Technical white paper

HP Reference Architecture for Client Virtualization

Client Virtualization from HP with Citrix XenDesktop and Microsoft Windows Server 2008 R2

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Executive summary

Businesses are looking to enable flexible workstyles for their users with the ability to work anytime, anywhere, from any device while increasing IT efficiency through cloud services. Client virtualization is a hot topic because it addresses these two pain points.

However, client virtualization can open a Pandora's Box of terms, ideas, and questions. Client virtualization can be as broad as providing access to a remote desktop to an end user to as specific as delivering a non-persistent streamed desktop, or virtual desktop infrastructure (VDI).

A hosted desktop solution, formerly known as server based computing, is straight forward and has been around for many years in the familiar Citrix XenApp/Metaframe products. In this model all users share the same desktop interface hosted on a server on the back-end, with no opportunity for user customization. Updates need only be applied to the server to affect all of the users. This approach works very well for entry level users running only a few apps and no requirement to modify or customize their environment. For users requiring administrator rights, specific unique applications or isolation from other users for security a virtual desktop infrastructure can be utilized.

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. The primary difference between a hosted desktop user and a non-persistent user is user isolation in a dedicated virtual machine. What one user does in the hosted desktop environment can affect all other users in that hosted environment, as all users are sharing the memory and CPU of the server.

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. When the user logs off, the differential files are deleted and re-created for the VM. If they exceed the capabilities of the assigned processing and memory it only affects that user's performance. Updates are applied to the base image and all users will get the updates.

Like a non-persistent user, a persistent VDI user is isolated from other users on the same server, but the difference is the user customizations are maintained between logins in an assigned virtual hard disk (vHD), one file per user. This model generates many vHD files to manage. Another approach for persistent users is similar to non-persistent users, but the differential files are maintained across logins so any changes the user makes will be stored in the differential files. However, if the base master image is ever changed one of two things will happen depending on the configuration. The first is the differential files are marked invalid, and the next time the user logs in they are deleted and re-created, and the user loses any customization they did. The second is the changes in the base image will be copied to all of the differential files, increasing the size if the differential files. Over time these differential files could grow to be quite large.

In many cases instituting a client virtualization solution is not a single solution, but a hybrid strategy. Companies that have tried to use hosted desktops for all users have found that not all users fit into the entry level user, nor do they all use the same applications.

Persistent desktops allow for isolation of users, and allow different user to have different applications. However, companies that have simply converted their existing desktop images into persistent desktops may lead to large and difficult to manage images, excessive storage consumption and may lead to a more costly model to support than dedicated desktops.

For VDI, the non-persistent user is the most desired model. Benefits of a non-persistent user model include:

- A single or only a few images to maintain.
- No one user can affect other users.
- The amount of required storage can be reduced.

However, and there always seems to be a however, users cannot customize their environments unless user virtualization is implemented using Citrix User Profile Manager or third party applications to manage the user environment. User virtualization allows for each user to customize their environment, and maintain that customization across logins.

Citrix also provides the FlexCast model, allowing for multiple ways to deliver the desktop to the end user, from using the hosted desktop capabilities of Citrix XenApp, to creating a virtual desktop that is streamed to an end user device using XenDesktop and Provisioning Server. And now with XenDesktop 5.6, Citrix has added personal vDisks, PvD. One of the downsides to non-persistent VMs even with user virtualization is allowing a user to install customized or specific software that only they have a need to access. The PvD from Citrix allows a non-persistent user to become a persistent

user, but still use the same base image. These users still boot from the master image maintained by IT, but have the capability to customize their environment, even install software, and have those changes remain across logins.

This document will focus on client virtualization using VDI technology with XenDesktop, and the considerations/implications of persistent vs. non-persistent users.

HP has partnered with Citrix to leverage the converged capabilities of HP servers, storage and networking to develop a VDI client virtualization (CV) Reference Architecture optimized to take advantage of Citrix FlexCast. Key differentiators of this reference architecture include:

Simplicity: Whether hosting a 100-user proof-of-concept or a 20,000 user production implementation, the building block remains the same. HP BladeSystem allows for the use of high scaling, distributed 2-socket servers in VDI implementations while maintaining a minimal amount of infrastructure to be managed. The result is a highly available, power efficient, simple to manage infrastructure that sacrifices nothing while delivering optimized costs, converged storage and networking, and simple scalability. This Reference Architecture provides validated configurations for a single enclosure containing the necessary compute, storage and network required to support 1,690 users and leveraging Virtual Connect across racks to support over 6,500 users. Each enclosure has all the servers, storage and network interconnects required to run XenDesktop.

Network flexibility with reduced costs: Leveraging HP Virtual Connect technology to deliver network flexibility and performance while reducing costs is accomplished by migrating as much of the infrastructure and compute resources as possible to within the Virtual Connect domain.

Optimize storage price/performance: This RA takes into consideration the unique characteristics of Citrix XenDesktop's Provisioning Server and personal vDisks and provides optimal configurations using the HP Virtual SAN Appliance (VSA) that maximize the usage of lower cost Direct Attached Storage and minimize the use of higher-cost SANs.

Rich user experience: HP has a line of Citrix Ready zero and thin-clients optimized to take advantage of Citrix HDX technologies to deliver a consistent, rich end-user experience – delivering an end-to-end solution

Target audience: This document is intended for IT decision makers as well as architects and implementation personnel who want to better understand HP's approach to client virtualization. The reader should have VDI knowledge and understanding, understanding of XenDesktop, Microsoft® Windows® Server 2008 R2 and Microsoft System Center Virtual Machine Manager (VMM) 2012, and understands sizing/characterization concepts.

This and other documents pertaining to client virtualization with HP may be found at hp.com/go/cv.

This white paper describes testing performed in March of 2012.

Client virtualization and HP

HP has been involved with client virtualization for many years, from HP's working with Citrix for hosted desktops with XenApp[1], previously known as Presentation Server, creating the Consolidated Client Infrastructure using PC based blades in the early 2000s, to HP Workstation Blades[2] allowing 1-to-1 connections delivering hardware accelerated 3D graphics to remote desktops, to working closely with Citrix and their development of XenDesktop as a product.

Purpose of this document

This paper focuses on HP's recommended approach to virtual desktops in client virtualization with Citrix XenDesktop 5.6, Citrix Provisioning Server 6.0, Microsoft Windows Server 2008 R2, and VMM 2012 using HP's blades and storage to create a reference architecture. The document will discuss HP's testing methodology, how testing and characterization was done, and highlight best practices in setting up a reference architecture. This is not a step-by-step instruction guide to build a reference architecture. This document will not give installation guidance, or show how to install the software discussed. It will highlight considerations and best practices to help ensure a successful VDI implementation.

This document will focus on the hardware and configurations that HP considers to be the sweet spot around VDI.

[1] HP has been working with Citrix around hosted desktop sizing and configuration. Information can be found at http://h20338.www2.hp.com/enterprise/cache/3916-0-0-0-121.html.

[2] For more on HP ProLiant WS460c Workstation blade, go to hp.com/go/workstationblades

Reference Architecture components

HP BladeSystem

Drive business innovation and eliminate server sprawl with HP BladeSystem, the industry's only Converged Infrastructure architected for any workload from client to cloud. HP BladeSystem is engineered to maximize every hour, watt, and dollar, saving up to 56% total cost of ownership over traditional infrastructures.

With HP BladeSystem, it is possible to create a change ready, power efficient, network optimized, simple to manage and high performance infrastructure on which to build and scale your VDI implementation. An HP BladeSystem c7000 enclosure populated with HP ProLiant BL460c Gen8 blades is shown in Figure 1.

Figure 1: The HP BladeSystem c7000 enclosure (pictured with HP ProLiant BL460c Gen8 server blades)

Benefits for VDI: HP BladeSystem allows for the use of high scaling, distributed 2-socket servers in VDI implementations while maintaining a minimal amount of infrastructure to be managed. The result is a highly available, power efficient, simple to manage infrastructure that sacrifices nothing while delivering optimized costs, converged storage and networking, and simple scalability.

HP ProLiant Servers

Choosing a server for VDI involves selecting a server that is the right mix of performance, price and power efficiency with the most optimal management. HP's experience during test and in production has been that 2 socket servers are the ideal platform for VDI. With the potential of over 100 VMs running on one platform, 2 socket systems offer better memory performance and thus better scaling models than larger systems. HP BladeSystem reduces costs and simplifies management through shared infrastructure.

HP ProLiant BL460c Gen8

The HP ProLiant BL460c Gen8 server blade offers the ideal balance of performance, scalability and expandability for any workload, making it the standard for dense data center computing.

Figure 2. HP ProLiant BL460c Gen8 server blade

The HP ProLiant BL460c Gen8 offers Intel® Xeon® E5-2600 series processors, Flex adapters supporting Flex-10[3] with Ethernet, iSCSI and even FCoE traffic, up to 512GB of DDR3 memory, two hot plug drive bays with an embedded HP Smart Array controller as well as industry leading HP Integrated Lights-Out 4 (iLO 4) management capabilities.

Benefits for VDI: The BL460c Gen8 is an ideal platform for all VDI user types. The BL460c offers not only high user counts per host, but also incredible density which is far more important in optimizing power and management efficiency as well as reducing infrastructure. It also makes no compromises with memory speed which plays an important role over capacity when achieving maximum performance.

HP Storage

Storage is as important as the servers in your client virtualization deployment. The storage infrastructure is directly in the critical path for hundreds or thousands of your end users and this introduces a number of unique challenges with respect to delivering consistently high performance, minimizing management and deployment costs, and scalability and efficient capacity utilization. For this reason, the storage platform you choose is critical to making the economics of client virtualization work while maintaining high quality of service levels to satisfy user requirements. HP provides storage solutions to meet small to large client virtualization deployments with a range of SAN, NAS and DAS solutions.

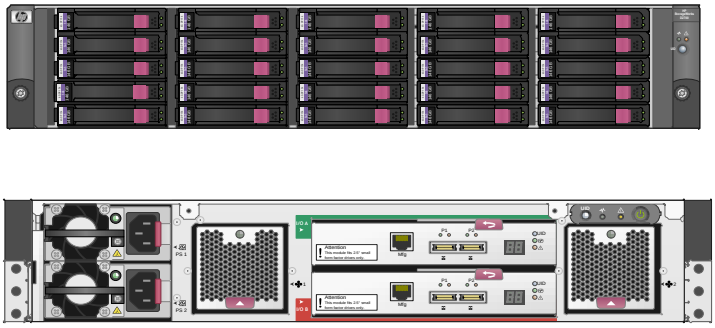
HP D2000 Disk Enclosures

The D2000 disk enclosures deploy with the next generation 6Gb SAS for a flexible tiered external storage system. The 6Gb SAS enclosures - Large Form Factor (LFF) D2600 with 12 drive bays and Small Form Factor (SFF) D2700 with 25 drive bays - offer modular solutions to simplify capacity expansion of HP ProLiant server environments to external storage without having to make the full move to SAN or NAS. This allows you to buy what is needed today and purchase additional capacity as data storage needs grow.

The HP D2700 w/25 300GB 6G SAS 10K SFF Dual Port HDD 7.5TB bundle is utilized to supply direct attached storage to the blades through 6Gb SAS switches. Expansion can be accomplished by adding additional D2700 disk enclosures and using the SAS management console integrated into the switch to assign the drives to blades.

