Enterprises in a wide range of fields are searching for simple, cost-effective ways to manage their ever-increasing storage capacity requirements. The rise in e-mail traffic, the proliferation of large multimedia files, and the move toward server virtualization are all contributing to the need for increased storage capacity. At the same time, government regulations—such as the Sarbanes-Oxley Act and the Health Insurance Portability and Accountability Act (HIPAA) in the United States as well as regulations from around the world that affect global enterprises—are forcing organizations to rethink their approach to storage. Storage area networks (SANs) that use the Internet SCSI (iSCSI) protocol can provide organizations with a cost-effective, consolidated, and flexible storage environment to meet the growing demand for storage capacity while facilitating the transformation to a virtualized data center.

SANs, which provide servers with a single shared pool of storage, offer distinct advantages over dedicated direct attach storage (DAS) systems. For example, even with the increased scalability of advanced DAS systems such as the Dell PowerVault™ MD3000 modular disk storage array, scaling DAS capacity can be expensive, and only a handful of servers may be able to share the same storage resource. In contrast, organizations can scale SANs easily and cost-effectively simply by installing additional storage devices and SAN network resources.

Although the DAS distance limit of 6 meters (19.7 feet) is sufficient for in-stack connectivity, that limitation can make connecting servers on different racks a challenge. SANs can be located long distances from the LAN, helping simplify data center and storage centralization efforts while offering geographical redundancy for disaster recovery.

Many organizations are also turning to SANs because of their ability to simplify provisioning and ongoing storage management. For example, the ability to boot servers from a SAN can dramatically reduce administrative burdens. Booting from a SAN can help accelerate distribution of OS images and updates as well as recovery from server failures, allowing administrators to boot a spare server in place of a failed or unavailable one instead of going through the time-consuming process of retrieving boot data or restoring the server from tape or CD.

In addition, SANs provide opportunities for centralized storage management. When all data is stored on a SAN, administrators can manage that data from a single console to greatly simplify the processes of provisioning, reconfiguring, and restoring server data. With the appropriate management tools, administrators can balance workloads so that high-demand applications with frequently used data do not overload some servers while leaving others idle.

**iSCSI helps reduce costs, simplify management, and enhance flexibility**

In the past, SANs have typically been implemented using a Fibre Channel fabric. Fibre Channel technology can provide...
exceptional performance for extremely heavy transaction processing or high-speed, large-block data transfers. Nevertheless, deploying a Fibre Channel SAN can be too costly for some organizations. Fibre Channel SANs require the use of Fibre Channel host bus adapters (HBAs), which connect the servers to devices on the SAN, as well as specialized switches or routers that connect to the various storage devices. The servers, meanwhile, still require network interface cards (NICs) to provide Ethernet connectivity. In addition, the processes of installing, maintaining, and operating a Fibre Channel SAN require an IT staff with specialized skills and knowledge.

iSCSI offers a cost-effective, simplified alternative to Fibre Channel. Because iSCSI encapsulates SCSI commands in TCP/IP packets and enables block data transport over IP networks, administrators can implement iSCSI SANs using standard, familiar, and relatively inexpensive Ethernet NICs, switches, and cabling (see Figure 1).

The Ethernet and TCP/IP compatibility of iSCSI SANs also enables greater geographic flexibility than a Fibre Channel system. Whereas Fibre Channel connections are limited to 10 kilometers (6.2 miles), an iSCSI SAN can be accessed from anywhere in the world that has Internet connectivity. As a result, organizations can use iSCSI SANs to provide storage access to geographically remote field offices, branch offices, and stranded servers. At the same time, iSCSI SANs enable enterprises to optimize storage centralization and enhance disaster recovery for data centers.

Of course, the emergence of iSCSI SANs does not mean that enterprises should abandon their Fibre Channel SANs. In fact, iSCSI and Fibre Channel SANs can easily coexist. Dell/EMC SANs, including Dell/EMC CX3 series arrays, offer dual-mode Fibre Channel/iSCSI technology to enhance flexibility. With dual functionality, organizations can cost-effectively expand their existing SANs by creating tiered host connectivity based on performance requirements and introducing the familiar, cost-effective Ethernet network components of an iSCSI SAN as appropriate.

iSCSI software initiators help facilitate iSCSI SAN adoption

The growing availability of iSCSI software initiators in popular server operating systems is helping spur adoption of iSCSI SANs. Software initiators perform the necessary functions to send SCSI packets over TCP/IP and Ethernet networks. By using operating systems with iSCSI software initiators, administrators can avoid relying on expensive HBAs and third-party network stacks, which also helps eliminate interoperability issues. Certified and standardized

**INTEL PRO/1000 SERVER ADAPTERS**

Intel PRO/1000 server adapters, available in single-, dual-, and quad-port configurations, help deliver cost-effective, streamlined implementations of iSCSI SANs while enabling dedicated I/O bandwidth and Gigabit Ethernet performance. The multi-port adapters enable administrators to segment network traffic while conserving PCI or PCIe slots. Intel PRO server adapters can also help alleviate host overhead by moving work to the network card. In addition, built-in diagnostic capabilities can help administrators increase application availability. For more information about Intel PRO/1000 server adapters, visit www.intel.com/network/connectivity/products/server_adapters.htm.

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This term does not connote an actual operating speed of 1 Gbps. For high-speed transmission, connection to a Gigabit Ethernet server and network infrastructure is required.
initiators in the OS enable administrators to use standard Ethernet switches and NICs for iSCSI SANs, such as the Intel PRO/1000 server adapter family (see the “Intel PRO/1000 server adapters” sidebar in this article).

