Technical white paper

HP Verified Reference Architecture for Citrix XenDesktop 7.6 on ConvergedSystem 700 2.0

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Executive summary

The modern workplace has created new challenges for enterprise administrators due to increased user expectations for mobile data and application access. End-users demand support for next-generation delivery mechanisms that can transform the way they work including the ability to work from any location, at any time, using any device. Until recently, most enterprises followed the common practice of providing Microsoft® Windows® applications via a fixed desktop. This model worked well when workers were also tethered to their desks. But today, the workforce is going global and mobile and IT needs to adjust to this new reality.

This document lays out an approach to client virtualization that is built on HP's vision of the next-generation data center, with emphasis on simplifying the server, storage and networking foundations of client virtualization. HP and Citrix have developed and tested a reference architecture for the HP ConvergedSystem 700 for Citrix XenDesktop solution, leveraging best-in-class technologies such as the HP 3PAR StoreServ all-flash array, HP ProLiant Gen9 servers and Citrix XenDesktop 7.6 with FlexCast 2.0. Taken together, this solution demonstrates a truly integrated client virtualization solution that can:

- Collapse the cost of client infrastructure while meeting the SLA and user experience demands of the business
- Accelerate and streamline desktop deployments with factory-integrated client virtualization building blocks
- Reduce risk with pre-tested server, storage and network configurations for Virtual Desktop Infrastructure (VDI)
- Streamline operations by automating VDI tasks for admin staff using HP OneView and intuitive wizards

Target audience: This document is intended for IT decision makers as well as architects and implementation personnel who want to understand HP's approach to client virtualization and benefit from a pre-tested solution. The reader should have a solid understanding of client virtualization, familiarity with Citrix products, VMware® vSphere products and an understanding of sizing/characterization concepts and limitations in client virtualization environments.

Document purpose: The purpose of this document is to describe a recommended architecture/solution, highlighting recognizable benefits to technical audiences.

This Reference Architecture describes the solution testing performed in February 2015.

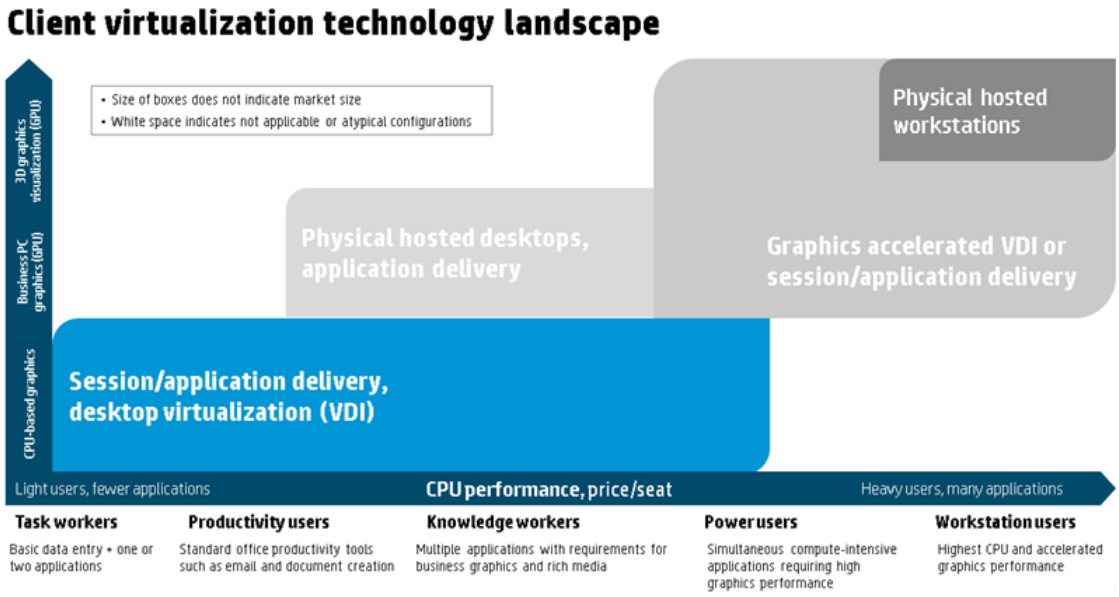
Introduction

One of the key drivers in the client virtualization market is end-user productivity. Today's end-users expect a fully integrated and seamless experience that integrates mobile and static devices, applications and connectivity to quickly perform specific business tasks. Citrix XenDesktop with FlexCast technology delivers an end user experience that meets these demands. HP storage, servers and networking provide the resilient and integrated infrastructure that meets the reliability, speed and security needs of client infrastructure administrators.

With these demands as the design center, HP and Citrix have teamed up to design and test an architecture that facilitates the delivery of the Citrix XenDesktop with FlexCast technology in a cost-effective, highly manageable fashion. The goal of the HP ConvergedSystem 700 for Citrix XenDesktop solution is to deliver an experience to the broadest spectrum of end user types with a minimal set of compromises.

For client virtualization, desktop and application delivery can vary based on use case requirements that range from task workers to workstation users. The graphic below shows client virtualization technology landscape as it exists today.

Figure 1. Client Virtualization Technology.



The desktop virtualization landscape today spans multiple user types and usage scenarios from simple application access and session based desktops to hardware based accelerated VDI environments that serve the needs of the most demanding graphics designers and engineers. Citrix XenDesktop offers all of the desktop and application virtualization schemes to meet the needs of every user in the organization.

This reference architecture focuses on the less complex but popular lower end of this spectrum and leverages the latest advancements in converged infrastructure and desktop virtualization technologies, to showcase an integrated client virtualization solution. HP and Citrix have laid out the connectivity components of an easily repeatable client virtualization building block. These building blocks can be used to scale to multiple thousands of users.

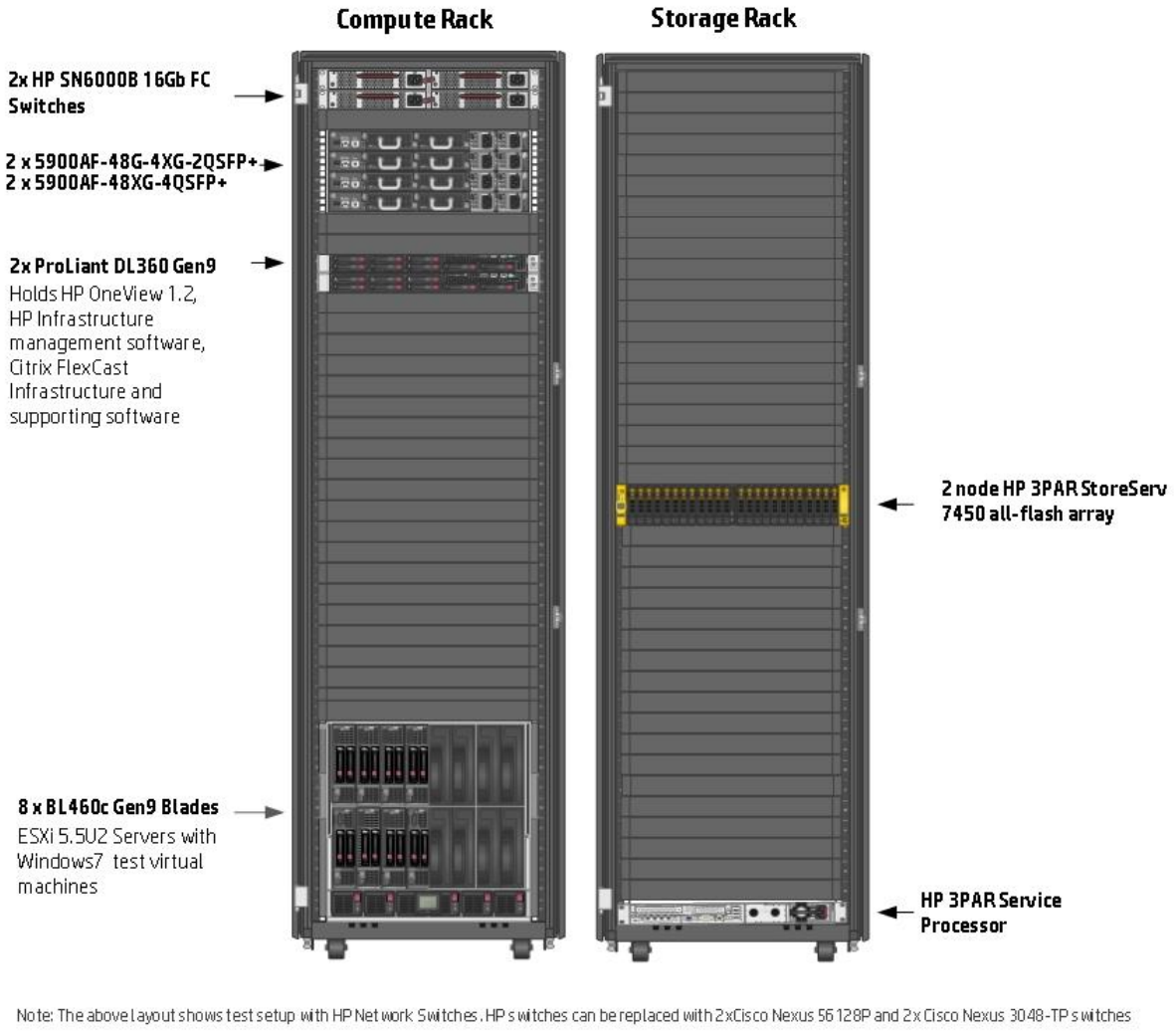
Solution overview

The fundamental building blocks of this reference architecture are a suite of core HP technologies with strategic partner software layered on, to create robust solution sets. This ConvergedSystem 700 (CS700) 2.0 Desktop Virtualization solution offers new and innovative technologies such as HP 3PAR StoreServ all-flash array, HP ProLiant Gen9 servers, HP OneView 1.2 and Citrix XenDesktop 7.6 with FlexCast 2.0. Non-persistent use cases are the primary focus of this reference architecture.

Key components of the CS700 2.0 solution are listed below.

- HP BladeSystem c7000 enclosure
- HP BladeSystem Virtual Connect FlexFabric 20/40Gb modules
- HP ProLiant servers including DL360 Gen9 and BL460c Gen9 servers
- HP 5900 series switching
- Cisco Nexus series switches
- HP 3PAR StoreServ all-flash array
- HP Intelligent rack and power solutions
- HP OneView 1.2
- Citrix XenDesktop 7.6
- VMware vSphere 5.5 Update 2
- HP Insight Control Server Provisioning

Figure 2. Shows the test infrastructure used for solution testing



Note

Cisco switches are not shown in the above graphic as the majority of the testing was performed on HP switches. Setup and configuration of Cisco switches was verified during the solution test cycle and found to be the same as HP switches in port numbers, cabling schema, bandwidth allocation and configuration parameters using Cisco CLI. A need to duplicate the entire solution testing on Cisco switches was not deemed necessary.

The above solution layout can be viewed as "blocks" of functionality and technology segmentation, namely compute, management, network and storage blocks. The reference architecture can be viewed as a series of building blocks summarized and described below and detailed later in the document.

Management block

Comprised of two DL360 Gen9 management host servers. The management servers provide a management software layer that manages the entire solution. The solution management stack includes, OneView 1.2, Insight Management, Citrix XenDesktop/PVS 7.6, vCenter 5.5u2 and other management components. Datacenter management components such as Active Directory, DNS, and user profile shares were external to the solution and managed at the datacenter management level.

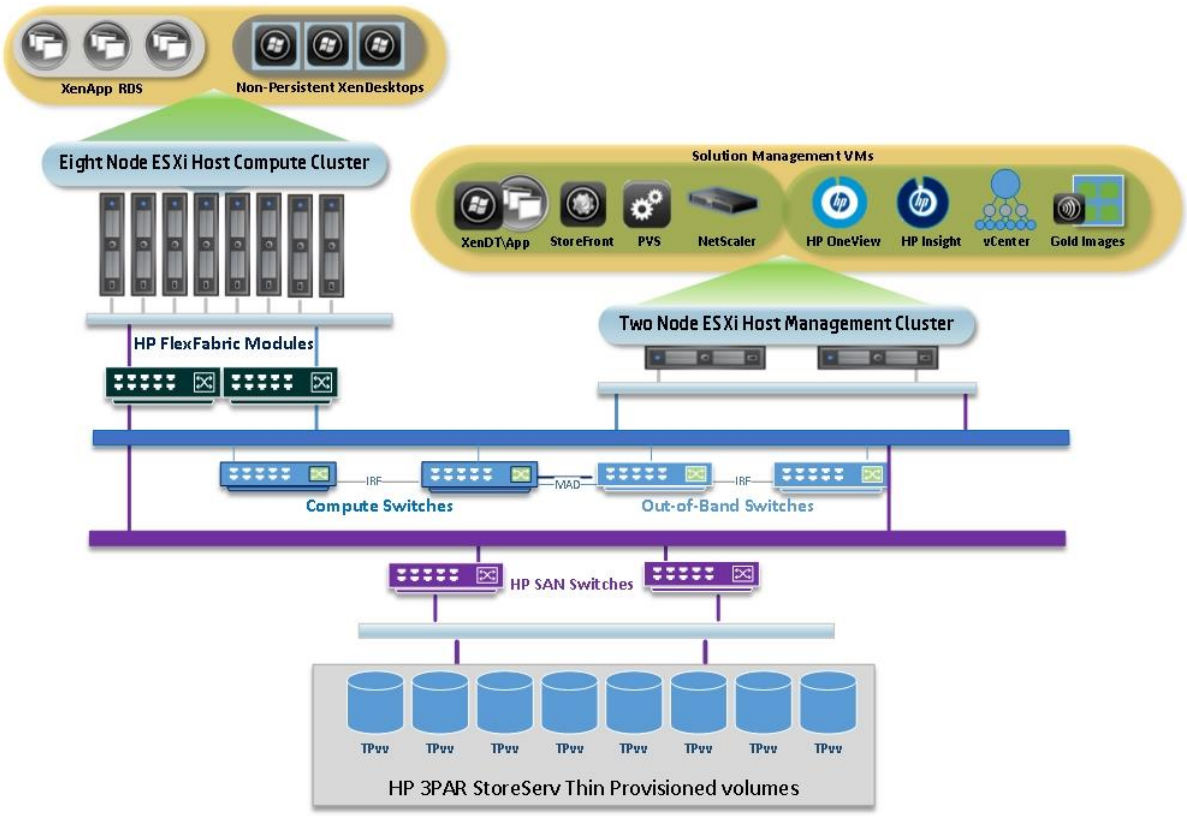
Central to management of the entire solution is HP OneView 1.2 which deserves special mention. With the integration with vCenter via "OneView for vCenter" it has become much easier for VMware administrators to perform hardware management tasks from the same vCenter Interface. vCenter administrations can deploy servers, provision on demand storage volumes and get health status from the same vCenter Interface.

Compute block
Comprised of VMware ESXi 5.5 u2 hypervisor hosts holding the Windows 7 x64 guest virtual machines. The test infrastructure was comprised of eight HP ProLiant BL460c Gen9 servers serving as hypervisor hosts.

Network block
Holds the networking infrastructure including HP 5900 series and FlexFabric switches. To make the solution flexible, HP has added an option to use Cisco Nexus switches.

Storage block
Comprised of HP 3PAR StoreServ all-flash array and supporting switches and drive trays.

Figure 3. Shows the logical layout of various hardware and software stacks used during testing.



Hardware components

Management block

HP ProLiant DL360 Gen9 management servers
The HP ProLiant DL360 Gen9 Server delivers a 1U chassis with up to two processors delivering an optimal unit that combines high-performance, low energy consumption, improved uptime, and increased density. The server, combined with Intel® Xeon® E5-2600 v3 processors and HP DDR4 SmartMemory support of up to 768 GB (LRDIMMs), delivers much improved performance and efficiency over the Gen8 family.

The management block of this reference architecture holds the solution management hardware comprises of 2 HP ProLiant DL360 Gen9 servers. Various management applications are installed on these management servers that will be discussed later in this document.

Table 1. HP DL360 Gen9 8SFF CTO Server

Component	Description	Notes
CPU	HP DL360 Gen9 E5-2680 v3 (2.5GHz/12-core/30MB/120W)	Quantity 2 per server
Memory	HP 16GB 2Rx4 PC4-2133P-R Kit	Quantity 16 per server (256GB total)
FlexibleLOM	HP FlexFabric 10Gb 2P 556FLR-SFP+ Adptr	1 per server
Local Disk	HP 600GB 6G SAS 10K 2.5in SC ENT HDD	8 per server
Expansion	HP 82Q 8Gb Dual Port PCI-e FC HBA	N/A

Compute block

HP BladeSystem c7000 Enclosure

The core of the compute block is the c7000 enclosure, HP ProLiant BL460c Gen9 blades and Virtual Connect modules. The BladeSystem c7000 enclosure provides all the power, cooling, and I/O infrastructure needed to support modular server, interconnect, and storage components. The enclosure is 10U high and holds up to 16 server and/or storage blades plus optional redundant network and storage interconnect modules. It includes a shared 7.1 Tbps high-speed NonStop mid-plane for wire-once connectivity of server blades to network and shared storage.

