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GeenBytes VDI Storage Optimization... Getting More with Less

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GreenBytes

Executive Summary

The Citrix VDI Capacity Program provided an important vehicle to demonstrate that modern innovations in storage technology can truly satisfy the virtual desktop user experience while achieving better performance and simultaneously reducing costs over conventional SAN-based options. You will learn through this white paper that the GreenBytes testing met the requirements outlined by Citrix, but with very little consumption of the storage resources. The GreenBytes solution economizes on the storage footprint through real-time inline deduplication that works incredibly well for the common image elements of a virtual Windows workload. You will see results that also highlight that GreenBytes improves performance while consuming very little capacity in this 750-user test. The results will surprise you, and might leave you wondering how such results could occur, and maybe even why this storage model isn't part of every VDI deployment.

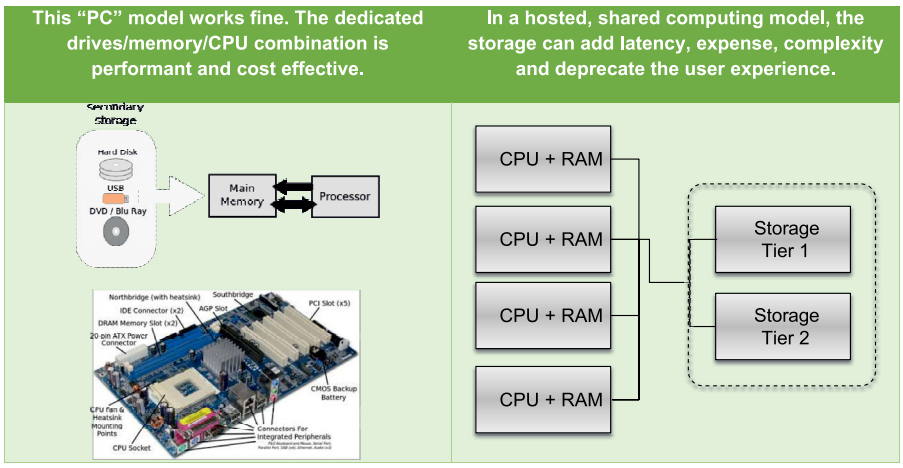
At the conclusion of this document, you will see how GreenBytes makes VDI storage "plug and play" simple, much more affordable, and provides users with a full-featured, **personal** computing experience. You will see why you should expect more from your data center ingredients, and get it at less capital expense. You will discover how to get over 100 IOPS per user at the SSD speed you should expect, but at the cost of conventional hard disk drives, and without over provisioning capacity. Take the risk out of your VDI project and make IT the solution heroes. Make your Citrix deployment outstanding!

The Business Challenge

Reproducing the performance of a physical PC in the virtual world presents some real challenges. Dedicated drives on your physical PC are always there, on demand, to serve the needs of the compute power with a dedicated 1:1 relationship. Shifting the workload of many users to a server that must share the resources of compute and storage places high demand on the IO events. Users feel under-performing systems through latency and throughput bottlenecks. The IT department faces the challenge of performance with a constant focus on the cost-per-user.

For the industry of virtual desktops to succeed, the users and IT economics need to align with the well-established alternative of purchasing a PC desktop or laptop. For the total cost of ownership (TCO) model to make sense, the solution "set" comprised of the data center, software, and the end point device of choice, must add up to an economically appealing acquisition cost. For those considering the "thin client" model, often considered the lowest TCO option, the sensitivity of cost-per-user often turns to the storage element – **typically** the highest cost data center ingredient.

Another critical success factor is the performance of the whole solution set. If users feel like they've taken a step backwards in their "personal" computing experience, then you may end up with a project mutiny on your hands. In particular, users feeling a difference between their physical and virtual computing options can be a positive, or it can become the cause of a failed VDI deployment project.



The key is getting the best balance of performance, capacity, and cost. A key win is to get them all! In the product space, the usual adage is good, fast, or cheap - pick two. Conventional enterprise architecture for storage often compensates for deficits through inefficiencies or half steps. Hard disk drives are frequently over provisioned because of slower IO speeds - more drives handle the throughput requests, but usually with capacity in excess of real needs (good and cheap, but not fast). Using SSDs can solve the performance problem, but without deduplication, flash-based storage is very expensive.

GreenBytes takes the unique approach of looking at data events as an opportunity to responsively get the CPU back to work while reducing the physical amount of speed-optimized SSD storage. By examining every block of data requested or written to the storage array and determining – in real time – whether that data is new or existing, GreenBytes consumes the smallest possible amount of storage. Each block of data from the operating system, applications, and swap file that is common to other users consumes only the space needed for the first instance. For VDI, where most users share a very high coincidence of common image composition, deduplication rates of up to 30x are common. Put another way, GreenBytes reduces the amount of SSD space required by up to 98%.

Overview: Citrix VDI Capacity Program for Storage Partners

In Q1 2014, Citrix launched a new program designed specifically to address the storage needs of customers who are implementing XenDesktop using the VDI FlexCast approach. VDI presents multiple types of data, each with its own unique requirements, to the storage infrastructure tier. Storage, in turn, can respond to these requirements using a variety of HW- and SW-based approaches, some of which can by combined in hybrid solutions. The variety of choices and the differences between them has led to some confusion for customers and partners. To resolve this, Citrix constructed a turnkey "VDI Capacity" test rig in their Santa Clara Solutions Lab. This rig contained the necessary server capacity to generate a 750 user reference workload for XenDesktop. The VDI farm was complete and fully operational with the exception of storage. Citrix storage partners were invited to connect their storage to the VDI farm and participate in a "VDI Capacity" test that simulated "a day in the life" of a 750 user Citrix farm.

