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How Veritas Storage Foundation Complements Microsoft Windows Server Enhancing the Data Center

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Content

- Introduction..... 4
- Storage Technologies introduced in Windows Server 2003..... 4
- Storage features introduced in Windows Server 2008 Storage 5
- Complimenting Windows Storage Technologies 5
- Virtual Disk Service (VDS)..... 5
- Automated System Recovery (ASR) 6
- Volume Shadow Copy Services (VSS) 6
- Veritas Storage Foundation for Windows FlashSnap Option 7
- Microsoft Exchange Server 7
- Microsoft SQLServer 8
- VxSnap 8
- Quick Recovery Configuration Wizard 8
- Multipath I/O (MPIO) 9
- Microsoft iSCSI Initiator 10
- Enhancing Windows Server with Veritas Storage Foundation 10
- Storage Management 10
- Capacity Monitoring and Automatic Volume Growth 11
- Thin Provisioning 11
- Volume Shrink 12
- Volume Shred 12
- Solutions Configuration Center 13
- Storage Foundation Manager 13
- Performance 13
- VxCache 14
- Automatic Track Alignment 14
- SmartMove..... 14
- Availability 15
- Microsoft Cluster (MSCS & Failover Cluster) 15

Veritas Volume Replicator	16
Summary.....	16

Introduction

Microsoft introduced several new storage management features in Windows Server 2003. In Windows Server 2008, they extend functionality to include the ability to shrink partitions and volumes online and DSMs to configure multi-pathing in iSCSI and FC environments. This paper will outline how Veritas Storage Foundation™ *for Windows* integrates and co-exists with, and complements these new features, and extends the capabilities of Windows with several features of its own.

Storage Technologies introduced in Windows Server 2003

Virtual Disk Service (VDS) - VDS enables the management of multi-vendor storage devices and is vendor-neutral and technology-neutral. VDS includes two command line utilities; DISKPART for software RAID (the CLI equivalent of Windows Disk Management), and DISKRAID for hardware RAID.

Automated System Recovery (ASR) - Automated System Recovery (ASR) extends the functionality of a traditional backup and restore application by providing an external mechanism to save information about the system state and configuration, including Veritas Storage Foundation for Windows information. If a disaster or other event causes a computer to be unbootable, ASR can be used to restore the system to a bootable state and prepare it for data recovery.

Volume Shadow Copy Service (VSS) - The Volume Shadow Copy service provides an infrastructure for creating point-in-time copies (snapshots) of volumes, and includes an in-the-box VSS provider that enables the creation of shadow copies via copy-on-write technology. Microsoft guarantees the integrity of these VSS snapshots.

Multipath I/O (MPIO) - Windows Server 2003 includes a multi-pathing framework for creating a highly available environment in which multiple paths are available from the host to the external storage device. Multipath I/O (MPIO) is not a feature of the operating system, but Microsoft provides the MPIO Driver Development Kit (DDK), which allows storage vendors to create interoperable multi-pathing solutions. Up to 32 paths are supported. Load balancing is an additional benefit that improves performance.

Storage features introduced in Windows Server 2008 Storage

With Windows Server 2008, Microsoft introduces a few new storage features, including enhanced support for multi-pathing in iSCSI and fiber channel environments via a MPIO device specific module (DSM), support for SCSI-3 to allow for persistent reservations in a cluster, the ability to dynamically shrink basic partitions and dynamic volumes, and alignment of newly created volumes within the boundaries of the physical tracks of the hard disk. Microsoft has also added an in-box VSS requestor for creation of hardware and software shadow copies. They document the following new features in Windows Server 2008:

Storage Explorer – Provides administrators a complete view of their storage infrastructure. It uses Windows Management Instrumentation (WMI) to generate a tree-view of storage area network (SAN) components, including fabrics, platforms, storage devices and LUNs (logical unit numbers).

Disk Management – Allows administrators to easily expand and shrink volumes, including the system volume. All volumes are also automatically aligned to optimize their use by applications such as Microsoft Exchange Server.

Windows Server Backup – Supports the Volume Shadow Copy Service for backing up volumes and can create incremental backups of data to support quick recovery in the event of a disaster.

Failover Clustering – Provides improved control over clustered storage compared to earlier versions of Microsoft clustering. Failover clustering supports GUID partition table (GPT) disks, which allow capacities greater than 2 TB.

