Novell
Open Enterprise Server

November 1, 2005

STORAGE AND FILE SERVICES
OVERVIEW

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Contents

About This Guide

This guide discusses storage and file services solutions available in Novell® Open Enterprise Server. This guide is intended for network administrators and is divided into the following sections:

Audience

This guide is intended for system administrators.

Feedback

We want to hear your comments and suggestions about this manual and the other documentation included with this product. Please use the User Comment feature at the bottom of each page of the online documentation, or go to www.novell.com/documentation/feedback.html (http://www.novell.com/documentation/feedback.html) and enter your comments there.

Documentation Updates

For the most recent version of the *Novell Storage Overview*, see the Novell Documentation Web site (http://www.novell.com/documentation/oes/index.html).

Additional Documentation

A list of all storage services and file services documents is provided in .

Documentation Conventions

In Novell documentation, a greater-than symbol (>) is used to separate actions within a step and items in a cross-reference path.

A trademark symbol (®, ™, etc.) denotes a Novell trademark. An asterisk (*) denotes a third-party trademark.

When a single pathname can be written with a backslash for some platforms or a forward slash for other platforms, the pathname is presented with a backslash. Users of platforms that require a forward slash, such as Linux* or UNIX*, should use forward slashes as required by your software.

Storage Solutions

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Because your business depends on its data, you need a storage solution that easily adapts to your changing business needs. This guide provides information to help you find the right components of Novell® Open Enterprise Server to create a variety of secure, flexible, scalable, and highly available storage solutions.

Open Enterprise Server supports several preconfigured solutions and provides a variety of storage services that allow you implement a wide range of storage architectures, from the simplest small office file server to a complex, fault-tolerant, highly available data center. Whether you measure storage in gigabytes or terabytes, OES can help you implement the storage solution that meets your needs.

To find the right storage solution, you first need to identify your data requirements by accurately assessing your data and understanding its business relevance. Compare your list of requirements to the typical storage criteria described in this document to identify features in Open Enterprise Server that address those needs.

IMPORTANT: For links to the documents mentioned in this section, see Section 1.11, "Storage Documentation," on page 24.

1.1 General Storage

Your storage solution must meet your basic file system management needs. In addition to the operating platform, servers store software and data. The primary challenge is to store the data efficiently while making it available to users when and where they need it. To simplify that task, your storage solutions should abstract diverse storage devices into a single logical storage space.

Storage solutions must be flexible and scalable. Flexibility lets you apply the storage solution to a variety of equipment. Scalability lets you continue to grow and adapt your solution as your business needs change.

The following table describes general storage requirements and OES solutions.

Storage Requirement	Novell OES Solution
Virtualized storage management: The ability to manage diverse storage devices from multiple vendors and to present the combined space as a single resource that you can subdivide and allocate according to your data management needs	Novell Storage Services™ (NSS) virtualizes the file storage to take advantage of all space available on disks. NSS supports a variety of storage device technologies and vendor products. NSS is available on both Linux and NetWare® kernels. For information, see *Novell Storage Services File System Administration Guide for OES*.
Flexibility: The ability to implement different storage solutions to meet a variety of workplace scenarios and to modify the storage solution easily as business needs change	NSS supports a variety of storage architectures, including direct-attached storage (DAS), network-attached storage (NAS) servers, and storage area networks (SANs). For information, see the *Novell Storage Services File System Administration Guide for OES*. NSS on NetWare supports both Fibre Channel and iSCSI SANs that allow authorized access to any device in the SAN fabric and optimization of available storage. For information about iSCSI SAN solutions, see the *iSCSI 1.1.3 Administration Guide for NetWare 6.5*. Novell Cluster Services™ supports server clusters. Data for the cluster can be shared as DAS or in SANs, or it can be unshared, depending on your application requirements. For information see the *OES Novell Cluster Services 1.8.1 Administration Guide for Linux* and the OES Novell Cluster Services 1.8 Administration Guide for NetWare.

1.1.1 Diverse Storage Devices

OES is compatible with a wide variety of storage devices such as disk drives, just a bunch of disks (JBOD) arrays, RAID arrays, storage subsystems, tape drives, and tape libraries.

Storage devices can be SCSI, ATA (or IDE), Fibre Channel, or iSCSI, depending on your performance and reliability requirements. In general, SCSI devices are faster and more reliable than ATA devices. Today's ATA devices can be used for primary and near-line storage or as staging areas in a disk-to-disk-to-tape backup strategy.

NetWare supports Fibre Channel and iSCSI SAN solutions. In a Fibre Channel SAN, the SAN equipment and connections are based on Fibre Channel interconnect technologies. In an iSCSI SAN, the equipment and connections are based on conventional Ethernet and IP interconnect technologies.

For conceptual information about devices and partitions used by the NSS File System and the NetWare Tradtional (Traditional) File System, see the *OES Server Disks and Storage Devices for NetWare*.

For information about devices used by Linux traditional file systems, see "Systems" in the *SUSE LINUX Enterprise Server 9 Administration Guide* (http://www.novell.com/documentation/oes/sles_admin/data/part-system.html).

1.1.2 Flexible Storage Architectures

For more information about general storage solutions such as DAS, NAS servers, SANs, and clusters, see "Storage Architectures" on page 29.

1.2 File Access and Collaboration Services

Users need to access data securely from a variety of locations including in the office and home, throughout the business campus, and on the road. Security and resources management should be easy to use for administrators and users. Security should protect the network resources but not impair the users' ability to do their job anywhere, at any time.

Storage Requirement	Novell OES Solution
Authorized access to data: The ability to restrict access to data based on user and applications rights	Novell eDirectory™ provides a rights and access control system that is integrated into the NSS file system. This maintains access control rights throughout the enterprise. For information, see the *Novell eDirectory 8.7.3 Administration Guide*.
Authorized access to data in the event that media is stolen: The ability to meet the legal standard of making data inaccessible to software that circumvents normal access control, such as if the media were stolen	For NetWare, NSS provides Encrypted Volume Support that requires password access to activate an encrypted NSS volume on server boot or restart. For information, see the "Managing Encrypted NSS Volumes" in the *Novell Storage Services File System Administration Guide for OES*.
Heterogeneous client and application support with transparent read/write access to network storage areas: The ability to access network data regardless of client or server operating system, the file storage system, or the database format	NetWare supports Native File Access for multiple client and server platforms including Windows*, Macintosh*, Linux, and Windows. Web Distributed Authoring and Versioning (WebDAV) clients are also supported. Protocols supported include NCP, CIFS, AFP, and NFS. Linux supports protocols for Window*, Linux, and UNIX. Protocols supported include NCP, CIFS, and NFS. You can use these protocols to create a network-attached storage solution. For information, see Section 2.2, "Network Attached Storage Solutions," on page 30 and the *OES Native File Access Protocols Guide.*
Secure access to network data from anywhere, at any time: The ability to securely access network data using a standard Web browser from anywhere at any time without requiring special software on the workstation	Novell NetStorage provides Internet-based access to network files. You can set up a NetStorage server to provide users with secure Web-based access to their files from anywhere, at any time. For information, see the *OES NetStorage Administration Guide for NetWare* and the *OES NetStorage Administration Guide for Linux.* NetStorage also provides access to previous file versions if you implement the Novell Archive and Version Services as part of your overall storage solution. For information, see the *Novell Archive and Version Services 2.0 Administration Guide for OES NetWare*.

Storage Requirement	Novell OES Solution
Secure access to local data from anywhere, at any time: The ability to access local data using a standard Web browser from anywhere at any time without requiring special software on the workstation	Novell iFolder® 2.1*x* provides Web- and network-based access to local files stored on network servers. iFolder provides users transparent, cross-platform file transfer by synchronizing files across multiple workstations from a secure, centralized network server.
Secure access to local data from specified workstations at any time:	Users can use the iFolder client on specified workstations to access their local files wherever they are working and know that they have the most current version of a file to work with.
The ability to access local data from different locations on the network	Users can use a Web browser to access files from anywhere using a secure sockets layer (SSL) connection; it does not require a virtual private network (VPN) connection.
	For information, see the Novell iFolder 2.1x documentation Web site (http://www.novell.com/documentation/ifolder21).
	Novell iFolder 3*x* supports shared access to iFolders. For information, see the Novell iFolder 3.x documentation Web site (http://www.novell.com/documentation/ifolder3).
Secure file access for clients: The ability to provide secure file services to NSS volumes on NetWare servers for clients in a heterogeneous environment	The Novell Client™ provides secure file access from clients using NCP. For information, see the *Novell Client for Windows Installation and Administration Guide*.
	For NetWare, OES supports native file access protocols such as CIFS (Samba), AFP, and NFS. For information, see the *OES Native File Access Protocols Guide*.
Secure file access for servers: The ability to provide secure file access to NSS volumes on Linux servers	For Linux, OES provides the NCP Server for Linux. For information, see the *NCP Server for Linux Administration Guide*.