Table 2. HP BladeSystem c-Class c7000 enclosure configuration

Component	Description	Notes
Fans	HP BLc Active Cool 200 Factory Integrated Fan	Quantity ten fans per enclosure
Power	Customer selectable voltage and connectivity, must use all 6 power slots	Customer choice
OA Bays	HP BLc7000 Onboard Administrator with KVM Option	Quantity two
Interconnect Bays 1 and 2	HP Virtual Connect FlexFabric-20/40 F8 Module for c-Class BladeSystem	Quantity two
Interconnect Bays 3-8	Empty	N/A

HP ProLiant BL460c Gen9 compute servers

Designed for a wide range of configuration and deployment options, the HP ProLiant BL460c Gen9 Server Blade provides the flexibility to optimize your core IT applications with right-sized storage for the right workload for a lower TCO. All of this is managed by HP OneView 1.2, the converged management platform that accelerates IT service delivery and boosts business performance. The server, combined with Intel Xeon E5 2600 v3 processors and HP DDR4 SmartMemory, has much improved performance and efficiency over the Gen8 family.

Eight blade servers were used for solution testing with the following configuration.

Table 3. HP ProLiant BL460c Generation 9 specifications

Component	Description	Notes
CPU	HP BL460c Gen9 Intel Xeon E5-2690 v3 (2.6GHz/12-core/30MB/135W) FIO Processor Kit	Quantity 2 per server
Memory	HP 16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit	Quantity 16 per server (256GB total)
FlexFabric Adapter	HP FlexFabric 20Gb 2P 650FLB FIO Adptr	1
Local Disk	HP 300GB 6G SAS 10K rpm SFF (2.5-inch) SC Enterprise 3yr Warranty Hard Drive	Quantity 2 per server in RAID10 configuration

Network block

HP Converged System 700 2.0 provides the customer option to choose HP or Cisco switches for their infrastructure. Whether the solution purchased contains HP switches or Cisco switches, the capabilities of the switches are the same in terms of redundancy to the components in the system. The HP switches were configured using Intelligent Resilient Framework (IRF). With IRF, the switches appear as a single logical switch. Similarly, the Cisco switches utilizes Cisco Virtual Port Channel (vPC) to appear as a single logical switch. Both technologies also allow for the use of Multi-chassis link aggregation (MLAG) so that you can use connections from both of the ConvergedSystem compute switches to each component in the solution. The majority of the solution testing was performed on the HP switches. As noted previously, setup and configuration of Cisco switches was verified during the solution test cycle and found to be identical to HP switches in port numbers, cabling schema, bandwidth allocation and configuration parameters using Cisco CLI. A need to duplicate the entire solution testing on Cisco switches was not deemed necessary. Two IRF clusters were configured, one for the compute and the other for out-of-band management switches. The two IRFs were linked via multi-active detection (MAD) connections.

HP 5900 Series Switches

Table 4. HP Network switches in IRF cluster

Component	Description	Notes
Network Switch	HP 5900AF-48XG-4QSFP+ (JC772A)	2 compute switches
Network Switch	HP 5900AF-48G-4XG-2QSFP+ (JG510A)	2 out-of-band management switches

Cisco Nexus Series Switches

Table 5. Cisco switches in IRF cluster

Component	Description	Notes
Network Switch	Cisco Nexus 56128P switch	2 compute switches
Network Switch	Cisco Nexus 3048-TP switch	2 out-of-band management switches

Storage block

Storage is the most critical piece in a VDI solution. Balancing cost, capacity, performance and efficiency is a daunting task that keeps most infrastructure administrators up at night. HP addresses these issues with the HP 3PAR StoreServ all-flash array. HP 3PAR StoreServ storage delivers the performance advantages of a purpose built, flash-optimized architecture without compromising resiliency, efficiency, or data mobility. It reduces the performance bottlenecks that can choke general-purpose disk arrays that have been retrofitted with solid-state disks (SSDs).

Note
CS700 2.0 platform can be ordered with HP 3PAR StoreServ 7450c all-flash array. Testing for this reference architecture was performed on HP 3PAR StoreServ 7450 model. HP 3PAR StoreServ 7450c has larger controller cache and capacity than the 7450 model. The remainder of this document will list the storage array model as “7450”.

Table 6 below lists the HP 3PAR StoreServ 7450 configuration.

Table 6. HP 3PAR StoreServ 7450 all-flash array

Component	Description	Notes
SAN Fabric Switch	HP SN6000B 16Gb 48/24 FC Switch	Quantity 2. No Flat-SAN Option
Storage Controllers	HP 3PAR StoreServ Node Pair	Quantity 1
Drives	1.92 TB cMLC SSD	24 drives
HP 3PAR 7000 Service Processor	HP 3PAR Physical Service Processor	Quantity 1

Note
24 drives were used as a baseline for testing. Actual sizing should vary based on specific business requirements, optimizing for unique performance, user experience, cost and capacity needs. HP 3PAR StoreServ best practices for HP Client Virtualization can be found at: http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA4-6479ENW

Software components

The software stacks that defined the reference architecture can be categorized into the following layers.

- Compute software layer

  This layer primarily holds the VMware ESXi 5.5u2 hypervisors installed on HP ProLiant BL460c Gen9 blades. Windows 7 x64 guest virtual machines with Citrix virtual delivery agent (VDA) were deployed within this layer and served as desktops which Login VSI test users logged on to and performed various automated tasks.

- Management software layer

  This layer is comprised of Citrix and VMware solution management software stacks. The Citrix management suite included the XenDesktop 7.6 software stack discussed later in this document. The CS700 2.0 VMware Solution Kit comes with the following management software within preconfigure virtual machines.

  – VMware vCenter 5.5u2
  – HP OneView 1.2
  – OneView for VMware vCenter Server
  – HP OneView for vRealize Operations Manager
  – HP VSR1001 Virtual Service Router
  – HP Insight Control Server Provisioning

Note
VMware vRealize Operations Manager and HP VSR1001 were determined to be out of scope for testing of this reference architecture and were not part of the management software infrastructure.

- Storage layer

  As the name suggests, this layer encompasses storage software such as HP 3PAR StoreServ management console, HP 3PAR StoreServ OS and plugins.

The following section discusses the management software layer in detail.

Management software layer

HP OneView Management Suite 1.2
HP OneView is a comprehensive, single platform designed from the ground up for converged infrastructure management. An integrated platform increases the productivity of every member of the team, across servers, storage, and networking. By

streamlining processes, incorporating best practices, and creating a new, holistic way to work, HP OneView provides organizations with a more efficient way to work. It is designed for open integration with existing tools and processes to extend these efficiencies.

In a nutshell HP OneView is:

Converged – Manage across compute, storage, and networking and enjoy a marked reduction in tools to learn, manage, deploy, and integrate.

Software-defined – Capture best practice knowledge in templates to guarantee that infrastructure is deployed and managed the right way every time.

Automated – Use HP OneView REST APIs to deploy a VMware vSphere cluster in just five easy steps and leverage HP OneView as the infrastructure automation hub for the enterprise.

A single instance of HP OneView 1.2 was installed that managed the entire blade infrastructure.

For more information on HP OneView please visit: hp.com/go/oneview

HP OneView for VMware vCenter 7.5

HP OneView for VMware vCenter plugin was installed on the vCenter Server virtual machine. It is displayed as a tab on the main screen of the VMware vSphere Client management console. By accessing this tab, an administrator can quickly obtain context-sensitive server- and storage-specific information for individual elements of the virtual environment. The HP OneView plug-in for vCenter server consists of a server or network module, and a storage module. The plug-in can be used to manage HP servers, networks, or storage systems. No specific testing was done on the plugin but it was used in day to day operations during the test cycle.

For more information on HP OneView for VMware vCenter 7.5 please visit:
https://h20392.www2.hp.com/portal/swdepot/displayProductInfo.do%3FproductNumber%3DHPVPR

For more information on HP OneView partner integration please visit:
https://h20392.www2.hp.com/portal/swdepot/displayProductInfo.do?productNumber=Z7500-63235

Citrix XenDesktop, XenApp 7.6

In its previous releases Citrix introduced a unified FlexCast Management Architecture (FMA) for provisioning all Windows applications and desktops either on hosted-shared RDS (Remote Desktop Services) servers or VDI-based virtual machines. The FlexCast 2.0 architecture combines simplified and integrated provisioning with personalization tools. The latest release of XenDesktop 7.6 resurrects previous but improved features made popular in earlier versions of XenApp, such as application pre-launch, session linger and anonymous logon. These features combine to deliver instant app access, which not only improves user experience, but also can be absolutely critical in industries such as healthcare, where doctors are able to increase their quality of care as a result of “instant-on” connectivity as they roam from location to location. Not only is access accelerated, but also even more highly available and resilient, with new features that are able to withstand the temporary loss of a database connection.

Note

For a complete list of XenDesktop 7.6 features, please visit: citrix.com/products/xendesktop/whats-new.html.

For a virtual desktop, persistent and non-persistent users need to be considered. A persistent user maintains changes to their desktop between logins. A non-persistent user gets a fresh new desktop from a base image every time they log in. In a non-persistent VDI environment all users share the same base image file, with any changes or modifications they make stored in a differential file, normally a few GB in size, and each user is allocated virtual CPU(s) and memory.

Some organizations choose to adopt a non-persistent user model since it requires only a single or very few images to maintain. In addition, no one user can affect another user in a non-persistent model, and storage costs have the potential to be lower. Other organizations may require the flexibility of persistent models for their end-user needs. This reference architecture focuses on a non-persistent model. The HP ConvergedSystem 700 supports all use cases within the Citrix FlexCast 2.0 architecture including MCS (Machine Creation Services) and PVS (Provisioning Services) with PVD (Personal Virtual Disk).

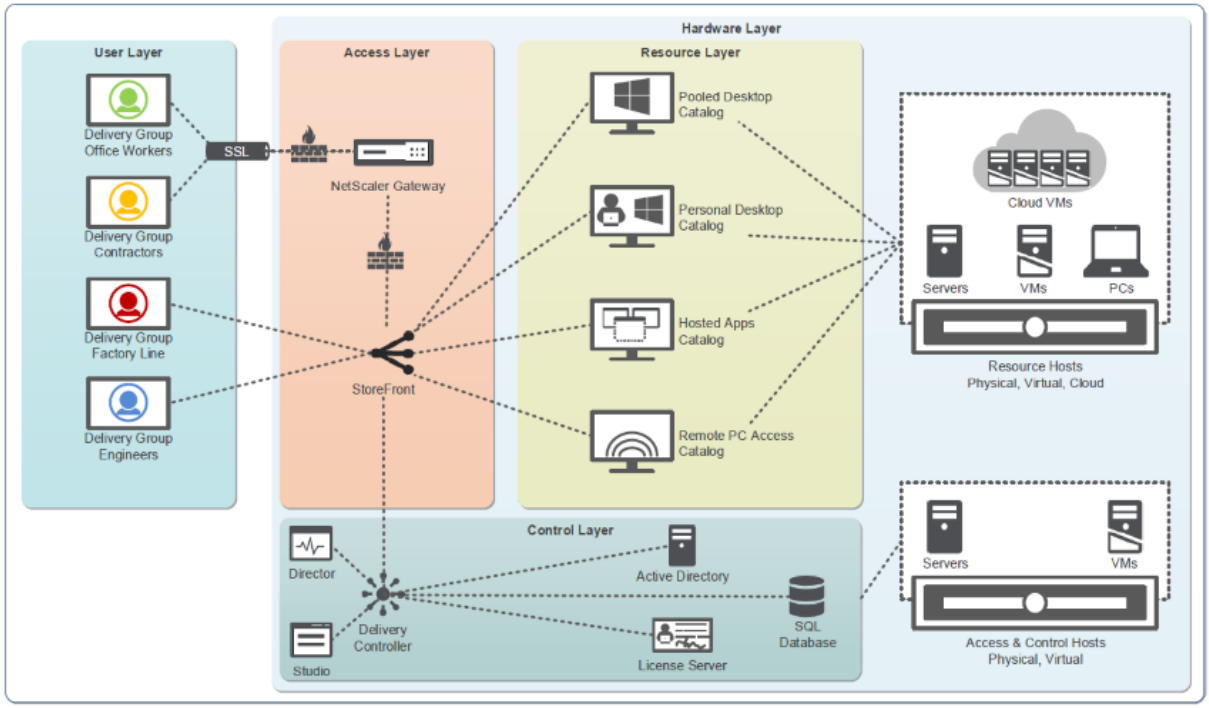
Benefits of a non-persistent user model include:

- Minimal shared operating system images to maintain
- Potentially less storage consumption in certain circumstances

In a Citrix environment, user virtualization can be implemented using Citrix User Profile Manager. User virtualization allows for each user to customize their environment, and maintain that customization across logins. It is a best practice to apply the user virtualization across all types of users, hosted desktop, non-persistent and persistent VDI. Citrix Personal vDisk or PVD can be set up for non-persistent virtual machines as well to deliver users the ability to install applications into their own virtual hard drive all while keeping the master golden image free and separate from additional software. While PVD has been tested in previous HP Client Virtualization reference architectures, it was not the focus in this round of testing

For use cases where user workload is less intense and requires less user based customizations the Hosted Shared Desktops (RDS) model would be a right choice. Multiple user sessions share a single, locked-down Windows Server environment running in the data center and accessing a core set of applications.

Figure 4. High-level graphical representation of Citrix software stack deployed in a production environment.



Tables 7, 8 and 9 list software versions used to build the Citrix test infrastructure.

Table 7. Citrix software versions

Item	Version
XenApp	7.6.0.5029
XenDesktop	7.6.0.5019
Studio	7.6.0.5029
StoreFront	2.6
Director	7.6. 5029
Virtual Delivery Agent	7.6. 5029
Receiver	7.6. 5029
NetScaler VPX	10.5

Table 8. Microsoft software versions

Item	Version	Description
Windows Server	2012 R2	Used for all infrastructure components requiring Windows server operating system, including Citrix XenDesktop, VMware vCenter, Microsoft SQL Server, etc.
SQL Server	2014	Provides database support for Citrix software in a clustered configuration
Windows Desktop OS	Windows 7 Enterprise, x64	All VDI guest instances and Login VSI launchers

Table 9. VMware components

Item	Version	Description
VMware vCenter	5.5 U2b	Central management of virtualization components
VMware ESXi	5.5 U2	HP Custom Image (VMware-ESXi-5.5.0-Update2-2068190-HP-5.77.3-Nov2014)

Capacity and sizing

To ensure exceptional performance and capacity for this solution, HP validated 2000 plus users running within multiple FlexCast options provided by Citrix XenDesktop/XenApp on eight BL460c servers. This included running around 2000 users against the delivery mechanisms provided by the architecture including Citrix XenApp (RDS) and Citrix XenDesktop instances configured using Citrix Provisioning Services.

The choice to test 2000 users for solution testing was in part based on single server sizing approximations. Login VSI was used to test the various use cases. At peak usage, these scripts require less than 1.5GB to 2GB of RAM per virtual desktop. In Windows 7 x64 environments HP has observed a more common minimum configuration of 2GB and above. With Login VSI there is no way to stress larger memory footprints, other analysis methods must be used to size the system appropriately. Environments with heavier CPU requirements as well as those with greater memory requirements will see a reduction in user counts.

HP did not want to have I/O become the limiting factor in the sizing of the overall solution and as such utilized HP 3PAR StoreServ all-flash array for the write cache files across the solutions. Write cache files create a highly randomized, write intensive I/O pattern while minimizing file growth and recycling files. This makes them ideal for a flash media.

Outside of benchmarking scenarios, sizing should be specific to unique business requirements and optimized for performance, user experience, cost and capacity. HP recommends proof of concept (POC) implementations when feasible. HP Client Virtualization Analysis and Modeling Service (CVAM) is a service provided by HP consulting that can assist in successfully implementing a client virtualization solution.

More information on CVAM and other HP client virtualization services can be found at: HP Client Virtualization Services

HP 3PAR StoreServ best practices for HP Client Virtualization can be found at:
http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA4-6479ENW

Workload description

Login VSI is a load generating test tool designed to test remote computing solutions via a variety of different protocols. The test suite utilizes a series of desktop applications running via automated script within the context of a virtual desktop environment including Citrix XenApp and Citrix XenDesktop.

A standardized set of applications are installed within every virtual machine and actions are taken against the installed applications. This set of applications is listed below.

- Adobe® Acrobat® 9.1
- Adobe Flash Player 11
- Adobe Shockwave Player 11
- Bullzip PDF printer
- Freemind
- Kid-Keylock

- 7-Zip
- Microsoft Office Professional 2010
- Internet Explorer 9 and 11

Test infrastructure VM sizing

Sizing of the infrastructure virtual machines generally depends on user environmental requirements. To achieve proper sizing, POCs or use of HP CVAM service is recommended in conjunction with best practices provided by HP and third party vendors for their applications. Sizing information below should not be considered "one-size-fits-all" and should be viewed in context.