Complimenting Windows Storage Technologies

Veritas Storage Foundation for Windows provides functionality which complements the new storage technologies in Windows Server 2003 and 2008.

Virtual Disk Service (VDS)

On Windows Server 2003, Veritas Storage Foundation for Windows (SFW) replaces the Logical Disk Manager (LDM) to provide disk and volume management functionality, including functionality that was previously provided by LDM. A VDS provider interface is provided by SFW to allow VDS applications, such as DISKPART or VDS-enabled third-party vendor applications, to function. If SFW is uninstalled, LDM is restored as the native disk and volume manager for Windows and resumes its role with the VDS service.

With Windows Server 2008, the native disk and volume manager is Microsoft Disk Management. SFW no longer replaces Microsoft Disk Management; it now co-exists with it, providing functionality similar to that provided on Windows Server 2003, while leaving Microsoft Disk Management intact and available to manage its own objects. If SFW is uninstalled, Microsoft Disk Management is not affected; however, SFW objects will not be able to be accessed or managed. Note that Microsoft Disk Management does not support objects, such as dynamic disks and volumes, which are created with SFW, and that SFW functionality is not available through the Microsoft command line VDS interfaces at this time.

Automated System Recovery (ASR)

During an ASR backup, several files are created, including `asr.sif`, `asrnpn.sif`, and `setup.log`. The `asr.sif` (ASR State Information File) stores the system name, host ID, and other system state information and contains a number of subsections that store specific types of information. SFW uses the following subsections to save dynamic disk group and volume configuration information:

- `InstallFiles` — lists the set of files that are needed to perform the recovery of the dynamic disk groups and volumes. It also contains information about the original installation media where these files are located. ASR uses this section during the text-only mode of recovery to prompt the user to insert the correct media and to copy the listed files to the requested location.
- `Commands` — contains two command entries: one is for installing the necessary SFW program components that will be used for recovery, and the other is the file that runs the recovery process.
- `VXVMASR.VOLUMECONFIG` — contains the configuration information for all the SFW volumes on the system.

The `asrnpn.sif` and `setup.log` files are used to store the PNP state and the system configuration information, respectively. Together with the `asr.sif` file, they create a complete picture of the layout and configuration of your system.

Volume Shadow Copy Services (VSS)

The FlashSnap™ Option for VERITAS Storage Foundation *for Windows* is fully integrated with the Volume Shadow Copy Service and includes a VSS provider, the VERITAS Volume Snapshot Service Dynamic Provider, and can act as a VSS requestor via GUI based wizards, a snapshot scheduler and a command line utility, `vxsnap`. As a requestor, SFW can independently initiate snapshots. With FlashSnap, it integrates with VSS to snapshot volumes associated with Microsoft Exchange

or SQL Server. VSS works to quiesce the application in preparation for the snapshot to be taken, after which the application is reactivated. Integrity of the snapshots is guaranteed by VSS.

Veritas Storage Foundation for Windows FlashSnap Option

With the FlashSnap Option, VERITAS Storage Foundation *for* Windows offers a solution that is a multi-step process which allows you to create independently addressable snapshot volumes that are copies or mirrors of their source volumes. It also integrates with and leverages the VSS technology in Windows to facilitate snapshot backups of Microsoft Exchange Storage Groups and Microsoft SQL Server databases. The snapshot volumes are full-mirror, point in time copies of volumes, which can be moved to another server for off-host operations, or kept on-host to be available for quickly recovering from a disaster. Single or multiple simultaneous snapshots can be done through the GUI or the vxsnap CLI command.

Microsoft Exchange Server

Snapshots can be taken of Microsoft Exchange Server 2003 and Microsoft Exchange Server 2007. FlashSnap supports Full and Copy VSS backup types, where full backups run Eseutil against the snapshots and truncates the transaction logs, and copy backups are essentially a point in time copy of the storage groups volumes without log management. Eseutil is available as an option for copy backups.

Snapshot sets can be one-time or scheduled. To schedule a one-time snapshot set, use the VSS Exchange Snapshot wizard in the GUI. To schedule a snapshot set, use the VSS Exchange Snapshot Scheduler wizard in the GUI. VxSnap is also available for creating one-time snapshots of an Exchange Storage Group from the command line.

Two snapshot recovery types are available – point-in-time and point-of-failure recoveries.

The point-in-time recovery restores the data to the time that the snapshot set was last refreshed—that is, it restores all the data that was recorded in the snapshot.

