



# Using Microsoft SQL Server with Dell EqualLogic PS Series Arrays

Best practices and configuration guidelines for deploying SQL Server with EqualLogic storage arrays.

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## Revisions

Report	Date	Description
1.0	October 2005	Initial release
2.0	June 2007	Added SQL 2005 coverage and support for PS Series 3.2 firmware release
2.1	March 2008	Added new information covering Auto-Snapshot Manager v3.0+ and Smart Copy features.
2.2	August 2010	Updated doc to SQL Server 2008 R2 and latest PS Series software
3.0	April 2014	Updated doc to SQL Server 2012 and latest EqualLogic software

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## Preface

PS Series arrays optimize resources by automating performance and network load balancing. Additionally, PS Series arrays offer all-inclusive array management software, host software, and free firmware updates. Visit [WWW.DELL.COM/PSseries](http://WWW.DELL.COM/PSseries) for more information.

## Audience

The information in this guide is intended for administrators that have or are planning to deploy SQL Server with EqualLogic storage arrays.

## Dell online services

You can learn about Dell products and services using this procedure:

1. Visit <http://www.dell.com> or the URL specified in any Dell product information.
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## Dell EqualLogic storage solutions

To learn more about Dell EqualLogic products and new releases being planned, visit the Dell EqualLogic TechCenter site: <http://delltechcenter.com/page/EqualLogic>. Here you can also find articles, demos, online discussions, technical documentation, and more details about the benefits of our product family.

## Feedback

We encourage readers of this publication to provide feedback on the quality and usefulness of this information by sending an email to [EQL\\_TME@Dell.com](mailto:EQL_TME@Dell.com).

## Executive summary

Dell EqualLogic PS Series arrays offer easy to use virtualized storage that come with an all inclusive software package. EqualLogic SANs automatically optimize performance offering an ideal platform to build and grow SQL Server database environments.

This deployment and configuration guide will discuss options and best practices for deploying SQL Server with EqualLogic storage arrays.



## Software and firmware versions

The following table shows the software and firmware used for the preparation of this document.

Vendor	Model	Software Revision
Microsoft®	SQL Server	2008, 2008 R2, 2012
Microsoft®	Windows Server	2008, 2008 R2, 2012
Dell™	EqualLogic PS Series Array Firmware	V7.x*
Dell™	EqualLogic Host Integration Tools for Windows	V4.7*

\*For complete version support see the Host Integration Tools Release Notes.

The following table lists the documents referred to in this Technical Report. All PS Series Technical Reports are available on Dell TechCenter at:

<http://en.community.dell.com/techcenter/storage/w/wiki/2660.equallogic-technical-content.aspx>

Vendor	Document Title
Microsoft®	TechNet SQL Server Library: <a href="http://technet.microsoft.com/en-us/library/bb545450.aspx">http://technet.microsoft.com/en-us/library/bb545450.aspx</a>
Dell™	SQL Server Solutions: <a href="http://www.dell.com/sql">http://www.dell.com/sql</a>
Dell™	EqualLogic Host Integration Tools for Windows Release Notes and User Guides
Dell™	EqualLogic PS Series Array Administration Guide and Firmware Release Notes
Microsoft®	<a href="#">SQL Server Books Online: Overview of the Recovery Models</a>
Microsoft®	<a href="#">How to Delay Loading of Specific Services</a>
Microsoft®	<a href="#">How to retrieve a specific table or rows from database backups or transaction log backups in SQL server</a>



# 1 Introduction

SQL Server provides the enterprise data management platform your organization needs to adapt quickly to a fast-changing environment. Benchmarked for scalability, speed, and performance, SQL Server delivers rapid return on your data management investment, with low implementation and maintenance costs as well as rapid development of enterprise-class business applications.

A PS Series group – an iSCSI SAN consisting of one or more EqualLogic storage arrays connected to an IP network – is an excellent storage choice for SQL Server environments. PS Series storage provides fast setup, automated management, linear scalability, multipath I/O support, SAN boot support, and volume replication among other capabilities to meet business needs. Not only does a PS Series SAN improve storage utilization efficiency and availability, it also delivers flexibility and ease-of-management, regardless of SAN scale.