[3] More information about HP Flex technology can be found at: http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01608922/c01608922.pdf

Figure 3: The HP D2700 Disk Enclosure – Front and Rear view



Benefits for VDI: The D2700 7.5 TB bundle allows for ease of growth by adding additional disk enclosures to support additional blades. Configuration for each disk enclosure is handled using the SAS management console and the HP ACU, array controller utility.

HP LeftHand Storage Solutions — ideal storage for client virtualization

HP LeftHand Storage solutions are highly optimized for virtual server and desktop environments, with a storage architecture that enables non-disruptive linear scaling of capacity and performance so you can grow your client virtualization solution as you need, when you need. With a wide range of storage solution deployment options – from a virtual SAN appliance to rack and blade systems – HP LeftHand Storage provides the optimal mix of storage affordability with the right set of features and scalability to meet your client virtualization storage needs, no matter how small or large. HP LeftHand Storage delivers:

- Storage Efficiency to Maximize Your client virtualization Investment:
  - Thin provisioning raises storage utilization and efficiencies
  - Clustering, density, and storage tiers optimize dollars per I/O
- High Performance to Enable Worker Productivity:
  - Clustered, virtualized architecture delivers maximum disk utilization
  - Dense spindle count, high-speed storage paths, optimized use of SSDs
- High Availability to Support Critical End User Applications:
  - No single-point-of-failure storage architecture through Network RAID
  - Non-disruptive software upgrades
- Wide Ranging Scalability to Grow When You Need:
  - Linear, non-disruptive capacity and performance scaling
  - Protect your capital investment, start small and grow large

For more information, see hp.com/go/lefthand.

HP LeftHand P4800 Storage Solutions for HP BladeSystem

The HP LeftHand P4800 Storage Solution delivers storage that is fine-tuned for client virtualization with HP BladeSystem. It is based on a tight integration with HP BladeSystem and offers a highly dense storage solution that dynamically and linearly scales as the infrastructure expands. Being converged into the HP BladeSystem architecture enables simplified administration, improved security, flexibility, and enhanced performance through network convergence of the virtual server and storage fabric using 10Gig Ethernet and Flex-10 Virtual Connect.

Convergence with the HP BladeSystem architecture also provides a significant density and footprint advantage further saving costs. HP P4800 Storage for BladeSystem is designed for departmental or enterprise environments with greater than 500 users.

Scaling from 2 nodes and 70 disks (see Figure 4) to 8 nodes with 280 disks in a single BladeSystem c7000 enclosure with associated storage drawers, or to 16 nodes with 560 disks across multiple BladeSystem c7000 enclosures and storage drawers ensures I/O performance is outstanding for the large scale VDI deployments that HP LeftHand P4800 addresses. The ability to make private storage networks where storage traffic remains within the Virtual Connect domain means one administrator can manage the entire infrastructure stack without the need for specialized storage skill sets or in depth network administrator involvement.

Figure 4: The HP LeftHand P4800 Storage Solution for HP BladeSystem

Whether you are looking to place persistent VMs or non-persistent VMs, the HP P4800 offers up the mix of capacity with thin provisioning and performance required for VDI.

Benefits for VDI: The convergence of not only storage but also the transport layer into a single, simple to manage infrastructure means intensive multi-team and multi-skill set involvement is a thing of the past. This leads to more rapid deployment and faster response to business-driven change requests. The fact that the fabric is integrated across high speed electrical links leads to performance that is both impressive and scalable, so your users are always productive.

HP LeftHand Virtual SAN Appliance Software

HP LeftHand Virtual SAN Appliance is a VM running the SAN/iQ software allowing local or direct attached storage to be used to create volumes and clusters to be shared between servers.

Benefits for VDI: Utilizing HP LeftHand Virtual SAN Appliance Software (VSA) for selective use as a storage layer allows for migration of infrastructure VMs, creation of volumes for clustering between hosts and SQL servers, and storage for provisioning servers. VSA is even managed from the same console as the other HP LeftHand storage tiers and scales simply to meet demand.

User data storage

Data centers today rely on a variety of storage solutions to support different networks, applications and users. Flexibility and scalability are key to meeting these various and often changing requirements. HP X3800 Network Storage Systems meet the requirements of any size data center. For example, the HP X3800 Network Storage Gateway, a network-attached storage (NAS) appliance, with Windows Storage Server 2008 R2, provides large data centers the performance, flexibility and scalability they need to support tens of thousands of users. HP recommends keeping user data on external storage outside of the VDI environment. Figure 5 shows the HP X3800.

Figure 5: HP X3800 Network Storage Gateway

Benefits for VDI: The HP X3800 Network Storage Gateway integrates into existing Microsoft Windows management processes and brings user data into data center backup plans while keeping management simple.

HP Virtual Connect Flex-10

HP VDI and Flex-10 technology

HP Virtual Connect Flex-10 technology creates dynamically scalable internal network architectures for VDI deployment. Multiple c7000 enclosures make up the core building blocks of the physical infrastructure. Each enclosure contains two Virtual Connect (VC) Flex-10 interconnect modules. Each module connects to two dual port 10Gb Flex-10 or FlexFabric adapters in each server (Gen8 BladeSystem servers have embedded FlexFabric adapters and can accommodate mezzanine Flex-10 or FlexFabric adapters). Each Flex-10 or FlexFabric adapter has four FlexNICs on each of its dual ports. The multiple FlexNICs can support the iSCSI storage, specialized virtual machine function, management, and production networks recommended for HP VDI.

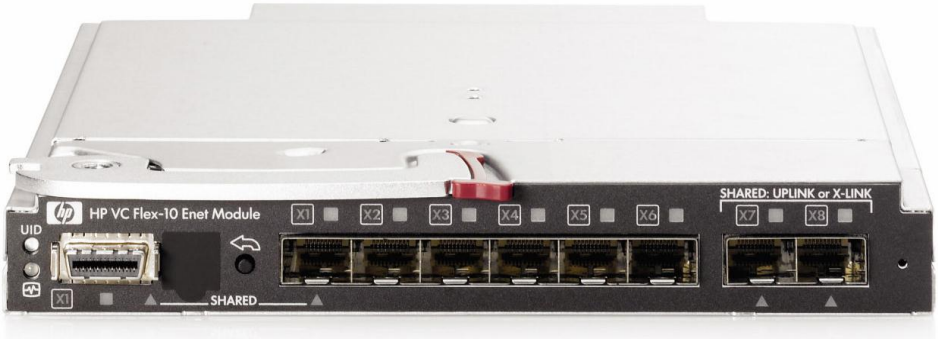
VC Flex-10 modules and adapters aggregate Ethernet and accelerated iSCSI storage traffic between the server and Flex-10 module (server-network edge) into a 10Gb link. Flex-10 technology partitions the 10Gb data stream into multiple (up to four) adjustable bandwidths, preserving routing information for all data classes.

Flex-10 modules and stacking

You can link the Flex-10 modules within each enclosure, and between enclosures, using the internal links available in each enclosure, and using stacking cables and appropriately configured ports on each module. This multi-enclosure stacking creates a single Virtual Connect domain between all the enclosures (up to four enclosures). This means that all HP BladeSystem VDI servers and the P4800 SAN operate in the same VC domain.

The ability to consolidate all VDI server/storage-side traffic on a single internal VC network, is a major advantage. Any network adapter can connect with any other adapter within the VC network (domain) without exiting to the external network, and without additional switches or network management. This simplifies management, reduces support requirements and a tremendous reduction in both uplink and switch ports. Figure 6 shows a Virtual Connect Flex-10 module.

Figure 6: The HP Virtual Connect Flex-10 Ethernet module



Benefits for VDI:

- Network isolation – Flex-10 technology provides physical network isolation for required network types. VM traffic within the server has access to eight FlexNICs per dual port Flex-10 or FlexFabric adapter (four FlexNICs per port).
- Network aggregation – The Flex-10 or FlexFabric adapter aggregates each set of four FlexNICs into a single 10Gb uplink so that each dual port adapter has only two 10Gb links between the server adapter and the Flex-10 module. From the enclosure or Virtual Connect domain to the core, as few as two cables aggregate networks you choose to egress straight to the core resulting in a dramatic reduction in cables as well as expensive switch ports.
- Single internal network – You can stack Flex-10 modules within the enclosure and between enclosures to create a single internal VC network (domain), eliminating the need for additional switches and greater intervention by network administrators, and in the case of the P4800 G2 SAN Solutions for BladeSystem, storage administrators.
- Unified management – The Onboard Administrator, Virtual Connect Enterprise Manager and LeftHand Centralized Management Console reduce and simplify the management burden for VDI administrators. Management and monitoring of the core pieces can be surfaced into your virtualization management software to further simplify the management picture.

HP 12500 Series Switches

When implemented with HP Virtual Connect, the 12500 series switch facilitates direct wiring to the core saving switch ports, cables and complexity while flattening the network within the data center. The resultant loss in switch ports, cables and management translates directly to lower costs, greater security through the reduction in access points and tremendous performance. Necessary services such as Active Directory, email and application delivery are immediately accessible.

Figure 7: HP 12500 Series Switch

Extend VDI to the branch with HP MSR series routers

HP Networking has published a reference architecture to help customers understand the implementation and design requirements as well as the benefits of making the shift to industry standard based networking. Consult the Data Center Network Reference Architecture at http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA3-4150ENW.

HP Thin Clients

Figure 8: HP Flexible Thin Clients

Innovative, reliable, secure. HP delivers real business results for your virtual computing world. We make it easy to deploy and manage thin client solutions whether you're near or far. HP provides best-fit solutions plus worldwide support, offering the widest range of choices that allow you to scale up or down. We offer maximum flexibility with industry-standard hardware and open software platforms, and our technology integration is seamless.

Flexible Thin Clients

Fast, flexible, secure. Give your business what it deserves. Our engineers did the hard work to develop a smart design with feature-rich power, so you can focus on what matters for you. We know key to growth is staying flexible. We are by your side to help make those growing pains less painful. We have designed our Flexible Thin Clients with the security you need now (and the security you'll need in the future), with options to grow and expand, all with performance as if you were on a PC.

Smart Zero Clients

Keeping it quick, simple, and flexible is the goal of HP Smart Zero Clients. No need to worry if the backend software changes. HP's Smart Zero Clients operate like a zero client, but are intelligent enough to reconfigure themselves to Citrix, Microsoft, or VMware protocols. Simply plug them in, turn them on, and they work.

Citrix XenDesktop

Citrix XenDesktop is a desktop virtualization solution that transforms Windows desktops and apps into an on-demand service available to any user, any device, anywhere. XenDesktop quickly and securely delivers any type of virtual desktops, Windows, web and SaaS (software as a service) applications to PCs, Macs, tablets, smartphones, laptops and thin clients – all with a high-definition user experience. Citrix FlexCast delivery technology enables IT to go beyond VDI and deliver virtual desktops to any type of user, including task workers, mobile workers, power users and contractors. XenDesktop also helps IT rapidly adapt to business initiatives, such as offshoring, mergers and acquisitions, and branch expansion by simplifying desktop delivery and enabling user self-service. The open, scalable and proven architecture dramatically simplifies virtual desktop management, support and systems integration, optimizes performance, improves security, and lowers costs.

