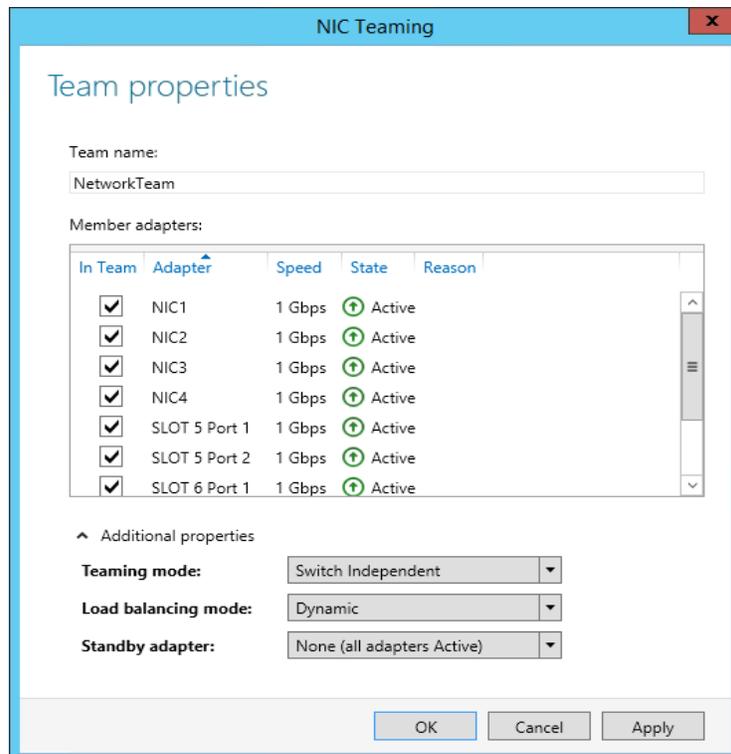
5.3 Virtual Networking

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.



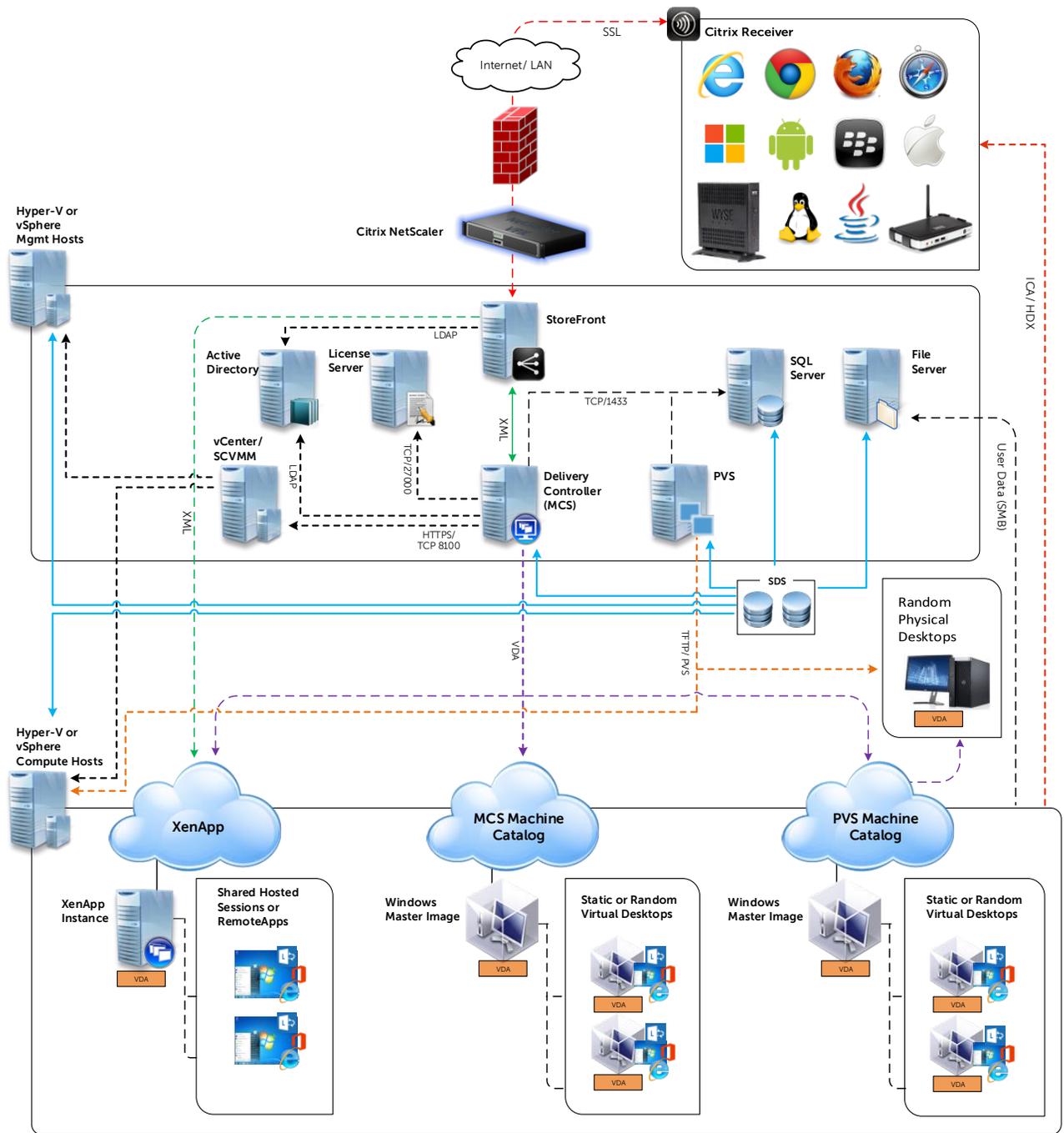
The NIC team for the Hyper-V switch is configured as switch independent, dynamic for the load balancing mode with all adapters set to active. This team is used exclusively by Hyper-V.