PS Series arrays include data protection capabilities like snapshots, clones and volume replication that can be integrated with technologies such as Microsoft Volume Shadow Copy Service (VSS), Dell EqualLogic Auto-Snapshot Manager, and commonly available backup applications to improve backup and restore operations through point-in-time copies of data called shadow copies or snapshots.

Thus, by deploying SQL Server with a PS Series SAN, businesses can combine their database environments with reliable, scalable, and high-performance disk storage to meet the ever-expanding needs of users.

To get the maximum benefits from SQL and a PS Series SAN, you should adhere to the best practices for SQL Server, as outlined by Microsoft and industry experts. In addition, this document describes requirements and recommendations for deploying SQL Server with PS Series storage arrays, including best practices for performance, reliability, scalability, flexibility, and recoverability.

Key issues in this report include the following:

- Design considerations, including availability, performance, scalability, and management
- How to set up a SQL server, including optimizing the server and connecting to volumes
- Migrating SQL Server databases to PS Series Storage
- SQL Server data management with PS Series storage
- Protecting SQL Server databases on PS Series storage

## 1.1 Benefits of deploying SQL Server with PS Series storage arrays

When designing a SQL Server environment, you should understand the challenges of optimizing the entire system from server to storage. PS Series storage arrays offer many benefits for data center environments including:

- Reliability, Availability, and Serviceability
- Performance and Scalability
- Protection and recoverability
- Comprehensive host integration
- Ease of use and management



**Reliability, availability, and serviceability** – The environment must be robust, resilient, and easily repaired with hot swappable components while the system remains available. In a SAN configuration, the server, network, and storage arrays should all have a high level of fault tolerance and redundancy to avoid costly downtime and allow scheduled maintenance to take place without service disruption. Special attention should be paid to fault isolation and overall operations while system components are being serviced.

EqualLogic storage arrays include redundant hot-swappable hardware as well as offer high availability and scalability through RAID and multipathing support.

**Simple and immediate capacity and performance expansion** – The SQL Server environment must provide optimal performance and response time. Access to SQL data is crucial to day-to-day operations, and under-performing storage can have a significant effect on the overall performance of SQL Server and on your company's productivity.

A SAN built with PS Series storage automatically optimizes its own performance and continually adjusts to changing demands. Integrated load balancing algorithms are designed to calculate various workload characteristics on each array and automatically balance the load across the array members in a PS storage pool. For more information on the PS Series load balancers see the following technical report:

<http://en.community.dell.com/dell-groups/dtcmedia/m/mediagallery/19949521/download.aspx>

As your workload grows and storage capacity needs increase, the environment must accommodate changes without affecting users. PS Series storage arrays scale easily without downtime and I/O performance increases as the number of arrays in the SAN increases. When a new array is added, its resources are integrated into the SAN and immediately available to the virtualized storage pool. In addition to its storage capacity, the new array's disks, controllers, and network ports provide for enhanced performance to the overall SAN.

Performance is also improved by utilizing technologies such as MPIO. MPIO allows IO to travel through simultaneous paths from the server to the storage resulting in much higher performance and lower latencies of databases volumes.

Administrators can isolate the SQL Server workload from other application workloads within the SAN by creating separate storage pools for SQL Server database volumes within the PS Series group. Isolating specific application workloads can increase manageability and availability of application volumes across the PS Series SAN.

**Data protection and disaster recovery** – All data is protected with both RAID and spare disks. Combined with "hot" service capabilities and SAN protection options, online operation is assured. It must be possible to quickly recover from situations that can cause data loss, ranging in scale from a corrupted or infected file to the loss of an entire data center due to hostile action or act of nature.

PS Series storage arrays offer hardware based snapshots and volume cloning as standard features, enabling automatic backup and quick recovery operations.



With PS Series replication capabilities, SQL Server data can be automatically transferred to remote data centers or replicated synchronously within the same datacenter or campus protecting the data from disasters.

**Comprehensive host integration** – The EqualLogic Host Integration Tools for Microsoft (HIT/Microsoft) software includes a suite of tools and utilities to assist server and database administrators with setting up Windows servers to run with PS Series SANs. HIT/Microsoft includes the following features to assist with set up and day to day tasks:

- Remote Setup Wizard utility allowing quick configuration of new arrays
- A VSS hardware provider service which interacts with the PS Series storage, Microsoft Windows Server, the SQL Server VSS Writer for consistent database copy protection.
- A VSS requestor application called Auto-Snapshot Manager Microsoft Edition (ASM/ME) that will allow administrators to centrally manage SQL Server instances and control point-in-time protection and recovery operations directly from a single management server.
- MPIO Device Specific Module (DSM) that intelligently routes IO from the server to the storage volumes for increased performance and efficiency.
- A Storage Management Provider that integrates with Windows Server 2012 to allow management and provisioning from the Windows File and Storage Services interface.
- A comprehensive set of Powershell tools to allow scripting and automation within the Windows and SQL Server storage environment.