The best choice for desktop virtualization

XenDesktop is a comprehensive desktop virtualization solution that includes all the capabilities required to deliver desktops, apps and data securely to every user in an enterprise. Trusted by the world's largest organizations, XenDesktop has won numerous awards for its leading-edge technology and strategic approach to desktop virtualization.

XenDesktop helps businesses:

- Enable virtual workstyles to increase workforce productivity from anywhere
- Leverage the latest mobile devices to drive innovation throughout the business
- Rapidly adapt to change with fast, flexible desktop and app delivery for offshoring, mergers and acquisitions, branch expansion and other initiatives
- Transform desktop computing with centralized delivery, management and security

A complete line of XenDesktop editions lets you choose the ideal solution for your business needs and IT strategy. XenDesktop VDI edition, a scalable solution for delivering virtual desktops in a VDI scenario, includes Citrix HDX technology, provisioning services, and profile management. XenDesktop Enterprise edition is an enterprise-class desktop virtualization solution with FlexCast delivery technology that delivers the right type of virtual desktop with on-demand applications to any user, anywhere. The comprehensive Platinum edition includes advanced management, monitoring and security capabilities.

Provisioning in XenDesktop

Citrix XenDesktop offers several methods of provisioning and deploying desktops. Citrix Provisioning Services (PVS) infrastructure is a software-streaming technology allowing computers and virtual machines to be provisioned and managed using a single shared-disk image. All management can be done on a single master image. A snapshot of a device's hard drive (physical device or virtual machine) is converted into a vDisk (virtual disk) and stored on the PVS server. This vDisk can then be streamed to PXE booted devices, either physical or virtual.

PVS has write cache files associated with each VM, these files are a defined size and will not grow beyond that set size. As a best practice, the write cache files should be created as fixed. Also, the files do not have to reside in the same location as the master image, and for best performance it is recommended to never place the write cache files on the PVS server (i.e. do not configure for "Server-side write cache mode"). The write cache files should be maintained either on a SAN accessible by the hypervisor host or on direct attached storage on the host.

A second method of provisioning VMs is using MCS, or machine creation services. With MCS using the Desktop Studio in XenDesktop a catalog type of Pooled is created, and an existing VDI VM is selected as the master image. Then the number of VMs to be created is specified and differential and identity disks for each VM are created on the specified server or on shared storage for access by multiple servers. The differential files are dynamically created, but can grow to be the same size as the master image. The identity disks require very little storage and do not change size. It should be noted that with MCS the differential/identity disks and the master image must reside on the same storage repository. If there are 10 servers and the master image is placed on each server, there are now 10 master images to manage. If the master image is placed in a cluster and shared by the 10 servers there is only one image to manage, but all of the differential/identity disks are in the same storage location. If each server is supporting 100 users, there are now 1000 differential files being read/written to the shared storage, and any or all of these differential files could grow to the size of the master image.

PVS is more involved to setup and configure, requiring either a physical or virtual server to install PVS, and depending on the size of the environment may require multiple PVS servers. However, due to the performance and flexibility that PVS offers, this RA will focus on PVS to do provisioning for the VDI sessions.

Something new in XenDesktop 5.6 is the personal vDisk, or PvD. This feature of XenDesktop retains the option of using a single image while allowing users to customize their desktop environment and maintain those customizations across logins, creating a persistent user but managing a single image. PvD uses redirection of changes made in a user's VM to a separate vDisk attached to the user's VM. The PvD has two parts using different drive letters and are by default equal in size:

- The first part comprises the C:\Users folder in Windows 7 containing user data, documents, and the user profile.
- The second part is a Virtual Hard Disk (VHD) that contains other items, for example programs installed into C:\Program Files. This drive is hidden from the users and not displayed in Windows Explorer.

How to configure and manage PvD can be found at citrix.com/edocs.

The addition of a PvD to a VM does not increase the number of IOPs associated with a user, but redirects the IOPs between the streamed image, the write cache file, and the PvD in a PVS configuration. The current version of PvD does have a CPU impact of roughly 20% on the host. This needs to be considered when looking at how many users can be supported with PvD.

More information about XenDesktop, PVS, MCS and PvD can be found citrix.com/edocs.

Microsoft Windows Server 2008 R2

Microsoft Windows Server 2008 R2 SP1 was used to supply the Hyper-V hypervisor. This hypervisor was used for host VMs on all of the blades. The Dynamic Memory capabilities of Windows Server 2008 R2 SP1 was utilized to balance and distribute memory between the VMs. All VMs were started with a minimum of 768 MB of memory and a maximum of 1.5GB.

Microsoft Windows Server 2008 R2 offers the capability to do live migration of VMs using Clustered Shared Volumes (CSV). The ability to live migrate is configured for the management servers and the infrastructure VMs running on those servers. Live migration was not implemented for the desktop VMs. The desktop VMs are configured with differential files to hold changes and updates. These files are deleted and re-created at every login, and are kept on storage directly attached to the servers. Storing throw-away differential files on expensive SAN storage just so a user can be live migrated from one host to another needs to be considered in the design. This RA uses direct attached storage to store the differential files associated with PVS. However, a SAN can be used, but at a higher per user cost for storage and more complex management infrastructure. It becomes a math problem to ensure the SAN has enough IOPs to support the users. In the event of a system failure, the user simply logs back in and is connected to a VM running on a different host. Using Citrix maintenance mode and planning will allow for users to be moved from one server to another by simply having them log off and back on. If the environment is configured correctly the user will see no changes, nor be aware they are on a different server and VM. For the infrastructure VMs it is recommended to configure for live migration. This will be discussed in more detail later in the document.

System Center 2012 Virtual Machine Manager

System Center 2012 is offered as a suite. The Virtual Machine Manager component of System Center 2012 manages the virtual machines and interfaces with the Citrix Desktop Delivery Control to start, stop, delete, and create virtual machines. A new set of features are included with System Center 2012 Virtual Machine Manager:

- Storage Management
- Bare-metal Provisioning
- Hyper-V Clustering
- Server update services

It is also important to note that with these new features also comes new increased VM scalability with VMM 2012 and XenDesktop. Microsoft and Citrix jointly tested VMM 2012 and XenDesktop 5.6 at the Microsoft Enterprise Engineering Center in Redmond, Washington. This project resulted in a new certified scalability architecture that shows a single VMM 2012 instance can support 2000 XenDesktop virtual machines. This increase in scalability allows for simpler VDI management and less VMM instances to maintain.

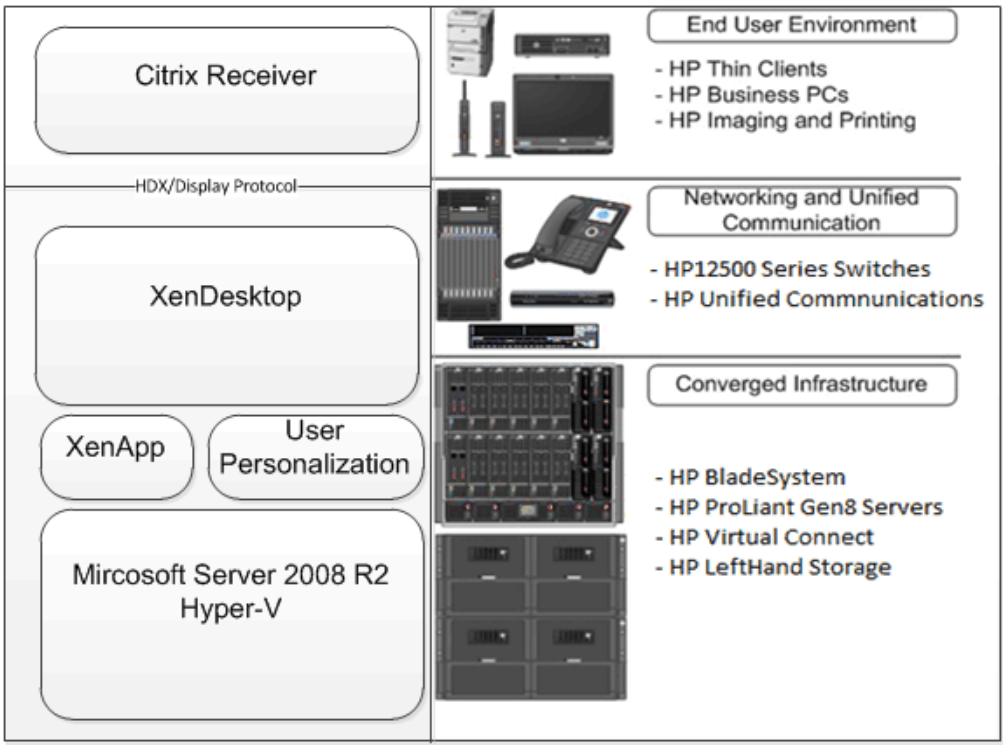
For more information around Microsoft Windows Server 2008 R2, System Center, System Center 2012 Virtual Machine Manager, and Microsoft cluster, go to microsoft.com.

Reference Architecture overview

Core design

The HP Reference Architecture tries to take into account the software, hardware and communication mechanisms required to connect the end user with the compute resource as well as with the world at large. As such, HP is uniquely positioned in the market as a provider of all of the products required to make VDI work from end to end.

Figure 9: VDI Overview

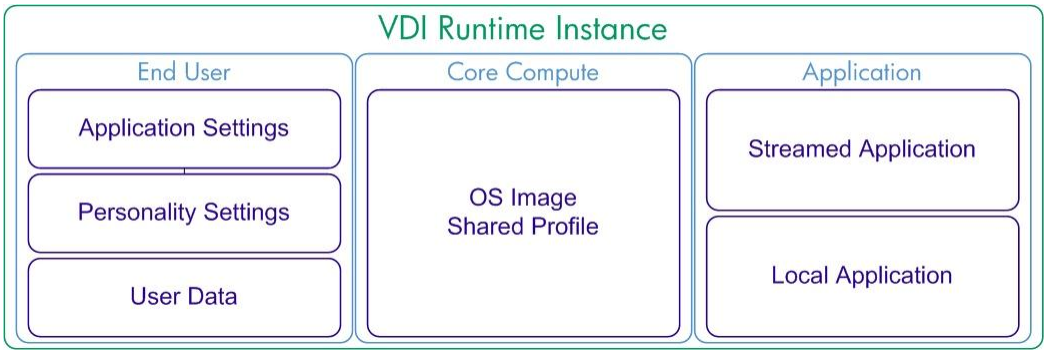


Understanding the VDI Client Virtualization Reference Architecture

VDI is one possible implementation of the Client Virtualization (CV) Reference Architecture. Citrix's FlexCast model offers several methods of delivering a desktop to a user including hosted desktops. With VDI, a desktop is created as a virtual machine. Applications and user personality are injected into the core desktop virtual machine and a brokering mechanism manages connecting end users to the VM via a connection protocol.

More than simply a virtual machine, the runtime VDI instance is the real time compilation of the end user's data, personal settings and application settings with a core operating system instance and shared generic profile where the applications are either installed locally as a fully installed or packaged instance or streamed from outside the VM. While seemingly complex at first glance, the proper management of these individual pieces yields a far more flexible end user computing environment that is simpler to manage. This is accomplished in part by the decoupling of the user and application from the core operating system. The single OS image with few applications is easy to manage as part of an overall, comprehensive client management strategy using tools such as HP Client Automation. Once the user and application are segmented from the device, the device itself starts to matter less as well. With the right approach, an end user can receive the same experience regardless of what core compute resource they are logged onto at the moment. This also means that changing the OS layer is greatly simplified making tasks like Windows operating system migrations simpler for users who have been virtualized. Figure 10 highlights the compute device at runtime in more detail.

