Data Center Converged SAN Infrastructure

OPENBENCH LABS

Analysis: Maximize ROI with Diskless Desktop VMs

Using Low-Latency Autonomic Storage

xiotech

Analysis: Maximize ROI with Diskless Desktop VMs Using Low-Latency Autonomic Storage

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Executive Summary

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Distributed Computing 2.0

Distributed computing has dominated IT architecture for nearly 20 years. From early notions of client server computing, IT has needed to implement significant changes in the infrastructure required to support the way that users access applications, which have been rapidly growing in complexity. The most dramatic changes, however, are yet to come. The real revolution in distributed computing starts with the adoption of hosted virtual desktops. In a hosted desktop scenario, IT centralizes the running of PC operating systems and applications on virtual machines (VMs) hosted on servers in the data center while streaming a display protocol to a light-weight client application that can be run on various devices on the network.

Desktop virtualization builds on the notions of server virtualization, which utilizes a physical server to host multiple virtual machines that run their own server-class OS and applications, which are typically in the form of backend services. In a desktop virtualization scenario, however, the hosted desktop VMs need to support a highly GUI-centric environment running interactive client applications. As a result, a virtual desktop infrastructure (VDI) introduces a number of new specialized technologies—from session brokering to display streaming—for IT administrators to support.

openBench Labs Test Briefing:

Xiotech® Emprise™ 5000 ISE™-based Storage

1) **Maximize Performance Automatically:** Advanced firmware stripes data at the disk head level, which eliminates the need for IT administrators to create disk-centric storage pools and creates a low-latency environment that facilitates the IO characteristics of a Virtual Desktop Infrastructure.
   Iometer Streaming I/O Benchmark: For a VM running Windows 7, streaming read I/O throughput averaged 370MB per second and streaming write data average 175MB per second.
   Iometer I/O Operations Benchmark: With the low latency of the Emprise 5000, 8KB reads and writes (80/20 percent mix), on a single VM sustained 3,500 IOPS with an average access time under 25ms, while two VMs sustained an I/O load of 6,500 IOPS.
2) **Improve I/O Scalability:** Storage capacity and performance can be easily expanded by adding multiple Emprise 5000 systems. This adds local cache and processing power via active-active Managed Reliability Controllers, which locally manage I/O processes.
3) **Improve Storage Reliability:** Intelligent Storage Element (ISE) technology provides autonomic self-healing to minimize storage-based service events.

In a traditional PC environment, resolving configuration management and problem remediation issues requires IT administrators to attend to physical clients individually. This situation dramatically drives up the cost of IT operations associated with hardware

and software provisioning and maintenance. As a result, centralizing virtual PC operations in a datacenter with hosted desktop VMs, applications, and data all residing securely on servers in the datacenter should make managing and securing desktops significantly easier for IT. To fully leverage such a scheme, even more advanced VDI solution are needed to address such issues as virtual desktop provisioning and the streaming of PC applications and disk images.

In terms of today's $150 billion worldwide market in business PCs, Gartner pegs client systems deployed on VMs to be around 500,000—about the level of a rounding error. Nonetheless, as IT finds it conceptually easy to leverage existing infrastructure to offset VDI entry costs, Gartner projects the percent of new business PCs being deployed on VMs to rapidly rise to 40%. According to Gartner, IT in the US will lead this trend by migrating 30 percent of their installed base of desktop PCs to VMs by 2014. At that rate, the ranks of VMs running client systems will swell to over 18 million.

That rosy scenario for VDI is not without its dark side. In a survey of CIOs implementing server virtualization, IDG reported that the percent of CIOs saying that datacenter management had become more complex rose from 47 percent at the end of 2008 to 67 percent. That increase in perceived complexity raises a serious red flag for VDI, as best practices call for deploying desktop VMs four to eight times more densely than server VMs. What makes dense deployment plausible is the sporadic nature of desktop PC usage. While dense VM deployment enhances the potential for significant cost savings, dense deployment also increases the need for IT to be prepared for resource-utilization storms involving I/O, memory, and CPU resources.

A pivotal resource for making the transition to server and desktop virtualization is a SAN-based storage infrastructure that scales out in capacity and performance. The inextricable links that storage resources have to the capital and operational expenses that IT must restructure to maximize the return on investment (ROI) of any virtualization or consolidation initiative continue to make optimized storage a critical success factor.

While there are numerous formulas to size capacity requirements for desktop provisioning, ensuring reliability and bandwidth using storage built on the traditional "Just a Bunch of Disks (JBOD)" model is a particularly complex problem that involves multiple independent variables including FC ports, array controllers, and disk spindles. At the heart of the problem, hypervisors on host servers concentrate and randomize I/O from multiple VMs making a hash of traditional read-ahead and caching algorithms and creating an absolute requirement for hardware with minimal I/O latency.

To provide the scale-out storage infrastructure needed in any virtual operating environment (VOE), every Emprise 5000 added to a SAN fabric provides more cache and I/O processing power to the SAN. More importantly, Xiotech redefines the notion of a storage building block with a radically different construct dubbed ISE™ technology. In stark contrast to the traditional JBOD and RAID, ISE technology utilizes sealed multi-drive DataPacs, which contain specially matched Seagate Fibre Channel (FC) drives with specialized firmware that provides detailed information about internal disk structures.

Using that detailed knowledge of disk structures, DataPacs implement data striping at the drive-head level. As a result, IT administrators never create—or worse have to reformat—a RAID array. For an IT administrator, RAID issues are reduced to a simple virtualized RAID 5 or RAID 10 check-off characteristic, which is assigned to a virtual volume as it is created in the Emprise management GUI. Gone are all issues associated with ports, controllers, spindles and RAID levels as they relate to I/O bandwidth.