HIT/Microsoft also configures host settings according to PS Series best practices. When installed, the HIT kit makes appropriate changes to the registry that improve performance and reliability of Windows hosts running with EqualLogic iSCSI SANs.

**Ease of use and management** – Setup and configuration, backup and recovery, and day-to-day administration should be handled easily and have minimal impact on operations and users. Automation of complex operations like RAID configuration, disk sparing, data provisioning, and load balancing means that even novices can effectively manage the SAN.

PS Series storage automates complex tasks such as RAID configuration and provides both graphical and command line user interfaces for easy and intuitive storage management.

PS Series storage comes standard with a comprehensive set of features including:

- Automatic load balancing
- Virtual volume management
- Thin-provisioning
- Space-efficient snapshots for instant backup and restore
- Volume cloning for rapid server provisioning
- Multipath I/O (MPIO) support
- Cluster support
- Replication for comprehensive disaster recovery solutions
- Storage pools for isolating workloads



- Member-by-member RAID level control
- Collections (consistency groups) tying volumes together across arrays and pools
- Command line and PowerShell scripting



## 2 Planning and design considerations

When designing a SQL Server environment, you should understand the challenges of optimizing the entire system from server to storage and target a design that addresses the following aspects:

- Server resources
- Storage volume distribution
- RAID choices
- SQL database volume sizing
- Database files and layout

It is critical to focus on these challenges before you begin the initial SQL installation. The EqualLogic iSCSI Initiator and Operating System Considerations guide for *Optimizing your SAN Environment for High Availability*, describes how to design a robust server and network environment that uses PS Series storage to overcome the challenges IT managers face today. This robust server and network environment will provide a sound base for your SQL Server environment. A link to this guide and other valuable technical information is provided below.

<http://en.community.dell.com/techcenter/storage/w/wiki/2660.equallogic-technical-content.aspx>

### 2.1 Optimizing server resources

Prior to installing SQL Server onto an operating system it is important to make sure the operating system and system resources are sufficient to operate the SQL Server database environment you plan to run. That includes configuring your server with enough memory, processor, and network resources to accommodate your SQL Server deployment.

A good starting place is to follow the server deployment recommendations in the EqualLogic Best Practice Technical Report *Deploying Microsoft Windows Server in an iSCSI SAN*, It is also important to follow Microsoft's guidelines for minimum and recommended system requirements for deploying SQL Server.

In SQL Server 2012 there were significant changes and improvement made to the SQL Server buffer engine that affects the performance of SQL databases as well as the underlying storage. Buffer manager can determine how SQL will read and write to and from the storage system based on the size of memory allocated in the server. For example: a larger buffer cache size will cache more pages in memory thus reducing the IO to disk. These optimization operations can change a highly read intensive database pattern to a more write intensive pattern on disk.

This is important to consider when configuring server and storage resources. More details on this can be found in the white paper *OLTP I/O Profile Study with Microsoft SQL 2012 Using EqualLogic PS Series Storage* at:

<http://en.community.dell.com/dell-groups/dtcmedia/m/mediagallery/20308518/download.aspx>

Starting with SQL Server 2014, changes were made to allow the buffer pool to be extended to the file system for additional caching capabilities. This can add significant performance benefits to the database



engine as well as lower the IO load on the storage system. When planning to utilize the buffer pool extension, it's recommended to use local SSD disks for the buffer pool file system.

## 2.2 Distributing data

The load on a database file consists of sequential and random reads and writes. The load on a log file consists of sequential writes during normal operation and sequential reads during the restoration of a database. In traditional direct-attached (DAS) storage deployments, the write profile of these files can have a significant impact on performance because of the potential for I/O bottlenecks. However, the distinction in the write profile is less important when using a PS Series group because I/O is automatically distributed across arrays, RAIDsets and disks, dynamically balancing the load.