1.3 Compatibility

Your storage solution must be compatible with the network architecture. It must use the same or compatible protocols and technologies for connecting servers and devices and for communicating with other networking equipment, servers, and clients in a cross-platform environment.

Storage Requirement	Novell OES Solution
Compatible with existing security solution: The ability to work with the preferred secure access solution or directory service	Novell eDirectory provides an integrated rights and access control system for NetWare.
	For information, see the *Novell eDirectory 8.7.3 Administration Guide*.
Compatible with network communications protocols: The ability to access network data regardless of the network equipment and interconnects	NetWare servers operate in an Ethernet and TCP/IP network environment. For information, see the *Novell NetWare TCP/IP Administration Guide for OES* (http://www.novell.com/documentation/oes/tcpipenu/data/front.html) and TCP/IP for Linux (http://www.novell.com/documentation/oes/sles_admin/data/sec-net-allg-tcp.html#sec-net-allg-tcp) in the *SLES 9 Administration Guide*.

Storage Requirement	Novell OES Solution
Compatible with SAN communications protocols: The ability to access network data regardless of the SAN equipment and interconnects	NetWare SAN solutions support popular interconnect protocols such as Fibre Channel and iSCSI. For information, see the *OES Novell Cluster Services 1.8.1 Administration Guide for NetWare*, the *OES Novell Cluster Services 1.8.1 Administration Guide for Linux*, and the *iSCSI 1.1.3 Administration Guide for NetWare 6.5*.
Compatible with cross-platform environments: The ability to access network data regardless of client or server operating system, the file storage system, or the database format	NetWare supports clients and servers natively with Network Attached Storage Protocols. NetWare will fit into any environment with support for open source technologies, directory integration, and synchronization. It natively supports multiple client and server platforms including Windows, Macintosh, and UNIX/Linux. It also supports WebDAV clients. For information, see the *OES Native File Access Protocols Guide*.

1.4 Reliability

Your storage solution must provide reliable access to data for users and applications. One way to improve reliability is through redundancy of components to avoid single points of failure in your network design. OES supports redundant devices, connections, and servers.

Storage Requirement	Novell OES Solution
Reliable access to data in the event of disk failure: The ability to provide fault-tolerant solutions to allow users and applications to access data in the event of disk failure	NSS software RAID 1 and RAID 5 devices provide disk fault tolerance. NSS supports software RAIDs 0, 1, 5, 10, and 15 on both the Linux and NetWare kernels. For information, see the *Novell Storage Services File System Administration Guide for OES*.
Reliable access to data in the event of connection failure: The ability to provide fault-tolerant solutions to allow users and applications to access data in the event of connection failure	NSS supports multipath I/O to devices for connection fault-tolerance. Multipathing can be used for DAS, NAS, and SAN (iSCSI and Fibre Channel) architectures in single server and in cluster solutions. For information, see the *Novell Storage Services File System Administration Guide for OES*.
Reliable access to data in the event of server and application failure: The ability to provide fault-tolerant solutions to allow users and applications to access data in the event of server or application failure	Novell Cluster Services provides server and application fault-tolerance options. See the *OES Novell Cluster Services 1.8.1 Administration Guide for NetWare* and the *OES Novell Cluster Services 1.8.1 Administration Guide for Linux*.

1.5 Scalability

Your storage solution must be able to grow with your business.

Storage Requirement	Novell OES Solution
Rapid access to data: The ability to rapidly mount and access data regardless of file, directory, or volume size	NSS allows you to aggregate and manage large amounts of storage without any degradation in performance. NSS can recognize and store massive files (up to 8 terabytes) and large numbers of them (up to 8 trillion). Up to one million files can be open concurrently (server RAM permitting).
	You can mount up to 255 NSS volumes concurrently on a given server, plus the system volume.
	Volumes can be mounted with a minimum amount of RAM. It takes only seconds to mount a volume of any size.
	For information, see the *Novell Storage Services File System Administration Guide for OES*.
Scalable storage structures: The ability to expand storage solutions with minimal service interruptions	You can create and expand NSS pools and volumes while the servers are up and running and the volumes are mounted and online. NetWare supports up to 8 terabytes per volume.
	You can dynamically add NetWare NAS servers into the network to provide additional network data access without disrupting the network.
	You can add devices to a SAN while the SAN and servers are up and running and the volumes are mounted and online.
	For clusters, you can add servers incrementally to increase processing power or expand resources without system interruption.
	For information, see the *OES Novell Cluster Services 1.8.1 Administration Guide for NetWare* and the *Novell Storage Services File System Administration Guide for OES*.
Modifiable storage structures: The ability to easily modify storage solutions to reorganize data and to optimize and expand capacity	NSS supports moving and splitting volumes to reorganize data and to optimize and expand capacity.
	For information, see the *Novell Storage Services File System Administration Guide for OES*.

1.6 Availability

Your users must be able to access network data on demand. Your storage solution must remain available through server, connection, and device failures. Automatic failover solutions empower the administrator to set failover policies so that the network continues to work transparently to users whenever a failures occur.

Beyond the day-to-day failures and outages, most businesses today must provide high availability solutions and business continuance solutions to ensure continuous data access and network security in the event of site failures and disasters. Your solution should ensure that your mission-critical data is never at risk.

Storage Requirement	Novell OES Solution
High availability of access to data in the event of server failure: The ability to provide highly available solutions to allow users and applications to access data via alternate servers in the event of server failure	Novell Cluster Services supports up to 32 cluster nodes for service and storage failover in the cluster. It also supports Web service-enabled failover, quarantine of failing service, maintenance mode, and XML (Extensible Markup Language) management. A read-only shared cluster volume capability is also available.
	A NetWare server can boot directly with the operating system on a local hard drive or on a SAN. Booting from a SAN allows administrators to immediately swap out server hardware in the event of a disaster and directly boot without having to re-install NetWare. The automatic hardware detection in NetWare allows for a new server to have updated or different controllers when booting from a SAN.
	For information, see the *OES Novell Cluster Services 1.8.1 Administration Guide for NetWare* and the *OES Novell Linux Cluster Services Administration Guide for Linux.*
High availability of access to data in the event of connection or device failure: The ability to provide highly available solutions to allow users and applications to access data via alternate routes or resources	NSS supports both Fibre Channel and iSCSI SAN solutions. It also supports full Novell Cluster Services on both SAN solutions.
	For information, see the *OES Novell Cluster Services 1.8.1 Administration Guide for NetWare* and *iSCSI 1.1.3 Administration Guide for NetWare 6.5.*
High availability of access to data in the event of device failure: The ability to provide highly available solutions to allow users and applications to access data via alternate routes in the event of a single device failure	NSS supports software RAIDs 1 (mirroring) and 5 (striping with parity). It also supports software RAIDs 0, 10, and 15.
	For information, see "Managing Software RAID Devices" in the *Novell Storage Services File System Administration Guide for OES*.
High availability of access to data in the event of connection failure: The ability to provide highly available solutions to allow users and applications to access data via alternate routes in the event of connection failure	For NetWare, NSS supports multipath I/O solutions for redundant storage interconnects in all storage architectures. It automatically identifies all paths and lets you set the primary path and priorities for failover sequence to the alternate paths. Failover is automatic. If you do not specify priorities, NSS will do it for you.
	For information, see "Managing Multiple Connection Paths to Devices (NetWare)" in the *Novell Storage Services File System Administration Guide for OES*.

1.7 Data Protection and Security

Today's businesses must be able to survive the loss of data by planning recovery alternatives. Backup and restore services focus on fault tolerance of data by preventing disastrous data loss.

Your storage solution must protect against catastrophes or data erasure, whether malicious or accidental. Typically, you need to provide a regular backup solution. In addition, snapshot technology can defend against data loss by maintaining a point-in-time version of files until you can back up the data or until you need to clear the space for other purposes.

