Xsan 2

Technology Overview
March 2008

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Introduction

Xsan benefits

- **Storage consolidation.** Pool data across multiple RAID arrays for better performance and more efficient storage utilization.
- **High throughput.** Eliminate the bottlenecks of Ethernet-based networks.
- **Simultaneous read/write access.** Enable workgroups to collaborate easily and accomplish results faster than ever.
- **Easy volume scalability.** Plug in more RAID devices as storage requirements grow—expanding shared volumes easily.
- **Increased data availability.** Eliminate single points of failure through metadata controller failover and Fibre Channel multipathing.

In 2005, Apple introduced the Mac community to the power and efficiencies of a storage area network (SAN). With the Xsan clustered SAN file system, workgroups and entire organizations gained shared high-speed access to terabytes—even petabytes—of data over a Fibre Channel network. Multiple computers and servers could read and write to the same storage volumes simultaneously, without compromising data integrity. Best of all, this breakthrough SAN solution could be deployed without the complexity or the cost of competitive offerings.

Since then, Xsan has been deployed in tens of thousands of businesses, from small video post-production houses to large data centers and television stations—thanks to enterprise-class scalability and availability features. With the introduction of Xsan 2, individuals in these organizations now can share and access their data faster and more easily than ever.

What's New in Xsan 2

- **Simplified setup.** With preconfigured settings for common SAN deployment scenarios, Xsan 2 makes it easy for SAN novices to set up a storage area network.
- **Intuitive management.** The completely redesigned Xsan Admin 2 application simplifies day-to-day SAN administration.
- **MultiSAN.** Now users on a single workstation or server can access multiple Xsan volumes at the same time—ideal for broadcast video deployments.
- **Spotlight searching.** Support for Spotlight, Cover Flow, and Quick Look in Mac OS X v10.5 Leopard makes it easy to find and access content across multiple SAN volumes.
- **Leopard Server integration.** Xsan 2 works seamlessly with Server Assistant in Mac OS X Server for easy configuration of network services over a SAN.
- **Third-party RAID storage.** Along with Apple's Xserve RAID, Xsan 2 is qualified to work with the Promise VTrak E-Class RAID subsystem, tuned for Xsan, Mac OS X Server, and Apple's professional video applications.

Xsan 2 is a powerful and scalable solution for enterprise storage consolidation and demanding post-production and broadcast workflows.

SAN Basics

Limitations of DAS and NAS systems
DAS and NAS architectures suffer from the same limitations, including:

- **Single point of failure.** The DAS host or NAS appliance is the single point of access to storage—and, potentially, a single point of failure.
- **Performance bottlenecks.** Since all file system requests must go through a single workstation or server, performance bottlenecks occur. These bottlenecks can be magnified by Ethernet bandwidth limitations.
- **Difficult scalability.** In both scenarios, scalability is limited by the number of storage devices that can be attached to the server. It's also cumbersome to add disks or RAID arrays to DAS or NAS systems.

Virtually every industry is experiencing exponential growth in storage requirements. Beyond a demand for capacity, organizations are increasingly concerned with data protection, as well as near-instant and reliable access to mission-critical files. Three basic types of storage networking architectures have emerged to address these needs: directed-attached storage (DAS), network-attached storage (NAS), and the storage area network (SAN).

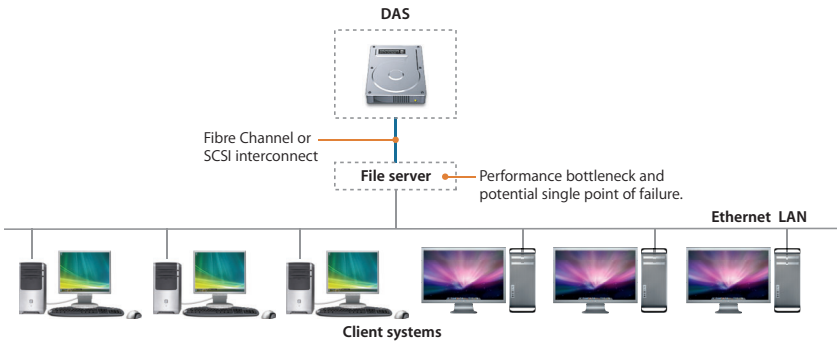
To appreciate the benefits of Xsan, it's helpful to understand the differences among storage architectures and the advantages of a SAN file system.

DAS and NAS Architectures

Direct-attached storage (DAS)

In a DAS configuration, disk drives or storage systems are connected directly to a server over SCSI or Fibre Channel. The host server formats the DAS using a compatible disk file system, such as UFS or HFS+, and shares the storage with clients over Ethernet using a network file system, such as AFP, SMB/CIFS, or NFS.

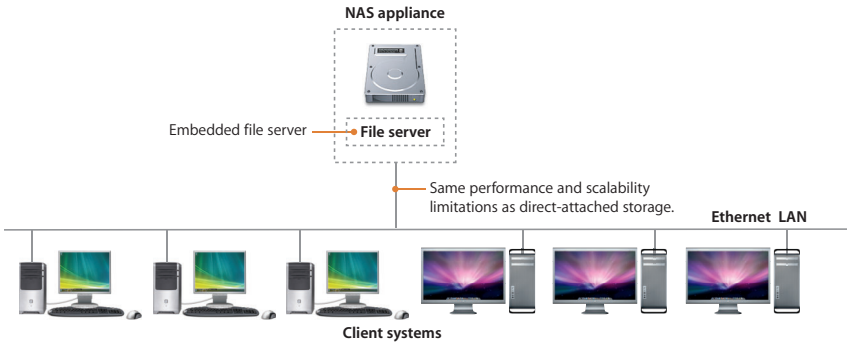
Direct-Attached Storage



Network-attached storage (NAS)

A NAS is a storage device with a built-in computer. This "NAS appliance" connects to a local area network and, like a DAS, shares storage with clients over Ethernet using a network file system. A NAS appliance typically features a specialized server operating system designed to make file-sharing setup and maintenance easier than with most general-purpose servers.

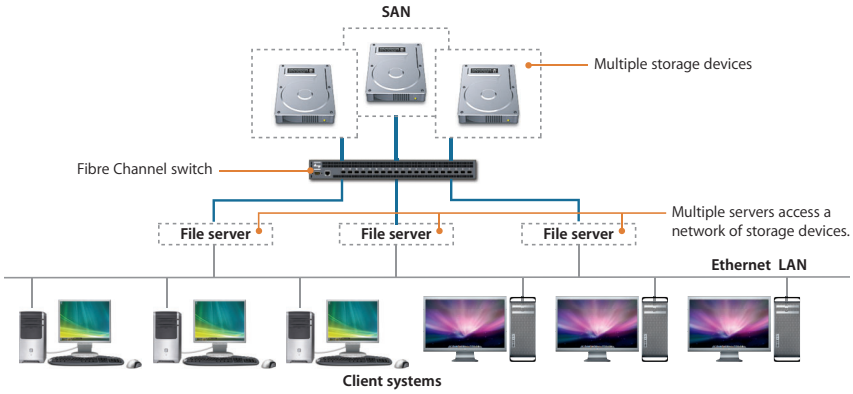
Network-Attached Storage



Why a SAN with a SAN File System?

A storage area network, or SAN, is a method of aggregating storage devices and allowing servers and client computers to access them as a single virtual storage entity. The volume looks just like a DAS—like a big hard drive—to the servers. The difference is that, with a SAN file system such as Xsan, all the servers can access the storage volume at the same time. These host servers can then share the data with additional clients on the local Ethernet network using a network file system, such as AFP, SMB/CIFS, or NFS.

Storage Area Network



Benefits of consolidated storage

A SAN file system provides important benefits over DAS and NAS architectures:

- Fast, concurrent file sharing for streamlined workflows
- Increased uptime through the elimination of single points of failure
- Simplified administration and access controls using directory-based management
- Reduced costs through more efficient disk use
- Flexible deployment and easy scalability without interrupting operations

High-performance, concurrent file sharing

Unlike NAS or DAS systems, which use network file-sharing protocols to deliver stored data to clients, a SAN typically uses a high-speed Fibre Channel interconnect. SCSI data and commands are sent across the SAN over high-speed Fibre Channel protocols for faster file access and more efficient sharing. This allows many users in a workflow to work with the same data at the same time, facilitating collaboration and increasing productivity.

