

HP Client Virtualization SMB Reference Architecture for Citrix VDI-in-a-Box



An all-in-one VDI solution on HP ProLiant DL380p Gen8 servers

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Executive summary

This document describes a reference architecture—the HP Client Virtualization SMB Reference Architecture for Citrix® VDI-in-a-Box™—that can be rapidly deployed to support a scalable Virtual Desktop Infrastructure (VDI) building block that is fully tested, pre-sized, benchmarked, and easy to implement. The reference architecture defines 75 and 150-165 user configurations based on the HP ProLiant DL380p Gen8 server and the Citrix® VDI-in-a-Box™ software. The configurations were extensively performance-tested to determine optimal sizing, allowing small and medium-sized customers to provision client desktop images to various worker types efficiently and quickly.

This white paper is intended for a technical audience of IT architects, administrators, and managers, and describes testing performed in October 2012 and February 2013.

Introduction

Client virtualization used to be considered a large enterprise solution, but with improvements in virtualization software, bring-your-own-device (BYOD)/mobility plans, and lower overall cost per user, client virtualization is quickly emerging in the mainstream small and medium-sized business (SMB) market. This technical document describes a reference architecture designed to help a channel reseller or customer construct a simple Virtual Desktop Infrastructure (VDI) configuration starting at 75 users based on the HP ProLiant DL380p Gen8 server and Citrix® VDI-in-a-Box™. The reference architecture—the HP Client Virtualization SMB Reference Architecture for Citrix VDI-in-a-Box (HP CV SMB RA for Citrix)—is an appliance-like configuration that removes the guesswork from sizing and deploying a virtual desktop solution. By adhering to the recommended guidelines tested and validated by this reference architecture, you'll know in advance how many servers and what software licenses you'll need to support various workloads. And because the solution follows a building block approach, it scales on demand without re-architecture or expensive infrastructure, delivering predictable, repeatable performance at a defined price point.

Value proposition

By providing a solution blueprint that has been fully tested, pre-sized, and optimized, the HP CV SMB RA for Citrix VDI-in-a-Box accelerates time-to-production.

The HP CV SMB RA for Citrix VDI-in-a-Box encompasses the following components:

- Citrix VDI-in-a-Box software
- Microsoft® Hyper-V hypervisor
- HP ProLiant DL380p Gen8 Server
- HP Flexible Series Thin Clients or HP Smart Zero Clients

The benefits of this solution include:

- **Rapid deployment** – In less than three hours you can import the VDI-in-a-Box software appliance to an HP ProLiant server, configure desktop images, and deliver virtual desktops to users. There is nothing to architect or install, and no additional infrastructure, such as management servers, SQL databases, or storage area networks required.
- **Predictable, repeatable cost, and performance** – Whether you use a single, standalone HP ProLiant DL380p Gen8 server or a grid of multiple servers, the performance capacity per server remains unchanged—and that means predictable, affordable cost and scalable performance.
- **Built-in high availability** – To protect users in the event of server failure without requiring shared storage, you can add additional HP ProLiant DL380p Gen8 servers to the grid and the system automatically balances load across all servers, facilitating high availability.
- **Rich high-definition end-user access to applications** – Application access is delivered securely no matter what the access device. Using Citrix HDX™ and Citrix Receiver™ provided with Citrix VDI-in-a-Box, users can experience excellent performance over both WAN and LAN environments.
- **Assured log-in performance** – Users can access the information they need, when they need it, even when numerous users log in at the same time.
- **Integrated solution-level performance** – To reduce the demands on your IT staff, HP and Citrix engineers have validated all software and hardware components, so everything works correctly, right out of the box.

Citrix VDI-in-a-Box 5.1 enables single instance management to support personalized as well as pooled virtual desktops. Rather than juggling the demands of managing persistent desktops, IT can maintain a single master copy of desktop images while preserving the personalization of user applications and data. This dramatically reduces recurring management overhead and lowers datacenter storage costs.

Target customers and use cases

Typical VDI-in-a-Box customers need a simple, affordable virtual desktop environment. VDI customers come from a range of various industries, including but not limited to:

- Education, such as universities, schools, and training centers
- Public service, such as libraries, city halls, and police stations
- Healthcare, such as hospitals and medical group offices
- Financial services, such as credit unions and insurance companies
- Manufacturing facilities

In addition, regional or divisional offices of large organizations tend to look for simple and affordable virtual desktop solutions where the HP CV SMB RA for Citrix VDI-in-a-Box may be a good fit. It is important to understand how employees at these customer organizations connect to their VDI desktops. There are two types of users to consider. First, there are on-premise desktop users connecting to their desktops over wired and wireless connections. In addition, there are mobile executives, “road warriors”, or remote employees that access their desktops using mobile devices and wireless connections from off-premise locations, such as external client sites. HP CV SMB RA for Citrix VDI-in-a-Box with the HDX protocol provides excellent user experience over both LANs and WANs, enabling users to connect anytime, from anywhere, on any device and supporting both the on-premise desktop and mobile use cases.

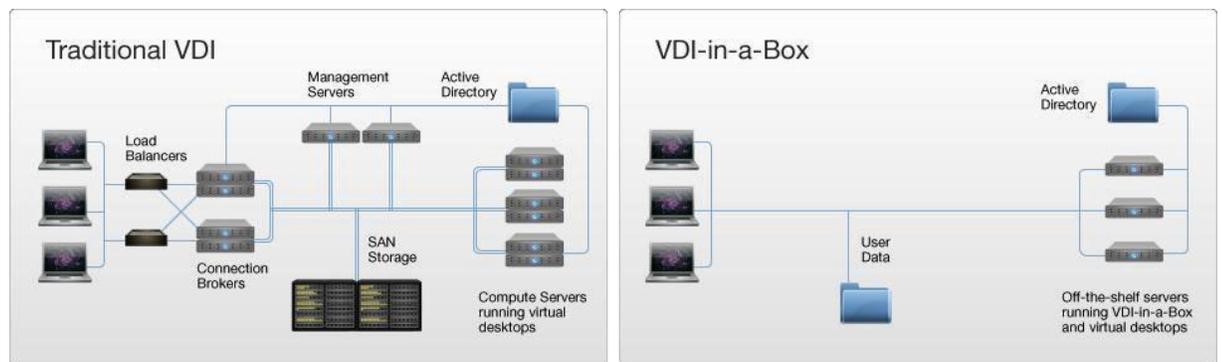
For customers looking to deploy desktop virtualization across a large enterprise under multiple use cases and requiring advanced management capabilities, please refer to the [HP CV Gen8 RA for Citrix XenDesktop® on Microsoft Hyper-V](#) or [HP CV Gen8 RA for Citrix XenDesktop on vSphere](#); and the technical documentation available at hp.com/go/cv.

Solution architecture

Citrix VDI-in-a-Box is a simple, all-in-one software that enables Microsoft® Windows® administrators to rapidly deliver centrally managed virtual desktops to any user, anytime, on any device—for less than the cost of traditional PCs.

Figure 1 compares a traditional enterprise VDI production deployment with a VDI-in-a-Box solution. The traditional enterprise-class VDI deployment includes a pair of load balancers and connection brokers to manage connections to desktop sessions and ensure high-availability, as well as compute servers to run the desktops and management servers that provision and control the environment. SANs, high-speed interconnects, and clustered SQL databases are also required. VDI-in-a-Box consolidates this functionality into a software virtual appliance, eliminating much of the infrastructure in an enterprise implementation. With VDI-in-a-Box, the connection brokering, load balancing, high availability, desktop provisioning, and management are all built in and managed through an intuitive web-based console. This radically simplifies setup and management, lowering both complexity and cost.

Figure 1. How VDI-in-a-Box eliminates complexity and lowers cost



Solution components

The components required to deploy this reference architecture are as follows:

- An HP ProLiant DL380p Gen8 Server
- A hypervisor. Although VDI-in-a-Box runs on multiple hypervisors, this reference architecture was tested with Microsoft Hyper-V. (For more information on Citrix VDI-in-a-Box supported hypervisors, please go to the [Citrix VDI-in-a-Box website](#).)
- Citrix VDI-in-a-Box for Hyper-V, which runs as a virtual appliance on any Hyper-V-enabled server.
- Endpoint devices. This reference architecture provides recommendations for HP Thin Clients.

In addition, for secure remote access, Citrix NetScaler® can also be used.

Hardware architecture

Server configurations

The HP ProLiant DL380p Gen8 server provides a full solution that is modular and scalable to meet a variety of customer needs. For the HP CV SMB RA for Citrix VDI-in-a-Box, the HP ProLiant DL380p Gen8 Server can be configured to support 75 and 150-165 users running a standard “medium” user workload. “Medium” workload simulates the desktop activity of a typical knowledge worker using office applications and web browsers with media streaming. Table 1 shows tested configurations for these user densities.

Figure 2. HP ProLiant DL380p Gen8

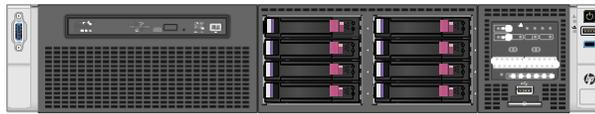


Table 1. Tested Solutions for 75 and 150-165 Virtual Desktop Users

Server Specs for 75 Users	Qty.	HP PN	Server Specs for 150-165 Users	Qty.	HP PN
HP ProLiant DL380p Gen8 Server (with HP Smart Array P420i)	1	653200-B21	HP ProLiant DL380p Gen8 Server (with HP Smart Array P420i)	1	653200-B21
(1) Intel® Xeon® E5-2680 @ 2.70GHz CPU	1	662228-L21	(2) Intel® Xeon® E5-2680 @ 2.70GHz CPU	1	662228-L21
128GB RAM (16GB x 8)	8	647901-B21	256GB RAM (16GB x 16)	16	647901-B21
8 SFF Drives*			8 SFF Drives*		
(6) 300GB 6G SAS 10,000 RPM drives, RAID 0+1	6	652564-B21	(6) 300GB 6G SAS 10,000 RPM drives, RAID 0+1	6	652564-B21
(2) 200GB 6G SAS SLC SSDs, RAID 1	2	653078-B21	(2) 200GB 6G SAS SLC SSDs, RAID 1	2	653078-B21
HP Smart Array P420i/2GB with Flash Backed Write Cache (FBWC) (RAID 0+1)	1	631681-B21	HP Smart Array P420i/2GB with Flash Backed Write Cache (FBWC) (RAID 0+1)	1	631681-B21
HP 10GbE 2P 530FLR Ethernet Adapter	1	684210-B21	HP 10GbE 2P 530FLR Ethernet Adapter	1	684210-B21
750W Power Supply Kit	1	656363-B21	750W Power Supply Kit	2	656363-B21

*Can be expanded to 16 SFF drives maximum

This reference architecture uses solid-state drives (SSDs) as well as traditional hard disk drives (HDDs) installed in the HP ProLiant DL380p Gen8 server. Although SSDs tend to be more expensive than traditional hard disk drives, they do not exhibit the latencies imposed by moving parts and can therefore deliver thousands of IOPS, in contrast to hundreds of IOPS for HDDs. In this solution, SSDs store the “golden” desktop image and help to significantly increase desktop performance, enabling higher user densities.

It is possible to scale storage capacity beyond the tested configurations described in this reference architecture. For example, 450GB 10k SAS drives can be used in place of the 300GB ones. An optional storage cage can further increase drive density from 8 to 16 drives—in this case, a second RAID controller must also be added. Please see the [DL380 Quickspecs](#) for additional information.

Endpoint devices

VDI-in-a-Box uses Citrix Receiver along with Citrix HDX protocol to provide virtual desktops to almost any device form factor: thin clients, desktop PCs, laptops, tablets, and smartphones. Through Citrix Receiver, VDI-in-a-Box provides fast, reliable virtual desktops to over 2 billion Citrix Receiver-enabled devices sold.

