How to Cut VDI Storage Costs and Optimize Performance with VERDE Storage Optimizer™
Cache I/O Technology

A Virtual Bridges, Inc. Briefing Paper
by Leo Reiter, Co-Founder and CTO, Virtual Bridges
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A significant drawback to large VDI deployments is the need for extensive and costly storage. VERDE Storage Optimizer™ cache I/O technology from Virtual Bridges takes a completely new approach to caching, dramatically reducing network traffic to optimize storage, boost performance, and cut costs.

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Executive summary

The challenge of storage inefficiencies is widely acknowledged as a problem with conventional Virtual Desktop Infrastructure (VDI) implementations. Traditional VDI requires excess amounts of top-tier storage, which is costly to purchase and complex to manage, often making large-scale VDI deployments too expensive and slow to be practical. Some vendors offer third-party solutions to address storage issues, but they add expense and integration headaches and can fail to solve the problem.

Virtual Bridges addresses the storage cost issue at its roots with VERDE Storage Optimizer cache I/O. Native to Virtual Bridges VERDE software, so there are no third-party costs or integration issues, Storage Optimizer cache I/O approaches caching in a unique way, reducing traffic over the storage area network (SAN) by 90 percent or more, and cutting VDI storage spindle needs by an order of magnitude. The result is huge savings on storage, with desktop-like performance for users. This paper explains the technology behind VERDE Storage Optimizer and how it works in VDI deployments.
VERDE Storage Optimizer™ Cache I/O

Challenges with traditional VDI storage
- High IOPS within Tier 1 storage arrays and across the network
- Prohibitive cost
- Performance issues
- Complexity

Unique benefits of Storage Optimizer
- Works with existing storage
- Easily handles boot storms
- Reduces network infrastructure in general
- Works with any virtual desktop
- Caches at data center and branch levels
- Automatic workload balancing and tuning
- Off-hours synchronization
- Security settings to eliminate cross-talk

Summary
The push toward virtualization in general, and desktop virtualization in particular, is drawing interest and adherents across the IT and business landscapes. In theory, virtualization offers greatly reduced management complexity, better desktop control, and far lower infrastructure costs. In practice, however, there are challenges with current VDI solutions.

The problem of storage inefficiencies is widely acknowledged as one of the largest issues facing conventional VDI implementations. In short, traditional VDI requires excess amounts of “Tier 1” storage, which is costly to purchase and complex to manage. That often makes large-scale VDI deployments, in particular, too expensive and slow to be practical.

To address this issue, Virtual Bridges offers VERDE Storage Optimizer cache I/O technology as part of its VERDE solution. It works by caching the Input/Output Operations per Second (IOPS) from each virtual desktop onto VDI compute nodes for common data reads and transient data writes. Because Storage Optimizer takes advantage of local storage on VDI nodes, rather than remote storage on the SAN, the reduction in traffic and Tier 1 spindle counts is dramatic.

VERDE Storage Optimizer™ Cache I/O can reduce traffic over the SAN as well as Tier 1 spindles by 90 percent or more, cutting VDI storage needs by an order of magnitude and resulting in huge savings.
Storage Optimizer replicates shared virtual desktop data at scheduled intervals, while running virtual desktop workloads directly from local direct-attached storage (DAS). This reduces both the need for Tier 1 spindle IOPS, as well as the bus bandwidth required to transfer data from the SAN to the VDI nodes. The resulting reduction in storage needs, and in the amount of data that must be transferred, means cost savings and performance benefits for large-scale VDI deployments. Figures 1 and 2 illustrate how leveraging local, low-cost DAS rather than remote SAN storage greatly reduces the number of costly storage spindles needed on the SAN system.