The point-of-failure recovery recovers the Exchange storage group by restoring the old image of the data volumes only and replaying the logs to accomplish a roll-forward recovery, provided that the log volume is intact.

SFW 5.1 also allows snapshot recovery to the Recovery Storage Group with Microsoft Exchange Server 2007 SP1, allowing production volumes to remain intact.

Microsoft SQL Server

FlashSnap also supports taking Full backup and Copy VSS snapshots of Microsoft SQL Server databases. A Full backup is required to replay logs in SQL Server as part of restoring a database. Logs can be replayed from the time of the last Full backup. Copy backups do not affect the sequence of log replay. They are typically used as an out-of-band copy for purposes such as testing or data mining.

Snapshot sets can be one-time or scheduled. To schedule a one-time snapshot set, use the VSS SQL Snapshot wizard in the GUI. To schedule a snapshot set, use the VSS SQL Snapshot Scheduler wizard in the GUI. VxSnap is also available for creating one-time snapshots of a SQL database from the command line.

Snapshots can be used to recover SQL databases in three ways:

Recovery + Log replay restores the database and the transaction log volumes. Transaction log backups are also applied the database is left in an online state.

Recovery restores the database and the transaction log volumes. No other logs are applied and the database is left in an online state.

No Recovery restores the database and the transaction log volumes. However no logs are applied and the database is left in a loading state and ready for backup transaction logs to be applied.

VxSnap

The vxsnap command line utility integrates with the Windows Volume Shadow Copy Service (VSS) as a VSS Requester, allowing for the simultaneous snapshot of all volumes associated with an Exchange Server Storage Group or SQL Server database.

Quick Recovery Configuration Wizard

As part of the Solutions Configuration Center (covered later in this paper), the Quick Recovery Configuration Wizard offers users an easy way of configuring snapshot backup sets for Microsoft Exchange Server 2003 and 2007, and Microsoft SQL Server 2005. The wizard covers the steps to setup schedules for all phases of snapshot creation and maintenance, including preparing the mirrors, creating the initial snapshot sets and periodically refreshing the snapshot sets. It permits the scheduling of multiple snapshot sets for one or more storage groups for Exchange, or one or more databases for SQL. Different schedules can be set up for each snapshot set. The wizard also facilitates the scheduling of when to prepare the snapshot mirrors, when to create initial snapshot sets, and when to refresh the snapshot sets, allowing for the creation of a

schedule that best suits the environment. The scheduling capability also allows for automating the process to refresh the snapshot sets; at the scheduled time, the snapshot volumes are automatically reattached, resynchronized, and then split again.

Multipath I/O (MPIO)

Dynamic MultiPathing (DMP), available as an option to VERITAS Storage Foundation *for Windows*, is VERITAS' multipathing solution for Windows. DMP provides an enterprise solution that is supported on both Windows Server 2003 and Windows Server 2008. It is also available on the other major OS platforms – Linux, Solaris, HP-UX and AIX. On Windows, DMP supports an extensive list of hardware arrays via MPIO Device Specific Modules (DSMs).

NOTE: In versions preceding SFW 5.1, support for multi-pathing was provided via two methods - Veritas' Array Support Libraries (ASL) and MPIO Device Specific Modules (DSMs), giving the user a choice at installation. However, MPIO DSMs were the recommended option. With the release of SFW 5.1, ASLs have been retired and MPIO DSMs are the only choice for multi-pathing support.

DMP supports multiple load balancing modes:

- Failover only - Active/Passive
- Round Robin - Equally distributes I/O among the paths in a Round Robin sequence
- Dynamic Least Queue Depth - Schedules IO through the path that has the least number of I/Os pending
- Balanced Path - Special load balancing of round-robin. This algorithm follows a "balanced path policy" for scheduling I/Os across available paths for Active/Active disk arrays
- Weighted Path - This algorithm allows the customer to define the priority to be assigned on a per path basis based on how the system including the SAN pathway is configured
- Least Blocks - This algorithm periodically keeps track of I/O statistics to find the path with the "expected greater throughput" for I/O size
- Round Robin with Subset - A set of paths can be active and another set of paths can be standby. Active paths are used in round robin fashion.

