White Paper

Intelligent Fabric Applications: Simplifying Storage Operations to Enable Continuous Data Availability and Information Lifecycle Management

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Introduction

Enterprise computing environments are larger and more complex than ever. Today's IT infrastructures include servers from multiple vendors, diverse network connectivity technologies, and heterogeneous, tiered storage environments. To keep pace, storage administrators need a uniform, easy way to perform essential management operations that masks and simplifies the underlying and increasing complexity of the infrastructure.

As information assets become more important to maintaining competitive advantage, IT must deliver on increasingly demanding service levels. These demands come in two forms.

The first demand is for increased data availability. "High availability" in the usual sense refers to a system that is able to circumvent unplanned outages. But, as organizations increasingly want 24-hour operations capability, the ability to eliminate unplanned downtime is not enough. Planned downtime, which may result from operational requirements such as data center moves, upgrades, or platform migrations across the infrastructure, regardless of storage vendor, must also be addressed. Eliminating both types of downtime will provide for the new, required standard of "continuous data availability."

The second demand is for an increased ability to deliver on the information requirements of the business. Storage infrastructures need to deliver the right information to the right place at the right time. Storage resources across an organization need to be effectively allocated and dynamically reallocated based on business policy and the value of the data to the business at any point in time. The process by which this is accomplished is called "information lifecycle management" (ILM), and it is essential to cost-effectively meet the new service-level demands for information availability and access.

Storage virtualization is an enabling technology that can address both challenges: simplifying management of complex infrastructures, enabling non-disruptive operations, and facilitating critical elements of a proactive ILM strategy. However, it can only do so if it delivers the right capability on a suitable platform. Today, a new class of storage virtualization technologies is emerging that deliver this capability in the infrastructure, as part of the storage network. EMC and Cisco Systems® are collaborating on such a network-hosted virtualization solution: EMC® Invista™ running on the Cisco® MDS 9000 Family multilayer directors and switches. This paper outlines that solution.

Delivering Capability in the Storage Network: The Right Functions

The proper guiding principle for delivering intelligence in a storage network is this: *intelligence belongs closest to what it controls*.

Storage arrays should remain in control of data-preservation functions. This includes implementing redundant array of independent disks (RAID) levels, caching, checksums, hardware resilience, proactive error detection, and so forth. Duplicating or recreating these preservation functions at the network layer does not deliver new business value, and could negatively affect data integrity and performance.

Servers should primarily be focused on running business applications. Today, however, there are many storage management operations that are also performed on the server, such as volume management (a data *access* function), which can potentially move off the host. This would enable servers to remain dedicated to their core, application-centric functions.

Data-*access* functions can then be moved into the network. These functions become essential capabilities of a network-hosted virtualization product:

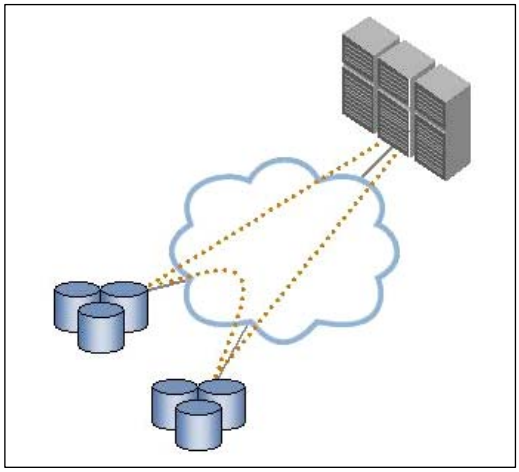
Storage Pooling and Network-Hosted Volume Management

Network-hosted volume management is the ability to create and configure a heterogeneous storage pool and present "virtual" volumes from the pool to the hosts. Volume-management functions and benefits become available to all qualified connected hosts and work across storage from all qualified, connected storage arrays.

Dynamic Volume Migration

Dynamic volume migration allows storage administrators to transfer data from one device to another while the applications accessing that data remain online (Figure 1).

Figure 1. Dynamic Volume Migration



To transfer a virtual volume, the virtualization software performs a synchronization of the source and target volumes, and then a redirection of I/O (the subsequent data reads and writes) from one physical location to another. The host remains attached to the same virtual address throughout the process, and is unaware that the physical location of the back-end volume has changed. No host cycles are required, which allows servers to remain dedicated to their core function: running business applications, rather than performing storage volume migrations.

Point-in-Time Copies

The ability to make a copy of a virtual volume on any other device that is virtualized is another benefit of storage area network (SAN)-based virtualization. Point-in-time copies can be used for backups, data warehouse loads, or by test systems to reduce the access load on production storage. The capability to make these point-in-time copies across any tier of storage adds a great deal of flexibility to the operational scenarios that employ them.

In general, replication can exist in multiple places in an IT environment. Where and how replication is done (in the network using a product like EMC Invista, on disk arrays using software such as EMC TimeFinder®, or on the host, using software such as EMC RepliStor®) depends on a customer's particular use case. Customers will evaluate which solution is most appropriate based on their specific business requirements. EMC is unique in offering such a broad range of choices in this area—and point-in-time copy functions with EMC Invista adds another option.