Network-based storage management

By consolidating data into one shared volume, you can utilize all available storage resources more efficiently—and with greater flexibility. Storage devices can be connected using a Fibre Channel switch to any computer or server on the SAN. Centralized storage also streamlines management and makes it easier to control user access.

Why a SAN file system?

Storage devices on the SAN appear as Logical Unit Numbers, or LUNs. A LUN may be a disk, a RAID set, or a slice of a RAID set. Using a SAN file system, a SAN can aggregate LUNs into a single volume, permitting simultaneous access to the same data from multiple systems, while maximizing resource utilization and scalability.

A SAN by itself—without a SAN file system—must assign, or "provision," each LUN to an individual server or computer for its exclusive use. This effectively separates data into "silos," stopping short of the collaboration benefits of a SAN, as well as many of the management and scalability benefits.

Eliminating single points of failure

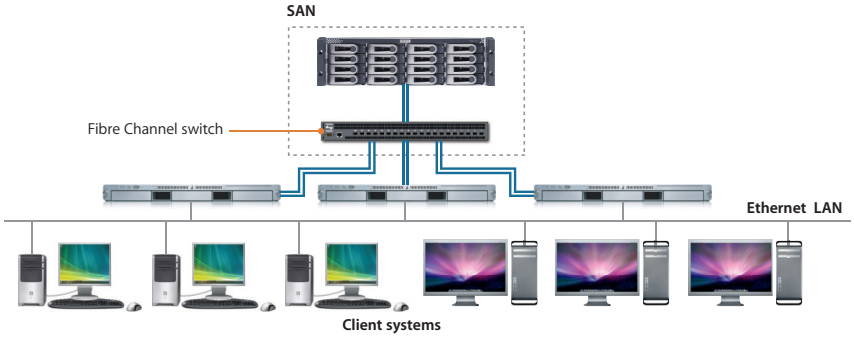
Because a SAN file system gives multiple servers access to shared storage, you can eliminate single points of failure. For example, if one of the servers fails, another server can take over its job and continue to serve the data to clients on the network.

Flexible SAN topology

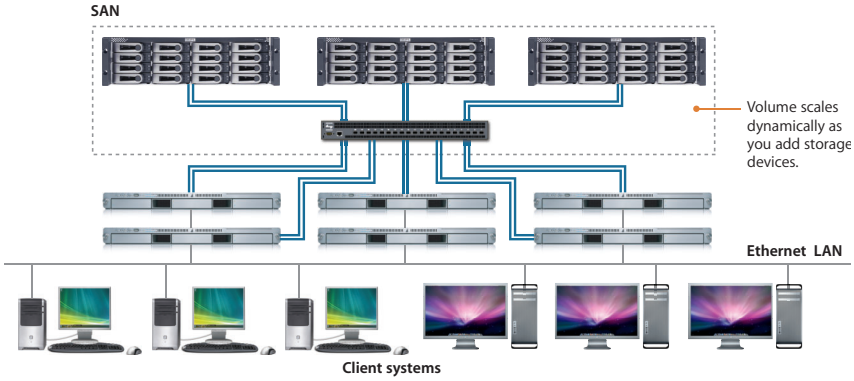
With a SAN file system, such as Xsan, it's easy to expand the capacity of your SAN as storage needs grow. Simply add more RAID devices, and you can expand existing volumes—or create new ones—that can be shared among the attached servers.

To increase the available bandwidth or processing power to your network services, you can add more servers running the Xsan file system. These new systems can have immediate block-level access to the same storage volumes and host network services, such as web serving, file sharing, or media streaming, for additional network or Internet clients.

SAN File System Scalability



Initial configuration of SAN



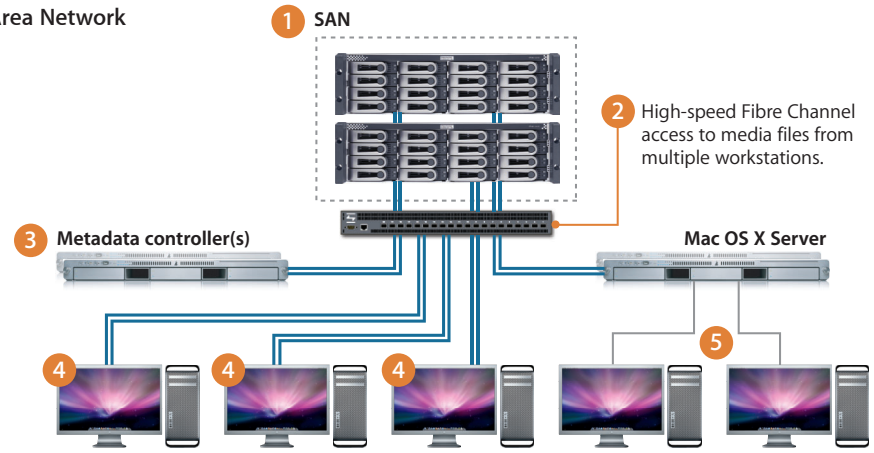
Scale up easily by adding servers and/or storage

Product Overview

How Xsan Works

Xsan is a 64-bit cluster file system specifically designed for small and large computing environments that demand the highest level of data availability. This specialized technology enables multiple Mac desktop and Xserve systems to share RAID storage volumes over a high-speed Fibre Channel network. Each client can read and write directly to the centralized file system, accelerating user productivity while improving workgroup collaboration. Here's how the Xsan solution works.

Xsan Storage Area Network



1. **SAN volume.** Xsan allows you to consolidate data into a single storage volume that's accessible to all systems on the SAN. Adding capacity is as easy as attaching more RAID storage systems to your Fibre Channel network.
2. **Fibre Channel network.** The SAN volume connects to the Xsan metadata controller and all Xsan clients through a high-speed Fibre Channel switch. Apple has qualified many popular third-party switches for use with Xsan.[1]
3. **Xsan metadata controller.** Xsan includes software called the "metadata controller," which acts as the traffic cop for the SAN. When an Xsan client attempts to read or write to a file, it gets permission from the metadata controller, then accesses the data directly on the SAN over high-speed Fibre Channel. Any Mac desktop or Xserve system running Xsan can be the metadata controller.
4. **Xsan clients.** Mac desktop or Xserve systems running Xsan have direct block-level access to files stored on the SAN volume and full read/write capability. As performance needs grow, Xsan allows you to add servers and computers to the SAN. Apple has designed and tested Xsan 2 to support hundreds of clients on the SAN.
5. **Network clients.** An Xserve with Mac OS X Server and Xsan can share data from the SAN volume with an unlimited number of networked computers over the Ethernet network using file-sharing protocols, such as AFP, SMB/CIFS, and NFS.

Components of an Xsan solution
Xsan extends the value of these high-performance Apple products:

- **Mac OS X Server version 10.5** is the sixth major release of Apple's easy-to-manage, UNIX-based server operating system.
- **Xserve** packs quad-core Xeon processing power into a 1U rackmount enclosure. An unlimited-client license for Mac OS X Server is included at no additional cost.
- **Mac Pro** is the ultimate video workstation. A high-bandwidth architecture ensures that data flows through the biggest available pipe.
- **Apple Fibre Channel PCI Express** cards enable Xserve and Mac Pro systems to access RAID storage using a dual- or quad-port 4Gb Fibre Channel interface.
- **RAID storage solution** includes subsystems such as the Promise VTrak E-Class or Apple Xserve RAID.

Key Features

Xsan is a specialized file system that enables you to manage terabytes—even petabytes—of consolidated storage and provide high-availability, high-performance data access across your network. Its features include the following.

Simplified setup
Once again, Apple offers a powerful solution that's also easy to use. Xsan 2 takes the complexity out of configuring a storage area network. The new SAN Setup Assistant—designed especially for small shops and departments without dedicated IT resources—steps users through the process of installing software, creating volumes, and setting up computers on the network. There are even preconfigured settings for common deployment scenarios.