HP CV SMB RA for Citrix VDI-in-a-Box works with HP Flexible Series Thin Clients. The HP t610 or HP t510 Flexible Series Windows Embedded Standard 7 (WES7) Thin Clients benefit from full HDX capabilities while potentially improving server scalability since they can perform Citrix client-side rendering. These thin clients are ideal for customers requiring an advanced graphical user experience. Customers selecting the HP t610 over the HP t510 will benefit from a more powerful CPU, graphics hardware acceleration, quad-display, internal dual-antenna Wi-Fi, Fiber NIC, and PCIe expansion bay options. Customers who purchase the HP t610 typically have a greater mix of remotely virtualized apps and locally embedded apps. Both the HP t610 family and the HP t510 thin clients come standard with dual-core CPUs and legacy ports for powerful, flexible connectivity to a broad array of peripheral devices. Smart Zero Technology can also be deployed on the Flexible Series Thin Clients, providing a “zero touch” experience at the endpoint device. For additional details, go to [HP Flexible Series Thin Clients](#).

Figure 3. HP Flexible Series Thin Clients



Software architecture

The software components in a Citrix VDI-in-a-Box deployment include:

- Citrix VDI-in-a-Box
- Citrix Receiver
- Microsoft Hyper-V hypervisor
- Optionally, software to support the use of Smart Zero Technology on HP Thin Clients

Citrix VDI-in-a-Box

VDI-in-a-Box is designed to make virtual desktop administration easy, automated, and cost-effective for desktop IT while delivering a rich user experience. Key features include:

- **Efficient support for both pooled and personalized virtual desktops.** Pooled desktops are standardized virtual desktops that run from a single, centralized virtual desktop “golden” image. Pooled desktops are a good solution for students or task workers since they offer a high-level of administrative control, enforce security, and reduce management costs by preventing users from making permanent changes to their environment. In addition to pooled desktops, VDI-in-a-Box 5.1 provides efficient support for personalized desktops in which users can customize a “golden” image, installing their own applications and storing their own configuration information and data on a personal virtual disk (vDisk). Personalized desktops provide the best of both worlds: users get personalized desktops while IT can manage a single master image, much like pooled desktops, saving time and money while delivering a highly personalized end-user experience. VDI-in-a-Box 5.1 delivers both pooled and personalized virtual desktops using a centrally managed golden image approach.
- **Simple and intuitive administration.** Point-and-click wizards guide you through key virtual desktop administration tasks, such as desktop image preparation and updates. VDI-in-a-Box 5.1 has an expanded set of wizards to cover frequent operations, and setting up and upgrading master images is simple. The VDI-in-a-Box grid appears as one logical server, thus eliminating the need to manage servers individually.

- **Support for more than two billion devices.** With Citrix Receiver, you can provide secure access to any desktop from any of over two billion devices, including iOS, Android, Chrome OS, Mac OS, Linux and Windows PCs, thin clients, and mobile devices.
- **Built-in scalability and high-availability.** Traditional VDI solutions require shared storage to deliver high availability. In production settings, this means a SAN with high-speed interconnects. While this type of shared storage environment is suitable for enterprise class deployment, the solution can quickly get complex and expensive, and requires specialized administrative expertise. VDI-in-a-Box eliminates this requirement, providing high availability and scaling via inexpensive direct-attached storage (DAS). By running VDI-in-a-Box in an N+1 configuration (i.e., on two or more servers), the VDI-in-a-Box grid automatically load balances and takes advantage of redundancy for high availability. In the event of a server failure, VDI-in-a-Box automatically rebalances the desktop load across the remaining healthy servers to prevent outages. VDI-in-a-Box 5.1 extends built-in high availability to device access and Microsoft Active Directory. When an IT environment is configured for Active Directory failover, VDI-in-a-Box 5.1 will default to a backup Active Directory server when a primary server fails. VDI-in-a-Box 5.1 features a grid-wide virtual IP address, making the entire grid accessible through a single highly available virtual IP address. These capabilities promote end-to-end high availability regardless of the endpoint device being used and without the need for a load balancer.

Citrix Receiver

Users today typically use multiple computing devices—including smartphones, tablets and PCs—and crave a consistent computing experience across all of them. Organizations everywhere are struggling to cope with the rapid proliferation of devices and yet give users the mobile, high-definition experience they demand.

Citrix Receiver is a free, easy-to-install software client that lets you access enterprise data, applications and desktops from any of these computing devices. In tandem with a Citrix-enabled IT infrastructure, Citrix Receiver provides consistent, secure, high-performance access without introducing layers of IT management complexity. It is a key enabling technology for organizations that want to adopt a bring-your-own-device (BYOD) strategy that promotes the ad hoc use of personal devices to supplement or replace corporate endpoints.

Citrix Receiver is a client-based plug-in that is installed on the user's endpoint device. It works in conjunction with Citrix VDI-in-a-Box when the user requires the ability to interact with their virtual desktop. When a user logs into a VDI-in-a-Box site to access a virtual desktop, the website can detect whether Citrix Receiver is absent from the endpoint, automatically prompting the user if necessary to download and install it.

Smart Zero technology

Available on HP Smart Zero (HP t410) and Flexible Thin Clients (HP t510 and HP t610), HP Smart Zero Technology gives you a simple, reprogrammable, and affordable solution. It supports multiple protocols and can be reprogrammed on the fly, delivering a no-compromise, intelligent zero client experience for remote and cloud computing environments. With HP Smart Zero Technology installed on the virtualization infrastructure, it allows end users to be up and running in seconds with no configuration or management required on the device side. Just set up the server, boot the client, and connect. HP Smart Zero Technology combines the benefits of a zero client with HP auto-sensing technology that automatically connects to the network and searches for the right client virtualization infrastructure and downloads everything it needs to deliver a robust user experience. The user is up and running quickly with no local user interface and just three steps from log on to productivity.

Services and support

Complete your HP Client Virtualization SMB Reference Architecture for Citrix VDI-in-a-Box solution with services and support, delivered by HP experts you trust.

HP Technology Support Services

The new HP Technology Support portfolio features three levels of on-going customer support services and a comprehensive family of added value service offerings that customers can deploy as needed.

The portfolio includes:

- **HP Foundation Care** – A portfolio of reactive hardware and software support services that is significantly enhanced with the introduction of HP Collaborative Support.
- **HP Proactive Care** – An innovative, higher value support services leveraging new product technology and HP support infrastructure investments to achieve an unprecedented price point for proactive support.

- **HP Datacenter Care** – Our most flexible level of support, which is personalized, tailored to the needs of each customer. This environmental support covers heterogeneous hardware and software in the datacenter, and enables our customers to bring expertise from all of HP to bear on their needs.
- **HP Lifecycle Event Services** – A complete portfolio of ad hoc services that reduce customer’s time to value throughout the technology lifecycle.

HP recommends HP Proactive Care for the HP VDI-in-a-Box SMB RA. Customers with a more environmental approach should consider HP Datacenter Care.

Scaling and sizing

This reference architecture provides sizing options for servers tested with user densities running standard “medium” virtual desktop workloads as defined by Login VSI. The HP ProLiant DL380p Gen8 server was configured with the necessary CPU cores, RAM, and disk spindles to support a given number of Windows 7 desktops.

Scaling and high-availability

VDI-in-a-Box provides on-demand scaling and provides built-in high-availability using an N+1 model. Additional servers can be added as more desktop capacity is required, and the VDI-in-a-Box software automatically configures and provisions the server to run virtual desktops. VDI-in-a-Box architecture delivers built-in high availability without shared storage or connection brokers—all that is needed is one additional server in the grid. With an N+1 configuration, VDI-in-a-Box automatically ensures that if one server fails, another server is able to host the virtual desktops. Due to the shared-nothing architecture, all servers are equally replaceable. When a physical server fails, the remaining servers in the grid have the needed information, including templates and images, to create extra desktops to replace those on the failed server. When the failed server is repaired and rejoins the grid, key operational and configuration information is forwarded to it, allowing it to then resume desktop provisioning.

The figure below illustrates three server configurations. The top configuration consists of a single server designed to host 150 virtual desktops. The middle configuration shows two servers joined together in a grid and sized to either run 150 virtual desktops in high-availability (HA) mode or 300 desktops without HA. In the HA configuration, when one server fails, the remaining server runs all 150 desktops until the failed server is repaired and restored into the grid. In non-HA mode, 300 desktops can be run across the two servers. If a server fails in a non-HA configuration, only 150 desktops of the 300 are available for use until the failed server is repaired and returned to the grid. The third configuration supports 300 users with HA or 450 users without HA. Likewise, more servers can be added to the grid to increase the capacity of the solution. This illustrates the simplicity of VDI-in-a-Box and the advantages of its all-in-one appliance approach. Everything that’s needed—all the management software and all the hardware, including local storage—is provided in a single appliance, allowing a seamless, “no think” approach to production scaling that features high availability.

Figure 4. Server configurations

150 Users



150 Users with HA or 300 Users without HA



300 Users with HA or 450 Users without HA



Calculating storage requirements

While the CPU cores, server memory and IOPS figures have been pre-calculated within this reference architecture, each individual use case must determine how much storage capacity is required in a particular environment.

The number of pooled versus personal desktops is a significant factor in calculating the amount of storage needed, along with the number of shared golden images. Pooled desktops use only about 15% of the size of a golden image per desktop. This savings is due to the implementation of pooled desktops through “differencing disks” in which desktops share a common master image, reducing storage capacity requirements. With differencing disks, when desktops are provisioned, a separate, small difference disk is created. All changes to the desktop—such as registry changes or installation of new applications—are stored in its difference disk. All reads use the parent disk or the golden image itself. The difference disk grows with use over time. For non-persistent desktops that are refreshed periodically, these difference disks are typically very small, usually about 10-15% of the golden image. This reference architecture assumes that pooled desktops are refreshed frequently (at least weekly or bi-weekly), and that user and profile data is stored externally. If that is not the case, or if applications require additional write space, you should allocate more than 15% of the “golden” image size per pooled desktop, or consider the provisioning of personalized desktops.

Calculating the required storage capacity follows several basic formulas. To estimate the storage needed, you'll first need to know the number of golden images, the size of each golden image, the number of pooled desktops, the number of personal desktops, and the size of the personal vDisk to be provisioned for each personal desktop. The paragraphs below describe the general formulas used to estimate the amount of storage needed. (Citrix makes available an on-line [VDI-in-a-Box 5.1 Server Sizing Calculator](#) that follows these formulas to predict the amount of storage required in a deployment.)

The first formula estimates the amount of storage needed for golden images:

Formula 1: 2 X (Size of Golden image) X (Number of Golden Images) = Disk space (GB) required for Golden Images

For example, if there are two 20GB golden images, the formula is as follows:

Example 1: 2 x 20GB x 2 Golden Images = 80GB

The second formula determines how much space the pooled desktops consume. The rule of thumb is that each differencing disks takes up roughly 15% of the golden image size. Assuming a 20GB golden image, the differencing disks storage calculation for 105 pooled desktops is as follows:

Formula 2: 15% X (Size of Golden image) X (Number of Pooled Desktops) = Disk space (GB) for Pooled Desktops

Example 2: 15% of 20GB x 105 Pooled Desktops = 315GB

The next formula determines how much space is required for personalized desktops. Personal desktops are assigned using a vDisk template that varies in size from 4GB to 60GB (the default is 8GB). Using the 8GB default, the storage calculation for 45 personal desktops would be as follows:

Formula 3: (Size of VHD Template) X (Number of Personal Desktops) = Disk space (GB) for Personal Desktops

Example 3: 8GB x 45 Personal Desktops = 360GB

The last formula determines the amount of swap space to configure. This value represents the memory allocated for each virtual desktop times the total number of virtual desktops configured:

Formula 4: (VM RAM Size) X (Number of VMs) = Disk space (GB) for swap

Example 4: (2GB x 150 Pooled or Personal Desktops) = 300GB

Options for expanding storage

Storage is easily expanded beyond the capacity of the tested configurations in this reference architecture. Larger capacities can accommodate larger personal vDisks that are used in conjunction with personalized desktops. The tested Pooled with Personal Desktop configuration over-commits storage, so there is the possibility of a storage shortfall if several users' personal vDisks expand to their maximum capacity (10GB per desktop). Of course, this is dependent on the number of applications that each user installs. For this reason, each site must determine storage capacity based on individual workload requirements.

