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White Paper

Utilizing Brocade Storage Application Services with EMC RecoverPoint

Applied Technology

Abstract

This white paper covers the utilization of Brocade Storage Application Services by EMC® RecoverPoint. With Storage Application Services, RecoverPoint supports heterogeneous fabric-based data protection and replication for all open-system server solutions without the need to install host-based agents.

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Executive summary

Every organization has unique business continuity requirements that are directly tied to their business goals. Risk avoidance has become a boardroom priority for many organizations since the business implications and costs associated with critical application downtime can be in the millions. Because of this, many organizations need to implement broader disaster recovery solutions for their business-critical applications in which applications and the associated data can be replicated, protected, and backed up, not only locally but across to a secondary remote data center. This then allows applications to be recovered to any point in time with a guaranteed data consistency locally or remotely, in case of an unforeseen event.

EMC® RecoverPoint is an intelligent data protection and recovery solution that provides comprehensive data recovery for critical business applications so that you can protect your organization from data loss due to common issues such as server failures, data corruption, software errors, viruses, and end-user errors, as well as from catastrophic events that can bring entire data centers to a standstill. RecoverPoint enables the reliable continuous replication of data either locally or remotely with protection across multiple time points using continuous data protection. RecoverPoint installs into an existing SAN infrastructure to seamlessly connect to heterogeneous hosts and storage subsystems. For long-distance replication, RecoverPoint uses the existing IP network to send replicated data over a WAN or an FC network to send replicated data over fibre; for local replication RecoverPoint uses resources in the existing SAN fabric.

RecoverPoint leverages the Brocade Storage Application Services (SAS) APIs in the Connectrix® Application Platforms − the AP-7600B platform switch or the PB-48K-AP4-18 platform blade for the Connectrix ED-48000B, ED-DCX-B, and ED-DCX-4S-B director. Connectrix Application Platforms provide intelligence in the SAN and enable RecoverPoint to utilize a network-based replication service to provide continuous data protection and recovery for critical business applications. Connectrix Application Platforms are designed with purpose-built components to run enterprise storage applications. A fully pipelined multi-CPU RISC and memory system provides inline processing capabilities for optimum performance and flexibility. A partitioned port processing system utilizes separate control and data path processing to perform data movement operations (such as write splitting) at wire speed.

The SAS API is based on the T11 FAIS standard, which provides the building blocks to host and support high-performance storage applications. This API not only provides accelerated primitives like mirroring, copying, extent maps, striping, and concatenation for volume management, but also advanced features like dirty region logging, range locking, copy on write, and resync. This network-based technology removes a layer of complexity and makes RecoverPoint easy to deploy in existing Connectrix fabrics. Deploying RecoverPoint with a switch that supports the SAS API requires no software on the host platforms; instead, the RecoverPoint software resides on appliances, which are configured to interact with the Brocade SAS application platform switch in the local SAN.

Introduction

This white paper covers the integration of EMC RecoverPoint with the Brocade Storage Application Services (SAS) APIs provided in Connectrix Application Platforms for fabric-based replication.

Audience

This white paper is targeted to storage and server administrators, IT managers, and application engineers, as well as storage integrators, consultants, and distributors.

Brocade Storage Application Services and RecoverPoint overview

SAS API: Optimized architecture for data replication

Brocade Storage Application Services (SAS) is based on the T11 FAIS standard to deliver reliable, scalable, and highly available storage applications. SAS runs on Connectrix Application Platforms – the Connectrix AP-7600B application platform switch, and the PB-48K-AP4-18 application platform blade in the Connectrix ED-48000B and DCX family directors. SAS, as configured by the RecoverPoint SAS agent, enables the appropriate Connectrix Application Platform to transparently "split" host writes between a target LUN and a RecoverPoint appliance (RPA). This results in one copy of the write data being sent to primary storage and the other copy being sent to RecoverPoint.

A RecoverPoint SAS agent runs on the application platform and communicates with the storage services using a SAS API. The RecoverPoint SAS agent provides housekeeping instructions to the platform, updates RecoverPoint with a SAS service status, and receives tasks from RecoverPoint. In addition, the RecoverPoint SAS agent uses mechanisms in the SAS API to manage errors, failures, and outages with either the storage array or with the ports/connectivity between the RecoverPoint appliance and the application platform.