Distributing database files and logs across volumes can provide more flexibility when backing up and restoring data but not a lot of value add for performance. File groups allow for partial restore or 'piecemeal' database restore operations so distributing data over multiple file groups and multiple volumes increases the availability of data sets.

On the other hand, table partitioning can add significant database performance improvements. It's important to first identify tables that are candidates for partitioning. These tables would be tables that exhibit the highest throughput characteristics. Partitioning and distributing these tables can improve database performance in most cases.

## 2.3 Choosing array RAID levels

Before creating a PS Series group, you should determine which RAID level, RAID 10, RAID 50, or RAID 6 to configure for each individual group member (storage array). When choosing the RAID level for each array, you need to consider not only the performance characteristics of the various SQL Server files, but also the availability each RAID level provides. For example RAID 6 offers the highest data availability of all the RAID sets but sacrifices an extra parity write operation which can have performance implication for write intensive workloads. Microsoft best practices call for deploying SQL Server log files on RAID 10 volumes where possible for best performance and protection from failures.

For high performance SQL implementations that require optimal performance, RAID 10 is a good choice for the group RAID level. However, for many SQL environments, RAID 50 can be used to provide maximum storage capacity, in addition to the performance benefits of striping.

A good way to test the storage against a given workload is to run IO tests using IOMeter or SQLIO. If you understand your workload characteristics, these tools can help validate the storage settings required to run the environment.

### 2.3.1 Using tiered storage principles

In cases where a mix of RAID types is desired, a tiered storage design will be beneficial. Tiered storage can be set up by using different arrays with different RAID characteristics or setting RAID preferences by storage pool. This provides a more granular level of storage management as well as more control over IO designation to specific volumes (e.g., logs vs. database volumes).



Automatic tiering can be achieved within a single pool by utilizing the PS Series group's automatic load balancing algorithms. The load balancers continually work to balance the workload across all the arrays in the pool. Over time, volumes may be automatically moved to arrays offering the best RAID level for that volume. This activity happens automatically based on the performance needs of the volume and the array on which it is hosted. Additionally Dell offers the EqualLogic hybrid arrays which combine spinning disks and SSD's in the same chassis. The load balancing algorithms work much quicker in these arrays and are based on the workload characteristics of individual pages within the array. These arrays can be beneficial for SQL database environments where there is a subset of the database that is hot (active) and the majority of the database is cold (inactive). The caveat here is the hot part of the database must be able to fit in the SSD space for the performance benefit. It is also a best practice not to mix hybrid arrays and standard arrays in the same storage pool.

With a PS Series SAN, administrators can migrate volumes from one pool to another to manually control volume tiering. This approach gives more control to the administrator but requires more monitoring of the environment. For more information on these topics please refer to the following docs listed on the EqualLogic Technical Content page in Dell TechCenter:

<http://en.community.dell.com/techcenter/storage/w/wiki/2660.equallogic-technical-content.aspx>

*EqualLogic™ PS Series Storage Arrays: Choosing a Member RAID Policy*

*EqualLogic PS Series Architecture: Load Balancers*

*EqualLogic PS Series Architecture: Hybrid Array Load Balancer*

## 2.4 Planning SQL Server volume configuration

The goal when setting up SQL Server volumes in a PS Series group is to optimize manageability and performance according to the needs of the organization.

Microsoft recommends separating data and log files onto their own set of disks in order to separate the different IO workloads. Before storage virtualization this was a common practice, but with today's data storage virtualization technologies it may have little or no impact on performance. (Note that in large enterprise database deployments this is still a performance best practice.) For more information on sizing guideline for SQL Server using PS Series arrays, see the following reference architecture docs:

*Best Practices and Sizing Guidelines for Transaction Processing Application with Microsoft SQL Server 2012 using EqualLogic PS Series Storage*

<http://en.community.dell.com/dell-groups/dtcmedia/m/mediagallery/20321740/download.aspx>

*Best Practices for Decision Support systems with Microsoft SQL Server 2012 using Dell EqualLogic PS Series Storage Arrays*

[http://en.community.dell.com/techcenter/extras/m/white\\_papers/20422540/download.aspx](http://en.community.dell.com/techcenter/extras/m/white_papers/20422540/download.aspx)