Storage Requirement	Novell OES Solution
Data protection against major loss: The ability to back up, archive, and restore network data	The Novell Storage Management Services™ (SMS) infrastructure is supported by all the major backup/restore application vendors. Novell SMS allows backup/restore application vendors to fully protect all Novell metadata, including file system access control lists, inherited rights filters, and complex data such as databases, e-mail post offices and mailboxes, and Novell eDirectory objects and attributes. For information, see the *Storage Management Services Administration Guide* nd the *Open Enterprise Server SBCON Administration Guide*.
Data protection against intermediate loss: The ability to make immediate, anytime backup of network data with snapshots of storage pools	For NetWare, NSS pool snapshots allow you to back up active data at any time. Snapshot tools are integrated into the Web-based management interfaces. The snapshot function is independent of hardware vendors, even for a mix of vendors. Users can view and select file versions from active snapshot volumes. Snapshot data inherits the rights of the original data. For information, see "Managing NSS Pool Snapshots (NetWare)" in the *Novell Storage Services File System Administration Guide for OES*.
Data protection for files that are open at the time of backup: The ability to back up, archive, and restore network data, even if files are open at the time of the backup	The NSS volume's File Snapshot attribute enables SMS, or other third-party backup solutions, to back up the last closed version of exclusively open files. This is useful in an environment that uses applications that are always active and open. For example, Lotus* Notes*, Oracle*, and SAP* databases need to remain available at all times. For information, see "Using the File-Level Snapshot Attribute to Enable the Backup of Open Files" in the *Novell Storage Services File System Administration Guide for OES*.
Data protection for branch office data: The ability to back up, archive, and restore branch office data	Nterprise Branch Office™, included in NetWare, acts as a loosely coupled synchronization service providing file storage, authentication, printing, and connectivity with a central IT facility. Nterprise Branch Office synchronizes all data, including file and directory data, between branch offices and the central site whenever a connection is available. If resources are unavailable (either locally or at the central site) Nterprise Branch Office allows users to continue working uninterrupted. When connections are reestablished or resources at either location are restored, Nterprise Branch Office resumes synchronizing files. If there is a system failure at either location (remote office or central site) users can still continue to work productively. For information, see the *Nterprise Branch Office Administration Guide*.

Storage Requirement	Novell OES Solution
Data protection for local user data: The ability to back up, archive, and restore local user data	Novell iFolder 2.1*x* and 3.*x* enables users to be more productive from work and home by providing resources to back up their local files, synchronize them, and make them accessible anywhere, anytime, from any computer. For information, see the *Novell iFolder 2.1 Installation and Administration Guide* and the *Novell iFolder 3.x Administration Guide* (http://www.novell.com/documentation/ifolder3).
File version archive and retrieval: The ability to save versions of files at scheduled times and store them in an archive database for easy retrieval by users to recover lost, deleted, or modified files	For NetWare, Novell Archive and Version Services provides support for self-service file versioning. It allows users to locate and restore earlier versions of files on specified volumes. The archive database can be on the same or different server than the source volumes. A browser-based, self-service interface allows users to view and restore a previous file version. This can be done at a subdirectory level, a file type level, multiple subdirectories, volume, or any combination. It also shows who the last modifier of the file was. The browser-based user interface can be run from a NetWare, Macintosh, Linux, UNIX, or Windows computer. For information, see the *Novell Archive and Version Services for NetWare User Guide for OES*.
Safeguards against inadvertent access to data: The ability to protect against configuration mistakes by restricting which storage areas a server can access	NSS provides virtualized LUN masking in SANs. Whenever you allocate devices to a server, NSS makes them unavailable to other servers. NSS multiple server access prevention (MSAP) prevents against accidental activation of physically shared pools of storage on multiple servers at the same time. For information, see "Preventing Pools from Activating on Multiple Servers" in the *Novell Storage Services File System Administration Guide for OES*.
Data protection for a variety of file systems: The ability to protect data stored in a variety of file system formats and levels of data storage formats	Novell SMS supports backing up and restoring of NSS, Traditional, and DOS file systems. It also supports higher-level data such as the data in GroupWise® and eDirectory. For information, see the *Storage Management Services Administration Guide* and the *Open Enterprise Server SBCON Administration Guide*.
Back up and restore data to a variety of storage media: The ability to back up and restore data to multiple possible storage media	Novell SMS supports tape drives and tape libraries in addition to other storage media devices such as direct-attached disks, network drives, CDs, and DVDs. These options provide the ability to create a backup onto media other than tape, if desired, or as a fault-tolerant alternative in the event of a tape drive failure. For information, see the *Storage Management Services Administration Guide* and the *Open Enterprise Server SBCON Administration Guide*.

Storage Requirement	Novell OES Solution
Scheduled backup: The ability to schedule and manage backup jobs	Novell SMS provides the infrastructure for third-party backup/restore applications to schedule jobs and manage them. Scheduling management makes it easy to handle tape rotation methods and media management computations.
	For example, scheduling management features are present in Veritas* Backup Exec, SyncSort* Backup Express, Computer Associates* BrightStore, and many others.
	For information, see the *Storage Management Services Administration Guide* and the *Open Enterprise Server SBCON Administration Guide*.
Management alerts: The ability to send out a notification if the backup process fails	Novell SMS provides the infrastructure for third-party backup/restore applications to alert administrators or management utilities in the event that the backup process fails.
	For information, see the *Storage Management Services Administration Guide* and the *Open Enterprise Server SBCON Administration Guide*.
Remote backup: The ability to back up a remote system's data	Novell SMS includes an RPC mechanism for remote backup. Most third-party backup/restore applications leverage this mechanism.
	For information, see the *Storage Management Services Administration Guide* and the *Open Enterprise Server SBCON Administration Guide*.
Online or database catalog: The ability to create an online or database catalog of the backed-up data	Novell SMS provides the infrastructure for third-party backup/restore applications to create an online or database catalog. The vendor software solution determines whether the catalog is stored on the backup media or if it is created dynamically whenever you want to access the media.
	For information, see the *Storage Management Services Administration Guide* and the *Open Enterprise Server SBCON Administration Guide*.
Backup strategies: The ability to implement a variety of backup strategies	Novell SMS provides the infrastructure for third-party backup/restore applications to implement a variety of backup strategies, including normal, incremental, differential, copy, and daily.
	Backup strategies are made easier with the SMS TSA being enabled to utilize the NSS Event File List (EFL). Backup software can use the file system journals to track which files have changed since the last backup. A change journal can track changes in file content, file or directory name, and file or directory permissions.
	For information, see the *Storage Management Services Administration Guide* and the *Open Enterprise Server SBCON Administration Guide*.

1.8 Performance

You need to be able to improve the I/O performance for your storage solution and to make the best use of the storage resources you have available. Your system must perform well for the number of users and amount and type of data served. As the number of users increases, the amount of storage space and the performance demands also increase.
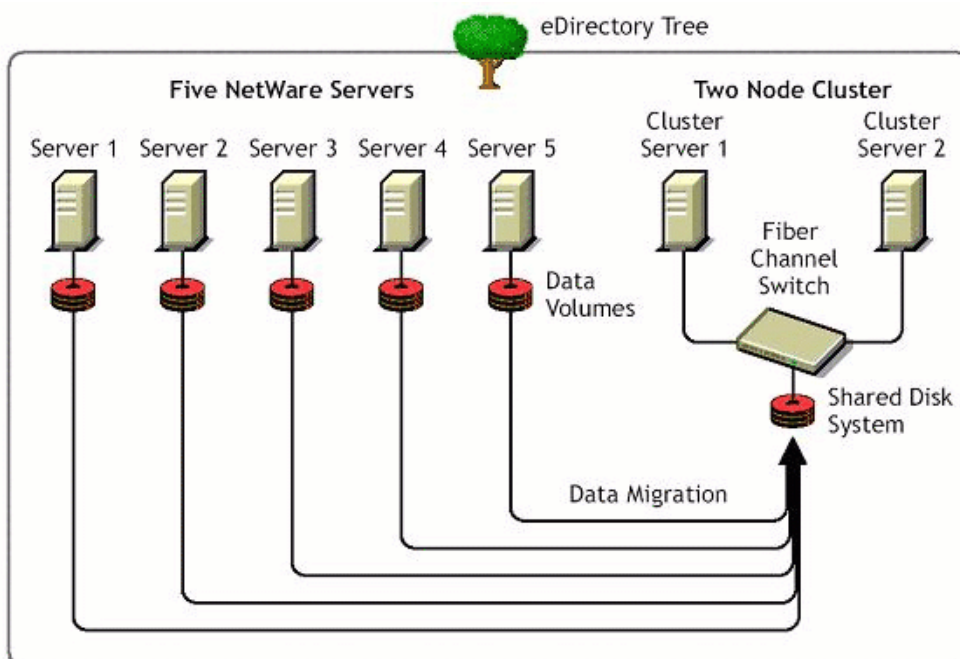
Storage Requirement	Novell OES Solution
Enhanced I/O performance: The ability to improve the I/O performance as experienced by your customers and users	NSS provides software RAIDs, which allows multiple disk I/O access. For NetWare, NSS supports RAIDs 0, 1, and 5. For Linux, NSS supports RAIDs 0 and 1. For information, see "Managing Software RAID Devices" the *Novell Storage Services File System Administration Guide for OES*.
	Novell Cluster Services provides I/O access to data via multiple servers. For information, see the *OES Novell Cluster Services 1.8.1 Administration Guide for NetWare*.
Optimized storage capability: The ability to grow, reorganize, reallocate, and restrict use of storage space, as needed, with minimal service interruption	NSS supports DAS, NAS server, SANs, and shared-disk SAN solutions. For information, see Chapter 2, "Storage Architectures," on page 29 and the *Novell Storage Services File System Administration Guide for OES*.
	For NetWare, Distributed File Services (DFS) supports volume moves and splits on the same or different server within the same tree. DFS allows you to logically split up your volumes so they appear as a single volume to users, thus improving storage management. For information, see "Using Distributed File Services to Move and Split Volumes (NetWare)" in the *Novell Storage Services File System Administration Guide for OES*.
	NSS supports data compression of files in a volume based on periods of inactivity or on demand. For information, see "Managing Compression on NSS Volumes" in the *Novell Storage Services File System Administration Guide for OES*
	The NSS near-line and off-line Migration feature for volumes supports third-party solutions for moving seldom-used data to offline storage. For information, see "Understanding Volume Attributes" in the *Novell Storage Services File System Administration Guide for OES*
	NSS provides volume space quotas, directory space quotas, and user space restrictions that enable you to control the storage capacity and how it is used. For information, see "Conserving Disk Space with Volume, Directory, or User Space Quotas" in the *Novell Storage Services File System Administration Guide for OES*
	Shared-disk clustering supports 32 by 32 configurations with 32 nodes in a cluster and 32 processors per server. Storage capacity is virtually unlimited with support for up to 2 petabytes per server. It can run on any SAN hardware, including iSCSI. For information, see the *OES Novell Cluster Services 1.8.1 Administration Guide for NetWare* and the *iSCSI 1.1.3 Administration Guide for NetWare 6.5*.