Figure 10: The VDI runtime instance



Citrix User Profile Manager can be used to manage the user and application settings, Citrix XenApp can be used to deliver applications to the user. Figure 11 highlights the overall architecture at a high level.

Figure 11: VDI within the overall enterprise

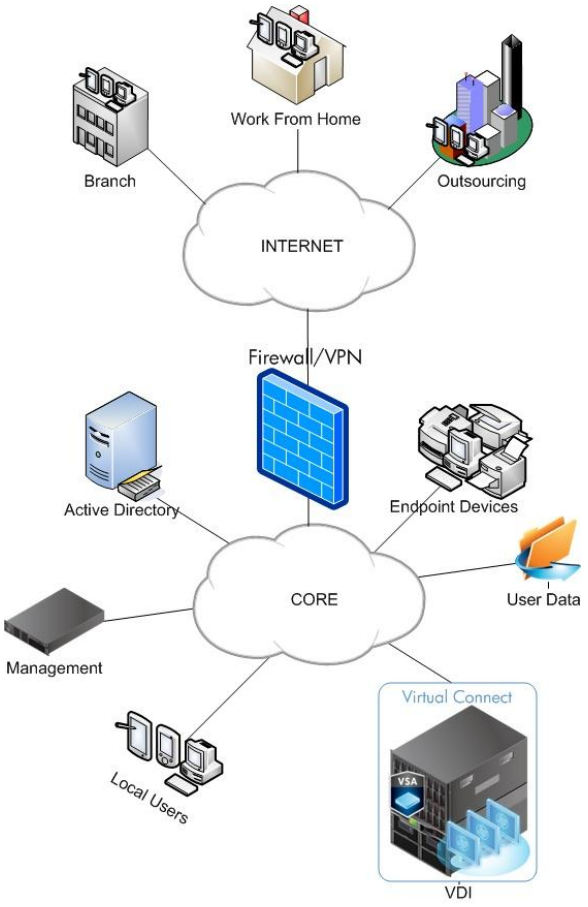
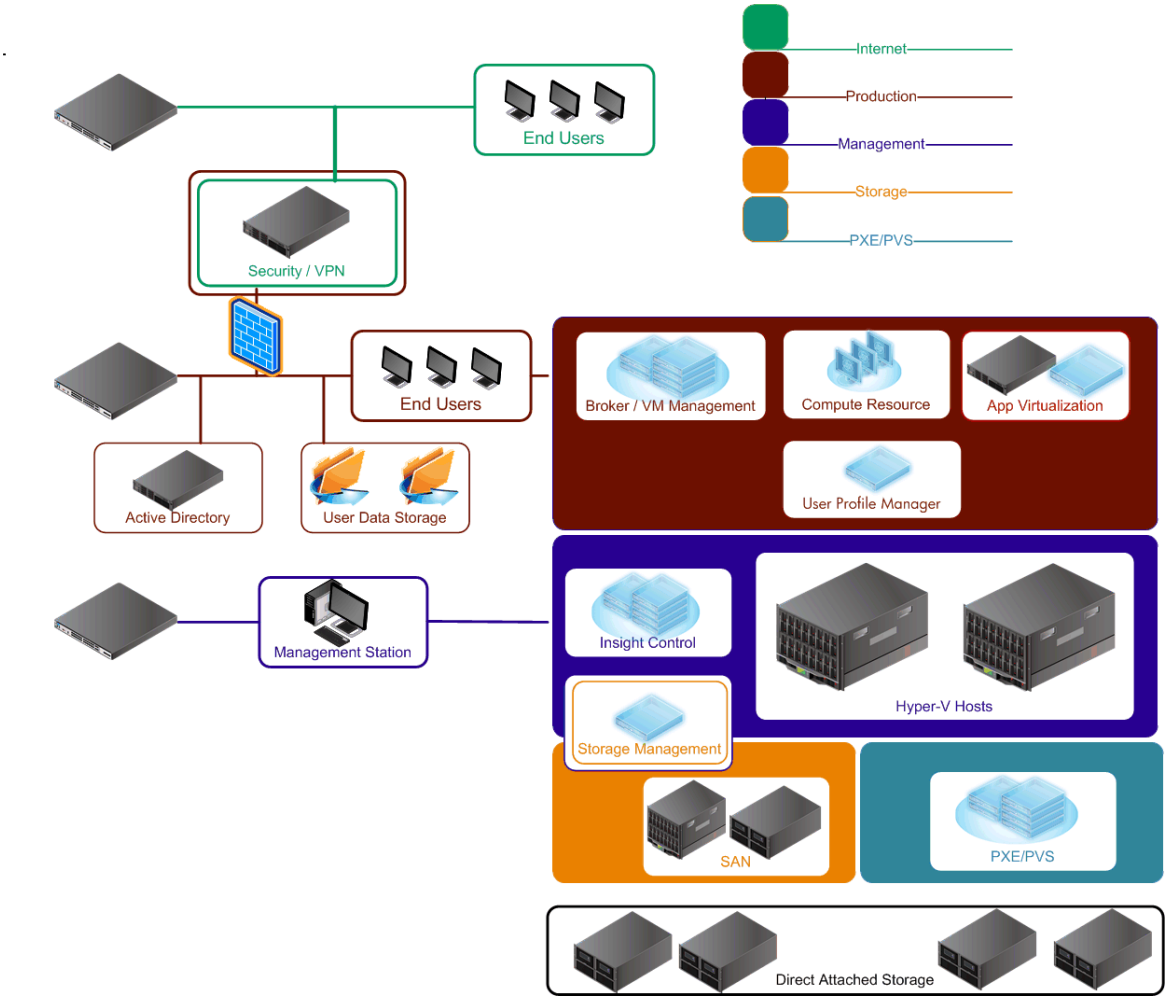


Figure 12 shows the architecture from the network perspective. There are four internal networks and one external network that must be considered when utilizing the HP architecture. The external network is the Internet itself which enables off campus users to access a compute resource. The first internal network is the production WAN/LAN to enable corporate users to achieve an end user experience. A management network is also in place to support the management of the hardware via a variety of mechanisms including HP Integrated Lights-Out (iLO). A network is created for the PXE/PVS boot and streaming traffic. Finally, a storage network is defined to allow communication between initiators and

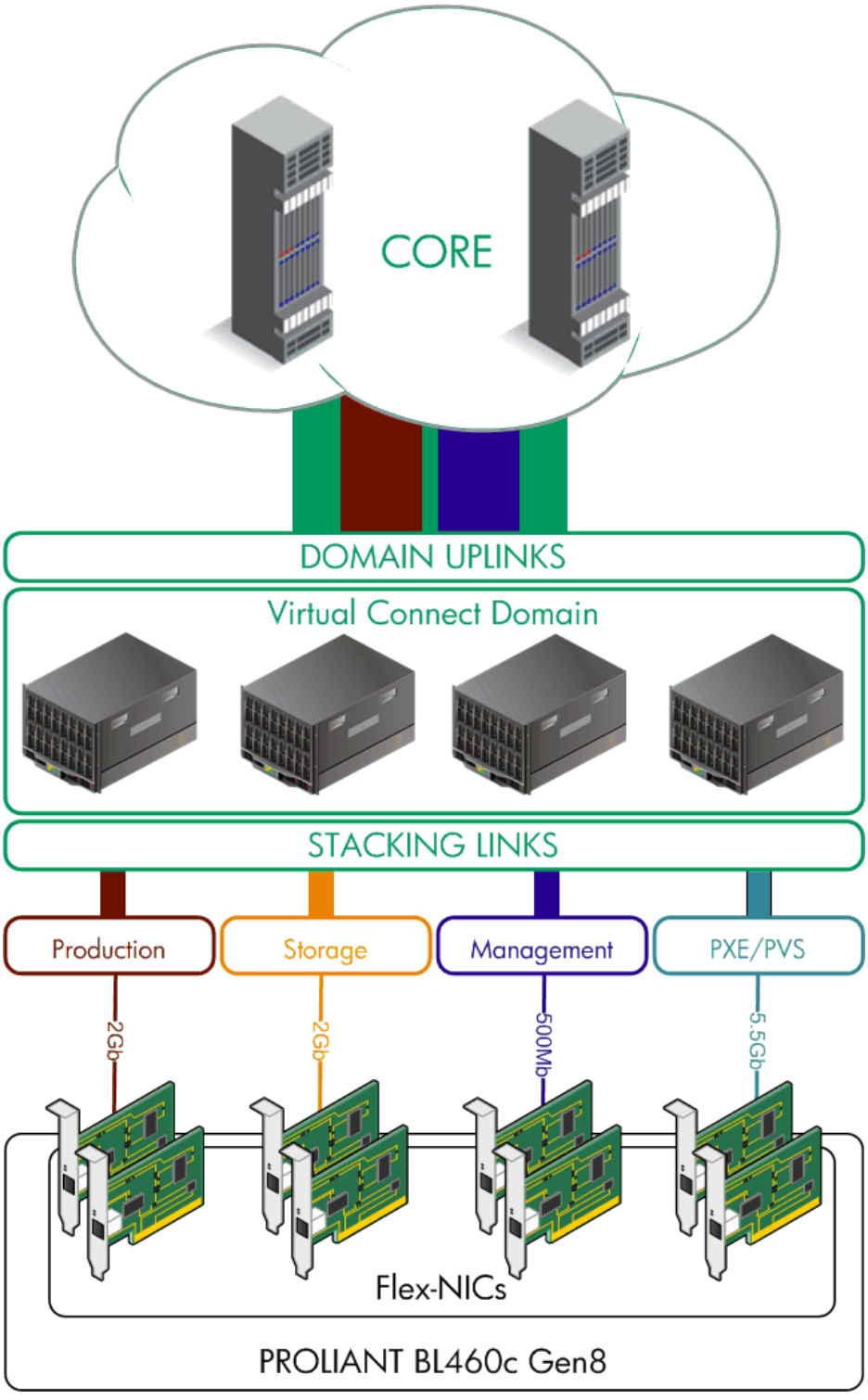
targets. The storage network is only required when doing persistent users and SAN storage. One of the key differentiators for this architecture when compared against other offerings is the emphasis on network flexibility and cost for the core of the environment. This is accomplished by migrating as much of the infrastructure and compute resource as possible to within the Virtual Connect domain. This eliminates or minimizes the need for switch ports, allows for the management of intra-domain traffic by a single infrastructure administrator and improves performance and reliability by utilizing mostly cable free internal connections between hosts and management services. Both the PXE/PVS and Storage networks are completely internal to the Virtual Connect domain.