Table 10. Virtual machine specifications

VM	vCPU	Memory	HDD	Networks	OS
2x XenDesktop/App Controllers	2	10GB	60GB	Production DC mgmt	Windows 2012 R2
2x StoreFronts	2	8GB	60GB	Production	Windows 2012 R2
4x PVS servers	4	10	60GB OS 200GB Local + SMB3	Production DC mgmt	Windows 2012 R2
2x NetScaler VPX	2	2GB	20GB	Production PXE	BSD
PVS image template	1	1.3GB	6GB write cache	Production PXE	Windows 7 x64
Server for SMB3 file share	2	8GB	60GB OS 500GB SMB3 Share	Production	Windows 2012 R2
VAMT (Volume Activation Management Tool)	2	4GB	60GB	Production	Windows 2012 R2
2x SQL 2014 cluster for Citrix Infrastructure	4	10GB	60GB	Production	Windows 2012 R2
1x SQL 2012 for vCenter 5.5 U2	4	10GB	60GB	DC mgmt	Windows 2012 R2
1x vCenter 5.5 u2 server	4	8GB	60GB	Production DC mgmt	Windows 2012 R2
1x HP OneView 1.2 appliance	2	10GB	160GB	DC mgmt	Linux®
1x HP Insight Management	4	16GB	200GB	DC mgmt	Linux
1x DHCP server for PVS	2	4	60GB	PXE	Windows 2012 R2
XenApp (RDS) Image template for PVS	4	12GB	30GB Write Cache	Production PXE	Windows 2012 R2
1x Windows RDS (Remote Desktop Services) License server	2	4GB	60GB	Production	Windows 2012 R2

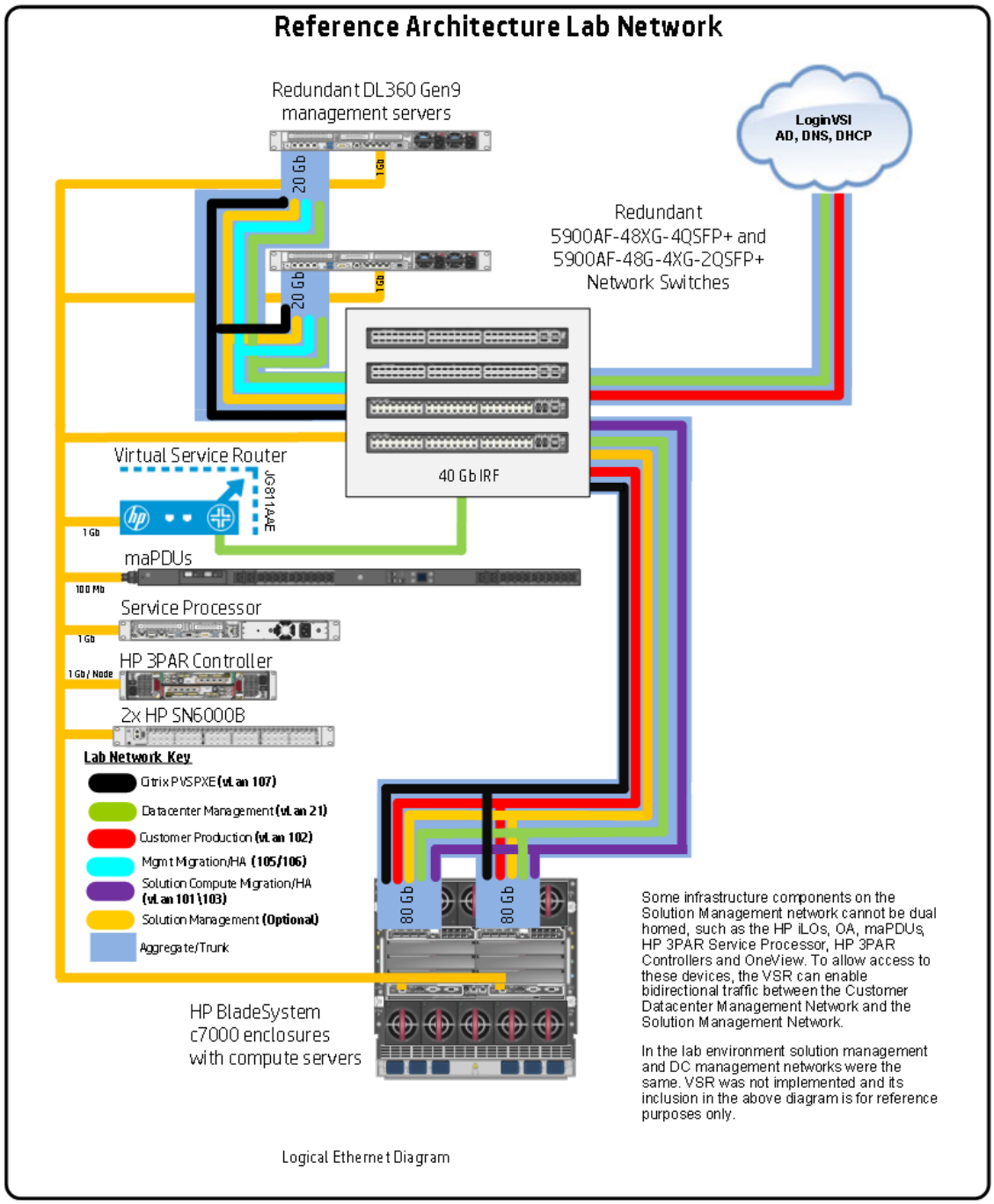
Note

Hard drive size for PVS and XenApp master images were 37GB and 45GB.

Reference Architecture design and configuration guidance

Network layout

Figure 5. Logical Network layout used for building the reference architecture



HP Virtual Service Router is shown in the above image as a reference. VSR was not deployed for reference architecture testing.

Solution networks and vlans

HP OneView managed the solutions infrastructure where all the network and infrastructure related components were defined and managed. Several vlans were defined to segment and isolate traffic. Active/Active configuration was used to configure the network and storage connections. Brief descriptions of the vlans follows. Migration and HA networks for solution management were defined at the switch level.

Production network (vlan 102)
The Production network can be considered as a client or customer network through which clients connect to their desktops and applications. In this case this is the Login VSI network, which had the Login VSI test infrastructure. Test domain, DNS/DHCP also resided on this network.

Management network (vlan 21)
Solution management related components such as HP OneView, vCenter, 3PAR management components, etc. resided on this network. This network had its own domain infrastructure.

Management migration (vlan 105)
vMotion network dedicated to solution management virtual machine migrations, including OneView, vCenter and Citrix Infrastructure.

Management HA network (vlan 106)
Network dedicated to HA for solution management virtual machines.

Compute migration (vlan 101)
vMotion network dedicated to ESXi compute hosts and used for desktop virtual machine migrations.

Compute HA network (vlan 103)
Network dedicated to HA for Compute virtual machines.

PXE network (vlan 107)
This network provided isolation for the Citrix PVS PXE network. A bandwidth allocation of 4Gb for this network was based on previous testing for the VDI workloads tested. No bandwidth bottlenecks were observed.

Storage area network
Network for 3PAR StoreServ SAN. 8Gb bandwidth was allocated for the FCoE network which is in line with the storage bandwidth requirement for the array.

Note
Vlans are customizable per the CID (Customer Intent Document) at the time the CS700 is ordered. Note that for this reference architecture testing, ConvergedSystem 700 networks were integrated into the existing lab production network.

The figure below shows a snapshot of the various vlan configurations and bandwidth allocations in HP OneView.

Figure 6. OneView vlan configuration

Connections >

	ID	Name	Type	Address	Network	Requested bandwidth (Gb/s)
◆	1	SAN_A	Fibre Channel	WWPN 10:00:62:c8:b7:d0:00:00 (v) WWNN 10:00:62:c8:b7:d0:00:01 (v) MAC BA:89:62:C0:00:00 (v)	SAN_A Fabric attach	8
◆	2	SAN_B	Fibre Channel	WWPN 10:00:62:c8:b7:d0:00:02 (v) WWNN 10:00:62:c8:b7:d0:00:03 (v) MAC BA:89:62:C0:00:01 (v)	SAN_B Fabric attach	8
◆	3	Mgmt_A	Ethernet	MAC BA:89:62:C0:00:02 (v)	Mgmt_Set_A (network set)	1
◆	4	Mgmt_B	Ethernet	MAC BA:89:62:C0:00:03 (v)	Mgmt_Set_B (network set)	1
◆	5	Prod_HA_Migration_A	Ethernet	MAC BA:89:62:C0:00:10 (v)	Production_HA_Migration_A (network set)	7
◆	6	Prod_HA_Migration_B	Ethernet	MAC BA:89:62:C0:00:11 (v)	Production_HA_Migration_B (network set)	7
◆	7	PXE_A	Ethernet	MAC BA:89:62:C0:00:12 (v)	Citrix_PVS_PXE_A vlan107	4
◆	8	PXE_B	Ethernet	MAC BA:89:62:C0:00:13 (v)	Citrix_PVS_PXE_B vlan107	4

The HP Virtual Connect FlexFabric 20/40 F8 Module provides one flexible interconnect interface to any network. One device supports the most common data center network protocols, such as Ethernet, Fibre Channel (FC), FCoE and iSCSI. In addition, with 20/40 Gb connections, it offers more than enough bandwidth to satisfy any workload requirements.

Figures 7 and 8 present an overall logical view of the bandwidth allocation for the entire solution.

Figure 7. Bandwidth distribution for compute nodes

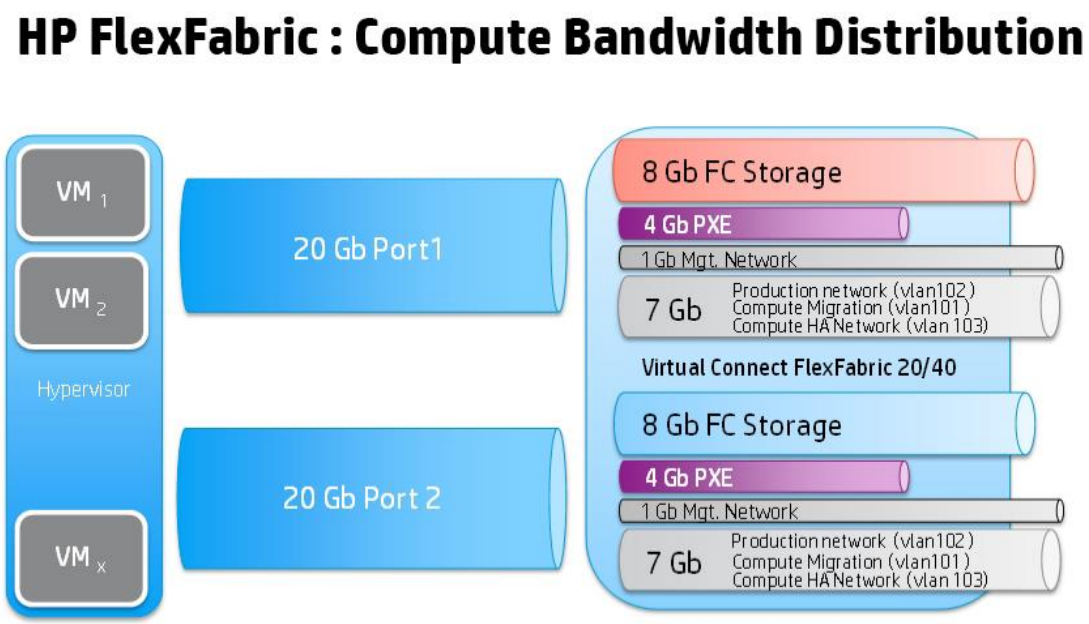
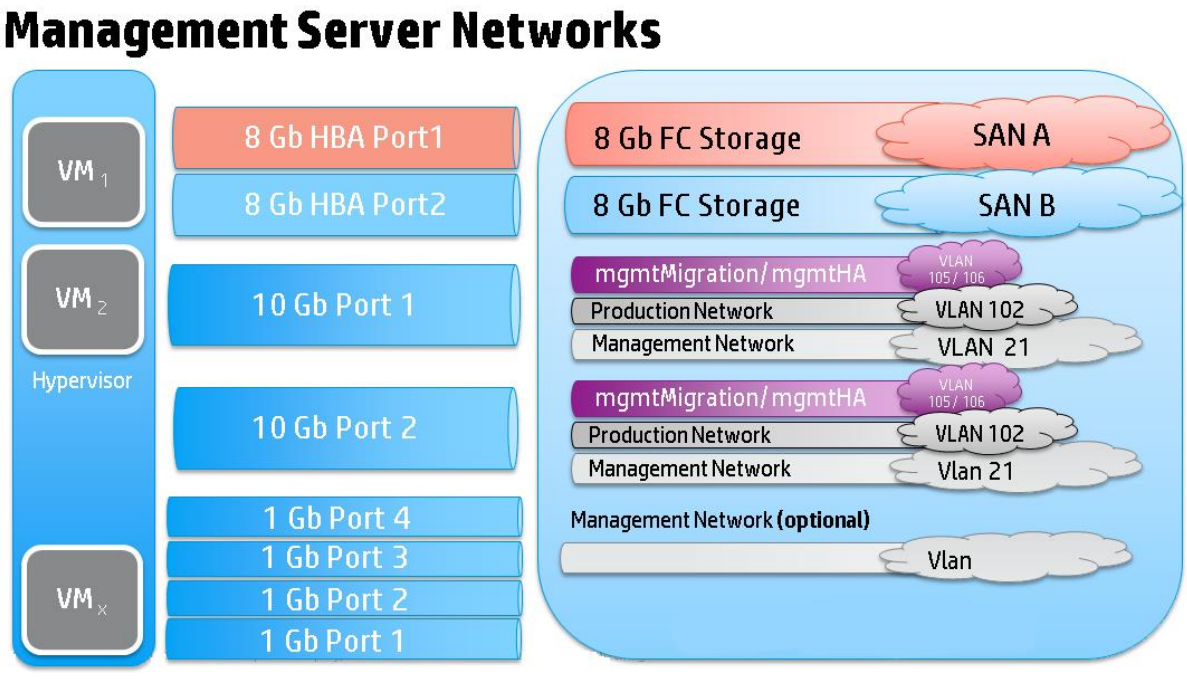


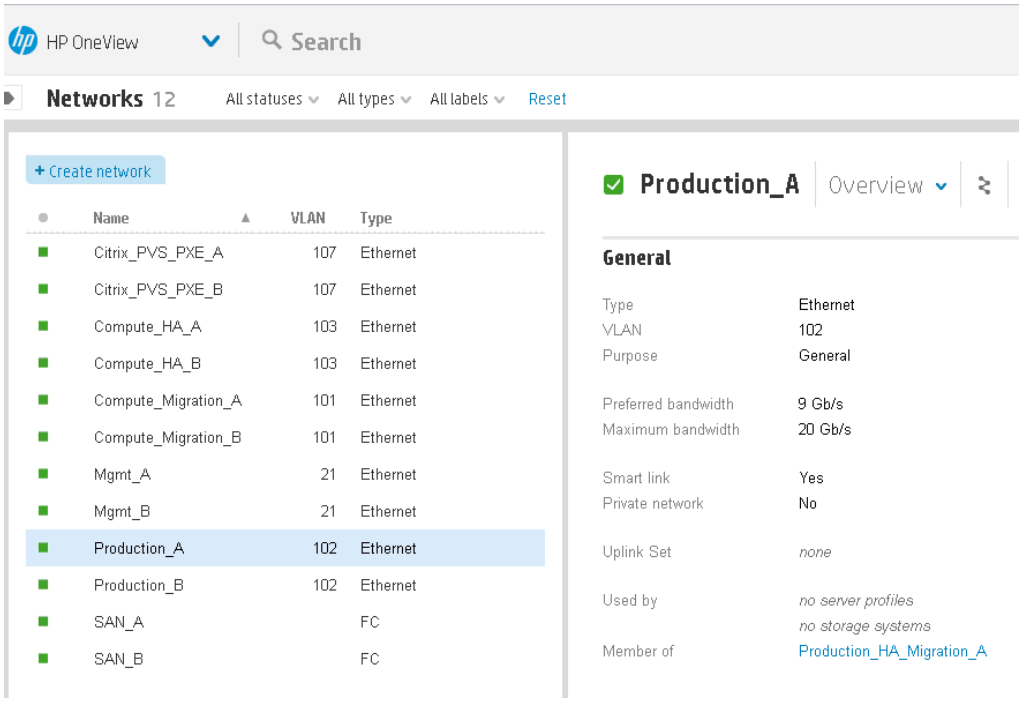
Figure 8. Bandwidth distribution for the management network



As mentioned previously HP OneView was used to configure the blade enclosure and accompanying hardware. Below are some screenshots of the OneView 1.2 configuration parameters with high level explanations where needed.

Figure 9 shows networks and vlans configured as described previously in this document.

Figure 9. Solutions' networks and vlans



The figure below shows an example of Ethernet uplink ports and the associated networks.