5.4 Appliance Density

Hypervisor	Provisioning	Workload	User Density (LARGE Appliance)
Hyper-V	XenDesktop	Standard	180
Hyper-V	XenDesktop	Enhanced	150
Hyper-V	XenDesktop	Professional	100
Hyper-V	RDSH	Enhanced	300

5.5 Dell Wyse Datacenter for XenDesktop Communication Flow



6 Solution Performance and Testing

6.1 Load Generation and Monitoring

6.1.1 Login VSI – Login Consultants

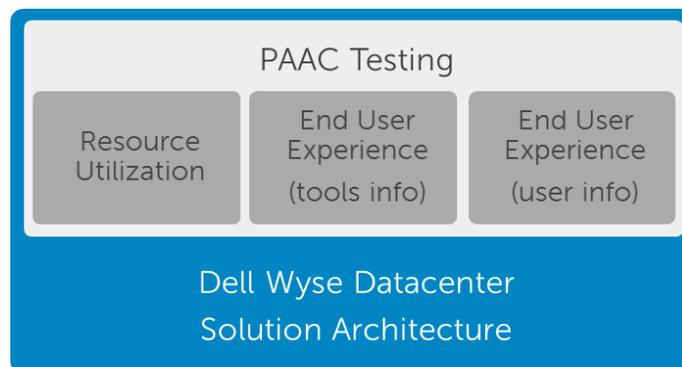
Login VSI is the de-facto industry standard tool for testing VDI environments and server-based computing or RDSH environments. It installs a standard collection of desktop application software (e.g. Microsoft Office, Adobe Acrobat Reader) on each VDI desktop; it then uses launcher systems to connect 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 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.

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	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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. <ul style="list-style-type: none"> 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. <ul style="list-style-type: none"> Each loop will open and use: <ul style="list-style-type: none"> 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, <i>or</i> , Private	<p>The heavy workload is based on the medium workload except that the heavy workload:</p> <ul style="list-style-type: none"> • 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 Citrix XenDesktop Test Results

Validation for this project was completed for Citrix XenDesktop 7.6 and XenApp 7.6 on the following platforms:

- MS Windows Server 2012 R2 with Hyper-V / System Center VMM 2012 R2 / Citrix XenDesktop 7.6 / R730
- Windows Server 2012 R2 with Hyper-V / System Center VMM 2012 R2 / XenApp brokered by XenDesktop 7.6 / R730
- All provisioning was performed using MCS.

