EQUALLOGIC®
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VIRTUALIZED iSCSI SANS:
FLEXIBLE, SCALABLE ENTERPRISE STORAGE FOR VIRTUAL INFRASTRUCTURES

MANAGEMENT SERIES

iSCSI is a flexible and powerful storage area networking (SAN) protocol that delivers superior capabilities and benefits across all market segments. In addition to providing enterprise-class data availability and performance, the iSCSI protocol enables breakthrough virtual storage designs that parallel the advanced designs of server virtualization technologies such as VMware® Infrastructure 3.

Enterprises of all sizes are building flexible storage infrastructures using iSCSI and advanced virtualization technologies that let them allocate and shift SAN resources dynamically in response to the demands of their virtualized server environments.

This white paper describes a virtualized infrastructure that applies storage and server virtualization technologies to cost-effectively achieve a flexible, high performance, dynamic IT infrastructure that is simple to manage and scale.

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SERVER VIRTUALIZATION

Server virtualization is one of the most significant technology trends in IT today. Managing server hardware and software as separate infrastructure components makes it possible to significantly improve data center operating efficiencies. At a high level, server virtualization works by encapsulating 'guest' operating systems into a set of 'virtual machine' files. The operating system and its unique execution variables and associated data sets are maintained in these files.

Given sufficient memory and disk storage, a single hardware system running server virtualization software can support many guest virtual machines. Applications and data are processed in exactly the same way as in the physical environment, using the same operating system facilities for making system requests. The only difference is that the operating system is now a virtualized guest running in a virtual system environment.

Virtual machine files can be transparently migrated from one server hardware platform to another, giving administrators the ability to allocate and shift physical server resources in response to changes in application workloads. A scalable, highly resilient, flexible server environment is created, resulting in greater resource utilization, greater IT flexibility, and lower operating costs.

STORAGE VIRTUALIZATION

Today, most IT professionals define storage virtualization as a technology that allows discrete storage systems to operate as a single resource. In light of recent advancements in server virtualization, the concept of storage virtualization is being further refined as a way to create an abstraction layer between the storage hardware and logical data volumes.

Given sufficient protocol support (as with iSCSI), virtual storage products are now being designed that allow data volumes to be located and striped across multiple (and diverse) physical storage resources, including storage systems, RAID groups, disk types, and controllers. Not only does this provide higher performance and scalability, it also allows data volumes to be transparently moved from one set of resources to another without disruption to the operating systems and applications that are utilizing data. A scalable, highly resilient, flexible storage environment is formed, resulting in better storage utilization rates and far lower operating costs.
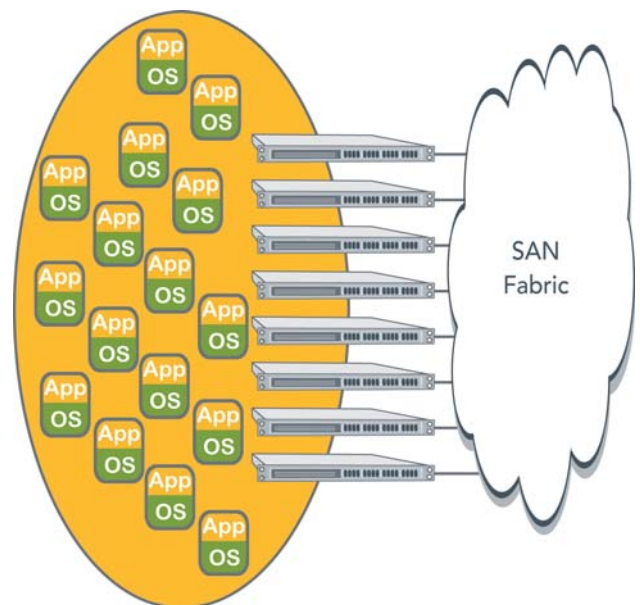
REQUIREMENT FOR NETWORKED ENTERPRISE STORAGE IN A VMWARE INFRASTRUCTURE

In a VMware Infrastructure 3 environment, multiple physical servers are networked into a cooperating set of computing resources (see Figure 1). In lieu of a standard Linux or Windows® operating system, each of the x86 standard servers run a copy of VMware ESX Server™, which provides the abstraction layer between the physical servers and guest operating systems. Multiple ESX servers are organized into an ESX cluster that are controlled and coordinated by VMware's VirtualCenter, a centralized management system.