## 3 Deploying SQL Server with a PS Series SAN

The following sections describe SQL Server requirements and recommendations and the basic tasks for deploying SQL with a PS Series SAN. The following section will reference related Windows server and application deployment best practices and reference architecture documents. For copies and downloads of these documents, please visit the EqualLogic Technical Content page on Dell TechCenter at the following link:

<http://en.community.dell.com/techcenter/storage/w/wiki/2660.equallogic-technical-content.aspx>

### 3.1 Basic steps

1. Optimize the SAN network for performance and high availability. Please refer to the *Dell EqualLogic PS Storage Arrays: iSCSI Initiator and Operating System – Optimizing your SAN Environment for High Availability* guide.
2. Optionally, configure the environment so that SQL servers can boot from the SAN. For details, see the *Configuring Windows Server 2012 for iSCSI SAN Boot with EqualLogic Storage*.
3. Install the EqualLogic Host Integration Tools for Microsoft on the SQL Server hosts. Be sure to set up the EqualLogic MPIO DSM to include the subnet for the iSCSI NICs and exclude the LAN subnet. See the *EqualLogic Host Integration Tools for Windows User and Installation Guide* for more information.
4. Set up a PS Series group and create the volumes required for the SQL environment. Be sure to create access control records for each volume to allow the appropriate servers access to the volume. Also, reserve snapshot space for each volume if you will be creating snapshots or using Auto-Snapshot Manager for VSS operations.

Note: If this is a cluster environment be sure to allow multiple iSCSI initiator connections to the volumes. See the *PS Series QuickStart* and *Group Administration* manuals for more information.

5. Prepare and optimize the Windows servers and connect them to volumes. For details, see the EqualLogic Technical Report *Using Dell EqualLogic Storage with Microsoft Windows Server 2012*.
6. Install SQL on the server and configure it to use the PS Series storage. See *Configuring SQL Server to Use PS Series Storage* for information about specifying the iSCSI disks for the database and log files.

After deployment, you can expand iSCSI disks online, expand PS Series group capacity, and backup volumes, as described in the [SQL Server Data Management](#) section.

### 3.2 Configuring SQL Server to use PS Series storage

If this is an initial install or you are adding PS Series storage to an existing SQL Server installation, there are some basic concepts to consider.

- It is highly recommended to install the Dell EqualLogic Host Integration Tools for Microsoft.



HIT/Microsoft optimizes the server to run with PS Series iSCSI storage. It also installs the EqualLogic MPIO DSM and Auto-Snapshot Manager. The EqualLogic MPIO DSM is proven to improve performance on hosts connected to PS Series storage volumes. Auto-Snapshot Manager can act as a centralized management portal for managing settings to PS Series groups as well as a VSS requestor for application consistent point-in-time protection of SQL databases.

- Configure the NICs to be used for iSCSI access

It is recommended to use dedicated NICs for iSCSI access. In each of the NIC's properties settings, enable Jumbo Frames. This is typically done by setting the frame size to 9014 bytes in the Advanced tab.

- Configure the Microsoft iSCSI Initiator

Add access to the PS Series Group by configuring the portal IP in the Microsoft iSCSI Initiator settings. Set the SQL Server service dependent on the Microsoft Initiator service. When connecting to volumes, check both the boxes for *Add this connection to the list of Favorite Targets*. and *Enable multi-path* (if MPIO is set up).

### 3.3 Configuring volumes for SQL Server databases

The most important thing to consider and plan when creating volumes that will be used for user database is the performance needed. Understanding performance requirements will determine on what type of storage the volumes should reside.

In general SQL database log files should reside on faster disks configured with RAID 10. With PS Series arrays, SQL database files can reside on RAID 10, RAID 50 or even RAID 6 (providing the RAID 6 write penalty doesn't affect performance of the individual database). Table 1 lists some general guidelines for creating volumes for SQL Server deployments on PS Series arrays.

Table 1: SQL database file performance guidelines

File Type	Typical Performance Requirements	RAID Options / Recommendations
User database data	Low to high	RAID 10, 50, 6
User database logs	High performance	RAID 10
System databases	Lower performance	Local disks or RAID 50, 6
TempDB and log	Low to high	Local disks or RAID 10, 50
Backup	Low performance	RAID 50, 6

After the storage requirements have been determined it is always good practice to create a volume naming scheme. This helps with management and understanding of what volumes are associated with specific applications as well as SQL Server database and log volumes.



