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technical blueprint

hp StorageWorks rapid restore for Microsoft® SQL Server 2000 solution

using hp StorageWorks enterprise volume manager and
hp StorageWorks enterprise virtual array

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executive summary

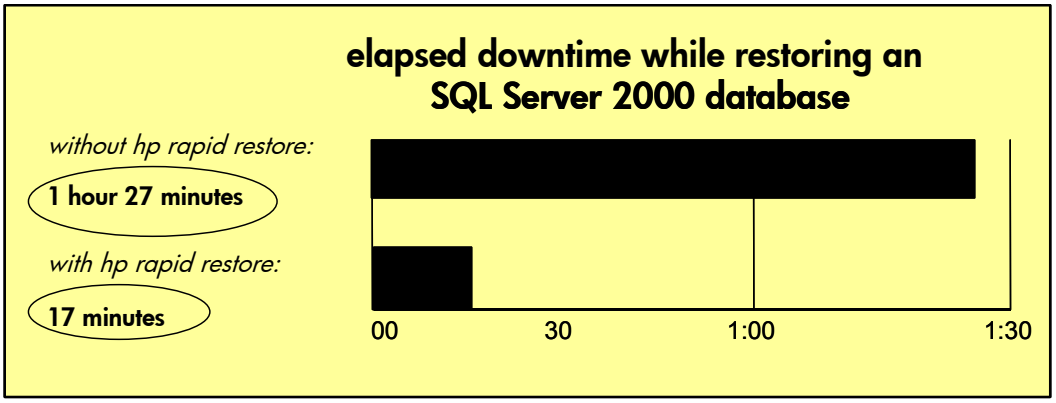
This technical blueprint describes a quick and complete method of recovering clustered Microsoft® SQL Server 2000 databases with minimal disruption. Using HP StorageWorks Enterprise Volume Manager (EVM) v2.0D and HP StorageWorks Enterprise Virtual Array (EVA) v2, customers can create virtually capacity-free snapshots (Vsnaps) and snapclones of their SQL Server databases and resume full operation of their clustered SQL Server environments in minutes. A Vsnap is a space-efficient point-in-time copy of the data. A snapclone is a complete physical point-in-time copy of a data volume. Both Vsnaps and snapclones can be used to perform an extremely rapid restoration of application environments.

Performance testing provided numerous insights into the best ways to use Vsnaps and snapclones with EVA for rapid recovery of SQL Server data. By using the information in this guide, customers will be able to do the following:

- determine whether Vsnaps or snapclones are more suitable for their environment
- create Vsnaps or snapclones of the SQL database
- restore data from Vsnaps or snapclones
- create scripts to implement automatic backups from snapclones
- back up from Vsnaps or snapclones to tape

Administrators face lengthy delays when restoring a SQL environment from tape. The HP StorageWorks Rapid Restore for Microsoft SQL Server 2000 Solution, which is based on creating Vsnaps and snapclones with EVM in a SAN configuration, reduces the restore time from hours to minutes and causes minimal disruption to end users. You can achieve a highly available SQL environment with a complete set of hardware, software, and supporting utilities. In addition, the time savings can be dramatic when restoring your SQL environment, as illustrated in **figure 1**.

figure 1. comparison of disk-to-disk restoration times using SQL Server 2000, a 400 GB database, and 200 users



By using this solution to augment your tape-based recovery plan, you can recover your entire application environment rapidly, decreasing the amount of application downtime. When you create a Vsnap or snapclone of your database, you have an exact point-in-time copy of your production data. In addition, you can offload operations from the production server. These operations include tape backup, which is discussed in this guide, as well as testing, data mining, and system maintenance. The solution also utilizes a Microsoft-supported interface and is engineered within Microsoft support guidelines.

"Microsoft SQL Server 2000 customers put their trust in the performance and reliability of the database. HP StorageWorks solutions for SQL Server 2000 help provide even more robust storage solutions for our customers. Rapid Restore for SQL Server and Virtualized Storage Management for SQL Server 2000 are pretested and automated solutions that take advantage of our highly scalable and versatile storage management software. Together, HP StorageWorks and SQL Server 2000 offer enhanced application availability and organizational agility in fast-paced environments."