Within the VMware environment, a virtual machine's configuration parameters, operating system, data sets, and applications are encapsulated in a set of files managed by the VMFS file system. VMFS is a clustered file system that coordinates access across ESX servers, enabling the ability to migrate live virtual machines across systems in the ESX cluster.

The power of this architecture comes from the ability to run any guest OS, its applications, and its data without modifying any physical server in the cluster. As the need arises, additional server resources can be non-disruptively added to the ESX server cluster, and current workloads are load balanced to take advantage of the newly available resources.

FIGURE 1: ESX Cluster with SAN Storage

WHAT IS iSCSI?

Developed by the Internet Engineering Task Force (IETF), iSCSI is a standard storage access protocol for interconnecting servers and storage using an IP-based network interconnect. iSCSI is built upon the SCSI and TCP/IP protocols, the dominant standards for storage and networking in use today. iSCSI is recognized for its simple integration, interoperability, fundamentally lower costs, and its ability to leverage an organizations' inherent networking skills for quick and broad adoption.

Software-based initiators, generally available for all major operating systems at minimal or no cost, take advantage of standard Ethernet interfaces included as basic features of servers and desktops, enabling widespread deployment. Easy access to this technology at little to no cost, coupled with the application of pre-existing IP networking skills fundamental to today's IT organizations, provides for easy, affordable, and rapid adoption of iSCSI technology.

Using an ordinary IP network, iSCSI transports block-level data between an iSCSI initiator on a server and an iSCSI target on a storage device. The iSCSI protocol encapsulates SCSI commands and assembles the data into TCP/IP packets sent over the network using a point-to-point connection. Upon arrival at the storage device, the encapsulated SCSI commands are unpacked from the TCP/IP packet for processing.

When an iSCSI initiator connects to an iSCSI target, the storage is seen by the operating system as a local SCSI device that can be formatted as usual. The process is transparent to applications, file systems, and operating systems. By consolidating storage with an iSCSI Storage Area Network (SAN), multiple platforms can share the same storage, greatly improving utilization and efficiency.

The opportunity to use a standard Gigabit Ethernet NIC to connect servers to storage makes iSCSI both simple and affordable. Today's high speed CPUs can run iSCSI at line speed over standard NICs using only a marginal amount of CPU. Onboard Gigabit Ethernet NICs ship standard with servers, so no additional cost is incurred and the administrator need not bother with installing adaptor cards.

Together, standard NICs and the lower cost of Ethernet switches offer a compelling cost savings over Fibre Channel, while maintaining the performance advantages of a SAN. However, the savings are not limited to the hardware costs alone. With iSCSI, IT departments leverage their existing IP networking expertise, without needing specially trained staff. This familiarity with the network infrastructure eliminates a key problem of complexity associated with Fibre Channel SANs.

Effective VMware deployments depend on shared access to storage – in other words, a SAN. SANs ensure that each ESX server has immediate access to any virtual machine's data sets, enabling immediate re-hosting of the virtual machine. This eliminates the unacceptable and time consuming necessity of copying virtual machine files, applications, and data from one ESX server to another.

SANs support powerful features within VirtualCenter – these include VMotion, the online migration of active virtual machines without interruption, and Distributed Resource Scheduling (DRS), which monitors and automatically migrates virtual machines to balance workloads across all resources within the ESX cluster. VMware HA monitors the proper functioning of ESX servers within the cluster, and in case of an ESX server failure, re-hosts and restarts virtual machines affected by the failure onto another ESX server within the cluster.