1.9 Data Consolidation

Your storage solution must allow you to reorganize and consolidate storage resources to improve manageability and to lower costs. For example, you can consolidate servers, applications, and operations into a cluster built with commodity components (such as iSCSI SANs, storage subsystems, and IP networks) to help lower costs.

For many organizations, the first step in a business continuity plan or disaster recovery plan is to consolidate existing resources in order to simplify management and reduce administration variables. A good business continuity plan accommodates remote, mobile, and distributed systems with virtual centralized management while providing comprehensive and automatic failover and redundancy.

Figure 1-1 *Example of Server Consolidation*

Storage Requirement	Novell OES Solution
Data consolidation: The ability to consolidate files, data, and other network resources to leverage SAN and other high-availability solutions while reducing the number of software and hardware configurations you have to manage	The Novell Server Consolidation Utility consolidates your server, data, and printer infrastructure, simplifies administration, and lowers cost. You can move from NetWare 4.2, 5.1, 6, and even Windows NT servers to OES NetWare and maintain all attributes during migration. It copies the accompanying rights, trustees, ownership, and name space information to the destination servers or cluster/SAN. The utility also copies many user attributes from one tree to another and can relocate printer agents from one print services manager to another.
	Consolidating to a NetWare storage SAN simplifies future hardware upgrades and expansions. For information, see the *Novell Server Consolidation and Migration Toolkit Administration Guide* (http://www.novell.com/documentation/scmt11/data/front.html).

| Storage Requirement	Novell OES Solution
Cost effectiveness: The ability to make the best of the storage resources you have by adapting them to a variety of solutions in your network	Because NSS supports a variety of storage architectures, as outlined in Chapter 2, "Storage Architectures," on page 29, you can easily use the resources you have whenever you modify your existing storage solution. For information, see the *Novell Storage Services File System Administration Guide for OES*.
	The Novell Server Consolidation Utility 2.5 enables you to easily transfer your existing configuration and data from multiple servers to a single server. For information, see the *Novell Server Consolidation and Migration Toolkit Administration Guide* (http://www.novell.com/documentation/scmt11/data/front.html)...
	The NSS Volume Copy Upgrade utility allows you to upgrade from earlier versions of NetWare. For information, see "Upgrading Legacy NSS and NetWare Traditional Volumes" in the *Novell Storage Services File System Administration Guide for OES*.
	Legacy support for the NetWare Traditional File System enables you to upgrade or maintain your existing storage solution. For a direct comparison of NSS and Traditional file systems, see "Comparison of NSS on NetWare and the NetWare Traditional File System" in the *Novell Storage Services File System Administration Guide for OES*. For information on configuring and using Traditional file systems, see the *NetWare Traditional File System Administration Guide for OES*.

1.10 Storage Monitoring and Maintenance

Your storage solution must be monitored and maintained. The ability to monitor from a distance allows you to centralize your storage administration tasks.

Storage Requirement	Novell OES Solution
Centralized storage management: The ability to perform storage management tasks remotely to reduce complexity and costs	The browser-based Novell iManager 2.5 allows IT staff to manage servers, storage, directory, users, security and the network from any location. You can remotely manage servers from NetWare, Windows, Linux, and UNIX computers. Novell iManager provides monitoring and management access for pooled, clustered, remote, synchronized, and redundant systems throughout the network. iManager provides role-based management of the environment. Different people in the organization can have rights to manage different parts of the enterprise, even if they are not IT staff. For general information about iManager, see the *Novell iManager 2.5 Administration Guide*. For information about the Storage plug-In for NSS, see "Novell iManager Storage Plug-In" in the *Novell Storage Services File System Administration Guide for OES*. For information about the Archive Versioning plug-In for Novell Archive and Version Services, see "Managing Jobs" in the *Novell Archive and Version Services 2.0 Administration Guide for OES NetWare*.
Local storage management: The ability to perform storage management tasks on the server when the operating system volume is not mounted	The NSS Management Utility (NSSMU) is a C-Worthy utility used to manage storage when the Web-based tools cannot be used, such as when the sys: volume is not mounted on NetWare. NSSMU is available for NetWare and Linux. For information, see "NSS Management Utility" in the *Novell Storage Services File System Administration Guide for OES*.
Unified resource management: The ability to centrally maintain and manage access authorization and information about network resources	Novell eDirectory is the cornerstone of a business continuity solution. eDirectory is a repository for all intelligence about network resources and access authorization information, settings, rights, locations, control variables, etc. Because of its architectural design, eDirectory is not tied to any specific domain, volume, or hard drive. This makes it possible for disk drives, servers, clusters, and even multiple locations to fail, but eDirectory and all of the intelligence contained therein remains intact for recovery and continued functionality. A network can continue to exist and rebuild itself using contingency solutions, providing full capability as long as one simple segment of the network remains intact. For information, see the *Novell eDirectory 8.7.3 Administration Guide*.

Storage Requirement	Novell OES Solution
Mixed environment data exchange and management: The ability to securely synchronize, transform, and distribute data across applications, databases, and directories on the network and across firewalls to partner systems	Novell Identity Manager (formerly DirXML) provides a means to synchronize, transform, and distribute data across applications, directories, databases on the network and across firewalls to partner systems. Idenity Manager achieves uniform data integrity and automated efficiency by helping to eliminate the manual and repetitive tasks of creating and modifying user identities in different systems and applications within an enterprise. It makes automatic changes based on business rules and preserves authoritative data sources. For information, see the *Novell Nsure Audit 1.0.3 Administration Guide*.
Monitor and manage system performance: The ability to monitor and manage server and storage performance	NetWare includes performance monitoring and management tools. The Novell Remote Manager interface includes many system performance monitoring and graphing tools. For information, see the *Novell Remote Manager for NetWare Administration Guide for OES*.
Monitor and manage backup/restore performance: The ability to monitor and manage server and storage performance during back up and restore processes	The TSATEST utility is included to help find backup/restore performance bottlenecks in the overall hardware/software system. For information, see the *Utilities Reference for OES*.
Remotely monitor and manage system performance: The ability to remotely monitor and manage server and storage performance	Novell Cluster Services management provides remote cluster resources management from any Java-enabled Web browser. Server storage can be dynamically assigned or reassigned, as needed. Administrators are automatically notified of cluster events and cluster state changes. For information, see the *OES Novell Cluster Services 1.8.1 Administration Guide for NetWare*.
Monitoring tools: The ability to monitor and report space usage, events, and policies for quotas and access	The iManager Plug-In for NSS provides reports of volume quotas and user space restrictions. For information, see "Conserving Disk Space with Volume, Directory, or User Space Quotas" and "Monitoring Quotas and Space Usage for NSS Pools and Volumes" in the *Novell Storage Services File System Administration Guide for OES*.