Figure 12: The HP client virtualization Reference Architecture for VDI with an emphasis on networking



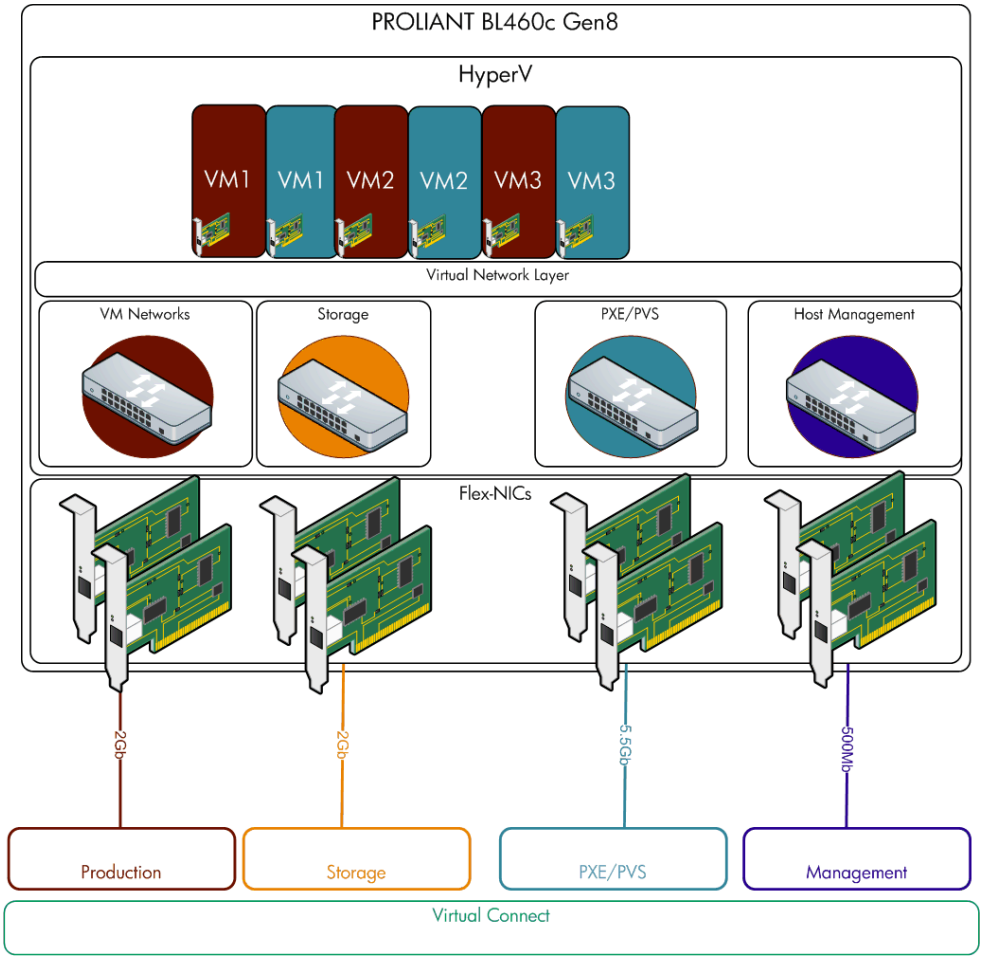
If we look at the previous figure 12, it is clear that Virtual Connect plays a critical role in the overall architecture. Figure 13 is a closer view of how traffic flows and is segmented between the server and the core. Of particular note is the minimized number of uplinks. A Virtual Connect domain is cabled directly to the core with a minimal number of cables while maintaining required bandwidth and availability. This eliminates the need for rack switches which not only saves cost, but also greatly simplifies the management of the network. In the figure below, production traffic and management traffic that need to reach the network core are sent via shared uplinks. Of equal interest are the internal networks created. These networks, labeled storage and PXE/PVS in the figure below, traverse between enclosures but never egress the Virtual Connect domain and thus never touch core network infrastructure. In a VDI environment where numerous teams may need to interact simply to keep the environment up and running it can be difficult to manage the various levels of interactions. The internal storage and PXE/PVS networks can reduce or even eliminate involvement from the storage and network teams. This in turn centralizes ownership of the solution stack and increases flexibility. One final note is that every ProLiant BL460c Gen8 server blade is equipped with at least two (2) onboard 10Gb FlexNICs each allowing for the creation of up to four (4) redundant networks of variable bandwidth between 100Mb and 10Gb.

Figure 13: Networks internal and external to the Virtual Connect domain



In the context of VDI, there is an additional layer that must be comprehended. Within VDI environments, each hypervisor host communicates through an abstracted virtual networking layer that allows the individual VDI and management VMs to communicate with the production network as well as the individual hypervisor hosts to transmit traffic to storage, be managed and make use of any special function networks. Figure 14 highlights the relationship between the server, hypervisor, virtual machines, virtual networking layer, FlexNICs and Virtual Connect.

Figure 14: Virtual networking stack from FlexNIC through to the virtual machine



Persistent and non-persistent VMs

A VDI user is considered to be either a persistent or a non-persistent user. A persistent user maintains changes within the VM across logins. To support persistent VMs normally dedicated VHD files are assigned to each user or a set of differential files are assigned to a user. Any changes the user makes are stored in these files, and remain there for the next time the user logs in. With dedicated VHD files, this can be extremely storage intensive. If each user has a 50GB VHD file assigned to them, and there are 1000 users, then 50000 GB, almost 49 TB, of disk space is required. If using differential files, these files can grow to be as large as the base image file over time and the potential of users losing everything in the differential files exists if care is not taken in maintaining and updating the master image file and the differential files.

For a non-persistent user a single image is shared by all users, and this image is write protected. Any changes or modifications the user makes while logged in are stored in differential files. These changes made while logged in will be lost on log out, and at the next login the user will be presented with the original pristine VM and desktop. This does not allow for user customization of their environment. For non-persistent users, user virtualization needs to be

implemented using tools like AppSense[4] or Citrix User Profile Manager. This allows a user to customize their environment and have those customizations applied at each login.

With the addition of Personal vDisk in XenDesktop 5.6, Citrix has provided a method to use non-persistent single image management but allow the user the benefits of being a persistent user.

For this paper, all users will be treated as non-persistent users sharing a single or multiple images with Citrix User Profile Manager or AppSense used to allow each user to customize their environment. However, not all users fit into a non-persistent model, there are users that require persistence due to application requirements, storage requirements, or other factors. For these users, a Personal vDisk will be assigned, giving this set of non-persistent users a persistent environment. The PvD will be stored on a SAN to allow the user to login to any server in the environment.

The Reference Architecture

Whether hosting a 100 user proof-of-concept or a 20,000 user production implementation, the building block of the HP Reference Architecture for Client Virtualization remains the same. To understand the different models and how they fit together, you must understand the testing and characterization per server.

Testing methodology

HP has a longstanding tradition of using its own tools to measure server performance for VDI. In the past, these methods have produced reliable numbers that were achievable in real world usage. This greatly helped with planning VDI implementations and setting realistic expectations around costs. There has been a demand for a standardized number that reflects the capacity of a system in addition to a reliable estimation of real world performance.

The industry as a whole has settled on more of a benchmark approach using a small number of tools to approximate system capacity. HP shunned this approach for a period of time as results produced tended to be extremely optimistic and when misused resulted in much higher costs for VDI at implementation time versus estimation time. HP sought a tool that could thus approximate both capacity and real world numbers. After examining tools, HP settled on Login VSI from Login Consultants.

For testing, HP used the Login VSI 3.5 test tool. Login VSI measures response times for opening applications and clicking within the UI of applications. The application stack utilized includes Microsoft Word, PowerPoint, Excel, Internet Explorer and Adobe® Flash video. Testing was done running the light, medium, and heavy loads as defined by Login VSI. The results of the Login VSI testing are given as VSIMax, the point at which response times exceed the acceptable limit. With Login VSI, VSIMax can be either a set value of 4000ms referred to as VSIMax Classic, or a dynamically calculated value using a baseline response within the test referred to as VSIMax Dynamic. All VSIMax numbers in this document are VSIMax Dynamic at the recommendation of Login VSI. Information about Login VSI and details about administering the test environment can be found at loginvsi.com.

Test environment

All tests were performed using the XenDesktop configuration defined in this document. All infrastructure components were virtualized and running on a single management server, no redundancy was created for testing purposes. The server under test was an HP ProLiant BL460c Gen8 with 2 Intel Xeon E5-2680 processors, Hyper-Threading was on, and 256 GB of 1333MHz PC3-12800R RAM. HP testing with Hyper-V has shown that memory speed has a major impact on performance, with 1333 speeds showing over a 15% increase in number of users over 800 speeds, when using the same amount of memory.

The virtual machines were optimized using the PVS image conversion tool and additional optimizations recommended by Citrix in their Windows 7 optimization guide[5]. The virtual machines were configured with Windows 7 x64 SP1 and a single vCPU. Microsoft Dynamic Memory was utilized, with each VM having a minimum of 768 MB of memory and a maximum of 1.5GB. This configuration was used for all tests.

[4] More information about AppSense can be found at appsense.com
[5] Optimization guide can be found at: http://support.citrix.com/servlet/KbServlet/download/25161-102-648285/XD%20-%20Windows%207%20Optimization%20Guide.pdf

Workloads

Login VSI offers a number of workloads intended to emulate different user behaviors. To best emulate HP's traditional test methodology, the medium, light, and heavy user workloads were chosen. These workloads represent productivity, task, and knowledge workers respectively.

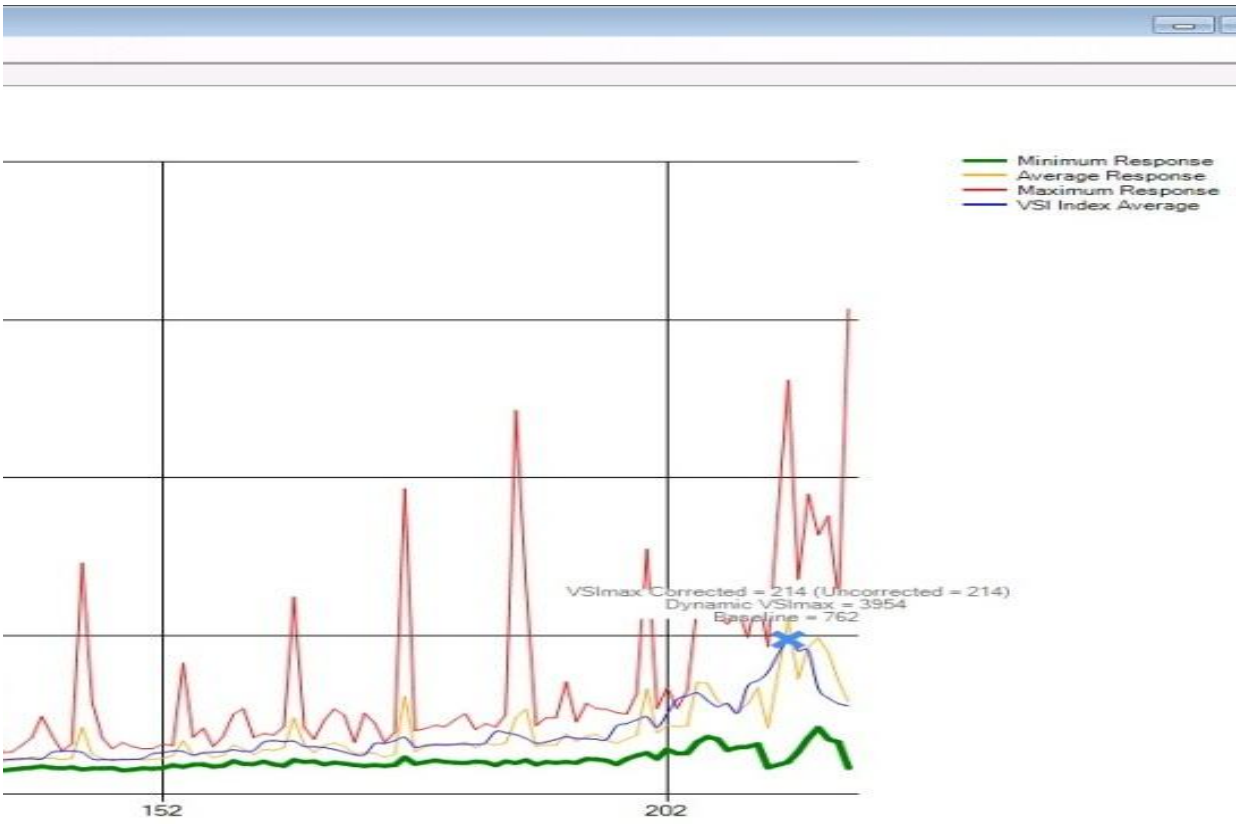
Detailed information about Login VSI is available at loginvsi.com. An explanation of how tests are run as well as how scores are calculated is available at loginvsi.com/en/admin-guide.