There are several options for expanding storage capacity in this reference architecture. First, 450GB 10k SAS drives can optionally replace the 300GB drives in the tested configurations. Also, adding a second RAID controller and an optional storage cage can increase the number of drives from 8 to 16. Please see the [DL380 Quickspecs](#) for additional information.

Performance and testing

The following section describes performance testing and presents key results for the HP CV SMB RA for Citrix VDI-in-a-Box solution. Multiple test iterations were performed.

In the initial series of tests, a single server configuration was customized to accommodate 75 and 150 user deployments, and test runs were conducted using Microsoft Windows Server 2008 R2 SP1 Hyper-V and VDI-in-a-Box 5.1. In a subsequent round of testing, tests were conducted using Microsoft Windows Server 2012 with Hyper-V and VDI-in-a-Box 5.2, and achieved user densities of up to 165 users.

Test configuration overview

Tests were performed using Login VSI (loginvsi.com), a load generation tool for VDI benchmarking that simulates production user workloads to generate desktop workloads and gather data about VDI performance. All tests were done using the default Medium workload to simulate the desktop activity of a typical knowledge worker. Login VSI generates an office productivity workload that includes Microsoft Office 2010 with Microsoft Outlook, Word, PowerPoint, and Excel, Internet Explorer with a Flash video applet, Java app, and Adobe® Acrobat® Reader. Follow-on testing was also conducted to examine the impact of a Microsoft Office 2013 workload.

Pooled versus personal desktops

The test results presented in this reference architecture compare workloads of pooled versus personalized desktop users. Pooled desktops allow multiple virtual desktops to run from a single, centralized virtual desktop image. By using a centralized virtual desktop image, administrators have the option to simply install all required business applications directly on that golden image, which is then referenced in Citrix VDI-in-a-Box as Pooled Desktops with Installed Applications. The pooled desktop and installed application model can be implemented quickly and with a minimal amount of infrastructure using linked clones.

Personalized desktops are created from a published Windows 7 image through the VDI-in-a-Box administrative interface. They leverage the simplicity of pooled desktop management while enabling the customization of a personal vDisk. Administrators can customize and maintain the golden image with applications, just as in pooled desktops. In addition, users can install their own applications in their personal vDisk. When the published golden image is updated, the base image of all personal desktops is automatically updated with the administrator's changes while the user-installed applications, profiles, and data on the personal vDisk remain intact. Citrix recommends using a profile management application with the personal desktop feature—Citrix Profile management is included with VDI-in-a-Box.

Test environment and components – test series #1

The test environment for the first series of tests included these core components:

- **Citrix VDI-in-a-Box 5.1.** Citrix VDI-in-a-Box is a complete VDI solution designed to scale simply by adding additional units, and features built-in connection brokering and load balancing across multiple servers. It takes advantage of the Citrix Receiver and the HDX protocol to support a variety of device types, including smartphones, tablets, thin clients, laptops, and workstations. The testing used the default HDX settings with a resolution of 1024x768 and Flash redirection was disabled.
- **Microsoft Windows Server 2008 R2 SP1 Hyper-V.** VDI-in-a-Box runs on Microsoft Hyper-V, Citrix XenServer®, and VMware vSphere hypervisors. The testing for this solution used Microsoft Hyper-V. Hyper-V Dynamic Memory was used for all testing with these parameters: 1GB startup RAM, 3GB maximum RAM, and 20% buffer.
- **Desktop VM.** The desktop VM image deployed a 32-bit instance of Microsoft Windows 7 SP1 using 1 virtual CPU and 1-3GB of dynamic memory. Note: The Login VSI Medium workload consumes approximately 800MB of RAM per desktop VM.
- **HP ProLiant DL380p Gen8 Server.** The testing used an HP ProLiant DL380p Gen8 in two different configurations to support capacities of 75 and 150 users. To support 75 users, the server was configured with a single Intel Xeon E5-2680 CPU @ 2.70GHz (8 cores, 16 threads) and 128GB of memory, while the 150-user configuration had twice the CPU and memory resources — two Intel Xeon E5-2680 CPUs and 256GB of memory. The local storage configuration was the same for both configurations; only the compute and memory resources differed. The server used an HP Smart Array P420i 6 Gb/s PCIe 3.0 SAS controller with 2GB Flash Backed Write Cache and was configured with two datastores as follows:

Pooled desktops solution

- Datastore1 C: Drive – (2) SSDs, configured as RAID1, 186GB Total
 - Hyper-V OS
 - (1) golden image
 Note: 27GB storage consumed.

- Datastore2 D: Drive – (6) 10k RPM SAS drives, configured as RAID0+1, 838GB Total
 - (150) pooled desktops VMs (differencing disks VHDs)
 - Hyper-V VM configuration files (i.e., *.bin files that are the same size as the allocated RAM per VM)
 - OS pagefile (20GB)

Note: 424GB storage consumed.

Personal desktops solution

- Datastore1 C: Drive – (2) SSDs, RAID1, 186GB Total
 - Hyper-V OS
 - (2) golden images

Note: 56GB storage consumed.
- Datastore2 D: Drive – (6) 10k RPM SAS drives, RAID0+1, 838GB Total
 - (105) pooled desktop VMs (differencing disks VHDs)
 - (45) personal desktops – includes both sets of VHDs (i.e., same differencing disks VHDs as pooled desktops, plus personal vDisk VHDs)
 - Hyper-V VM configuration files (i.e., *.bin files that are the same size as the allocated RAM per VM)
 - OS pagefile (20GB)

Note: 547GB storage consumed.

Pooled desktops were tested along with a mix of 70% pooled and 30% personal desktops. To simulate a real-world scenario, Microsoft Office 2010, MindMap, and Adobe Acrobat Reader were installed in the personal vDisk, while Flash, Shockwave, Java, and the Bullzip print driver were installed in the base image (since these are considered foundation applications).

Test environment and components – test series #2

The test environment for the second series of tests was largely the same, with the following changes:

- **Citrix VDI-in-a-Box 5.2.** The 5.2 release of VDI-in a-Box adds support for Microsoft Windows Server 2012 with Hyper-V and integrates VDI-in-a-Box more closely with other Citrix products, adding support for Citrix Cloud Gateway StoreFront and Citrix Desktop Lock. Citrix VDI-in-a-Box 5.2 also enables support for configuring a third data store for personal vDisks, which can be implemented on fast storage devices to optimize performance.
- **Microsoft Windows Server 2012 with Hyper-V.** In the second set of tests, VDI-in a-Box 5.2 was tested using Microsoft Windows Server 2012 with Hyper-V. Dynamic Memory was configured slightly differently, with 1GB startup RAM, 768MB minimum/2GB maximum RAM, and 20% buffer.

The second series of tests achieved higher user densities: 165 users for pooled desktops, 160 users for a 70%/30% mix of pooled/personal desktops, and 330 users for testing scalability with a dual server grid. User densities were also tested with Microsoft Office 2013 workloads to understand the impact of that workload in comparison to Microsoft Office 2010. In the second round of tests, data stores were configured with relatively the same placement, but the storage consumed was slightly different:

Pooled desktops solution

- Datastore1 C: Drive – (2) SSDs, configured as RAID1, 185GB Total
 - Hyper-V OS
 - (1) golden image

Note: 27GB storage consumed.
- Datastore2 D: Drive – (6) 10k RPM SAS drives, configured as RAID0+1, 836GB Total
 - (165) pooled desktops VMs (differencing disks VHDs)
 - Hyper-V VM configuration files (VM save state was disabled)
 - OS pagefile (20GB)

Note: 424 GB storage consumed.

Personal desktops solution

- Datastore1 C: Drive – (2) SSDs, RAID1, 185GB Total
 - Hyper-V OS
 - (2) golden images
 - Note: 47GB storage consumed.

- Datastore2 D: Drive – (6) 10k RPM SAS drives, RAID0+1, 836GB Total
 - (112) pooled desktop VMs (differencing disks VHDs)
 - (48) personal desktops – includes both sets of VHDs (i.e., differencing disks VHDs as pooled desktops, plus personal vDisk VHDs)
 - Hyper-V VM configuration files (VM save state was disabled)
 - OS pagefile (20GB)
 - Note: 457GB storage consumed.

Test methodology

In all testing, the test runs followed this sequence of steps:

1. Using the VDI-in-a-Box Management Console, all desktops were powered up and in an idle “Hold” state.
2. The VSI launchers were restarted and verified as ready for testing.
3. A Perfmon script was started to capture comprehensive system performance metrics.
4. With the desktops powered up and idle, Login VSI began the workload simulation portion of the test. Desktop sessions were launched at 30-second sequential intervals and Login VSI initiated user logins to start the test run.

Once all users were logged in, the steady state portion of the test began in which Login VSI continued to track application performance statistics, looping through specific operations and measuring response times at regular intervals. Response times are used to determine Login VSI_{max}, the maximum number of users that the test environment can support before performance degrades consistently. In the testing, Login VSI defines success criteria as application response times lower than the VSI_{max} threshold (over the baseline) with exceptions occurring less than six times consecutively. This is calculated by averaging the response time of the first 15 Login VSI measurements. The formula for the dynamic VSI_{max} threshold is: Avg. Baseline Response Time x 125% + 3000. As a result, when the baseline response time is 1800, the VSI_{max} threshold is 1800 x 125% + 3000 = 5250ms.

5. After a specified amount of elapsed steady state time (300 seconds), Login VSI started to log off the desktop sessions.
6. After all sessions were logged off, the performance monitoring scripts were stopped. Since the desktops were configured with roaming profiles, the locally cached profiles were deleted at logoff.
7. Lastly, the Login VSI logs were processed using [VSI Analyzer](#) and Perfmon CSV using [PAL](#) (Performance Analysis of Logs) to analyze the test results presented here.

Metric descriptions

The test results that follow include these metrics:

VSI_{max} Scores: Derived from the Login VSI Analysis Tool, this data determines the VSI_{max}, which is the maximum capacity of the tested system expressed as the number of Login VSI sessions. Within each workload test loop the response times of seven specific operations are measured at a regular interval: six times within each loop. The response times of these seven operations are used to establish VSI_{max}.

Hyper-V Physical Server Processor Analysis: This analysis checks the processor utilization of physical processors in the host computer. The “\Hyper-V Hypervisor Logical Processor(*)\% Total Run Time” performance counter is more accurate than using the “% Processor Time” counter on the host, root partition computer because the “% Processor Time” counter only measures the processor time of the host, root partition computer only. The “\Hyper-V Hypervisor Logical Processor(*)\% Total Run Time” performance counter is the best counter to use to analyze overall processor utilization of the Hyper-V server.

Note: Because the other server components (RAM, storage, etc.) were sized and configured proportionally, CPU utilization was the gating factor for determining the desktop host server capacity.

Hyper-V Hypervisor Logical Processor Context Switches/sec: The rate of virtual processor context switches on the processor. This is the number of times a new Virtual Processor (VP) has been scheduled to a particular Logical Processor (LP).