For IT's bottom line, the most powerful impact of ISE technology comes in the form of autonomic self-healing storage that is service avoidant. Xiotech matches the specialized drive firmware used in a DataPac with specialized firmware on Managed Reliability Controllers (MRCs), which have the ability to monitor and reduce the rate at which DataPac components fail by repairing many component failures in-situ and mitigating the impact of any failures that cannot be repaired. MRC remedial reconditioning extends to remanufacturing disks through head sparing and depopulation, reformatting low-level track data, and even rewriting servo and data tracks.

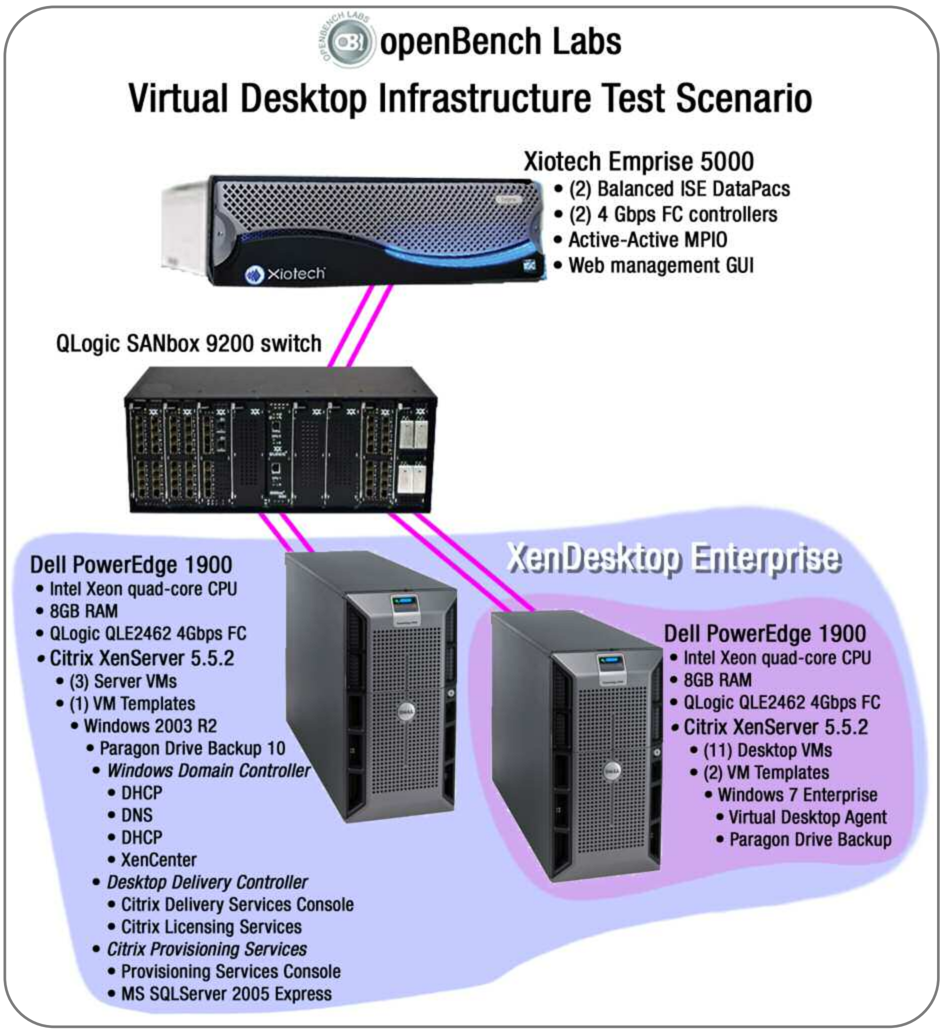
What's more, an ISE separates the function of the two external FC ports from that of the two internal MRCs in order to independently maximize external SAN fabric traffic and internal data access. Via active-active MPIO support, an ISE presents host servers with the ability to balance FC frame traffic across two FC ports to optimize full-duplex data flow on each SAN path. As a result, a typical server configuration with two FC ports has the potential to balance SAN fabric traffic over four paths. Internally, the ISE then redirects the balanced read and write I/O requests arriving at the FC ports to the two MRCs in order to maximize internal throughput for the DataPacs.

In effect, Xiotech's ISE technology makes a DataPac the base configurable storage unit, which slashes operating costs by eliminating all of the low-level device-management tasks that IT administrators must perform to maintain and optimize the performance of standard JBOD-based storage resources. In addition the heal-in-place technology allows ISE-based systems, such as the Emprise 5000, to reach reliability levels that are impossible for standard storage arrays. As a result, Xiotech is able to provide IT and OEM users with a five-year warranty that eliminates storage service renewal costs.

VDI Test Scenario

"VOE software in a VDI scenario will move VMs within a pool of logical disks to load balance I/O requests and that puts a very high premium on a highly-adaptive, low-latency, autonomic storage system to respond to sudden disruptive changes in I/O processing."