Figure 10. Ethernet Uplink Port Configuration

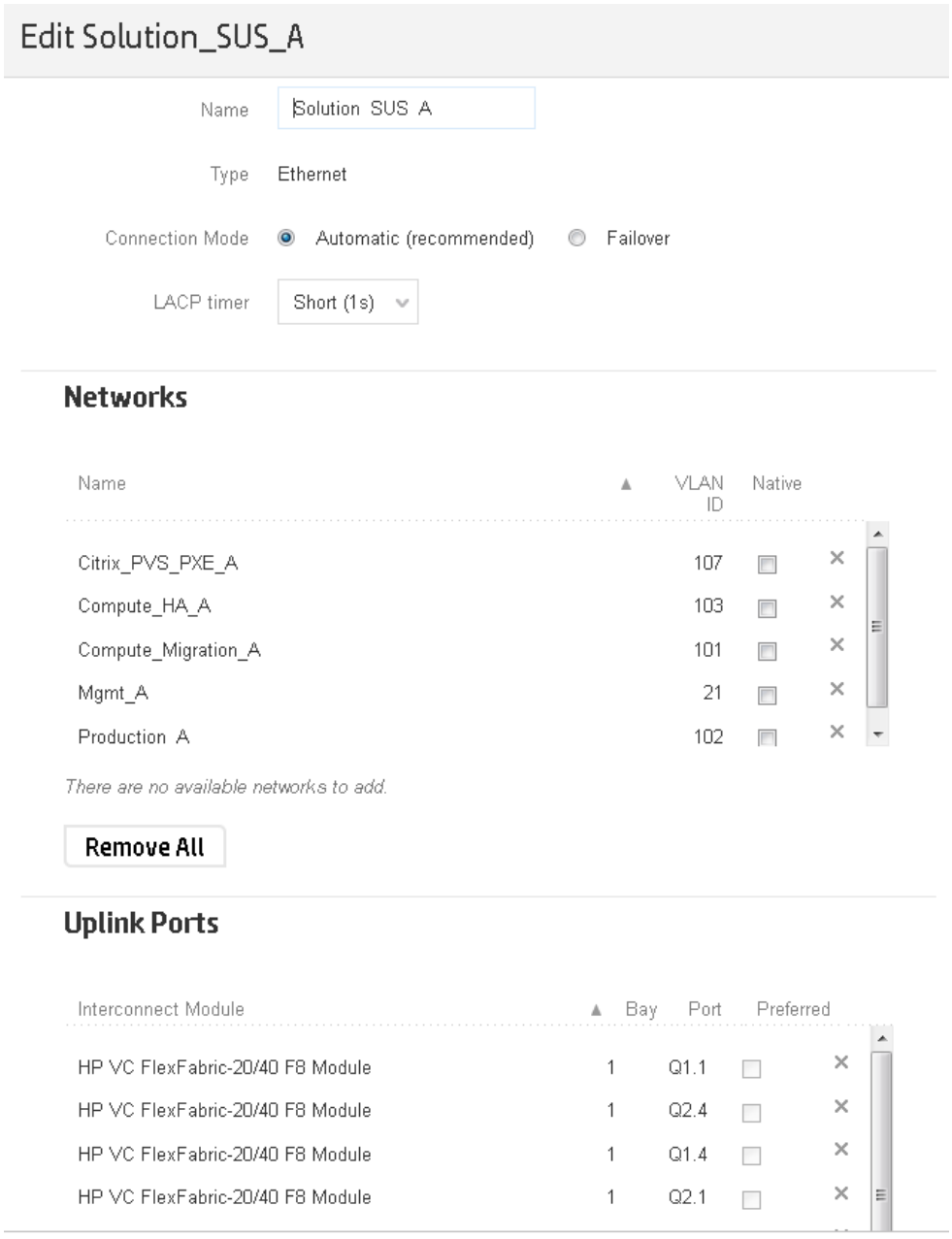
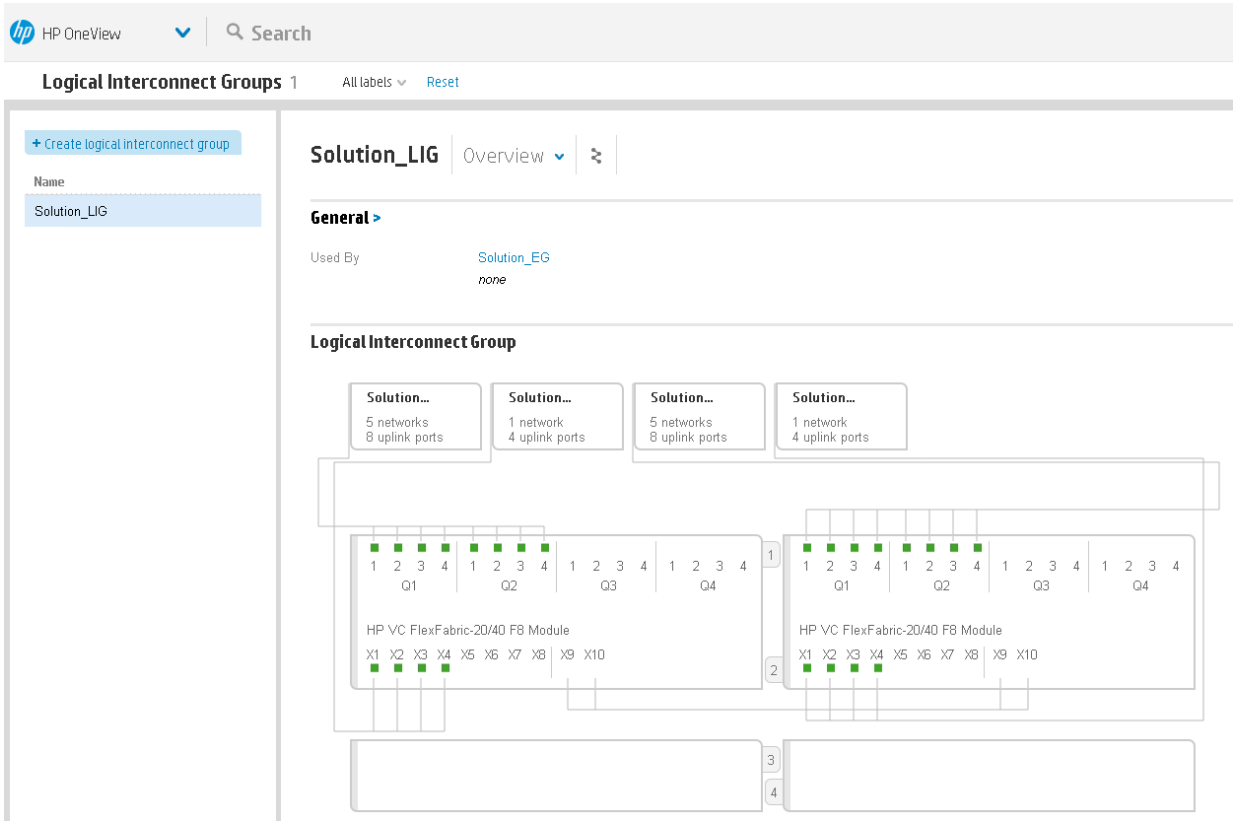


Figure 11 below shows the Logical Interconnect Group (LIG) configuration. A LIG is a group of logical interconnects that share the same configuration for network connectivity. A logical interconnect is defined as a set of physical interconnects and their links, including the following:

- Uplinks to data center networks as mapped by their uplink sets
- Downlinks to the servers
- Stacking links

The graphic blow shows four uplink sets, two for Ethernet networks and two for HP 3PAR StoreServ SAN.

Figure 11. Logical Interconnect Group Configuration



vSphere configuration

vSphere 5.5U2 was used for reference architecture testing. The following section describes the configuration of the Datacenter and Cluster containers within vCenter.

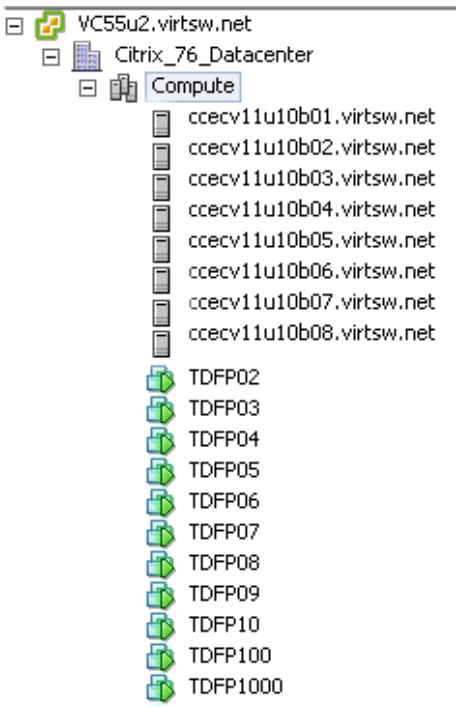
Three separate clusters were used to manage three different types of resources.

- Compute Cluster
- Login VSI Launchers
- Solution Management Cluster

Compute Cluster

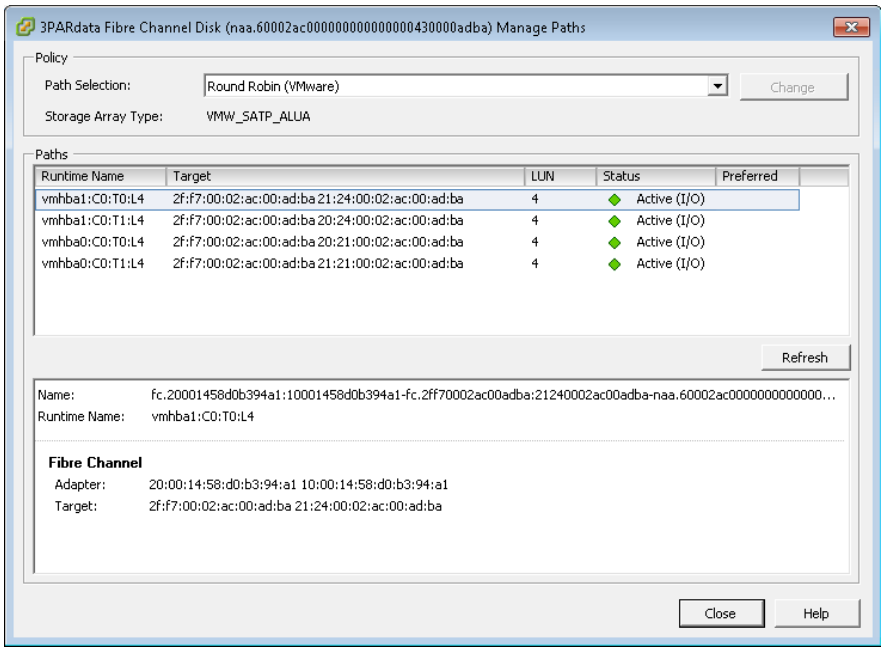
Primarily used to house BL460c Gen9 ESXi hosts running the Citrix XenDesktop VMs or XenApp RDS hosts. Each cluster was configured with HA and DRS with default settings.

Figure 12. Compute cluster with 8 BL460c Gen9 servers



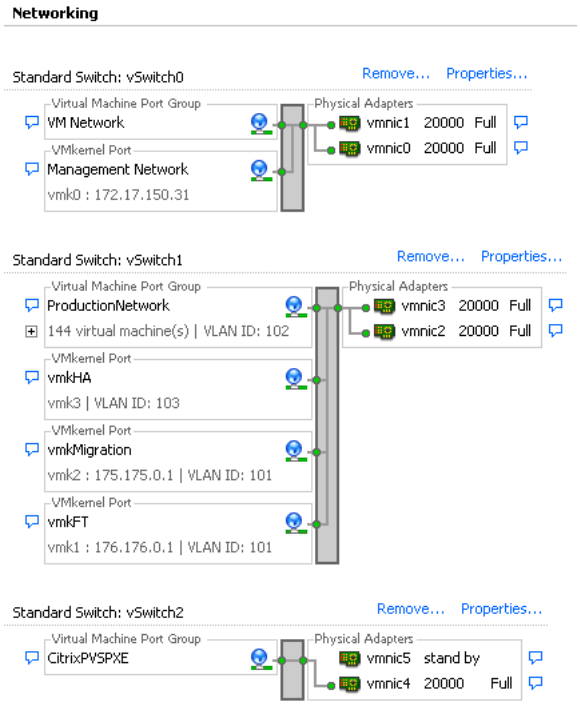
All volumes were configured with Round Robin load balancing as recommended by HP 3PAR StoreServ VMware best practices documentation. The best practices document can be found at the following link http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA4-3286ENW

Figure 13. Round Robin configuration for HP 3PAR StoreServ volumes



Three standard vSwitches directed all of the compute traffic. vSwitch2 providing PXE network for the Citrix PVS was configured in Active/Standby configuration as prescribed for PXE networks.

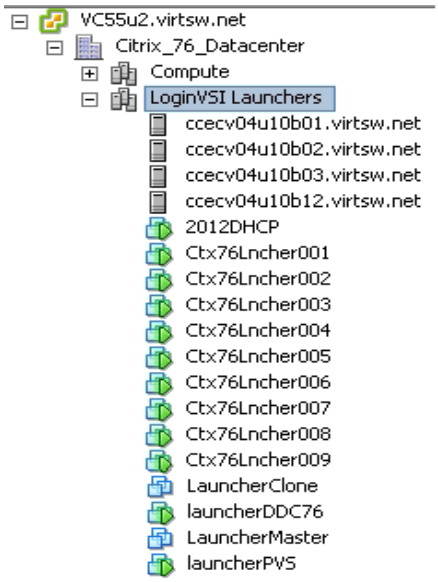
Figure 14. vSwitch Configurations



Login VSI Launchers Cluster

Login VSI test infrastructure was built using the four HP BL460c blade servers. Login VSI launchers were deployed using Citrix PVS. A separate DHCP server and Citrix XenDesktop Controller were used to facilitate deployment of the launchers. This provided launchers on the fly as needed. All Login VSI components were configured per Login VSI best practices. The cluster had 150 launchers in the pool. Depending on the test being run appropriate number of launchers were provisioned with maximum of 12 sessions per launcher.

Figure 15. Login VSI Launchers cluster



Solution Management Cluster

Two HP ProLiant DL360 Gen9 servers were used to host the solution management and Citrix software stack. This included HP OneView, HP Insight Control, VMware vCenter and all Citrix components. Three resource groups were configured with the Citrix stack resource group assigned 50% of the cluster resources. Resources allocation was adjusted based on requirements and the breakdown ended up being 50/25/25 between Citrix, Solution management and Support resource groups. VMware HA and DRS was enabled on the cluster. DRS groups were created along with appropriate rules to ensure that the software stack was distributed among the two management servers, to increase availability in case of a management server failure. A brief description of the resources and their membership information is listed below.

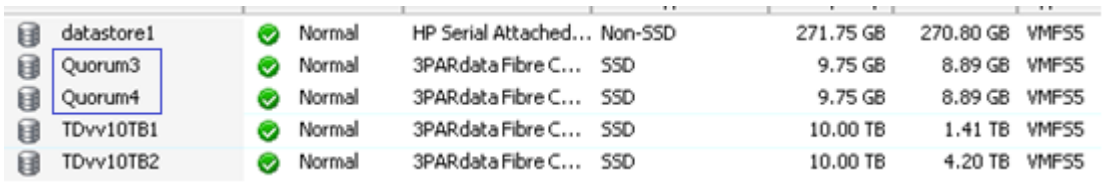
- Citrix Stack: allocated to Citrix XenDesktop Infrastructure, which included:
  - 2 XenDesktop 7.6 Delivery Controllers and StoreFront servers
  - 4 Citrix PVS 7.6 servers for VM provisioning
  - 2 NetScaler VPX for connection load balancing
  - 2 SQL 2014 as infrastructure database
  - 1 DHCP server for providing addresses to PVS PXE clients
- Solution Stack: allocated to servers supporting the infrastructure including:
  - HP OneView
  - HP Insight Control
  - VMware vCenter
  - SQL Server for vCenter database
- Solution support: allocated to VMs as infrastructure including supporting cast:
  - System management VM
  - Volume Activation Management Tool (VAMT)
  - PVS, XenApp and other VM templates
  - Microsoft RDS (Remote Desktop Services) License server
  - Windows 2012 Server for SMB3 file share

Note

Microsoft RDS (Remote Desktop Services) and SMB3 file share servers can also be part of the datacenter infrastructure, but were collocated with the test infrastructure for simplicity reasons.

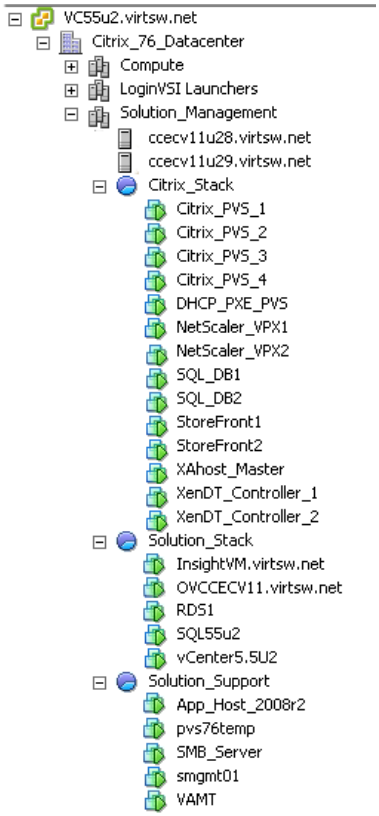
Two volumes were configured for HA storage heartbeat as shown in the figure below.