The table below summarizes the hardware configurations for the Appliance platform that were validated.

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

	Workload	Users / Sessions	Peak CPU%	Peak Memory Consumed (GB)	Avg IOPS / User	Avg Network Usage Kbps / User
Virtual Desktops	Standard	180	52	237	5.13	115
	Enhanced	150	60	224	6.86	89
	Professional	100	70	216	8.07	166
Shared Sessions	Enhanced	300	83	172	2.63	138

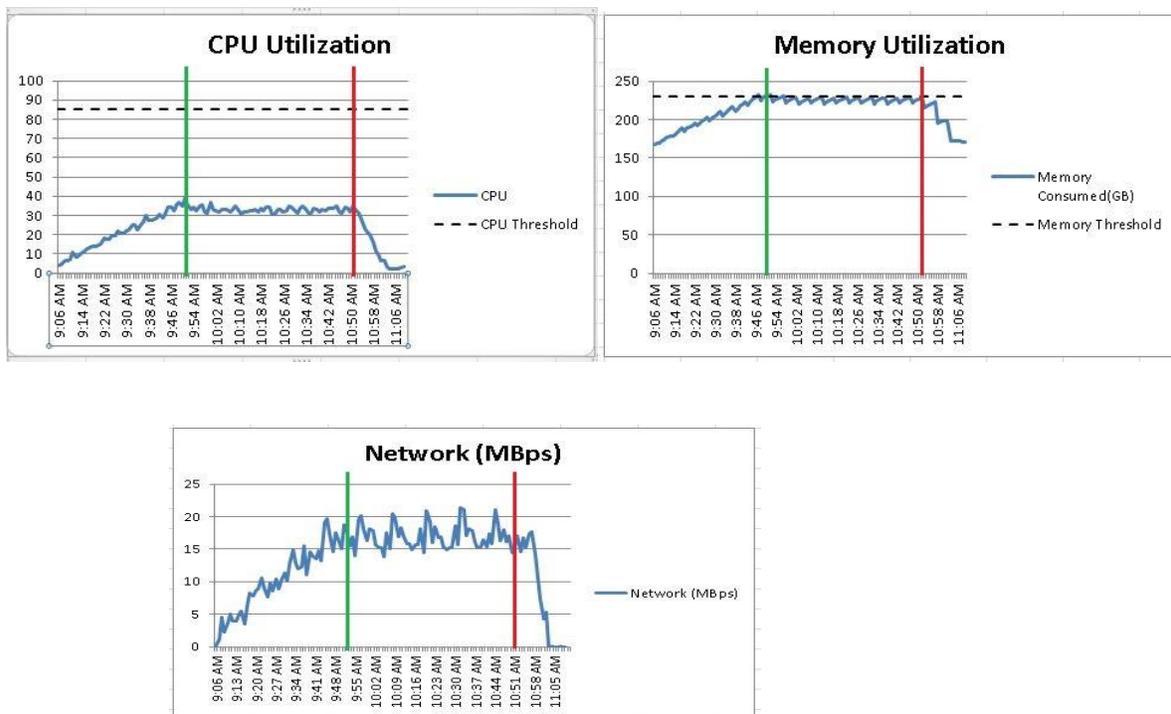
- **CPU Utilization:** The figure shown in the table is the host steady state peak CPU Usage.
- **Memory utilization:** The figure shown in the table above is the average memory consumed by host over the recorded test period (Compute and Management are on the same machine).
- **The IOPS:** Results are 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.
- **Memory Threshold VDI:** The memory threshold has been set to 90% memory utilization due to the appliance having both management and compute resources in one. This threshold is set for Virtual Desktops only and does not cover Shared Session Desktops which is 85%. Testing has determined that a threshold of 90% is adequate to cover the needs of Standard, Enhanced and Professional workloads, without reducing the user experience.

6.4.2 Persistent Virtual Desktop, Standard Workload (180 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Server 2014, XenDesktop 7.6 and SCVMM 2012 R2 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.