For the tests HP started the launchers at a fixed, 30 second interval. There were three physical launchers and 25 virtual launchers. All launchers are connected to a domain and configured for NTP services. Tests are run multiple times to validate consistency as well as to check for problems in scripts. The best result of all tests is reported in this document. Because a "response" time value is used to determine success it is extremely difficult to re-create the exact test results each time. There are many influences that could impact the results. No test result varied by more than 3-5% between different runs of the exact same test. Prior to the start of any test run the server under test (SUT) is rebooted and all virtual machines are restarted. The SUT is allowed a period of rest to reclaim memory prior to test start.

Results

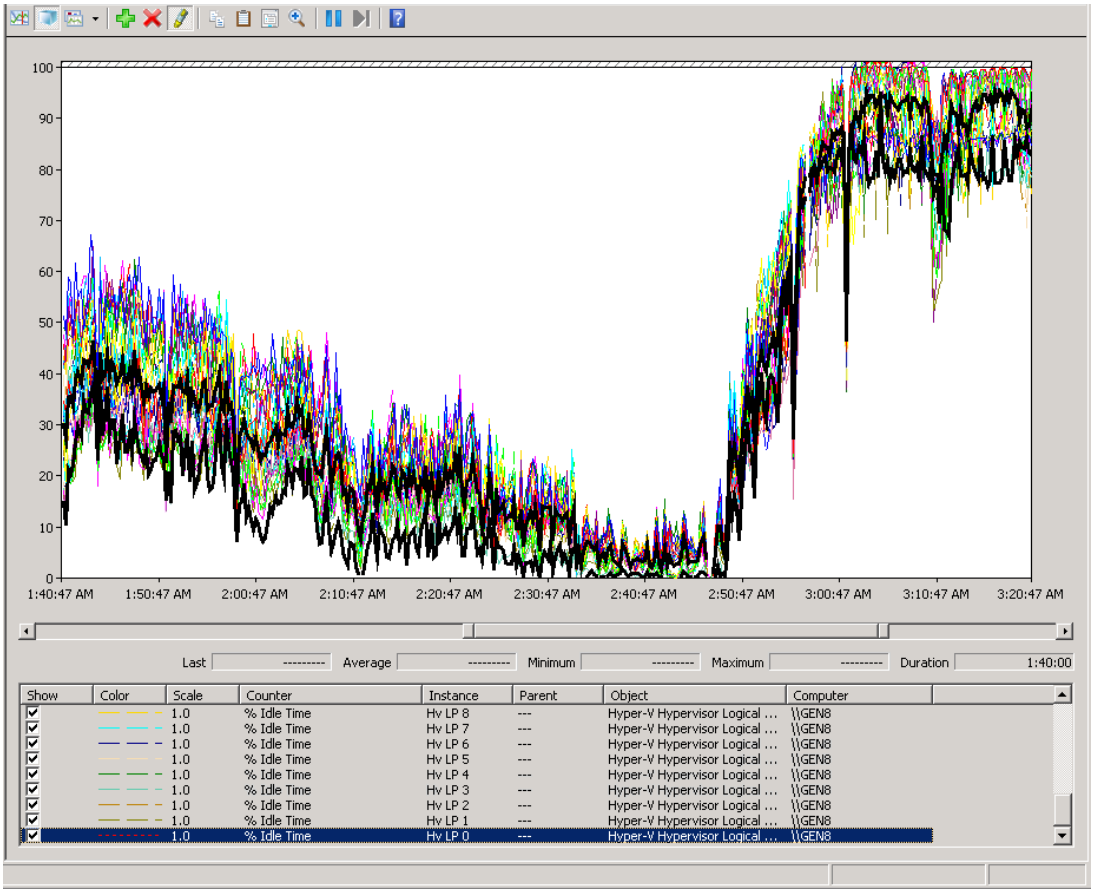
For the medium user workload, VSIMax showed a value of 214 as shown in figure 15.

Figure 15: Login VSIMax and response times for Medium user test.



Prior to the tests starting the overall idle time for the SUT for all logical processors was over 80%, with total logical processor idle time averaging 90-95%. When VSIMax was reached, idle time for the logical processors went to nearly zero, with LP0 (logical processor 0) being flat lined at zero idle time. LP0 having zero idle time means the system has been saturated. The following graph highlights the Total idle time for all logical processors (higher black line) and LP0 (lower black line).

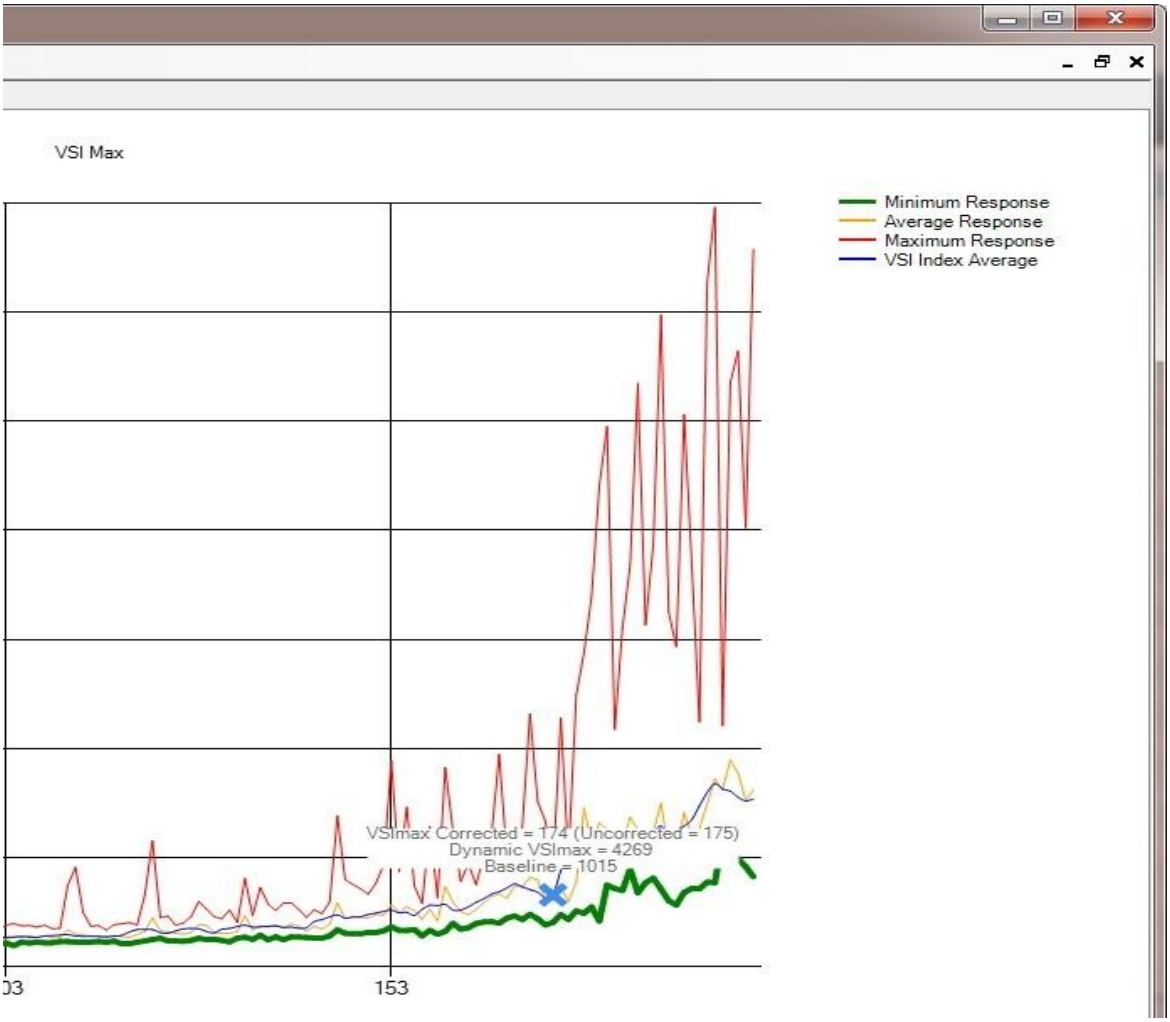
Figure 16. Logical Processor Idle Time.



Changing the workload to Light workload a VSIMax was not achieved, in other words response times did not exceed an acceptable limit. The final tests had 265 VMs running in 256 GB of memory on the server. All 265 VMs were active and running under load, memory allocation on the server was near 100% and Microsoft's dynamic memory was beginning to come into play. The logical processors had not reached zero idle time, holding just under 10% idle.

For the heavy user workload VSIMax was 174 as shown in Figure 17.

Figure 17: Login VSIMax and response times for heavy user test



During testing flash offload using Citrix HDX 3 was utilized. This allows any flash video to be executed on the endpoint device, if that device has enough compute power to handle running the video. Testing in the lab showed offloading of flash video gained almost 10% in performance for the server over server side rendering. As noted, the end point device must be powerful enough to support rendering the flash video, otherwise the rendering will occur on the server.

In all cases LP0 idle time was at almost a constant zero when VSIMax was achieved.

Real world vs. lab

All numbers given here were achieved in the lab under known circumstances, including exactly the workload being executed. The performance you achieve may/will be different depending on the workloads of the users. HP recommends doing an assessment of your environment to determine the workload, types of users, and which users are best suited for going to VDI. HP offers an assessment program called CVAM (Client Virtualization Analysis and Modeling). For more details on CVAM go to http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA3-2409ENW or contact your HP representative for more details. Adherence to best practices during all aspects of the design and build phases of your VDI implementation as well as choosing optimized methods for deploying and managing VDI will nearly always result in greater user density. Selecting problematic applications, poorly suited user groups and failing to follow recommendations will nearly always have the opposite effect. This is critical because these densities have a potentially large impact on the acquisition and long term costs of running VDI in a given environment.

From HP's viewpoint, Login VSI is an excellent capacity analysis tool. When you achieve Login VSIMax the user experience is no longer acceptable. However, the user experience is affected prior to the maximum point. If you look at the VSI Index Average in the VSIMax graphs there is an inflection point where the line starts to trend upward, estimated at 60-70%. At this point HP feels the user experience will begin to deteriorate, and this is a more realistic number of users for the defined workloads. For light and medium level users a range of 60-65% is used, for the heavy level user the range is 55-60%. Table 1 shows the recommended numbers.