Intuitive administration tools
Day-to-day SAN management is also easy using a completely redesigned Xsan Admin application. With one intuitive tool, you can manage, grow, and monitor your SAN from any Internet-connected Mac. For immediate notification in the event of a failure or impending issue, Xsan Admin can alert you via email or pager.

64-bit cluster file system
Xsan supports volume sizes of up to 2 petabytes (PB) and billions of files per volume.[2] Features such as file-level locking and block-level access allow high-speed, concurrent read/write access to storage volumes from multiple systems. Multiple users can access even very large files simultaneously—improving the efficiency of post-production and other data-intensive workflows, because everyone can be working with the same files on the network. Xsan also reduces transfer time, thanks to the high-performance Fibre Channel connection.

High availability
Xsan has a high-availability design that allows users to access mission-critical data even in the event of a system or Fibre Channel network failure. Metadata controller failover protects storage availability from server hardware failure. File system journaling tracks modifications to metadata, enabling quick recovery of the file system in case of unexpected interruptions in service. And Fibre Channel multipathing allows file system clients to automatically use an alternate data path should a failure occur.

Volume management
Volume management and easy file system scalability maximize the flexibility of your storage deployments. Xsan allows you to create storage pools made of identical sets of LUNs and stripe them together for fastest-possible performance. Different pools offering special storage characteristics can be combined into volumes; and data placement settings, or affinities, enable you to direct data to specific volumes depending on performance and protection requirements.

Data access control
Xsan simplifies administration with flexible data management features. Using volume mapping, you can control which SAN volumes are visible to specific nodes in the SAN. Integration with Open Directory, Active Directory, or any other enterprise LDAP directory service allows centralized management of user and group access privileges. Directory-based management and file system ACLs also make it easy to set file system quotas, so you can control resource utilization on a per-user, per-group, or per-application basis.

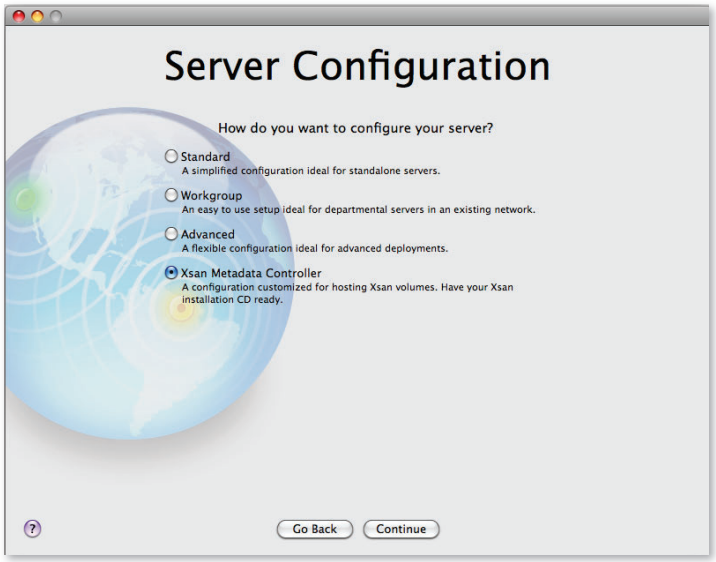
Intuitive Setup and Management

Xsan 2 takes the complexity out of setting up and maintaining a SAN, while providing powerful remote management capabilities for IT and network experts. An intelligent new SAN Setup Assistant expedites the setup process for nontechnical users, with custom tools just a click away. There's also a newly designed Xsan Admin application, featuring a straightforward interface for SAN management and monitoring.

Simplified Setup

Xsan 2 handles the entire "after cable up" setup and configuration of your SAN, perfect for first-time users. The SAN Setup Assistant walks you through the process—creating private metadata networks, optimizing volumes for different data types, and more. So small organizations and workgroups can take advantage of a SAN and clustered network services, without any networking expertise.

The simplicity starts with the out-of-box server setup experience. Upon installation, Mac OS X Server automatically recognizes that your system has a Fibre Channel card installed. Server Assistant asks if you want your server to be the metadata controller of a storage area network and guides you through the Xsan installation and setup process.



To make it easier for you to get the most performance out of your SAN, the new SAN Setup Assistant offers a choice of predefined volume configurations for common SAN scenarios. With a single click, you can organize your storage into pools optimized for the data type, file size, and file use that are typical of the scenario you select.

The options are:

- **Uncompressed high-definition video** for 720p, 1080p, and 1080i uncompressed HD video
- **Standard-definition video** for DV, DVCAM DVCPRO, and uncompressed SD video
- **General file server** for NFS, AFP, and SMB file servers
- **Home folder server** for NFS, AFP, and SMB home folder servers
- **Mail cluster** for shared storage of Mac OS X Server mail services data
- **Podcast Producer cluster** for Podcast Producer video and audio data
- **Calendar server cluster** for shared storage of iCal Server data
- **Custom** for expert users who prefer to configure all volume settings

Integration with Mac OS X and Mac OS X Server

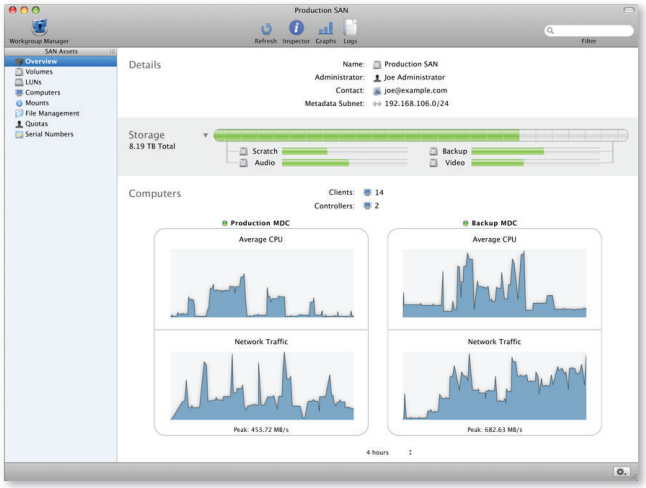
Admin guide online
For detailed information about Xsan Admin and how to put Xsan software into action, visit www.apple.com/xsan to download the complete *Xsan 2 Administrator's Guide*.

Xsan 2 leverages the power of Spotlight, making it easy and instantaneous for users to find files on massive SAN volumes—even across petabytes of data—right from the Finder. Spotlight works the way people think: by searching the content itself, not just the filenames. With richer Spotlight vocabulary in Leopard, searches can be more exact. New options include Boolean logic, quoted phrase searching, category labels, and range support. And with the Quick Look feature in Leopard, you can use Cover Flow to scan hundreds of files in just seconds, without ever needing to open them.

Key services in Mac OS X Server—iCal Server, Mail Server, and Podcast Producer—have been designed to use Xsan 2 as a clustered file system. Clustering improves network performance and scalability, while reducing the potential impact of a service outage should any one server on the network fail.

Intuitive Remote Administration Tools

Xsan includes Xsan Admin, a complete application for remote management and monitoring of your SAN. A graphical user interface enables users on any Mac OS X or Mac OS X Server system to perform administration tasks—such as creating storage pools, managing SAN volumes, setting up affinities, and assigning quotas—that would otherwise be accessible only from a command-line interface. By guiding you through these complex tasks, Xsan Admin not only facilitates SAN administration, but also reduces the chance of critical configuration errors.



With Xsan 2 comes Xsan Admin 2, with a redesigned interface that will look and feel familiar to Mac users. The SAN assets column clearly displays volumes, LUNs, computers, and mounts. Just click to manage each component of your SAN. Context-sensitive menus change, depending on the configuration of your SAN. To identify the LUNs that you are managing, you can even use Xsan Admin to turn on the drive's activity lights.

When it's time to grow your SAN, Xsan Admin 2 makes it easy to add a volume. Similar to the original setup process, Xsan Admin asks what you're using the volume for and what you want to call it—and configures the volume accordingly.

