openBench Labs
Executive Briefing:

January 10, 2010

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January 19, 2012

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Distributed Computing Vision

With the successful adoption of on-site infrastructure virtualization, IT is now turning to the Cloud as the new vehicle for accessing resources such as computing—Infrastructure as a Service (IaaS)—and storage—Data Storage as a Service (DaaS)—on demand. As a result, the Cloud represents a new business model more than it does a new technology. That means resources intended to support Cloud computing need to be evaluated in terms of their ability to support a business model to reduce operational and capital costs and take advantage of economies of scale.

Nexsan Storage Value Proposition:

1) **Simplify SAN Administration via a Single-Pane-of-Glass Interface:** The Nexsan managemet software integrates with the Windows Virtual Disk Service (VDS) to provide a complete single-pane-of-glass storage management interface for Nexsan and Microsoft storage management tools.
2) **Utilize Microsoft Tools to Automate Management of Nexsan Resources:** Through integration with VDS, extended Microsoft management software, including Server Manager and Storage Manager for SANs, gains full access to all Nexsan configuration data and to directly manage any Nexsan device.
3) **Maximize Density and Reliability with Hierarchical Storage:** Nexsan devices support a mix of SSD, SAS, and SATA drives to support a full range of SLA storage requirements with respect to capacity, throughput, access, and reliability.
4) **Maximize I/O Performance:** Sophisticated MPIO options support Asymmetric LUN Access by hosts and biased FC/iSCSI path utilization.

Cloud services first emerged as platforms for running applications in a scalable Internet-accessible virtual environment. Running applications, however, goes hand-in-hand with storing data. As a result, the charter of Cloud services has quickly generalized and expanded to encompass the delivery of resources as a service. In particular, the hot new resource is data storage.

This makes SAN-based storage infrastructure that can scale out in capacity and performance a pivotal resource for Cloud providers. Even in a Web-based resource paradigm with the added latencies associated with Web Service APIs. What makes storage so important is the internal need to meet the data access and throughput requirements of systems running a hypervisor, which concentrate the I/O streams of multiple Virtual Machines (VMs) to create an overall random access pattern at the storage device interface. As a result, optimally performing storage resources are critical for Cloud vendors and the associated capital and operational expenses associated with storage are critical to maximizing their return on investment (ROI).

To meet IT needs at Cloud services sites, Nexsan's storage architecture helps drive IT productivity on two key constructs:

1) **Create a highly scalable storage cloud that can be managed as a single virtual device using Nexsan software.**
2) **Integrate tightly with operating system and hypervisor APIs to allow IT to leverage all productivity features developed by third-party vendors to optimize hosted applications.**

Storage Cloud Configuration Management

To simplify server provisioning in a scale-out storage infrastructure, Nexsan embeds a WEB-enabled Graphical User Interface (GUI) in each storage array. Through this single interface, IT administrators can access all of the Nexsan devices in the storage cloud and provision every server with a hierarchy of logical volumes built from RAID arrays using SAS, or SATA drives. This interface also makes it very easy for IT administrators to leverage Nexsan's MultiSAN I/O architecture.

In particular, an IT administrator can simultaneously map a logical volume to Fibre Channel (FC) and iSCSI ports on the Nexsan device. While an IT administrator typically uses this capability to share logical volumes among local servers via FC and remote servers via iSCSI, an administrator is also free to map a logical volume to a host server via both FC and iSCSI paths. For the latter configuration, Nexsan's sophisticated MPIO option to bias I/O over faster FC paths is particularly important.

Nexsan SASBeast Sequential Access I/O Throughput
Windows Server 2008 R2 — 4Gbps FC SAN

RAID & Disk Type	Read Throughput Iometer benchmark 128KB blocks	Write Throughput Iometer benchmark 128KB blocks
RAID-5 SAS	554 MB/sec	400 MB/sec
RAID-6 SAS	505 MB/sec	372 MB/sec
RAID-5 SATA	522 MB/sec	430 MB/sec

Nexsan's MultiSAN I/O archtecture is particularly important for Cloud resource providers. Cloud data storage services is all about the delivery of virtualized storage on demand and that makes Data Storage as a Service highly dependent on the ability to provide Tier 2 and Tier 3 storage resources to clients. In this regard, Nexsan arrays are particularly well suited to providing a mix of Tier 2 SAS-based storage arrays for actively accessed applications such as ERP and email, along with capacity-centric, Tier 3 applications, such as data warehousing analytics and file backup, which fit well with SATA-based storage arrays.