In addition to the requirement for networked storage, a virtualized environment heightens the need for high performance, highly available, resilient storage to meet the needs of the aggregation of workloads. As more critical applications, production workloads, and data assets are consolidated into fewer resources, greater is the need for high performance, non-disruptive scalability, and continuous availability of the storage assets. Enterprise-class storage, designed for mission critical deployments is a basic requirement when building a virtualized IT infrastructure.

In particular, purpose-built storage architectures should be deployed that include mirrored memory write caches, fully-redundant hot-pluggable components, online hot spare disks, environmental monitoring, and enterprise-class disk drives with RAID protection. Furthermore, advanced availability features including storage controller and I/O path failover are required to guarantee data access even in the case of component failure.

Consideration should also be taken to evaluate the data protection software features enabled within the storage system. Storage consolidation within a SAN enables the consistent application of data protection and disaster recovery, assuming the basic SAN-based tools are available and enabled. Space-efficient, non-intrusive snapshot-based point-in-time copies as well as efficient array-based replication tools should be considered as basic requirements of the storage infrastructure for a virtualized environment. Multiple use cases exist for the application of these tools in virtualized environments including disaster recovery, online backup and quick recovery of virtual machines, simple extraction of lost or corrupted data files, rapid virtual machine and data set provisioning using snapshots and clones for production and temporary use, as well as server-less tape- and disk-based backup and recovery of the organization's data assets.

A thorough evaluation of the storage platform should be considered prior to deployment, reflecting not only upon the robustness and feature set, but also the total cost of ownership over its useful life, with particular consideration of the required system growth in terms of both performance and capacity.

ESX SERVER AND iSCSI
With the advent of VMware Infrastructure 3, iSCSI initiators are integrated into the ESX kernel, allowing native access to iSCSI storage directly from ESX Servers. Both hardware initiators (QLogic™ QLA4052C) and software initiators are available. NIC teaming (multiplexing a single logical connection across multiple interfaces) is supported with the software initiator. The hardware initiator includes support for multi-pathing as well as boot from SAN.

iSCSI support broadens the potential for full-fledged VMware infrastructure deployments in the small and medium business market segment by obviating the need for a costly and complex Fibre Channel SAN deployment. The acquisition, implementation, and operational cost of an iSCSI-based SAN are intrinsically lower, removing an economic barrier to the adoption of server virtualization technologies. In addition, but far less well recognized, is the opportunity for advanced iSCSI-based system architectures to dramatically change customer expectations in mid-market and enterprise deployments as well.

The addition of iSCSI protocol interfaces to classic storage system designs do not fully exploit the potential of the iSCSI protocol and, in turn, do not adequately solve the storage management challenges faced today by IT managers. Even with the introduction of iSCSI, the storage administrators of classic storage system designs require a rarified level of knowledge for configuring and tuning storage arrays, RAID geometries and data layout considerations, application workload analysis, forced data migration and complex system upgrades.

HOW iSCSI ENABLES VIRTUALIZED SANS
Storage virtualization can simplify provisioning and ongoing management, increase storage utilization, provide unlimited scalability in capacity and performance, and enable online migration of data sets among controllers and storage tiers. By consolidating network-based storage into a simple, flexible, consolidated pool of storage that can arbitrarily grow in capacity and performance (as in an EqualLogic environment), storage virtualization is a key enabler for simplifying a virtualized IT infrastructure.

Historically, the adoption of storage virtualization technologies in SAN environments has been limited, primarily to enterprise data centers needing a tool for online data migration between heterogeneous storage environments. This add-on design allows for heterogeneous storage and data movement, but does not simplify management of the configuration. Most of these designs have been implemented as external appliances sitting within the storage area network. These devices generally add more complexity to an already complex environment – introducing additional points of management within the SAN, masking value-added features of the attached arrays, and limiting performance and scalability of the consolidated SAN storage pool to a single gateway hosting the backend storage. In the iSCSI realm, simpler design alternatives make the promises of storage virtualization easier to achieve.