PS Series arrays allow volumes to be configured with thin provisioning. Thin provisioning has tremendous benefits for managing storage space on the SAN and volume capacity-on-demand. Thin provisioning has always been recommended for files that grow slowly over time and/or the data is not reconstructed from time to time. In SQL it has been a best practice not to use thin provisioning for PS Series volumes designed for indexes that require rebuilds or reindexing due to the block layout completely changing on the storage system. These type of operations would defeated the purpose of thin provisioning by changing the block layout of the volume and thus requiring the storage system to allocate new wirtes to match the block changes on the volume.

Starting with PS Series firmware v6 and the SCSI unmap standard, this best practice is no longer a recommendation because the unmap standard allows storage to understand when data is deleted or changed on the Windows volume and unmap the blocks that are no longer in use by the operating system. Upmap is supported by default in Window 2012 and 2012 R2 and by a driver in the EqualLogic Host Integration Tools on Windows 2008 and 2008 R2.



## 4 Migrating SQL Server databases to PS Series storage

If you are currently using a local system disk, DAS, or other storage media for your current SQL configuration, you can easily migrate databases and logs to volumes in a PS Series group and gain the performance and scalability benefits of an iSCSI SAN. Several methods for migrating databases to your PS Series SAN are described below.

Method 1: Use Detach/Attach to move existing databases to a PS Series SAN.

Using detach and attach to move existing SQL Server databases is an easy way to migrate a database to a new location. Although this method is typically the fastest method to migrate a database, it does require scheduled database downtime and cannot be done with the database online.

As the user or DBA you can detach a SQL Server database using T-SQL or from the Management Studio GUI. Once the database is detached from the database server the database files can be copied to PS storage volumes and attached using T-SQL or the Management Studio GUI.

To move your existing user and system databases, refer to the Microsoft Knowledge Base article How to move SQL Server databases to a new location by using Detach and Attach functions in SQL Server:

<http://support.microsoft.com/default.aspx?scid=kb:en-us:224071>

Method 2: Use Backup/Restore to move existing databases to a PS Series SAN.

This method of migrating existing databases to a PS Series SAN uses traditional methodologies for backing up and restoring SQL Server databases. Like the detach/attach method, this technique requires database downtime and could require extensive restore times depending on your environment. In this case you can backup an existing database as you normally would and then restore by pointing the database restore operation to the new volume mount points.

Method 3: Use the Copy Database option to move or copy existing databases to a PS Series SAN.

This method offers several options available through the Copy Database Wizard, including the ability to move the database while it remains online. The Copy Database Wizard gives you the choice of moving, copying, or upgrading an existing SQL Server database from one location to another. With the Copy Database Wizard you have the option to:

- Transfer a database when the database is still available to users.
- Transfer a database by the faster detach/attach method with the database unavailable during the transfer.
- Transfer databases between different instances of SQL Server.
- Upgrade databases from SQL Server instance to another.





The Copy Database Wizard can perform all the tasks above, but there are restrictions on each. Note that the destination server must be running SQL Server 2005 SP2 or later. For more information on the Copy Database Wizard and options in SQL Server 2005, see the following Microsoft article.

<http://msdn2.microsoft.com/en-us/library/ms188664.aspx>

Note: To ensure optimal performance of an upgraded database, Microsoft recommends running `sp_updatestats` (update statistics) against the upgraded database on the SQL Server.

Table 2: SQL Server Database Migration

	Detach / Attach	Backup / Restore	Copy Database
Online Migration	No	Only if restore to new	Yes – Side by Side
Offline Migration	Yes	Yes	Yes – Attach / Detach
Automated Process	Yes – Wizard	Yes – Wizard	Yes – Wizard
Manual Operation	Yes – Scripts	Yes – Scripts	No



## 5 SQL Server data management

Data integrity is vital in a solid SQL Server environment. Backing up your data as well as monitoring for disk space usage are two important disk management tasks. You should monitor your SQL volumes so they do not fill up unexpectedly. When a volume starts to get full, you may want to consider increasing the volume size, as described below. Tested and documented backup and restore procedures are important in maintaining uptime of SQL Server environments.

Optionally, you can set the `PAGE_VERIFY_CHECKSUM` to increase data protection. The `PAGE_VERIFY_CHECKSUM` feature starting in SQL Server 2005 replaces the previous `TORN_PAGE_DETECTION` option in SQL Server 2000. When a page checksum error is detected, the DBA can restore the affected pages by using online page-level restore.