Performance Monitor Host Metrics

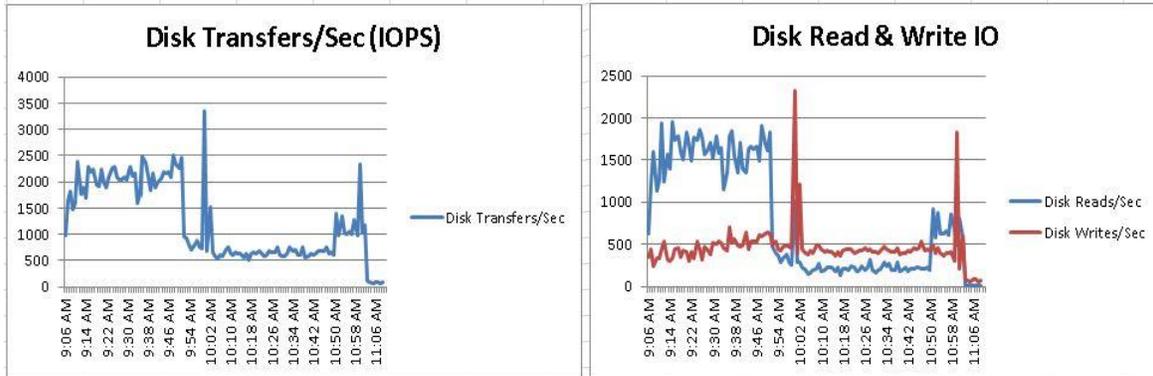
CPU utilization did not spike above our 85% limit at various times on each host but on average, remained at or below the limit. Memory utilization is within the 230GB (90% of 256GB) threshold however there is no additional capacity as dynamic memory has been allocated. Network utilization spiked during logon and logoff but remained well within limits for 8 x 1Gbps (teamed) switching infrastructure.



The charts above begin at the start of the logon period at 9:06AM which lasts until 11:05AM. The green vertical line indicates the beginning of the steady state period at 9:51AM which lasts until 10:51AM. The red vertical line indicates the beginning of the logoff period at 10:52AM which lasts until 11:05AM.

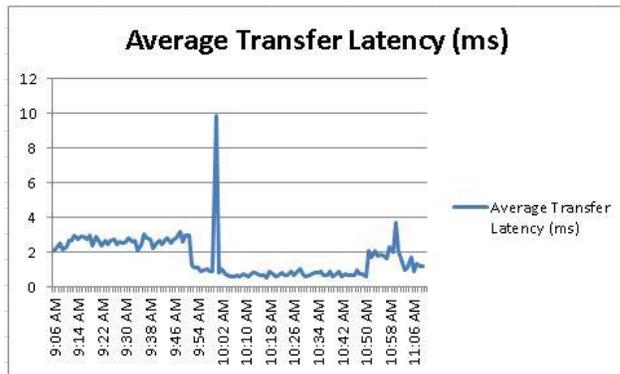
IOPS

The IOPS spiked to 3338 during the logon period while users were logging in every 15 seconds. During steady state, all users are executing the test workload and IOPS averaged 764 yielding about 4.25 IOPS/user. During the logoff period, IOPS peaked at 2328. The chart below graphs the IOPS.



Disk IOPS by Host

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



Disk latency peaked around 9.78ms but remained below our 20ms threshold.