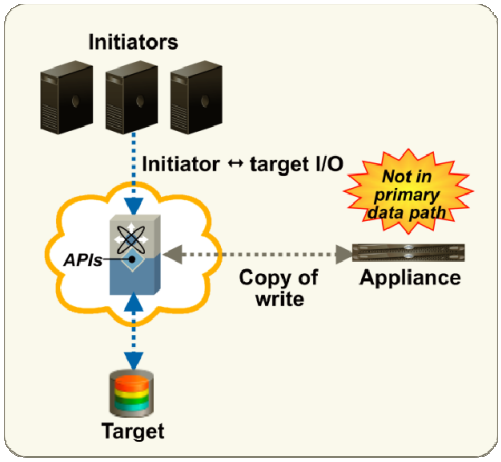

Figure 1. SAS-based connectivity for RecoverPoint data replication

RecoverPoint leverages SAS and the specialized high-performance processing power in the appropriate Connectrix Application Platform (switch or blade) for deployment of a SAN-based replication service that provides continuous data protection and recovery for critical business applications. The Connectrix Application Platform delivers intelligence into an existing SAN infrastructure and performs the required write-split function for sending data at wire speed to RecoverPoint and to the storage subsystem. Deploying RecoverPoint with the Brocade Storage Application Services requires no software on the host platforms; instead, the RecoverPoint software resides on appliances, which are configured to interact with the Connectrix Application Platform in the SAN.

Connectrix Application Platform: Intelligent fabric benefits for data replication

The following are some of the features provided by the Connectrix Application Platform:

- **Optimum performance and flexibility**

  Fully pipelined multi-CPU RISC and memory systems with 4 Gb/s port speed and up to 1 million IOPS deliver high-speed inline processing.

- **Split-path hardware acceleration**

  Partitioned port processing utilizes separate control and data path processors to provide high-speed data transfer and not compromise host application performance.

- **No host or storage recabling**

  The Connectrix AP-7600B connects to an existing SAN fabric using E_Port ISLs so host and storage connections do not need to be moved to implement RecoverPoint. The PB-48K-AP4-18 blade enables all ports in the director in which it is installed, either a Connectrix ED-48000B or a DCX family director, and all ports ISL'd into the same director to utilize the Storage Appliance Services.

- **Deployment flexibility**

  Application platform ports can be configured as E_Ports or F_Ports. For small fabrics, host initiators can connect directly to ports on the Connectrix AP-7600B switch.

- **Performance aggregation**

  Brocade Storage Application Services provides advanced features like exchange-based trunking to further aggregate application performance.

- **Fabric-based delivery of the storage application**

  Brocade Storage Application Services eliminates the need for host-based agents, and can be seamlessly deployed in existing SANs using the Connectrix Application Platform.

- **No disruption of the primary I/O from the server to the storage array**

  Write-split operations are performed at wire speed, ensuring the availability and performance of critical applications remain high.

- **Deployment flexibility and investment protection**

  RecoverPoint services can be provided to all the existing servers and storage in the SAN, irrespective of the operating systems or array types. This allows customers to get more out of the existing storage and server infrastructure investments.

- **Unlimited scalability, no performance bottlenecks**

  Customers are no longer constrained by the performance limitations of using host CPU cycles and in-band appliances. The performance scales by simply adding additional Connectrix Application Platforms to expanding SAN environments.

- **Error recovery logging**

  Brocade Storage Application Services provides error recovery mechanisms like Dirty Region Logging (DRL) to recover from an appliance or platform failure.

Recent enhancements to SAS

A number of developments and enhancements have been added to the SAS firmware in order improve application availability and speed troubleshooting. These include:

- **Improved debugging and troubleshooting**

  SAS was enhanced to gather fine-grained error statistics for every Host-VT-LUN (ITL) and VI-Storage. This data is made available to the storage application and for support purposes.

- **Improved logging**

  Development within the SAS integrated log upload capability with FOS-based support data gathering speeds up and simplifies troubleshooting efforts for administrators and support personnel. In addition, an embedded Fibre Channel frame tracing capability was added to reduce the need for deploying protocol analyzers in the field.

- **Improved resiliency enhancements**

  Improvements were made to enable transparent fabric application hardware restarts to better assure SAS objects are reloaded properly following a crash. In addition, path failback capabilities have been made to be more robust.