Memory Available Mbytes: Available MBytes is the amount of physical RAM, in Megabytes, immediately available for allocation to a process or for system use. It is equal to the sum of memory assigned to the standby (cached), free and zero page lists. If this counter is low, then the computer is running low on physical RAM.

PhysicalDisk Calculated IOPS: Disk Reads and Writes/sec is the rate of read and write operations on the disk.

PhysicalDisk Avg. Disk Queue Length: Avg. Disk Queue Length is the average number of both read and write requests that were queued for the selected disk during the sample interval.

Network Interface Bytes Total/sec: Bytes Total/sec is the rate at which bytes are sent and received over each network adapter, including framing characters. Network Interface\Bytes Total/sec is a sum of Network Interface\Bytes Received/sec and Network Interface\Bytes Sent/sec.

Results—Windows Server 2008 Hyper-V and VDI-in-a-Box 5.1

This section provides data points from the first series of tests using Windows Server 2008 with Hyper-V and VDI-in-a-Box 5.1. Customers may reference this data in designing their own implementations on these releases.

75-user pooled desktops, single server

This section contains Login VSI test results for the server configured to run 75 Windows 7 pooled desktops. The Login VSI tests indicate that VSImax was not reached. (In separate testing, Login VSImax was reached at 80 users.) This means that good user experience was achieved with this configuration when running 75 users.

Figure 5. Login VSI Data (no VSI Max reached)

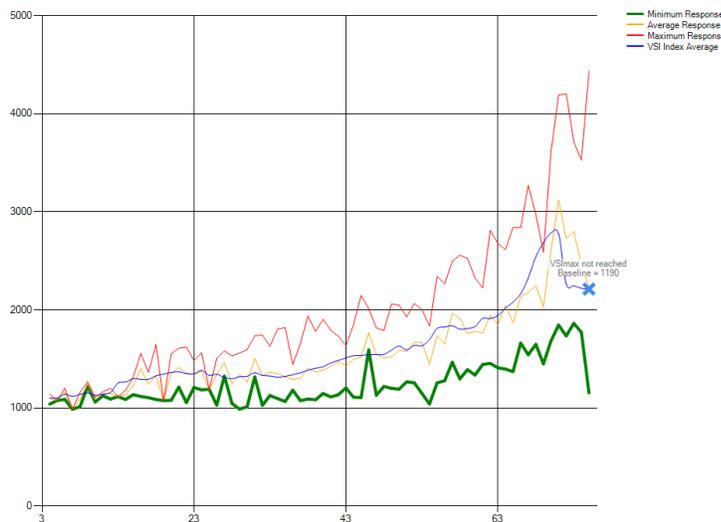
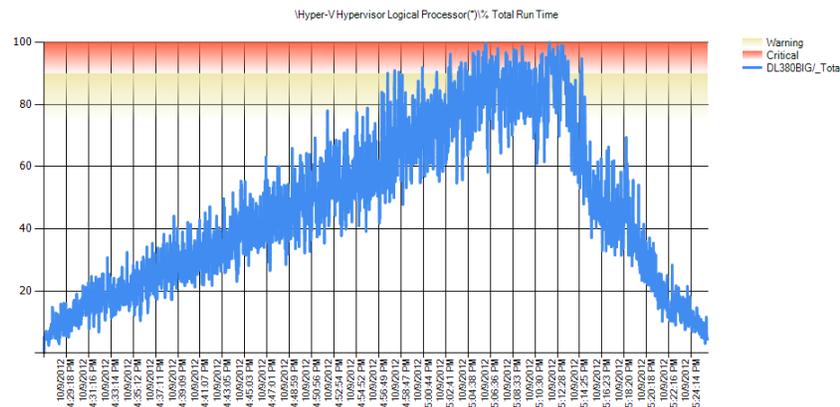


Figure 6. CPU (Single, 16 logical cores)



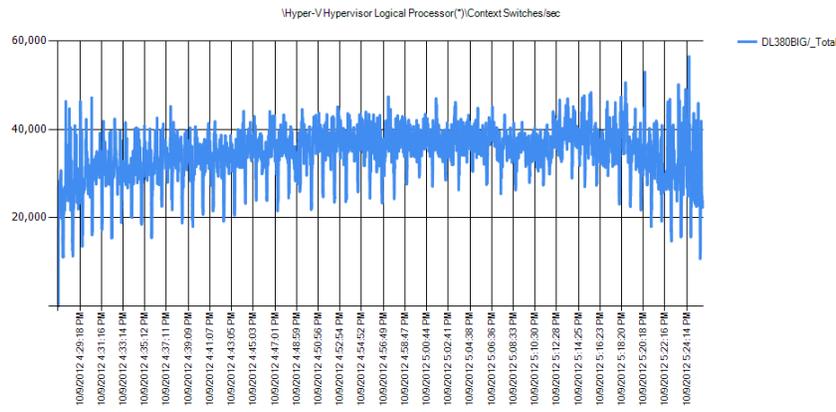
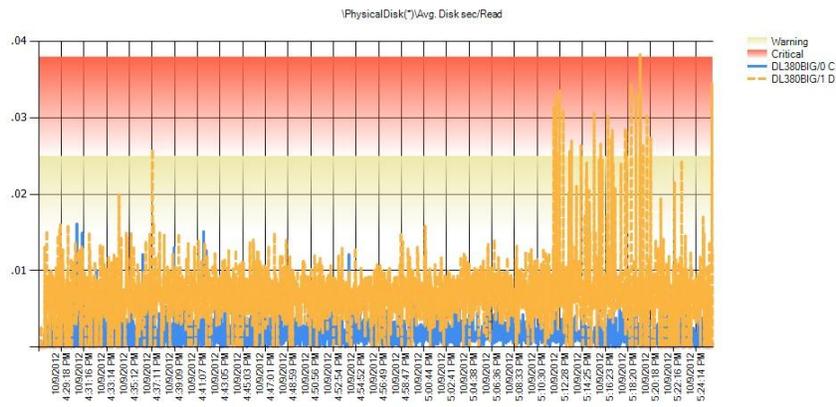


Figure 7. Memory (128GB Total)



Figure 8. Storage IOPS and Queue Length



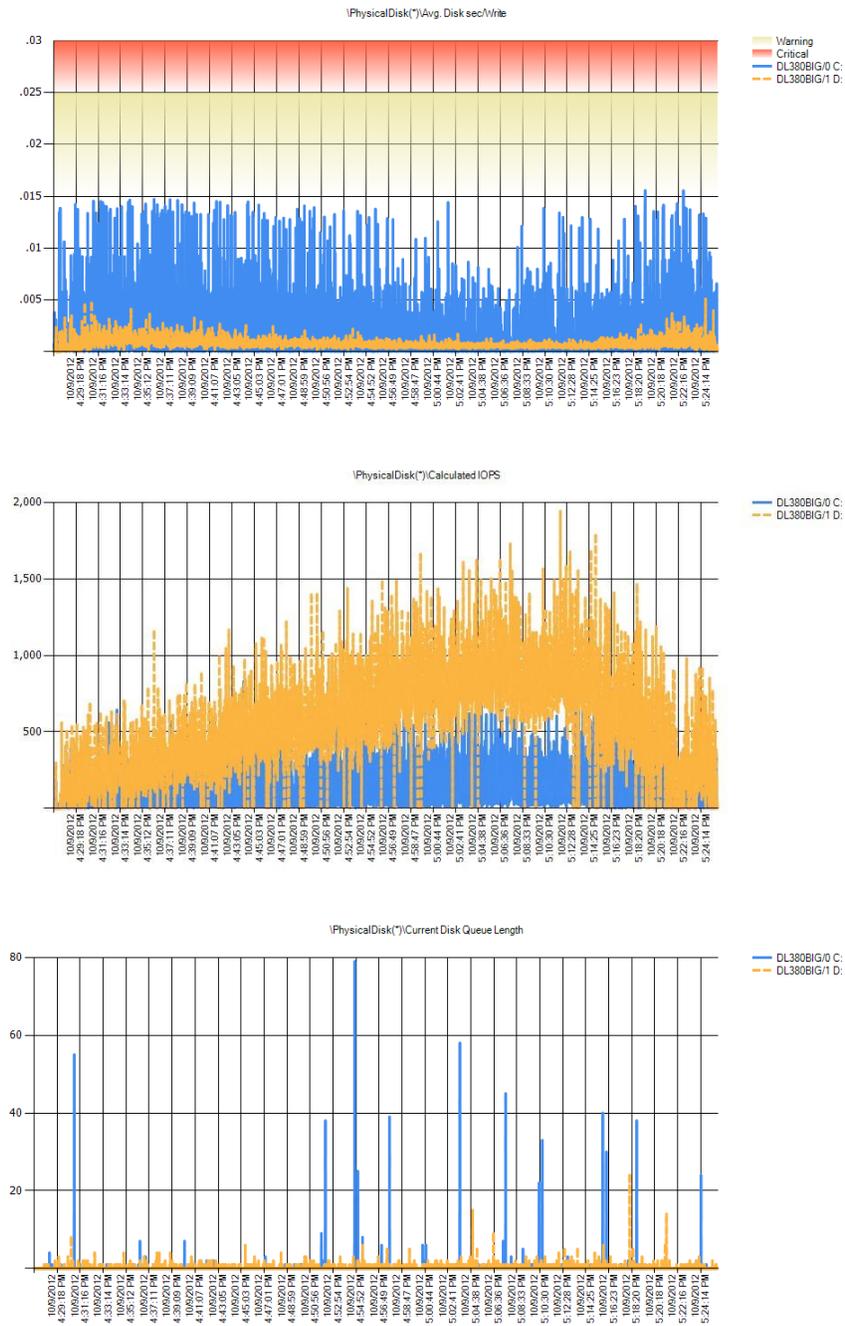
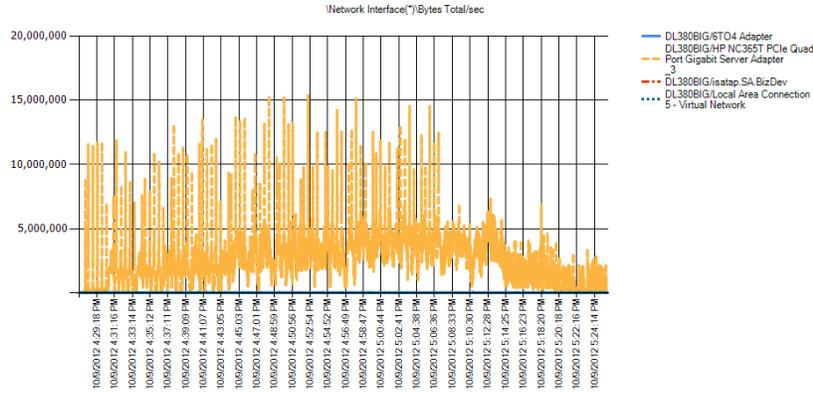


Figure 9. Network



150-user pooled desktops, single server

The following are Login VSI test results for the server configured to run 150 Windows 7 pooled desktops. The Login VSI tests indicate that VSImax was not reached. (In separate testing, Login VSImax was reached at 163 users.) This means that good user experience was achieved with this configuration with 150 users.