The most advanced storage virtualization technologies offer the ability to virtualize storage at the storage device level. This approach achieves scalable performance and capacity and reduces overall management by aggregating

multiple controllers into a cooperating set of resources, i.e., virtualizing volumes not only across disks within a controller but also across storage systems in a SAN. EqualLogic PS Series storage arrays are an excellent example of such a "scale-out" architectural design. Ironically, despite their elegant simplicity, such designs are virtually non-existent in the Fibre Channel SAN world, primarily due to architectural constraints inherent in Fibre Channel network deployments.

Devices in a Fibre Channel SAN are attached to the network via a World Wide Name (WWN), a physical port address specifically assigned and encoded within the device hardware/firmware. World Wide Names are assigned for all devices within the SAN, including each physical port within each host server and each physical port within the storage controllers. Furthermore, data paths between the hosts and the storage array are statically set when the host is added to the SAN.

Herein lies the inflexibility of Fibre Channel SANs. The topology of the SAN is intrinsically hard coded into the environment, making changes within the infrastructure burdensome, time consuming, and error-prone. Expansion of resources in the host, fabric, or storage layer propagates changes throughout the infrastructure, causing intrusive downtime to the applications and infrastructure.

In contrast, TCP/IP networks support virtual addressing and dynamic routing, whereby paths through the network are not statically defined. With DHCP, addresses can be dynamically assigned, or through address proxying, physical addresses can be virtualized, making it possible for devices in the network to transparently act on the behalf of other devices on the network. If the IP address of the resource being accessed is known from within the network, the entity (such as a SAN initiator) requesting access can find the resource dynamically without prior knowledge of the paths or the resource's physical address.

IP address proxying makes storage access fully virtualized across multiple EqualLogic storage controllers. In an EqualLogic group, for example, each member array has 3 active physical gigabit Ethernet ports. A 4-member group has a total of 12 active Ethernet ports, providing 12 Gb/second of peak bandwidth. Each of these Ethernet ports is assigned an IP address. The members within the group are aware of and coordinate use of these multiple IP addresses and the underlying physical resources.

External access to the group by all hosts within the SAN is exclusively addressed via the group IP address, a unique IP address that transcends all the underlying member IP addresses. The only IP address known by the attached hosts in the SAN infrastructure is the group IP address. All I/O's may be serviced by any physical gigabit Ethernet port.

Shielding host systems within the SAN from being aware of the physical topology of the storage serving its data is vitally important, particularly in a virtualized server environment. By virtualizing all physical I/O ports, a flexible storage utility is created. Pooling storage assets within the SAN is now possible, enabling a rich set of features to maximize storage utilization and effectiveness, extending beyond the limitations of a single, physical end-to-end connection to a single storage controller.

Data is accessed by the host without intimate knowledge of where in the storage utility the data is stored, providing the opportunity for data volumes to span controller boundaries and exploit the combined resources of multiple controllers. Controllers coordinate among themselves to balance workloads and optimize storage resource utilization.