	Summary of benefits of using the Brocade SAS API with EMC RecoverPoint
1.	By eliminating the need for host-based agents, it eliminates impact to the host or host-based applications
2.	No disruption of the primary I/O from the server to storage
3.	Simplifies solution implementation and reduces implementation risk
4.	Simplifies change management of servers and OS
5.	Takes advantage of existing SAN investments
6.	Supports many open-systems servers or OS platforms[1]
7.	Supports many storage arrays connected to the fabric[1]
8.	Can replicate and protect data across heterogeneous storage and servers and support multitier applications[1]
9.	Based on the T11 FAIS standard for reliable, scalable, and highly available data storage applications

RecoverPoint fabric-based replication benefits

Universal enterprise data protection

RecoverPoint with the Brocade Storage Application Services is an end-to-end solution for continuous remote replication and continuous data protection across heterogeneous server and storage platforms, enabling complete data protection for the entire enterprise. Because storage systems at the primary and secondary sites do not have to be the same, there is flexibility to deploy lower-cost storage (for example, at the secondary site) or to leverage already existing storage. With the SAS architecture, RecoverPoint can be used with virtually every open-system-based environment. No changes are required on the storage arrays, hosts, or SAN configuration.

Guaranteed data consistency

RecoverPoint guarantees a consistent replica of business-critical data in the event of any possible failure or disaster. With RecoverPoint, consistency is maintained at all times, even through rolling disasters or during resynchronization.

[1] The *EMC Support Matrix* has a complete list of server operating systems and storage platforms supported by RecoverPoint. See https://elabnavigator.emc.com for full details. Registration is required.

Intelligent use of bandwidth

RecoverPoint employs intelligent bandwidth reduction technologies to deliver unprecedented bandwidth savings. As a result, the system always provides superior protection for the available bandwidth, while dramatically reducing WAN costs, particularly over long distances. Data reduction is achieved through application-aware and storage-aware algorithmic techniques that conserve bandwidth to an extent not possible with traditional compression technologies.

Policy-based data replication

RecoverPoint offers a full spectrum of replication modes that are managed automatically, with strict adherence to user-defined policies that are tied to desired business objectives. The system adapts its replication dynamically for each application according to these policies, based on the available bandwidth and the application workload. This greatly simplifies data and disaster recovery management for complex and heterogeneous environments. For example, within the same storage array, replication policies can be set for minimal lag for critical applications and policies can be set to minimize bandwidth for less-critical application data.

Recovery to any point in time

RecoverPoint efficiently maintains a snapshot history to allow convenient rollback to any point in time, enabling a quick and effective recovery from any disaster. It supports multiple transactional-consistent snapshots at the remote site, allowing reliable recovery in database environments. Frequent, small-aperture snapshots (zero to seconds apart) are remotely replicated to minimize the risk of data loss due to data corruption. Local replication utilizes continuous data protection (CDP), which captures every change to the data, eliminating the risk of data loss.

Data processing at the secondary site

RecoverPoint enables direct read/write access to the replicated image at the secondary site. There is no requirement to first make an additional copy. The system supports robust failover and failback capabilities, reducing management and operational costs.

Intuitive management

RecoverPoint offers multiple management features that make implementation and operation extremely easy. The system, consisting of two to eight appliances per site, is centrally managed through a single intuitive graphical user interface (GUI) or through a command line interface (CLI), both of which are accessible from a secure Internet connection. RecoverPoint provides automated discovery of LUNs, is SNMP-enabled for integration with standard enterprise network- and system-management applications, and offers call-home capability that proactively reports system status in the event of failure.

SAN basics for intelligent fabric-based write-splitting with RecoverPoint

Zoning

Many devices and nodes can be attached to a SAN. When data is stored in a single cloud, or storage entity, it is important to control which hosts have access to specific devices. Zoning controls access from one node to another. Zoning lets you isolate a single server to a group of storage devices or a single storage device, or associate a grouping of multiple servers with one or more storage devices, as might be needed in a server cluster deployment.

Zoning is implemented at the hardware level (by using the capabilities of Fibre Channel switches) on a World Wide Name (WWN) basis. WWNs are 64-bit identifiers for devices or ports. All devices with multiple ports have WWNs for each port, which provides more detailed management. Zoning is configured

on a per-target and per-initiator basis. Consequently, if you need to attach multiple non-clustered nodes to the same storage port, you must also use LUN masking.

LUN masking

LUN masking, performed at the storage controller level, allows you to define relationships between LUNs and individual servers. Storage controllers usually provide the means for creating LUN-level access controls that allow access to a given LUN by one or more hosts. By providing this access control at the storage controller, the controller itself enforces access policies to the devices. LUN masking provides more detailed security than zoning, because LUNs provide a means for sharing storage at the port level.

When properly implemented, LUN masking fully isolates servers and storage from events such as resets. This is critical for preventing the problems previously noted. It is important to thoroughly test your design and implementation of LUN masking, especially as LUN masking is required for the Virtual Initiators presented to the back-end storage target.