Storage Optimizer works hand-in-hand with the Virtual Bridges VERDE “gold master” model. While the concept of a gold master is used throughout the VDI world, Virtual Bridges applies it in a unique manner. With Storage Optimizer, the gold master model allows IT organizations to retain single-image management, while allowing users to store persistent personalized data (documents, settings, and unstructured data outside user profiles) according to desktop policies.
CacheIO and the VERDE “gold master” model combine the efficiencies of non-persistent pools with the flexibility of persistent desktops thanks to native system and user state separation. In this mode, virtual desktops run with two layers: a non-persistent “system disk” layer and a persistent “user disk” layer. This technology is native to VERDE, requires no third-party tools, and introduces no application compatibility issues.

Because the system disk is common to many workloads, it is not duplicated on the SAN. Instead, it can run locally, and is replicated to any VDI compute nodes that will run the workload. The image runs in a copy-on-write mode, in which writes are stored in a transient bit bucket for the length of each virtual desktop session. These transient bits never leave the internal storage or scratch space of the VDI compute node executing the desktop.

Writes to persistent user data, on the other hand, are written back to the shared storage volume, with the guest operating system using a cache elevator and asynchronous I/O at the hypervisor level to improve performance. This ensures that user data is always properly stored safely on Tier 1 storage, while transient or common data is optimized on non-critical DAS storage.

Rather than deploying a complex set of data stores and organizing countless Logical Unit Numbers (LUNs) that are served over expensive FiberChannel or iSCSI interfaces, organizations can now deploy a simple Network Attached Storage (NAS) volume for authoritative VDI data. This includes system configuration, policies, user data, and gold master image sources. In order to provide the performance necessary for large-scale VDI deployments, CacheIO then distributes the storage processing to local spindles or simple DAS paths.
As stated earlier, traditional VDI storage presents several challenges that drive up the cost of storage, including a high number of spindle IOPS, increased network and/or FiberChannel capacity and complexity, and overall performance issues.

High IOPS within Tier 1 storage arrays and across the network

Any VDI storage discussion must consider the number of IOPS that will be generated by each virtual desktop; IOPS are the single most important metric in VDI desktop performance. Booting Windows 7, for example, with its many reads and writes, makes IOPS performance extremely important.

Large numbers of IOPS per user results in equally extensive Tier 1 storage requirements with traditional VDI deployments. Meeting the performance expectations of users, who are used to native desktop-like response times, means large bandwidth and infrastructure expenditures to handle network traffic volumes. This leads to a costly expansion of FiberChannel or network capacity to transfer the data from the spindles to the compute nodes.
**Prohibitive cost**

Beyond the high volume of storage required by traditional VDI is the fact that expensive Tier 1 disk spindles are required in order to achieve desktop-like performance and backup. Costs of large VDI deployments thus become prohibitive, which is why storage costs are a highly visible and troubling VDI issue. Companies may be enticed by the promise of VDI, or in the middle of a deployment, but find themselves unable to resolve issues with storage costs and performance.

Customers often cite Tier 1 storage CapEx figures up to ten times the cost of equivalent DAS solutions, or up to $1,000 per user in spindles alone, in order to achieve equivalent native desktop experience.

**Performance issues**

Standard VDI deployments face particular performance issues when a large number of users start up or log in to their systems at once, generating a “storm” of IOPS. High storage costs in VDI deployments can often be traced to efforts to address this issue – adding spindles and bus bandwidth to mitigate performance hits during boot or login storms. Competing vendors often bring in third-party solutions to address the problem. IT staff must choose to purchase either vast amounts of additional storage, or additional software that must be integrated and managed.

**Complexity**

The cost and complexity of traditional VDI solutions means organizations spend much more on traditional systems in order to get the same performance offered by Virtual Bridges. Storage costs with Storage Optimizer cache I/O technology can be five to ten times less than with competing VDI solutions.
Virtual Bridges Storage Optimizer cache I/O technology addresses those issues of cost, complexity, and performance, offering a unique, built-in approach to VDI storage.

**Works with existing storage**

Because Storage Optimizer takes advantage of underused internal spindles on nodes, network engineers can save money by reducing, re-allocating, and re-using storage. In many cases, the existing SAN can be used for authoritative data stores without upgrading, or Storage Optimizer can take advantage of underutilized, lesser tier storage, reducing expensive Tier 1 storage requirements.