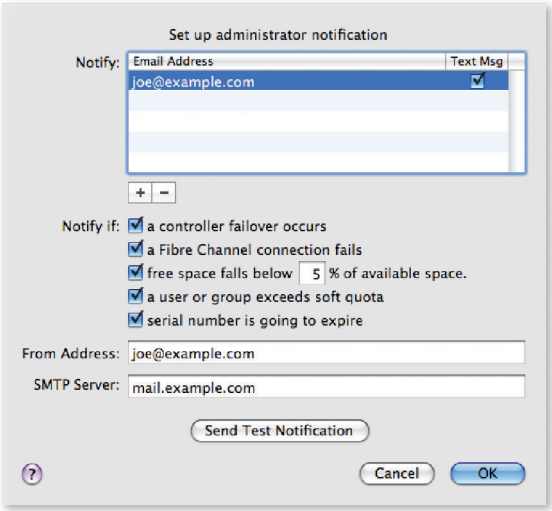
Real-time monitoring

Xsan Admin 2 prominently displays an overview of your SAN's health. With real-time monitoring, you'll always have the following information:

- Free space in a volume or storage pool
- User quota utilization
- Graphs of processor and network utilization
- Status of file system processes
- Log file
- Connected clients
- Fibre Channel failures

Event notification

You can also use Xsan Admin to set status thresholds that trigger automatic notification via email or pager. Whether a Fibre Channel connection fails, available disk space falls below a specified level, or a critical workstation is nearing its disk quota, the notification feature enables you to respond quickly to serious problems.



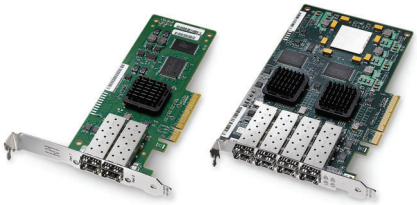
File System Capabilities

Xsan features enterprise-class SAN capabilities that meet your organization's requirements for data consolidation and fast, shared access to storage volumes.

Cluster File System

Xsan is a 64-bit cluster file system that provides concurrent data access over high-speed Fibre Channel to multiple systems on the network. For better performance and higher availability, you can pool storage across multiple RAID devices, and each Xsan client can use this centralized data as if it were directly connected. Cluster file systems of this class include SGI InfiniteStorage Filesystem CXFS and VERITAS Storage Foundation Cluster File System.

Support for 2PB files and volumes
Xsan lets your users share multiple files and volumes; each can be as large as 2PB,[2] or more than three months' worth of uncompressed 1080i high-definition (HD) video at 30 frames per second. Xsan supports billions of files per volume, with each metadata controller hosting multiple volumes at the same time.



Apple 4Gb Fibre Channel PCI Express cards
Apple's dual- or quad-channel 4Gb Fibre Channel cards offer dedicated throughput of up to 400MB/s per channel—providing the bandwidth required by video editors when connecting to a SAN.

File sharing over Fibre Channel
Xsan storage networking eliminates the bottlenecks of traditional network file servers that use Gigabit Ethernet and are not fast enough to transfer dense formats such as HD video. Fibre Channel gives you a 4Gb-per-port connection for increased data transfer and can be used with Fibre Channel multipathing for greater aggregate throughput. This is perfect for multiple editors working on a video project or a compute cluster that needs fast data access for maximum utilization of processing power.

File-level locking
Fine-grained file-level locking enables simultaneous access to shared files. All clients can access all the files on the volume, but only the client that has read/write privileges can edit a locked file. This contrasts with volume-level locking, which enables only one computer at a time to write to an entire volume. File-level locking provides enormous productivity advantages in post-production workflows where multiple editors are using a single large file.

File system access controls
Xsan supports flexible file permissions that not only work with Mac clients, but are fully compatible with Windows Server, Windows Vista, and Windows XP. With file system ACLs, any file object can be assigned multiple users and groups, including groups within groups. Each file object can also be assigned both allow and deny permissions, as well as a granular set of permissions for administrative control, read, write,

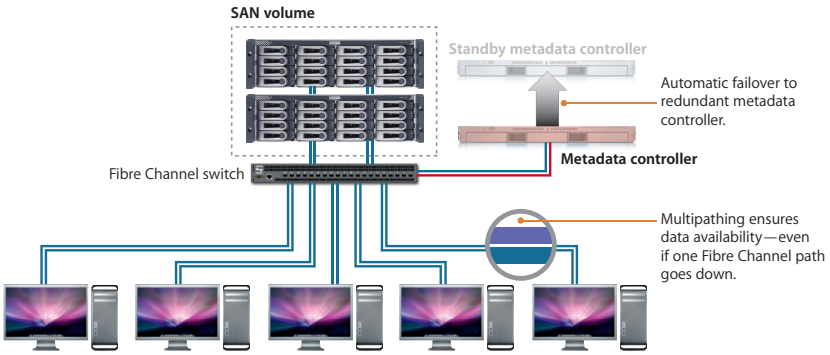
and delete operations. For added security, Xsan supports a file permission inheritance model, ensuring that user permissions are inherited when files are moved to the SAN and rewritten when files are copied to the SAN.

High-Availability Features

Xsan is designed for high availability, with features that make it suitable for mission-critical environments. Metadata controller failover and Fibre Channel multipathing eliminate single points of failure, and bandwidth reservation allows you to keep bandwidth available for critical applications.

High-availability hardware
Dual redundant active/active RAID controllers on the Promise VTrak E-Class RAID subsystem provide exceptional data availability. In the event of a storage subsystem failure, affected Xsan clients transparently reestablish a connection to a remaining device in the SAN.

Always Available



Metadata controller failover
If the metadata controller on your SAN fails for any reason, another computer running Xsan can take over. Metadata controller failover is built into Xsan, unlike many SAN solutions that require you to pay extra for this high-availability feature.

Xsan software includes both the metadata controller and file system client components. Using Xsan Admin 2, you can specify the "laws of succession," or the order in which Xsan metadata controllers take over for a failed controller. You can also choose a different primary metadata controller for each volume, and set up volume failover priorities to minimize the possibility of more than one volume failing over to the same metadata controller—particularly useful in MultiSAN scenarios.

Sophisticated algorithms ensure that succession occurs properly, avoiding "split brain," or multiple conflicting metadata controllers. Once the file system clients "elect" a new metadata controller, the failed system can be deactivated until the problem is resolved.

For high-volume, mission-critical production environments, you may want to dedicate a computer as a standby controller. A standby controller also enables you to update Xsan software without interrupting service to your users.

Fibre Channel multipathing
Apple's Fibre Channel host bus adapters (HBAs) are dual-port or quad-port cards, providing every Mac desktop or Xserve system with two or four connections to the SAN. Fibre Channel multipathing takes advantage of multiple connections: If one Fibre Channel path fails, Xsan continues to use another for storage access—eliminating a potential single point of failure at the cabling layer.

All data paths from the client to the various storage volumes are discovered automatically based on load and availability. This provides two major benefits: Any failure is handled without affecting the user's work, and all paths are load-balanced to ensure maximum performance and reliability.

File system journaling

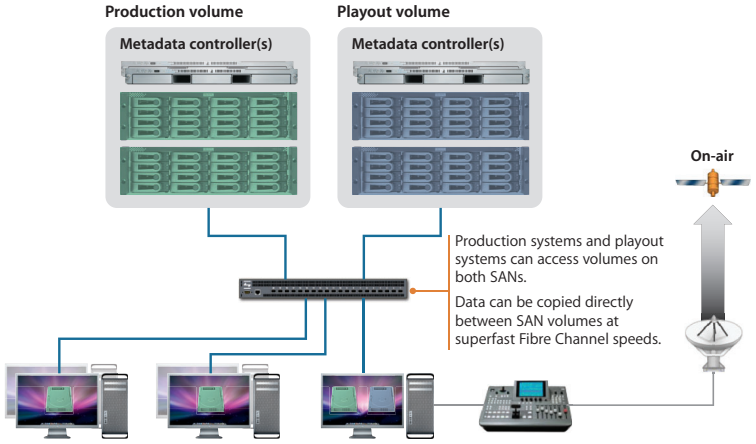
Xsan is a journaled file system that can be recovered in seconds in the event of a server failure. Journal data includes a record of file system transactions, eliminating the need for time-consuming integrity checks after an unplanned shutdown of the entire network or of the metadata controller. Your storage can be back online immediately.