Stan Sorensen
Director, SQL Server product marketing
Microsoft Corporation

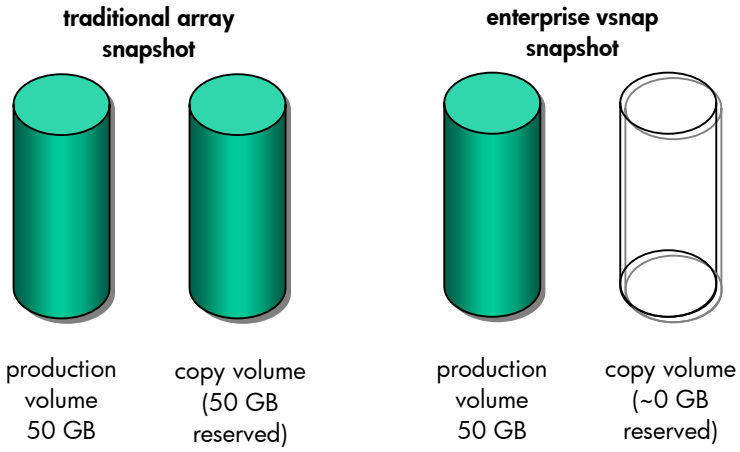
about Vsnaps and snapclones

With EVA, you can create traditional snapshots, demand-allocated snapshots (Vsnaps), and snapshots that normalize into snapclones. The traditional snapshot requires that you reserve and set aside space equal to the size of the original active virtual disk (Vdisk). Data is not written into this reserved space until necessary. As data changes in the original active Vdisk, the original data is written to the snapshot. Virtually capacity-free Vsnaps and virtually instantaneous snapclones are the powerful recovery technologies used in the Rapid Restore for SQL Server 2000 Solution.

Vsnaps allow on-the-fly space allocation. You can replicate data instantly by taking a "picture" of the data within seconds, without reserving an equal amount of capacity. Similar to traditional snapshots, Vsnaps are point-in-time copies of data volumes, although space is only used as the original virtual disk data changes. Once the snapshot is taken, the Vsnap takes up very little capacity. As users write to the database, the Vsnap grows as the Vdisk changes. With Vsnaps, the amount of disk capacity used by the copy only grows as data in the production volume changes over time, resulting in the most cost-efficient use of storage space.

Snapclones are complete physical point-in-time copies of data volumes and are ideal for reducing I/O loads on the production volumes. These copies can be used for backups to tape, disk-based backup, or application testing and data mining that will not impact production data. Snapclones are snapshots that normalize into clones. A snapclone has the same properties as a snapshot, so it is instantly available. The normalization process of copying the data from the original LUN happens in the background. Like a snapshot, a snapclone can be instantly mounted or backed up to tape. However, with snapclones, once the normalization process is complete, you have an exact copy of the database or LUN you wanted to clone. This is especially useful for fast restores if a catastrophic failure happens. Snapclones can be taken in any redundancy level (Vraid 0, 1, or 5) and they do not require extensive advanced preparation. Long "re-sync" times are also eliminated with snapclones since a current clone copy can be available for use in moments rather than hours.

figure 2. comparison of traditional snapshot to Vsnap snap



features and benefits

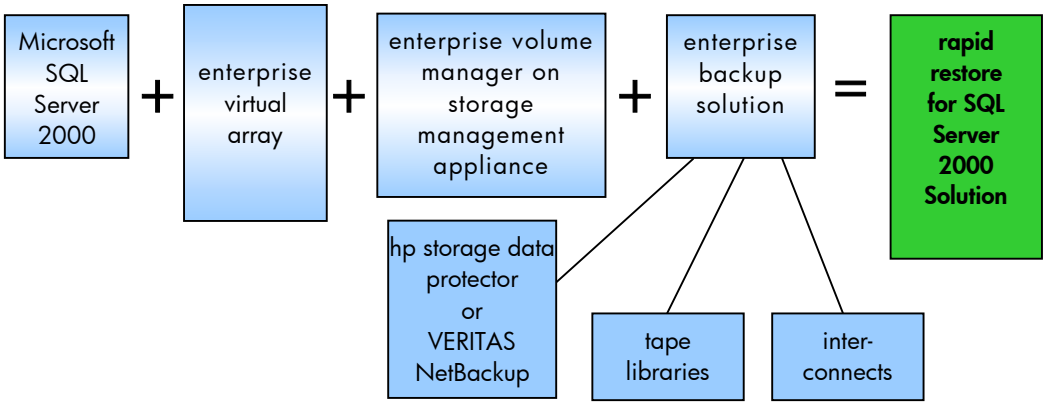
This solution provides the following benefits to administrators:

- dramatically improved restoration times for SQL Server 2000 databases
- best practices for maximizing SQL Server 2000 availability during database recovery scenarios
- simplified implementation and management, including script examples
- data integrity and engineering within Microsoft guidelines
- investment protection by leveraging existing HP hardware and software, supporting multiple configurations, and providing interoperability with future products
- integration with third-party tape backup applications—specifically tested with VERITAS NetBackup and HP OpenView Storage Data Protector

solution overview

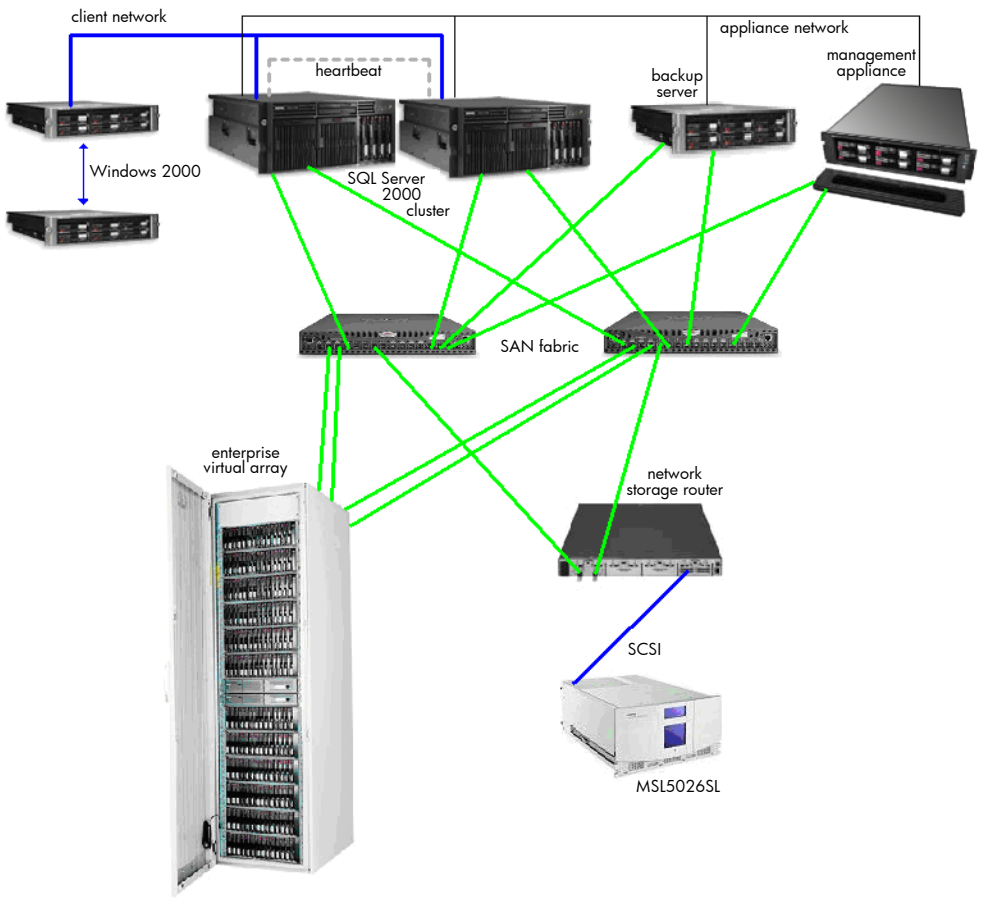
The Rapid Restore for SQL Server 2000 Solution is a validated and fully integrated configuration that provides a SAN-based backup and restore infrastructure for end-to-end data protection. This solution leverages the capabilities of EVA v2, EVM v2.0D, and the HP StorageWorks Enterprise Backup Solution (EBS), as illustrated in **figure 3**.

figure 3. solution building blocks



solution components

figure 4. diagram of components



The Rapid Restore for SQL Server 2000 Solution consists of the following basic components:

- **Microsoft SQL Server 2000**—You can configure the SQL Server 2000 application and database on any Windows® 2000 server and use a Microsoft Windows 2000 Cluster Service (MSCS) configuration for improved application availability.
- **enterprise virtual arrays**—The SQL Server database volumes must be located on the EVAs. Vsnaps and snapclones are created on the virtual array using virtual controller software (VCS), which operates the storage subsystem. EVA is the newest generation of disk arrays enabled by virtualization technology, an HP technology that allows you to manage disparate resources in a central pool.