Test Methodology

The focus of the VDI Capacity Program for Storage Partners is on provisioning the appropriate amount of storage performance and capacity with a cost-efficient design. Using a simple, binary pass/fail methodology, if a partner's provided storage solution can successfully support "a day's" run to the defined user capacity while sustaining required performance metrics, the partner passes and the test ends. Once passed, Citrix will describe the storage partner as "750 User Verified" for XenDesktop.

Login VSI, a highly regarded and respected tool for standardized VDI performance and capacity testing, was used to generate VDI workloads and to measure performance. 750 desktops were created, launched and executed a workload program that simulates a typical work day. Pass/fail was determined by whether or not the storage system used could successfully handle the storage demands placed on it without reaching a latency limit called "VSI Max." More information about Login VSI can be found here:

Partner Overview

GreenBytes® is a software technology company delivering a patented IO storage optimization solution. GreenBytes amplifies effective storage capacity while improving throughput performance, leveraging the powerful speeds of SSD storage. GreenBytes' solutions simplify the VDI storage infrastructure and provide persistent, full-featured virtual desktops with the manageability, scalability and affordability of traditional desktops.

Storage-related IO is the principal bottleneck for desktop virtualization, and many vendors are promoting flash as the solution; however, deploying flash without GreenBytes' patented zero latency inline deduplication technology is cost prohibitive. GreenBytes has true, real-time, inline deduplication that increases the write-intensive IOPS needed for responsive virtualized desktops. GreenBytes' patented technology reduces SSD wear through deduplication by reducing IO to the SSDs, which increases the flash endurance while achieving superior performance.

GreenBytes offers two software-defined storage solutions:

- **GreenBytes IO Offload Engine (IOOE)** is a full-featured SAN solution running on Dell hardware and is aimed at enterprise customers and service providers.
- **GreenBytes vIO** is a Virtual Storage Appliance that enables an all-in-one compute/storage VDI combination for rapid time to value: unpack, plugin and deploy. The vIO shares the same unique core file system optimizations as the IO Offload Engine, but operates on a single blade while still delivering high availability fail-over resilience.

Both solutions are highly complementary to the Citrix XenDesktop solution set that achieves high performance without complicated workarounds, and at the lowest cost per user. This means IOP bottlenecks go away and customers get a streamlined VDI implementation that offers a cost-effective, **fully persistent virtual desktop user experience**.

Partner Solution

GreenBytes is typically deployed as a Tier 1 storage target that services the virtual machine IO needs through NFS or iSCSI. The Citrix testing environment required the use of a shared storage device, so the GreenBytes test utilized the IO Offload Engine (IOOE) using an iSCSI interface. The standard configuration of a GreenBytes IOOE utilizes a pair of controllers for high availability, connected to a SAS drive enclosure. The two controllers are interconnected for a 'heartbeat' for constant mutual awareness of conditions so any fail overs occur gracefully and without consequence to the VDI compute nodes. The storage shelf can accommodate up to 24 drives, which supports approximately 2300 **fully persistent** users (each user has their own dedicated drive image) when fully populated with 200GB SSD drives.

The controllers host the GreenBytes IO Offload Engine software that receives and responds to I/O events. As an NFS or iSCSI Tier 1 storage target, the IOOE simply connects as a standard storage device that responds to standard administration server tools (e.g., LUN/volume creation). The controllers contain a lightweight operating system that evaluates the data events in real time, which provides the following key values to the performance of a virtual desktop workload:

1. Responds to IO events within 1 to 2 CPU clock cycles so the compute nodes get back to doing a more useful task; not waiting for the storage system to respond.
2. Determines the need to respond (read) or commit an IO event to the media (write). If the data exists in the controller, or we register that the block already exists, then the physical media is not tasked with any activity. Data deduplication evaluation is at the 4k block level (not file, not tiered, and not post-process deduplicated).

GreenBytes

io offload engine

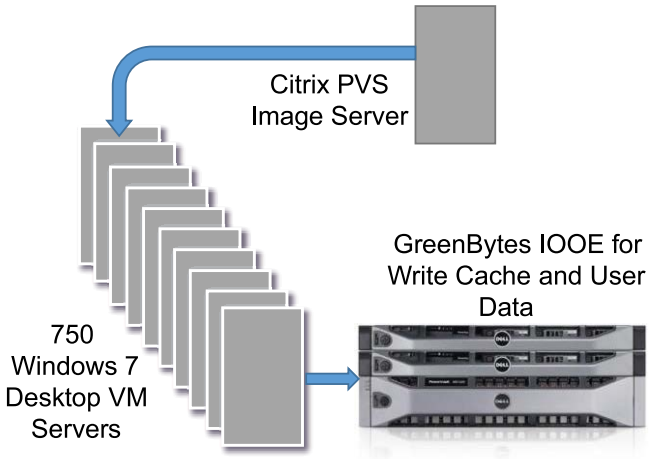
We submitted the GreenBytes IOOE Model 2400 for the Citrix Solutions Lab for testing (our mid-range configuration for sub-1200 user deployments for persistent desktops). The configuration leverages the physical components outlined above with the GreenBytes software license entitlement for the effective capacity that normally supports approximately 1150 dedicated persistent desktop images (each user has their own full image). Since this test leveraged a minority of the storage requirements for just write cash, our configuration was over provisioned for this 750-user test because the image was deployed by the Citrix PVS server to the server VMs.

While partner-based pricing will vary from street prices, the above configuration typically results around the following pricing model. Please note that GreenBytes **does not charge per user**, just on the effective storage capacity.