Table 1. Recommended planning numbers by user type.

User Type	VSIMax	Recommended Range Client side flash rendering	Recommended Range Server side flash rendering
Medium	214	128-139	116-126
Heavy	174	95-104	86-94

As noted previously, HP did not achieve a VSIMax with light user workload running 265 VMs and client side flash rendering. When doing server side flash rendering a VSIMax of 236 was achieved.

There are many variables that will affect your sizing, from application delivery, operating system, protocols, and provisioning to number of active users and total number of users. As stated before HP recommends doing an assessment of your environment as part of the planning process for VDI.

The non-persistent model

Figure 18 highlights a single BladeSystem enclosure and four D2700 disk enclosures supporting non-persistent users, with a user count of 1690 using 130 users per blade. As stated previously, this document will not provide step by step configuration details.

Figure 18: Non-persistent Configurations.

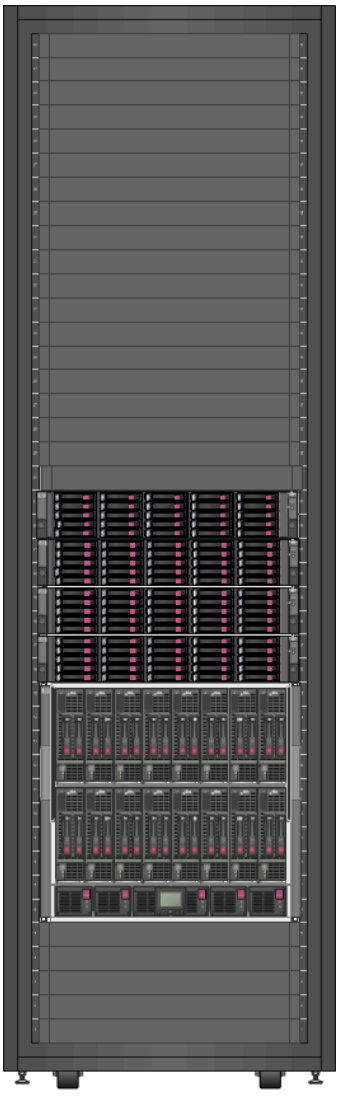


Table 2 represents a bay by bay placement of each component in the configuration. A device bay (D) refers to the bays on the front of the c7000 enclosure that hold servers and storage. These bays are numbered left to right and top to bottom with the top row being labeled bays 1 through 8 and the bottom row labeled bays 9 through 16. An interconnect bay (I) refers to the numbered bays in the rear of the c7000 enclosure that handle I/O communication for the environment. The Onboard Administrator (OA) bays are assumed to be filled with redundant OAs and are not listed in the table.

HP D2700 7.2 TB disk enclosures provide direct attached storage to each of the servers. Six drives in a RAID 1+0 configuration are assigned to each server using the SAS Manager within the OA of the BladeSystem enclosure. The disk enclosures are daisy chained together. A VSA is on each management server to leverage the D2700 drives assigned to each server, creating a cluster between the management servers.

Table 2. Device by bay and function

Bay	Device	Function
D1	HP ProLiant BL460c Gen 8	Hosts core management VMs – Broker, SQL, DHCP for PXE Network, PVS, VSA
D2	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D3	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D4	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D5	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D6	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D7	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D8	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D9	HP ProLiant BL460c Gen 8	Hosts core management VMs – Broker, SQL, DHCP for PXE Network, PVS, VSA
D10	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D11	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D12	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D13	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D14	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D15	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D16	HP ProLiant BL460c Gen 8	Hosts core management VMs – Additional PVS VMs to support increased number of users, VSA
I1	HP Virtual Connect Flex-10 Module	Master storage and Ethernet traffic communication module
I2	HP Virtual Connect Flex-10 Module	Redundant storage and Ethernet traffic communication module
I3	HP 6Gb/s SAS Switch	SAS link for connecting DAS storage to blades
I4	HP 6Gb/s SAS Switch	SAS link for connecting DAS storage to blades

There are three management servers in the configuration. Each management server runs the infrastructure VMs required to support the XenDesktop configuration.

Management VM configurations

The infrastructure VMs are defined in the next table. Microsoft Clustering Shared Volumes is used between the management servers to allow migration of the infrastructure VMs.

Table 3. Management VM configuration information

Virtual Machine Function	Operating System	Number of VMs	vCPU	Memory	Disk Size
PXE DHCP	Microsoft Windows Server 2008 R2 SP1 Datacenter	1	2	6GB	40GB
PVS	Microsoft Windows Server 2008 R2 SP1 Datacenter	4	4	16GB	50GB
VMM 2012	Microsoft Windows Server 2008 R2 SP1 Datacenter	2	2	8GB	50GB
Citrix Desktop Delivery Controller(DDC)	Microsoft Windows Server 2008 R2 SP1 Datacenter	2	4	8GB	40GB
SQL Server	Microsoft Windows Server 2008 R2 SP1 Datacenter	2	2	8GB	60GB
HP Systems Insight Manager 7/ LeftHand Centralized Management Console	Microsoft Windows Server 2008 R2 SP1 Datacenter	1	2	8GB	60GB
HP LeftHand VSA	HP SAN/iQ 9.5	3	2	4GB	NA

Each management server is assigned 6 drives from the D2700. These drives are configured with RAID 5 for increased storage. These drives are assigned to the HP VSA running on each management server. A SAN cluster is created using the LeftHand CMC (Central Management Console) between the VSAs. This will create a 1500GB cluster for two management servers, 2000GB for three management servers. Within this cluster, seven volumes are created. The following table defines the volumes.

Table 4. Cluster Volumes

Volume Name	Access by	Size
Master	Management servers, holds VM vhd files	500GB
PVS_1	PVS Server 1, holds master image files	250GB
PVS_2	PVS Server 2, holds master image files	250GB
SQL_Volume	SQL VMs	250GB
VMM-Library	VMM VMs for library	250GB
PVS_3	PVS Server 3	250GB
PVS_4	PVS Server 4	250GB

For PVS, 400-500 streams is the HP recommendation for a virtualized PVS server. The breakdown on what VMs run on which server by default is shown in the next table.

Table 5. Infrastructure VM and Management Host

Server	VMs
Management Server 1	PXE DHCP, PVS, DDC, VSA, SQL, SC 2012 VMM
Management Server 2	PVS, DDC, VSA, SQL, SIM/CMC, SC 2012 VMM
Management Server 3	Two PVS VMs, VSA

The VSAs are stored on the internal drives of each management server. The DAS storage associated with each management server is given to the VSA to manage, and all VSAs are put into a cluster. The management servers attach to the VSA cluster to store the other infrastructure VM VHD files. This allows clustering to be setup between the management servers, allowing for live migration of the infrastructure VMs between the management servers. The other VSA volumes are then attached to the correct infrastructure VMs.

For networking, four networks are defined with Virtual Connect as discussed previously. Table 6 lists the networks and associated bandwidth.

Table 6. Virtual Connect Networks

Network	Type	Link Speed
Management	External	500 Mb
Production	External	2 Gb
PXE/PVS	Internal	5.5 Gb
Storage	Internal	2 Gb

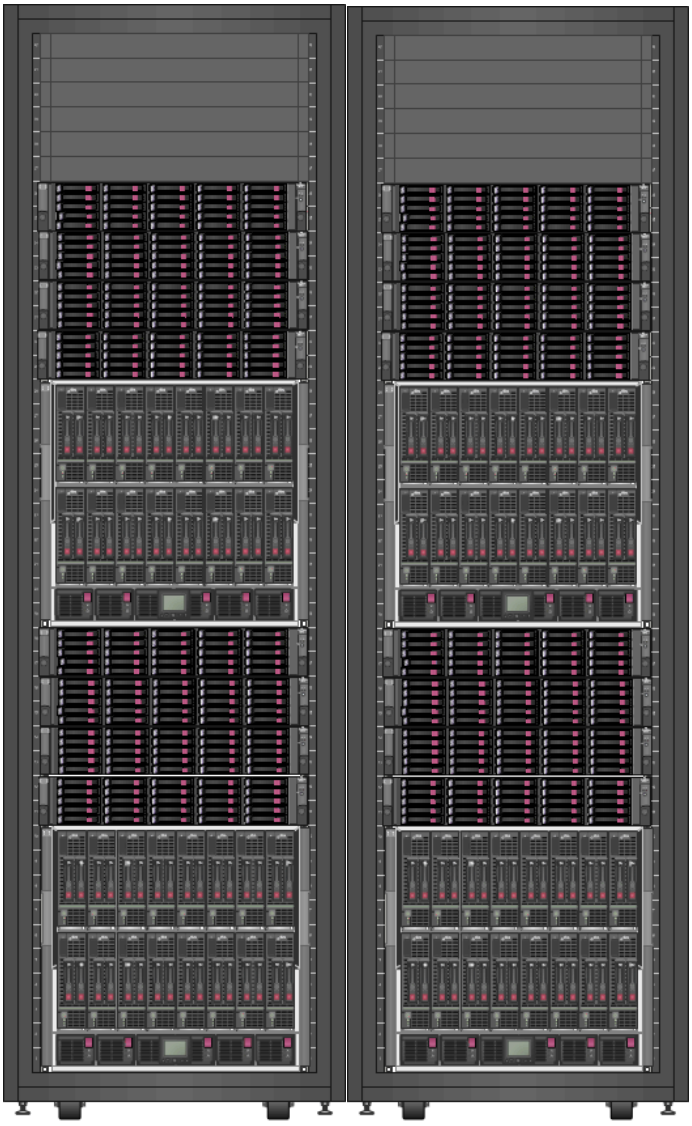
The Storage network is used for the clustering and migration of infrastructure VMs in the non-persistent model, and in the persistent model (covered next) to also access the SAN.

Each network is redundant. The BL460c Gen8 FlexNICs have two 10Gb ports that can be divided into 4 NICs each, sharing 10Gb of bandwidth across the 4 NICS.

A rack solution

With a single enclosure supporting 1690 users, two complete configurations can fit into a single rack, creating support for more than 3380 users. A single Virtual Connect domain can be created between the two enclosures to make the environment easier to manage, and up to four enclosures can be configured into a Virtual Connect domain using two racks and supporting over 6500 users.

Figure 19: Two full racks – Over 6500 users



The persistent model

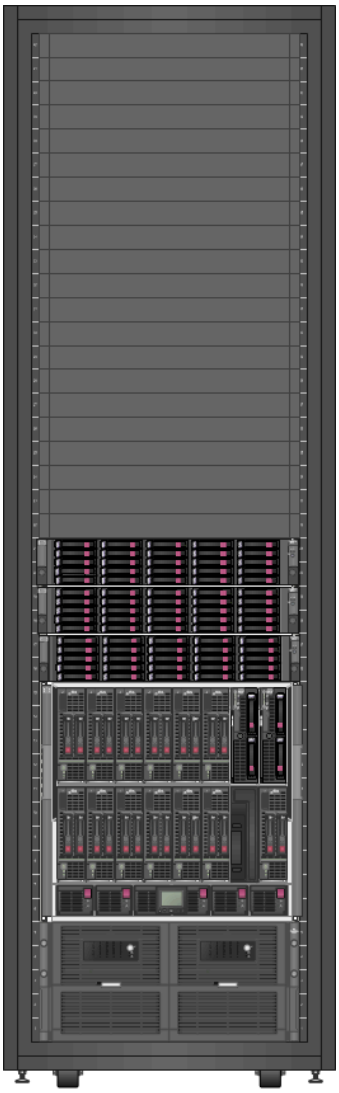
As discussed before, the persistent model maintains changes to the VM over logins. For all users, persistent or non-persistent, a user virtualization tool like Citrix Profile Manager should be used to manage the user profiles and customization. A persistent user has needs beyond that of other users, such as needing to install specific software that you do not want in the master image or streamed from a XenApp or AppV server. This user has requirements/needs beyond the average user. This personal vDisk should not be used to store user data, as with non-persistent users the user data should be stored on a network device like a CIFS share. The personal vDisk will be stored on a SAN added to the hardware. This prevents the persistent user from being tied to a single physical server. To accomplish this a catalog of servers is created in XenDesktop Desktop Directory to connect to the P4800 SAN and support the persistent users.