MultiSAN

In many environments, it's common to separate volumes on more than one SAN, whether to improve performance or to improve reliability and sustainability of critical data. Xsan 2 addresses this requirement with a new feature, MultiSAN, that allows a single workstation or server to access volumes on multiple SANs.

For example, in video broadcast scenarios, you may have one Xsan volume for production and another for playout or broadcast. Without MultiSAN capabilities, in order to permit users to access all data, each volume would need to be hosted by the same metadata controller. If the metadata controller were to fail, both production and playout volumes would be affected. With Xsan 2 and MultiSAN, each volume can have its own metadata controller—eliminating a single point of failure—while enabling users to access both volumes. In addition, the user can continue to work on the failover system.

MultiSAN Environment



Volume Management

Flexible volume management capabilities enable you to maximize the efficiency of your storage resources. Xsan makes it easy to target data types to specific classes of storage for optimal storage performance—for example, assigning all uncompressed HD video files to one high-performance storage pool. You can then combine pools into volumes for simplified management.

For maximum performance, Xsan Admin 2 provides pretuned volume workload settings for different data types, file sizes, and use scenarios—ranging from very large files, such as uncompressed HD video or 2K and 4K film, to small files in data center scenarios, such as shared files or network home directories.

With the new Xsan Admin 2 application, it's easy to expand your storage resources as data needs grow: You can add LUNs and storage pools and create new volumes—without interruption in service. The downtime to grow a volume is typically just seconds.

Storage pools and SAN volumes

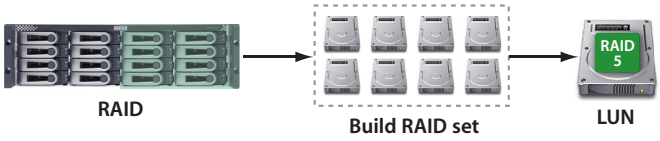
Storage pools allow you to aggregate storage resources with similar attributes. Using Xsan administration tools, you can pool LUNs with identical size, performance, and data protection properties. Different types of storage pools can then be combined into the same volume.

For example, you can create one storage pool of RAID 5 LUNs and another pool of RAID 1 LUNs. The RAID 5 LUNs provide high performance and good capacity with some protection. The RAID 1 sets use redundant drives for the highest level of protection. By creating a SAN volume from these two different pools, you can achieve a good balance between speed and protection in a single volume. This allows the administrator to choose how to manage storage, without having to involve the user.

Striping at a higher level

Xsan stripes data across the individual LUNs that make up a storage pool. This improves performance because multiple pieces of the file are written in parallel, instead of one piece at a time. You can tune Xsan performance by adjusting the amount of data written to each LUN in a storage pool.

Volume Management

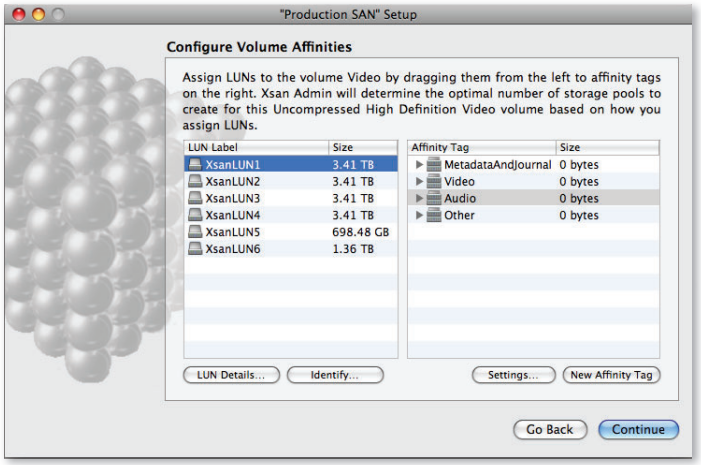


Affinities for automated data placement

Affinities allow allocation of different classes of storage to different purposes. Seamless to the end user, affinities help ensure that an application or task that requires speed or extra protection always stores its files in a suitably fast or protected pool.

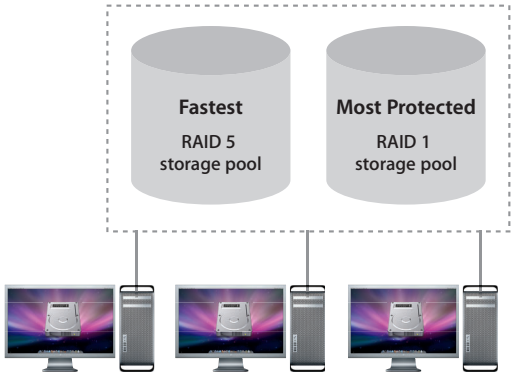
Xsan 2 uses a next-generation data distribution technology with enhanced affinity management to specify how data is laid out on the disk. By optimizing placement of different types of data—for example, keeping large video files sequential and separate from smaller audio files—affinities can dramatically improve disk performance, especially with high-bandwidth video streaming workloads.

Xsan 2 automatically sets up affinities based on the Volume Configuration Profile selected during setup. However, expert administrators can use Xsan Admin to define their own affinities. By mapping a folder to a specific storage pool, files in the folder are stored only on that pool.



In the following example, users have two folders in the volume: One is named "Fastest," associated with the pool of RAID 5 sets; the other is named "Most Protected," associated with the pool of RAID 1 sets. During development, working files can be maintained in the Fastest folder, which automatically places them in a RAID 5 pool. Finished work is saved to the Most Protected folder and maintained in a RAID 1, or mirrored, pool.

SAN Volumes



Data Access Control

Xsan works with your directory server to help you manage file ownership and access quotas—protecting your organization's data and improving storage utilization. With LDAP integration, a central directory allows you to create consistent file system permissions across all computers accessing the storage.

Volume mapping
Using Xsan administration tools, you can map storage volumes to specific systems on the SAN, enabling you to define which systems can see which volumes. This protects your organization's sensitive information without getting in the way of authorized use. Although all Mac OS X file permissions still apply to Xsan, volume mapping provides an added layer of control and security.

Directory integration
Because Xsan is simply another file system, it adheres to the file system permissions built into Mac OS X, including permissions established in a central LDAP directory. Whether you use Open Directory, Active Directory, or another enterprise LDAP service, Xsan accesses information in the directory accounts that you have in place—making it easy to share permissions across computers.

If a directory service is not in place when Xsan is installed, Mac OS X Server automatically configures an Open Directory server with the metadata controller as its master—ensuring that file permissions can be properly set and managed across all systems. With file system ACLs, any file object can be assigned multiple users and groups, including groups within groups.

Control over access permissions
You can use Xsan Admin to set user and group permissions, as well as access privileges, at several levels:

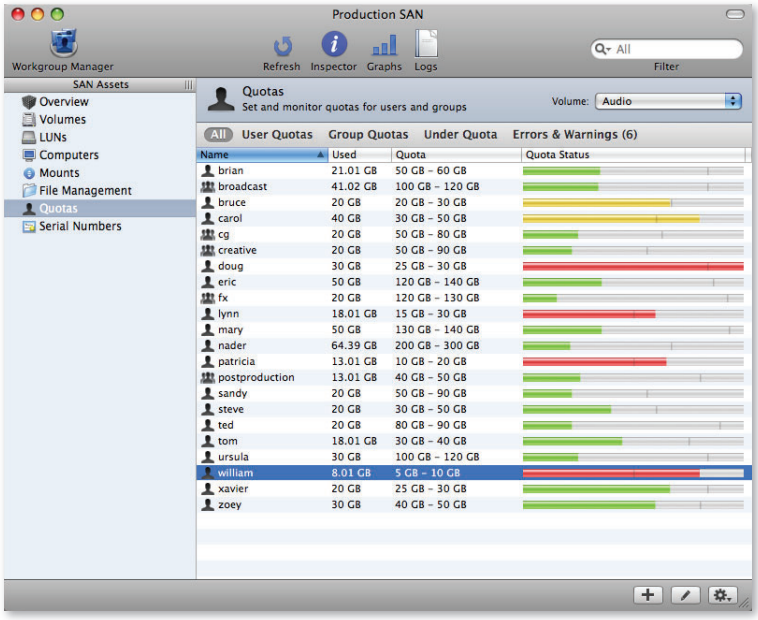
- Restrict user access to folders on a volume by specifying owner, group, and general access permissions.
- Unmount a SAN volume from selected client computers.
- Restrict a client computer to read-only access to a volume.
- Remove a client from a SAN.