Figure 2 is an example of zoning and LUN masking in a traditional Layer 2 fabric.

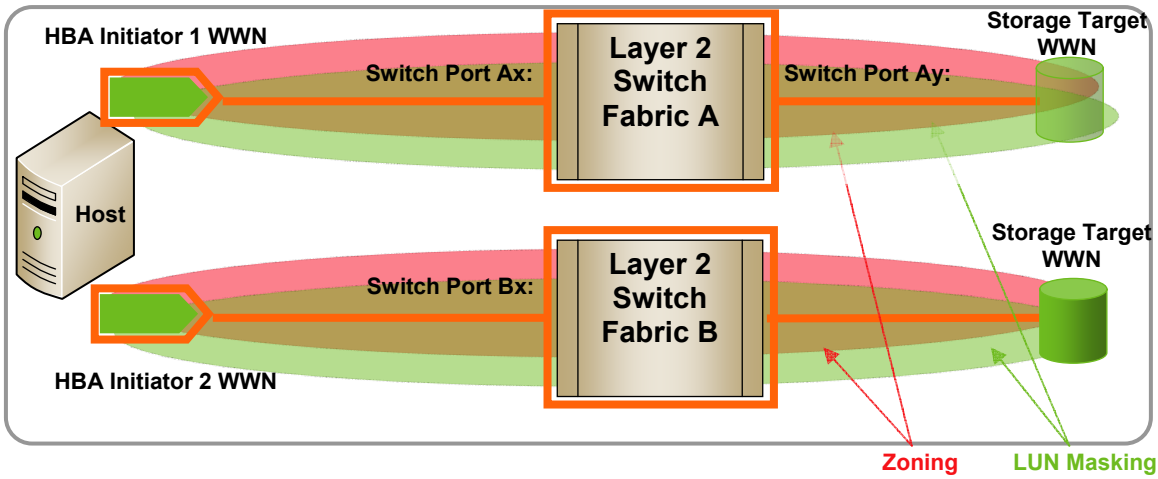

Figure 2. Traditional zoning and masking

Leveraging intelligent-fabric splitting

The Connectrix Application Platform (switch or blade) is designed with custom ASIC hardware called a data path controller (DPC) that is used by data storage applications to enhance I/O processing performance. The Brocade SAS API allows the platform to be configured to perform data movement operations, such as fabric-based write splitting. Once configured for RecoverPoint, the platform will examine write operations and decode the target storage port and logical unit number (LUN).

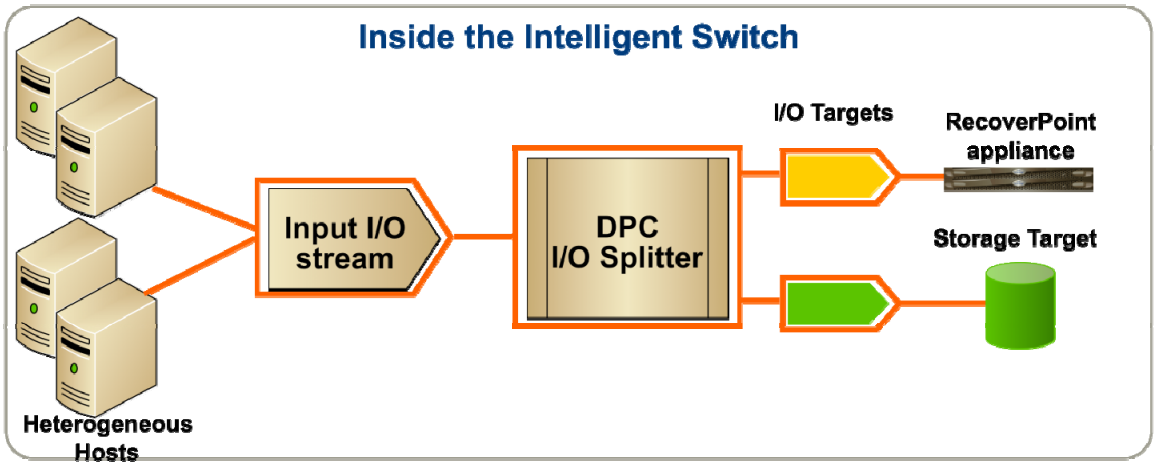

Figure 3. Intelligent-fabric architecture

SAS Virtual Initiator and Virtual Target support

Virtual Initiator (VI) and Virtual Target (VT) support is used with Storage Application Services for the replication services. VIs and VTs are transparent to the host and the storage target because the DPC in the intelligent switch creates them without host knowledge. The VTs are created from the storage target addresses and contain the product vendor, product ID, and GUID of the storage target; however, VTs do not receive the actual volume ID or actual array serial number. Virtual Targets show up as additional paths to the back-end storage target. Traffic is diverted to the intelligent switch only for the LUNs that are being replicated. This is done by making the Virtual Target paths as primary paths. Hence all traffic flowing thought the intelligent switch pertains only to the replicated LUNs. Once writes reach the intelligent switch, it will split the write operation, with the original being sent to the physical storage target and a copy of the write sent to RecoverPoint.