Users of Cloud-based data storage services access resources using applications based on Web Services APIs. This introduces a degree of latency that essentially rules out Tier 1 storage for transaction processing applications. Moreover, a large number of customers

and potential customers of Cloud-based data storage services are SMB users that need storage virtualization, but have not yet implemented a SAN. These users are most concerned with the Cloud Data Management Interface that they will use to create, retrieve, update and delete data elements from the Cloud. As a result, the primary focus of these users is functional with respect to storage flexibility with respect to configuration and provisioning, as well as storage scalability.

Equally important for IT at Cloud service vendors is the semi-active nature of much of the user data in Tier 3 storage. This makes MAID technology is a good choice for that data. AutoMAID is a key feature provided within the Nexsan management suite. AutioMAID provides for the optimization of up to three power-saving modes, which are applied array-wide depending upon the disk drives used in the array.

Once the disks enter into a power saving mode, they can be automatically restored to full speed with only the first I/O delayed when the array is accessed. More importantly, over the period that we ran extensive tests of sequential and random data access, the power savings for each of our disk arrays was remarkable uniform with an average power savings of 52 percent. These savings were garnered over a period that saw each of the 42 disks in our SASBeast average 1,500,000 reads and 750,000 writes.

Pushing Productivity Up The Stack

Further distinguishing the Nexsan storage cloud is the ease with which it can be optimally integrated into a VMware® vSphere™, Windows Hyper-V, or Windows Azure, which is Microsoft's cloud services operating system for running Windows applications and storing data in a scalable Internet-accessible virtual environment. The key to this optimal integration is adherence to such APIs as vStorage for VMware vSphere and Virtual Disk Service (VDS) and Volume Shadow Services (VSS) for Windows.

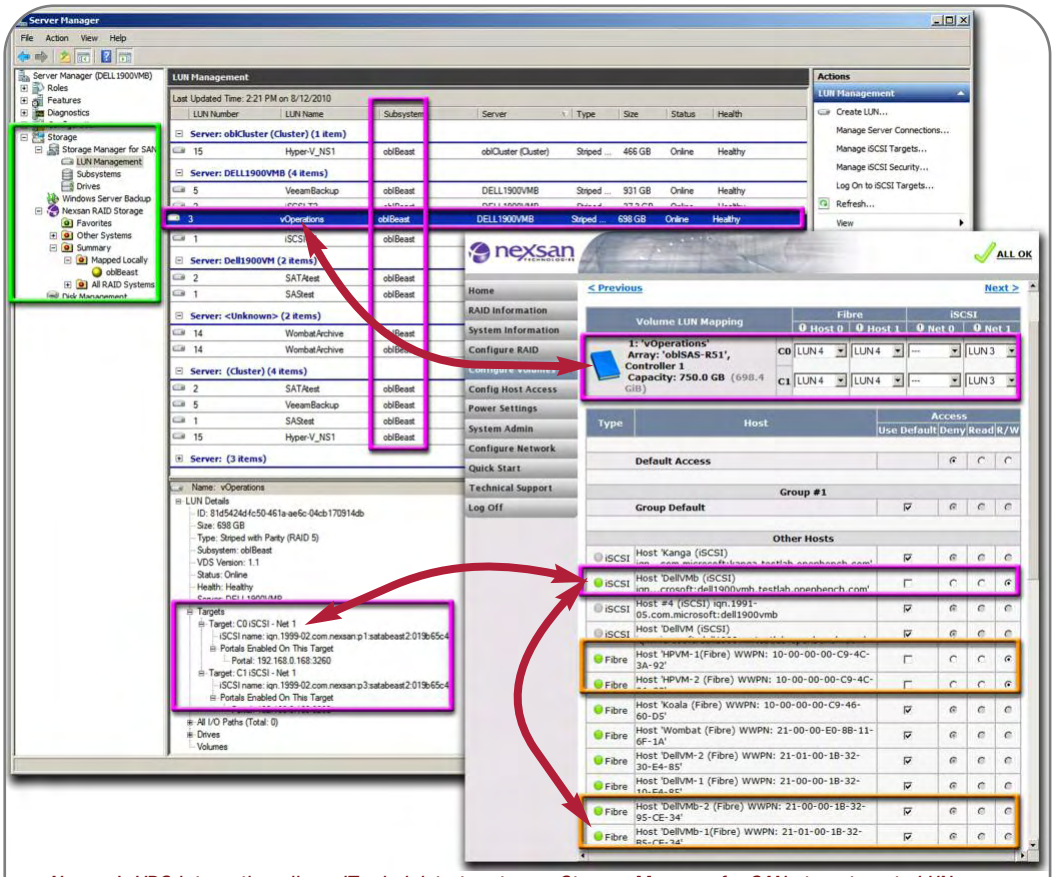
All SAN storage subsystems represent partitions of internal RAID arrays as simple logical disks. To create, manage, and optionally add functionality to logical disks, SAN storage vendors bundle proprietary software with their devices. As a result, storage in SAN fabrics typically evolves into isolated pools of logical disks that require proprietary management processes and reduces IT to managing storage devices as individual assets with out-of-date spreadsheets to represent current resource configurations. Such isolation of SAN resources leaves most IT organizations without a clear set of links needed to tie storage resources with applications and business value.

