

# Data Protection Using Premium Features For the Dell™ PowerVault™ MD32/MD36 Series of Arrays

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A Dell Technical White Paper

PowerVault MD32X0, MD32X0i, MD36X0i, and MD36X0f  
Series Storage Arrays

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## Data Protection Using Premium Features Overview

Dell offers key-enabled premium features to help enhance the functionality of the PowerVault MD32X0, MD32X0i, MD36X0i, and MD36X0f Storage Arrays (PowerVault MD32/36 storage arrays). These optional premium features include Virtual Disk Snapshot, Virtual Disk Copy, and Remote Replication. These data protection features provide real-world benefits for data backup, data management and protection. They are illustrated graphically in [Figure 1](#).

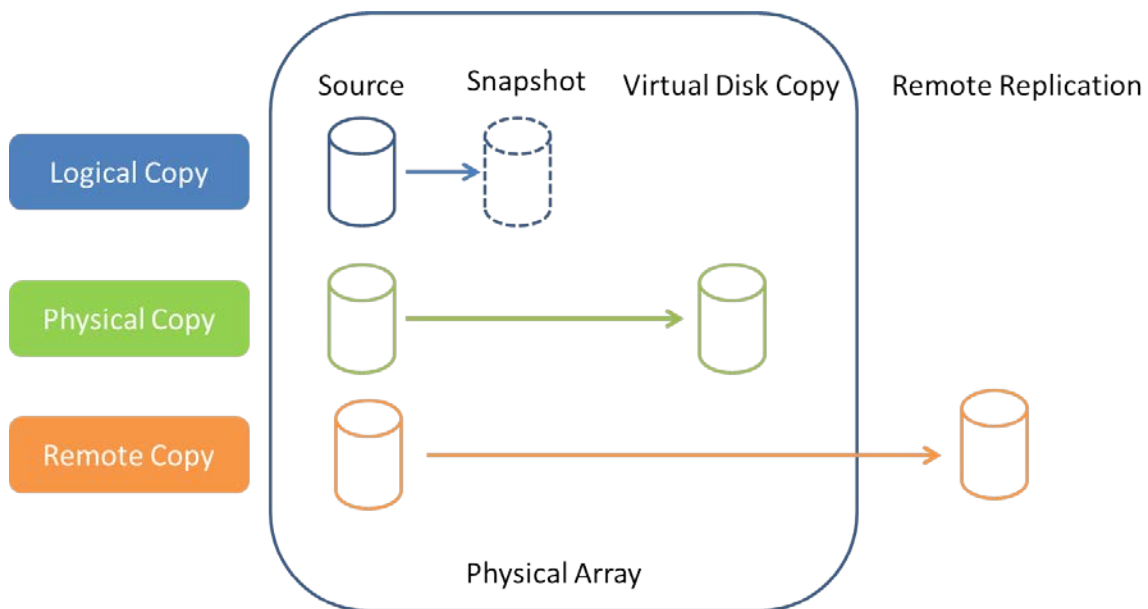


Figure 1: Data Protection using Premium Features

The Virtual Disk Snapshot premium feature includes the following capabilities:

- Data protection by providing a readily available point-in-time image that reduces restore time, especially as compared to traditional tape media backups
- Offline backups of production data without disrupting access to that data
- The creation of multiple snapshots in a single day allowing for the recovery of the most recent data possible
- Application compatibility and patch testing on non-production point-in-time images

The Virtual Disk Copy premium feature includes the following capabilities:

- Virtual disk relocation and optimization
- Disk-based backup and restores
- Application development and data analysis on non-production stand-alone copies without affecting the performance of the production virtual disk

The MD36X0f Virtual Disk Remote Replication (RR) premium feature includes the following capabilities:

- The Remote Replication (RR) feature allows the implementation of disaster recovery initiatives and centralization, consolidation and migration of data
- Remote Replication of virtual disk volumes to another MD36X0f
- The MD36X0f offers three replication modes: Synchronous Replication, Asynchronous Replication, and Asynchronous with Write Order Consistency Replication.

## Activating Premium Features

When you order premium features, you should receive a Premium Feature Activation booklet. Follow the directions in the booklet to obtain the key file that is used to enable the premium features through the Modular Disk Storage Manager software. Contact your Dell sales representative for more information about how to purchase premium features.