  Based on the HP HSV controller, EVA is a high-performance, high-capacity, and high-availability virtual RAID storage solution that eliminates the time, space, and cost boundaries of traditional storage. EVA can save significant disk space and improve disk utilization efficiency because it does not reserve the same amount of disk capacity as the production volume being copied.
- **enterprise volume manager v2.0D**—Enterprise Volume Manager is browser-based storage management software that facilitates controller-based clone operations to make a block-to-block copy of a storage volume. With EVM, you can create, run, and manage automated storage replication jobs as well as link them with external jobs.

  You must have an EVM host agent on each database server to utilize controller-based database cloning. The HP OpenView Storage Management Appliance is the operating platform for EVM, which offloads processing from the user host systems.

- **enterprise backup solution (optional)**—EBS provides a consolidated backup infrastructure composed of multiple servers connected over a high-speed Fibre Channel SAN to centrally attached SCSI tape libraries. EBS significantly shrinks backup windows with a flexible approach to data protection.

  EBS combined with HP OpenView Storage Data Protector version 5.0 or VERITAS NetBackup version 3.4 provides SAN-based backup and restore operations for snapclone-based tape backups. You must use a SAN-attached backup configuration when using this solution for clone-based offline tape backups. An approved third-party backup application with associated SQL Server agents and SAN agents provides backup management. A separate backup host with the backup application loaded and viewable to the storage subsystem is required to act as the dedicated backup server. For granular backups and restores, a copy of the SQL Server 2000 application must be loaded on the backup server.

test environment

This section describes the baseline configuration and provides listings of the hardware and software components used in the solution.

test configuration

Two ProLiant DL580 servers, each with two FCA2101 (2 Gb HBA) adapters, powered the SQL Server (active/passive) cluster. A ProLiant DL380 was used as a backup server to host the backup applications and manage data protection for the tape library. The SAN was configured with two redundant 2 Gb 16-port SAN switches and managed by the HP OpenView Storage Management Appliance. The storage consisted of an Enterprise Virtual Array with 3.1 TB of disk storage and was backed up with an MSL5026 SDLT tape library. The SQL database was 370 GB.

The Ethernet was set up and configured for cluster operations using Cluster Administrator. Three different submasks were used for the Ethernet configuration. A submask was set up for the heartbeat between the two cluster nodes. The heartbeat was configured as a private network for cluster communication only. A second submask—configured as a public network—was set up for client access to the application servers. The third submask was set up for the Storage Management Appliance and its applications. This network was set up as a mixed network so the applications running on the Storage Management Appliance could operate corresponding agents on the hosts connected to the SAN.

hardware and software components

Following are the hardware and software components used in the test configuration.

table 1. hardware components

ProLiant servers hardware	part number
ProLiant DL580 servers: Quad Intel® Pentium® III Xeon 900 MHz processors, 512 KB level 2 cache (256 KB per processor) 4 GB RAM	(2) 155618-003 (4) 222627-B21 (2) 189083-B21
18 GB Ultra3, 15K rpm drives in each server	(2) 188122-B22
FCA 2101 (LP952) host bus adapter	(4) 245299-B21
backup server	
ProLiant DL380 server: Dual Pentium III 1 GHz processors, 512 KB level 2 cache (256 KB per processor) 2 GB RAM Thermal upgrade kit	193706-001 187602-B21 128280-B21 210818-B21
FCA 2101 (LP952) host bus adapter	(2) 245299-B21
SAN appliance	
Storage Management Appliance II	189715-002
storage hardware	
HP StorageWorks Enterprise Virtual Array—2C6D-A: 42U M3220 controller assembly with dual HSV110 controllers and 6 M5214 dual fibre loop 14-bay drive enclosures	283194-B21
36 GB 10K rpm dual-port 2 Gb/s FC-AL 1-inch drive	(84) 238590-B21
Enterprise v1.0 to v2.0 upgrade kit (Vixel Switches)	283266-B21
2 Gb 16-port SAN switch	(2) 240602-B21
2 Gb SFF-SW transceiver kit	(32) 221470-B21
Modular data router	163083-B21
MSL5026SL RM SDLT Minilibrary (2 drives)	231892-B22
30 m LC-screen Multi-Mode Fibre Channel cable	221691-B26
15 m LC-screen Multi-Mode Fibre Channel cable	221691-B23
5 m LC-LC Multi-Mode Fibre Channel cable	221692-B22
15 m LC-LC Multi-Mode Fibre Channel cable	221692-B23