Real-World Value

EMC Invista on the Cisco MDS 9000 Family will help companies address the most pressing challenges they are facing.

Simplifying Management of Complex Storage Infrastructures

Deploying these critical functions in the storage network helps ensure they are available to, and work uniformly across, all qualified and connected devices. This gives organizations a single, centralized way to manage and perform these functions in a complex, tiered, heterogeneous environment. For example, volume management becomes a centralized service in the network, eliminating the need to load and configure host-based software on individual hosts. This is a significant problem in environments of any reasonable size. Today, administrators can spend as much as 20 to 30 percent of their time on volume management-related tasks. By centralizing volume management, data movement, and cloning in the network, IT teams can significantly reduce the amount of time they

spend on these types of tasks, freeing up resources to focus on other, more critical areas of their companies' businesses.

Delivering Non-Disruptive Operations

EMC Invista's non-disruptive dynamic volume-migration capability has many uses in cases where planned downtime is required. A challenge facing most organizations today is deploying new storage arrays. It is often difficult to move existing data onto the new array, because current migration solutions are highly complex, manual, and disruptive. Just finding a downtime window that can accommodate the whole migration is often a difficult task. Dynamic volume migration capabilities, delivered as part of a network-hosted virtualization system, will significantly improve this process.

In a virtual environment, an organization can add a new storage array to its infrastructure, virtualize enough capacity to hold the source data, and then use dynamic volume migration to copy the data from the original source to the new storage array. This process occurs in the background, without affecting the performance of the host.

Once the copy is complete and the I/O is rerouted, the old storage array can be removed from the environment. This entire process can occur while the applications that require access to the storage array remain online. Furthermore, there is no performance penalty on the hosts as there would be with a host-based volume manager.

Enabling Information Lifecycle Management Processes

Virtualization is critical to information lifecycle management strategies. One of the core capabilities required to implement ILM is a data movement facility. As the value of data changes, it must be relocated to the most appropriate tier or class of storage according to cost and value. Transparent, non-disruptive data mobility enables organizations to perform these moves routinely, continuously optimizing the infrastructure without affecting the business applications that rely on it.

Networked storage virtualization can also help storage managers maintain optimal service-performance levels. For example, an administrator of a network configuration with medium- and high-performance storage pools observes that a volume in the medium pool is not meeting a specified service-level agreement (SLA). To comply with the service level guaranteed to the application owner, the administrator begins migrating this volume into the high-performance pool.

As in the "technology refresh" example above, a copy is performed in the background that does not affect the host's performance or interrupt its applications. Once the copy is complete, I/O is redirected to the new volume in the high-performance pool. In the future, policy-based automation capabilities will transparently and automatically optimize the performance of the storage infrastructure in accordance with business requirements, delivering an infrastructure that is continually updated and optimized to serve business requirements.

Embedding Functionality in the Storage Network: The Right Platform

Networked storage virtualization solutions must be designed with the fundamental notion that the technology should be suitable for deployment in an enterprise data-center environment. The following three criteria must be met for successful deployment:

- Easy implementation
- Enterprise-level performance and scalability
- Open architecture that supports multi-vendor host, network, and storage devices

The Cisco MDS 9000 Family delivers the foundation for such a solution.

Easy Implementation

The Cisco MDS 9000 Family's modular design allows interchangeable modules to be inserted into the chassis. By inserting Cisco MDS 9000 Family Storage Services Module (SSM) into open slots in one or more Cisco MDS 9000 Family multilayer directors and switches, fabric-hosted applications can easily be deployed on existing SAN infrastructures. The solution is implemented within the network, requiring no additional fabric ports or cables.

Performance and Scalability

In an enterprise-level virtualization solution, I/O should be managed by purpose-built components rather than by general-purpose processors and PC server-based architectures. Powerful processors should run the complex storage applications and be designed for high performance.

The Cisco SSM contains 32 Fibre Channel ports and provides the additional hardware required to run fabric-hosted applications. The Cisco SSM fits into any Cisco MDS 9000 Family switch or director that has an open slot, helping to maximize the flexibility and return on investment (ROI) for the customer. The Cisco SSM contains purpose-built, application-specific integrated circuits (ASICs) to manage each I/O, in-line, at line speed. The Cisco SSM is designed to scale linearly for highly distributed processing. The considerable bandwidth of the backplane allows for a scalable implementation of fabric-hosted applications. Virtualization performance can be easily scaled to the level required by even the largest organizations. By adding SSMs, organizations can improve virtualization performance and server connectivity in increments of 32 ports. As a result, an organization can be assured that as it grows, its system can grow with it.

Open Architecture

Cisco and EMC worked together using a set of APIs to help ensure the SAN has scalable and secure storage intelligence. The storage services interface used in the product is being developed in tandem with the T11 organization's Fabric Application Interface Standard (FAIS)-specification definitions. FAIS is an industry effort to develop a standard API across multiple intelligent networked platforms. Cisco chairs the FAIS workgroup, and plans to have its own Intelligent Storage API conform to FAIS, after it becomes ratified. Cisco is committed to standards, recognizing the benefits of using proven products, taking advantage of development economies of scale, reducing cross-vendor qualification efforts, and future-proofing the offering.