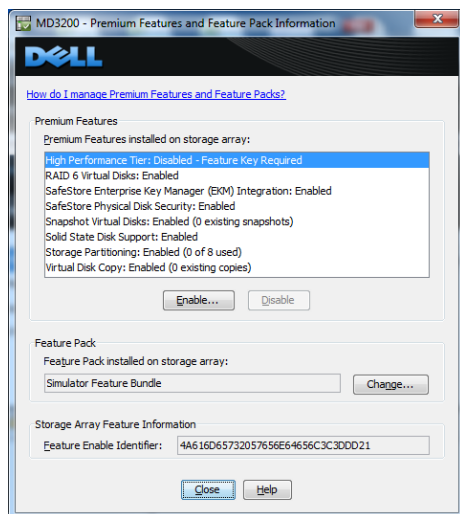


Figure 2: The View/Enable Premium Features Dialog

## Virtual Disk Snapshot

A snapshot virtual disk, also called simply a snapshot, is a point-in-time image of a virtual disk. A snapshot is functionally equivalent to a complete physical copy. However, a snapshot is created almost instantaneously and requires less disk space than the source virtual disk. To a host server, a snapshot appears and functions just as a standard virtual disk does. A snapshot can be assigned to a host server to be read, written to, or copied from.

A snapshot uses copy-on-write technology to maintain the snapshot while minimizing disk utilization. When a snapshot of a virtual disk is taken, the storage array controller suspends I/O to the source virtual disk momentarily while it creates a repository virtual disk. The repository virtual disk stores snapshot copy-on-write data. When data on the source virtual disk is modified, a copy-on-write occurs, copying the data that is to be modified into the repository virtual disk. This repository virtual disk combined with the source virtual disk creates the

logical snapshot virtual disk. Because the only data that is stored in the repository virtual disk is data that has changed after the creation of the snapshot, a snapshot uses less disk space than a full physical copy. The default size for the repository virtual disk is 20 percent of the source virtual disk capacity.

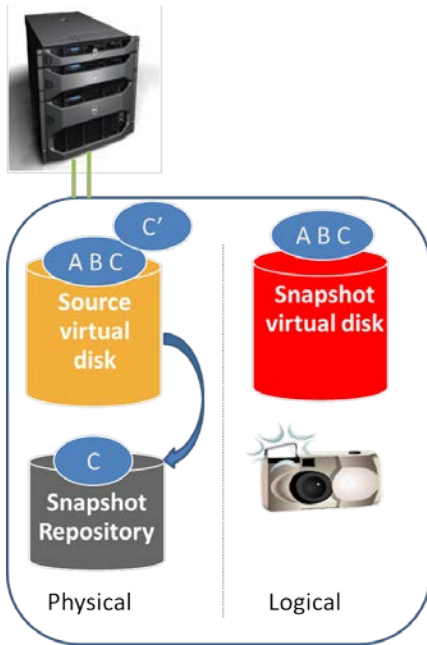


Figure 3: Copy on Write

Each virtual disk can support up to eight snapshots, with a maximum of 128 snapshots per storage array.

## Using Snapshots

Snapshots provide many benefits for data backup and data manipulation.

### *Continued Data Processing during Backups*

The Virtual Disk Snapshot premium feature enables offline backups of production data without disrupting access to that data. Snapshot creation requires that the application or file system be paused only briefly. After the snapshot is created, access to the original data is again available for business processing, and the point-in-time image of the data is ready for backup.

The Dell Modular Disk Storage Manager software allows snapshots to be mapped to a separate backup server. This capability is designed to reduce the performance impact to the application server by placing the burden of the backup processing on an alternate server. 5

### *Data Protection through Easy, Fast Restoration of Data*

Time and cost to back up data are major considerations, but more important is the ability to restore data and to restore it quickly. Tape restorations can result in a day or more of lost

time. In contrast, the ability to create multiple snapshots in a single day allows access to the most recent data possible for recovery, helping to minimize recovery time.

### ***Application Testing***

Application testing is a necessary practice in 24X7 IT environments. New applications and application patches generally must be tested before they can be put into production. Snapshots are designed to allow for the rapid creation of a point-in-time image to perform these tests against. Testing on these non-production images essentially eliminates the risk of lost production data or lost data access. It can also save system administrators time by eliminating the need to restore production data that might become corrupted or lost due to an incompatible application or patch.

### ***Data Analysis***

Snapshots can provide point-in-time images for data analysis. The images can be created almost instantaneously, allowing for the data analysis to occur on the snapshot rather than the production virtual disk. Any performance impact of the data analysis will be incurred on the snapshot rather than on the production virtual disk. Additionally, the smaller disk space requirement of a snapshot — which is by default 20 percent of the source virtual disk — saves disk space for the creation of additional test or analysis environments.

## **Creating a Snapshot**

A snapshot can be created by using the Dell Modular Disk Storage Manager graphical user interface or through the command line interface (CLI). The CLI has the added benefit of command scripting, which allows for task automation and scheduling.