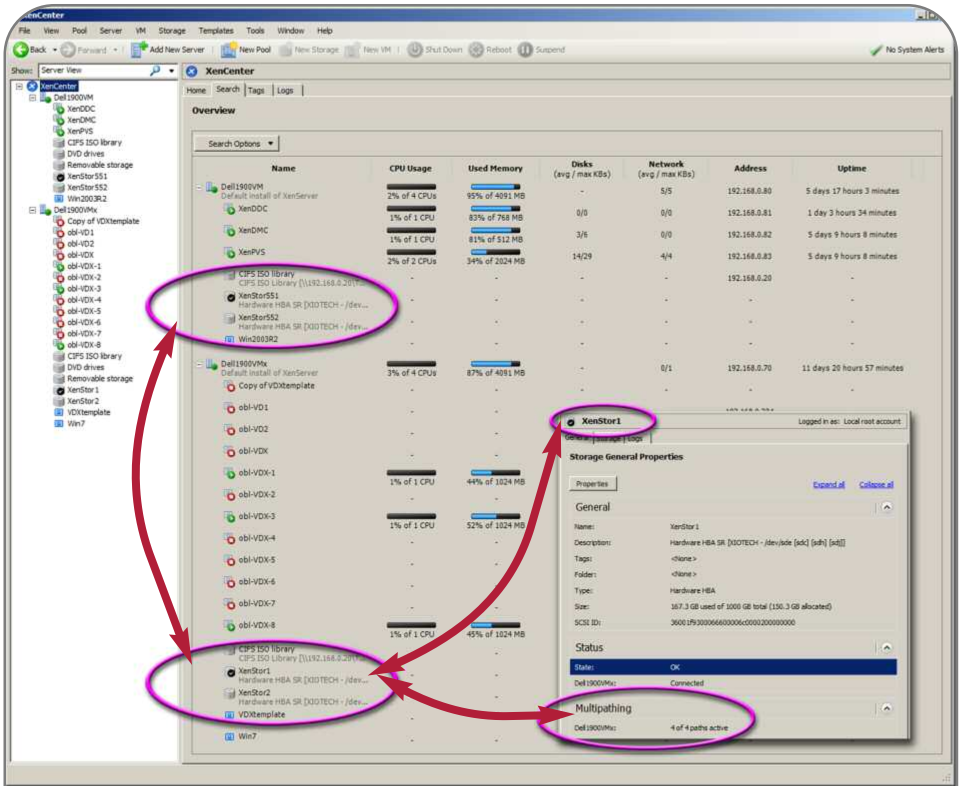
Provisioning for High I/O Throughput



With server virtualization rated as one of the best ways to optimize resource utilization and minimize the costs of IT operations, many sites typically run four to eight server VMs on each host server in a production VOE. As a result, VOE each host must be capable of delivering a very high I/O throughput load via a limited number of physical connections.

To provide a VOE foundation for VDI testing, we set up a Citrix® XenDesktop™ Enterprise Edition environment with two Dell PowerEdge servers running Citrix XenServer™ 5.5.2. Each host was equipped with a quad-core CPU, 8GB RAM, and a dual-port QLogic QLE2462 4Gbps Fibre Channel HBA. The first server hosted three management server VMs, each of which ran Windows Server 2003 R2. The second host supported 11 desktop VMs, all running the 32-bit version of Windows 7 Enterprise.

XenCenter VM & Storage Overview



The XenCenter application presents a single pane of glass construct for managing Citrix XenServer hosts and their resident VMs. At the top level of all hosts connected to an instance of XenCenter, we were able to examine the state of all active and inactive VMs alike. In particular, we were also able to easily identify the storage resources related to the Xiotech Emprise 5000 and drill down on the configuration details, such as the active-active MPIO status of the four SAN fabric paths connecting those storage resources.

The first management VM took on the role of domain controller for our test domain, dubbed XenVDI.com. In addition to Active Directory, this server provided DHCP and DNS services to all VMs in the XenVDI domain. It was also used to run the XenCenter Console, which is used to run administrative services on the VMs and their host servers.

On the second of our server VMs, openBench Labs ran the Desktop Delivery Controller software along with the Citrix Licensing Services. The Desktop Delivery Controller authenticates users, brokers connections between users and their desktop VMs, and manages the assembly of that user's virtual desktop VM.

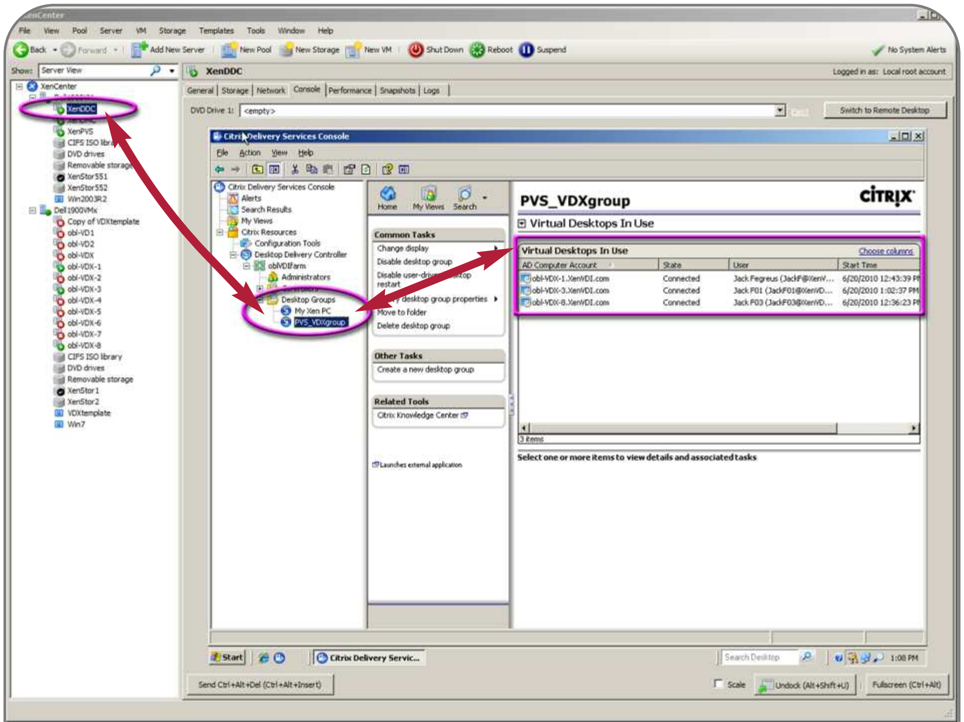
Virtual Machine Farms

The key construct for the Desktop Delivery Controller is that of a "farm," which by default is structured within an MS Access database. A Desktop Delivery farm consists of administrators, systems that are running the Desktop Delivery Controller, and defined groups of desktop VMs, which can now be managed as single object.