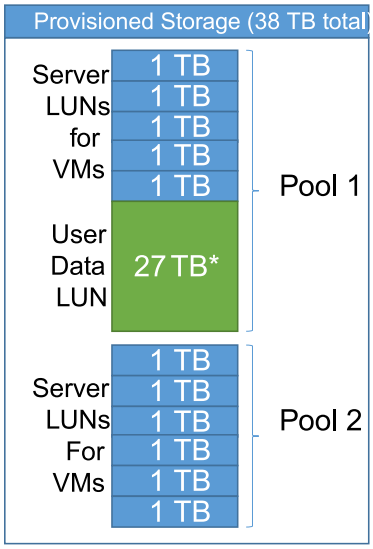
GreenBytes IOOE-2400	$84,750
Citrix 750 User Test	$113 per user (Only 0.2% of capacity consumed)
GreenBytes 1150 Capacity	$74 per user*

* Normally storing a 40GB image for each user

The illustration below highlights the data space seen as allocated by the storage system to the 750 user server configuration. The Citrix test published the images from the PVS (Provisioning Server) along with the Personalization Virtual Disk (PVD). This means the images were **not** persisted for each user on our storage array, so each time the servers start their respective VMs, PVS must respond to the initial I/O requests. Had this test been configured to populate the GreenBytes array with each users' initial image, the user changes and full persistence would then continue like a physical PC user with the greater benefit of all common blocks only being deposited ONCE on the GreenBytes storage array. See more on this architectural option later in the document.



In this tested configuration, the storage array is split into two pools: Pool 1 and Pool 2 each represent 6x 200GB SSD drives for 1.2TB of physical capacity and an effective capacity of 48TB. Each controller processes IO activity for these respective pools, but each controller has the capacity of taking over full IO activity in a fail over situation. The two pools had the following thin provisioned LUNs allocated for the Citrix test:

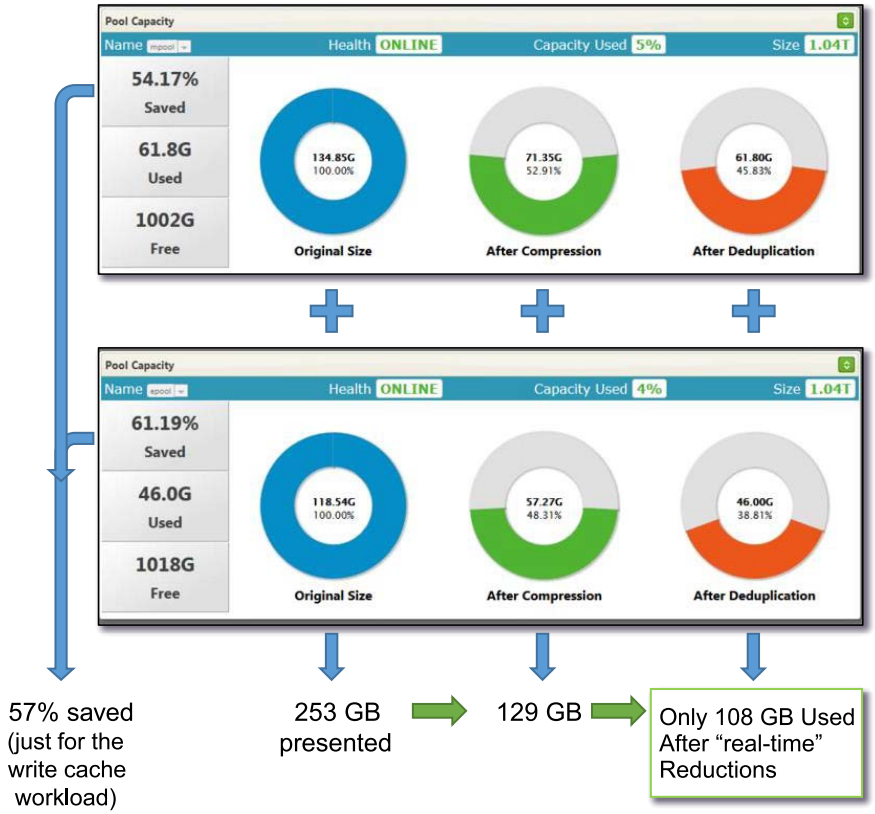


* Normally GreenBytes recommends leveraging a tier 2 storage option using hard disk drive (HDD) media for this less IO sensitive allocation

Since each image was allocated virtually to each VM, and the storage was allocated to write caching, our deduplication benefits were exercised to a lesser extent than dedicating a full image to each user (as you might do using Machine Creation Services [MCS] – more on this later in the document). Nonetheless, our inline compression and deduplication resulted in a 57% savings of storage space; only 108GB of raw storage was consumed in successfully passing this test.

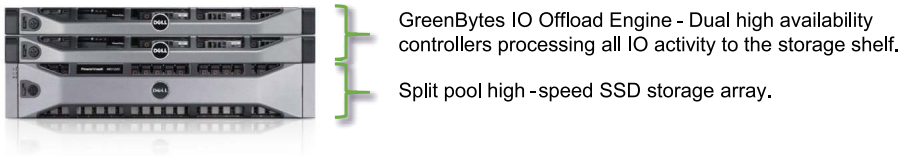
The 27TB of user space was allocated but not consumed for this Citrix test, but would have been deduplicated as well. Architecturally, it makes more sense to leverage Tier 2 HDD media for this user data because it is less performance sensitive.

These are the actual screen shots taken from the GreenBytes web console that shows real-time performance information.