NOTE: Before creating or re-creating a snapshot, it is recommended to stop all I/O activity to help ensure that you capture an accurate point-in-time image of the source virtual disk. You also should run the SMrepassist utility on the source virtual disk. SMrepassist (replication assistance) is a host-based utility for Windows® that is designed to ensure that all the memory-resident data for the file system is flushed to disk. In addition, SMrepassist updates disk signatures to help prevent conflicts when the snapshot is assigned to the same host as the source virtual disk.

Refer to the appropriate Dell PowerVault documentation for procedures on your chosen method for creating a snapshot virtual disk.

### ***Snapshot Repository Virtual Disk***

For every snapshot that is taken, a repository virtual disk is created to hold the copy-on-write data for the snapshot. There is a one-to-one relationship between a snapshot and its associated repository virtual disk. The repository virtual disk is not accessible for host I/O. The repository virtual disk is only used internally to manage the snapshot point-in-time image.

A best practice is to create the repository with a default value of 20 percent, and then use the following procedure to estimate the life expectancy of the snapshot and its associated repository.

The required size of the repository depends on the size of the source virtual disk and the write patterns that occur on the source after the snapshot is established. If the snapshot is created as a point-in-time image for data backup, a default repository size of 20 percent or less of the source virtual disk is usually sufficient. If the snapshot is created for functions other than backup, such as application testing or data manipulation, a larger repository might be needed. The repository size depends on the rate at which data changes in the source virtual disk, the snapshot virtual disk, and on the length of time that the snapshot remains active. 6

1. Record the creation date and the creation time for the snapshot.
2. After a period of operation in your environment, record the repository virtual disk capacity used, the available repository capacity remaining, and the current time.
3. Subtract the snapshot creation time from the current time to determine the elapsed time (length of time the snapshot has been active).
4. Use the following equation to calculate the amount of time that the snapshot repository will be available for copy-on-write data before reaching its capacity:

$$\text{Total time available} = (\text{elapsed time} \times \text{available capacity}) / \text{used capacity}$$

Based on the results, you can decide how much to increase the capacity of the repository virtual disk. If the repository will become 100 percent full during the expected life time of the snapshot, you should increase the capacity of the repository virtual disk. A snapshot's repository virtual disk can be dynamically expanded at any time.

To alert yourself of an impending "repository full" condition, configure a warning threshold for repository free capacity when you are creating the snapshot. The default and the recommended value for the threshold is 50 percent. This value should provide enough advanced warning to allow you time to assess the repository virtual disk use and to expand the capacity if required. By default, the snapshot will be failed if the repository becomes completely full. The option to fail writes to the source virtual disk is also available. This option allows the snapshot to remain active, and writes to the source virtual disk resume after the repository capacity has been increased.

You can locate the snapshot repository virtual disk in any disk group. However, to simplify physical disk management, locate the repository virtual disk in the same disk group as the source virtual disk whenever possible. This ensures that if you must move the physical disks associated with the disk group to another storage array, all the virtual disks associated with the snapshot reside on that group and the snapshot remains accessible.

### ***Re-creating a Virtual Disk Snapshot***

When you are finished working with a snapshot, you have the option of disabling or deleting it. Deleting a snapshot deletes the repository virtual disk and associated data. Disabling a snapshot saves the snapshot and its associated repository for later use. Using a disabled snapshot to re-create a snapshot takes less time than creating a new snapshot. For example, if you need to create daily backups of the same source virtual disk, rather than creating a new snapshot every day, you simply re-create the existing disabled snapshot. The Re-create



Snapshot option is extremely beneficial in environments where frequent backups or frequent manipulations of the same data set occur.

NOTE: All data previously written to the snapshot is overwritten when a snapshot is re-created.

### **Virtual Disk Snapshot and the Microsoft Volume Shadow Copy Service**

The Microsoft Volume Shadow Copy Service, also called Volume Snapshot Service (VSS), is a storage management interface for Microsoft® Windows Server® 2003 and Microsoft Windows Server 2008 operating systems that allows you to create snapshot data images. VSS enables your storage array to interact with third-party applications that use the VSS Application Programming Interface (API) to create snapshots that are consistent by ensuring that all memory resident application data is flushed to the storage array before the snapshot is taken. Typical uses for VSS include data backup and restoration and data transport (only supported through a VSS hardware provider) for testing, data mining, or backup. Dell supplies a VSS hardware provider on the PowerVault MD Resource CD to enable VSS functionality on the PowerVault storage arrays.

#### ***VSS Architecture***

The VSS architecture consists of three components that interact to help create a consistent snapshot. Overall coordination of the snapshot creation process is under VSS framework in the operating system.

**Requestor-** A requestor is a third-party application, usually a backup application that requests VSS to perform a shadow copy (snapshot) of a particular virtual disk. The requestor initiates the VSS process to create a snapshot.