When an IT administrator creates a desktop VM group, the desktop VMs are associated with end users or end-user groups via Active Directory. In this assignment process, an administrator can explicitly assign a desktop VM to an end user; allow the automatic creation of a permanent link to an end user on first use of the VM; or configure the Desktop Delivery Controller to randomly allocate a VM to an end user at each logon. Within the context of this role as a session broker, the Desktop Delivery Controller also starts and stops desktop VMs based on user demand and configuration

rules created by IT administrators.

Xen Desktop Connection Broker



The cornerstone of a XenDesktop environment is the Desktop Delivery Controller. We utilized the Console tab of XenCenter with XenDDC, our Desktop Delivery Controller, to manage the controller with the Citrix Delivery Services Console. We had created two desktop groups in a farm dubbed oblVDIfarm. The VMs in one group, My Xen PC, were all directly assigned to user accounts, while the VMs in the PVS_VDXgroup were configured to be randomly assigned to a group of users on demand. Using the Citrix console we were easily able to identify active VMs, the user of each VM, and the host server where the VM was running.

On the third server VM, we installed Citrix Provisioning Services along with MS SQL Server 2005 Express. In a desktop virtualization environment, administrators use Citrix Provisioning Services to create and provision a group of virtual desktops using a single common disk image that is used to boot each desktop VM in the designated group. This method of provisioning optimizes storage utilization, simplifies OS change and security management tasks, and provides end users with a clean virtual desktop each time they log on.

Desktop VM Scale Out

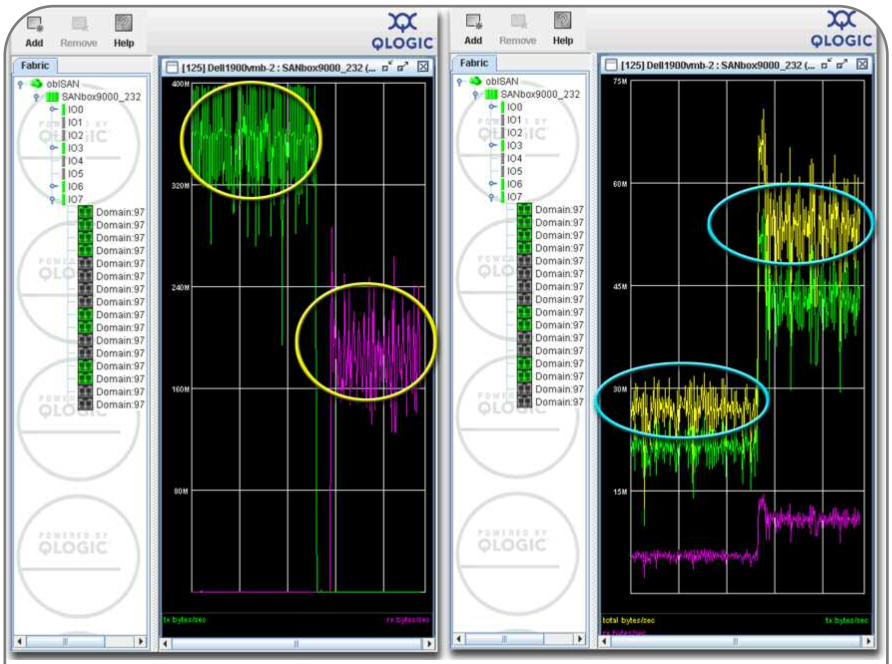
To anchor an edge-driven FC SAN fabric, we utilized a Xiotech Emprise 5000 system with two “Balanced” DataPacs—Xiotech provides DataPacs tuned to support transaction processing, data archiving, or multi-purpose computing. Each of our two Balanced DataPacs provided 4.352TB of raw storage and isolates the optimization of the external SAN fabric traffic from internal MRC access of the DataPacs. In particular, using a Dell PowerEdge 1900 server as a physical system, openBench Labs was able to utilize multiple disk volumes on the Emprise 5000 to stream full-duplex I/O in excess of 1GB per second and sustain a rate of 10,000 IOPS when responding to 8KB random access data requests in a mix of 80 percent reads and 20 percent writes.

Traditional core-driven SAN fabrics are characterized by a large number of physical servers and a small number of storage devices. That has made the fan-out ratio of connections from storage devices to servers a key metric in existing SAN fabrics. With a VOE, however, lightly loaded servers are converted into VMs, which are consolidated on

a small number of VOE hosts. In turn, those hosts drive the I/O load within the SAN fabric and create an edge-driven SAN topology.

More importantly in a VOE environment, IT Service Level Agreements (SLAs) for business applications must now take into account the interactions of multiple VMs. Multiple VMs fluidly moving within clusters of VOE hosts is a particularly vexing problem for IT. With the density of desktop VMs on a host invariably several times greater than the density of server VMs, the automated movement of desktop VMs for the purpose of CPU, memory and storage resource load balancing is all the more likely and that makes VM tracking all the more difficult.

XenDesktop VM I/O Performance Spectrum



To assess potential I/O performance of desktop VMs in our XenDesktop environment, we ran Iometer on two VMs in the My Xen PC group. As all our test VMs, these systems utilized a single logical disk.

On a single VM, a sequential I/O stream using 128KB blocks generated 360MB of data per second on reads and 185MB per second on writes. This sets a very high I/O potential for non-traditional workstation applications such as video editing, finite element modeling, and data mining.