table 2. software components

software	part number
Windows 2000 Advanced Server with Service Pack 2	Third party
Microsoft Cluster Server	Included
Microsoft SQL Server 2000 Enterprise Edition with Service Pack 2	Third Party
HP StorageWorks Secure Path v4.0 (5 licenses)	231292-B22
HP StorageWorks EVM 2.0D (Starter kit, 5 host licenses)	263670-B22
Windows NT®/Windows 2000 kit v2.0 ENT VIR ARY	250195-B22
Snapshot License for VCS v2.0 dual HSV controllers up to 3.1 TB	253256-B22
VCS PKG v2.0 dual HSV controller (base controller software)	250203-B23
HP OpenView Storage Data Protector 5.0 with SQL Server 2000 data agents: Starter pack SAN drives Online extension for SQL agents	 B6961AA B6953AA (one per drive) B6965BA
TPC-C Benchmark Kit for SQL (load generator)	Third party
VERITAS NetBackup v3.4 Server Software and SQL data agents	Third party

performance results

A baseline configuration was developed to determine the impact of snapclones and Vsnaps on the SQL Server 2000 database. All performance tests were compared against this baseline configuration, which included a clustered SQL Server 2000 without EVM installed, 200 users, and a 50 percent CPU load against the database servers. TPC-C benchmarking was used to create the OLTP load on the database and the performance numbers were collected using Windows Performance Monitor. The numerical results are displayed in **table 5**, "system and application performance results." The following configurations were tested:

- **baseline with EVM—test 1.** EVM v2.0D was installed into the SAN environment and a baseline test was performed to determine the impact of EVM on the SQL Server and SAN environment.

  Results: Introducing EVM to the SQL Server SAN environment did not have an impact on the performance of the environment.

- **creating snapclones—test 2.** Creating snapclones with Enterprise Virtual Array involves utilizing available disk space in the disk group of the parent virtual disk to create the virtual disk copy. Using snapclones in this solution will consume 1.2 TB of data, including the mirrored database of 400 GB.

  Results: The performance counters showed a slight degradation in the performance of the database by about 14 percent while the snapclones were being built. The snapclone creation took about one minute and 50 seconds. During this time, the SQL Server database remained online, database reads were unaffected, and database writes were temporarily queued until the creation was complete. During the snapclone building process, all transactions occurred normally. Creating and building snapclones has a minimal effect on the SQL Server and EVA performance.

Table 3 shows the snapclone building times for different-sized database volumes.

table 3. snapclone building times

LUN size/type	normalization time without load	normalization time with load
100 GB log	74 minutes	132 minutes
100 GB data	80 minutes	97 minutes
200 GB data	137 minutes	135 minutes
Total 400 GB	281 minutes	339 minutes

- **creating Vsnaps—test 3.** Four Vsnaps were created for each virtual disk. The performance impact was measured while changes were being made to the SQL Server database. Like the previous test, this test ran until the data consumed about 1.2 TB, including the database.

  Results: The performance counters showed a slight degradation in the performance of the database by about 12 percent while the Vsnaps were growing. The Vsnap creation took about two minutes and ten seconds. During this time, the SQL Server database remained online, database reads were unaffected, and database writes were temporarily queued until creation was complete.

- **backing up to tape—test 4.** For comparison purposes, a tape backup was made of the SQL Server database while it was online. The time it took to create the tape backup was compared to the time it took to back up the snapclones to tape. Both tests used the tape backup applications (HP OpenView Storage Data Protector and VERITAS NetBackup) and SQL Server data agents when necessary.

  Results: The time to perform a full online tape backup of the database was six hours and ten minutes, or 278 times longer then the time needed to create the snapclone.