Microsoft iSCSI Initiator

A major portion of Windows servers that connect to iSCSI storage use Microsoft's iSCSI Initiator, a software equivalent of an iSCSI HBA or TOE (TCP/IP Offload Engine). The software initiator's main advantage is price; it is available with the OS. Because it is a piece of software which only initializes after the OS starts, iSCSI disks presented via the Microsoft iSCSI Initiator are not available during boot time. This isn't a problem for basic disks, which come online on their own, but with dynamic disks, which have to be imported during system boot, the software initiator presents a problem as it is not available during boot time. When the system boots, iSCSI disks which are dynamic will be offline (in a departed state) and applications dependent on these disks will be inaccessible.

Veritas Storage Foundation provides the Veritas DG Delayed Import Service (VxDgDI), which delays the import of dynamic disks that include iSCSI storage presented via the software initiator. Making the VxDgDI service dependent on the Microsoft iSCSI Initiator service (MSiSCSI) will allow time for the storage to become available, after which the dynamic disk group will be imported.

The VxDgDI service can also be applied to other types of storage which may not be available during system startup as well.

Enhancing Windows Server with Veritas Storage Foundation

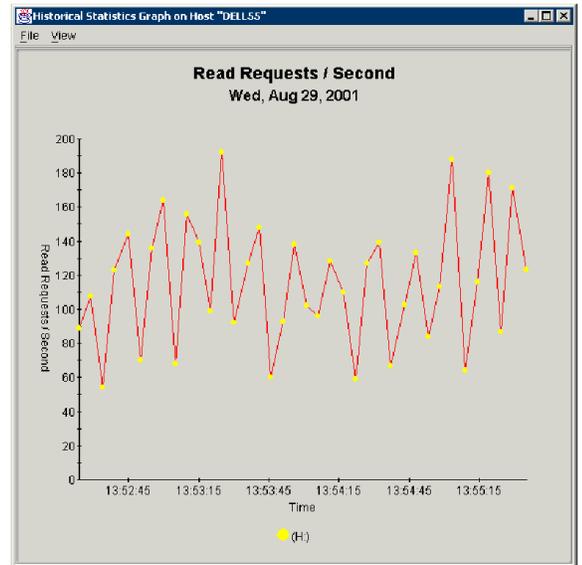
In addition to the Windows Server 2003 features discussed above, VERITAS Storage Foundation for Windows offers several new features and options that extend the capabilities of Windows. The following features, which are not available in Windows Server 2003, are available in VERITAS Storage Foundation for Windows:

Storage Management

VERITAS Storage Foundation for Windows provides capabilities for centralized Storage Management & Reporting

- VERITAS Enterprise Administrator – Configure and manage remote storage while the system remains online
- Configure and manage different volume layouts, including mirrored striped volumes and up to 32-way mirrors
- Drag & Drop GUI – Easily migrate data to new storage from the GUI.
- Subdisk operations - Move, split and join subdisks to reclaim storage

- Capacity Monitoring
- Automatic Volume Growth
- Dynamic Relayout – Dynamically re-layout volume configurations while keeping volumes online
- Multiple Disk Groups
- Configuration backup – manually and automatically backup dynamic disk group configuration information
- Storage Event Log
- Notification
- Proactive Storage Resource Monitoring
- Volume shrink
- Volume shred
- Solutions Configuration Center
- Storage Foundation Manager



Capacity Monitoring and Automatic Volume Growth

The capacity of dynamic volumes can be monitored and policies set so that, when preset thresholds, warning or critical, are reached for a volume, an action is taken based on the policies set for that volume. Actions include logging an alert and/or sending an e-mail or pager message. An option to automatically grow the volume can also be set for individual volumes on which Capacity Monitoring has been enabled. When the space used on the volume reaches the critical threshold it can be set to automatically grow within parameters set for the size by which the volume should grow and whether that growth should be unrestricted i.e. no maximum size limit set for the volume, or restricted growth, where the volume grows by a specified amount, but never exceeds the maximum size specified.

Thin Provisioning

The ability to automatically grow volumes also brings additional benefits. Many of today's storage systems provide support for thin provisioning, where space is logically provisioned to end users, but only allocated in the hardware when actually used by a file system; as the file system writes to the storage, chunks space are allocated in the array. This allows for more efficient utilization of storage.