The storage savings alone highlights the additional headroom for hosting more users within this half populated storage shelf. The efficiencies of the GreenBytes system are further represented by the relatively low utilization of array activity. The following section highlights two attributes of performance:

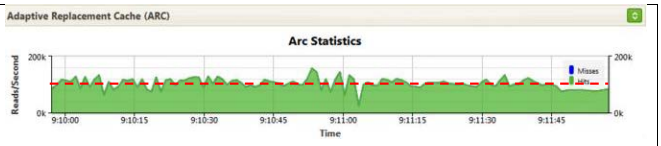
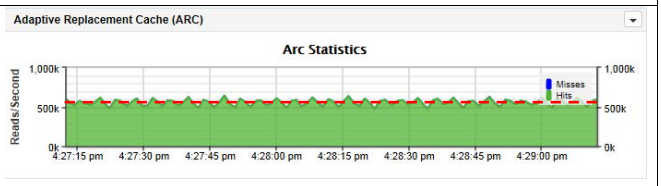
1. How efficiently the GreenBytes IO Offload Engine handles most IO events in **the controllers** that reduce IO activity to the drives (less SSD wear).



2. How relatively little performance capacity was consumed for the Citrix test.

To improve storage performance, ideally, any read/write activity occurs in the controllers through what is called the ARC (adaptive replacement cache), which operates as a Level 1 caching system in the ZFSbased platform used by GreenBytes. Unique algorithmic improvements made by GreenBytes in the hashing system (used for fingerprinting deduplicated data) enables us to process deduplicated IO rates extremely efficiently.

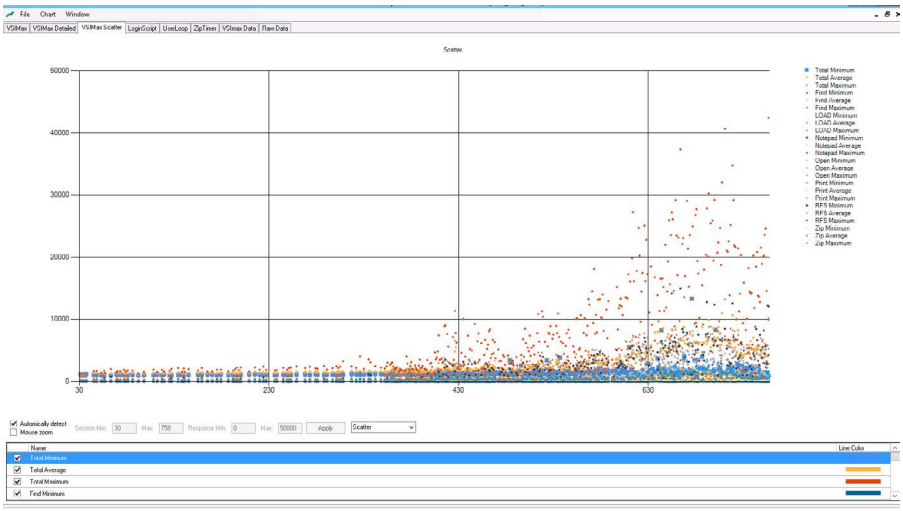
The "hit" rates shown by the green areas indicate that virtually all of the IO activity is hitting the Level 1 cache processed at the controller. These two monitoring screen shots from the GreenBytes console highlight that the Citrix load did not utilize much of the available capacity; only ~16% was utilized. The key takeaway is that the test did not stress the GreenBytes storage solution with this 750-user setup.

Sample taken during the **Citrix load test**: ~90k/sec processed via the ARC on the GreenBytes controller	
Sample showing a **high capacity workload**: ~550k/sec processed via the ARC	

Login VSI Test Results

As most architects now understand, the user response time critically depends on the storage subsystem. Windows is a very "chatty" IO workload for virtual machines. Delays in getting an application to respond feels like working on a slow PC. Virtual memory contributes to this during use, but boot (read intensive) activity can affect fellow users also booting. The end-of-day logoff write storms that occur when changes get recorded also test the storage bottleneck.

The Login VSI graph below shows that nearly all application activity is clustered in the sub 1-second response time region, all the way through 750 users with virtually all activity occurring under the 4-second threshold. **Note that during this entire test, the GreenBytes inline deduplication engine is running; nothing was turned off to achieve a benchmark result.**



IOPS Matter

Steady-state or "average" IOPS matter for statisticians that provide rough estimates. But as we all know from driving in traffic, the "average" speed of traffic during the day doesn't matter when you are crawling through commuter congestion at 10 MPH/KPH, right? For storage, dealing with spikes of user activity means being prepared to perform in a PC-like dedicated hard drive manner for an outstanding user experience ALL THE TIME. Getting the "average" of 5 to 7 IOPS per user may mean the storage SPEC sheet meets your needs, but the user experience will feel like commuter traffic when put under stressful loads. **This can cause your VDI deployment project to fail**.

The reduction of data consumption in the GreenBytes IO Offload Engine does not come at the expense of speed or latency (and you should always ask about latency). The following performance metrics were captured as part of the Dell Technology Partner certification testing that ran on the previously described Dell servers and storage systems. The industry standard benchmarking tool, IOmeter, was used for the following IOPS performance and latency figures for the GreenBytes IO Offload Engine running on Dell systems.

Running 2 IOmeter Load Generator Servers – iSCSI, 10Gb

Test	IOPS @ 4K block size*	Latency*
100% Read	411k	.47 ms
50/50% Read/Write	281k	.68 ms
100% Write	237k	.81 ms

To further illustrate limits of the configuration, and to highlight the even higher READ and mixed READ/WRITE IOPS possible, these test results show how three IOmeter load generators perform.