Changes in storage infrastructure can be achieved seamlessly, without impacting host connectivity or data access. The iSCSI-based infrastructure can be scaled non-disruptively, automatically applying the resources of the additional controllers and disks to extend performance and capacity. Multiple tiers of storage can be seamlessly integrated in the utility, providing for automatic placement of data within a volume to the appropriate tier based on the volume's access patterns.
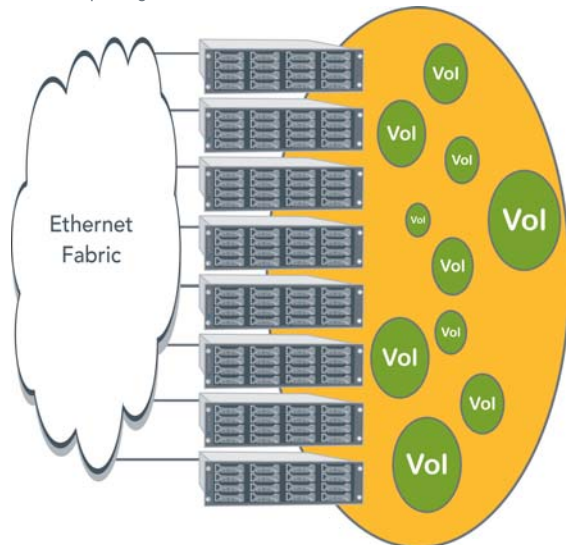
A flexible storage architecture as described above is particularly appealing in a virtualized server environment as the "scale out" architectures of both server and storage infrastructures uniquely complement each other, providing an end-to-end virtualized infrastructure. Deployed together, IT managers achieve an infrastructure that is particularly adaptable to changing business requirements by providing non-disruptive workload migration and balancing across all physical resources (both storage and server resources) as well as online resource expansion that immediately apply to pre-existing server and storage workloads without intervention and tuning.

EQUALLOGIC VIRTUALIZED iSCSI SANS

A virtualized iSCSI SAN complements – and is characteristically equivalent to – a VMware ESX server farm.

The foundation of an EqualLogic virtualized iSCSI SAN (see figure 2) is the PS Series storage array. Each array is fully-redundant, containing disks, multiple high-performance network interfaces, redundant controllers with mirrored battery-backed caches, and other advanced features. The disks are automatically protected with RAID (RAID 10, RAID 50, or RAID 5) and hot spares. Multiple models of arrays exist, leveraging high performance 10K and 15K RPM SAS drives or more cost effective, higher density SATA-II drives.

FIGURE 2: EqualLogic Virtualized iSCSI SAN

A PS Series storage group is comprised of a single PS Series array or multiple arrays. A group is a virtualized resource, appearing to ESX servers as a single entity that offers network storage access to a single large pool of storage – a storage area network (SAN) composed of a single, virtually scalable, high performance storage system. Unlike a conventional SAN, in which multiple controllers appear as independently managed islands of storage, each group member in an EqualLogic SAN "cooperates" with other members to automate resource provisioning and performance optimization.

ESX administrators create data volumes from within the EqualLogic group storage pool. The group exports its volumes as iSCSI targets protected with security, including authentication and authorization. Upon connection, ESX servers work with EqualLogic's volumes as VMFS DataStores, which contain multiple virtual machines and virtual disks. A variation on this is a Raw Device Map in which the SAN-resident volume is mapped directly to correspond to a virtual disk within the ESX environment, circumventing the VMFS DataStore. A third alternative is to employ the native iSCSI software initiator of the individual guest operating system to connect directly to the SAN-resident volume.

AUTOMATIC LOAD BALANCING

Volumes are distributed among the group's member arrays, with data placement and access continually adjusted for optimal performance as resources are added or workloads change. When an array is added as a group member, its disk space is added to the group's storage pool. Volumes are automatically re-striped and distributed across all the members of the storage pool. Controller resources are also dynamically adjusted based on the workloads being generated by the ESX server farm. Data and network I/O to the group are automatically load balanced across the group members' resources.

As capacity and performance requirements increase, a group can be scaled linearly in both capacity and performance – all while online. New members "learn" configuration and performance information from the group – with no manual intervention. Data and client connection load balancing occur automatically as the group scales. I/O activity is monitored, and data and network connections are adjusted as needed.

NON-DISRUPTIVE SCALABILITY

The scalability model allows for automated, online expansion in all storage dimensions, and the PS Series architecture nearly eliminates downtime caused by expanding or managing a storage system. Because capacity can be added so easily, IT managers need to buy only the storage necessary for today's applications, easing budget constraints caused by excessive purchases.