Figure 16. Two 10G volumes for HA storage heartbeats.



The graphic below shows a snapshot of the solution management cluster.

Figure 17. Solution Management Cluster



Physical cabling

Physical cabling of the entire solution was done per ConvergedSystem 700 2.0 specifications. Below are a few examples of basic network cabling. It is highly recommended that customers doing their own solution integration should consult HP CS700 2.0 documentation or contact an HP consultant. This document does not provide the entire solution cabling schemes.

The following table depicts the naming convention used for cabling various components in this section.

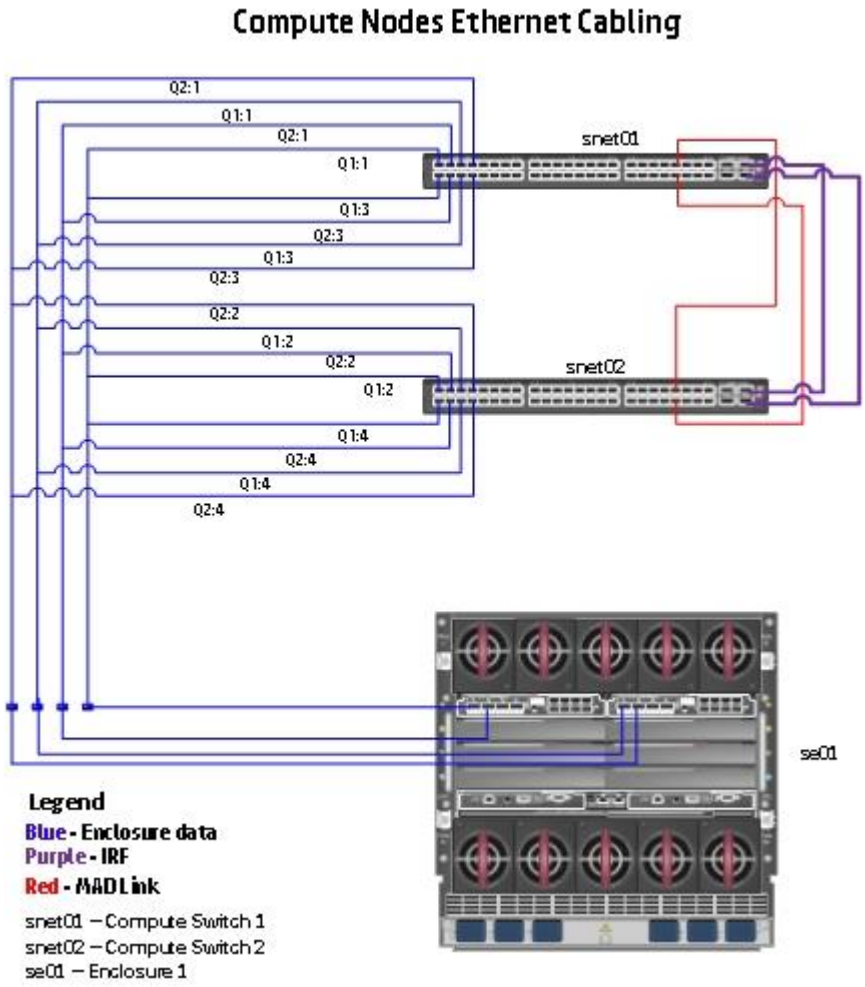
Table 11. Naming convention

Abbreviation	Description
sRack01	Compute Rack 01
sstor01-Rack1	Storage Array 1, Rack 1
se01	c7000 solution enclosure 1
se-oa01	c7000 solution enclosure onboard administrator 1
se-ic01	c7000 solution enclosure interconnect 1
sms01, 02	DL360 Gen9 solution management server 1, 2
snet01, 02	solution network switch 1, 2
soobm01, 02	solution out of band management switch 1, 2
ssan01, 02	solution SAN switch 1, 2
sstor-sp	Service processor

Compute nodes and switches

Figure 18 below shows physical cabling of the c7000 enclosure for this reference architecture. CS700 2.0 recommended ports were used to maintain consistency.

Figure 18. Compute switches and FlexFabric cabling



Note

The connections depicted above are independent of the brand of switches used for the solution. Port connections are identical between HP and Cisco switches.

Storage

The reference architecture was built with a 2 node 3PAR StoreServ all-flash array. The figure below shows HP 3PAR StoreServ controller/switch cabling.

Figure 19. HP 3PAR StoreServ switch cabling

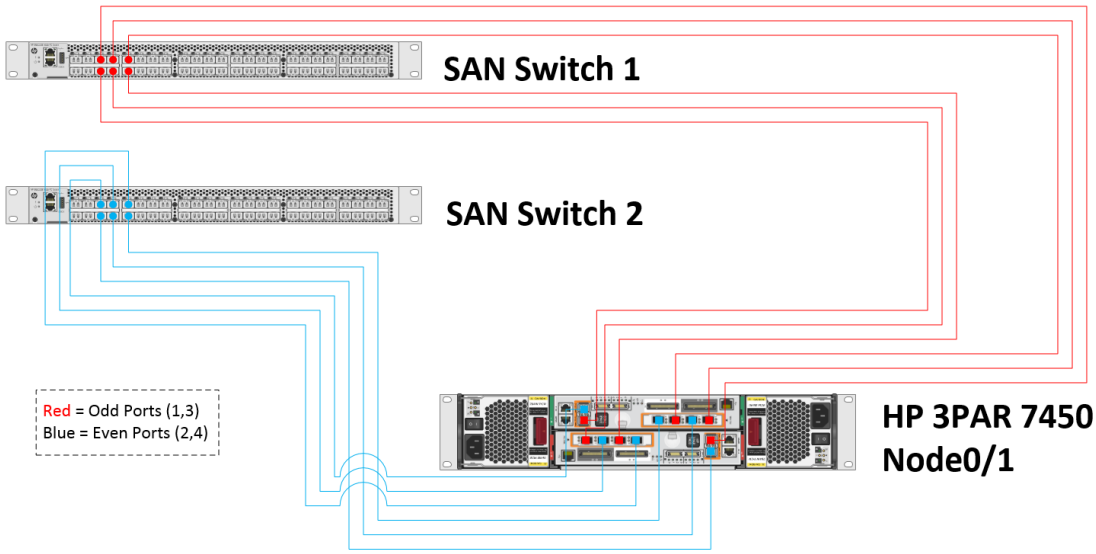
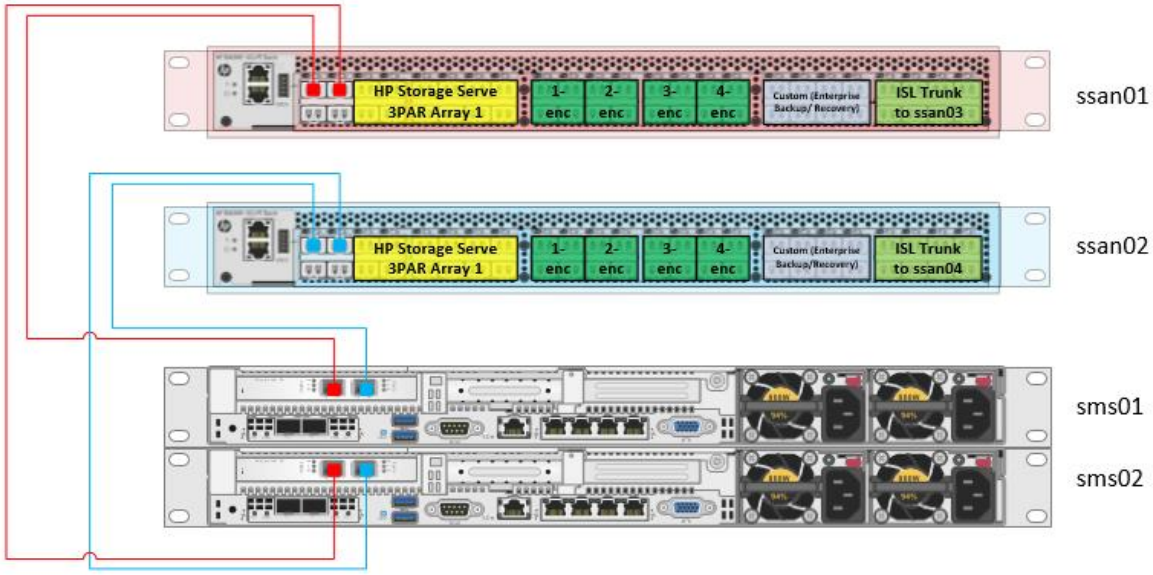


Figure 20. Below depicts the SAN switch connections from the 2 management servers.



Managing software and firmware updates

The HP ConvergedSystem 700 2.0 is an integrated solution with specific software and firmware versions, qualified at time of delivery. The HP ConvergedSystem 700 2.0 is designed for solution level support across all components within the solution. Unless in response to a support case as instructed to by the HP Customer Response Center, you will not need to update the software and firmware versions within the solution until the support window expires.

The HP Customer Response Center may instruct you to apply specific hot fixes to address potential issues. Hot fixes are supported as part of the solution level support criteria for the HP ConvergedSystem 700 2.0 solution.

Before updating any software or firmware versions, contact the HP Customer Response Center to verify the compatibility of the updates. Any firmware or software updates applied that are later than the compatibility listing will change the solution level support experience and must be accepted by the HP Customer Response Center.

HP Customer Response Center contact information can be found at: Contact HPRC

Test methodology and results

Test strategy overview

The goal of this solution testing was to investigate and determine the features best suited for the target use cases defined for this reference architecture. Close feature analysis was done prior to use case selection on both HP CS700 2.0 platform and Citrix XenDesktop 7.6 features to determine the value proposition the resulting reference architecture should provide. Based on this methodology, testing focused on HP hardware and Citrix software features that complement each other to improve user density, performance and scalability.

PVS Non-Persistent desktops: also known as Pooled VDI desktops. Each time a user logs on to use one of these desktops, they connect to a dynamically selected desktop in a pool of desktops based on a single master image. All changes to the desktop are lost when the machine reboots. Citrix Provisioning Server provided the image streaming from a common vDisk.

XenApp: Server OS machines run multiple sessions from a single machine to deliver multiple applications and desktops to multiple, simultaneously connected users. Each user requires a single session from which they can run all their hosted applications.

Data collection tools

Login VSI 4.1 was the primary tool for the majority of the tests and data collection. ESXTop and vCenter Performance Monitors were used to collect VM/Host real-time performance metrics for each test run. In addition 3PAR System Reporter and 3PAR web based data collectors were used to gather data for most storage related testing. A brief introduction to Login VSI and its workloads follows.

Login VSI

In a nutshell, Login VSI works by starting a series of launchers that connect remotely to VDI hosts via a connection protocol. The launchers execute a series of end user actions on that host (or hosts) to simulate the load of actual end users. Response times are measured for a variety of actions within each session. When response times climb above a certain level on average, the test is finalized and a score, called VSImax, is created. VSImax represents the number of users at or below the average response time threshold. A detailed explanation can be found on Login VSI website at loginvsi.com/documentation/VSImax

Login VSI 3.7 versus 4.1

The workloads from Login VSI version 3.7 to 4.1 have changed significantly. Due to the change in load created by the new tool, test results cannot be compared. HP testing has indicated that version 4.1 yields a lower VSImax number than version 3.7. Differences in workloads created by the old and new versions of the test tool along with applications tested with each workload can be found on the Login VSI website at: LoginVSI_old_and_new_workloads

Login VSI workload changes

The table below compares the various 4.x workloads. Knowledge worker is the base workload which is used as a baseline when comparing the various workloads below.

Table 12. Login VSI workloads

Workload	VSI Version	Apps Open	CPU Usage	Disk Reads	Disk Writes	Estimated IOPS	Memory	vCPU
Light	4	2	66%	52%	65%	5	1GB	1vCPU
Medium	4	5-7	99%	93%	97%	7	1GB	2vCPU
Heavy	4	8-10	124%	89%	94%	7	1GB	2vCPU
Task Worker	4.1	2-7	70%	79%	77%	6	1GB	1vCPU
Office worker	4.1	5-8	82%	90%	101%	8	1.5GB	1vCPU
Knowledge worker	4.1	5-9	100%	100%	100%	8	1.5GB	2vCPU
Power worker	4.1	8-12	119%	133%	123%	10	2GB	2vCPU+

As the matrix above shows, 4.1 workloads are significantly different and should not be compared with earlier versions.

Benchmarks versus field implementations

As with most benchmarking tools, Login VSI results should be used in conjunction with results from actual system performance data from the field or via POC implementations. Login VSI presents response times from various tasks and applications that could be used as a primitive baseline in a controlled environment with limited applications and resource assignments. Although these metrics are useful when comparing systems with similar resource attributes, they can be misleading when used to extrapolate to “real world” implementations. For example finding a VDI deployment that requires 1 or 1.5GB of memory is a rare occurrence.

Historically HP has recommended sizing solutions at 60-65% of Login VSI numbers. This recommendation however is dependent on the fact that similar resource allocation is used as in the test results presented. Hence, HP strongly recommends complete analysis of the specific user requirements prior to any VDI implementations and not solely be based on benchmark results.

HP Client Virtualization Analysis and Modeling Service (CVAM) is a service provided by HP consulting that can assist in successfully implementing a client virtualization solution. More information on CVAM and other HP client virtualization services can be found at: HP Client Virtualization Services

Test setup and results

Single server testing

To size the entire solution, tests were run on a single compute server first, to determine the capacity or user density metrics for a single system. Once this baseline number was determined, tests were run on a larger number of servers to determine the overall capacity of the solution. Although the "task worker" workload of Login VSI would have yielded a greater user density, HP used the office worker workload to do single server sizing as this workload is to the "middle of the pack" and provides more commonly used applications. Blade server performance options were adjusted using the RSBU and are listed in the Table 13 below.

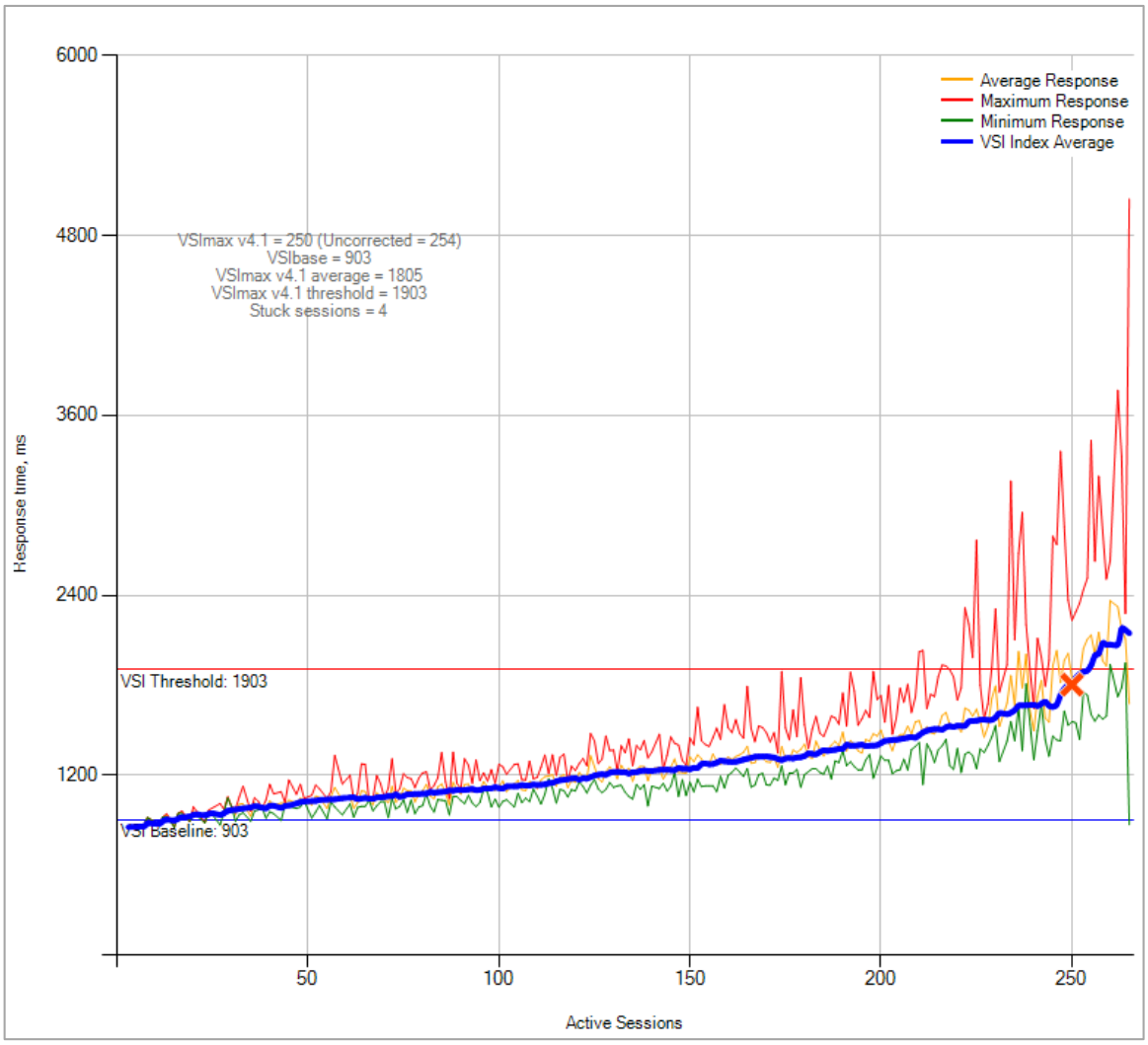
Single server test: 256GB memory

The first test was run with 256GB memory configuration. Non-Persistent virtual machines were deployed using Citrix Provisioning Services. Test yielded a VSImax of 250 users. Memory utilization was high as expected, hovering around 95%. CPU usage stayed steady at 85-90%. At user counts higher than 250 memory appeared to be the limiting factor and many desktops appeared to be hung or frozen. No other system bottlenecks were observed. Past testing had shown that using client side flash offload with Citrix HDX, improves user count by 5-10%. This however is greatly dependent on the virtual machine configuration. The end point device must be powerful enough to provide this flash rendering or the rendering should happen at the server end. Per Login VSI, the new 4.1 workloads generate negligible load. Hence no flash offload was configured for the test results listed in this document. Key configuration items are listed below. The VMs were deployed using Citrix PVS non-persistent model with write cache on hard drive option.