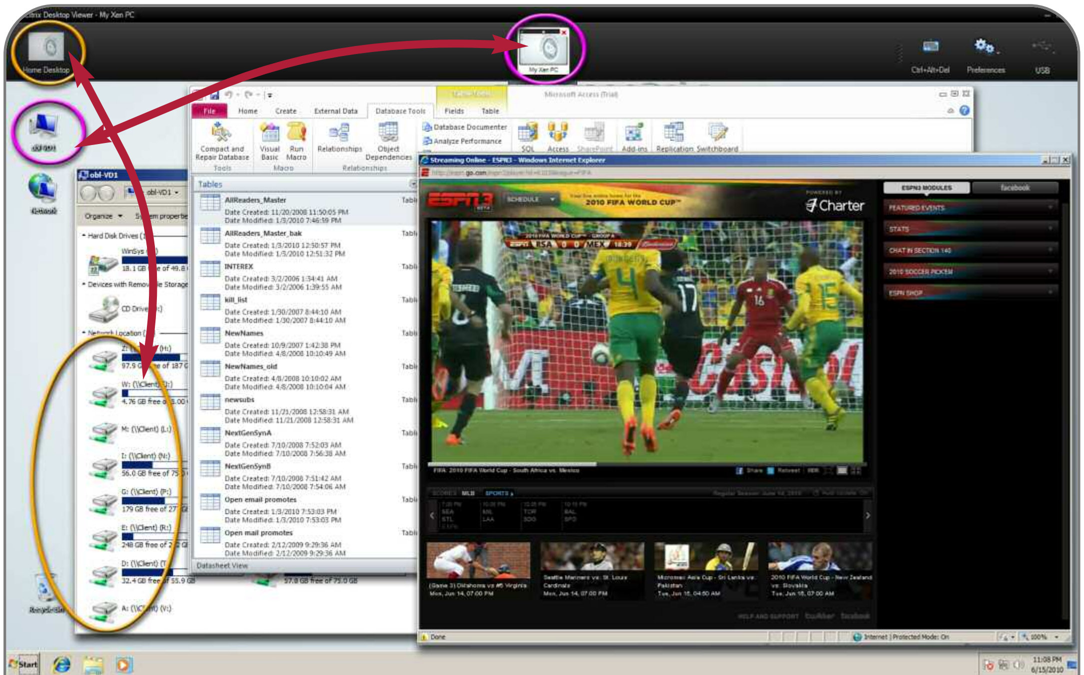
On the other hand, understanding random small-block I/O is essential for assessing the scaling of large numbers of desktop VMs running traditional PC applications. In particular, we maximized IOPS throughput using random 8KB reads and writes—80 percent reads and 20 percent writes—with the constraint that the average response time for all I/O requests be no more than 25ms. In a VDI environment, the average access time constraint is essential for setting a performance envelope that will not mask the starving of individual desktop VMs. In our tests, one VM, which equated to one Emprise 5000 DataPac, sustained a load of 3,500 IOPS and generated a combined data stream of 27MB per second—21.5MB per second for reads and 5.5MB per second for writes. With two VMs and two DataPacs in play, the sustainable I/O load scaled to 6,500 IOPS, as total I/O scaled to about 52MB per second.

The erratic nature of data access patterns by applications in a desktop environment adds to the problem of configuring storage for a VDI. Unlike server applications, which often depend on disk throughput for performance and are tuned for either I/O streaming or optimal handling of random IOPS, desktop applications seldom optimize for I/O and rely on general file access patterns that use 8KB data blocks. As a result, disk I/O patterns for desktop applications exhibit minimal throughput levels, which are generally well within the boundaries of most storage systems. That's why insufficient CPU and memory resources are often the root causes of bottlenecks for desktop systems.

Within a virtual desktop infrastructure, however, the traditional desktop I/O utilization pattern scales in a way that leaves desktop VMs prone to severe degradation during

unforeseen I/O storms, which are sporadic but statistically predictable events that occur when multiple users simultaneously implement administrative processes such as logging in, running a virus scan, or updating software on line.

Windows 7 VM Business Desktop



We tracked the I/O demands of desktop VMs while running typical business. In all cases, work on individual desktops, such as obl-VD1, put very little stress on our backend Emprise 5000. Even opening and rebuilding a large MS Access database, which was one of our most demanding storage-related interactions our throughput spiked at upwards of 50MB per second while averaging about 15MB per second.

While video performance was extraordinary with the ICA protocol, more important for business processing was the automatic setup of all drives on the initiating PC as mapped network drives on the VM desktop.

Meeting the irregular nature of I/O patterns in a VDI demands that IT plan for VDI storage that can scale performance with respect to peak I/O activity, rather than typical user activity. In particular, as IT admins densely provision multiple desktops VMs on a VOE host, the aggregate I/O load that is passed to the host and transmitted over the SAN takes on the characteristics of random 8KB I/O requests targeting the logical disks on which the VMs reside. As a result, VOE software in a VDI scenario will move VMs among logical disks in a storage pool to load balance I/O and that puts a premium on a highly-adaptive, low-latency, autonomic storage system that can respond to sudden disruptive changes in I/O processing.

This is a particularly strong point for the Emprise 5000 and its ISE technology. Using the single virtualized system disk of a VM, we sustained 3,500 IOPS with an average access time under 25ms for random 8KB I/O requests in an 80/20 read/write split. With two VMs on different DataPacs, the sustainable I/O load scaled to 6,500 IOPs with the same constraint of an average access time of less than 25ms.