Additional benefits of the virtualized SAN environment include the transparent application of storage tiers. EqualLogic storage groups can use multiple storage tiers contained within the storage pool and automatically optimize data placement based on workload. Alternatively, storage tiers may be segmented into independent resource pools to guarantee specific resources to specific workloads, concurrently maintaining the flexibility to migrate volumes online from one tier to another, fully transparent to the ESX host servers.

END USER CASE STUDY: COSTAR GROUP, INC.

CoStar Group, Inc., based in Bethesda, MD, is recognized as the number one provider of information services to commercial real estate professionals throughout the United States as well as in the United Kingdom and France. Every day industry professionals throughout the U.S., U.K. and France depend on Internet access to CoStar's services, tools and analytics as their business information lifeline. Today, CoStar's database contains over 2.3 million verified and continuously updated commercial properties representing more than 40 billion square feet of inventory as well as over 800,000 properties actively being marketed for sale or for lease.

With more than 13,000 client sites and approximately 75,000 subscribers to CoStar's online database, a robust, scalable IT infrastructure is vital to the company's success and future growth. Consequently, CoStar is always looking for ways to enhance and simplify its technology infrastructure.

CoStar turned to virtualization to reign in an expanding IT footprint and reduce management costs. The company built a virtualized IT environment based on VMware Infrastructure 3 and an EqualLogic PS Series virtualized iSCSI SAN as a key element of their infrastructure.

By leveraging both server and storage virtualization, CoStar has architected a solution to reduce its IT footprint, increase responsiveness for provisioning new IT assets, simplify the ongoing management of both servers and storage, and seamlessly scale their infrastructure over time.

VIRTUALIZED SERVERS
The production environment includes 8 ESX Servers based on dual & quad-processor, dual-core Opteron-based servers each with 24 to 32 GB's of RAM in support of a phased rollout of more than 200 virtual machines. Three additional ESX Servers are dedicated to test and development. Qlogic QLA4052C iSCSI HBAs are configured in each of the ESX Servers to enable SAN boot capability, Jumbo Frames support, and reduced I/O processing overhead.

At present, 115 virtual machines are in production, hosting a variety of Windows Server 2003R2-based applications including SQL databases, time accounting, source control, helpdesk applications, data creation and management tools, and internal back office processing. VMware's VMotion and High Availability (HA) features are actively used for workload balancing, proactive maintenance, and increased application availability.

VIRTUALIZED STORAGE
The storage backbone of the VMware infrastructure is an EqualLogic virtualized iSCSI SAN, connected with the ESX Server environment over a fully redundant gigabit Ethernet fabric. Comprised of 5 EqualLogic PS3600X arrays, the EqualLogic group contains 80 high performance, 10K RPM Serial-Attached SCSI (SAS) disks configured as RAID-50 with hot spares, for a total usable capacity more than 15 terabytes. Currently, the 11 ESX Servers access nearly 4 TB's of provisioned storage, configured as 8 VMFS file systems and 11 ESX boot volumes, all resident on the EqualLogic SAN. Each VMFS file system's data volume is auto-load balanced across the 5 member arrays and all the disk drives in the SAN. The aggregation of workloads from across 100 virtual machines in the 8-member ESX Server cluster produces a random workload profile that particularly benefits from the multi-controller architecture and aggregate performance of the large number of fast spinning drives.

FUTURE DIRECTIONS
Future expansion of CoStar's virtualized infrastructure will include the rollout of an additional 100 virtual machines, including their Exchange environment and additional SQL Server databases. CoStar is also planning to add a second tier of virtualized storage; the EqualLogic group will be expanded online to include two additional SATA-II-based PS400E arrays as a 20 terabyte secondary storage pool. The EqualLogic instant cloning and online volume migration features will be used to quickly generate test and development environments from production data.

Additional focus will also be placed on disaster recovery processes; a second EqualLogic group, comprised of 2 PS3600X arrays, is already in place as the disaster recovery target for the VMFS file systems. Using EqualLogic's autoreplication feature, the production VMFS volumes are being replicated to the EqualLogic group at the corporate DR site.