**Writer-** A writer is an application provided module which takes application-specific action to ensure that its data store on the virtual disk is consistent (memory resident data is flushed) before the snapshot is taken. Applications such as Microsoft Exchange Server 2003 (and later) and Microsoft® SQL Server® 2005 (and later) are examples applications that incorporate VSS writers.

**Provider -** A provider is the interface to the storage array used by the VSS framework to request the storage array to create a snapshot. The provider can be a hardware device specific, such as the Dell Modular Disk VSS provider, or a software provider like the one included in Windows Server 2003 or 2008. The VSS framework attaches to the provider and uses it to coordinate the creation of snapshots on the storage array.

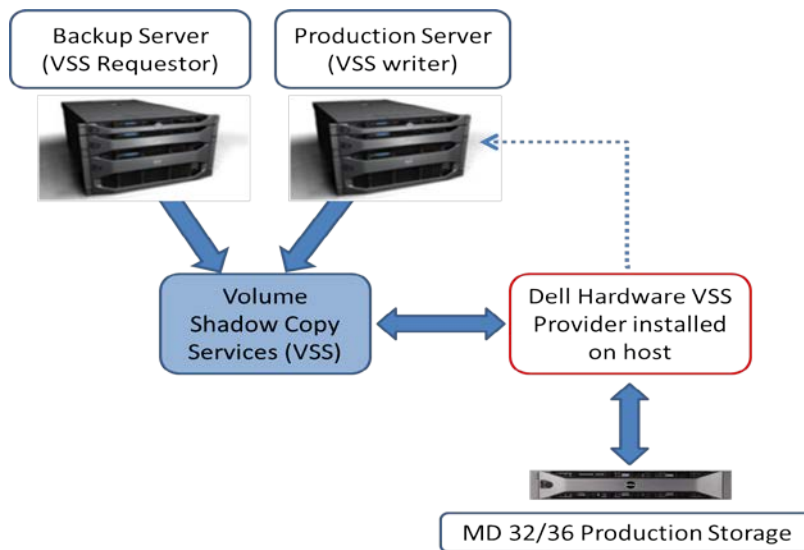


Figure 4: Interacting Components in a typical VSS configuration.

### *Using VSS to Create Snapshots*

The most common use of VSS is in backup applications. Most third-party backup applications today provide VSS requestor functionality. Used in conjunction with a VSS aware application (Microsoft SQL Server, Microsoft Exchange) and the Dell hardware VSS provider, backup applications can automatically create snapshots on the storage array and back them up according to the user-defined backup policy. Because VSS manages the entire process, there is no need to manually prepare the data for snapshot creation. Applications that are integrated with VSS automatically perform these operations. Pre-defined policies are designed to help reduce the time and the complexity associated with data backups and thus helps ensure consistent backups that can be restored quickly.

The Dell PowerVault MD32/36 Series of Arrays and the Dell hardware VSS provider also make it possible to create a snapshot of the source data on one server, and then to import that snapshot onto another server. This process, known as snapshot transport, is accomplished in minutes, regardless of the size of the data. This transport capability reduces the performance impact to the application server by placing the burden of the backup processing on an alternate server.

## Virtual Disk Copy

Virtual Disk Copy creates a physical copy, or a clone, of a source virtual disk. A virtual disk copy appears and functions as a standard virtual disk. A virtual disk copy can be addressed by the host and can be read, written to, or copied from. Virtual Disk Copy is a background operation with user-defined priority settings, enabling administrators to minimize either copy time or the overall I/O impact to the storage array. As Virtual Disk Copy is based on the storage array controller, creating a virtual disk copy requires no host interaction or CPU cycles — minimizing the impact to applications and the storage infrastructure.

The virtual disk copy relationship is established between a source and a target virtual disk. To help ensure data integrity, all I/O to the target virtual disk is suspended during the procedure. This is because the state of data on the target virtual disk is inconsistent until the procedure is complete. Also, all updates to the source virtual disk are suspended to help prevent chronological inconsistencies from being created on the target virtual disk. After the Virtual Disk Copy operation is complete, the target virtual disk automatically becomes read-only to the hosts unless the default write protection setting is altered. In order to preserve the data on the target virtual disk, it is best to keep the write protection setting set to Read-Only.

When Virtual Disk Copy is enabled, the PowerVault MD32X0, MD32X0i, MD36X0i, MD36X0i and MD36X0f series storage arrays each support up to 255 virtual disk copies and up to eight concurrent virtual disk copy operations.