The DPC creates a VI, and the storage targets are zoned and LUN masked to the VIs. The host's initiator logs in to a VT and the DPC automatically connects it to the VI. The result is that the host is picking up the storage resources from the intelligent switch. The host has no knowledge of the write splitting that occurs behind the scenes.

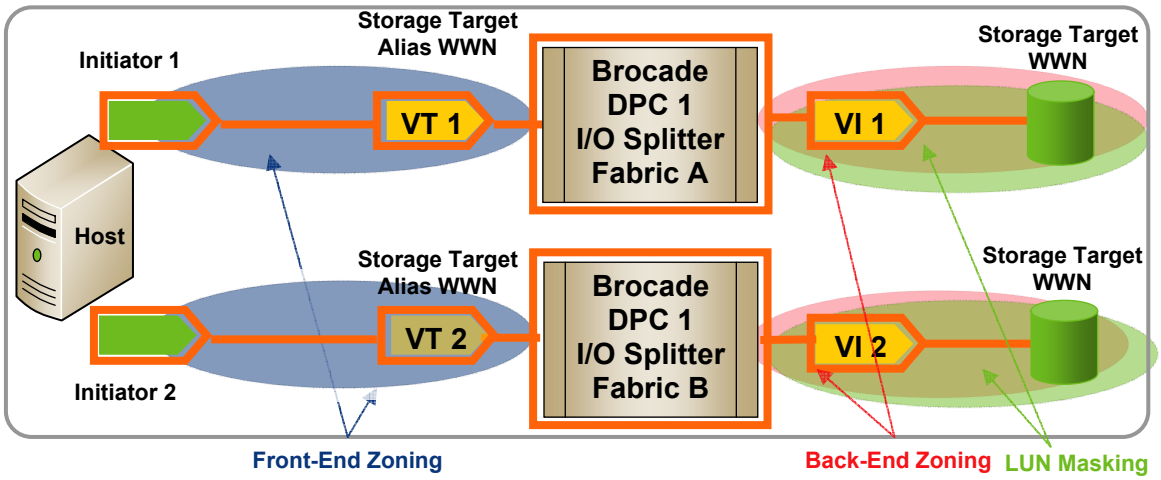

Figure 4. VT and VI examples

Zoning models for RecoverPoint

Figure 5 shows three different zoning models required for RecoverPoint depending on the type of write splitting. In the first model, traditional zoning is used, with a simple zone to enable access between a host and its target. This type of zoning is used when host-based write splitting is performed.

The second model provides replication with Storage Application Services running on an early generation Connectrix Application Platform, the AP-7420B switch. As shown in Figure 5, this scenario requires that every initiator/target pair used for replication services uses an additional Virtual Initiator and Virtual Target. This results in a potential doubling of the number of devices in the fabric as well as other issues, including zoning changes for each initiator/target, zoning of the initiators with the Virtual Targets, and WWN change of the initiator (which will require changes to LUN masking for every host). When the host issues a write, it is sent to the Virtual Target, which will process the write commands, and send it along to one or more Virtual Initiators. On reads, the physical target will send its data to the Virtual Initiator, which will process the request and then send it on to the Virtual Target.

Using Storage Application Services running on next-generation Connectrix Application Platforms – the AP-7600B switch or PB-48K-AP4-18 blade – there is a new, easier-to-deploy mode called Frame Redirection. With Frame Redirection, the initiator and target zoning is unchanged. On writes, the initiator will send its data to the target. Internal to the platform the write is redirected to the Virtual Target for processing. The Virtual Target then forwards the data to the Virtual Initiator and then on to the real target. On reads, the target will send its data back to the initiator. Again, in the platform, the read will be redirected to the Virtual Initiator for processing and then the Virtual Initiator will forward on the data to both the Virtual Target and on to the real initiator.