Some file systems, such as Veritas File System, can be considered to be 'thin friendly', as they're aware of the type of storage below them and can function to take advantage of and benefit that storage. Windows NTFS is not a thin friendly file system. When a volume which is located on thin storage is formatted with NTFS, the file system will occupy the entire volume, causing full allocation in the hardware, essentially removing the benefits of thin provisioning. Veritas Storage Foundation's Automatic Volume Growth feature can be used to make NTFS volumes thin friendly. Creating a small volume and formatting it with NTFS will cause the allocation of enough storage in the array to host that volume. As the volume's capacity reaches the critical threshold set in Capacity Monitoring, the volume will grow automatically within the parameters set for the amount the volume should grow by and the maximum volume size. As the volume grows, the file system will grow and this will trigger equivalent storage allocation in the array, effectively mimicking the benefits of a thin friendly file system.

Volume Shrink

Dynamic volumes that are either RAW or NTFS formatted can be decreased in size with the **Shrink Volume** command, which removes unneeded storage. Data remains intact. Veritas Storage Foundation 5.1 for Windows adds data movement capability to maximize the amount of space reclaimed from shrinking while honoring the best practice of maintaining 15% free space on the volume i.e. the maximum amount that a volume would be shrunk would be to a size equal to the used space plus 15%.

Volume Shred

Storage Foundation also includes the **Shred Volume** feature. Shredding a volume completely removes all data from the volume and deletes it. Veritas Storage Foundation 5.1 for Windows offers three levels of shred: single pass, where the volume is overwritten once with a pattern of zeros, three pass, which meets Dod-5200.22-M specifications, and seven pass, which meets the Dod-5200.22-STD specification.

Solutions Configuration Center

The Veritas Storage Foundation Solutions Configuration Center (SCC) provides a workflow to setup Veritas Storage Foundation and High Availability (HA) environments through wizards for various high availability, campus cluster, quick recovery and wide area disaster recovery configurations for Microsoft Exchange Server 2003 and 2007, Microsoft SQL Server 2000 and 2005, Enterprise Vault Server and additional applications. Using the SCC can significantly reduce the number of steps required to setup some of these configurations when compared to setting up without it.

Storage Foundation Manager

Veritas Storage Foundation for Windows integrate with Storage Foundation Manager, a no-cost product add-on from Symantec, to provide centralized application, server and storage visibility and management, alerts and reporting across a heterogeneous infrastructure. With SFM, administrators can centrally monitor and manage up to 3000 instances of Storage Foundation across complex data centers.

Performance

VERITAS Storage Foundation for Windows improves system and disk performance with:

- Hot spot detection via performance monitoring
- Subdisk Move, Split and Join - Performance tuning via moving subdisks from areas of high I/O activity (hot spots) to disks with lower usage. Subdisks can also be split to allow for evenly spreading the load across multiple disks.
- VxCache – Volume based caching to facilitate improved performance for read intensive applications. On VxCache enabled volumes, data is stored in and read from memory, as opposed to being read from slower disks.
- Mirrored volume read policies (Round Robin or Preferred Plex)
- Event monitoring
- Real Time Statistics Collection and Display
- Historical Statistics Collection and Graphing
- Multiple threads – Set the number of I/O threads to perform various mirror operations
- Automatic track alignment
- SmartMove

VxCache

VERITAS Storage Foundation for Windows includes the VxCache option, which can be enabled on a per volume basis to improve I/O performance for read operations by dedicating a portion of a system's physical memory for caching. A memory pool of up to 4 GB can be set aside at the system level for VxCache, and volumes can be individually enabled to utilize this pool of memory for block level caching by specifically enabling VxCache on them. The VxCache driver can address either a portion of Extended Memory or PAE memory on systems that are PAE enabled. VxCache uses write-through caching where writes go directly to disk; thereby eliminating the potential for data loss on VxCache enabled dynamic volumes in the event of a system crash. Performance can be monitored via the VxCache Volume Monitoring window.

Automatic Track Alignment

Dynamic volumes created with Veritas Storage Foundation for Windows can be automatically aligned to store data within the boundaries of the physical tracks of the hard disk they're located on with the Track Alignment feature. Automatic track alignment accounts for the different offset requirements of the different hardware vendors. Storing data in this way helps optimize I/O performance. This provides a non-invasive method of aligning volumes, making it easier for users who previously depended on the invasive procedure accomplished with the Microsoft Diskpart utility.