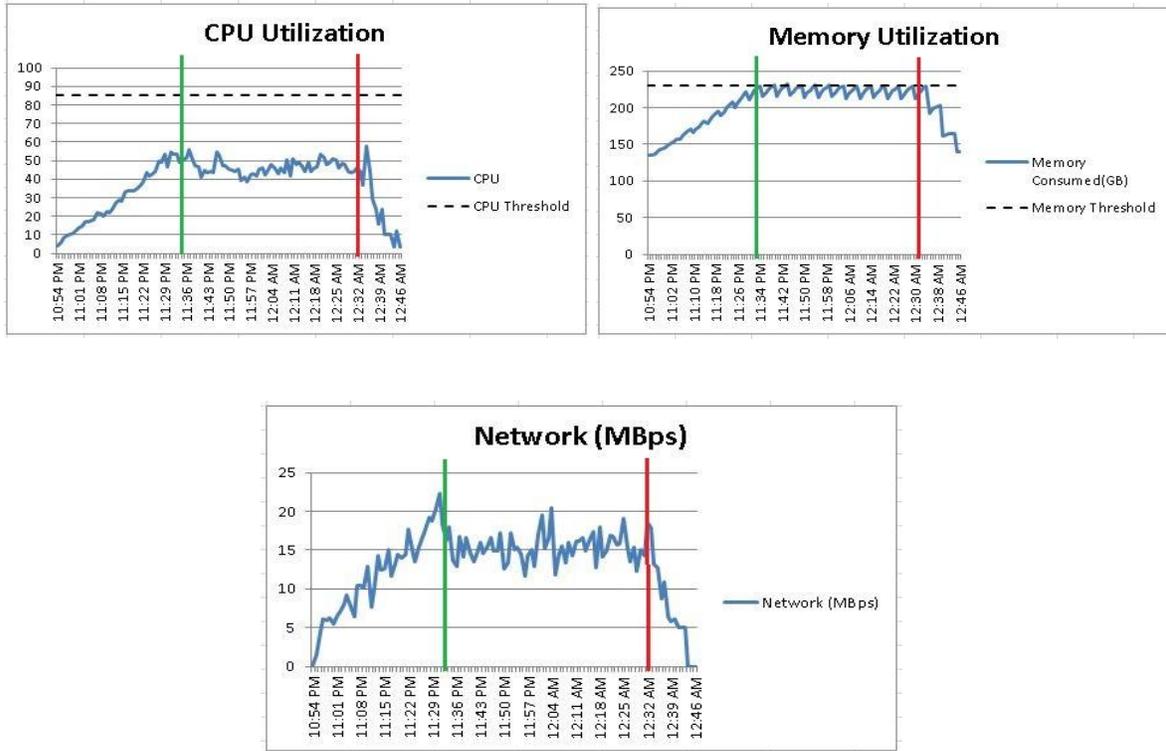
Disk Latency

6.4.3 Persistent Virtual Desktop, Enhanced Workload (150 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Server 2014, XenDesktop 7.6 and SCVMM 2012 R2 as configured in the appliance architecture. The VM load was split across the management and compute resources. All 150 users successfully logged on, executed the test workload, and logged off.

Performance Monitor Host Metrics

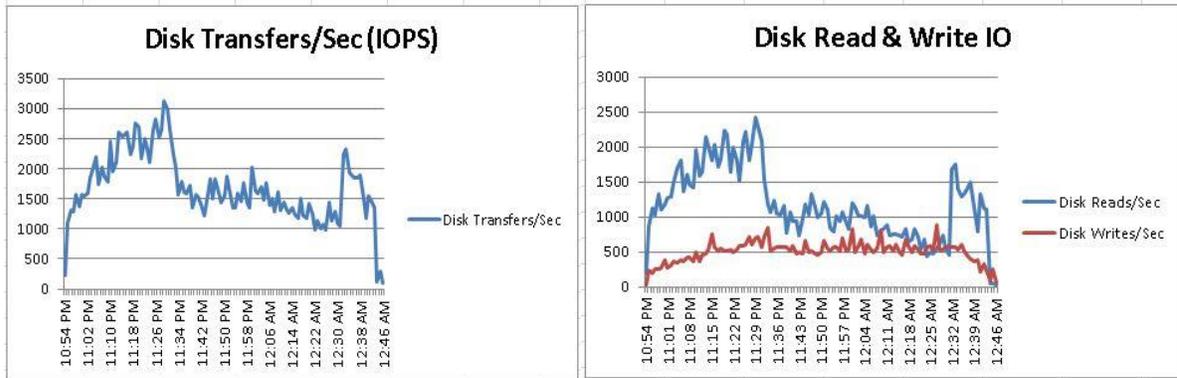
CPU utilization did not spike above our 85% limit at various times on each host but on average, remained below the limit. Memory utilization is just below the 230GB (90% of 256GB) threshold however there is no additional capacity as dynamic memory has been allocated. Network utilization spiked during logon and logoff but remained well within limits for 8 x 1Gbps (teamed) switching infrastructure.