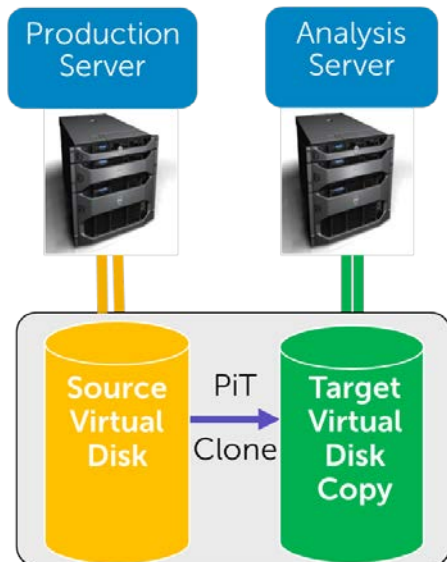


Figure 5: Creating a Virtual Disk Copy

## Using Virtual Disk Copy

Virtual Disk Copy offers many benefits for data backup and manipulation.

### *Data Backup and Restoration*

The virtual disk copy procedure can be leveraged into a high-throughput backup solution providing disk-based backup. The storage array manages the data transfer internally, intelligently balancing backup-related traffic against production traffic on the drive channels. This is designed to minimize the impact on production processing and to isolate all traffic within the array itself, with the goal of eliminating the requirement for additional external I/O channels for backup purposes. Because the operation is carried out entirely within the array, the backup process is designed to be completed as efficiently as possible and to outperform conventional tape-based systems, server-to-tape systems, and even other external disk-based systems.

The data can be recovered almost instantly by simply unmapping the source production virtual disk, and mapping the backup virtual disk in its place. In this case, the roles of the virtual disks

change: The previous backup virtual disk becomes the new production virtual disk, and the old production virtual disk can be re-used as a target for future backups.

### ***Virtual Disk Relocation***

Virtual disk requirements can and do change over time. The overall required capacity might increase. Usage patterns might change from a mix of read and write operations to predominantly read-only operations, and access patterns might change from predominantly random requests to predominantly sequential requests. The Virtual Disk Copy feature allows a systems administrator to optimize virtual disk performance by moving a data set from one set of physical disks to another set. In a single operation, the administrator could optimize application performance and capacity use for virtually every aspect of virtual disk geometry for the data set — such as size, RAID level, number of drives, and so forth.

### ***Application Development and Data Analysis***

Typical uses for a virtual disk copy include decision support systems where analysis must be done on the source data without affecting the source's performance or application development where multiple full copies of the data can be subjected to different test scenarios with full performance in each.

## **Creating a Virtual Disk Copy**

You can use either the Dell Modular Disk Storage Manager graphical user interface or the command line interface (CLI) to create a virtual disk copy. The CLI has the added benefit of command scripting, allowing for task automation and scheduling.

**NOTE:** Before creating a virtual disk copy, stop all I/O activity to the source and target virtual disks. You should also run the SMrepassist utility on the source virtual disk. SMrepassist (replication assistance) is a host-based utility for Windows that is designed to ensure that all the memory-resident data for the file system is flushed to disk.

When you configure a virtual disk copy, it is a best practice to use different physical disks and disk groups for the source virtual disk and the target virtual disk. By doing so, you can increase the availability of your data. If the disk group that contains the source virtual disk or the target virtual disk becomes unavailable you can still have access to the other disk group and your data.

Refer to the appropriate Dell PowerVault documentation for procedures on your chosen method for creating a virtual disk copy.

## **Re-Copying a Virtual Disk Copy**

The Re-copy option enables you to create a new virtual disk copy for a previously defined copy pair that might have previously had a status of Stopped, Failed, or Completed. Use the Re-copy option for creating scheduled, complete backups of the target virtual disk that can then be copied to a tape drive for off-site storage. The Re-copy option is extremely beneficial in environments where backups or manipulation of the same data set frequently occur.

**CAUTION:** The Re-copy option overwrites existing data on the target virtual disk and makes the target read-only to hosts. The Re-copy option is designed to fail all snapshot virtual disks associated with the target, if any exist.

## Remote Replication

Remote Replication (RR) is available on the MD36X0f. Remote Replication replicates data from one MD36X0f known as the primary to a different MD36X0f known as the secondary. This functionality can be used as part of a site protection plan, or for data migration. There are three types of replication; Synchronous Replication, Asynchronous Replication, and Asynchronous with Write Order Consistency Replication. The distance the primary and secondary can be separated is a function of the type of replication being deployed, the bandwidth between sites, and the performance needs of the applications being replicated, but can, and often do, span 100's of KM.