Table 13. Single server configuration with 256GB memory

Component	Description	Notes
CPU	HP BL460c Gen9 Intel Xeon E5-2690 v3 (2.6GHz/12-core/30MB/135W) FIO Processor Kit	Quantity 2 per server
Memory	HP 16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit	Quantity 16 per server (256GB total)
FlexFabric Adapter	HP FlexFabric 20Gb 2P 650FLB FIO Adptr	Quantity 1
Storage	2TB thin provisioned SAN volume	Quantity 1
Server BIOS	Server BIOS options adjusted to enhance performance	HP Power Profile set to Maximum Performance Memory Power Savings Mode set to Maximum Performance Thermal Configuration set to Maximum Cooling
Login VSI Workload 4.1	Office worker	1vCPU, 1.3GB memory per VM

Figure 21. Login VSI VSImax score with 256GB memory



For Login VSI VSImax graphs, the Y Axis represents response times in milliseconds (ms) while the X Axis represents number of active virtual machines.

Solution testing

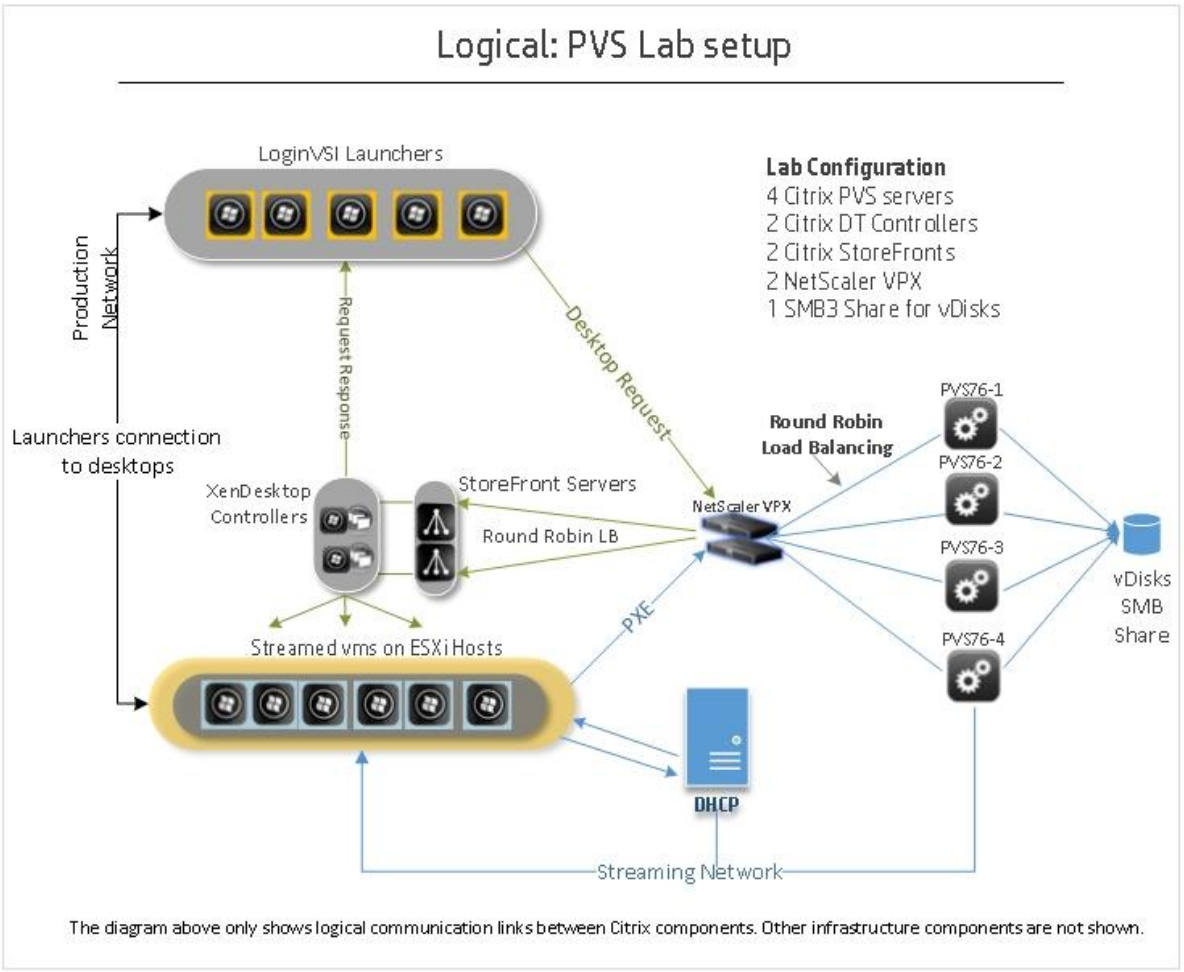
Solution testing was conducted on eight BL460c Gen9 compute servers. HP 3PAR StoreServ 2-node all-flash array with 24 x 1.92TB SSD drives and HP 3PAR physical service processor were used to build the storage infrastructure.

Note

During solution testing HP discovered an issue with the Emulex driver that is part of the VMware firmware and software recipe dated December 2014. During medium to heavy I/O, ESXi hosts disconnect from the network and storage infrastructure. Emulex has a fix available for download from the Emulex website. The driver version that fixes the issue is 10.4.255.13. Please note that this driver will be available in the next release of HP Service Pack for ProLiant (SPP) slated to be released in July 2015 timeframe. All systems with the Emulex native driver listed above should be updated with the official HP driver when the SPP is released.

Citrix PVS non-persistent VDI model test

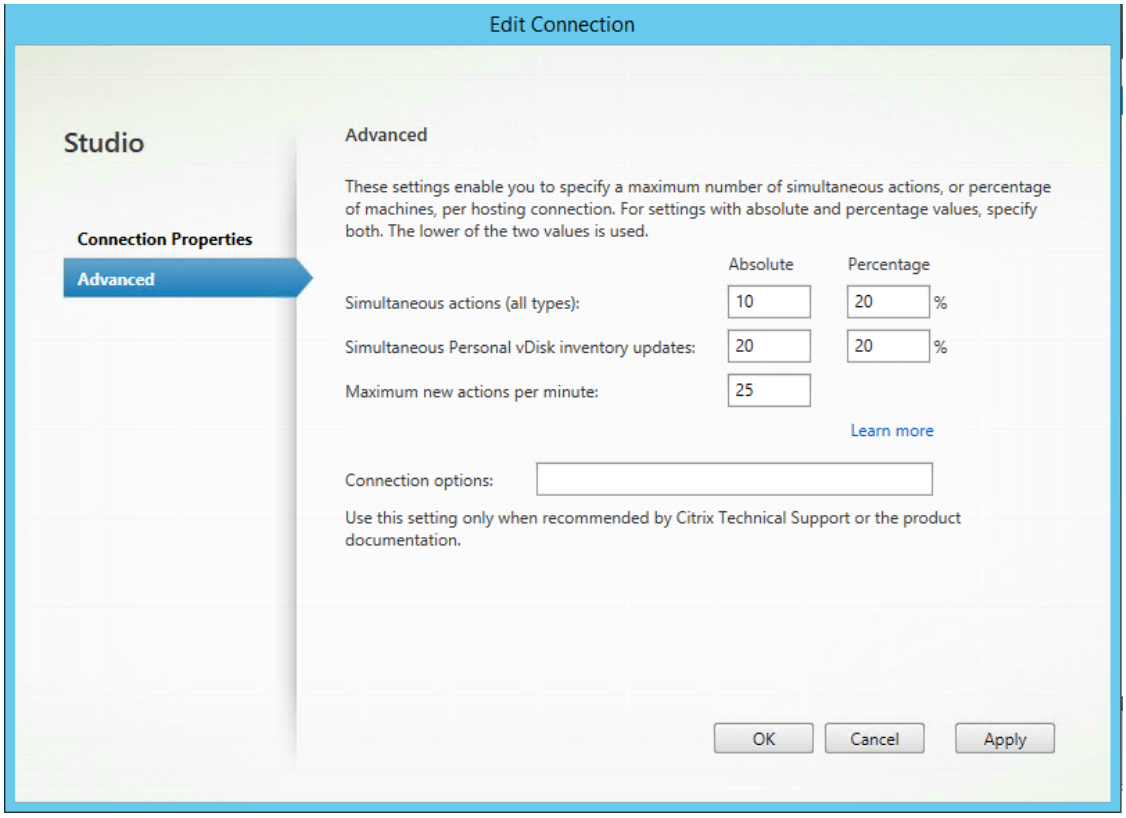
Figure 22. Shows the logical communication path and setup for the non-persistent test scenarios.



In this PVS model a shared operating system is streamed to end point target VMs. Session specific differential files are captured in a write cache file. This file is reset when the user logs off and the virtual machine is shut down. Citrix XenDesktop 7.6 provides an interface that can be used to control virtual machine availability, power up/down timings, etc. This is accomplished via a host platform specific API, which in this case was VMware vSphere.

Figure 23 below shows the settings used to power up the VMs during solution testing. The Personal vDisk setting can be ignored in this case as no PVDs were present and the setting did not take effect.

Figure 23. VMs power up/down sequence settings



To keep all the test virtual machines powered up throughout a test run, Citrix commandlets for Windows PowerShell were used. The PowerShell SDK is installed by default on XenDesktop Controllers. Below is a snapshot of sample PowerShell commands used.

```
PS C:\Users\JamilAth> Set-BrokerDesktopGroup "PVSNP" -ShutdownDesktopsAfterUse $False
PS C:\Users\JamilAth> Set-BrokerDesktopGroup "PVSNP" -PeakBufferSizePercent 100
PS C:\Users\JamilAth> Set-BrokerDesktopGroup "PVSNP" -OffPeakBufferSizePercent 100
PS C:\Users\JamilAth>
```

Virtual machines provisioned via Citrix PVS were placed on eight thinly provisioned 3PAR shared volumes, 5TB each. Each volume held equal numbers of virtual machines. Virtual machines on a single volume were registered to a single host creating a one-to-one relationship between datastore and hypervisor host. This one volume to one server mapping was chosen to isolate I/O per server/volume for data collection and analysis purposes. Non-persistent virtual machines were deployed using Citrix Provisioning Services 7.6. Thinly provisioned volumes were used instead of deduplicated volumes due to the fact that minimal impact of deduplication would be seen in an environment where cached data is discarded with every power cycle of the VMs and in real world implementations, this cache would be non-deduplicatable in most cases.

An HP 3PAR StoreServ 7450 all-flash array was used to store VMs for all testing. RAID10 was chosen due to its lowest raid penalty. With these two choices, I/O was never a bottleneck. User profiles were redirected to a Windows SMB3 share external to the test environment and was part of the datacenter infrastructure as would be the case in real world implementations.

With 10/20 Gb pipes, network bandwidth was more than enough for all the workloads tested and performance was exceptional. No in-depth network performance analysis was deemed necessary for these workloads.

The table below shows the test configuration for the non-persistent Login VSI test runs.

Table 14. Citrix PVS non-persistent configuration

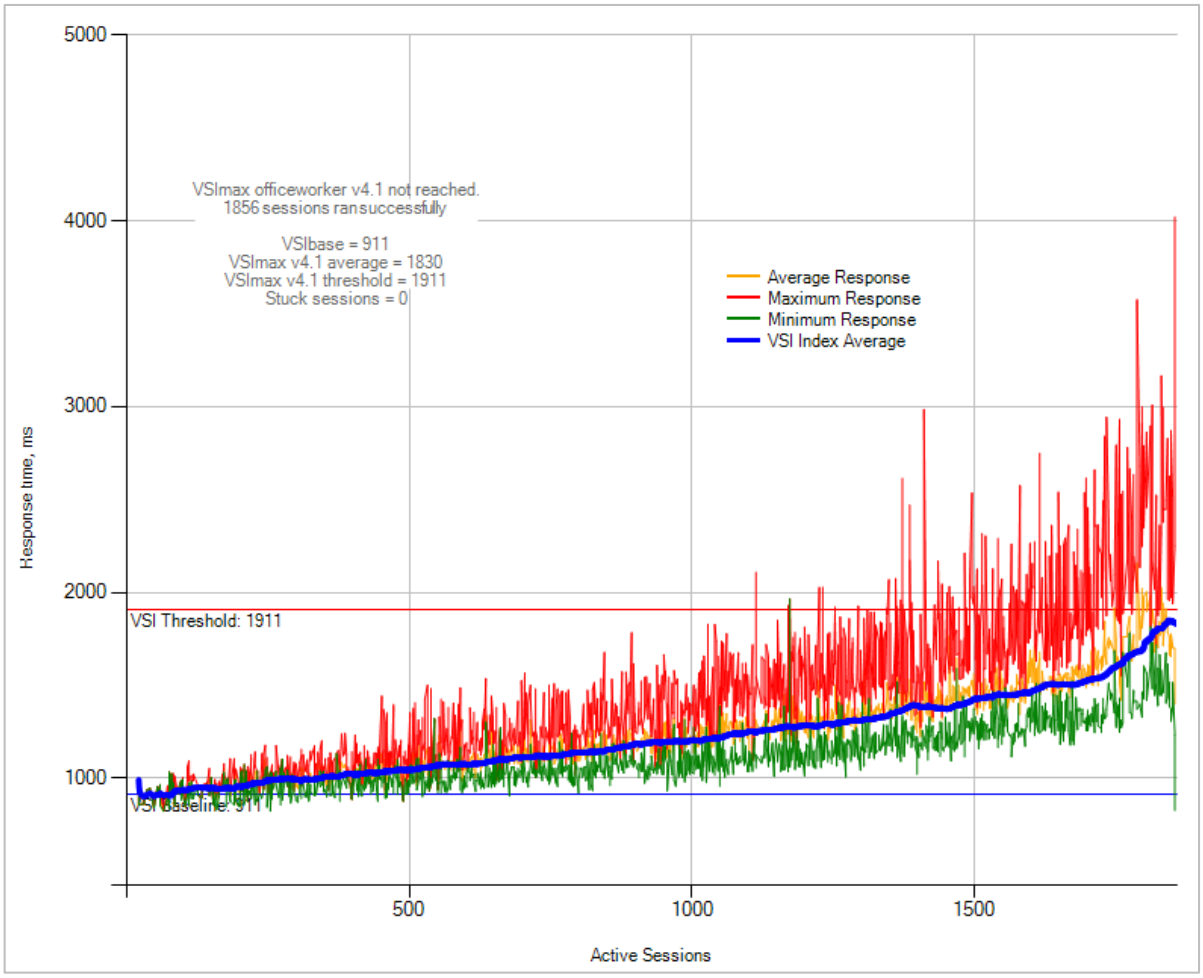
Component	Description	Notes
Compute Servers	HP ProLiant BL460c Gen9	8 servers
CPU	HP BL460c Gen9 Intel Xeon E5-2690 v3 (2.6GHz/12-core/30MB/135W) FIO Processor Kit	Quantity 2 per server
Memory	HP 16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit	Quantity 16 per server (256GB total)
FlexFabric Adapter	HP FlexFabric 20Gb 2P 650FLB FIO Adptr	1
Storage	2TB thinly provisioned volume on 3PAR 7450	1
Server BIOS	Server BIOS options were adjusted to enhance performance	HP Power Profile set to Maximum Performance Memory Power Savings Mode set to Maximum Performance Thermal Configuration set to Maximum Cooling
Login VSI Workload 4.1	Office worker	1vCPU, 1.3GB memory per VM
Datastores	3PAR thinly provisioned volumes	8 at 5TB each
Write Cache Disks	User deferential data	6GB each

For consistency, Login VSI benchmark mode settings were used to run the tests. ESXTop and 3PAR performance analyzers were used to collect performance data. The test run achieved a user count of 1856 or 232 per server. This is consistent with single server sizing metrics documented earlier in this document. Historically, tests have shown that in general, user density for large scale solution tests is around 92% of single server density, with 1% margin of error. Since the desired user density percentage was achieved, no further tests were run to achieve a VSImax number.