Figure 1-2 *Example of the Novell iManager Interface*
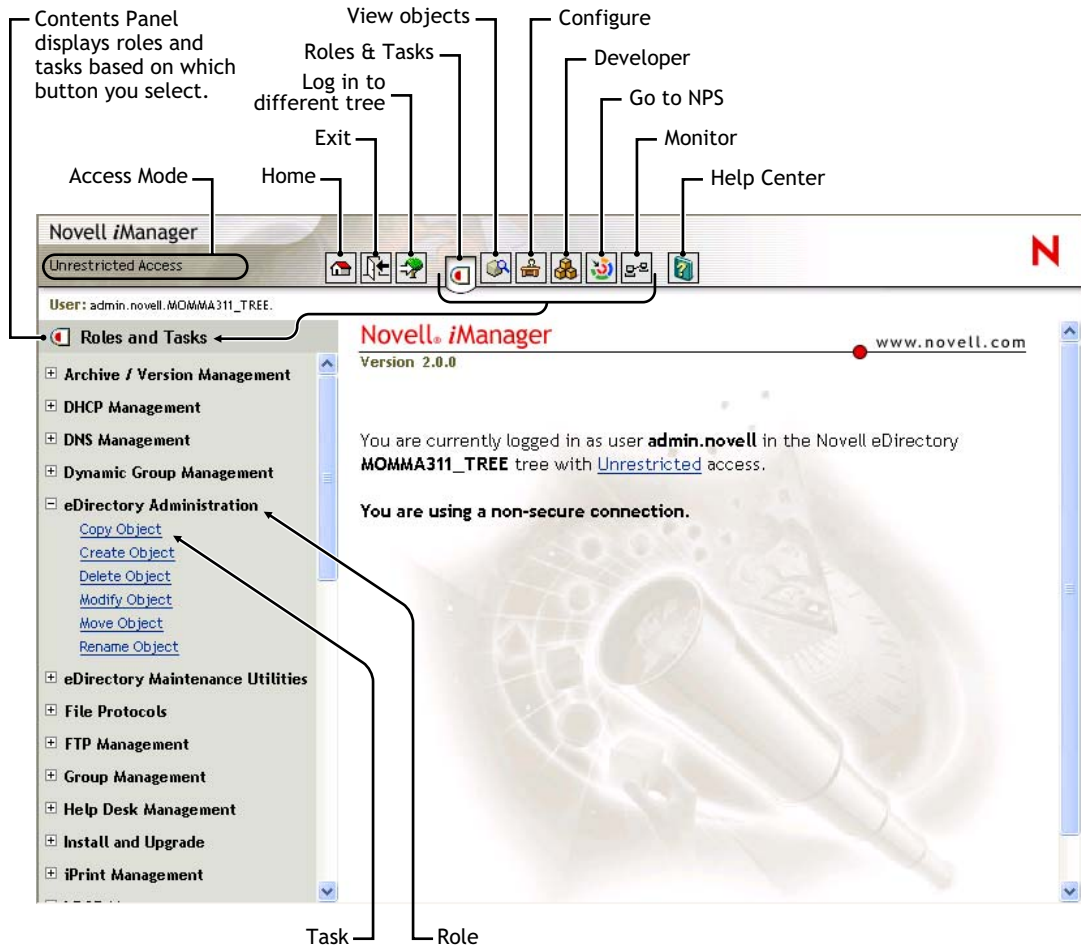
1.11 Storage Documentation

To learn more about other storage provisioning decisions with Open Enterprise Server, refer to the following storage-related documents.

NetWare Storage Solution	Reference
Novell Storage Services The primary file system management that virtualizes storage devices. NSS is available for NetWare and Linux.	*Novell Storage Services File System Administration Guide for OES*
NetWare Traditional File System A legacy method of NetWare file system management	*NetWare Traditional File System Administration Guide for OES*
Linux Traditional File Systems Traditional file systems, such as EXT3 and REISERFS, used for the Linux system and data files	*SUSE LINUX Enterprise Server 9 Administration Guide* (http://www.novell.com/documentation/oes/sles_admin/data/front.html)

NetWare Storage Solution	Reference
Server Disks and Storage A conceptual introduction to server disks and storage for NetWare server solutions	*OES Server Disks and Storage Devices for NetWare*
File Systems Management File systems management and access control to directories and files, using file system trustees and trustee rights for NSS volumes on Linux and NetWare and for NetWare Traditional volumes on NetWare.	*File Systems Management Guide for OES*
Linux Access Control Lists Local access control for Linux traditional file systems	"Access Control Lists" (http://www.novell.com/ documentation/oes/sles_admin/data/cha-acls.html) in the *SUSE LINUX Enterprise Server 9 Administration Guide* (http://www.novell.com/ documentation/oes/sles_admin/data/front.html)
Novell Cluster Services Server clustering application for 2 to 32 servers using shared or unshared volumes on direct attached storage devices or in Fibre Channel or iSCSI storage area networks	*OES Novell Cluster Services 1.8.2 Administration Guide for NetWare* *OES Novell Cluster Services 1.8.2 Administration Guide for Linux*
Novell iSCSI Support for iSCSI SANs; servers can be iSCSI initiators or targets	*iSCSI 1.1.3 Administration Guide for NetWare 6.5* (http://www.novell.com/documentation/iscsi1_nak/ iscsi/data/h4hgu4hs.html)
Network Attached Storage Server and Native File Access Protocols A special purpose NetWare server that provides secure, native file access in a cross-platform environment	Section 2.2, "Network Attached Storage Solutions," on page 30 *OES Native File Access Protocols Guide*
NCP Server A special purpose server that provides secure file services for NSS volumes on Linux and for Linux traditional volumes	*NCP Server for Linux Administration Guide* (http:// www.novell.com/documentation/oes/ncp_lx/data/ h9izvdye.html)
Novell Archive and Version Services A special-purpose NetWare server that copies versions of files at specified intervals or times to its file version archive, then makes saved file versions available to users via NetStorage for secure, on demand user data recovery	*Novell Archive and Version Services 2.0 for NetWare Administration Guide for OES* *Novell Archive and Version Services for NetWare User Guide for OES*
Novell Nterprise Branch Office A special purpose NetWare server that automatically synchronizes branch office data with an IT data center	*Nterprise Branch Office Administration Guide* (http:/ /www.novell.com/documentation/nbo2/adminguide/ data/h6bqnv8x.html)

NetWare Storage Solution	Reference
Novell NetStorage A special purpose NetWare server that provides secure Web-based access to network data and optionally to archived file versions (requires Novell Archive and Version Services)	*OES NetStorage Administration Guide for NetWare* (http://www.novell.com/documentation/oes/netstor/data/h9izvdye.html) *OES NetStorage Administration Guide for NetWare* (http://www.novell.com/documentation/oes/netstor_lx/data/h9izvdye.html)
Novell iFolder 2.1*x* and 3.*x* A special purpose NetWare server that provides file synchronization of users' local data and provides users secure access to their local data from anywhere, at any time	*Novell iFolder 2.1 Installation and Administration Guide* *Novell iFolder 2.1 User Guide* *Novell iFolder 3.x Administration Guide* (http://www.novell.com/documentation/ifolder3).
Novell Storage Management Services A basic server backup utility and interface for vendor backup/restore applications	*Storage Management Services Administration Guide* (http://www.novell.com/documentation/oes/smsadmin/data/hjc2z4tu.html)
Novell eDirectory A powerful directory services application that provides secure user access and network resources management	*Novell eDirectory 8.7.3 Administration Guide*
Linux User Management A service that enables eDirectory users to access volumes on Linux using non-NCP protocols and Linux utilities, commands, and services	*Novell Linux User Management Technology Guide* (http://www.novell.com/documentation/oes/lumadgd/data/front.html)
Novell Nsure Audit A data sharing service that leverages Novell eDirectory to synchronize, transform, and distribute data across applications, directories, databases on the network and across firewalls to partner systems	*Novell Nsure Audit 1.0.3 Administration Guide*
Novell iManager A Web-based network resources management tool used to manage storage solutions, including the NSS (Storage plug-in), CIFS (File Protocols plug-in), Archive and Version Services (Archive Versioning plug-in), and Clustering (Cluster Services plug-in).	*Novell iManager 2.5 Administration Guide* (http://www.novell.com/documentation/imanager25/imanager_admin_25/data/hk42s9ot.html)
Novell Storage Services Management Utility A C-Worthy device management tool to configure storage devices when the Web-based Novell iManager tool is not available (such as when the sys: volume is not mounted). NSSMU supports creating and mounting encrypted NSS volumes on both Linux and NetWare.	"NSS Management Utility" in the *Novell Storage Services File System Administration Guide for OES*

NetWare Storage Solution	Reference
File System Rights Utility (RIGHTS) A management tool for setting file system trustees and trustee rights for NSS on Linux and NetWare and for the NetWare Traditional File System	"RIGHTS" in the *Novell Storage Services File System Administration Guide for OES*
NetWare Remote Manager A Web-based monitoring and management tool for network resources, including the NetWare Traditional File System. You can also use this tool for managing file system trustees and trustee rights for directories and files in NSS volumes on Linux and Netware and on NetWare Traditional volumes.	*Novell Remote Manager for NetWare Administration Guide for OES* *Novell Remote Manager Administration Guide for Linux for OES*
ConsoleOne™ A Java-based monitoring and management tool for network resources, including clustering and distributed file services. These management interfaces are planned to be moved to Novell iManager in a future support pack release.	*ConsoleOne 1.3.x User Guide* (http://www.novell.com/documentation/consol13/c1_enu/data/hk42s9ot.html)
NetWare Utilities Reference A compendium of NetWare command line interface commands for NSS and Traditional file systems and for other management utilities	*Utilities Reference for OES*
Server and Data Consolidation Information for consolidating servers and data.	*Novell Server Consolidation and Migration Toolkit Administration Guide* (http://www.novell.com/documentation/scmt/index.html).