VDI Automation & ROI

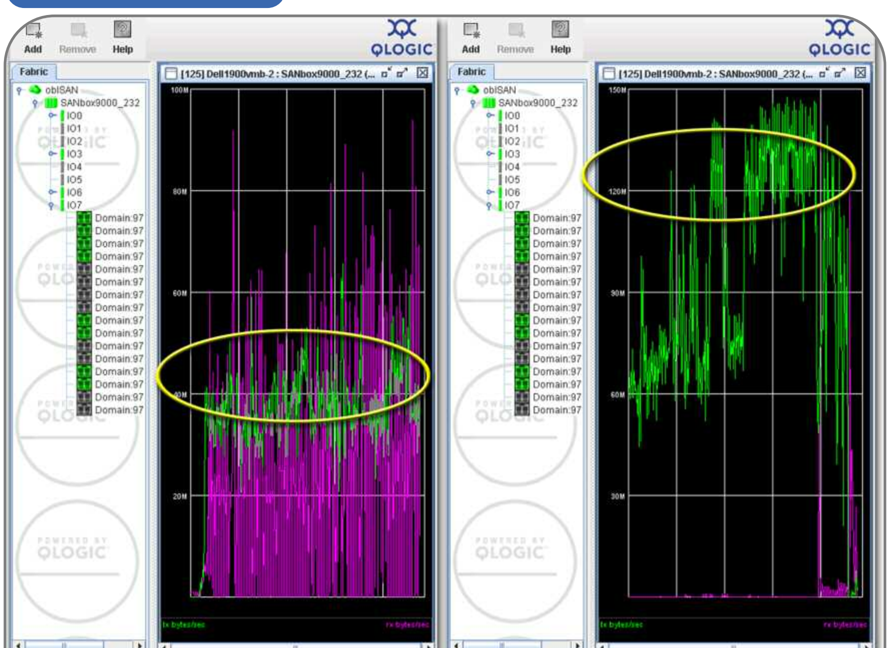
> "A key part of the Citrix Provisioning Services value proposition is the utilization of SQL Server to maintain and stream a disk image, which is dubbed a vDisk and used by all of the members of a Desktop Group associated with a Desktop Delivery Controller as a boot disk."

Storage Connections

The key to garnering a positive ROI on any VDI initiative rests in simplifying the management and optimizing the utilization of storage, CPU, and memory, and resources. By far, the greatest payback for any VDI initiative will come out of improvements in the management and utilization of storage resources.

We started our evaluation by configuring two desktop VMs running Windows 7 and MS Office 2010 Professional. Each VM was configured with one CPU core, 1GB of memory, and a 50GB storage volume. One of the most important advantages for a VDI comes from the ease of implementing an automated server-class data protection scheme for desktop VMs. In doing so in our test environment, we were able to leverage the throughput performance capabilities of the Emprise 5000 to meet a robust Recovery Time Objective (RTO).

Windows VM Backup



Using the imaging capability of Paragon Drive Backup 10, we were able to run a full backup of just data on VM disk at a real throughput rate of 47MB per second. Following a full backup, we were able to do frequent light-weight differential backups at upwards of 135MB per second.

Our Windows-based VDI environment allowed us to configure a backup protection plan with Paragon Drive Backup 10 Server Edition running on desktop and server VMs. Paragon's imaging scheme provided a number of distinct advantages in our VDI environment.

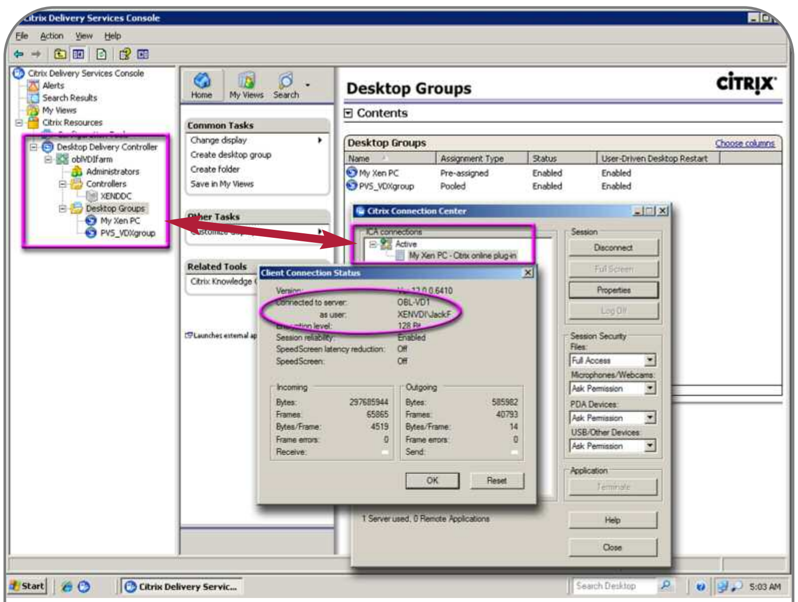
First and foremost, we were able to leverage the throughput envelope provided by the Xiotech Emprise 5000 to simultaneously stream reads and writes at 47MBs a second to rapidly generate a full image backup. We were

then able to run very small differential backups on a regular basis and roll those backups into synthetic full backup on a regular basis to recover archive space. Finally to simplify file-level restores for end users, we were able to mount differential as well as full backups as logical volumes without the need to run a synthetic backup process. Utilizing that image mounting capability, we were able to provide end users with a readily accessible time line of backup volumes for drag-and-drop restores.

Streaming Automation

We were able to create an easy-to-use base VDI environment with a standard XenDesktop configuration and VMs running Windows 7 Enterprise Edition. The management layer for our VDI environment came from the installation of the Desktop Delivery controller on a Windows Server 2003 VM resident on our VOE management host. This configuration provides IT with a connection broker architecture integrated with Active Directory.

Citrix Online Plugin Connection



For our tests we created two pools of desktop VMs. The first pool, dubbed "My Xen PC," contained conventional VMs that were manually assigned to specific end-user accounts in Active Directory. As a result, each time we connected to My Xen PC, we were presented with the same desktop VM.