Disk quotas

LDAP integration also makes it easy to manage disk space quotas. You can assign quotas to users, groups, applications, or any combination of the three. Xsan enforces two types of quotas for each user, group, or application:

- **Soft quota.** The soft quota is the maximum space a user or group is expected to occupy on a regular basis. Users can exceed their soft quota, for a specified grace period only, up to their hard quota.
- **Hard quota.** The hard quota is an absolute limit on the space a user or group can occupy. Users are prevented from using more space than specified by their hard quota.

Users or groups can exceed their soft quota provided that they drop below it at some point during the grace period you specify. If users or groups exceed their soft quota for longer than the grace period, the soft quota changes to a hard quota; they will not be able to save additional data on the volume until they delete old files and drop below the soft quota.



Quotas are set individually for each volume in a SAN. To establish clear limits, you can set the soft quota, hard quota, and grace period in combination—while still allowing temporary access to extra space for unexpected storage needs. Users for whom no quotas are specified can use all available space on a volume.

Compatibility and Interoperability

Xsan lets you create a SAN that is compatible with your existing infrastructure, giving you the flexibility to build a system that's right for your organization, while maximizing the return on your storage investment.

Support for native Mac OS X applications

Xsan is designed to support most native Mac OS X and UNIX applications and delivers incredible performance on Mac Pro and Xserve systems. For maximum flexibility and compatibility with non-Apple systems, it uses a case-sensitive, single-fork file system.

Fibre Channel infrastructure integration

Apple has qualified several of the most popular Fibre Channel switches for use with an Xsan network. These include the QLogic SANbox product line, the Cisco MDS 9000 family, and the Brocade SilkWorm series.

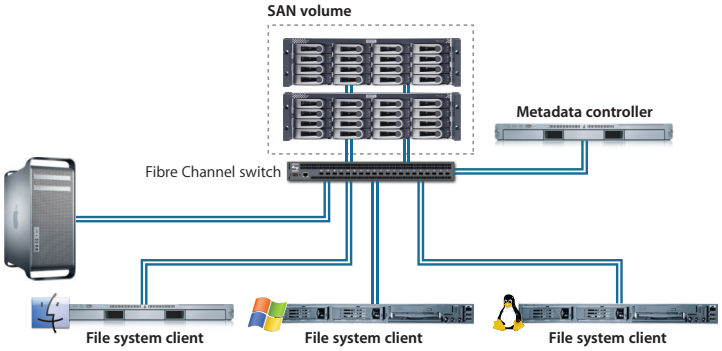
Sharing data over Ethernet

With an Xserve on your Xsan network, you can easily share storage using a network file system protocol, such as AFP, SMB/CIFS, or NFS. At no additional cost, every Xserve system comes with an unlimited-client license to Mac OS X Server and these cross-platform file services.

Quantum integration

In heterogeneous computing environments, you can add non–Mac OS X clients to your Xsan network using the StorNext File System. Computers running the StorNext File System can access Xsan volumes directly over high-speed Fibre Channel—without any modification. In addition, Mac and Xserve clients with Xsan can be added to an existing StorNext-based SAN environment.

Mixed-Platform SAN



Windows, Linux, and other UNIX systems can connect to Xsan volume using Quantum's StorNext File System.

The StorNext Management Suite also supports Xsan deployments. This policy-based information lifecycle management (ILM) solution can be used in conjunction with the Scalar line of tape libraries, offering a robust tape backup option for your Xsan volumes.

Xsan Storage Hardware

SATA and SAS drive technologies
The VTrak subsystem uses any combination of 750GB SATA (Serial ATA) and 300GB SAS (Serial Attached SCSI) drives.[2] Very reliable and delivering great performance, SATA is the better choice when high capacity and cost per gigabyte are of primary and equal importance. When the ultimate in performance and reliability is required, SAS is preferred, providing the industry's highest reliability and performance.

Apple 4Gb Fibre Channel PCI Express cards
Dual- and quad-channel 4Gb Fibre Channel PCI Express cards offer dedicated bandwidth with a throughput of up to 400MB/s per channel. Fibre Channel interconnect technology supports multiple application environments, using point-to-point, loop, and fabric topologies. Each card comes with a 2.9-meter (9.5-foot) SFP-to-SFP 4Gb active copper cable per channel.

For the first time, Xsan has been qualified to work with third-party RAID storage hardware. Along with Apple's Xserve RAID, Xsan 2 supports RAID solutions from Promise Technology, a leading supplier of sophisticated RAID storage devices.

Promise VTrak E-Class RAID Subsystems

Setting a new standard for RAID performance and data protection, Promise offers 3U rack-optimized VTrak solutions tuned for Xsan, Mac OS X Server, and Final Cut Studio. Two 4Gb Fibre Channel ports and 2GB of cache per controller combine with massive storage—up to 24 terabytes[3]—making it possible to handle multiple streams of uncompressed HD video in a single RAID configuration. At the same time, this enterprise-class solution offers amazing storage value—with costs as low as $1.12 per gigabyte.[4]

Dual 4Gb Fibre Channel host interface ports per controller provide connectivity into widely deployed Fibre Channel storage networks, perfect for supplementing existing SANs or building new ones.

Flexible storage and easy scalability
Each VTrak subsystem has 16 drive bays, supporting up to 16 integrated 3.5-inch drives. SATA and SAS drive technologies can be combined for the best balance of cost, performance, and reliability. Typically, two of the drives on the head unit can be configured to store Xsan metadata—rather than using a dedicated RAID controller to support metadata storage.

An expansion chassis provides affordable scalability, adding another 16 SATA or SAS drives to the RAID, for a total of 32 drives per RAID controller. And because this chassis connects to the head unit through dedicated, redundant expansion ports, it won't take up an additional Fibre Channel port on your switch. Beyond the two drives for the metadata controller, all drives are available for assignment to one or more RAID sets—supporting all the major RAID levels, including RAID 5 and RAID 6.

The Promise VTrak E-Class line allows flexible configuration, so you can scale along with your business needs. Start with an eight-drive configuration and add SATA or SAS drives—or an entire expansion unit—as your requirements change.

High-availability design
Demanding Xsan installations will benefit from a host of high-availability features on the Promise VTrak RAID subsystem. Two Fibre Channel ports on each RAID controller provide redundant data paths to storage volumes. In the event of a RAID controller failure, the other controller takes over its workload—thanks to active/active RAID controllers with failover/failback support. In addition, all VTrak components are constantly

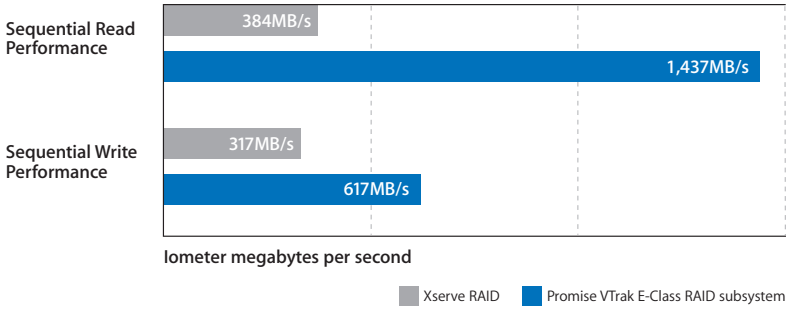
monitored to ensure continuous operation in case of failure or component malfunction. And redundant hot-swappable power supplies and cooling modules, along with global and dedicated hot-spare hard drives, keep your SAN up and running.

Outstanding Storage Performance

The Promise VTrak RAID subsystem boasts a high-throughput design that combines with enhancements in Xsan 2 to yield massive read and write bandwidth for multiple clients. Perfect for the most demanding Xsan video and server applications, this high-performance storage solution can handle multiple streams of uncompressed HD video.