Increased Benefits through Platform Integration

A network-hosted virtualization solution, such as EMC Invista, can be greatly enhanced through close integration with an underlying layer of network intelligence and capability. The Cisco MDS 9000 Family offers many features that contribute to the overall manageability and capability of the solution, including:

Virtual Storage Area Network Technology

Virtual storage area network (VSAN) technology divides a large physical fabric into separate isolated environments to improve Fibre Channel SAN scalability, availability, manageability, and network security. Each VSAN is a logically and functionally separate SAN with its own set of Fibre Channel fabric services that help reduce network instability by containing fabric reconfigurations and error conditions within an individual VSAN. The strict traffic segregation provided by VSANs helps ensure that the control and data traffic of a given VSAN is confined within its own domain, which helps to increase SAN security. In a fabric-hosted application environment, the virtualized storage pool can be contained within a "storage VSAN," while servers can access the virtual storage within their own "server VSANs" (Figure 2). Zoning changes and any accompanying mistakes will not affect the integrity of the data.

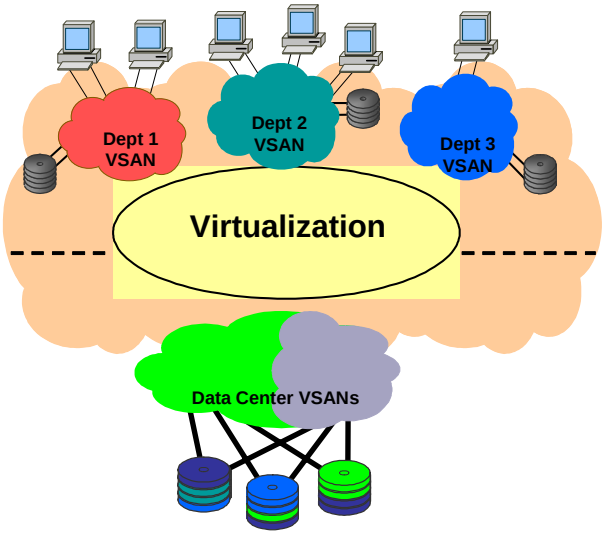


Figure 2. VSAN Technology

Network Security

Network security is managed with authentication, authorization, and encryption, but security can also be compromised when users make mistakes when changing configurations. With the Cisco MDS 9000 Family, users can create administrator roles that are limited in scope to certain VSANs. For example, a SAN administrator role can be created to allow configuration of all platform-specific capabilities, while other roles can be created to only allow configuration and management within specific VSANs. This helps improve the manageability of fabric-hosted applications and reduce disruptions caused by human error. The effects of a user's actions are isolated to a specific VSAN whose membership may be assigned based on switch ports or the worldwide name (WWN) of attached devices.

Quality of Service

The Cisco MDS 9000 Family employs advanced traffic-management features, such as hardware-based virtual output queuing, Fibre Channel congestion control, and quality of service (QoS). Using QoS, preferential frame-forwarding and congestion-avoidance services can be assigned to selected devices to help enable different classes of service. QoS policies can also be set on a per-VSAN basis. This provides maximum flexibility when scaling SANs, especially over extended distances or interswitch links.

Multiprotocol Connectivity

In addition to supporting Fibre Channel, the Cisco MDS 9000 Family also supports Small Computer System Interface over IP (iSCSI) and Fibre Channel over IP (FCIP) in a single platform. Native iSCSI support in the Cisco MDS 9000 Family helps customers consolidate storage for a wider range of servers into a common pool on the SAN. Native FCIP support allows customers to take advantage of their existing investment in IP networks for cost-effective business-continuance solutions. Along with FCIP, Cisco provides coarse wavelength-division multiplexing (CWDM) Gigabit Interface Converter (GBIC)/Small Form-Factor Pluggable (SFP) optics to economically extend connectivity, allowing fabric-based applications to fully use the copy services across vast distances.

The Cisco MDS 9000 Family helps extend the SAN through integrated modules and SFP optics. The Cisco IP services modules, the Cisco Multiprotocol Services Module, and the Cisco MDS 9216i Multilayer Fabric Switch all offer SAN extension through FCIP connectivity. Additionally, the Cisco CWDM GBIC/SFP solution is a convenient and cost-effective way to adopt Gigabit Ethernet and Fibre Channel in campus, data center, and metropolitan-area access networks.

EMC Invista will support these connectivity options in future versions of the product.

Conclusion

Network storage virtualization holds significant promise for organizations to solve their most pressing storage issues. Enterprises that deploy and implement EMC Invista on the Cisco MDS 9000 Family have the opportunity to gain an unprecedented level of control over their data-center storage infrastructure: simplifying management of complex infrastructures, providing a non-disruptive operations capability, and facilitating critical elements of a proactive ILM strategy. This powerful combination helps organizations build highly available, scalable networked application architectures with comprehensive security and unified management.