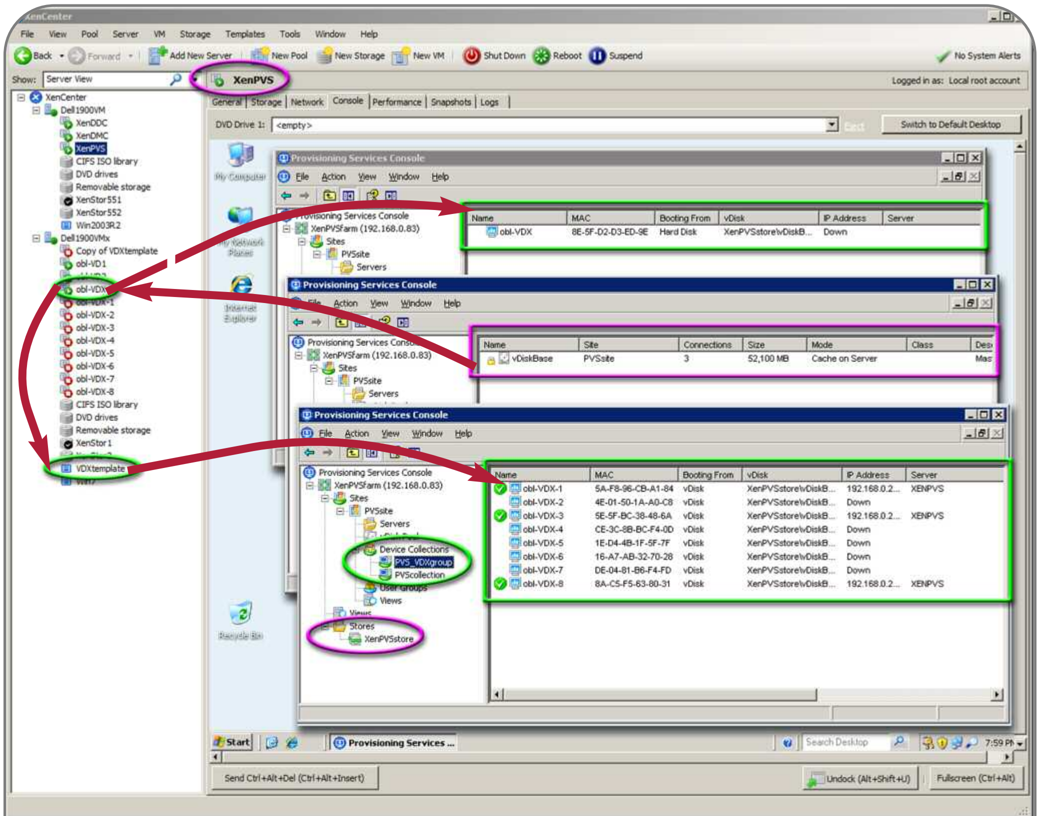
End users request desktop services via the Citrix Online or Web Plugin utilities, which are installed on any system that will function as a client. The end user provides the Internet address of a server running a Desktop Delivery Controller and Active Directory credentials. Alternatively, the Citrix Plugin can be configured to automatically pass the user's credentials established on the client device. Based on the login information provided by the Citrix Plugin, the Desktop Delivery Controller returns a list of Desktop Groups, which are pools of VMs that are available for that user. In turn the Citrix Plugin displays the list of available Desktop Groups as part of its user interface.

When the end user chooses a Desktop Group, the Desktop Delivery Controller brokers a connection with the host server for an appropriate desktop VM. The host server starts the VM and ICA communications are established between the Citrix Plugin and the Virtual Desktop Agent that is running on the VM.

More importantly the collection of VM desktop pools and the Windows servers running the Citrix Delivery Services are all part of a larger database construct dubbed a farm. A similar more complex SQL Server-based farm construct is utilized by Citrix

Provisioning Services. A key part of the Citrix Provisioning Services value proposition is the utilization of SQL Server to maintain and stream a disk image, which is dubbed a vDisk and used by all of the members of a Desktop Group associated with a Desktop Delivery Controller as a boot disk.

Diskless Desktop VM Provisioning



*There are four essential steps in configuring a pool of desktop VMs that will boot from a single disk image. The process starts with the configuration of a standard desktop VM, **obl-VDX**. That VM is then added to a Device Collection, **PVScollection**, in a Provisioning Services farm, **XenPVSfarm.***

*Next we created a vDisk, **vDiskBase**, and mounted it on, **obl-VDX,** which was now a member of the **PVScollection.** With **vDiskBase** mounted on **obl-VDX** as a hard disk, were then able to copy an image of the initial system disk on **obl-VDX** to **vDiskBase** and set **obl-VDX** to boot from the network using the DHCP service on **oblDMC.***

*We then generated a template from obl-VDX from which to clone diskless VMs. Next we used the Xen Desktop Setup Wizard, to clone 8VMs from the template and add those VMs to both Active Directory and a Device Collection dubbed **PVS_VDXgroup.** The wizard then added that group to both **XENPVSfarm** and **oblVDIfarm** on **XenDDC,** our server VM running the Desktop Delivery Controller.*