This configuration is more streamlined, because the original zoning and mapping between initiator and target are unchanged. There is no need to map/mask Virtual Initiators and no need to present Virtual Target paths to the host. As part of the SAS services configuration, a second zone between the Virtual Initiator and Virtual Target is created for use by the RecoverPoint replication services. The end devices involved in Frame Redirect need to be connected to a switch running FOS 5.3.0 or later.

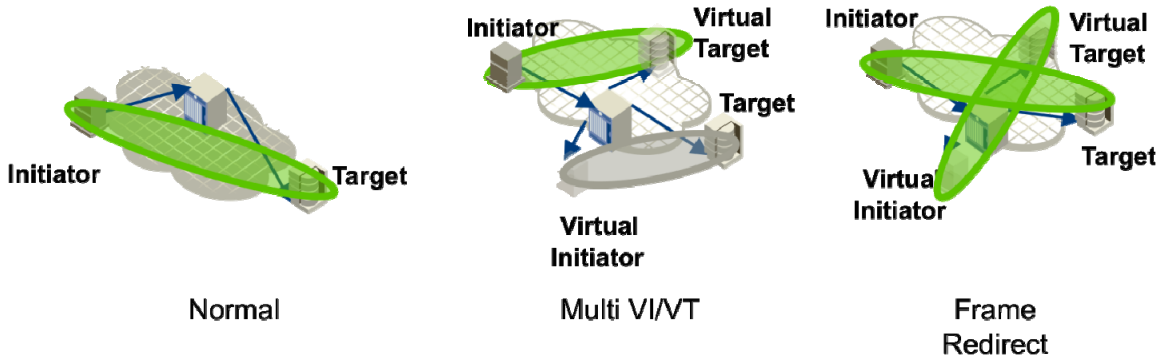

Figure 5. Different zoning types for RecoverPoint

RecoverPoint data replication using SAS

As discussed previously, Brocade Storage Application Services running on the Connectrix Application Platform enables the splitting of host writes to the primary storage array and to the RecoverPoint appliance at the source site. Once received by RecoverPoint, writes are processed for transfer over a WAN connection to a RecoverPoint appliance at the target site.

The RecoverPoint SAS agent executes in the Brocade Storage Application Services and is used by RecoverPoint to configure the Connectrix Application Platform to perform the write-splitting operations. The RecoverPoint SAS agent uses the SAS APIs to communicate housekeeping tasks to the platform (for example, commence Storage Application Services) and query the status of the Storage Application Services, as well as data commands from the platform to provide a copy of data to RecoverPoint. In addition, the SAS protocol includes mechanisms for dealing with errors, failures, and outages with either the storage array or the ports/connectivity between the RecoverPoint appliance and the platform.

All SAS protocol communications are based on industry-standard SCSI commands running over Fibre Channel (SCSI-FCP). The Storage Application Services registers as both an initiator and a target device in the Fibre Channel Name Server. Communications between the Storage Application Services and RecoverPoint fits into three classes:

- Control messages from RecoverPoint to Storage Application Services
- Control messages from Storage Application Services to RecoverPoint
- Data traffic (reliable writes) mirrored from a host issuing a write to a storage array

The first two classes of communication are messages/notifications between the devices to control various aspects of Storage Application Services. Since both the Storage Application Services and RecoverPoint appear as both a standard SCSI initiator and target, SCSI write operations are used between Storage Application Services and RecoverPoint to convey control messages.

The third class of communication contains copies of any write I/O traffic between a host and a storage array. Copying of data traffic commences once RecoverPoint has registered itself with Storage Application Services and has requested the service to start. SAS guarantees that the mirrored write I/O traffic is an exact copy of write I/O operations issued by the host.

Communication between the application platform and RecoverPoint starts with the RecoverPoint SAS agent registering for the SAS write-splitting services. RecoverPoint initializes the SAS protocol via a control message requesting a copy of all write operations from a given initiator (host) to a given target (storage array port and LUN). The SAS write-splitting service is activated when RecoverPoint issues a command to commence the copy.

With SAS write-splitting service operational, write operations are intercepted and delivered in a parallel manner to RecoverPoint and the storage array.

1. The host writes data to the volume that is processed by the application platform and a copy is sent to RecoverPoint and the original is sent on to the storage target (the replication "source").
2. Immediately upon receiving the data, RecoverPoint returns an ACK to the RecoverPoint SAS agent, which communicates this back to the application platform. The storage system returns an ACK upon successfully writing the data to storage.
3. Once the ACK has been received from the storage system and from RecoverPoint, the intelligent platform will send an ACK to the host that the write has been completed successfully.
4. If RecoverPoint fails to acknowledge the write operation, the RecoverPoint SAS agent enters error-recovery mode. During error-recovery mode, all writes are marked in the Dirty Region Log and an ACK is sent to the host that the write has been completed successfully. However, the writes are not split and copied to RecoverPoint until the error is corrected.