Remote boot capabilities further simplify iSCSI SAN management

In addition to offering a cost-effective alternative to HBAs and third-party network stacks, Intel PRO/1000 server adapters for PCI Express (PCIe) now offer iSCSI SAN remote boot capabilities. Remote boot functions can help administrators create a consolidated and virtualized server environment with centralized management and enhanced disaster recovery capabilities. Figure 2 illustrates a typical iSCSI boot process.

Detaching the OS image and data from the physical server is a critical step in creating a flexible virtualized data center with both shared pools of storage (in a SAN) and consolidated virtualized servers. iSCSI remote boot capabilities make it easy to connect the OS image to a different server quickly. iSCSI also enables easy migration of virtual machines (VMs) to a different physical server for load balancing.

The remote boot capabilities offered by Intel PRO/1000 server adapters can help administrators establish a centralized management environment. By storing OS images on a SAN, administrators can streamline server provisioning and management. In addition, booting from the SAN enables administrators to easily deploy upgrades and patches to servers, requiring them to perform those upgrades only on the central OS image instead of the multiple individual OS images on servers’ direct attach disks.

Remote boot capabilities also enhance and accelerate disaster recovery. Administrators using a SAN with remote boot capabilities can easily duplicate the boot information, OS image, applications, and data on the remotely located SAN. If a server fails, administrators can simply boot a spare or new server from that remote SAN (see Figure 3). Because iSCSI SANs can be located anywhere that Internet connectivity is available, organizations can help ensure that the disaster recovery data centers are sufficiently far away from the primary data center, helping protect against catastrophic events.

Intel has led the way in working with major OS vendors to provide remote boot capabilities for standard LAN adapter cards with OS iSCSI initiators. As a result, the Intel PRO/1000 remote boot capability for PCIe adapters is designed to work with many major operating systems, including Microsoft® Windows Server® 2003 with Service Pack 1 (SP1) and Microsoft iSCSI Software Initiator 2.02, Red Hat® Enterprise Linux® 4 Update 3 and later with Linux iSCSI initiators, and Novell® SUSE® Linux Enterprise Server 9.0 with SP3 and later with Linux iSCSI...
initiators. The remote boot ROM code is also available from Intel at www.intel.com/network/connectivity/products/iscsiboot.htm.

Intel I/OAT enhances iSCSI SAN performance

When iSCSI was introduced, some organizations were reluctant to adopt it because they were concerned that the increased overhead from TCP/IP packet processing would impede throughput. Today, the availability of processor acceleration technology can help alleviate this overhead and increase throughput without significantly adding to the cost of the SAN. Included in Intel Xeon® processor–based Dell PowerEdge servers, Intel I/O Acceleration Technology (Intel I/OAT) provides an easy way to enhance I/O performance in iSCSI SAN environments.

Developed to address I/O bottlenecks, Intel I/OAT is a platform-oriented approach that comprises processor, chipset, motherboard, LAN silicon, and software components. This technology, which is now available on dual-core and quad-core Intel Xeon processor–based Dell PowerEdge servers, addresses I/O processing aspects that can burden the processor, including system overhead, memory access, and TCP/IP processing. Intel I/OAT is designed to offer system-wide increases in I/O performance through minimized system overhead as a percentage of processor use, fast memory access, and highly efficient packet processing, helping decrease overall I/O overhead as application packet size increases (see Figure 4).

At the same time, Intel I/OAT helps streamline system administration. For example, Intel I/OAT preserves key network configurations, such as teaming and failover, helping avoid the OS or application modifications that can be required when implementing other technologies that attempt to enhance processor performance. Intel I/OAT also offers OS flexibility by supporting both the Microsoft Windows Server 2003 OS and leading Linux distributions. And importantly, Intel I/OAT is supported by all Intel PRO server adapters for PCIe, helping administrators realize the iSCSI SAN advantages of those adapters while minimizing processor utilization.

![Figure 4. Typical example of relative system overhead, memory access, and TCP/IP processing utilization for increasing application I/O sizes using Intel I/OAT](image)

**Dell servers with Intel PRO server adapters offer outstanding iSCSI SAN performance**

Several Dell PowerEdge servers offer the option of adding Intel PRO/1000 server adapters for PCIe, helping provide cost-effective iSCSI connectivity with remote boot capabilities for iSCSI SANs. For example, the Dell PowerEdge 6800 server can be equipped with single-, dual-, or quad-port Intel PRO/1000 server adapters for PCIe, which support Intel I/OAT to help relieve processor overhead and increase iSCSI traffic throughput. The PowerEdge 6800 server combines high-performance technologies, such as second-generation dual-core Intel Xeon 7100 series processors, with management tools and storage features designed for critical database environments.

The Dell PowerEdge 2950 server provides a rack-dense configuration that can include single-, dual-, or quad-port Intel PRO/1000 server adapters for PCIe. The PowerEdge 2950 server is designed to deliver high performance with 64-bit quad-core Intel Xeon processors along with internal expandability (by adding drives or integrating additional PCIe and PCI Extended cards), all in a 2U enclosure.

The drive for increased storage capacity is unlikely to wane anytime soon. With the advent of iSCSI software initiators and iSCSI remote boot capabilities, iSCSI SANs now provide viable storage options with numerous potential benefits. For many organizations, iSCSI SANs can help reduce storage costs while streamlining management and enhancing flexibility. Dell PowerEdge servers with Intel PRO/1000 server adapters for PCIe can help enterprises realize the promise of those iSCSI SAN environments.

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