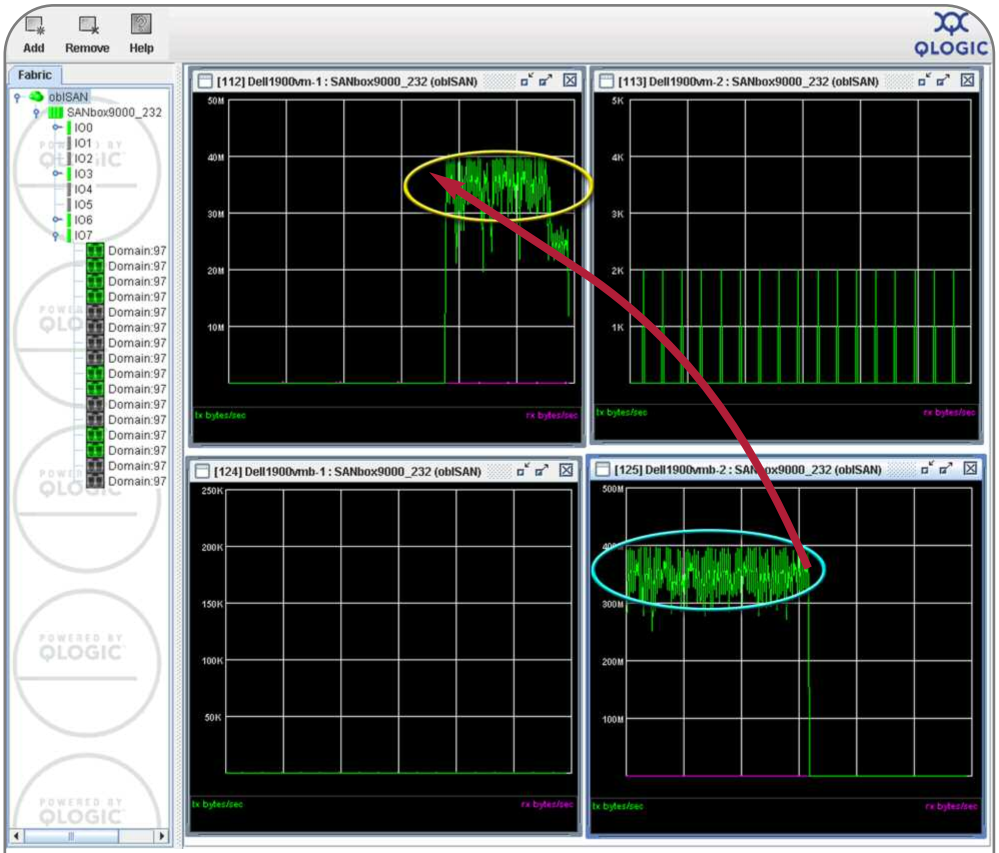
In our test case, we created a single 50GB vDisk from which we booted 8 diskless VMs saving 350GB of storage. The big contribution to ROI, however, does not come from the substantial space savings and storage optimization. By using a common boot disk, we could update and refresh the operating system or any applications installed on all of the VMs in the Desktop Group dubbed PVS_VDXgroup by updating the vDisk via the originating VM, obl-VDX. As a result, we were able to dramatically simplify IT operations with respect to managing OS changes and security.

More importantly, using the diskless VM model with Citrix Provisioning Services significantly changes I/O throughput characteristics. All data must now passes through SQL Server with all communications between the desktop VM and SQL Server passing

over the LAN.

As more VMs utilize vDisks as their boot devices, the SQL Server data stores for these devices become more critical for maintaining site operations. What's more, SQL Server constantly updates internal tables with on-going operations-oriented metadata. This makes it essential for IT to provide these database servers with fast highly reliable storage in order to support a quick recovery time should a database become corrupted.

vDisk Performance



To assess I/O with a vDisk, we ran Iometer with large 128KB sequential reads from the standard logical disk assigned to obl-VDX, the VM used to create the template and vDisk for the Citrix Provisioning Services farm. We started running Iometer on the original VM disk throughput streamed from the Emprise 5000 to the Citrix XenServer hosting obl-VDX at 380MB per second.

We then switched to reading from the vDisk. The data stream from the Emprise 5000 switched to the Citrix XenServer hosting the SQL Server database, which in turn transferred the data being read by Iometer over the LAN to our VM. In this process throughput dropped to 37MB per second, which is perfectly acceptable for standard desktop applications, such as Microsoft Office.

Customer Value

"Xiotech's change to the underlying technology of storage systems transforms the notion of a basic storage building block for both IT and OEM users in a way that makes provisioning synergistic with Service Level Agreements."

Better Building Blocks

Xiotech's ISE technology provides an innovative solution for improving the reliability and performance of disk-based storage systems. By approaching disk drives as a grid of storage surfaces, Xiotech has enabled the controllers in the Emprise 5000 to go beyond simply accessing data and actively manage component reliability.

Xiotech Emprise 5000 Feature Benefits

1) **Application-centric Storage:** DataPacs tuned to application needs define the base storage unit rather than individual disk drives.
2) **Autonomic Self-healing Storage System:** Integrated firmware on drives and controllers allows fine-grain data access to be defined at the level of drive heads in order to boost I/O throughput and automatically repair and rebuild drives in-situ.
3) **High Streaming Throughput:** Running with Balanced DataPacs, openBench Labs benchmarked streaming read performance at 380MB per second and streaming write performance at 175MB per second on VMs running Windows 7.
4) **Linear Scaling of IOPS:** Using random 8KB I/O requests in an 80/20 mix of reads and writes sustained 3500 IOPS with an average response time of less than 25ms. Using two VMs on separate DataPacs, performance scaled to 6,500 IOPS.

More importantly, Xiotech's change to the underlying technology of storage systems transforms the notion of a basic storage building block for both IT and OEM users in a way that makes provisioning synergistic with Service Level Agreements. The sophisticated characteristics of DataPacs, rather than simple electronic specifications of a bus, define storage building blocks that are application-centric rather than connection-centric devices.

The Emprise 5000 storage system builds on ISE technology to eliminate the need for maintenance intervention by IT administrators and to provide near-linear scaling of application throughput metrics as the number of storage systems increases. Using Emprise 5000 systems, IT administrators are able to cost-effectively meet and support Service Level Agreements for multiple application-centric environments, including Virtual Operating Environments for servers, Virtual Desktop Infrastructure, nonlinear video editing, database-driven transaction processing applications, as well as archival applications and D2D backup.