User density depends on many factors, such as storage used, system memory and CPU ceilings, user workloads, etc. Depending of these requirements user density will vary. It is highly recommended that a carful sizing analysis of your environment is done based on your specific requirements.

Figure 24 below shows the Login VSI Office workload test run. Initial or VSIBase was 911ms. Average response times stayed between one to two seconds.

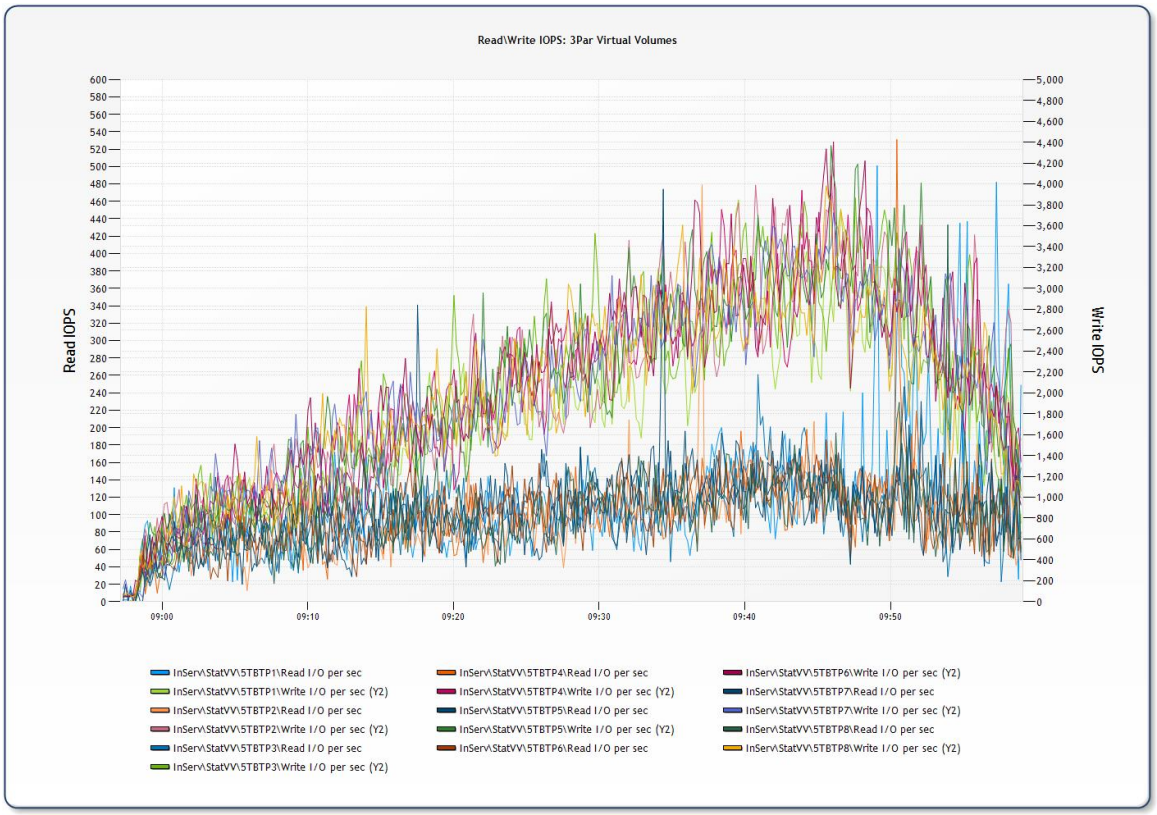
Figure 24. Non-Persistent PVS test VSImax



The HP 3PAR storage flash virtual volume layer was barely exercised as Login VSI does not create a high IOPS environment. What follows is an analysis for storage functionality during the tests. As mentioned earlier, all VMs were distributed across 8 volumes equally. Hence, the performance metrics across volumes were very similar and for clarity only single volume data is displayed in some of the graphs that follow.

The graph in Figure 25 below plots the read and write IOPS generated on the 8 virtual volumes. On average the workload produced a 5/95% read/write ratio. On average the workload produced 8 IOPS per user which is in line with Login VSI published matrices.

Figure 25. Read/Write IOPS



Latencies at the HP 3PAR LUNs were below 1ms indicating that the HP 3PAR all-flash array worked very well for this workload. At less than half a millisecond read and write times on average, user experience was exceptional. Peak usage latencies remained low as well.

The graph in Figure 26 below compares throughput vs. latencies (aka Service time) of a single virtual volume

Figure 26. Throughput vs. Read/Write Latencies

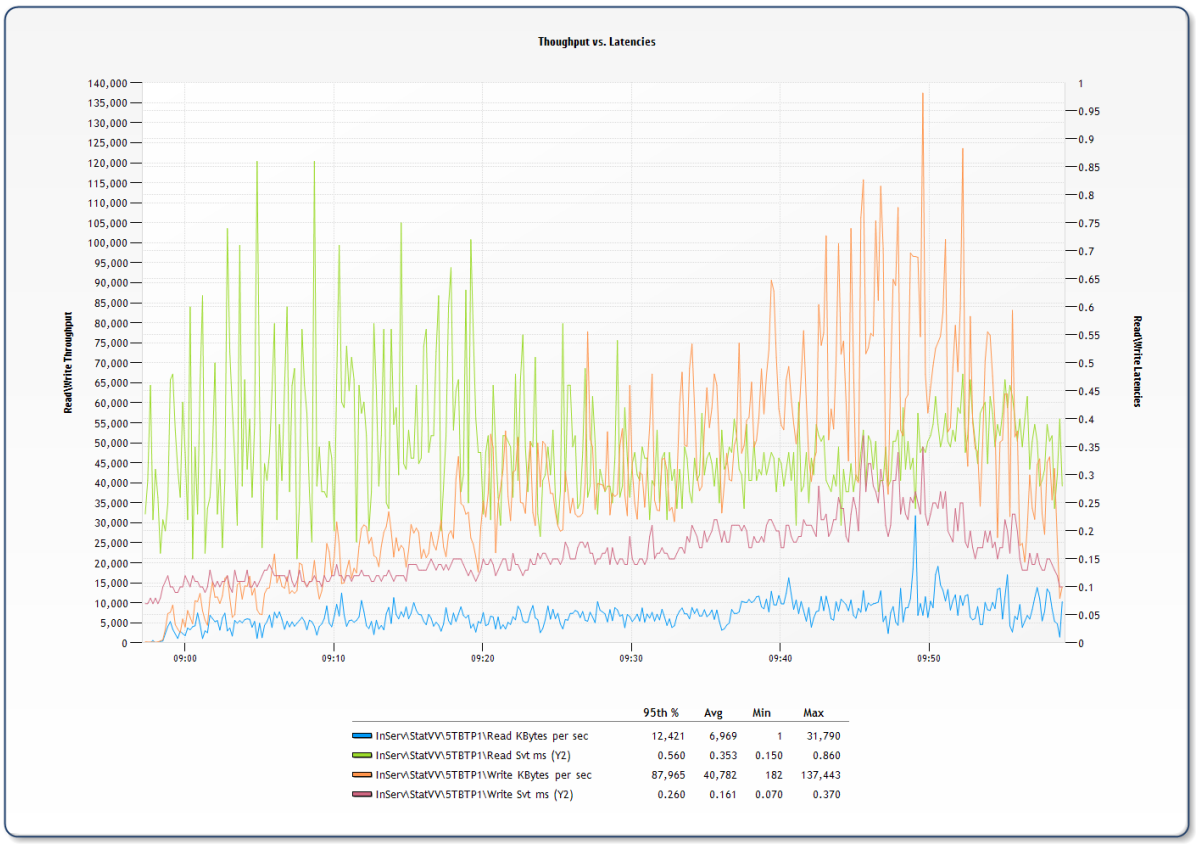


Figure 27 below represents the I/O that is hitting the storage Virtual Volume layer. This is I/O that is occurring at the flash media of the HP 3PAR StoreServ 7450 all-flash array. There are a few interesting trends to call out in the data. First, per user I/O, which can be inferred from cumulative I/O, is not remarkable. The Login VSI workloads do not generate a great deal of I/O to the disk. Based on this it may appear that a flash media would be an overkill. However, it is expected in production environments that I/O will be much higher. It is the real world observation of such I/O that leads HP to utilize an all-flash layer for these files. The second item of interest is the latency of writes to disk. This reflects of course, the underlying flash layer, but also the ability of the controllers to handle the I/Os and commit them to disk in a timely manner. By this gauge alone it is clear that the SAN is not taxed. Second, a much lighter read I/O is noticed in this test run. During an initial test such as this the behavior is expected. When applications are hosted from a shared copy of the operating system such as in this test design, nearly all reads in the environment are cached in memory on the PVS server. It should be noted that over the course of an extended day and with a broader set of applications it is likely that more reads will occur in the environment as write cache files fill with data that is referenced. In HP's experience though, planning on at least 90% or greater random writes for I/O is the correct approach to selecting disks and RAID layouts.

The graph in Figure 27 below provides another view of the read/write service times vs. IOPS of a single volume

Figure 27. Read/write service times vs. IOPS

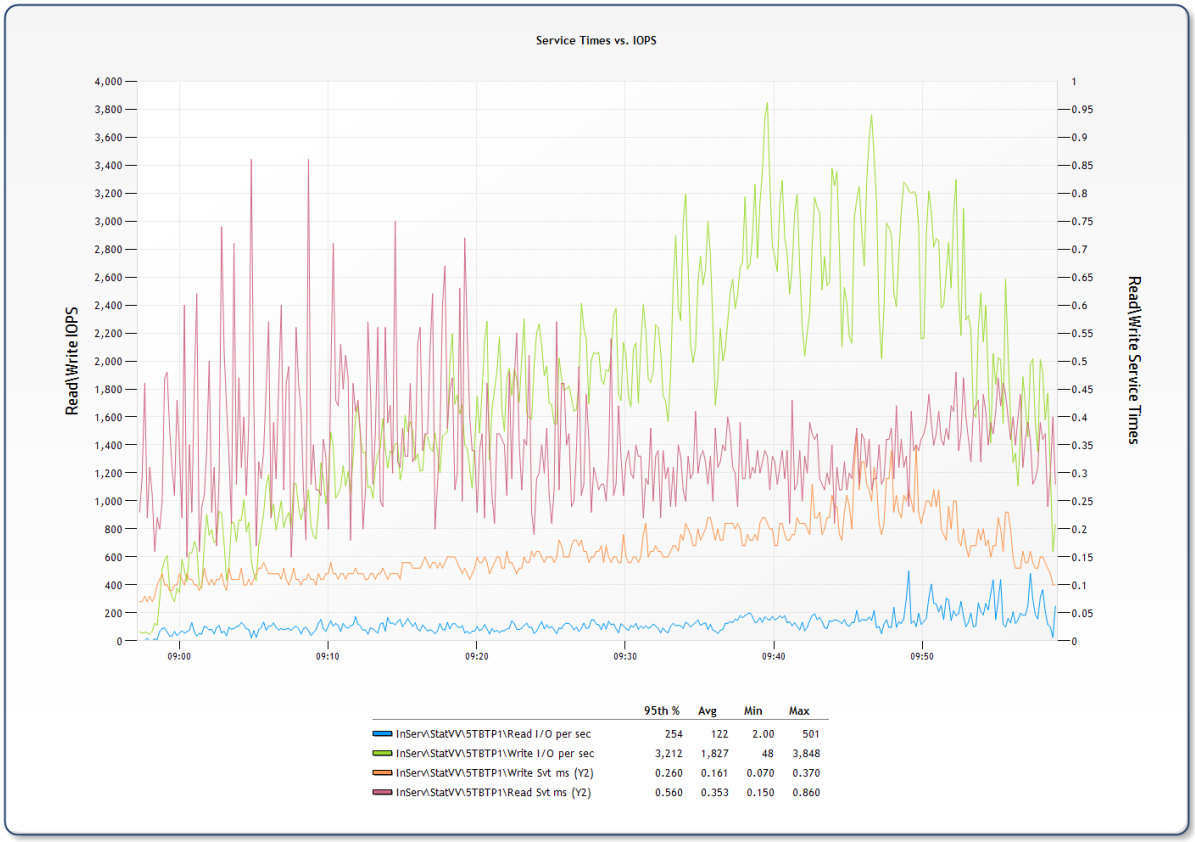


Figure 28 below looks at a single host in the stack. The other seven host graphs are essentially mirrors of this host and are thus omitted from the discussion except as they relate to calculating bandwidth requirements. The adapters in question form a vSwitch on the VDI host that carries PXE traffic from the PVS server. Two vmnics were used in an active/standby configuration. Vmnic4 to the active virtual and vmnic 5 to standby. This is visible in the graph where no traffic is passing through the standby vmnic. Most of the PXE traffic on the virtual machine host is received as the Windows operating system is being streamed to the virtual machine. Very little transmitted traffic is seen on the host PXE adapters as shown by the negligible green line in the graph.

The graph represents throughput for this controlled test environment. In production environments bandwidth allocation for PXE traffic should be sized on a case by case basis and per user requirements. There are a number of factors that contribute to this including image size and optimizations as well as how applications are delivered to the end user. HP and Citrix recommend higher bandwidth configurations for the PXE network on each host based on real world experience and analysis. With eight systems in the environment the cumulative requirement for the PVS server may be low. When a full enclosure or multiple enclosures are utilized at scale it is important to insure the network pipes are sized correctly and accounted for in the overall design.