Note that in all cases the path between the primary I/O initiator and the target storage array is unaffected.

Brocade Storage Application Services performance

One benefit of using a SAN-based fabric application like the Brocade Storage Application Services is that I/Os are managed by purpose-built components at line speed, rather than by general-purpose processors. The Connectrix Application Platform running SAS supports many other intelligent features that contribute to the overall value and effectiveness of the RecoverPoint solution. These include:

- A fully pipelined, multi-CPU RISC and memory system providing in-line software processing capabilities to increase scalability, performance, and flexibility compared to other architectures
- Partitioned port processing utilizing separate control and data path processors to scale storage network software and deliver wire-speed data transfer
- Data modification and copy engines to accelerate common storage functions by using a range of data translation and copy avoidance techniques
- A compact and cost-effective deployment footprint
- Investment protection by interoperating with existing equipment while leveraging new and existing software tools

RecoverPoint and SAS error recovery

RecoverPoint and the Brocade SAS API provide a number of error recovery capabilities to enable rapid recovery and prevent data loss in the event of various failure scenarios. These capabilities are supported through RecoverPoint internal recovery mechanisms in conjunction with error recovery mechanisms provided by Brocade Storage Application Services.

Dirty Region Logging

Dirty Region Logging (DRL) is a feature that helps track the regions on which *write* I/O operations were performed. It marks regions as dirty based on the granularity specified by the RecoverPoint SAS agent. DRL is used by RecoverPoint in various failure scenarios.

In some RecoverPoint failure conditions, host writes will continue to be written to storage without being copied to RecoverPoint. The RecoverPoint SAS agent detects such events and uses device quiescing to minimize the number of such writes and delay further incoming writes until recovery. Once the failure ends, the RecoverPoint system will query the DRL to detect whether host writes were performed during the failure condition. If needed, RecoverPoint may then rapidly resynchronize replication volumes between the source and target site.

RecoverPoint uses markers to persistently log on a SAN volume which blocks were modified on the storage array. In the case of a WAN failure or other failures at the local site, these markers are used to determine which blocks need to be resynchronized. In case of a failure in RecoverPoint before marking was persistently stored, RecoverPoint can recover this information from the DRL. The RecoverPoint SAS agent detects writes that were not acknowledged by the storage array but did reach RecoverPoint. In this case, RecoverPoint quickly resynchronizes the affected volumes.

Fabric configurations for Brocade Storage Application Services

Core configurations

In Figure 6, an existing Brocade core fabric, built using a Connectrix ED-DCX-4S-B director-class device, is being enabled for intelligent-fabric splitting. It is assumed that each host and storage array is connected directly into one of the directors in each fabric. To add intelligent-fabric splitting, a PB-48K-AP4-18 blade is added into both directors in both fabrics. Additionally, two ports on each RecoverPoint appliance are connected to one of the ED-DCX-4S-B directors in each fabric. All of the ports are enabled for Storage Application Services though the backplane that connects to each blade. Any of the VTs and VIs can be accessed from any port in the fabric. If required for more bandwidth, an additional blade would be added to each fabric.