Iometer
Iometer is an I/O performance analysis tool originally developed by Intel and later released as an open source benchmarking tool. It measures system read and write performance—both throughput and latency—as it stresses the system with a controlled workload.

Promise VTrak E-Class Raw Disk Performance
Superior throughput



Testing conducted by Apple in February 2008 using preproduction Promise VTrak E-Class units, shipping Xserve RAID, and two shipping Fibre Channel switch–connected 3.0GHz 8-core Xeon-based Xserve units. Kernel tuned to increase AIO threads, AIO max, and AIO procmax all to 128. Testing conducted using Iometer 2006.07.27 with a 30-second ramp-up, 5-minute run duration, 64K (for VTrak read) or 1MB (for all else) request size, 8 outstanding IOs, and accessing two raw 8-disk 750GB SATA LUNs (for Promise VTrak E-Class RAID subsystem), or two raw 7 x 750GB PATA RAID 5 LUNs (for Xserve RAID), using both RAID controllers. Performance tests are conducted using specific computer systems and reflect the approximate performance of Promise VTrak E-Class RAID subsystem.

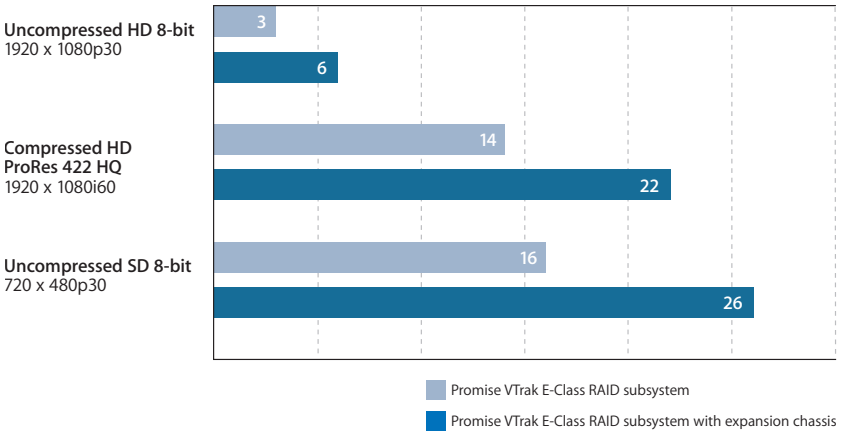
With sixteen 7200-rpm 750GB SATA hard drives configured as two 8-disk RAID 5 LUNs, the VTrak unit exceeded 1.4GB/s of sequential read performance and 600MB/s of sequential write performance. Compared with an Xserve RAID fully loaded with two 7-disk RAID 5 LUNs, the VTrak outperformed Xserve RAID by over three times for reads and almost two times for writes—highlighting the performance of the RAID controller architecture in the Promise unit.

Video streams

To test the real-world video performance of an Xsan 2 volume using Promise VTrak E-Class storage, Apple built a SAN with four 3.2GHz 8-core Mac Pro client systems, each with a dual-channel 4Gb Fibre Channel card; a 3.0GHz 8-core Xserve as the metadata controller; a QLogic 5600 Fibre Channel switch; and a Promise VTrak storage unit.

Two test configurations were run. The first consisted of a single VTrak system configured with sixteen 7200-rpm 750GB SATA drives: a 2-disk RAID 1 LUN for the metadata, two 6-disk RAID 5 data LUNs, and two spares. The second configuration added a VTrak expansion chassis with another sixteen SATA drives: two 6-disk RAID 5 data LUNs and four spares. Each client played one or more video streams with Final Cut Studio 2 for at least 30 minutes—without any frame drops—until the maximum number of streams was achieved.

Simultaneous Final Cut Pro Streams
Promise VTrak E-Class with Xsan 2



Testing conducted by Apple in February 2008 using preproduction Promise VTrak E-Class units, preproduction Xsan 2, a shipping 3.0GHz 8-core Xserve metadata controller, and shipping 3.2GHz 8-core Mac Pro clients. Testing was conducted using simultaneous unique 10-minute clips for each content type. Performance tests are conducted using specific computer systems and reflect the approximate performance of Promise VTrak E-Class RAID subsystem and Xsan 2.

Running Xsan 2 with the Promise VTrak subsystem and expansion chassis, the SAN delivered up to six streams of uncompressed 8-bit HD video, 22 streams of ProRes 422 HQ compressed HD video, and 26 streams of uncompressed 8-bit SD video.

Deploying Xsan

Xsan relies on a proven architecture that's ideal for video post-production and broadcast video workflows, as well as for delivering IT services in data center environments. What's more, Apple's SAN solution is available at significantly lower costs than competitive offerings.

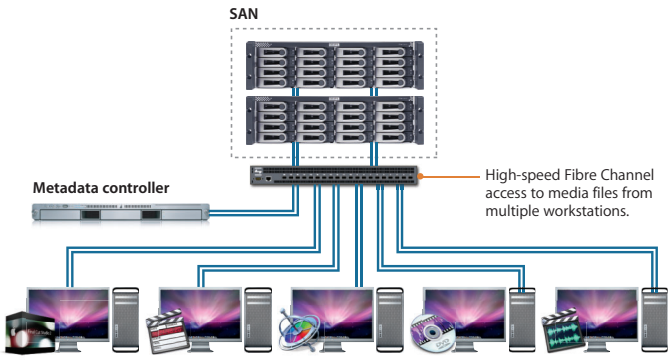
Xsan for Post-Production

Professionals in film and video post-production depend on high-bandwidth, scalable storage that can be accessed concurrently by multiple workstations. The SAN—not the LAN—becomes the key to collaboration and efficient workflow for these organizations. A SAN simplifies the work for end users, eliminates data duplication between systems, and reduces overall storage needs.

Apple's SAN solution delivers these benefits in film and video editing environments:

- **Concurrent access to source files.** Multiple editors can work from the same source media concurrently, without having to transfer these files between stations. Each Mac accesses shared files on the SAN as if the storage were directly attached. File-level locking ensures that only one station at a time can modify the contents of the file.
- **Consistent high-bandwidth performance.** Xsan is designed for demanding applications where guaranteed rate of bandwidth must be maintained, such as ingesting video or audio data from tape to a digital storage system. Using Fibre Channel technology, Xsan delivers consistent high-bandwidth performance.
- **Tremendous capacity.** With Xsan and the Promise VTrak solution, you can work with files and volumes of up to 2PB,[2] making it easy to share enormous media files. Each VTrak RAID subsystem can hold up to 24TB of data.[3]

Post-Production SAN



Bandwidth requirements
Xsan 2 allows editors to work well within the bandwidth required per video stream for the most common editing formats.

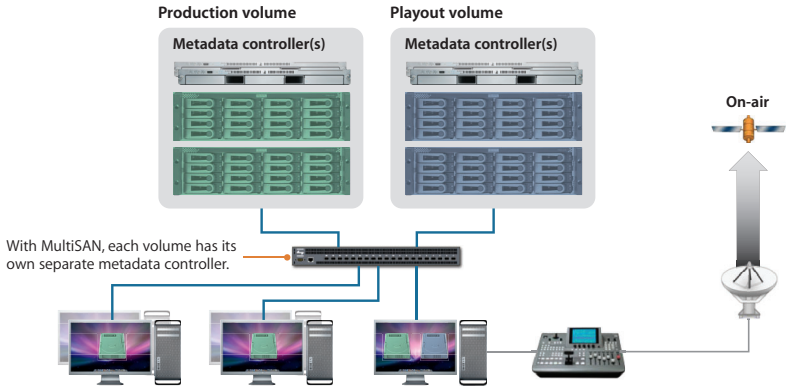
Standard definition	Bandwidth per stream (MB/sec)
MiniDV, DVCAM, and DVCPRO	3.6
DVCPRO 50	7.7
Uncompressed (8-bit)	20
Uncompressed (10-bit)	27
Compressed high definition	
DVCPRO HD	5.8 to 14
Apple ProRes 422	up to 27.5
Uncompressed high definition	
720p 24fps	46
720p 30fps	50
720p 60fps	100
1080 24p (8-bit)	98
1080i (8-bit)	120
1080 24p (10-bit)	110
1080i (10-bit)	165

Xsan for Broadcast Video

Post-production professionals in broadcast video studios look to Xsan for consistent, concurrent high-bandwidth access to tremendous amounts of production data. However, live broadcast adds stringent availability requirements—and Xsan 2 delivers the features that keep 24-hour newsrooms and other on-the-spot operations up and running.