Figure 28. PXE network throughput

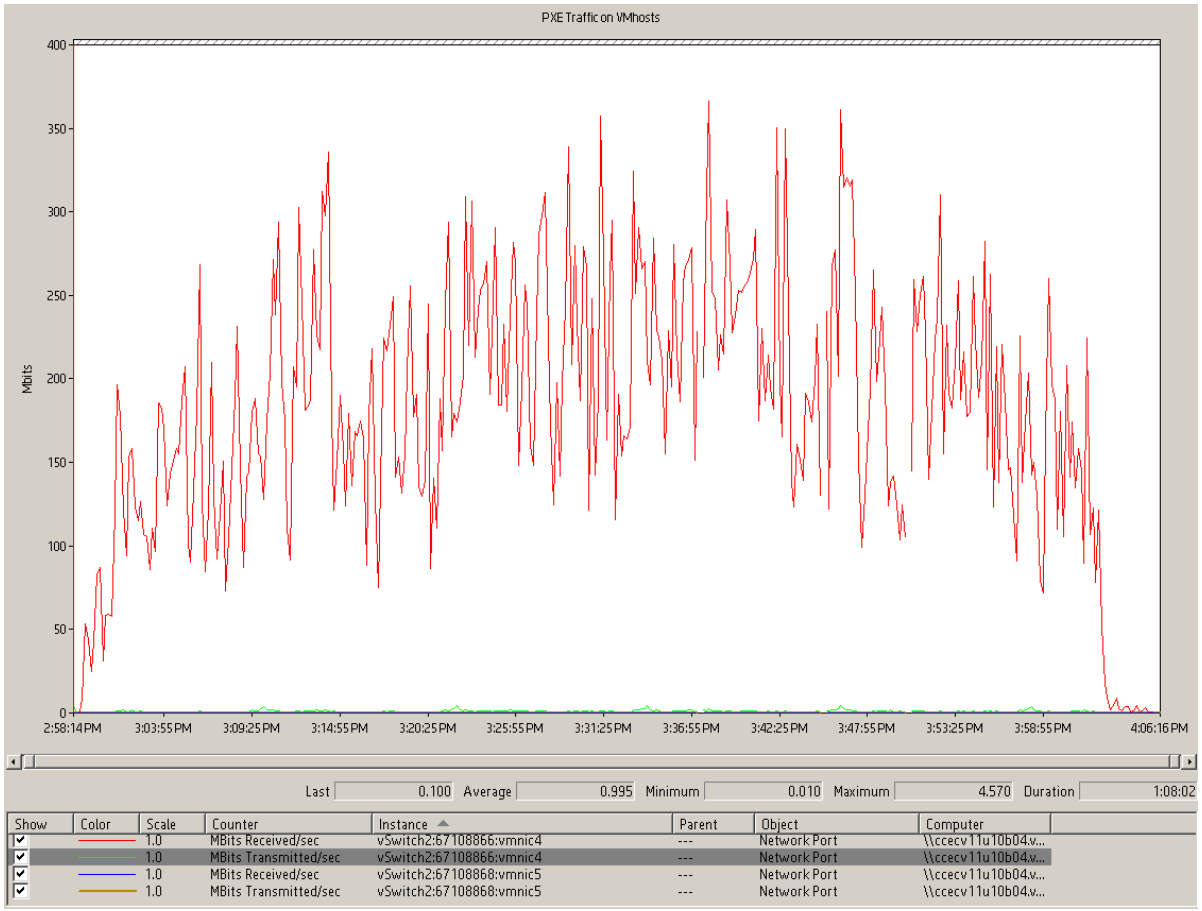
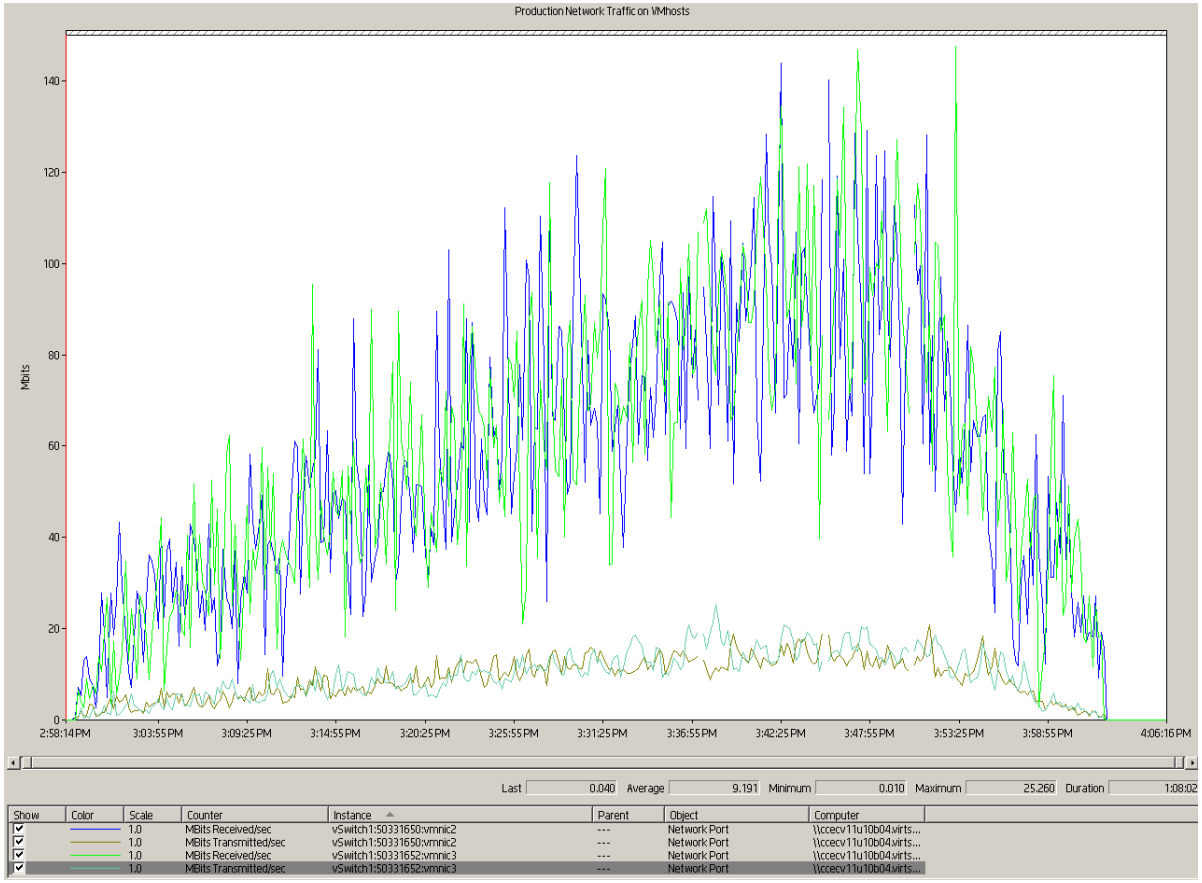


Figure 29 below represents production level traffic on the same host during the same timeframe. As with PXE traffic, all hosts mirrored each other due to the hypervisor and core VDI software ability to balance out load across systems. Total bandwidth is evident from the graph and well within the limits of the bandwidth assigned to the two adapters that make up the vSwitch. It is worth noting that this traffic includes the protocol as well as redirected user data and any application delivery mechanisms that stream or copy files to the target at runtime. Items such as file copies would also occur on this network as would traffic to web based applications and services. Graphics intensive applications will also have a marked effect on these traffic streams as some protocols can easily utilize orders of magnitude more bandwidth as the workload changes. The test environment does not model the vast majority of these variables. As such and as is recommended elsewhere in this document, an assessment of your environment prior to implementing any form of client virtualization is recommended to help with planning and sizing the overall environment in a way that recognizes the uniqueness of your software stack and usage patterns. For larger implementations, heavier usage patterns and further traffic segmentations, where needed, adding additional FlexFabric switch modules and FlexFabric mezzanine adapters should be considered.

Figure 29. Production Traffic

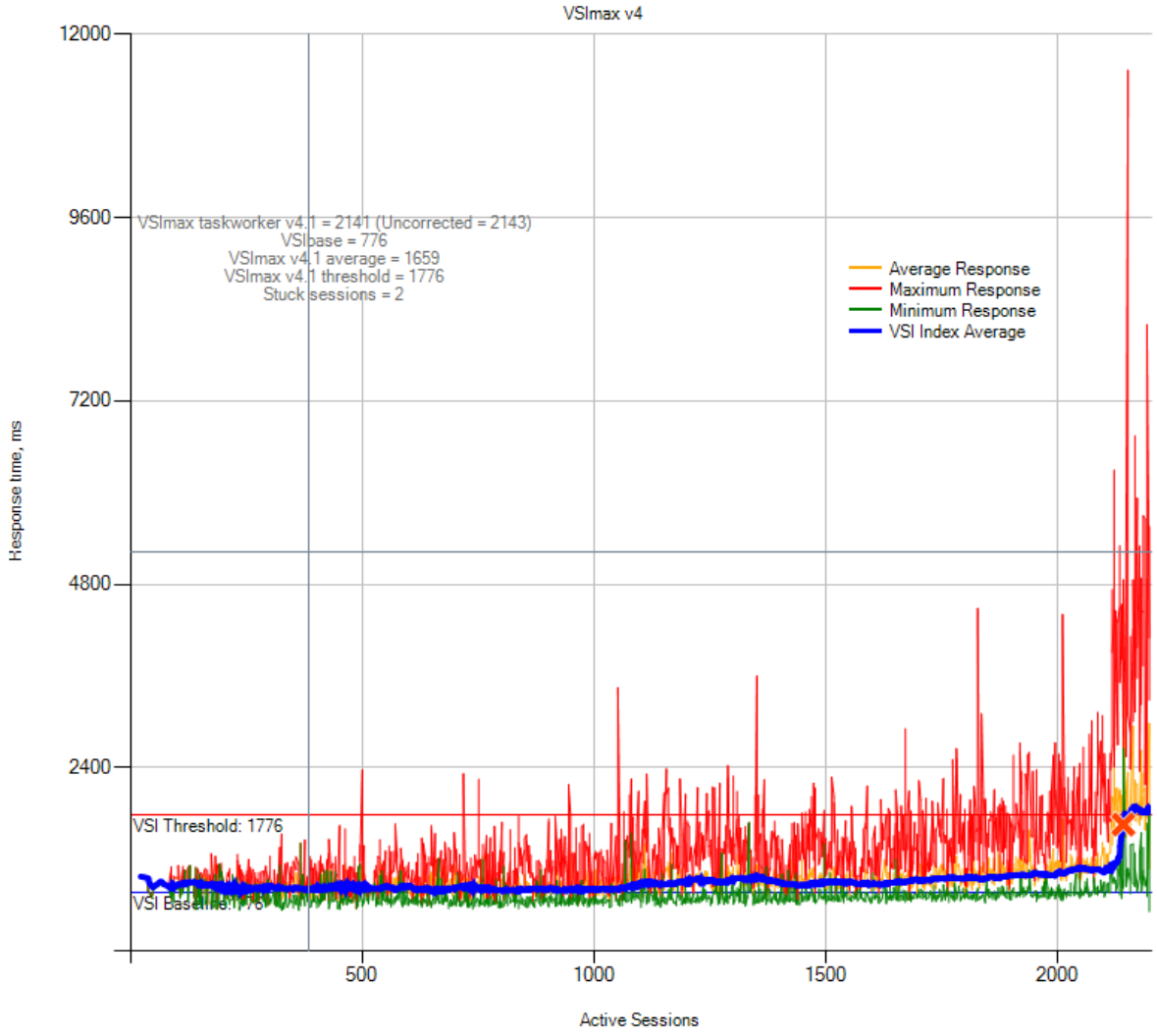


Citrix XenApp Shared Hosted Desktops test

XenApp was configured on a Windows 2012 R2 server running RDS (Remote Desktop Services) to host shared desktops. An image was captured of this master VM. VMs were configured for 14 user sessions per VM per Citrix recommendations. A single RDS host was configured to provide licenses for the user sessions. For XenApp, a goal was set to achieve a VSImax of around 2000 user sessions for the eight blades servers. 2200 user sessions were launched resulting in a VSImax of 2141 which exceeds the desired goal and validated the exceptional performance of the HP CS700 2.0 platform. In this use case, the taskworker workload was run without flash video to better emulate the user types that would be typically associated with the solution.

Figure 30 below shows the Login VSI results for this use case. The baseline (initial) response time measurement was the highest of the use cases at 776 ms. There were small spikes in the peak times, but these were limited to a small subset of VMs and were more related to Login VSI session timers rather than system performance. Over all the graph represents a typical Login VSI/XenApp test run with better than expected results.

Figure 30. VSImax for Shared Hosted Desktops



During the test, storage, network and other related metrics were similar to the PVS non-persistent use case mentioned previously in this document and analysis is not duplicated here. CPU usage on the XenApp VMs was higher than what was observed in the PVS non-persistent test run. This is expected for hosted shared VMs and no further analysis is required.

Bill of materials

Note
Part numbers used are based on the part numbers that were used for testing and subject to change. The bill of materials does not include complete support options or other rack and power requirements. If you have questions regarding ordering, please consult with your HP Reseller or HP Sales Representative for more details.
hp.com/large/contact/enterprise/index.html

Table 15. Bill of materials

Qty	Part Number	Description
1	K9T74A	HP ConvergedSystem 700 Virtualization 2.0 Foundation Kit
Recommended options		
		Management hosts
2	755258-B21	HP DL360 Gen9 8SFF CTO Server
2	755394-L21	HP DL360 Gen9 E5-2680v3 FIO Kit
2	755394-B21	HP DL360 Gen9 E5-2680v3 Kit
32	726719-B21	HP 16GB 2Rx4 PC4-2133P-R Kit
16	652583-B21	HP 600GB 6G SAS 10K 2.5in SC ENT HDD
2	764632-B21	HP DL360 Gen9 SFF DVD-RW/USB Kit
2	727060-B21	HP FlexFabric 10Gb 2P 556FLR-SFP+ Adptr
		Storage
2	QR486A	HP 3PAR 7000 4-pt 8Gb/s FC Adapter
1	QR516B	HP 3PAR 7000 Service Processor
1	BD365A	HP 3PAR 7000 Service Processor SW Media
1	BD363A	HP 3PAR 7000/7450 OS Suite Media
1	BD372A	HP 3PAR App Suite for VMware Media
1	BD373A	HP 3PAR Reporting Suite Media
1	BD362A	HP 3PAR StoreServ Mgmt/Core SW Media
1	E7X89A	HP 3PAR StoreServ 7450c 2N St Cent Base
1	BD362A	HP 3PAR StoreServ Mgmt/Core SW Media
2	QK753B	HP SN6000B 16Gb 48/24 FC Switch
24	E7Y57A	HP M6710 1.92TB 6G SAS 2.5in cMLC SSD
		Rack, Power and Network Infrastructure
2	BW932A	HP 600mm Rack Stabilizer Kit
2	BW908A	HP 642 1200mm Shock Intelligent Rack
2	BW930A	HP Air Flow Optimization Kit
2	BW891A	HP Rack Grounding Kit
2	TK815A	HP CS Rack Door Branding Kit
2	TK816A	HP CS Rack Light Kit
1	TK821A	HP CS Rack Side Panel 1200mm Kit
1	433718-B21	HP BLc7000 10K Rack Ship Brkt Opt Kit
1	BW902A	HP Rack Baying Kit

Qty	Part Number	Description
8	JC680A B2B	JmpCbl-NA/JP/TW
8	H8B50A	HP 4.9kVA 208V 30A NA/JP maPDU
8	JC680A	HP A58x0AF 650W AC Power Supply
8	JC682A	HP 58x0AF Bck(pwr)-Frt(ports) Fan Tray
2	JG510A	HP 5900AF-48G-4XG-2QSFP+ Switch
2	JC772A	HP 5900AF-48XG-4QSFP+ Switch
1	681844-B21	HP BLc7000 CTO 3 IN LCD Plat Enclosure
2	691367-B21	HP BLc VC FlexFabric-20/40 F8 Module
1	456204-B21	BladeSystem Onboard Administrator (for redundancy)
6	412140-B21	HP BLc Encl Single Fan Option
6	733459-B21	HP 2650W Plat Ht Plg Pwr Supply Kit
		Virtualization hosts
8	727021-B21	HP BL460c Gen9 10Gb/20Gb FLB CTO Blade
8	726987-L21	HP BL460c Gen9 E5-2690v3 FIO Kit
8	726987-B21	HP BL460c Gen9 E5-2690v3 Kit
8	761871-B21	HP Smart Array P244br/1G FIO Controller
128	726719-B21	HP 16GB 2Rx4 PC4-2133P-R Kit
8	700764-B21	HP FlexFabric 20Gb 2P 650FLB FIO Adptr
16	759208-B21	HP 300GB 12G SAS 15K 2.5in SC ENT HDD
		Cabling requirements
8	AJ836A	HP 5m Multi-mode OM3 LC/LC FC Cable
4	JD095C	HP X240 10G SFP+ SFP+ 0.65m DAC Cable
4	JG326A	HP X240 40G QSFP+ QSFP+ 1m DAC Cable
6	JG330A	HP X240 QSFP+ 4x10G SFP+ 3m DAC Cable
1	TK732A	HP 42U PDU MANAGEMENT-BRACKETS Cable
1	TK732A	HP 42U PDU MANAGEMENT-BRACKETS Cable
5	C7536A	HP Ethernet 14ft CAT5e RJ45 M/M Cable
8	C7533A	HP Ethernet 4ft CAT5e RJ45 M/M Cable
4	C7535A	HP Ethernet 7ft CAT5e RJ45 M/M Cable
8	AJ716B	HP 8Gb Short Wave B-Series SFP+ 1 Pack
12	AJ837A	HP 15m Multi-mode OM3 LC/LC FC Cable
4	AJ835A	HP 2m Multi-mode OM3 LC/LC FC Cable

Summary

The decentralization of resources including applications and devices has caused customers to rethink how to deliver an optimal end user experience. Beyond this, user behaviors have also changed including where they work and on what device they prefer to work. HP and Citrix have addressed these challenges, The HP Verified Reference Architecture for Citrix XenDesktop 7.6 on ConvergedSystem 700 2.0, with VMware vSphere builds off of the strength and versatility of the Citrix FlexCast technology and leverages years of HP innovation delivering client virtualization solutions. Unique improvements in HP server, storage and networking technologies make this newest architecture the highest performing, lowest cost and easiest to manage that HP has ever developed. It is ideally suited for the performance and scalability requirements of Citrix XenDesktop deployments requiring architectural flexibility, extreme performance and rapid and simple scaling.

Implementing a proof-of-concept

As a matter of best practice for all deployments, HP recommends implementing a proof-of-concept using a test environment that matches as closely as possible the planned production environment. In this way, appropriate performance and scalability characterizations can be obtained. For help with a proof-of-concept, contact an HP Services representative (hp.com/large/contact/enterprise/index.html) or your HP partner.

Appendix

Vlan names and configuration used to build the reference architecture differs from what is shipped with CS700 2.0. The following table outlines the differences.

Table 16. Vlan names and configuration differences

Reference Architecture Network name	RA Vlan	CS700 2.0 network name	CS700 2.0 Vlan
Management Network	vlan 21	Solution_Management_Network	vlan 1
		DC_Management_Network	vlan 100
Production network	vlan 102	Production_Network	vlan 101
Compute Migration	vlan 101	Compute_Migration_Network	vlan 102
Compute HA Network	vlan 103	Compute_HA_Network	vlan 103
Management Migration	vlan 105	Mgmt_Migration_Network	vlan 105
Management HA Network	vlan 106	Mgmt_HA_Network	vlan 106
PXE Network	vlan 107	Not configured	Not configured

For more information

HP ConvergedSystem 700, hp.com/go/convergedsystem/cs700

HP OneView, hp.com/go/oneview

HP 3PAR StoreServ 7450 Storage, hp.com/go/StoreServ7450

HP Networking, hp.com/go/networking

HP ProLiant BL460c, hp.com/servers/bl460c

HP ProLiant DL360, hp.com/servers/dl360

Login VSI, loginvsi.com

Citrix XenDesktop. citrix.com/products/xendesktop/whats-new.html

To help us improve our documents, please provide feedback at hp.com/solutions/feedback.

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hp.com/go/getupdated

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