Running 3 IOmeter Load Generator Servers – iSCSI, 10Gb

Test	IOPS @ 4K block size*	Latency*
100% Read	622k	.96 ms
50/50% Read/Write	316k	.76 ms
100% Write	230k	.75 ms

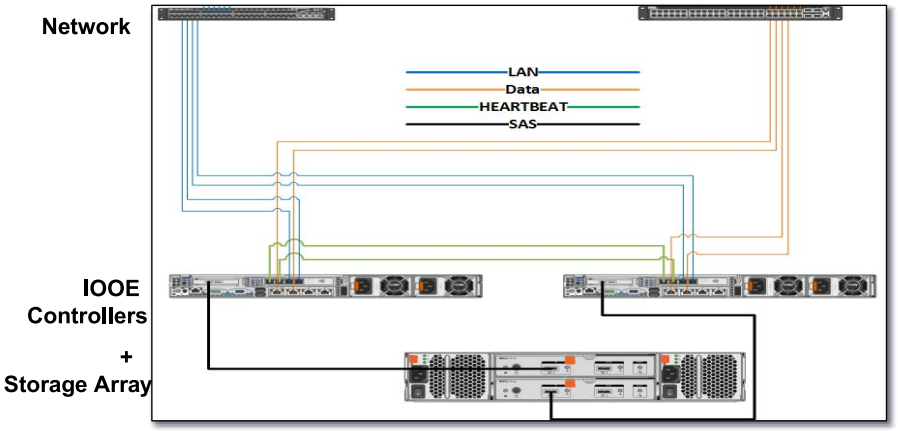
* All IOmeter numbers were achieved with deduplication and compression on.

The results illustrate the ability to service the full capacity workload at 122 to 137 mixed read/write IOPS per user (or you can provision more users). These IOPS ratings were achieved while remaining below a 1-millisecond latency, and with all deduplication and compression on. The 1 ms latency threshold is important because higher IOPS can be achieved by alternative storage options, but at higher latencies that users will feel in their desktop experience. Citrix Consulting Services outlined best practices in their excellent BriForum session in 2013 (see "Why IOPS Suck and Everything You Know About Them is Probably Wrong!).

The net result yields SSD performance for each user while provisioning a full persistent desktop experience at the cost of typically over-provisioned HDD or hybrid SSD/HDD.

Solution Components/Architecture Design

For the Citrix Storage test of 750 users, the GreenBytes IOOE was populated with 12 drives (200GB SSDs) that support an approximately 1150 **persistent user** deployment. Figure 1 illustrates the configuration:



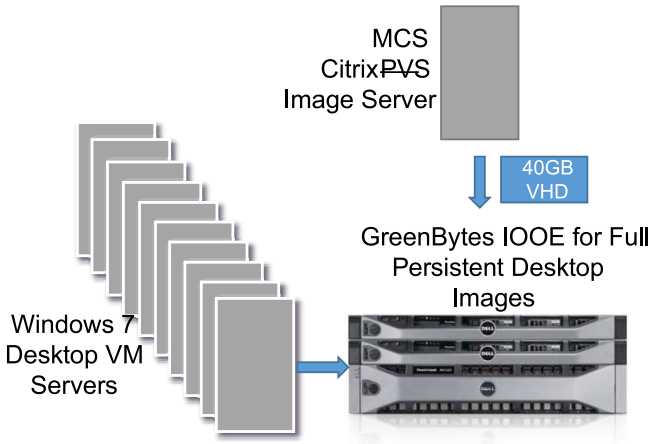
The GreenBytes baseline configuration utilizes the following Dell system components:

- IOOE controllers: Dell PowerEdge R620 1U rack server
- IOOE storage shelf: Dell PowerVault MD1220 SAS storage array equipped with (12) 200GB write-intensive workload class MLC SSD drives for a total of 2.4TB of physical media. The array is logically and physically split into two pools.
- GreenBytes IOOE-2400 software license entitling **48TB of effective storage**
- **Street Price - $84,750**

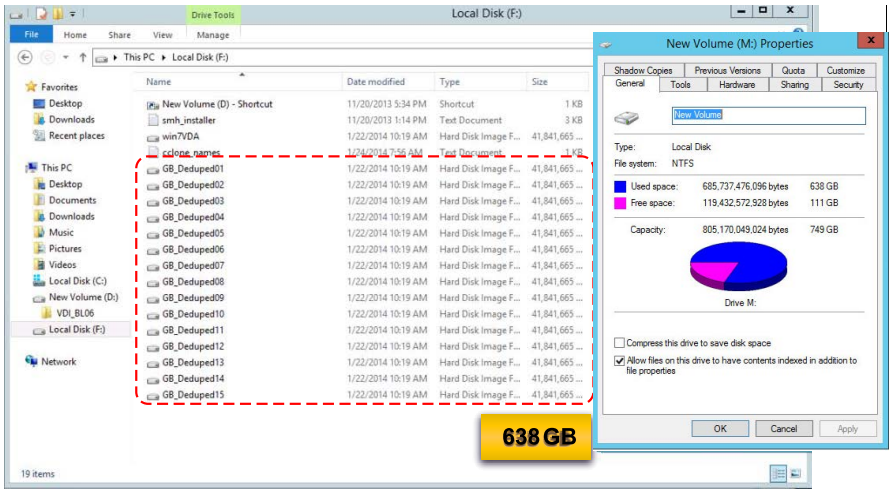
Additional Solution Data

Provisioning an image to each VM on the server provides one way of getting users their respective image. While we were at the Citrix Solutions Center, we ran an incremental test to provision the image to a dedicated virtual hard drive (VHD) on the GreenBytes IO Offload Engine to demonstrate the real benefits of deduplication. In this **abbreviated example**, we created 15 dedicated VHDs of 42GB to represent 15 users, each receiving their own persistent desktop. We limited the example to 15 for time conservation at the Citrix Lab, but this same illustration equally applies in scaling to thousands of users where the benefits are multiplied even further, and where the ROI is even more substantial.