Figure 10. Login VSI Data (no VSI Max reached)

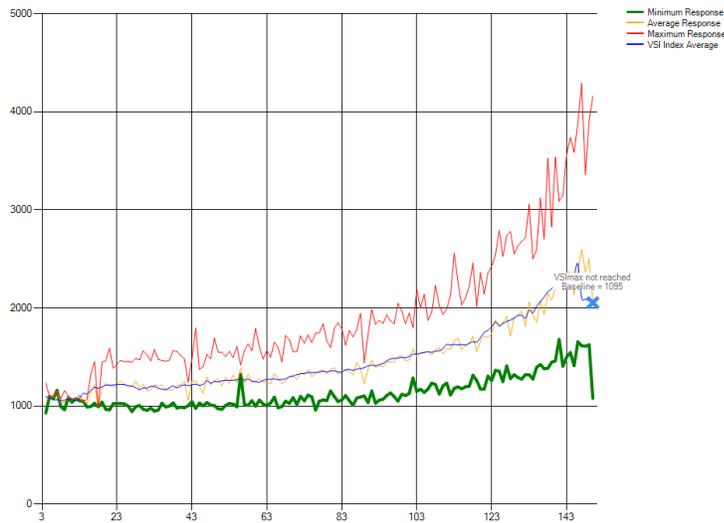
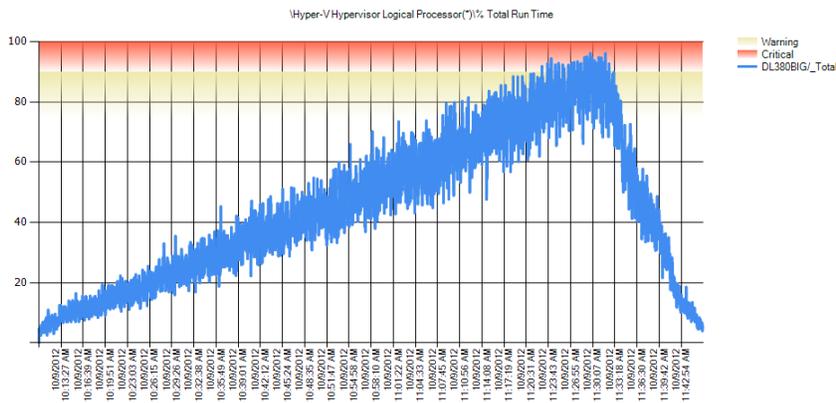


Figure 11. CPU (Dual, 32 logical cores)



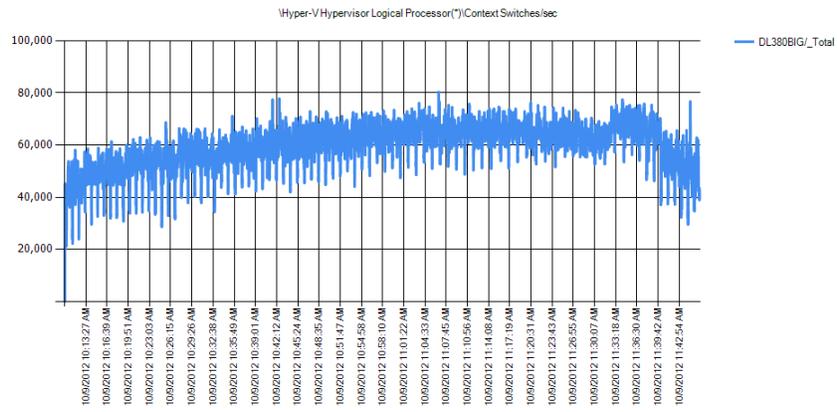


Figure 12. Memory (256GB Total)

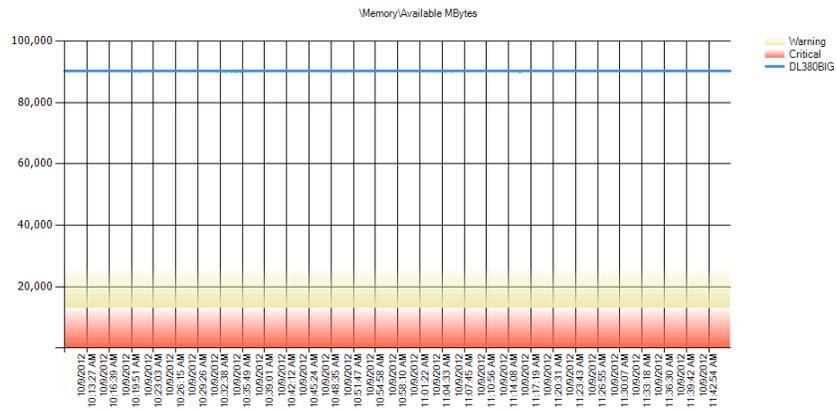
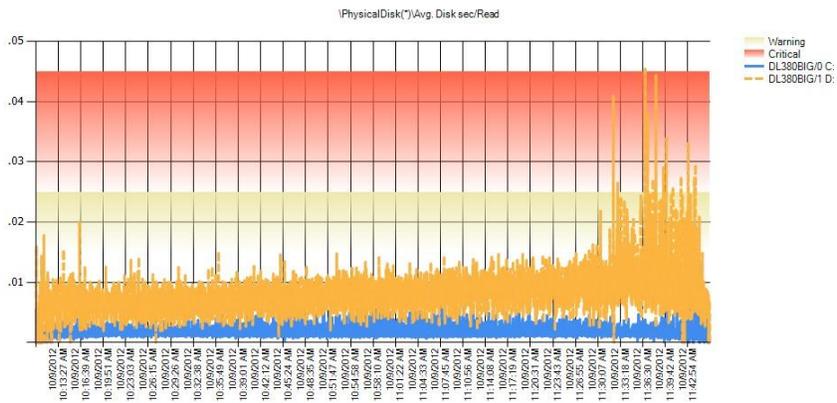


Figure 13. Storage IOPS and Queue Length



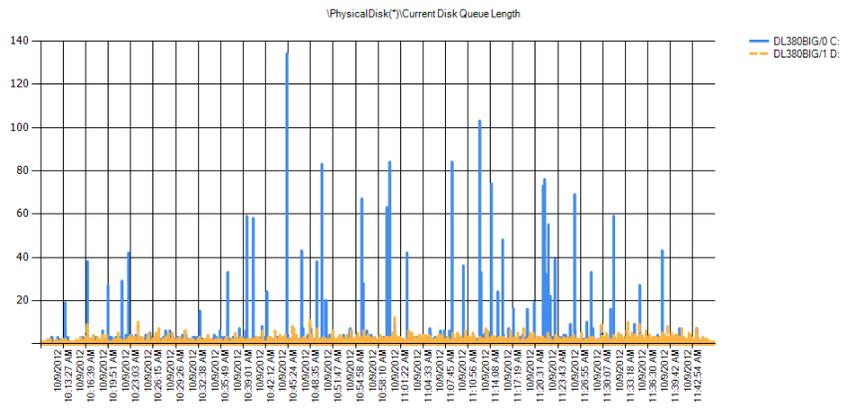
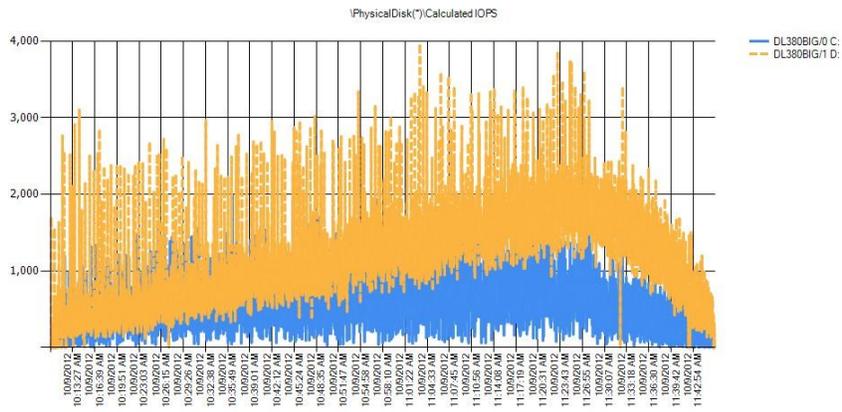
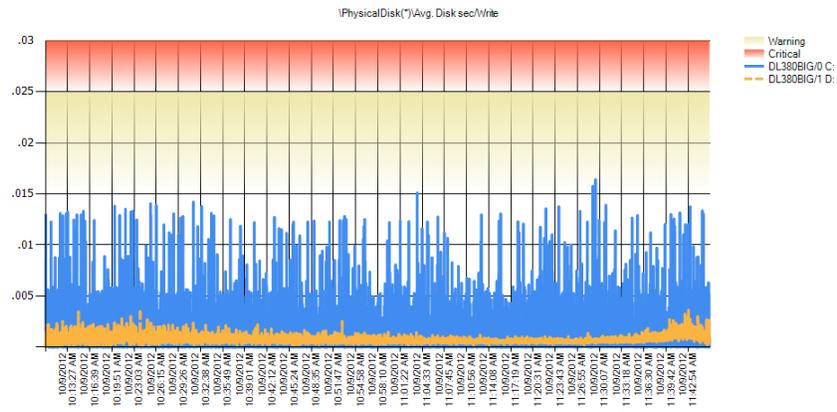
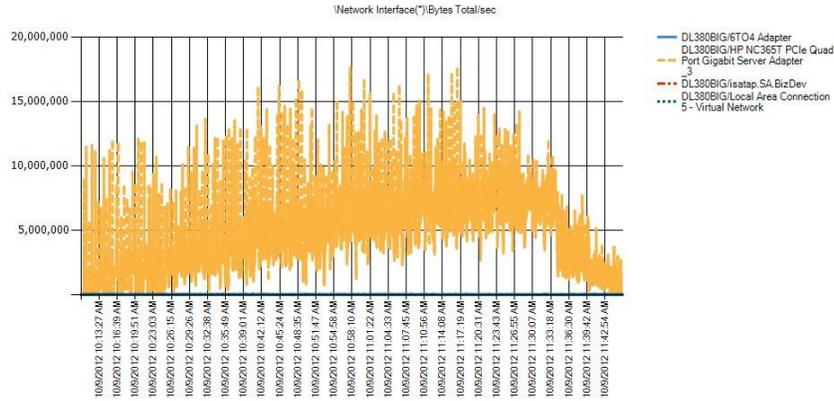


Figure 14. Network



150-user pooled/personal desktops (70/30% mix), single server

The following are Login VSI test results for the server configured to run a mix of pooled and personalized Windows 7 desktops. The mix consisted of 70% pooled desktops and 30% personal desktops, with 150 desktops total. The Login VSI tests indicate that VSI_{max} was not reached. This means that good user experience was achieved with this configuration when running 150 users.