SmartMove

Veritas Storage Foundation 5.1 introduces a the SmartMove feature, which improves the performance of mirror resynchronization operations by communicating with NTFS to understand which blocks on a volume are used by the file system and using that information during mirror resynchronizations to copy only those blocks used by the file system. Without SmartMove, all blocks in a volume are copied to its mirror during resynchronization. With SmartMove, the time taken to resynchronize a mirrored volume would be reduced to the time to copy only the blocks used by NTFS; new mirror volumes would not have to go through resynchronization as there would be no used blocks.

Availability

- Dirty Region Logging (DRL) – A log based recovery method to quickly resynchronize mirrored volumes after a system crash.
- RAID-5 Logging – RAID-5 volumes can be quickly reactivated after a system crash.
- Disk Replacement – A failed dynamic disk can be replaced by an empty basic disk. Volume configurations will be recreated.
- Disk Evacuation – The entire contents of a healthy disk can be moved to the free space on one or more dynamic disks.
- Hot Relocation – Subdisks of redundant volumes are moved from failed disks to hot spare disks. They can be moved back to their original location after the failed disk has been repaired or replaced with the Undo Hot Relocation command.
- Automatic Volume Growth – Policy based automatic volume growth protects against applications going offline due to their hosting volumes running out of space.
- Cluster Support, including Campus Clusters, for dynamic disks/volumes

Microsoft Cluster (MSCS & Failover Cluster)

Microsoft's clustering technologies, Microsoft Cluster Server (MSCS) in Windows Server 2003 and Failover Cluster in Windows Server 2008, included in the operating system, provide levels of protection for applications and the components supporting those applications to keep them highly available. At their most basic level, dynamic disks provide a means to protect access to data and applications at the storage layer through their ability to provide different RAID levels and dynamically resizing volumes. However, Microsoft does not include support for dynamic disks in its clustering solutions.

Veritas Storage Foundation for Windows' Cluster Option for Microsoft Cluster Server adds the Volume Manager Disk Group resource type to Microsoft clusters, providing support for dynamic disks and all of the benefits they afford. Volumes can be dynamically grown, RAIDed for availability and performance, mirrored across arrays to facilitate campus (stretch) clusters for protection at the site level and a host of other available features. While Failover Clustering in Windows Server 2008 requires SCSI-3 compliant storage, Veritas Storage Foundation provides support for using either SCSI-2 or SCSI-3 storage, giving the option to setup failover clusters with older or less expensive storage.

Veritas Volume Replicator

The Veritas Volume Replicator (VVR) option provides a mechanism for replicating data between sites for disaster recovery and other purposes over an IP network. The sites, referred to as 'primary' for the source site and 'secondary' for the target site can be any distance apart. Replication can be synchronous within latency distance limitations or asynchronous with no distance limitations. Associated volumes that will be replicated are placed in what's called a Replicated Volume Group (RVG), which also contains a Replicator Log (SRL) to which all writes for the volumes in the RVG are written in the order they were issued. The replication process maintains write order fidelity for the volumes in the RVG via the SRL. Consistency of the data in the RVG is guaranteed by the replication process, which sends the data from the SRL at the primary site to the secondary site in the correct order. Applications, such as databases and their associated logs, which are replicated from the same RVG, may not be up to date if replicated asynchronously, but they will be consistent i.e. the database can be mounted against its logs even if the secondary site is behind the primary site.

Bunker replication is a VVR feature which ensures a zero RPO for asynchronous replication by allowing for a secondary site (bunker) to be setup close enough to the production site to allow for synchronous replication of the replication logs to it. In the event of a primary site failure, recovery at the secondary site is accomplished by VVR copying any outstanding writes from the bunker site to the secondary site and then putting the secondary site into production, making it the new primary site.

Summary

Microsoft includes several storage technologies in its Windows Server operating systems. VERITAS Storage Foundation for Windows offers a set of tools that transparently integrate or co-exist with those in Windows Server 2003 and 2008. It provides a variety of features which come together to provide a complete package that extends the capabilities of Windows to deliver proven, enterprise-class, online storage management that enables organizations to deploy mission-critical applications on the Windows Sever platform with the same level of confidence that's typically reserved for deployments on traditionally more robust platforms.

About Symantec

Symantec is a global leader in infrastructure software, enabling businesses and consumers to have confidence in a connected world. The company helps customers protect their infrastructure, information, and interactions by delivering software and services that address risks to security, availability, compliance, and performance. Headquartered in Cupertino, Calif., Symantec has operations in 40 countries. More information is available at www.symantec.com.

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