The charts above begin at the start of the logon period at 10:54PM which lasts until 12:46AM. The green vertical line indicates the beginning of the steady state period at 11:34PM which lasts until 12:34AM. The red vertical line indicates the beginning of the logoff period at 12:35AM which lasts until 12:46AM.

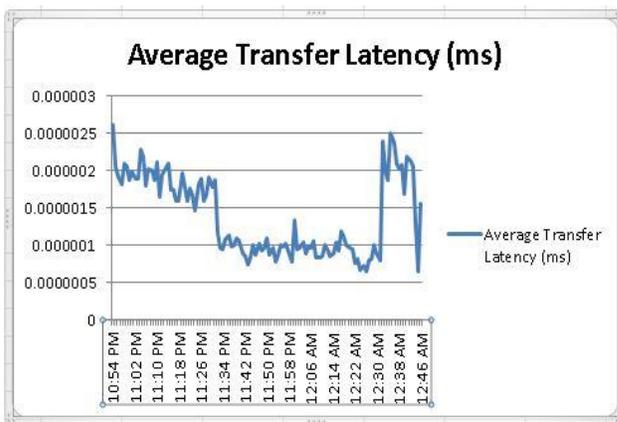
IOPS

The IOPS spiked to 3001 during the logon period while users were logging in every 15 seconds. During steady state, all users are executing the test workload and IOPS averaged 1479 yielding about 9.86 IOPS/user. During the logoff period, IOPS peaked did not peak above 2317. The chart below graphs the IOPS.



Disk IOPS by Host

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



Disk Latency

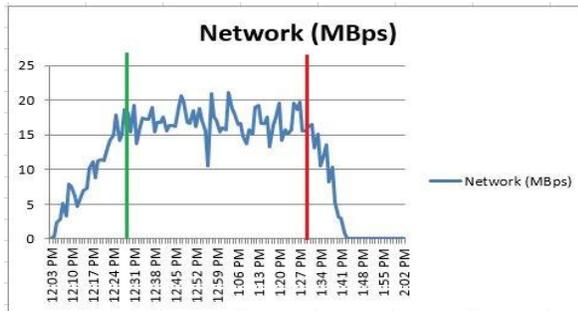
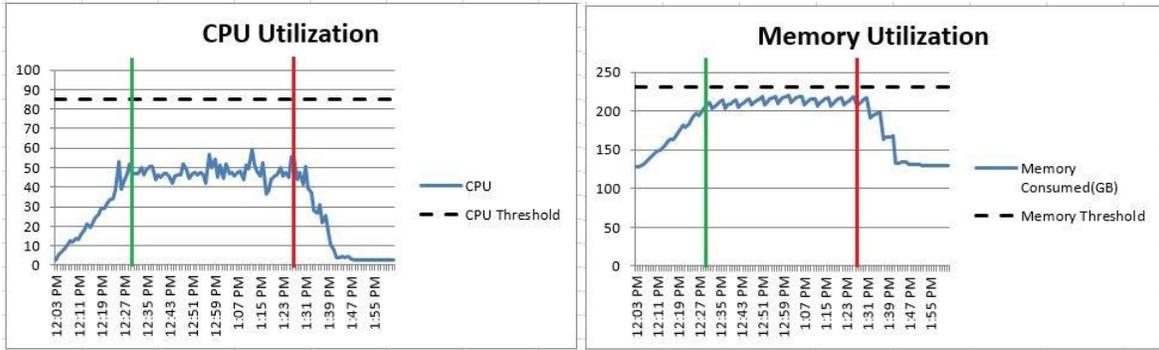
The latency peaked around 2.9ms but remained below our 20ms threshold.

6.4.4 Persistent Virtual Desktop, Professional Workload (100 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Server 2014, XenDesktop 7.6 and SCVMM 2012 R2 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