In a Windows Server environment, which is pegged as representing nearly 75 percent of the 2010 server market, tight integration of Nexsan's device firmware with the Windows OS significantly raises the visibility of Nexsan device configurations and lowers the complexity of storage management tasks for IT administrators. In particular, integration with VDS provides administrators with a single-pane-of-glass interface via the Microsoft® Management Console (MMC). The advantages provided by the ability to call up the Nexsan management GUI via MMC are dwarfed, however, by the end-to-end SAN infrastructure visibility that becomes available to all of the Microsoft management software to simplify management tasks and reduce OpEx costs.

By integrating its storage firmware with Windows VDS, Nexsan provides real-time SAN-wide visibility into the Nexsan storage cloud, including detailed device-specific information on internal arrays and array partitions. As a result, IT administrators gain immediate access to the essential information for SAN management that greatly simplifies all tasks associated with resolving root SAN performance issues. This is particularly important when IT administrators are subject to aggressive SLA constraints on the allowable length of time that a storage resource can be down or perform in a degraded manner.

At a base level, logical disks created on Nexsan devices have extended property sheets that include the name of the specific Nexsan device on which the logical disk was created, the array used within that device, and the internal name of the array partition that was mapped as a LUN. With the majority of IT administrators at SME site relying solely on out-of-date spread sheets mapping logical disks on hosts to array partitions on storage devices, this deep real time storage mapping is an essential resource for IT.

Nexsan Automation Enablement



Nexsan's VDS integration allows IT administrators to use Storage Manager for SANs to automate LUN configuration management. Using Storage Manager for SANs, the tedious seven-stage process of configuring a volume on an array, mapping the volume to a host over an FC or iSCSI fabric, and then formatting the logical disk on the host server is fully automated as a single end-to-end process.

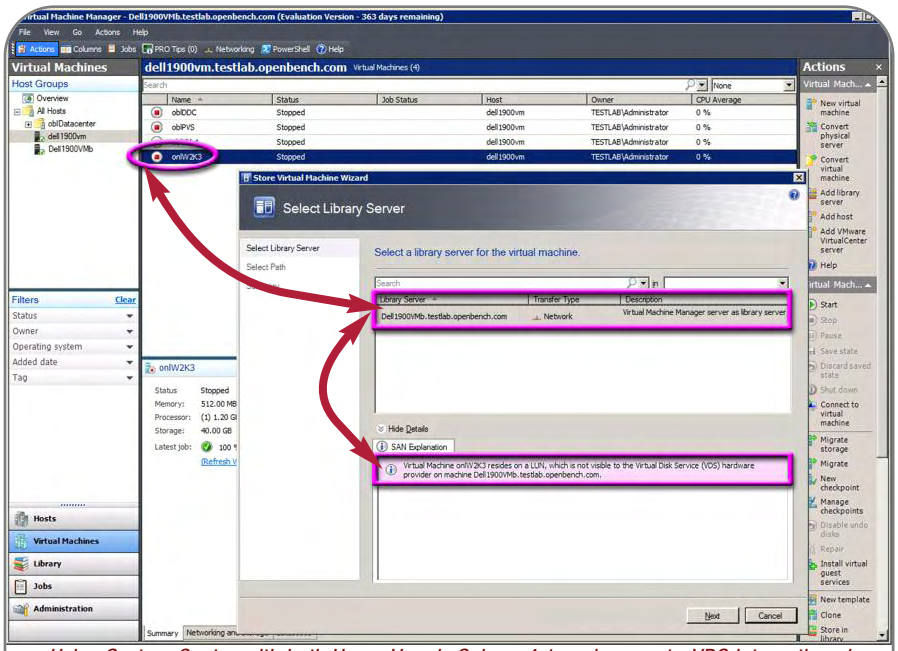
More importantly, VDS integration is a requirement to invoke additional feature-rich management software, such as Storage Manager for SANs. By enabling the use of Storage Manager for SANs with Nexsan devices, Nexsan is able to leverage the Microsoft management stack, including Storage Manager for SANs and System Center

for Virtual Machine Management to provide IT administrators with higher levels of functionality to improve IT productivity.