### Key Benefits of PowerVault MD Remote Replication (RR)

1. **SAN Based Replication** - Data replication between the primary volume and the secondary volume is managed by the MD36X0f storage arrays and is transparent to host machines and applications.
2. **Replication Modes** - RR supports Synchronous, Asynchronous and Asynchronous with Write order consistency replication modes. These modes help administrators to choose the replication method that best meets protection, distance or performance requirements.
3. **Dynamic Replication Mode Switching without suspending the replication** - Users can switch between replication modes at any time. This enables administrators to accommodate changing application and bandwidth requirements without sacrificing protection.
4. **Ease of use** - IT administrators can enable replication through the Modular Disk Management System (MDSM) GUI or MDSM CLI. Once enabled, RR functions can be managed using the MDSM GUI, the CLI, or MDSM vCenter Plug in. These tools are available free of charge.
5. **Multiple Replication Relationships** - A replication connection is not limited to a single primary RR system and a single remote RR system. In general, each MD36X0f with the optional RR premium feature installed and activated may be either a primary system or a secondary system or both. Up to 16 replication relationships are supported.
6. **Suspend and Resume** - RR provides the ability to suspend replication by explicitly using the Suspend command and under certain circumstances, to automatically suspend replication (consistency group suspension, asynchronous replication when link bandwidth exceeded).
7. **Role Reversal/Fail Over** - RR allows reversing the roles of Primary and Secondary virtual disks to recover from a disaster.
8. **Read-only replica access (includes Snapshot creation)** - RR enables the remote data to be utilized prior to a disaster without sacrificing protection of the primary site data.

The types of Replication can be changed on-line and move from Synchronous Replication, to Asynchronous Replication, and finally Asynchronous with Write Order Consistency Replication. A system replication type can be moved in the reverse order as well going from Asynchronous with Write Order Consistency replication to Asynchronous Replication, and finally Synchronous Replication. While these settings are not changed on a daily basis this flexibility is important as application and protection levels change over the deployment life of the system.

Synchronous Replication ensures that the write completes not only on the local or primary system but also on the remote system prior to acknowledging the write to the local application. While this ensures that both systems are always synchronized, speed of light limitations will ultimately limit performance of the local application as distance increases. Because of this distances are usually limited to around 10km.

Asynchronous Replication acknowledges the write to the local application once the data is written to the primary (local) system. The replication to the remote or secondary system is batched up and done in the background. This eliminates performance issues due to the speed of light limitations but adds the reasonable risk that the local or primary site will become unavailable between the short time of the primary and the secondary system write. This allows for much greater distances between the local primary system and the remote secondary system.

Asynchronous with Write Order Consistency Replication ensures that once a replication batch is applied that all writes to the remote secondary system are done in the same order as writes on the primary system. This is useful for database consistency and other write order sensitive applications.

More information on Remote Replication, and how to use it to set up disaster recovery site, can be found in the *Dell PowerVault MD 36X0f Remote Replication Functional Guide*, *Dell PowerVault MD36X0f Remote Replication Design Guide* as well as in the MD36X0f product documentation.

## Combining the Virtual Disk Copy and Virtual Disk Snapshot Premium Features

### *Creating a Virtual Disk Copy from a Snapshot*

As mentioned earlier, the Virtual Disk Copy operation suspends I/O to the source virtual disk during a virtual disk copy to help prevent chronological inconsistencies from being created on the target virtual disk. In a 24x7 production environment, it is not always possible to suspend I/O to the source virtual disk for the amount of time required to create a virtual disk copy. To help alleviate this contention of resources, Virtual Disk Copy can be used in conjunction with Virtual Disk Snapshot.

It is a recommended best practice for all Virtual Disk Copy operations on production virtual disks to first create a snapshot of the virtual disk, and use the snapshot as the source of the Virtual Disk Copy operation. This combination can enable a complete point-in-time clone to be created with no detectable interruption to the I/O activity of the production virtual disk.