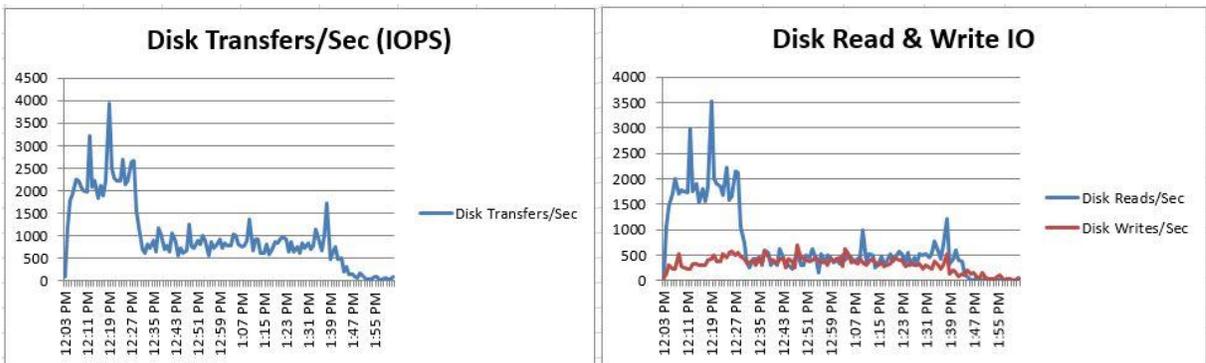
CPU utilization did not spike above our 85% limit at various times on each host but on average, remained below the limit. Memory utilization is just below 230GB (90% of 256GB) threshold however there is no additional capacity as dynamic memory has been allocated. Network utilization spiked during logon and logoff but remained well within limits for 8 x 1Gbps (teamed) switching infrastructure.



The charts above begin at the start of the logon period at 12:03PM which lasts until 1:55PM. The green vertical line indicates the beginning of the steady state period at 12:28PM which lasts until 1:28PM. The red vertical line indicates the beginning of the logoff period at 1:29PM which lasts until 1:55PM.

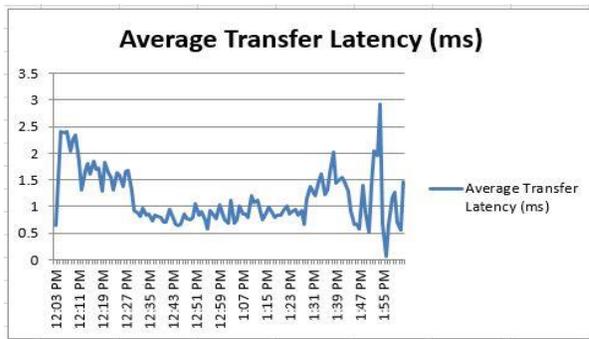
IOPS

The IOPS spiked to 4000 during the logon period while users were logging in every 15 seconds. During steady state, all users are executing the test workload and IOPS averaged 863 yielding about 8.63 IOPS/user. During the logoff period, IOPS peaked at 1727. The chart below graphs the IOPS.



Disk IOPS on Host

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



Disk Latency

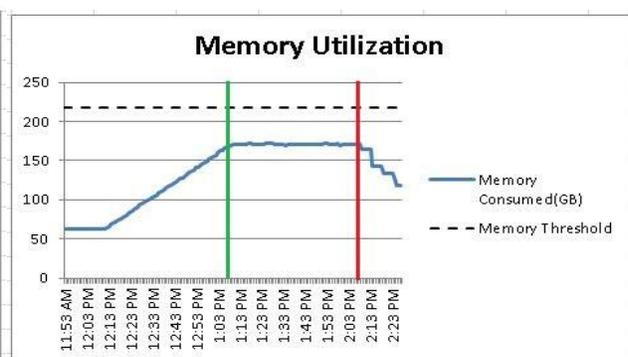
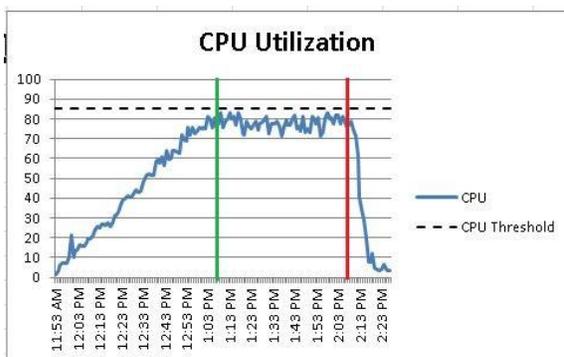
The latency peaked around 12ms but remained below our 20ms threshold.