QUICK, INTELLIGENT PROVISIONING

Within the EqualLogic environment, storage is quickly provisioned simply and easily with the click of a button. The key functions needed to configure, manage and scale storage is automated, cutting administration tasks for volume and capacity growth. Given the intelligence built into the PS Series software, decisions with respect to RAID type and data layout are made automatically at time of provisioning, and optimized as workload patterns for the newly provisioned storage evolve. As new resources become available, the resources are automatically applied where and when needed. By eliminating complex tasks and enabling fast and flexible storage provisioning, PS Series solutions dramatically reduce acquisition and ongoing operational costs and make enterprise class shared block storage practical for the mid-range storage market.

Thin provisioning extends EqualLogic's existing provisioning features. This makes the buy-as-you-grow storage model of the modular PS Series more seamless for servers and applications. Thin provisioning is an important advanced feature which enables the automatic addition of physical capacity on demand up to preset limits. With advanced thin provisioning, buy-as-you-grow storage management and virtualization are made seamless for servers and applications. When a volume is created, it can be sized for the long term needs of the application without initially allocating the full amount of physical storage. Instead, as the application needs more storage, capacity is allocated to the volume from a free pool.

EqualLogic's thin provisioning capability provides extensive flexibility and user safety controls. These include the ability to turn thin provisioning on and off as needed for any volume. This allows users to affordably test the most suitable applications and volumes for thin provisioning, with the knowledge that they can return to "normal" provisioning online. EqualLogic's implementation of thin provisioning also provides enhanced alerts and controls – with proactive, user-defined threshold alarms and controls, administrators can depend on automatic space allocation without worrying about reaching allocation limits or unexpected depletion of physical storage.

AUTOMATED MANAGEMENT

The PS Series architecture is designed to simplify storage management in several ways. RAID configuration and hot sparing is automated, and dynamic storage and network I/O load balancing occurs automatically as resources and performance metrics change. No longer must administrators manually map application data to specific physical devices and controllers.

A primary benefit of this automated, virtual storage system is that storage administration remains stable as the group is expanded. All administration is performed at the group level, through the EqualLogic Group Manager, an intuitive, single-pane administrative console. Because the group is managed as a single logical system, the ongoing operational costs of storage management remain fixed even as storage grows.
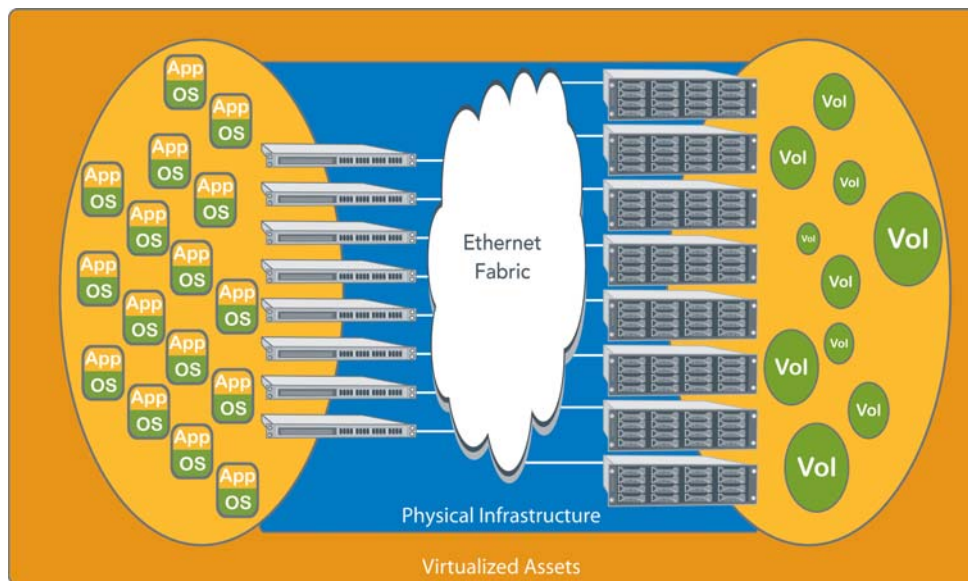
A FLEXIBLE, SCALABLE, VIRTUALIZED ENVIRONMENT FOR SERVERS AND STORAGE