In most customer situations the non-persistent/persistent mix runs about 80/20, but for this RA a 50/50 ratio is used. To allow the persistent user to not be locked to a specific server, the PvD will be stored on an HP LeftHand P4800.

To accommodate the P4460sb blades of the P4800, two Hyper-V hosts must be removed, so in a fully configured enclosure for persistent users, the limit is 1170 users. With less VDI hosts, the number of required D2700 storage enclosures is reduced to 3. Because PvD is being used to support the persistent users, and as stated earlier, CPU utilization is impacted and a performance reduction is incurred. This performance impact is calculated at 20%. Since half

of the users are considered to be using PvD, then the number of users supported on blades with PvD users is reduced to 104 users (130 – 20%). Total number of supported users is 5 servers * 130 user + 5 servers * 104 users equaling 1170 users.

Figure 20: Persistent Configuration, 50/50 user mix.



The changes are bays 7 and 8 now have the P4460sb blades in them and bay 15 is empty, the P4800 storage and switches have been added, and only three D2700 storage enclosures are required. The following table lists the device/bay configuration for the rack.

Table 7. Device by bay and function

Bay	Device	Function
D1	HP ProLiant BL460c Gen 8	Hosts core management VMs – Broker, SQL, DHCP for PXE Network, PVS, VSA
D2	HP ProLiant BL460c Gen 8	Hosts end user computing VMs

Bay	Device	Function
D3	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D4	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D5	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D6	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D7	HP P4460sb Storage Blade	Storage controller one for the HP LeftHand P4800 SAN for BladeSystem
D8	HP P4460sb Storage Blade	Storage controller one for the HP LeftHand P4800 SAN for BladeSystem
D9	HP ProLiant BL460c Gen 8	Hosts core management VMs – Broker, SQL, DHCP for PXE Network, PVS, VSA
D10	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D11	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D12	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D13	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D14	HP ProLiant BL460c Gen 8	Hosts end user computing VMs
D15	Blank	Blank
D16	HP ProLiant BL460c Gen 8	Hosts core management VMs – Broker, SQL, DHCP for PXE Network, PVS NOTE: VSA not required, P4800 will supply storage for third management server
I1	HP Virtual Connect Flex-10 Module	Master storage and Ethernet traffic communication module
I2	HP Virtual Connect Flex-10 Module	Redundant storage and Ethernet traffic communication module
I5	HP 3Gb/s SAS Switch	SAS link for the HP LeftHand P4800 SAN for BladeSystem
I6	HP 3Gb/s SAS Switch	SAS link for the HP LeftHand P4800 SAN for BladeSystem
I7	HP 6Gb/s SAS Switch	SAS link for connecting DAS storage to blades
I8	HP 6Gb/s SAS Switch	SAS link for connecting DAS storage to blades

NOTE: Additional 3Gb/s SAS switches are added to the back interconnects to support the P4800. The P4800 requires separate 3Gb/s SAS switches, which by default are placed in interconnect bays 5 and 6. The P721m for the Gen8 servers must reside on the blade mezzanine slot 2, meaning the 6Gb SAS switches needed to connect to the D2700s by default would also be placed in interconnect bays 5 and 6. The most straight forward solution is to place the 6 Gb SAS switches in bays 7 and 8, and use the Onboard Administrator to disable access to those bays for the P4460sb blades associated with the P4800. This also assumes all correct firmware versions for the Onboard Administrator, SAS switches and blades. Please check with your local service representative for complete HP recommendations.

NOTE: Availability of the P721m card is scheduled for August 2012.

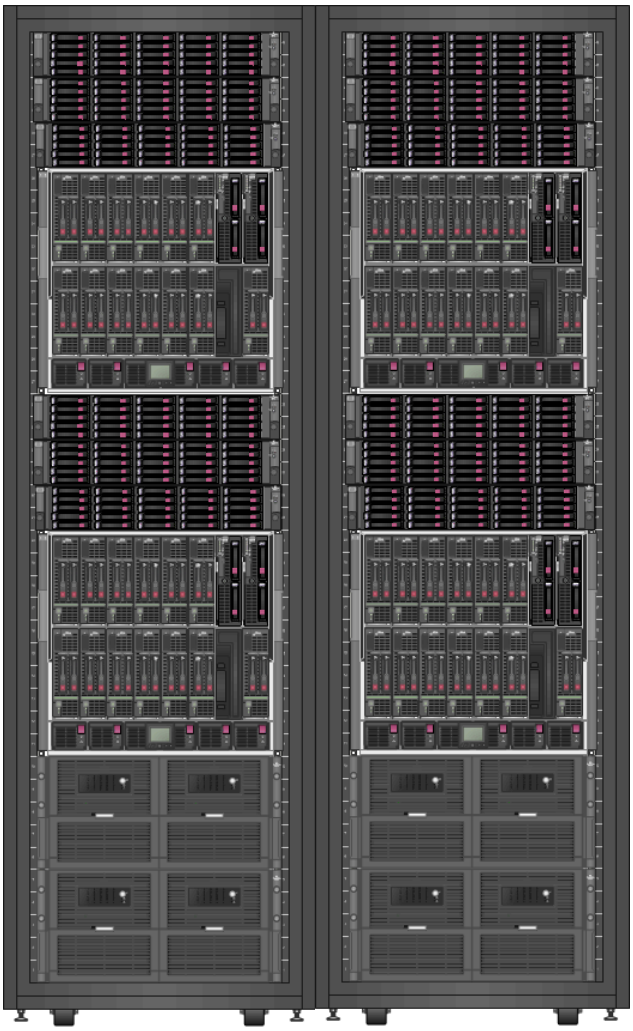
The third management server does not have direct-attached storage and no VSA is necessary. A 500 GB volume is carved out from the P4800 and added to the existing management cluster. The PVS VMs associated with the third management server are placed in this volume as part of the cluster using CSV, Cluster Shared Volumes, to allow migration of the PVS VMs with the other management servers.

The P4800 is carved into multiple volumes to hold the PvD files. For this RA, a size of 10GB is used for the PvD, and 250 PvD users are supported for each volume.

A complete rack

A complete rack can be configured to support 2340 users, two racks can be linked together to create a 4 enclosure Virtual Connect domain which can support over 4500 users. This does assume the 50/50 ratio for persistent and non-persistent users.

Figure 21: Multiple Persistent Model Racks



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Summary

This reference architecture outlines the performance of Citrix XenDesktop 5.6 on Windows Server 2008 R2 using the Hyper-V hypervisor running on HP ProLiant BL460c Gen8 servers. It also discusses the hardware and software configuration around the test environment that can be implemented in real world configurations.

Appendix A

The hardware required for configuring the RA is broken into several components. For ease of hardware configuration HP offers Factory Express to rack and stack the hardware. Using Factory Express will put all of the hardware into the rack using HP best practices. Contact your HP sales representative for using HP Factory Express in racking your hardware.

For rack and power infrastructure the following table defines the individual components.

Table A1. Rack and Power BOM

Qty	Part Number	Description
1	BW908A	HP 642 1200mm Shock Intelligent Rack
1	BW909A	HP 42U 1200mm Side Panel Kit
1	BW930A	HP Air Flow Optimization Kit
1	BW932A	HP 600mm Jb Rack Stabilizer Kit
2	AF916A	HP 3PH 48A NA/JP Pwr Monitoring PDU
2	AF502B	HP 2 STK 4X Fixed C-13 Offset WW Kit
4	142257-006	HP 10A IEC 320 C14-C13 4.5ft US PDU Cable
As Needed	AF070A	HP 10pk Carbt 1U Universal Filler Panel

A single rack can support two enclosures and configurations as show in previous figures.

The enclosure configuration is in the next table.

Table A2. Enclosure BOM

Qty	Part Number	Description
1	TC277AAE	HP Insight Control Encl Bundle 16 E-LTU
1	456204-B21	HP BLc7000 DDR2 Encl Mgmt Option
1	507019-B21	HP BLc7000 CTO 3 IN LCD ROHS Encl
1	517520-B21	HP BLc 6X Active Cool 200 FIO Fan Opt
1	517521-B22	HP 6X 2400W Plat Ht Plg FIO Pwr Sply Kit
1	413379-B21	HP BLc7000 1 PH FIO Power Module Opt

Qty	Part Number	Description
1	433718-B21	HP BLc7000 10K Rack Ship Brkt Opt Kit
1	591973-B21	HP VC Flex-10 Ent Edn for BLc7000 Opt
2	453154-B21	HP BLc VC1Gb RJ-45 SFP Opt Kit NOTE: This is optional.
2	455883-B21	HP BLc 10Gb SR SFP+ Opt NOTE: You may choose a direct cable connection for 10Gb connections. Consult your sales representative.
4	C7535A	HP Ethernet 7ft CAT5e RJ45 M/M Cable

For the servers, the following BOM is per server. For the non-persistent configuration 16 servers per enclosure, for the persistent model 13 servers are required.

Table A3. Single Server BOM

Qty	Part Number	Description
1	641016-B21	HP BL460c Gen8 10Gb Flb CTO Blade
2	652564-B21	HP 300GB 6G SAS 10K 2.5in SC ENT HDD
1	662063-B21	HP BL460c Gen8 E5 2680 Kit
1	662063-L21	HP BL460c Gen8 E5 2680 FIO Kit
16	672631-B21	HP 16GB 2Rx4 PC3-12800R-11 Kit
1	650072-B21	HP Smart Array P721M/2G FBWC Ctrlr (Available after August 2012)
1	684211-B21	HP Flex-10 10Gb 2P 530FLB FIO Adptr
1	TA688AAE	HP P4000 VSA – One per Management server, three management servers for full enclosure NOTE: if doing persistent with P4800, only two are required

For the D2700 storage, the following part numbers are required:

Table A4. D2700 BOM

Qty	Part Number	Description
1	BK764A	6Gb SAS Dual Pack – one per BladeSystem enclosure
1	AW525A	HP D2700 300GB 6G SAS SFF 7.5TB Bundle – One for every 4 servers
2	407339-B21	HP Ext Mini SAS 2m Cable – need two per D2700

SAN storage BOM for P4800:

Table A5. P4800 BOM

Qty	Part Number	Description
2	AJ864A	HP 3Gb SAS BL-c Switch
2	142257-006	HP 10A IEC320 C14-C13 4.5ft US PDU Cable
1	BV932A	HP P4800 G2 42TB SAS SAN BladeSystem

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