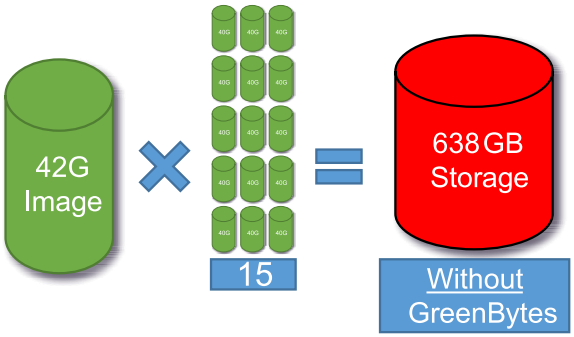
Just so it's clear, we are demonstrating a user receiving a 42GB VHD allocated on the GreenBytes IO Offload Engine. Rather than the VM on the server holding the image, the user has their hard drive on the GreenBytes-optimized storage device. The resulting architecture would look like the following, or better yet, it would show Machine Creation Services (MCS) instead of PVS because GreenBytes removes the IOPS and scale limitation:



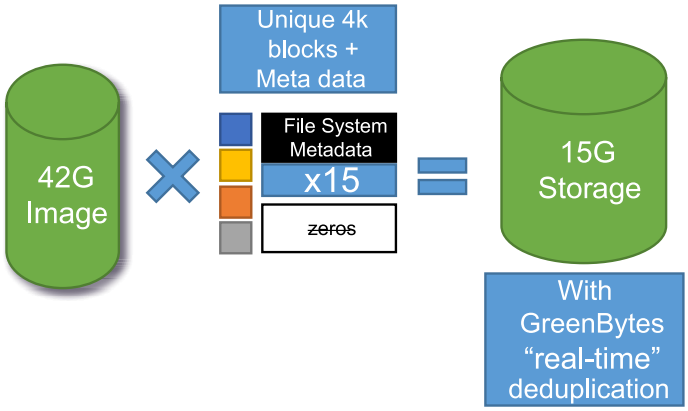
From the server side, this is what appears provisioned for each of the users for a total of 638GB of allocated space:



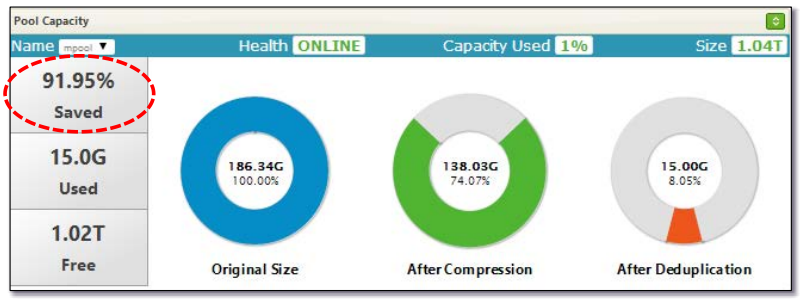
Normally, the above storage space would cause most budget-sensitive architects to cringe at the thought of giving this allocation enough performance bandwidth. Why? Because the options normally require overprovisioning magnetic or even hybrid media. If the option to overcome performance is to provision an all-flash array (AFA) without deduplication, the price for 638GB would cost over $300 per user, but this option would most certainly allow sufficient IOPS for a responsive virtualized desktop.



As mentioned earlier, the GreenBytes IO Offload Engine always conducts IO with deduplication on. Since we leverage the benefits of flash-based storage, the IO performance brings each user their own SSD level of performance, but with the denominator of deduplication added, this architecture enables cost effectiveness as well. Instead, the picture looks like this without impacting IOPS performance.



We used the same VHD contents that Citrix provided for the required certification testing to populate the 15 user images. The 42GB VHD image contains a combination of the operating system, applications, and unused space.



Thin provisioning saves part of the initial space because the actual OS/application image consumes 12GB of actual data. But normally, 15 more images would consume the 186GB of raw storage illustrated above by the **blue** donut from the GreenBytes web monitoring console. Then there are some benefits from compression illustrated by the center green donut. But the real benefit comes from the REAL-TIME deduplication steps that reduce the footprint by 93% in this example, as illustrated by the final **orange** colored donut. Larger full image clones and/or larger quantities of users reach efficiencies of over 98%!

The difference between the 12GB size of the first image and the final 15GB of raw storage consumed (3GB) is the only incremental capacity consumed for the metadata generated by the GreenBytes file system. In other words, each desktop image consumed a very small incremental 214 **Megabytes** of capacity. This is typical because we only consume enough data to populate our metadata table (256 bits for every 4k block). So, the key point here is that you get SSD performance at a fraction of the expense!

As mentioned earlier, this optimization is simple. GreenBytes is simply a storage target, so provisioning each user with their own image is so much "leaner" **and without adding another layer of image management or incrementally loading hardware or software on each server**. For larger deployment sizes, the economization illustrated here with only 15 desktops gets even more cost effective.