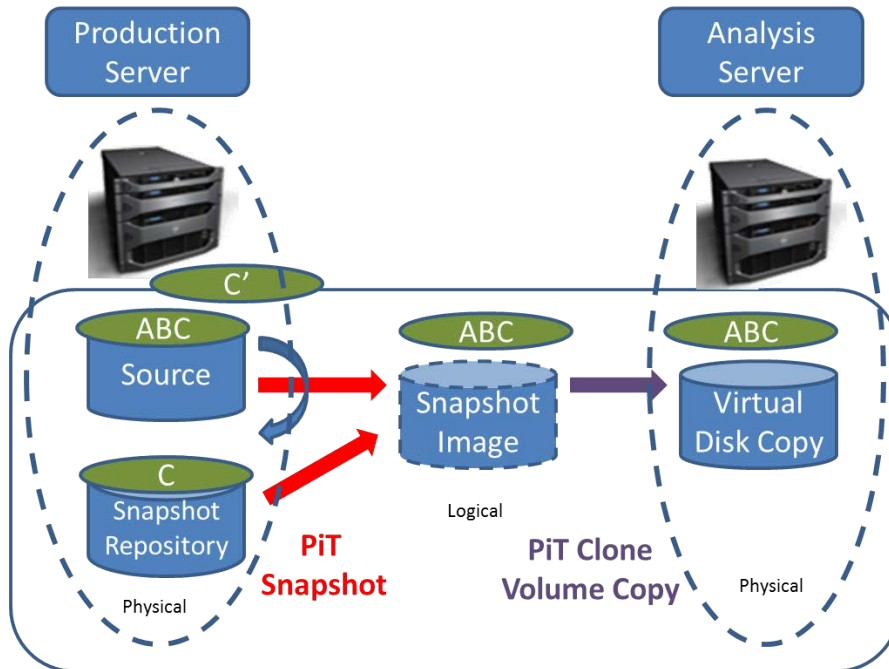


Figure 6: A Snapshot virtual disk as a source for Virtual Disk Copy

Figure 6 shows the Dell Modular Storage Manager view of a snapshot being selected as the source for a Virtual Disk Copy Operation.

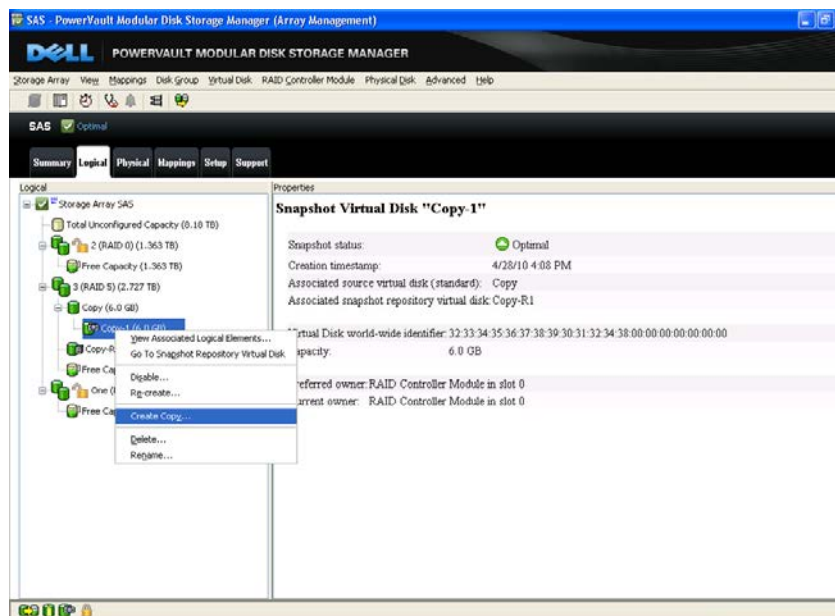


Figure 7: Snapshot of Virtual Disk Copy Operation

## Restoring Snapshot Data to the Source Virtual Disk Using Virtual Disk Copy

The Virtual Disk Copy premium feature can enable you to restore a virtual disk to the state represented by its snapshot. This can be used in the case where the data on a virtual disk is accidentally deleted or corrupted after a point-in-time snapshot is created. The data from the snapshot is now preferred to the data on the source virtual disk, and virtual disk copy can be used to restore the virtual disk to its original state using the snapshot.

Although Virtual Disk Copy can be leveraged to provide the desired functionality, the obvious method of simply copying from the snapshot back to the source virtual disk is not viable. Such a scenario would write to every block of the source virtual disk, creating a severe impact on the repository which tracks differences between the source virtual disk and all of its snapshots, including the snapshot from which it is being copied. As a result, the copy likely would fail as the repository fills to capacity.

The solution is to first create a new virtual disk to serve as a temporary target for the virtual disk copy. Then use Virtual Disk Copy to copy the snapshot to this temporary target virtual disk. Upon completion, remove this copy relationship and then create a new Virtual Disk Copy with the temporary target virtual disk serving as the source virtual disk and the original source virtual disk serving as the target.