1.12 What's Next

To learn more about storage architectures, see Chapter 2, "Storage Architectures," on page 29.

Storage Architectures

<div style="text-align: right; font-size: 3em;">2</div>

Novell® Storage Services™ (NSS) simplifies the ever-increasing demands of storage growth, provisioning, and management. NSS is a proven extent-based journaled file system that maintains its performance for large numbers of files and for small to large volume sizes.

NSS virtualizes all of the space available on the server's storage devices. You can allocate segments of those resources to pools that span multiple devices, using your hardware to its maximum potential. NSS allow volumes to grow dynamically up to 8 terabytes (TB) within a pool of storage, based on your storage policies. You can also restrict space usage by pool, volume, directory, and user quotas.

Regardless of the volume's size or its number of files, NSS requires only 4 to 10 MB of server memory to mount the volume. NSS mounts an NSS volume in just three seconds and recovers it in under ten seconds, regardless of the size of the volume, for server crashes where no data is corrupted. If they do need to be run, file system repairs following a hardware failure take only minutes. Recovery of volumes where data corruption has occurred can take several minutes to several hours, depending on the size of the volume.

NSS can dynamically assign storage devices to a server to expand capacity. This means you can add, format, or partition new drives when the system is up and running.

NSS supports the following types of storage architecture for your servers:

- Section 2.1, "Direct Attached Storage Solutions," on page 29
- Section 2.2, "Network Attached Storage Solutions," on page 30
- Section 2.3, "Storage Area Network Solutions," on page 31
- Section 2.4, "Fault Tolerant and High Availability Architectures," on page 33
- Section 2.5, "Business Continuance Architectures," on page 37

2.1 Direct Attached Storage Solutions

In direct attached storage (DAS) solutions, the storage media attach directly to a server, either internally or externally. Every server must have some directly attached storage devices because the NetWare sys: volume must reside (at least initially) on the server. Generally, external server storage refers to hardware storage arrays such as RAID and JOBD arrays. These arrays connect through an external SCSI bus.

In a cross-platform environment, your DAS storage architecture can support Native File Access Protocols (NFAPs). This enables data services to be accessed by clients using a variety of operating platforms. For an explanation of NFAPs, see "Native File Access Protocols" on page 30. The key difference between a DAS solution and a NAS solution is that the NAS server's only job is to serve files to application servers or users; no applications run on the NAS server.

Novell NetWare server uses Novell eDirectory™ and Novell Storage Services to assign user access rights for directories and files, and to manage space restrictions.

2.1.1 Planning Considerations for DAS

DAS solutions are typical of small offices and distributed network storage solutions. The DAS architecture creates islands of storage because the disks belong to the server and are not available for any overflow and support needs for other servers.

With DAS solutions, the server must be operational for its attached data to be accessible to users. If the server is offline or if the external storage device is offline, the server's data is not available.

As your data grows, you can attach additional devices to the server up to the number of available slots on the SCSI bus. You also must consider the impact on I/O performance of adding additional devices on an already-busy SCSI bus. DAS works well for a few servers, each with a few hundred gigabytes of data.

2.2 Network Attached Storage Solutions

A network attached storage (NAS) solution is a dedicated data server or appliance that provides centralized storage access for users and application servers. A NAS server attaches directly to the existing network using traditional LAN protocols such as Ethernet and TCP/IP. At Gigabit Ethernet rates, access speeds from other servers are on parity with direct attached storage devices.

2.2.1 NetWare NAS Server

OES NetWare provides a preconfigured solution for a NAS server. The NAS pattern deployment includes NetStorage, which allows for Web-based sharing of and access to files. Whatever protocol governs the file access, users can also access the files from a wide variety of Web browsers using HTTP, HTTPS, and FTP. From any Web client, or through WebDAV for sharing, all your data is securely accessible.

An OES NetWare NAS server is able to drop into and integrate with any of these environments seamlessly. It can also bridge between these environments. Although NAS servers can be configured as appliances (stripped-down versions of the operating system and fixed storage media), you can configure any server as a NAS device.

You can configure the storage media in the server as a software RAID 1 storage device for data protection. With RAID 1, you have a "hot" spare in waiting ready to replace a failed drive.

The Novell NAS server uses Novell eDirectory™ and Novell Storage Services to assign user access rights, space restrictions, and password, just as you would for any OES NetWare server. Windows, Macintosh, and UNIX users must have a User object and password before they can access network resources using native protocols. A User object specifies attributes and information about which network resources the user can access.

NOTE: Windows users can also be managed through a Windows Domain Controller and UNIX users can be managed through Network Information Service (NIS).

2.2.2 Native File Access Protocols

The OES NetWare NAS server supports Native File Access Protocols to enable data services to be shared between different types of servers and accessed by different types clients using any of those servers. In a cross-platform environment, multiplatform clients and application servers can access storage on NetWare using their native protocols.

NetWare supports the following NFAPs:

Type of Networking	File Access Protocol
Windows	Common Internet File System (CIFS)
Novell	NetWare Core Protocol® (NCP)
UNIX and Linux	Native File System (NFS)
Macintosh	Apple File Protocol (AFP)
Web access	Hypertext Transfer Protocol (HTTP)
Secure Web access	Secure Hypertext Transfer Protocol (HTTPS)
Web file transfer	File Transfer Protocol (FTP)
Shared Web access	Web Distributed Authoring and Versioning (WebDAV)

With multiprotocol file system services, clients with disparate operating platforms can store and access data in the same file system without compromising the data's respective file attributes, security models, or performance.

For more information about using NFAPs on NetWare, see the *OES Native File Access Protocols Guide*.

2.2.3 Planning Considerations for NAS

NAS provides a cost-effect centralized solution for small and branch offices. If you need more storage, simply add more devices to your existing NAS solution. Small offices, enterprise branch offices, and small to midsize businesses might use NAS servers to store e-mail files, software installation information, and any data they would rather not store in more expensive storage area network (SAN) solutions.

The down side of NAS is that it adds bandwidth demands to your existing network. Because data requests travel on the same pipes as the data itself in an NAS solution, the network performance might be inhibited by available bandwidth and competing resources. Depending on your current network load, you might need to make some changes in the infrastructure to use high-speed Gigabit Ethernet interconnects.

2.3 Storage Area Network Solutions

A storage area network (SAN) solution provides a separate, dedicated network of storage media interconnected by high-speed interconnects. Instead of sharing the normal network bandwidth, data queries travel between servers and the storage media on these interconnects. Because SANs create a neighborhood in which vital corporate data resides, a secure SAN should be a gated community with restricted and verifiable access.

Novell's internal storage architecture allows an OES NetWare server to boot directly with the operating system on a local hard drive or on a SAN since Netware 5.1. (Theoretically, it has been supported since NetWare 3.0 because of Novell's unique asynchronous I/O architecture). Booting from a SAN allows administrators to immediately swap out server hardware in the event of a

disaster and directly boot without having to re-install NetWare. The automatic hardware detection in NetWare allows for a new server to have updated or different controllers when booting from a SAN.

The SAN interconnect fiber is typically a technology that offers faster transmission (bigger pipes) than is available in DAS buses or in the network bandwidth used for NAS traffic. Two key SAN interconnect technologies are Fibre Channel and iSCSI (Internet SCSI). An iSCSI SAN typically uses Gigabit Ethernet interconnects, adapters, and switches and IP routing to connect storage devices. In 2005, the Fibre Channel equipment costs are many times that of standard Ethernet equipment that can support iSCSI traffic.

2.3.1 Novell iSCSI

A Novell iSCSI SAN can operate at standard Fast Ethernet speeds, or you can implement a higher-speed infrastructure for the SAN. Typically, high-speed Gigabit Ethernet devices are necessary to meet SAN performance requirements. Higher speed Ethernet technologies such as 10 Gigabit Ethernet at higher cost.

Novell's iSCSI solution uses Novell eDirectory™ to manage iSCSI resources. You can manage the SAN from anywhere with a separate management console or disk controller. Administrators use the same well-known methods in eDirectory for granting trustee rights and user file access.

Novell iSCSI ensures business continuity in multiple ways. A distributed SAN ensures that data will still be accessible from geographic locations unaffected by the outage. A mirrored SAN will ensure that all data is continuously available from one site or the other in the event of a disaster. In addition, centralized storage provides for more timely and complete backups and faster data recovery in the event of data loss.