**Easily handles boot storms**

Storage Optimizer cache I/O technology addresses high-use issues such as boot storms, login storms, and large application launches directly, without the need for additional hardware or software, because it offloads most IOPS from the SAN. Conventional VDI solutions on the other hand require five to ten times the number of spindles and bus bandwidth.

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For example, a midrange laptop computer designed to boot up under Windows 7 might deliver five IOPS under regular use, a common industry average. During boots, anti-virus scans, logins, and application launches, this number can easily increase to 50 IOPS. Multiply that by 100 or 1,000 VDI users, and the result is a prohibitively large load on the network, and huge Tier 1 spindle requirements. Storage
Optimizer offloads most of that traffic from external storage on the SAN to low-cost DAS. It also mitigates other problems with conventional VDI, including performance issues with boot storms, and the cost of building out and maintaining bandwidth to support high traffic.

**Reduces network infrastructure in general**

Performance characteristics depend not only on the number of storage spindles needed, but also the connections between the compute nodes and storage. Network performance and cost calculations often skip over the cost of more compute nodes, along with more bandwidth to support huge amounts of traffic. Faced with performance issues in VDI installations, IT often turns to expensive bandwidth-boosting solutions such as fiber channel, costly switches, and 10G Ethernet. Because Storage Optimizer moves perhaps a tenth of the data of conventional VDI deployments, bottlenecks across the network are greatly reduced, as is the need for network infrastructure and management, for additional cost savings. In fact, most organizations already centralize authoritative file storage on servers or NAS, so in many cases there is no increase in the network bandwidth required to deploy storage for a VERDE solution versus the status quo.

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*Storage Optimizer moves a tenth of the data of conventional VDI deployments, so bottlenecks – and costs – across the network are greatly reduced.*
Works with any virtual desktop

Conventional VDI technologies are unable to work with both Windows and Linux. Unique among VDI vendors, VERDE in general and Storage Optimizer specifically, treats Windows and Linux virtual desktops as equal citizens. And its benefits are as strong for Linux desktop workloads as they are for Windows.

Caches at data center and branch levels

Virtual Bridges is the only vendor to offer a true caching solution at the branch as well as the data center. Branches that require SAN storage because of a large number of users, can save costs at the branch level as well. In many cases, even branch locations with many users can use commodity NAS equipment rather than costly Tier 1 SAN to deliver VDI to local users.

Automatic workload balancing and tuning

Storage Optimizer automatically load-balances desktops to nodes with the most up-to-date cache. While synchronizing is taking place, or when a desktop requests a workload, Storage Optimizer cache I/O technology ensures that whatever compute nodes are available have the latest version of the state synchronized. This addresses situations in which a user logs in, but doesn’t yet have a cache to work on. For efficiency, desktop workloads are also automatically grouped onto nodes that already have a cache of gold images.

Technical performance characteristics

With Storage Optimizer, many requests never leave the VDI nodes. This results in a reduced number of network packets needed, as well as far fewer spindle IOPS. IOPS offloading results in 5 or fewer SAN or NAS IOPS per desktop, versus 20-50 IOPS per desktop with conventional VDI systems.
This approach, already in use by Virtual Bridges, has been extended in Storage Optimizer to take better advantage of the cache.

In general, automatic tuning means the entire VDI system is always tuned for maximum efficiency and availability. IT personnel never need to determine what cache is available where or how workloads should be grouped for maximum efficiency. Storage Optimizer handles it all.

**Off-hours synchronization**

Scheduling and synchronization in traditional VDI deployments can impact user performance, especially when synchronization is performed on-demand. If a user launches a non-cached desktop and the system begins synchronization immediately, performance is affected for all users on that node. Instead, Storage Optimizer schedules synchronizations, replications and cache updates to occur when the system is not in use, thus eliminating impact to users. Synchronization can even be scheduled individually by compute node, allowing IT administrators to stagger caching to meet network constraints.