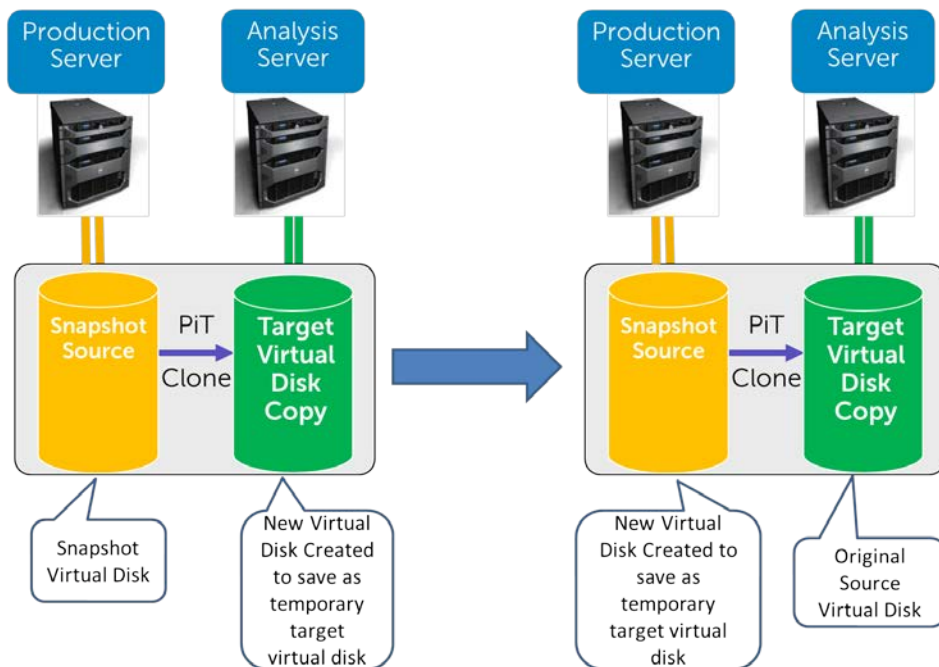


Figure 8: Virtual Disk Copy for Snapshot Virtual Disk to Source Virtual Disk



## Using Remote Replication, Virtual Disk Snapshot and Virtual Disk Copy together

The Dell Virtual Disk Snapshot, Virtual Disk Copy and Remote Volume Copy premium features can be combined to implement a remote disaster recovery site or leverage compute resources at the remote site for analysis of data. These features can also be leveraged by VMware SRM (Site Recovery Manager) to create a one click, testable, site recovery plan.

## Conclusion

The Dell Virtual Disk Snapshot, Virtual Disk Copy and Remote Replication premium features offer many benefits for data protection and management. Each feature provides a different level of data protection and management. In summary, Snapshot provides data protection by providing an instantaneous point-in time image that can be quickly restored to recover from events such as virus attacks. Virtual Disk copy provides a physical copy of the source, this copy can be used for fail over if the source disk degrades. Remote Replication provides data protection from a site failure; it creates a copy of the source data at a remote site. We can also achieve better performance by combining them.

The following table outlines some of the combined usage of the data protection / copy services features starting from the source data and their typical business usage of that particular combination.

Local Primary System				Remote Secondary System			Typical Business Usage
Local Primary Volume	Snapshot	Volume Copy	Remote Replication	Remote Secondary Volume	Snapshot	Volume Copy	
Data	X						Local Recovery, Analysis, Low-impact Development Testing
Data	X →	X					Heavy weight analysis, or High impact Development Testing
Data			X	X			Site Disaster Recovery, Data Migration
Data			X →	X →	X		Analysis, Business Continuity Testing
Data			X →	X →	X →	X	Disk Vaulting

## Data Protection Using Premium Features

## Appendix A: Comparing a Snapshot to a Virtual Disk Copies

Feature	Virtual Disk Snapshot	Virtual Disk Copy
Replication type	Copy-on-write	Point-in-time fully copy (clone)
Copy location relative to source	Same storage array	Same storage array
Performance impact	Processing against both source and pointer-based repository image can create some performance overhead	After the copy is complete, there should be no more performance overhead
Ongoing impact of maintaining copy	Some performance impact due to processing against both the data source and table of pointers	None
Max copies	8 per virtual disk / 128 per system	8 active copies per system / 255 total copies per system
Copy dependence on source	Lost if source is lost	Available if source is lost
Copy size	Fraction of the capacity of the source virtual disk (approx 20% or less of the source capacity typically)	Same amount of capacity as the source data required
Availability	Recovers source data in the event of corruption	Recovers source data in the event of corruption or hardware failure
Application access to source / target	Full read/write access while the snapshot is active	Source is read-only during copy process. No access to copy during this process
Typical uses	<ul style="list-style-type: none"> <li>Point-in-time backup images / File Restoration</li> <li>Operations where the data must be frozen at a particular point in time</li> <li>Data mining and analysis</li> </ul>	<ul style="list-style-type: none"> <li>Full point-in-time data for analysis, mining and testing without directly affecting the source's data or performance</li> <li>Migrating data between storage tiers</li> <li>Full recovery protection against virtual disk corruption</li> </ul>
Features	<ul style="list-style-type: none"> <li>Almost instantaneous - when limited time is available for a full virtual disk copy</li> <li>Less disk space than a virtual disk copy</li> <li>Can be mapped to any host</li> <li>Can be read from or written to</li> </ul>	<ul style="list-style-type: none"> <li>Eliminates I/O contention on the primary virtual disk</li> <li>Can be mapped to any host</li> <li>Can be read from or written to</li> </ul>

### Contact Information

Go to: <http://www.dell.com/> or call 1-800-WWW-DELL

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