iSCSI is a key technology enabling scalable, cost-effective, high performance virtualized SAN environments, a perfect complement to a virtualized server environment. The storage virtualization achieved in the advanced iSCSI-based design of the EqualLogic PS Series enables greater performance, scalability, ease of use, and flexibility in contrast to classic storage array architectures. As a result, both server and storage assets become fully virtualized (see Figure 3), abstracted from the physical hardware upon which they reside. Virtualized server assets leverage a pooled set of physical server resources. Similarly, virtualized storage volumes leverage a pooled set of physical storage resources.

By combining virtualized server and virtualized storage technology, a simple, flexible IT infrastructure is created, resulting in a comprehensive solution with a common set of benefits, resulting in increased IT flexibility, lower total cost of ownership and reduced complexity. These benefits include:

- Aggregation of Virtualized Assets on Consolidated Hardware – Operational procedures and best practices can be standardized and consistently applied to both storage and server assets (both physical and virtual) resulting in a more resilient infrastructure with greater resource utilization, higher levels of service, and enhanced protection of information assets.
- Simple, Centralized Management – Greater management efficiencies are achieved by centralizing management through intuitive, graphical management tools accessible from anywhere on the network, providing a comprehensive view to provision, monitor, and manage the entire virtualized infrastructure.
- Flexible and Quick Deployment of Virtualized Resources – Organizations can quickly adapt to changing and growing business needs by reducing the time to provision and deploy new applications via quick provisioning methods available for both servers and storage.

FIGURE 3: Virtualized Servers Meet Virtualized Storage

- Online, Non-disruptive Resource Re-allocation and Expansion – As workflows and business priorities change, both storage and server resources can be simply re-allocated online, with no disruption to operations. In addition, physical resources can be easily expanded online without downtime. Workloads are automatically rebalanced across these newly available resources without disruption to applications.
- Common IP Network-based Infrastructure – The IT environment is simplified by basing all operations on IP networking, including the interconnect for client access, inter-server communication, storage access, and off-site data replication. The organization's inherent IP networking expertise is leveraged, resulting in lower training and ongoing management costs.
- Enterprise-class Resiliency – With redundancy built into the physical server, network, and storage architecture, as well as component failure detection and failover software implemented within each layer of the infrastructure, overall reliability, availability, and service levels are enhanced.
- Advanced Data Management and Disaster Recovery – A rich set of server and SAN-based data protection tools ensure the organization's critical assets are protected and immediately recoverable at the local or a remote site.

SUMMARY

Virtualized iSCSI SANs are changing customer experiences of how simple an enterprise storage infrastructure can be to deploy, manage, and grow. They are uniquely positioned to enable broad adoption of virtualized server technologies by reducing technical complexity and cost barriers imposed by classic storage area network architec-

tures, without compromising the performance, scalability, and resiliency requirements of a virtualized IT infrastructure. As a result, organizations of all sizes are now deploying EqualLogic PS Series virtualized iSCSI SANs as the backbone of their virtualized infrastructure.

Characteristically, both server and storage virtualization provide key features for reducing complexity and increasing flexibility, including virtualized asset management, incremental online growth, workload migration, and load balancing. The complementary effects of EqualLogic virtualized iSCSI SANs and virtualized server technologies enable a simple, cost-effective, and dynamic enterprise-class IT environment.

For more information regarding EqualLogic solutions, contact us at 888-579-9762 ext 7792 or visit www.equallogic.com.

For more information on EqualLogic solutions in a VMware environment, visit www.equallogic.com/vmware.

For a live, web-based product demonstration, visit www.equallogic.com/demo.

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