- **High availability.** With Xsan 2 and MultiSAN, networks can be architected with one Xsan volume for production and another for playout or broadcast. Each volume can have its own metadata controller—eliminating a single point of failure—while enabling users to access both volumes. If one metadata controller goes down, the user can continue to work on the failover system. In addition, Xsan offers high-availability features such as metadata controller failover and Fibre Channel multipathing.
- **Cross-platform integration.** Xsan 2 fits into heterogeneous environments with Windows, Linux, and other UNIX systems, providing direct Fibre Channel block-level access to your Xsan volumes. Mac desktop and Xserve systems running Xsan can also join existing infrastructures that use the StorNext Management Suite, a policy-based information lifecycle management (ILM) solution.

Broadcast Video SAN



Powerful and affordable IT solutions
To provide scalable file services for Mac, Windows, and Linux clients on the network, you can use Xserve as a "NAS head"—a server attached to a SAN with NAS functionality.

Xsan in the Data Center

IT departments in every industry are facing constant growth in data storage needs, as well as more stringent government regulations for maintaining compliant records. Together these requirements place tremendous demands on storage infrastructures. By consolidating storage, reducing data duplication, centralizing management, and increasing the flexibility of existing storage hardware, a SAN solution can reduce an organization's storage needs and lower its IT costs.

Sharing data over a SAN also provides significant performance improvements over traditional file servers. Multiple systems have simultaneous access to exactly the same data. Data is never transferred over the LAN, preventing Ethernet bottlenecks and avoiding idle computing cycles while nodes wait for data to process. Xsan combines with Leopard Server to enable you to deploy centralized storage solutions for general file services, network home directories, iCal Server, Podcast Producer, mail services, and Final Cut Server.

An Xsan network can increase the flexibility of your storage infrastructure and the utilization of your storage resources, thanks to these features:

- **Consolidated storage resources.** An Xsan solution allows IT administrators to consolidate data and manage it centrally—increasing storage utilization and simplifying data management without compromising performance and scalability. You can allocate storage to any application, anywhere in the organization, thanks to built-in volume management and mapping tools. What's more, consolidation results in dramatically simpler scalability: Just add more RAID devices for expanded SAN capacity and increased performance.
- **Simultaneous data delivery.** An Xsan network is ideal for delivering load-balanced database services, home directory services, mail services, or web services. All your servers can share a single large storage repository, eliminating the need to duplicate data or divide data among multiple servers. Even your failover server doesn't need its own duplicate copy of the data: It can use the same files as the primary server.
- **Increased uptime.** Because one server is no longer the single point of access for stored data, you can increase the throughput and the reliability of your network services. An Xsan network makes it easy to take one system offline for updates—or add systems to meet expanding needs—without interrupting operations. In addition, Xsan offers high-availability features such as metadata controller failover and Fibre Channel multipathing.
- **Cross-platform integration.** Because Xsan is compatible with the StorNext File System, you can provide Windows, Linux, and other UNIX systems with direct Fibre Channel block-level access to your Xsan volumes. Mac desktop and Xserve systems running Xsan can also join existing infrastructures that use the StorNext Management Suite, a policy-based ILM solution. When Quantum's StorNext Management Suite is deployed in conjunction with its Scalar line of tape libraries, you can set up predefined service levels for different classes of data and automate your data placement and storage backup policies.
- **Dynamic scalability.** A SAN architecture is easy to scale with minimal interruption in service. Simply plug more storage hardware subsystems into the Fibre Channel network for more capacity and better storage performance. To expand the number of editing stations, you can install Xsan on the additional stations and attach them to the SAN.

Support and Training

Xsan comes with 90 days of toll-free telephone support for installation, launch, and basic troubleshooting, as well as lifetime access to Apple's online support resources, such as the AppleCare Knowledge Base and discussion forums. In addition, to keep critical data available day and night, you can purchase the AppleCare Xsan Support plan for round-the-clock support.

AppleCare Xsan Support

AppleCare Xsan Support delivers a year of priority phone and email support[5] for your storage deployment. You'll have direct access—24 hours a day, 7 days a week—to Apple's dedicated Xsan Support team. These experts provide in-depth problem-solving assistance with Xsan and your SAN, including support for migration to Xsan upgrades purchased during the support period. They also troubleshoot Apple hardware[6] running Xsan, as well as interconnectivity between Mac, Xserve, and RAID subsystems, including Apple-qualified Fibre Channel switches.[1] A separate AppleCare Xsan Support agreement must be purchased for each copy of Xsan software in your network.

In addition, Apple offers convenient, cost-effective service and support products: the AppleCare Protection Plan for Mac computers and the AppleCare Premium Service and Support Plan for Xserve. When you combine AppleCare Xsan Support with these AppleCare products, experts can help you troubleshoot your Apple storage solution—and even set up a repair—with a single call. To keep video workflows running smoothly, video professionals can purchase AppleCare Professional Video Support to cover Apple video production solutions. And for IT department–level support, network administrators can choose from three levels of Mac OS X Server Software Support.

For more information, visit www.apple.com/support/products.

Training and Certification

Apple offers a comprehensive lineup of instructor-led courses, as well as related certification programs. From application basics to advanced network management, these high-quality courses combine lectures, demonstrations, and hands-on exercises. Classes are taught by Apple Certified Trainers—either at an Apple Authorized Training Center or, by special arrangement, onsite at your business or institution.

For more information, visit www.apple.com/training.

Purchasing Information

Pricing

The U.S. suggested retail price of Xsan is $999. The education price is $499.[7]

One copy of Xsan must be purchased for every Mac or Xserve system connected directly to the SAN, including the metadata controller and each client or node. Volume licensing for 10 or more clients is available. There are no fees related to the capacity or number of storage devices in the SAN.

Xsan is available worldwide in English, French, German, and Japanese. It can be purchased from the Apple Store at www.apple.com/store, as well as through Apple value-added resellers and select catalogs.

System Requirements

- Xserve or Mac computer with an Intel or PowerPC G5 processor (second Ethernet connection recommended)
- 2GB of RAM, plus 2GB for each hosted volume
- Apple Fibre Channel card
- Mac OS X or Mac OS X Server v10.5 or later

Apple Maintenance Program
This optional program makes it easy to manage software expenditures while benefiting from the latest technologies and improvements. With one payment, you automatically receive major Xsan software upgrades for three years. For more information, including program terms and conditions, visit www.apple.com/server/maintenance.

Storage and Networking Requirements

- Switched Ethernet LAN (Gigabit Ethernet recommended)
- Qualified RAID storage system: Promise VTrak E-Class RAID and/or Apple Xserve RAID (with firmware 1.5 or later)
- Qualified Fibre Channel switches[1]
- Dedicated Ethernet interface recommended for file system metadata communications

For More Information

For more information about Xsan, visit www.apple.com/xsan. For information about other Apple server solutions, visit www.apple.com/server.

[1]For a list of Apple-qualified Fibre Channel switches, see www.apple.com/xsan/compatibility.html. [2]For hard drive capacity measurements, 1GB = 1 billion bytes, 1TB = 1 trillion bytes, and 1PB = 1000 terabytes; actual formatted capacity less. [3]Maximum capacity of 24TB achieved through use of sixteen 750GB SATA drives. Usable capacity depends on drive configuration and RAID level. [4]Based on a 24TB configuration with one head unit and one expansion chassis, both with sixteen 750GB SATA drives, at a total cost of $24,998 (U.S. dollars, valid in U.S. only; prices subject to change). [5]Telephone numbers and hours of operation may vary and are subject to change; local telephone fees may apply. Access to web-based resources requires the use of a compatible Internet service provider; fees may apply. [6]Software support covers only the graphical user interface. Hardware repairs that are not covered under warranty require an extended service contract, such as the AppleCare Protection Plan. [7]Price in U.S. dollars, valid in U.S. only; prices subject to change.