Figure 15. Login VSI Data (no VSI Max reached)

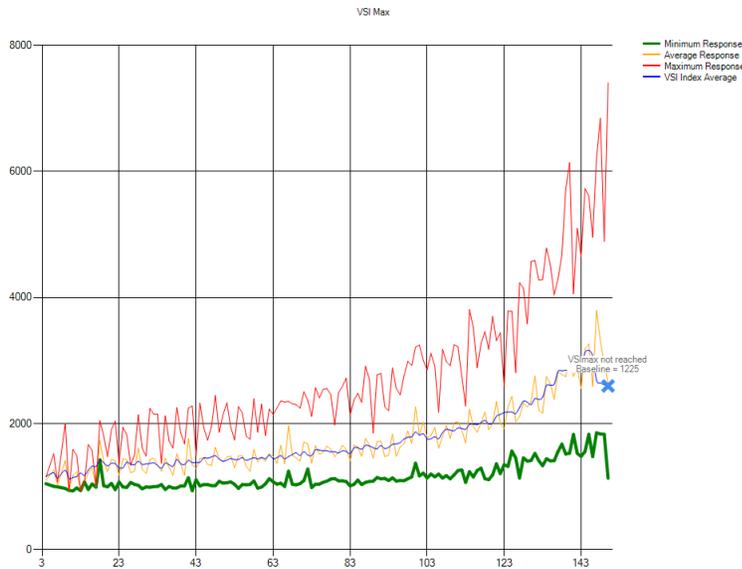


Figure 16. CPU (Dual, 32 logical cores)

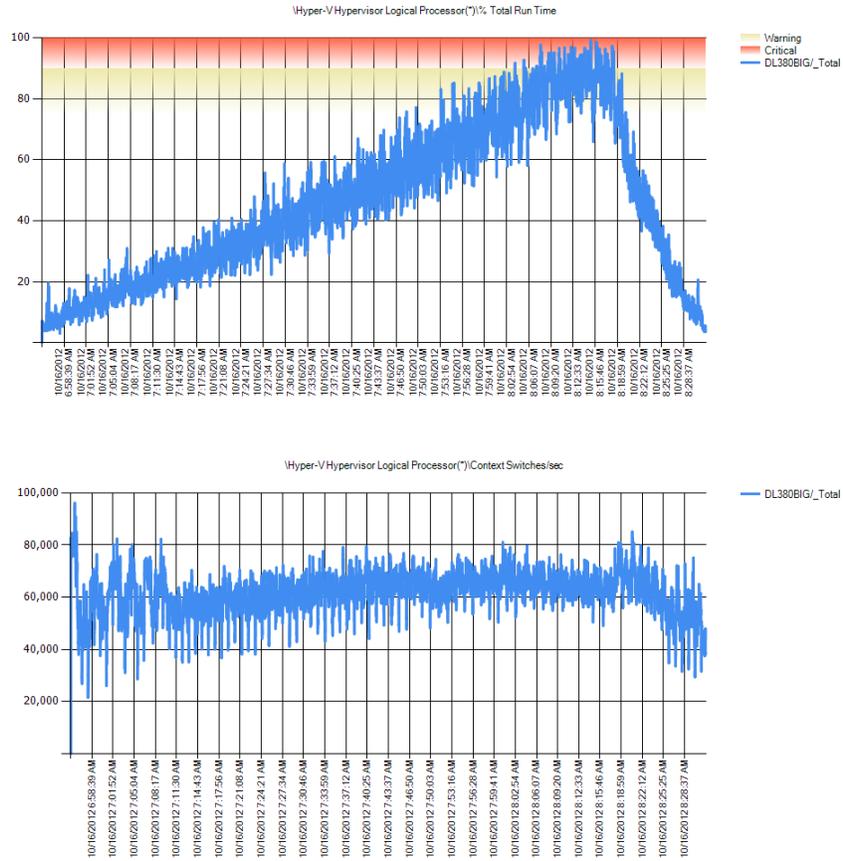
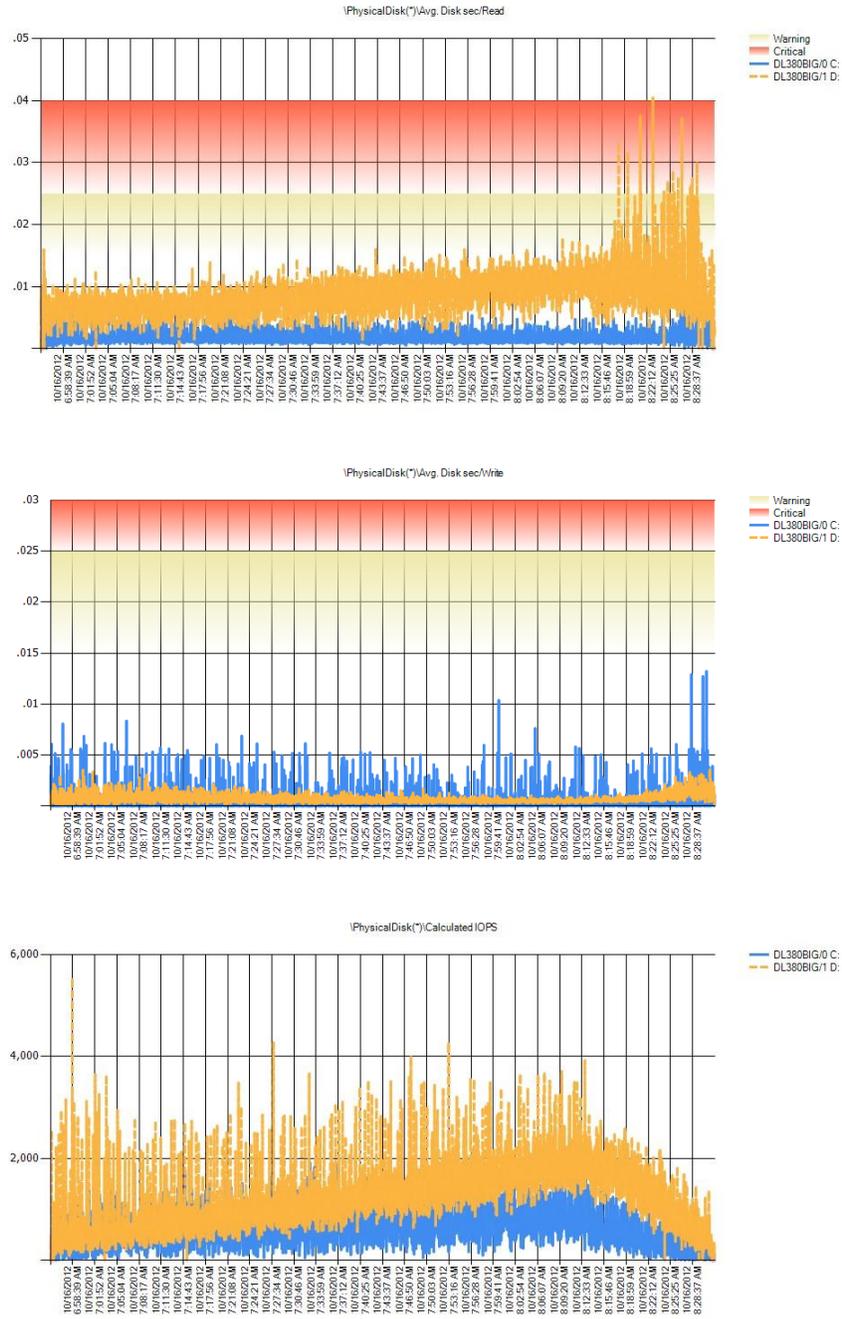


Figure 17. Memory (256GB Total)



Figure 18. Storage IOPS and Queue Length



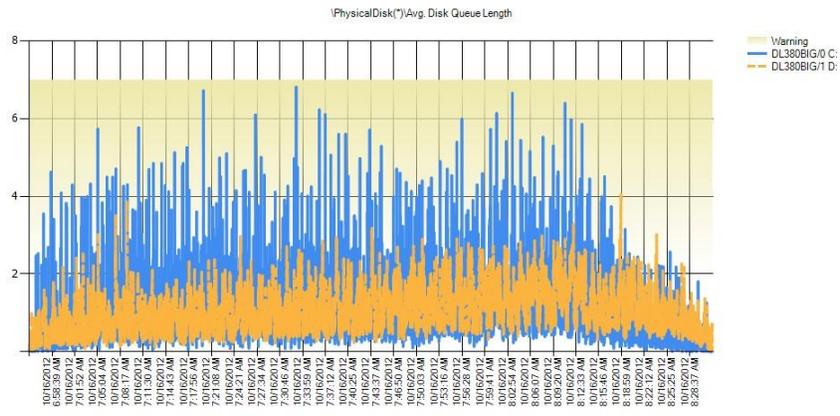
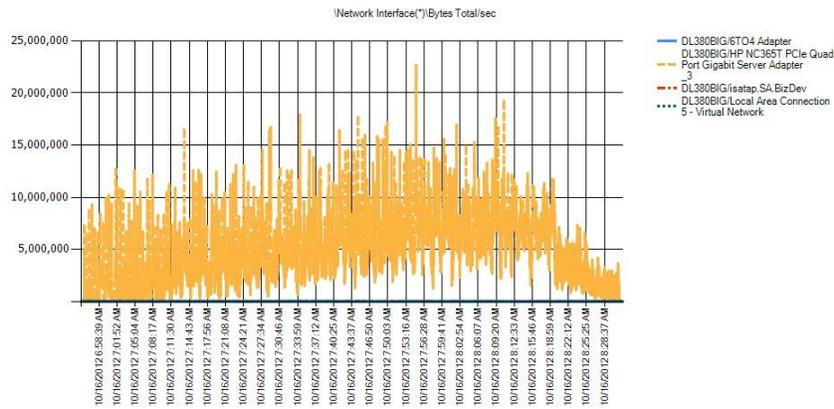


Figure 19. Network



Results — Windows Server 2012 Hyper-V and VDI-in-a-Box 5.2

This section provides data points from the second series of tests using Windows Server 2012 with Hyper-V and VDI-in-a-Box 5.2. Customers may reference this data in designing their own implementations on these releases.

165-user pooled desktops, single server

The following are Login VSI test results for the server configured to run 165 Windows 7 pooled desktops. The Login VSI tests indicate that VSImax was not reached. This means that good user experience was achieved with this configuration with 165 users.

Figure 20. Login VSI Data (no VSI Max reached)

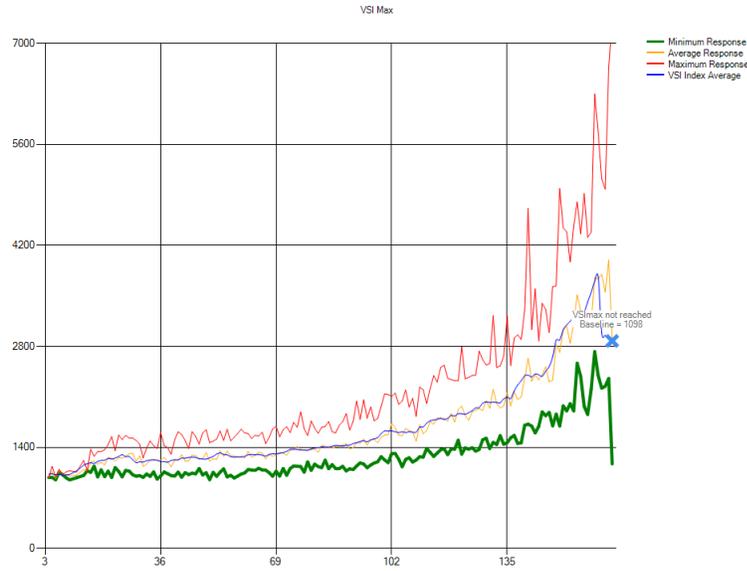


Figure 21. CPU (Single, 32 logical cores)

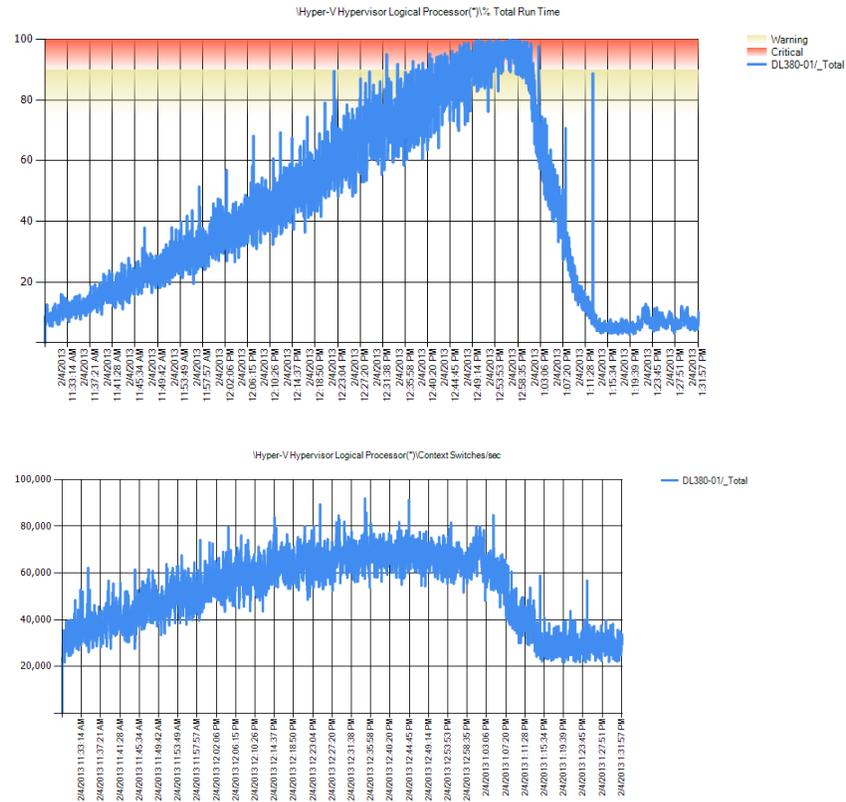


Figure 22. Memory (256GB Total)