**Security “enclaves” eliminate cross-talk**

Storage Optimizer addresses potential security issues around VDI deployments with settings that eliminate network cross-talk – caused when groups of users with different security permissions access the network simultaneously through the same channels. It can prevent this through easy-to-establish security “enclaves” that restrict simultaneous cache synchronization at the firewall level. For organizations with strict network security constraints, enclaves can eliminate cross-talk by ensuring that replication occurs at different intervals, controlled by a policy-based firewall. This mechanism is generally compliant with the highest standards of network security even within trusted organizations such as defense and healthcare.
The need for large amounts of Tier 1 storage to make conventional VDI deployments perform properly, especially in large installations, is a central issue with VDI technology. Virtual Bridges VERDE addresses the issue at its core with its unique native cache I/O technology. Without third-party components, Storage Optimizer offloads IOPS from the storage area network, dramatically reducing the number of SAN storage spindles and storage bus bandwidth needed. The result is huge storage cost savings and better performance – Tier 1 storage costs can be five to ten times lower than a conventional VDI solution. Reducing storage also slashes network infrastructure needs and management costs, since less network traffic means far less bandwidth demands.

It is easy to implement even for complex use cases, and automatically manages issues such as load balancing, tuning, and off-hours synchronization. A comprehensive and universal solution, it works with all desktops, both Windows and Linux, and all topologies, whether centralized or distributed branch architectures. Installations with security concerns can use its ability to eliminate network cross-talk without losing the benefits of centralized, single-image management.

In short, by solving the issue of costly storage requirements and performance hits at its roots, Virtual Bridges VERDE Storage Optimizer cache I/O technology restores the original promise of VDI – a truly cost-effective method of delivering native desktop performance to users, while returning control of those desktops to IT.
About the Author

Leo Reiter – Virtual Bridges Co-Founder and CTO

Leo Reiter is Virtual Bridges’ Chief Technology Officer. An experienced technologist, Leo guides the architecture, development and technical sales teams. His approach to product development considers customer needs, industry trends and visionary direction. Prior to Virtual Bridges, Leo was a senior architect at GTE (now Verizon) where he led various infrastructure software teams delivering innovative solutions using large scale enterprise technologies. Leo also spent several years as a consultant in the telecommunications industry in diverse roles involving design, development, and Software Configuration Management.

About Virtual Bridges

Virtual Bridges VERDE is the industry’s most comprehensive desktop management and provisioning solution that leverages virtualization to deliver desktops either on-premise or in the cloud. The VERDE solution lets enterprises transform their desktop TCO by simplifying desktop management, improving security and compliance by centralizing the administration of desktop images and data, and increasing the organizational agility by quickly providing desktop and application access to users on any client machine (PC, Macintosh, Linux, thin client, home computer or on a portable drive) at any time.
About VDI Gen2

VDI Gen 2 solutions provide the following characteristics:

All in One Solution – includes connection brokering, desktop image management, automated provisioning, and management with each element tightly integrated, simplified and purpose-built for VDI.

Scalable, Clustered Architecture - built to scale; there are no single points of failure, and scale-up or scale-out are as simple as additional nodes to the cluster.

Delivers the Dynamic Desktop - builds a fully personalized desktop for each user on demand and as requested; doesn’t require expensive third-party tools and/or complex configurations.

Breaks Down the Storage Barrier – keeps capacity requirements in check; patent pending technology dramatically reduces the IOPS; leverages local disk to optimize both read and write IOPS.

Provides Unified Management – single pane window into all virtual desktop provisioning and maintenance activities; provides visibility across on-line, off-line and branch VDI desktops.

Includes Broad Connectivity, Protocol and Device Coverage – designed for the way we work today, not re-engineered; sync technology provisions the best remote display protocol for a rich PC-experience; delivers Windows and Linux desktops to the most popular end point devices such as PCs, Macs, thin clients and even iPads.

Service-Based Pricing & Packaging – offers both hosted and on-premise options; all inclusive pricing.

Virtual Bridges VDI Gen2 is now.