  Although online tape backups have a minimal effect on SQL Server performance, they are an inefficient method for frequent backups because of the time required for completion and the potential contention with user activity. Snapclone-based backups also have minimal impact on the application performance but require much less time for completion.

- **restore operations—test 5.** Using snapclones or Vsnaps to restore an SQL Server 2000 database can be done with the Windows drag and copy functions. HP recommends that you take the time to copy the Vsnap files onto the original volumes.

  Results: The use of snapclones with EVA and EVM proves to be the fastest and most reliable means of restoring an SQL Server 2000 database (see **table 4**).

table 4. time needed for different restore methods

SQL Server restore method	time
SQL Server snapclone restore	17 minutes
SQL Server native restore	1 minute 27 seconds
Windows file drag and copy	17 minutes to 2 hours (depending on database file size)
SQL Server tape restore	22 hours

table 5. system and application performance results

	baseline without EVM	baseline with EVM	creating snapclones	creating Vsnaps
User connections	200	200	200	200
Benchmark profile	OLTP	OLTP	OLTP	OLTP
Length of test	4 hours	4 hours	6 hours	6 hours
Number of log disks	1	1	1	1
Number of database disks	2	2	2	2
Database pause time	n/a	n/a	1 min. 50 sec.	2 min. 10 sec.
processor utilization				
Processor time (%)	67.6	51.9	62.0	64.6
Processor % CPU time—SQL Server	n/a	246.7	241.0	248.0
memory utilization				
Available bytes (MB)	1631	n/a	160	1585
Pages/second	0.076	n/a	0.074	1.007
logical drive utilization				
Total average disk bytes/transfer	8412	8390	8415	8412
Total disk write bytes/second	12,413,923	8,291,141	6,534,211	7,292,705
Total disk read bytes/second	25,293,760	18,117,173	9,821,049	14,454,407
Total current disk queue length	179	179	188	159
Total percent disk time	225	154	90	114
Total disk transfers/second	4482	3143	2305	2585
SQL Server				
Transactions/second	177	117	101	103
Active transactions	156	150	160	159
Log flushes/second	36.6	23	18	22
Buffer cache hit ratio	89	89	89	89
Page reads/second	3028	2173	1577	1730
Page writes/second	1466	980	735	860
Cache hit ratio	99	99	99	99

adaptable, extensible, controllable

ENSAextended is an architecture that puts businesses in control of their storage environment and provides ways for them to control complexity, uncertainty, and risk. This Rapid Restore for SQL Server 2000 Solution supports the ENSAextended strategy in the following ways:

- **adaptability**—You can easily write customized EVM scripts to meet your business needs.
- **extensibility**—You can use several different third-party backup applications, such as VERITAS NetBackup and HP OpenView Storage Data Protector.
- **controllable**—You have total control over your backup process.

summary

Local replication of online disks and volumes is emerging as the technique of choice for protection of critical data. Companies today rely, to an unprecedented extent, on online, frequently accessed, constantly changing SQL databases to run businesses. Unplanned events that prevent the availability of data can have negative consequences for business operations. Even with a well-executed backup strategy, administrators face lengthy delays when restoring an SQL environment. The Rapid Restore for SQL Server 2000 Solution reduces the restore time from hours to minutes and causes minimal disruption to end users. You can achieve a highly available SQL environment with a complete set of hardware, software, and supporting utilities.

for more information

For additional information on the Rapid Restore for SQL Server 2000 Solution:
www.compaq.com/products/storageworks/solutions/rapidrestoresql/index.html

Microsoft SQL Server information:
www.microsoft.com/sql/default.asp

HP StorageWorks Enterprise Virtual Array information and documentation:
www.compaq.com/products/storageworks/enterprise/index.html

HP OpenView Storage Management Appliance information and documentation:
www.compaq.com/products/sanworks/managementappliance/index.html

HP StorageWorks Enterprise Volume Manager documentation:
www.hp.com/products/sanworks/evm/documentation.html

HP StorageWorks EVM integration with Enterprise Backup Solutions including VERITAS NetBackup: www.hp.com/products/storageworks/ebs/documentation.html

HP StorageWorks Secure Path information and documentation:
www.compaq.com/products/sanworks/secure-path/documentation.html

HP OpenView Storage Data Protector information and documentation:
www.openview.hp.com/products/dataprotector/index.asp

VERITAS NetBackup information and documentation:
www.veritas.com

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