Just one more click…

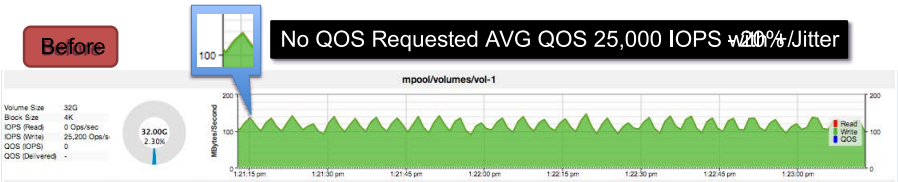
Take the above example one step further and look at what the ongoing lifecycle process could look like once each user has an efficient place for their own perpetual image:

- Users can add/change their image with personalization in any manner permitted by IT admin privileges.
- Adding individual user applications can be as simple as self-service installs permitted by standard Windows desktop management tools. In the case of Microsoft System Center, users can go directly to their Software Center listing of white listed applications and install whatever they need without asking for admin privileges or entering a help desk ticket for an IT event.
- Patching and any other lifecycle administration can occur from the same tools used for managing physical desktops. This can dramatically improve adoption levels of virtual desktops by leveraging talent resources already familiar with the PC management system.

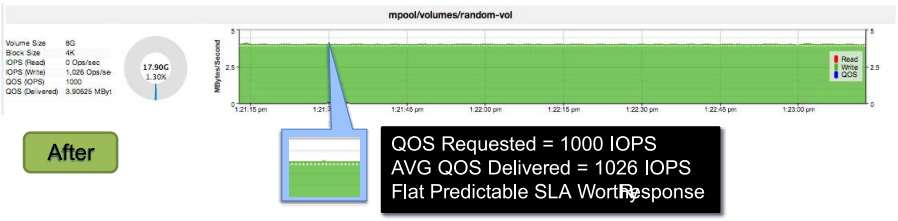
Slow things down… What?

Centralizing resources helps build a more unified and manageable delivery system. It also helps to leverage economy of scale; however, it can also cause problems if there are "noisy neighbors" to contend with, particularly on the storage side. One of the features that GreenBytes added to help address the needs of customer-like hosted service providers is a QoS (Quality of Service) control system to enable setting a quota on iSCSI LUNs.

Here's an example of what waves might ripple through the workloads of other users on the same system. The disruption felt by users may mean the difference between getting a support call or not, or meeting an SLA commitment which translates to real business metrics, like margin, if you have to over provision to make sure there aren't complaints.



Using GreenBytes QoS quota controls, we can ensure that subscribers to the storage workload each receive the promised service level, while keeping the waters quiet for everyone else.



Conclusion and Call to Action

GreenBytes addresses the complex problem of making persistent virtual desktops a cost-effective option with elegance and simplicity:

- **Point and shoot**: GreenBytes appears as a standard storage target. No extra server software, no incremental server hardware, and no additional administration.
- **Real-Time (really)**: We process IO events at full SSD flash speeds while reducing the media required to service the storage footprint. We don't introduce latency in the process; in fact, we service IO events in 1 to 2 clock cycles (1/2.8 billionth of a second). VDI should always be this easy and perform this well!
- **User Personal**: Give your users the virtual desktop experience they expect and demand. Just because you moved to a virtual Personal Computer, doesn't mean you have to create a "vanilla" experience. Plus, you can use your Windows lifecycle management tools!
- **Effectively Scale**: GreenBytes cost savings and exceptional performance enable VDI deployments to scale into the 1000s or 10,000s of users.

For more information on GreenBytes' award-winning desktop virtualization storage optimization offerings, please visit:

GreenBytes IO Offload Engine:

http://getgreenbytes.com/solutions/io-offload-engine/

GreenBytes vIO (virtual storage appliance):

http://getgreenbytes.com/solutions/vio/

Dell Certification Press Release:

http://getgreenbytes.com/news-events/press-releases/greenbytes-named-a-certified-dell-technology-partner/

GreenBytes on Dell:

http://getgreenbytes.com/solutions/greenbytes-on-dell/

Product Brochures:

http://getgreenbytes.com/wp-content/uploads/2014/03/Dell-Solution-Brief-FINAL_2014.pdf

http://getgreenbytes.com/wp-content/uploads/2014/03/Dell-VRTX-vIO-Solution-Brief-FINAL_2014.pdf

GreenBytes and Citrix – Better Together for Desktop Virtualization

http://getgreenbytes.com/wp-content/uploads/2013/05/GB-CITRIX-Solution-Brief_WEB_LR2.pdf

http://getgreenbytes.com/wp-content/uploads/2013/04/GreenBytes-Pantein-Case-Study.pdf

CTO Video Series:

http://getgreenbytes.com/press-room/media-downloads/cto-video-series/

Additional Resources

Facebook.com/GreenBytes
Twitter.com/GetGreenBytes
YouTube.com/GreenBytesVideos
Google+/GreenBytes
GreenPower Blog