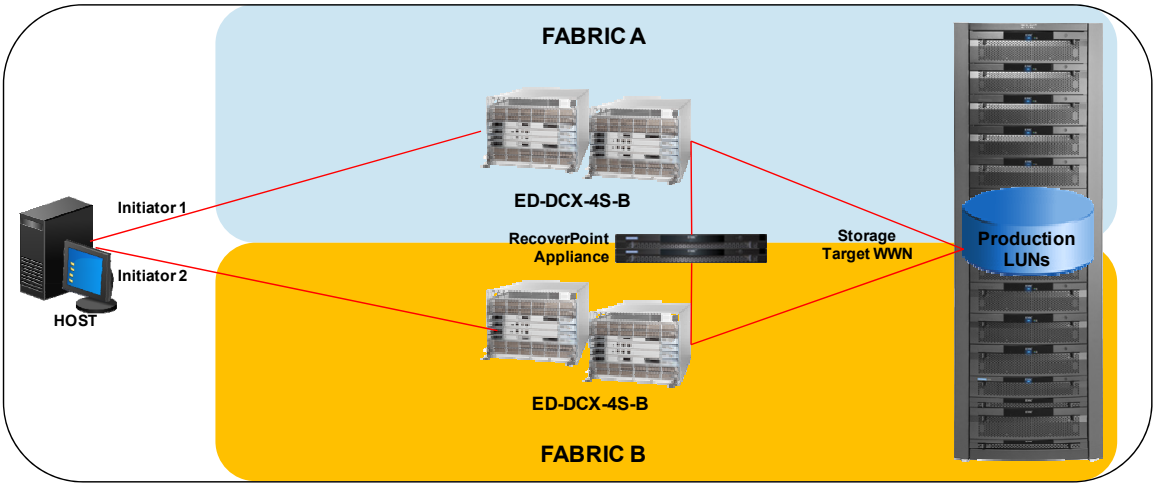

Figure 6. Core configuration

Core to edge

In a core-to-edge configuration, the hosts are not connected directly to the director switches; instead, they are connected to edge switches (such as a DS-4100B or DS-4900B) that are then connected to the directors. EMC recommends that intelligent-fabric write splitting not be used in these configurations.

Fabric configurations for McDATA interoperation

RecoverPoint also supports SAS for replication between Brocade and McDATA fabrics or in a native McDATA fabric environment. Successful interoperation requires the use of a Connectrix AP-7600B running in interop mode 2 (McDATA Native Fabric Mode) or interop mode 3 (McDATA Open Fabric Mode). The McDATA fabric must be at a minimum M-E/OS level 9.6.2.

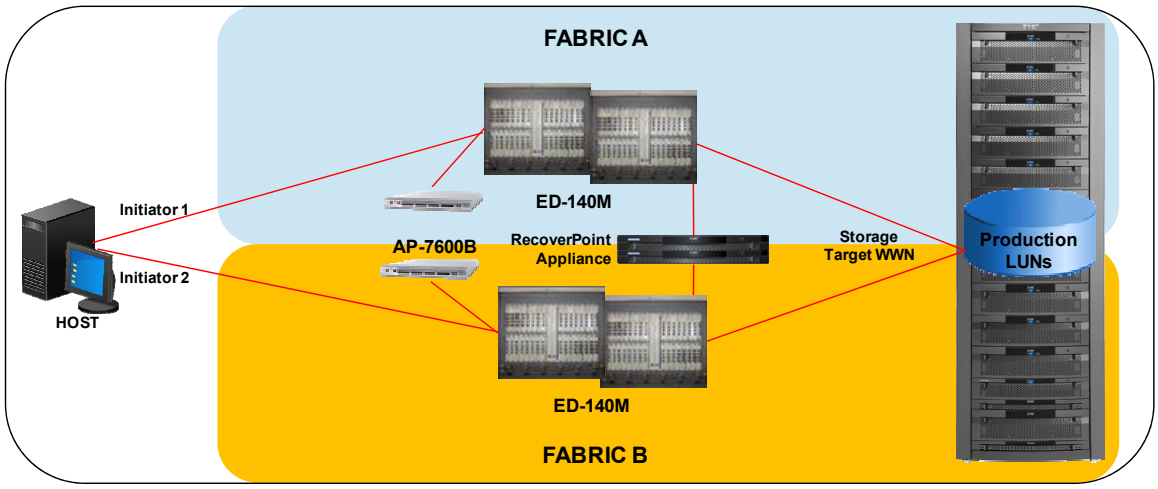

Figure 7. Enabling a McDATA fabric

RecoverPoint and SAS security

RecoverPoint together with Brocade Storage Application Services is compatible with all the management and fabric/target access security mechanisms offered on all members of the Connectrix family of director and switches. Using these security services, it is possible to deploy the RecoverPoint replication solution while maintaining high security and high service containment in the storage fabric.

Conclusion

Coupling the intelligent EMC Connectrix Application Platform—the Connectrix AP-7600B platform switch or PB-48K-AP4-18 platform blade— with EMC RecoverPoint data replication technology creates a superior data protection solution for the heterogeneous enterprise, with unprecedented levels of performance, scalability, manageability, and flexibility. Brocade's Storage Application Services API enables RecoverPoint to replicate data in heterogeneous storage and server environments across any distance, with zero impact to the primary I/O path or applications, and without rewiring, reconfiguration, or host software installation.

References

View http://www.EMC.com for more on EMC's proven solutions for data replication, data lifecycle management, disaster recovery, and continuous data protection, or contact an EMC Sales Representative today at 1-800-607-9546 or at 1-508-435-1000 outside of the U.S. for more information.