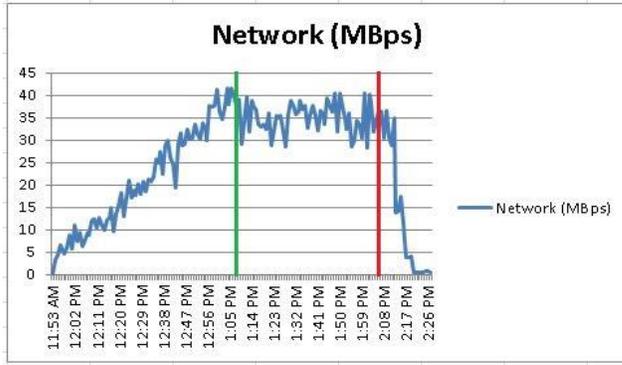
6.4.5 Shared Session (XenApp), Enhanced Workload (300 Users)

The results below were obtained from the host and management virtual machines with Hyper-V, SQL Server 2014 and XenDesktop 7.6 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. It should be noted that the memory maintains a straight line due to the fact that the RAM is statically assigned to the Management and RDSH VM's the rest is configured for use by the Operating system. Network utilization spiked during logon and logoff but remained well within limits for 4 x 1Gbps (teamed) switching infrastructure.

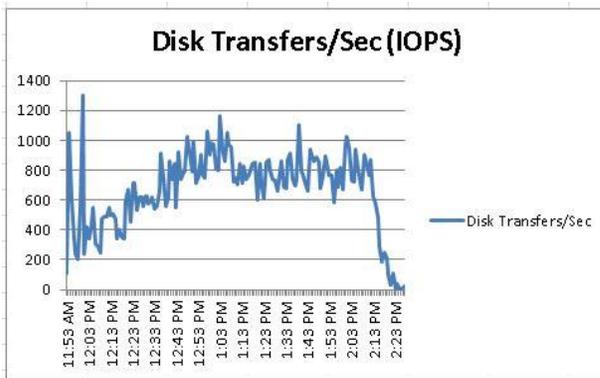




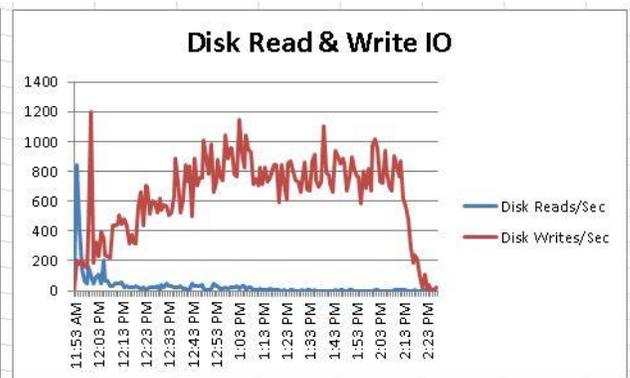
The charts above begin at the start of the logon period at 11:53AM which lasts until 2:27PM. The green vertical line indicates the beginning of the steady state period at 1:07PM which lasts until 2:07PM. The red vertical line indicates the beginning of the logoff period at 2:08PM which lasts until 2:27PM.

Appliance IOPS

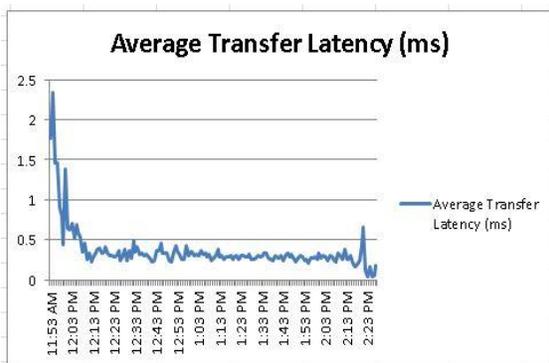
The IOPS spiked to 1302 during the start of steady state while users were logging in every 15 seconds. During steady state spiked to 1106, all users are executing the test workload and IOPS averaged 794 yielding about 2.64 IOPS/user. During the logoff period, IOPS peaked at 906. The chart below graphs the IOPS broken out by host.



Disk IOPS on Host



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



Disk Latency

The latency peaked around 2.33ms 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.