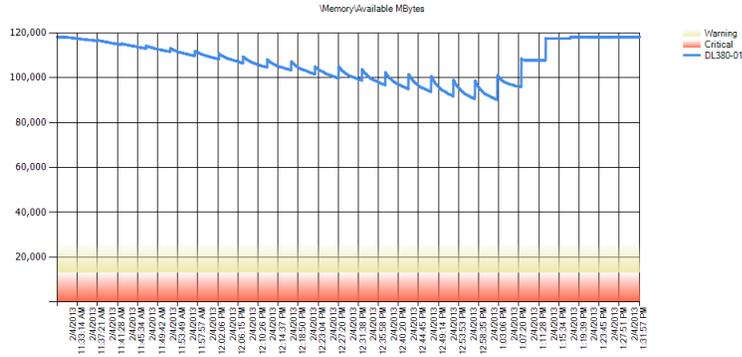
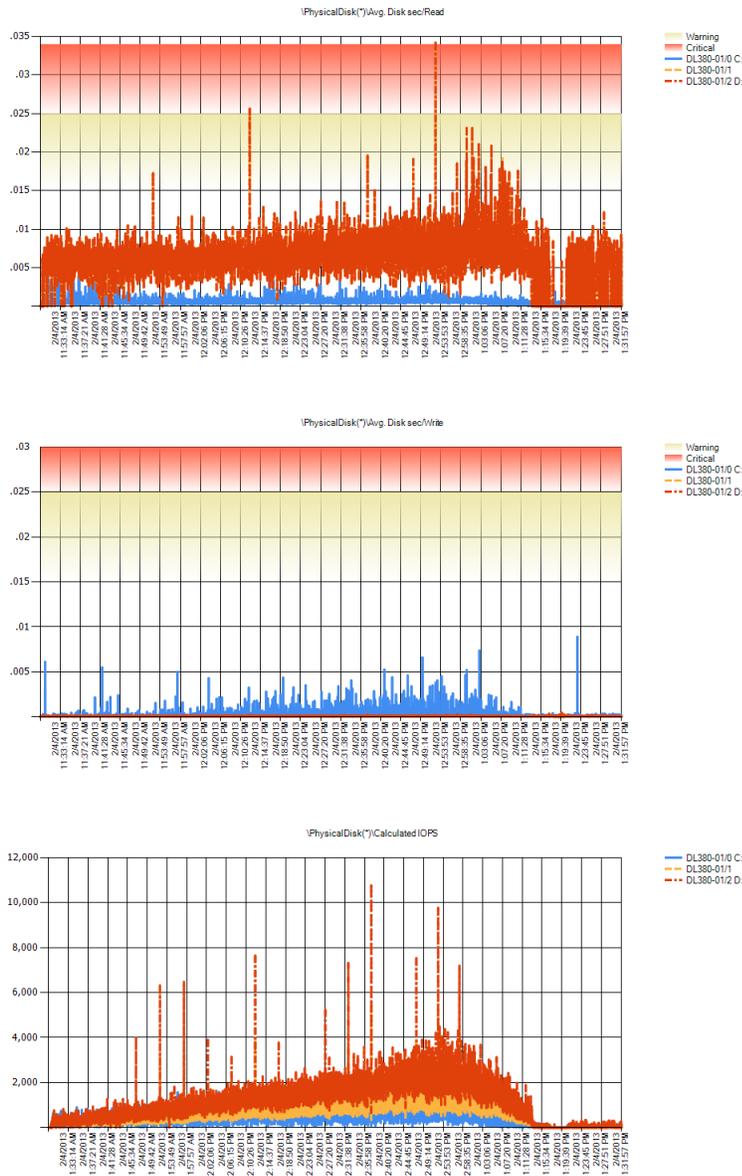


Figure 23. Storage IOPS and Queue Length



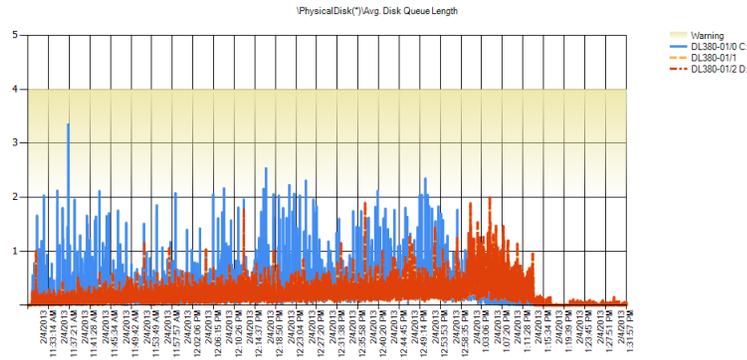
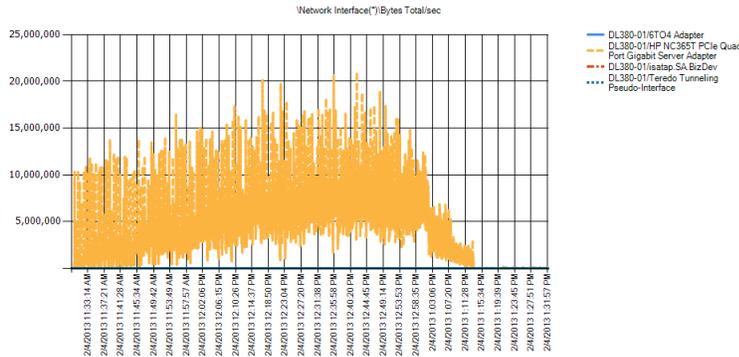


Figure 24. Network



160-user pooled/personal desktops (70/30% mix), single server

The following are Login VSI test results for the server configured to run a mix of pooled and personalized Windows 7 desktops. The mix consisted of 70% pooled desktops and 30% personal desktops, with 160 desktops total. The Login VSI tests indicate that VSImax was not reached. This means that good user experience was achieved with this configuration when running 160 users.

Figure 25. Login VSI Data (no VSI Max reached)

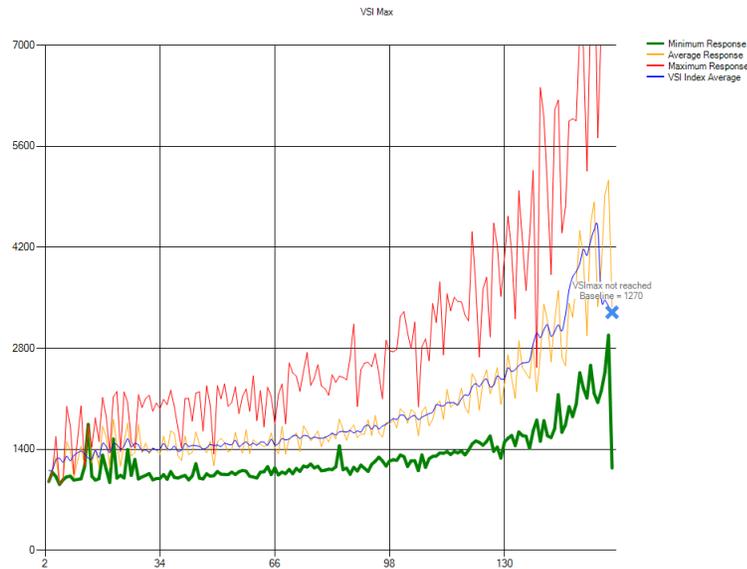


Figure 26. CPU (Single, 32 logical cores)

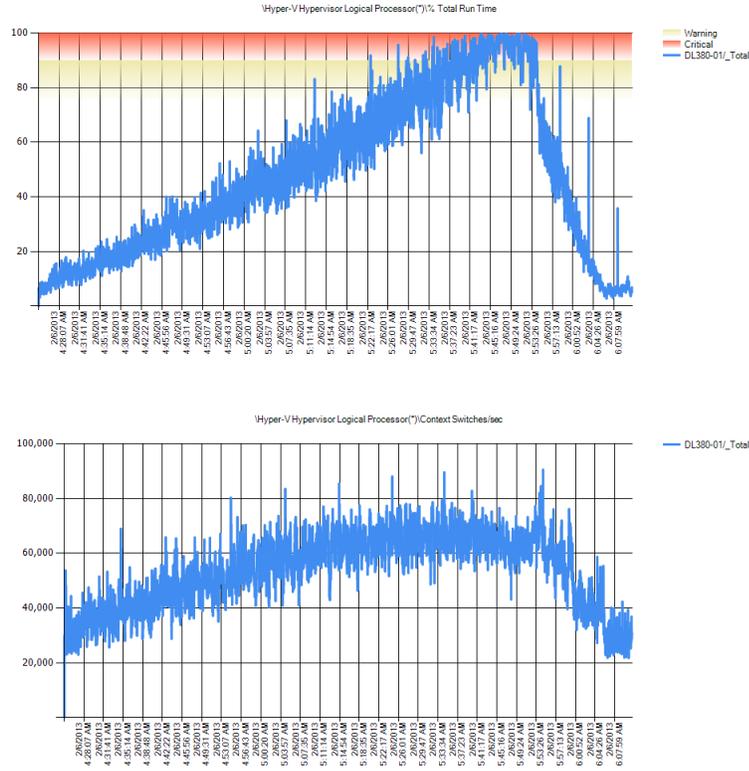


Figure 27. Memory (256GB Total)

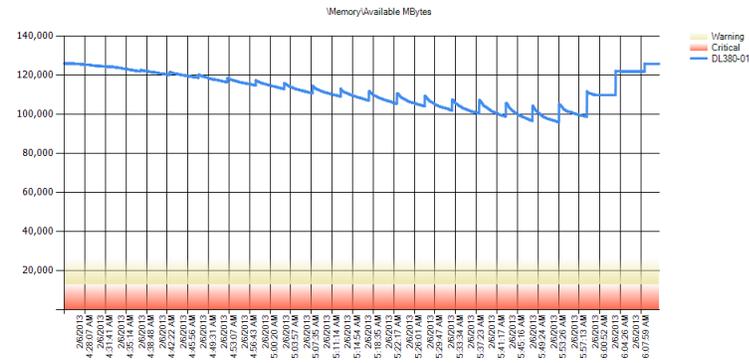
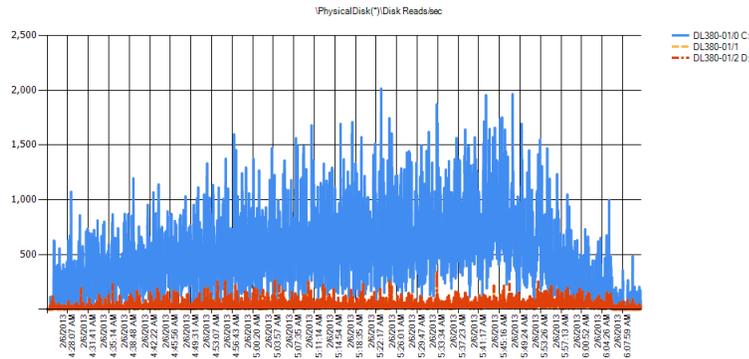