### 5.1 Defragmenting SQL Server files

Not only can the file system fragment, but SQL Server files and tables can also fragment over time, adversely affecting workload performance. Fragmentation can be avoided or at least reduced significantly by monitoring database volume growth and performing regular database maintenance tasks such as `DBCC DBREINDEX`, and recompiling stored procedures and triggers. If table rows are modified or deleted frequently, it is better to run intermittent `UPDATE STATISTICS` on the table(s) in question.

It is important to consider the workload type when determining whether or not to defragment. Microsoft reports that DSS workloads benefit much more than OLTP workloads due to the type of IO the workloads generate.

`DBCC SHOWCONTIG` allows you to determine the amount of fragmentation of index files. It is important to use necessary precautions before deciding to defragment SQL Server files.

Starting with SQL Server 2005 the `DBCC SHOWCONTIG` statement was replaced by the dynamic management function `sys.dm_db_index_physical_stats`. This new DMV will help detect fragmentation in a specific index or all indexes on a table or indexed view. With partitioned indexes, this DMV will also provide fragmentation information for each partition.

The scanning modes available are `LIMITED`, `SAMPLED`, and `DETAILED`, with `LIMITED` being the default mode displaying page counts and external fragmentation without page density. The `SAMPLED` and `DETAILED` modes will analyze the entire table for both internal and external fragmentation.

To return information for all the tables and indexes, use:

```
SELECT * FROM sys.dm_db_index_physical_stats (NULL, NULL, NULL, NULL, NULL);
```

For more information on defragmenting SQL Server databases see [SQL Server Books Online](#).



## 5.2 Expanding SAN storage online

As storage requirements grow for each application, PS Series storage can be easily expanded, online and with no disruption to users.

For example, you can increase the size of a PS Series volume using the Group Manager GUI or the command line interface (CLI). You must then enable the operating system to recognize the size increase. The additional space will be immediately available for use. This procedure is described in the EqualLogic Technical Report *Microsoft Windows: Expanding Basic Disk Volumes*.

<http://en.community.dell.com/dell-groups/dtcmedia/m/mediagallery/19861482/download.aspx>

Note: If the PS Series group does not have sufficient free space to increase a volume size or add new volumes, you will need to expand the group. To do this, simply add another array (member) to the group. See the PS Series QuickStart or the Group Administration manual for more information.



## 6 SQL Server database protection

Data protection is crucial for database applications. Microsoft has embedded data protection and high availability capabilities into SQL Server. With past versions of SQL Server database administrators could backup and restore databases, cluster SQL Server instances and databases, replicate transactions across distributed servers, and perform protection scenarios such as Log Shipping.

With the most recent versions of SQL Server, Microsoft has improved on these features and has added protection techniques such as Database Mirroring and Database Availability Groups. Database mirroring allows administrators to mirror database transactions either synchronously or asynchronously across the enterprise to a standby copy (mirror) of the database located locally or remotely. AlwaysOn Availability Groups build upon Windows Server Failover Clusters by offering local protection as well as disaster recovery protection for a set of user databases. With AlwaysOn Availability Groups, a set of databases are configured to replicate either asynchronously or synchronously to other nodes in the cluster. The cluster can geographically dispersed to offer DR and the replica nodes can be set up as primary or secondary replicas.

Storage vendors continuously improve on data protection offerings by including technologies like snapshots and replication. Utilizing the storage system rather than SQL native tools for these operations can reduce the extra processing and work that the database engine would need spend on these. In many cases storage vendors take these technologies much deeper into application awareness (consistency) and protection and recovery management. For most Microsoft applications, Volume Shadow Copy Services (VSS) is the mechanism used by storage vendors for protection and recovery integration.

### 6.1 Backing up data using VSS

The VSS architecture is made up of three main components, a VSS requestor, a VSS provider, and VSS writers. The requestor is the application that is requesting the VSS operation, the provider is the service that provides the point-in-time copy, and the writer is the service that interacts with the application to quiesce IO and prepare the app for a consistent copy to back up.