For more information, see the *iSCSI 1.1.3 Administration Guide for NetWare 6.5* (http://www.novell.com/documentation/iscsi1_nak/iscsi/data/h4hgu4hs.html).

2.3.2 Security Issues in the SAN

Unlike conventional IP networking security issues, security breaches in a SAN can have a permanent and devastating effect. Corruption of current data on disk or tape is absolute and recoverable only to the latest snapshot or backup version. For the highest degree of data integrity, synchronous data replication at least ensures that a current copy of real-time data is secured elsewhere.

Access Control Lists (ACLs) are another option for providing rudimentary verification, and prevent, for example, a newly introduced server from automatically logging on to the SAN fabric.

Cryptographic techniques (authentication and data encryption) add an incremental level of security for data in transmission and at rest, but cannot provide an absolute safeguard for storage. For data in transmission, authentication and encryption can ensure that sniffing the SAN transport will not yield usable data. This is especially applicable to IP storage environments, where data may be traveling over untrusted local or wide area network segments.

2.3.3 Planning Considerations for SANs

After NAS server solutions, an iSCSI SAN is the next price point of hardware entry and the lowest cost alternative for SAN solution. It provides the long-distance storage connectivity for multiple

applications, including disaster recovery for business continuity, storage consolidation, data migration, and remote mirroring.

The top reasons for implementing SANs are as follows:

- Improving backup and restore
- Improving disaster recovery
- Consolidating existing data capacity, typically as a result of server consolidation (Server Consolidation Utility)
- Supporting data sharing and collaboration
- Improving data access performance
- Managing data growth
- Improving storage management

2.4 Fault Tolerant and High Availability Architectures

To achieve fault tolerance and high availability in your storage architecture, you should consider incorporating one or more of the following technologies:

- Multiple Path I/O
- Software RAIDs
- Server Clusters

2.4.1 Multiple Path I/O

Multiple paths (multipathing) between the CPU/server and the disks can help to avoid a single point of failure in the connection between the CPU and the storage device. Your Novell OES Solution provides automatic path failover.

NSS automatically identifies multiple paths for in your server and storage configuration. By default, NSS chooses a primary path and sets priorities for multiple paths between each NetWare server and its storage devices. You can the NSS iManager Plug-In to view storage I/O paths for any given NetWare server, specify which path is the primary path, and configure priorities for automatic failover to alternate paths.

Multipath I/O is available in DAS, NAS server, and SAN storage solutions.

- In the case of external DAS and NAS server solutions, you can set up separate adapters in the server to attach to separate ports on the storage device.
- In SAN configurations, the number of paths between the server and the storage disks is more difficult to track manually. In all but the simplest configurations, you have at least two host bus adapters in each server. Each adapter connects to your fabric through a different switch for redundancy and performance. Each switch connects to the storage device through separate ports.

For more information, see ""Managing Multiple Connection Paths to Devices (NetWare)"" in the *Novell Storage Services File System Administration Guide for OES*

2.4.2 Software RAIDs

Building fault-tolerant disks can help maximize reliability. You can use RAID 1 (mirroring) to eliminate a single point of failure such as the failure of a physical disk. By using disk duplexing, each disk in the mirror set is on a separate controller. This eliminates another single point of failure such as the failure of a bus.

Data needs to be protected against losses that result from hardware failure. Typically, you need to configure devices with a software or hardware RAID 1 or RAID 5 solution. RAID 1 provides mirroring of the entire storage area. On failure of a single device, the mirror takes over and all data is immediately available to users.

RAID 5 provides striping with parity to allow recovery of data on the failure of a single hard disks. Service is degraded during the recovery, but all data is eventually reconstructed without data loss. Use RAID 5 when you want to optimize file access for a server, while also providing for protection against the loss of a single disk.

NOTE: In this release, RAID 5 is supported only on NetWare.

If you want the I/O performance of a RAID 0 and the data protection of a RAID 1, you can create a RAID 1 + 0 (RAID 10).

For more information, see ""Managing Software RAID Devices"" in the *Novell Storage Services File System Administration Guide for OES*.

2.4.3 Server Clusters

Novell Cluster Services combines two or more servers into a single group, known as a cluster. If one server in the cluster should happen to fail, another server automatically recovers the downed server's resources (applications, services, IP addresses, and volumes) and runs in its place. With Novell Cluster Services, you can configure up to 32 NetWare servers into a high-availability cluster where resources are dynamically allocated to any server in the cluster.

Resources can be configured to automatically switch in the event of a server failure, or can be moved manually to troubleshoot hardware, balance workloads, or perform maintenance. This frees IT organizations to perform maintenance and upgrades during production hours and eliminates scheduling down time with customer organizations.

In the event of an unplanned failure, any NetWare server in the cluster can restart resources from a failed server in the cluster. Typically, the failover occurs transparently to users with seamless access to authorized resources.

High Availability Clusters

To configure a fault tolerant Novell Cluster Services solution, a shared disk system is required for each cluster. All servers in the cluster are configured with the IP protocol and are on the same IP subnet in the same eDirectory tree. Additional IP addresses are required for each cluster resource and cluster-enabled volume.

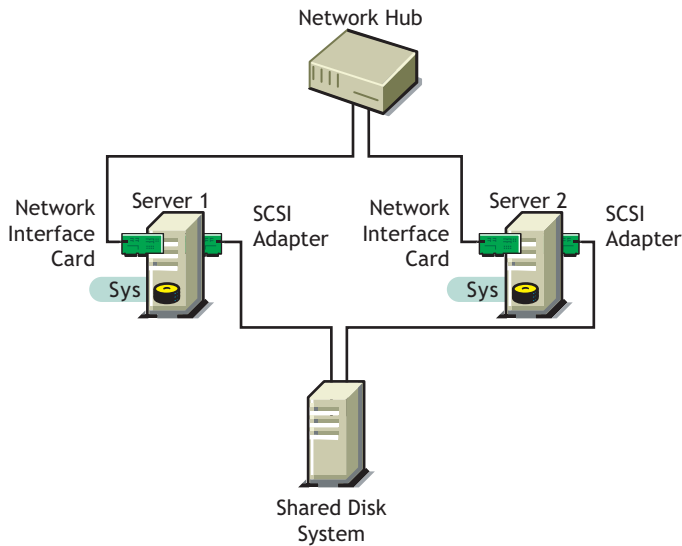There are three basic ways to share a volume using NetWare:

- Shared Volume on Direct Attached Storage
- Shared Volume in an iSCSI SAN

Shared Volume on Direct Attached Storage

For less complex needs, you can create a cluster using a the shared volume on direct attached storage.

Figure 2-1 *Example of a Shared Volume Cluster Using Direct Attached Storage*

Shared Volume in an iSCSI SAN

A new high-availability solution for shared volume clusters uses iSCSI protocols to connect the servers to the shared volume over commodity Ethernet and TCP/IP networks. Using these standard LAN technologies, iSCSI SANs can be centralized, distributed over multiple geographical locations, or configured as distributed mirrors so that one SAN continues in the event of failure of the other. For more information, see "Novell iSCSI" on page 32 and the *iSCSI 1.1.3 Administration Guide for NetWare 6.5* (http://www.novell.com/documentation/iscsi1_nak/iscsi/data/h4hgu4hs.html).

Figure 2-2   *Example of a Shared Volume Cluster Using an iSCSI SAN*
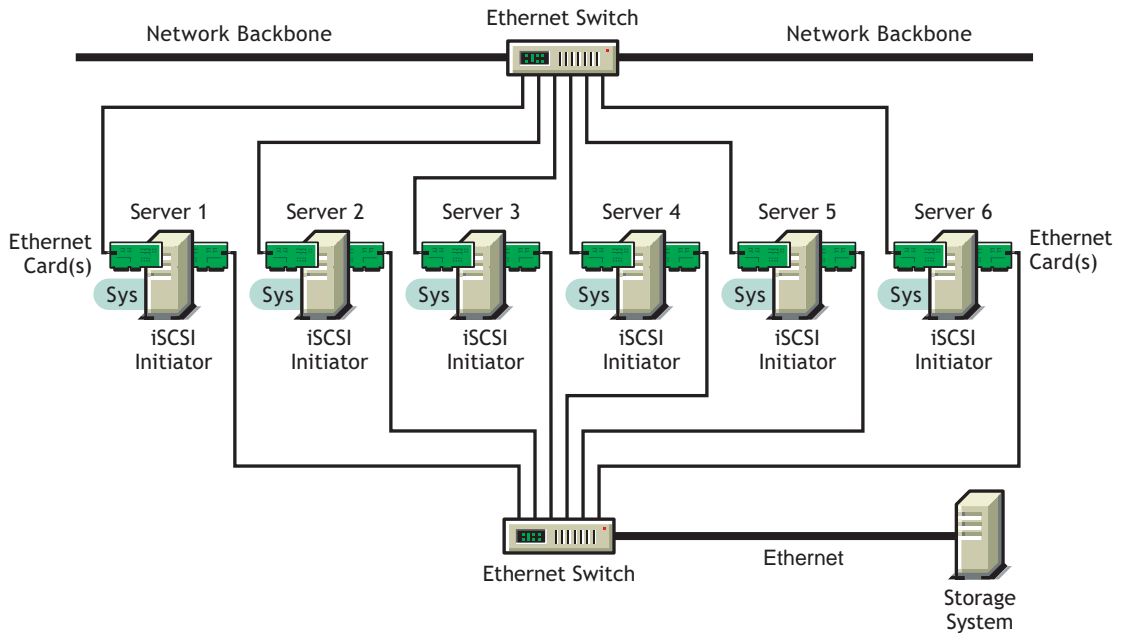
Shared Volume in a Fibre Channel SAN

The Fibre Channel SAN is the conventional method of creating high-availability clusters. For more information, see the *OES Novell Cluster Services 1.8.2 Administration Guide for NetWare* and *OES Novell Cluster Services 1.8.2 Administration Guide for Linux*.