Figure 28. Storage IOPS and Queue Length



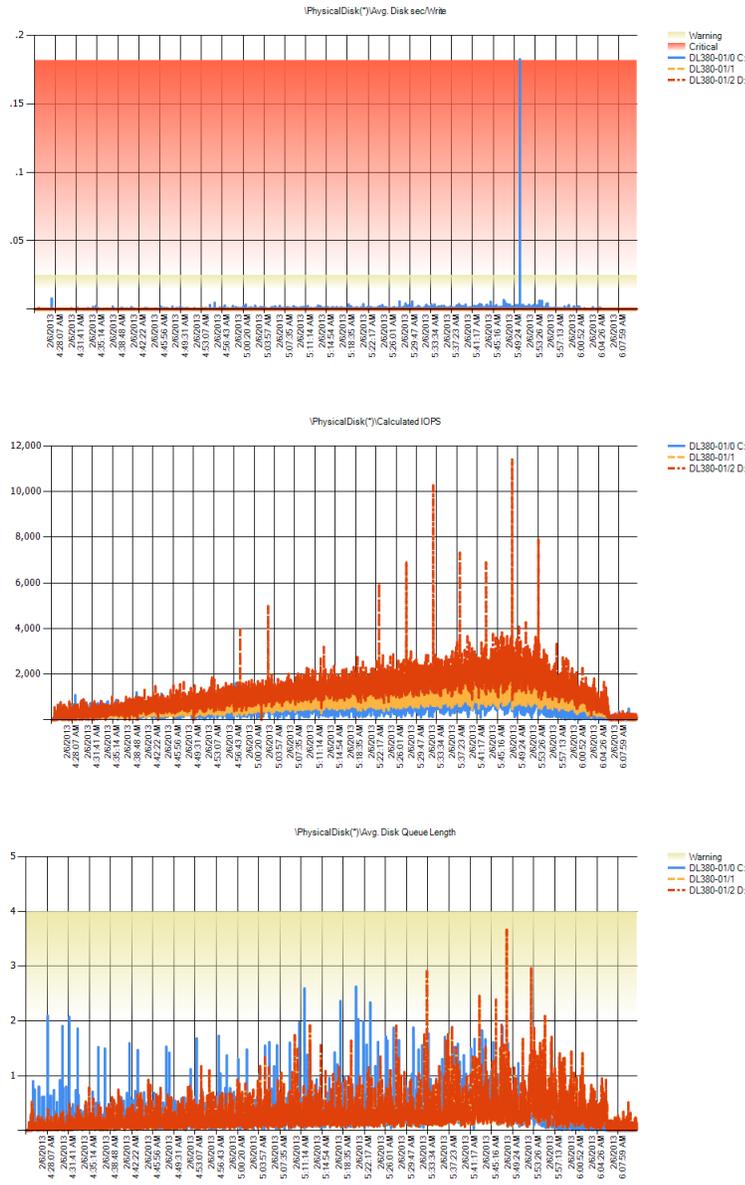
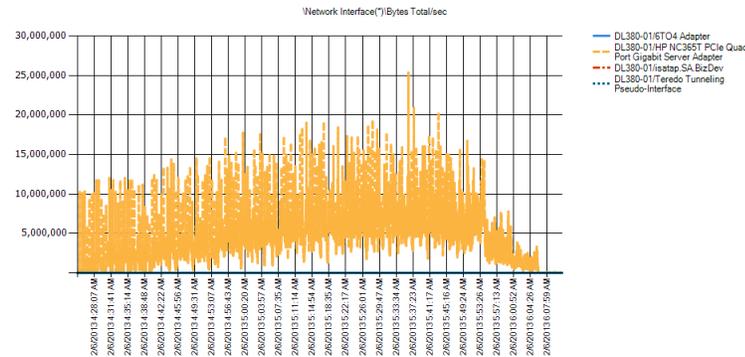


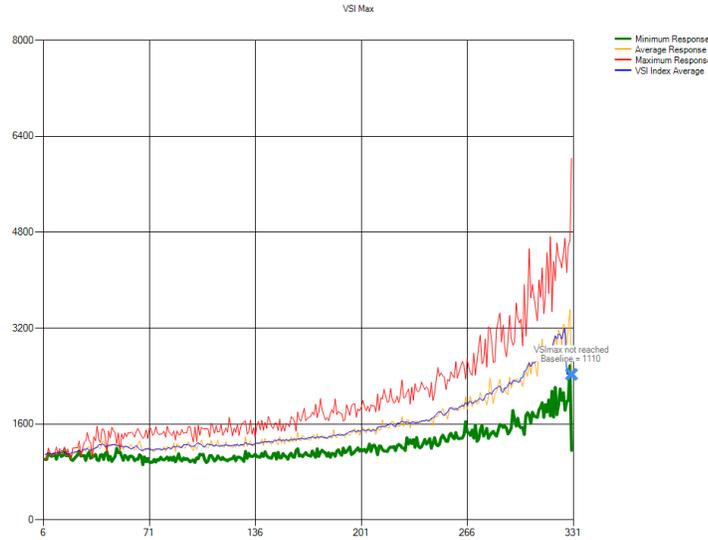
Figure 29. Network



330-user pooled desktops (165 per server), dual servers

Additional testing was conducted using a grid of two servers to demonstrate scalability. For dual servers running pooled Windows 7 desktops, the results on a two-server grid mirrored the results of single server testing, showing linear scalability. Again, Login VSI max was not reached. This means that good user experience was achieved with this configuration when running 165 users per server for a total density of 330 users.

Figure 30. Login VSI Data for Dual Server test (no VSI Max reached)



Testing of Microsoft Office 2013 workload

Additional testing was conducted to compare user densities under a Microsoft Office 2013 workload instead of a Microsoft Office 2010 workload. Test runs were conducted using a server configured to run Windows 7 pooled desktops without Dynamic Memory enabled. With Microsoft Office 2013, Login VSI max was reached at 140 users. In contrast, under a Microsoft Office 2010 workload, Login VSI max was reached at 174 users, which indicates that a Microsoft Office 2013 workload implies an approximate 20% decrease in user density. As with the other testing in this solution, CPU was the gating factor. Office 2013 was found to consume more CPU resources as compared to Office 2010.

Figure 31. Login VSI Data under Microsoft Office 2013 workload (VSI max reached at 140 users)

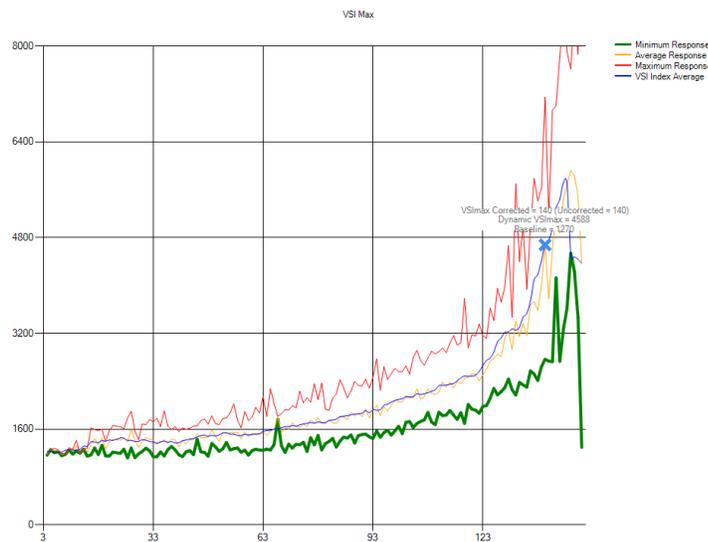
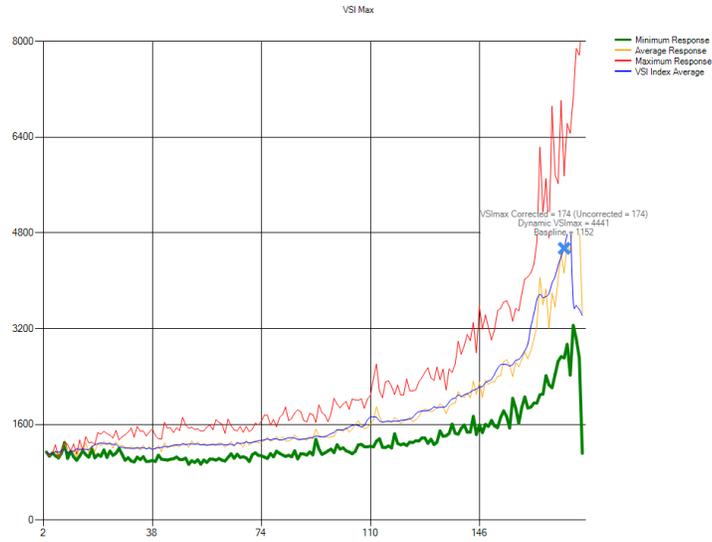


Figure 32. Login VSI Data under Microsoft Office 2010 workload (VSI Max reached at 174 users)



Summary

The configurations described in this reference architecture have been validated through this testing to be a good fit for the demonstrated user densities under a medium Microsoft Office workload. Together, the Citrix VDI-in-a-Box and HP ProLiant DL380p Gen8 server technologies in this reference architecture deliver predictable performance in a scalable building block. Along with the flexibility of personalized desktops, the solution offers many benefits of traditional enterprise VDI without the associated complexity and startup cost, providing a very practical, cost-effective, and easy-to-maintain VDI solution for small and medium-sized businesses.

For more information

HP technical documentation for Client Virtualization, hp.com/go/cv

HP ProLiant DL380p Gen8 servers, hp.com/servers/dl380

HP Flexible Series Thin Clients, hp.com/sbso/busproducts-thin-clients.html

HP CV Gen8 Enterprise RA for Citrix XenDesktop on Microsoft Hyper-V – Overview, <http://h10010.www1.hp.com/wwpc/us/en/sm/WF05a/457757-457757-5163273-5094724-51632755275757.html?dnr=1>

HP CV Gen8 Enterprise RA for Citrix XenDesktop on vSphere – Overview, <http://h10010.www1.hp.com/wwpc/us/en/sm/WF05a/457757-457757-5163273-5094724-5163275-5275883.html?dnr=1>

Citrix VDI-in-a-Box general product info, citrix.com/products/vdi-in-a-box/overview.html

VDI-in-a-Box feature descriptions, citrix.com/products/vdi-in-a-box/features.html

Citrix VDI-in-a-Box 5.1 technical documentation, <http://support.citrix.com/proddocs/topic/vdi-51/vdi-about.html>

VDI-in-a-Box 5.1 Server Sizing, <http://support.citrix.com/proddocs/topic/vdi-51/vdi-sizing.html>

Citrix VDI-in-a-Box 5.2 technical documentation, <http://support.citrix.com/proddocs/topic/vdi-52/vdi-about-wrapper.html>

VDI-in-a-Box 5.2 Server Sizing, <http://support.citrix.com/proddocs/topic/vdi-52/vdi-system-requirements-wrapper.html>

VDI-in-a-Box 5.1 Server Sizing Calculator, citrix.com/content/dam/citrix/en_us/documents/products/citrixvdi_in_a_box5.1serversizingcalculator.xlt

VDI-in-a-Box 5.2 Server Sizing Calculator, citrix.com/content/dam/citrix/en_us/documents/products/citrix-vdi-in-a-box-5.2-server-sizing-calculator.xlt

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