The EqualLogic Host Integration Tools for Microsoft (HIT/Microsoft) includes the PS Series VSS hardware provider and a VSS requestor application called Auto-Snapshot Manager. HIT/Microsoft and Auto-Snapshot Manager are available at no additional cost. The PS Series VSS hardware provider can be used with most 3<sup>rd</sup> party backup applications that support VSS storage providers. For example Symantec and CommVault both support 3<sup>rd</sup> party VSS storage providers. Auto-Snapshot Manager provides very similar functionality without the option for tape backup.

The Smart Copy features of Auto-Snapshot Manager allow for application consistent online copies of SQL Server database for quick restore and recovery operations. With Auto-Snapshot Manager for SQL Server administrators can:

Create copies of SQL databases, where the copy operation is coordinated with SQL Server operations.

- Use the management GUI or built-in scheduler to create Smart Copy sets
- Set up automatic e-mail notification of Auto-Snapshot Manager events



Allow system or database administrators to restore SQL Server databases in the following ways:

- In-place SQL Server database and volume recovery
- "Side-by-side" SQL Server database and volume recovery to new locations using transportable Smart Copies
- On a new system for testing, development, or reporting
- At a remote location for disaster recovery using Smart Copy replicas

For detailed information on SQL Server data protection with Auto-Snapshot Manager see the following document.

<http://en.community.dell.com/dell-groups/dtcmedia/m/mediagallery/20057781/download.aspx>

## 6.2 Using PS Series volume replication with SQL Server

PS Series arrays include the ability to set up and configure PS Series volume replication. Auto-replication can be configured between two PS Series storage groups, either in the same building or at a remote site for disaster recovery. Synchronous replication can be configured between two PS Series pools in the same group within the same datacenter or a campus. PS Series replication technology is built into all PS Series array products as a standard feature. From a SQL Server standpoint, this means disaster recovery options can be set up easily and efficiently.

PS Series auto-replication requires two PS Series groups that are configured as replication partners. With replication, volume data can be automatically transferred across the groups, protecting volume data from failures ranging from destruction of the volume to a complete site disaster. A typical disaster recovery set up will include a primary site that hosts all production data and a remote site to which data is replicated in case of a site failure. With auto-replication, data protection can be set up for one way or multi-way replication, meaning that both sites host production data and replicate to each other. PS Series auto-replication is fully supported by Auto-Snapshot Manager for SQL Server databases. By utilizing Auto-Snapshot Manager for replication operations, VSS is involved and each replica copy is in a consistent state prior to being copied to the other PS Series Group.

PS Series synchronous replication requires two PS Series pools in a single group. With synchronous replication, all writes are synchronously written to a sync alternate pool thus creating data consistency between pools. The volumes set up for sync rep can be moved manually from sync active to sync alternate at any time. The advantage of sync rep vs. auto-replication is that the volume data is consistent up to the last IO where with auto-replication the volume data is consistent up to the last replication operation.

For more information on PS Series replication technologies see the following documents:

*Understanding Data replication Between Dell EqualLogic PS Series Groups*

<http://en.community.dell.com/dell-groups/dtcmedia/m/mediagallery/19861448/download.aspx>

*Dell EqualLogic PS Series Arrays: Understanding Synchronous Replication*

<http://en.community.dell.com/dell-groups/dtcmedia/m/mediagallery/20175375/download.aspx>



## 7 Summary

An iSCSI SAN comprised of PS Series storage arrays provides an ideal storage infrastructure for SQL Server installations. A PS Series SAN brings all the reliability, performance and protection needed for a successful deployment. As your SQL Server installation grows and the workload increases, a PS Series SAN can scale easily and dynamically while maintaining availability.

For a successful SQL Server installation, be sure to follow Microsoft's recommendations for Windows system and SQL Server configurations. In addition, you should follow the configuration best practices described in this Technical Report to ensure a robust installation that will meet your needs now and in the future.



## Technical support and customer service

Dell support service is available to answer your questions about PS Series SAN arrays.

### Contacting Dell

1. If you have an Express Service Code, have it ready.  
The code helps the Dell automated support telephone system direct your call more efficiently.
2. If you are a customer in the United States or Canada in need of technical support, call 1-800-945-3355. If not, go to Step 3.
3. Visit <https://eqsupport.dell.com/secure/login.aspx>
4. Log in, or click "Create Account" to request a new support account.
5. At the top right, click "Contact Us," and call the phone number or select the link for the type of support you need.