Managing a Hyper-V Environment

Nexsan's ability to provide configuration insight, management simplification, and task automation through VDS integration are particularly important when implementing a Virtual Operating Environment (VOE) based on Microsoft Hyper-V™. For IT, a VOE introduces a comprehensive virtualization scheme involving servers, storage, and networks. As a result, a VOE also introduces multiple levels of physical device indirection, which can overwhelm IT if the proper software tools are not in place. Reflecting these difficulties, 67 percent of CIOs implementing virtualization reported increased datacenter management complexity in an IDC survey.

VDS Hyper-V Dependency



Using System Center with both Hyper-V and vSphere 4.1 environments, VDS integration also proved to be crucial when moving Hyper-V VMs between Hyper-V Library shares and VM storage pools. When we attempted to move a template VM—oblW2K3—into a shared library volume that was FC attached to the SASBeast from a locale VM store that was FC attached to a storage resource that was not integrated with VDS, the local disk-to-disk transfer had to be made over the LAN rather than directly over the SAN.

In a Hyper-V environment, VM data volumes—like other Windows logical disk volumes—can only be shared within the context of a Windows Cluster with Cluster Shared Volumes (CSVs). As a result, transferring VM disks and configuration data between two stand-alone hosts must be done using network transfers. To utilize SAN transfers, IT needs to deploy additional software, such as Microsoft System Center for Virtual Machine Management (SCVMM).

SCVMM uses VDS to avoid the pitfalls caused by the lack of a distributed lock manager in NTFS. To handle LUN sharing, SCVMM institutes a simple, highly effective, automated process that mounts and dismounts common SAN-based server volumes as VM data files are moved or copied. To make this scheme work, however, all of the logical disk volumes involved must be VDS compliant.

Automating Performance Optimization

While IT overhead is the primary factor in OpEx cost reduction, CTOs at vendors of Cloud services also have to worry about meeting expressed or implied Service Level

Agreements (SLAs) made with customers with respect to service availability. The robust Nexsan hardware architecture provides CTOs with a single platform that can satisfy a wide range of storage performance metrics with respect to access (IOPS), throughput (MB per second), or capacity (price per GB).

What's more, Nexsan storage devices support multiple internal controllers that connect to multiple FC and iSCSI ports in order to provide a high-performance scale-out storage architecture. All of these ports promote comprehensive redundancy to ensure availability. Nonetheless this solution for availability creates a challenge for optimal performance.

Every storage array is mastered by only one internal controller. I/O directed to a port on a controller that is not the array master incurs added overhead needed to switch control of the array. Making matters worse, many arrays simply report device ports as active or passive, which leaves a SAN configuration morass for IT administrators.

Nexsan implements Asymmetric Logical Unit Access (ALUA) when exporting target volumes to the OS or hypervisor running on a host server. The Nexsan device identifies the paths that are active and optimized (i.e. paths that connect to a port on the controller servicing the device) and paths that are active but are not optimized. As a result, an IT administrator can simply expose all LUNs through all FC and iSCSI ports and allow the host and device to implement an optimal path topology.

This is particularly important as mission critical applications used by customers are now being optimized to run within VMs. In particular we configured a VM with two CPUs on a host running the VMware ESX 4.1 hypervisor. We then installed MS Exchange 2010 with two database files on two Raw Device Mapped (RDM) volumes created on a Nexsan storage unit. This configuration easily supported 3,000 active mail boxes in a JetStress benchmark, which imposes a 20ms response time.

The bottom line for Cloud vendors is Nexsan's ability to provide a highly manageable multi fabric SAN infrastructure capable of supporting the performance characteristics that distinguish the I/O patterns of a VOE host server. By complimenting a high performance foundation with sophisticated management software and tight integration with host servers, Nexsan empowers IT to use any advanced VOE features for provisioning VMs, commissioning and decommissioning VM applications, and moving VMs among hosts for on demand load balancing.

Jack Fegreus is Managing Director of openBench Labs and consults through Ridgetop Research. He also contributes to InfoStor, Virtual Strategy Magazine, and Open Magazine, and serves as CTO of Strategic Communications. Previously he was Editor in Chief of Open Magazine, Data Storage, BackOffice CTO, Client/Server Today, and Digital Review. Jack also served as a consultant to Demax Software and was IT Director at Riley Stoker Corp. Jack holds a Ph.D. in Mathematics and worked on the application of computers to symbolic logic.