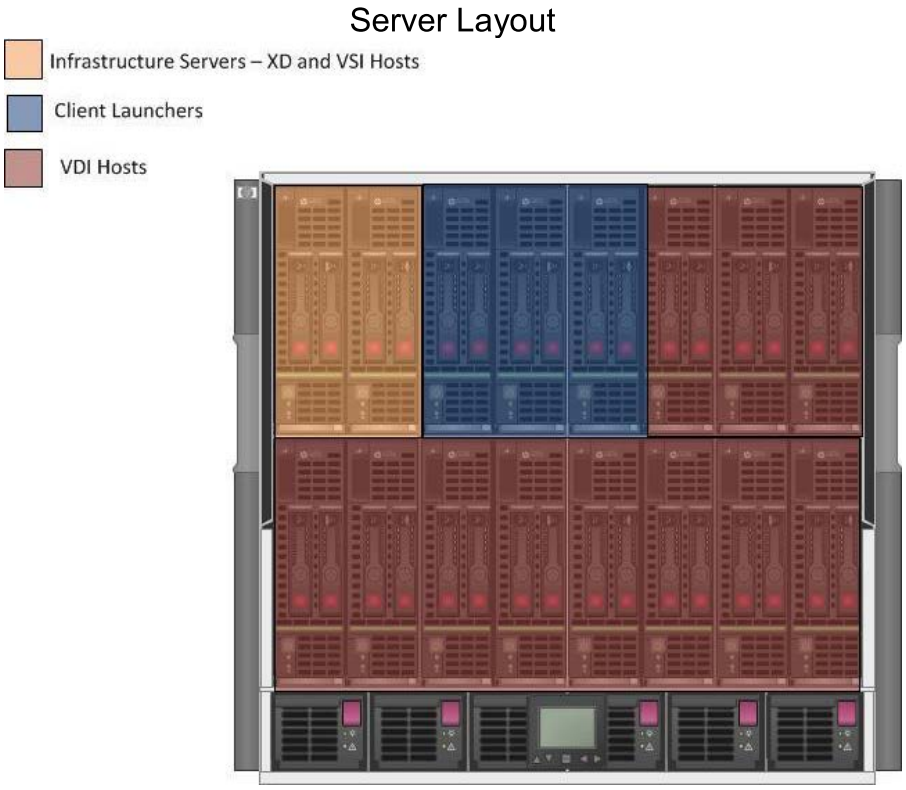
Addendum

Minimum storage requirements as determined by Citrix for 750 concurrent VDI desktop users:

- Write Cache Files:
  - 6 GB Write cache file per user
  - 4.5 TB minimum required
  - Additional 2.5 TB added to LUN for overhead
- User Data:
  - 30 GB allowed for each user
  - 750 * 30 = 22 TB of required space
  - 3 TB added for overhead
- Total storage capacity required:
  - 7 TB for write cache + 25 TB for user data = 32 TB required

Citrix Provided Server Configuration

- A single HP C7000 enclosure will be used hold the servers
- The enclosure will be in a separate isolated environment
- Servers will be BL460c G7 with 2 Procs and 192 GB of memory
  - 1 server to contained the necessary infrastructure VMs
  - 4 servers will contain client VMs necessary to drive work load
- A separate Login VSI 4.0 license will be obtained to further provide isolation
- VM Configuration - 32-bit Win7 1.5GB memory, 1 vCPU
  - 11 servers will contain XD7 desktops
- VM Configuration – 64-bit Win7 1.5 GB memory, 1 vCPU
  - Servers will be Windows 2012 Hyper-V

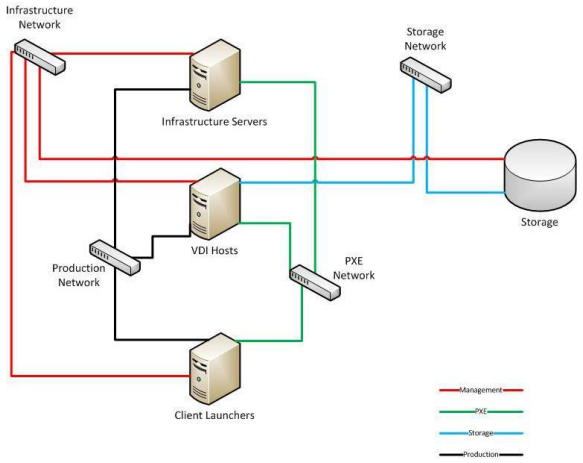


Citrix Provided Configuration

Network Configuration

- FlexFabric will be configured to allow for either Ethernet or Fibre connectivity from the blades. These will be connected to a 4gb Brocade switch
- Four networks will be created:
  - Network 1 – internal to HP Virtual Connect for PXE boot of VMs, 5 gb
  - Network 2 – Connection to lab storage and management, 1gb
  - Network 3 – Production network for connection between clients and XD VMs, 5 gb
  - Network 4 will be either:
- Connection to vendor storage for using iSCSI, 9 gb OR
- Fibre connection to SAN for vendor storage
- There will be no HA or redundancy across the NICs

Network Layout



XenDesktop Configuration

- XenDesktop 7 will be used
- Provisioning will be done with PVS version 7.0.0.46. Due to MCS working best with file based storage and not all vendors supporting file based storage (NFS), PVS will be used to provision the desktop VMs. This will create a write-intensive environment.
- One each broker (DDC) and PVS VM will be created to support the Infrastructure

Storage Configuration completed by Vendor

- Vendor controls setup of their storage: Number of LUNs, Cache Usage, iSCSI vs Fibre, etc.
- Citrix will provide any necessary configuration information prior to vendor on-site (IP addresses, etc)
- Vendor must provide full disclosure of configuration. Citrix must sign-off on configuration.
- All configurations must contain best practices as would be recommended to customers in productivity environment
- Vendor must disclose street price of storage configuration, that number will be used to determine cost per user for 750 users

Definitions

VM definitions

- Infrastructure VMs:
  - All will be 64-Bit Windows 2012
  - AD VM – 4GB memory, 1 vCPU
  - DDC VM – 8 GB memory, 2 vCPU – locally configured SQL
  - PVS VM – 4 GB memory, 2 vCPU – locally configured SQL
- Client VMs
  - 32-bit Win7, 1.5 GB memory, 1 vCPU
- XD VMs
  - 64-bit Win8, 1.5 GB memory, 1 vCPU

Login VSI

- Login VSI 3.7 will be used
  - VSIShare will be inside the chassis
  - IOPs medium work load will be used

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