Figure 2-3   *Example of a Shared Volume Cluster Using a Fibre Channel SAN*
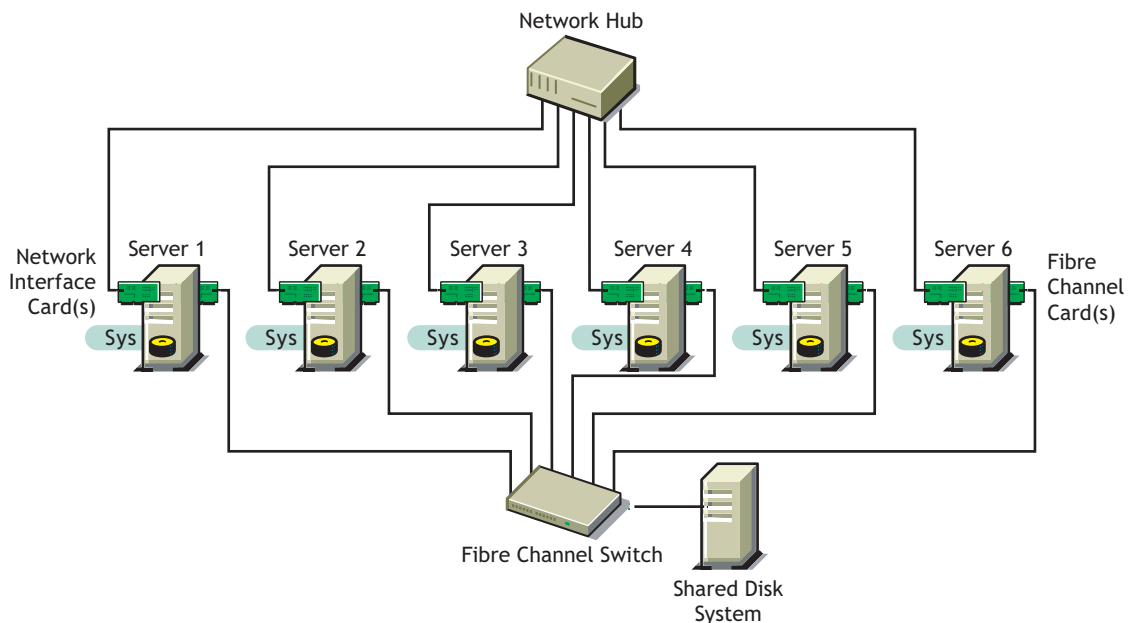
2.4.4 Novell Cluster Services

Novell Cluster Services ensures high availability and manageability of critical network resources including data (volumes), applications, server licenses, and services and provides the ability to tailor a cluster to the specific applications and hardware infrastructure for any organization. The Novell Cluster Services installation program automatically creates a new cluster object in eDirectory and installs Novell Cluster Services software on any servers specified to be part of the cluster. You can configure SANs and shared NSS pools in conjunction with clustered servers to create high availability networks.

Novell Cluster Services management provides remote cluster resources management from any Java-enabled Web browser. Server storage can be dynamically assigned or reassigned on an as-needed basis and administrators are automatically notified of cluster events and cluster state changes.

For more information, see the *OES Novell Cluster Services 1.8.2 Administration Guide for NetWare*, *OES Novell Cluster Services 1.8.2 Administration Guide for Linux*, and the *iSCSI 1.1.3 Administration Guide for NetWare 6.5* (http://www.novell.com/documentation/iscsi1_nak/iscsi/data/h4hgu4hs.html).

2.5 Business Continuance Architectures

Today's organizations are dispersed across multiple geographies, with increasing demands for flexible user access, application integration, and information backup. Business survival necessitates planning for every type of business disruption, including natural disasters, hardware and communication failures, and internal or external sabotage or acts of terrorism.

NetWare uniquely supplies the technologies to solve business continuity problems through intelligent consolidation strategies, redundancy, and automated failover. A viable disaster protection solution can be integrated without complexity or draining scarce IT resources.

With NetWare, you can implement the fault-tolerance, data-protection, and high-availability features to improve the reliability, security, and availability of your storage solution. For information, see the following NetWare features:

For information about:	Go here:
Fault tolerance and data integrity features including multipathing, distributed file services for moving and splitting volumes, Transaction Tracking System™, and Multiple Server Access Prevention.	See the following in the *Novell Storage Services File System Administration Guide for OES* • "Managing Multiple Connection Paths to Devices (NetWare)" • "Using Distributed File Services to Move and Split Volumes (NetWare)" • "Using the Transaction Tracking System for Application-Based Transaction Rollback (NetWare)" • "Preventing Pools from Activating on Multiple Servers"
Data fault tolerance and high performance features such as software RAIDs 0, 1, 5, 10, and 15	"Managing Software RAID Devices" in the *Novell Storage Services File System Administration Guide for OES*

For information about:	Go here:
Data protection features including backup/restore applications, pool snapshots, and the file snapshot volume attribute	"Managing NSS Pool Snapshots (NetWare)" in the *Novell Storage Services File System Administration Guide for OES*
Data backup and restore features	*Storage Management Services Administration Guide* (http://www.novell.com/documentation/oes/smsadmin/data/hjc2z4tu.html)
Highly available data solutions	*OES Novell Cluster Services 1.8.2 Administration Guide for NetWare*
	OES Novell Cluster Services 1.8.2 Administration Guide for Linux
	iSCSI 1.1.3 Administration Guide for NetWare 6.5 (http://www.novell.com/documentation/iscsi1_nak/iscsi/data/h4hgu4hs.html)
Mission critical data solutions	All of the above references.

Documentation Updates

A

This section contains information about documentation content changes made to the *Storage and File Services Overview for OES* since the initial release of Novell® Open Enterprise Server. If you are an existing user, review the change entries to readily identify modified content. If you are a new user, simply read the guide in its current state.

Refer to the publication date, which appears on the front cover and the Legal Notices page, to determine the release date of this guide. For the most recent version of the *Storage and File Services Overview for OES*, see Novell OES documentation (http://www.novell.com/documentation/oes/stor_ovw/data/front.html)

In this section, content changes appear in reverse chronological order, according to the publication date. Within a dated entry, changes are grouped and sequenced, according to where they appear in the document itself. Each change entry provides a link to the related topic and a brief description of the change.

This document was updated on the following dates:

- Section A.1, "November 1, 2005," on page 39
- Section A.2, "August 19, 2005 (OES SP1)," on page 39

A.1 November 1, 2005

The entire guide was reformatted to comply with revised Novell documentation standards. The content is unchanged.

A.2 August 19, 2005 (OES SP1)

Updates were made to the following sections. The changes are explained below.

- Section A.2.1, "Storage Solutions," on page 39

A.2.1 Storage Solutions

The following changes were made to this section:

Location	Change
File Access and Collaboration Services	Novell iFolder 3*x* supports shared access to iFolders. For information, see the *Novell iFolder 3.x Administration Guide* (http://www.novell.com/documentation/ifolder3).

Location	Change
File Access and Collaboration Services	**Authorized access to data in the event that media is stolen:** The ability to meet the legal standard of making data inaccessible to software that circumvents normal access control, such as if the media were stolen. NSS provides Encrypted Volume Support that requires password access to activate an encrypted NSS volume on server boot or restart. For information, see the "Managing Encrypted NSS Volumes" in the *Novell Storage Services File System Administration Guide for OES*.
Data Protection and Security	See also *Novell iFolder 3.x Administration Guide* (http://www.novell.com/documentation/ifolder3).