HITACHI
Inspire the Next

BROCADE

Hitachi Data Systems and Brocade Disaster Recovery Solutions for VMware Environments

Technical Brief

By Sarah Hamilton, Hitachi Data Systems, and Marcus Thordal, Brocade

December 2009

Executive Summary

The rapid adoption of server virtualization is changing the requirements for data center infrastructure capabilities and design. The primary objective for server virtualization has traditionally been the consolidation of servers. This virtualization is now recognized as a key technology for improving the efficiency and cost effectiveness of a company's information technology infrastructure. Server virtualization is maturing and has become more reliable. The underlying physical server technology has also improved and servers are now faster, with a significantly larger memory capability, enhanced caching and overall better performance. As a result, critical business applications are being moved to virtualized environments, bringing with them requirements for higher availability, protection of critical business data and the ability to fail over and continue supporting business operations in the case of a local outage or a widespread disaster. This changing environment has significantly increased the focus on ensuring that there is data mobility to support resource provisioning and business continuity solutions for disaster recovery, which in turn demand automation, manageability and repeatability to meet the response time and recovery time objectives required by the business.

The combination of VMware, from the leader in server virtualization, with Services Oriented Storage Solutions from Hitachi Data Systems and the Brocade® service oriented infrastructure, enables design and implementation of a robust disaster recovery solution for virtualized application environments. Such a solution enables application and server prioritization on a per VMware guest instance. The integration of Hitachi replication technology (Hitachi Universal Replicator, Hitachi TrueCopy® Extended Distance and Hitachi TrueCopy Synchronous software) with VMware Site Recovery Manager (SRM) and a Brocade-based network infrastructure provides end-to-end business continuity for disaster recovery solutions for VMware virtualized applications. This combination provides a flexible framework for designing a service oriented infrastructure to solve current and future business demands. This can result in the infrastructure simplification, reduced costs, higher resource efficiency and, most importantly, data protection and resiliency.

This technical brief describes how Hitachi storage — including the Hitachi Universal Storage Platform® V and Hitachi Universal Storage Platform VM, along with the Hitachi Adaptable Modular Storage family and their associated replication technologies — combined with Brocade SAN infrastructure and extension offerings, can greatly increase the availability, investment protection and performance of an enterprise's disaster recovery and business continuity solution for virtualized environments, utilizing VMware Site Recovery Manager, to meet the recovery time and recovery point objectives required by the business.

For best results use Acrobat Reader 8.0

Contents

Hitachi Data Systems and Brocade Disaster Recovery Solutions for VMware Environments

Technical Brief

By Sarah Hamilton, Hitachi Data Systems, and Marcus Thordal, Brocade

Introduction

The rapid adoption of server virtualization is changing the requirements for data center infrastructure capabilities and design. Virtualization consolidates business processes and data to a smaller group of physical resources and, as a result, businesses need to ensure that the data generated in this virtual server environment is properly protected.

Until recently, server virtualization has focused on consolidating servers; however, it is now also driving increased focus on data availability and mobility in support of resource provisioning, as well as business continuity solutions for disaster recovery. This expanded focus requires storage systems and network infrastructure that can provide automation, manageability and repeatability to meet the recovery time and recovery point objectives (RTO and RPO) required by the business and also by emerging corporate security legislation.

With more critical business applications moving to VMware virtualized platforms, businesses are discovering that traditional approaches for data management and movement, including their disaster recovery and business continuity processes and infrastructure, are not as effective in virtual environments from either a function or cost perspective.

Organizations need to consider the advances in performance and functionality of server virtualization, the supporting disk storage systems and their data center fabric infrastructure when architecting their virtualization infrastructure. During the design of virtualization solutions, it is important not only to design for server consolidation, but also to look at how to maximize the effectiveness of storage and network infrastructure to provide sustainable data protection solutions. A comprehensive design not only addresses the servers and access to storage during normal operations, but also includes the ability to fail over to backup systems, either locally or at a remote location. Such a design requires server availability and availability of and access to backup data that reflects the state of the data from the primary storage infrastructure before failover.

Hitachi Data Systems and Brocade provide leading edge solutions, enabling businesses to provide a storage infrastructure to support continuous, real time local and remote replication and automatic failover capabilities, ensuring resilient data protection, high availability and disaster recovery for VMware virtual environments.

Requirements

A sustainable server virtualization infrastructure must be architected with a focus on data mobility, which requires a flexible, scalable storage and data center fabric infrastructure. Such an infrastructure is critical to support the resource provisioning that disaster recovery solutions demand of the business. The solution must provide the tools to implement, manage and automate the infrastructure with an efficiency and level of granu-

larity that corresponds to the business demands. The optimal solution will facilitate creating an environment where the service level agreement (SLA) for each individual virtual machine or group of machines can be tailored to meet the specific business needs of the resident application(s).

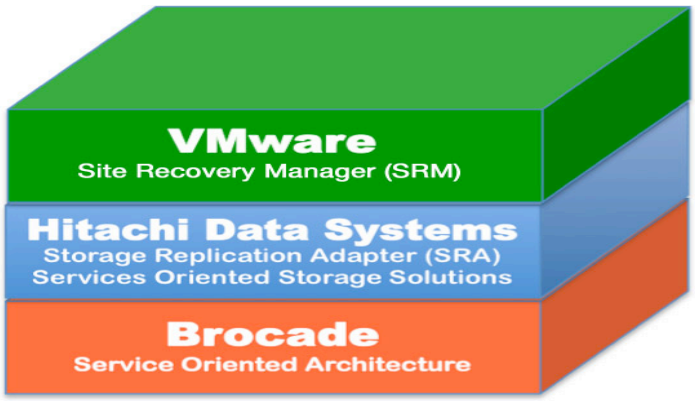
Solution Overview

Today, the Information Technology industry is delivering more cost effective ways to provide value through a service oriented approach. The combination of VMware with Services Oriented Storage Solutions from Hitachi Data Systems and Brocade's Service Oriented Architecture offerings delivers a robust set of solution choices, providing infrastructure services and technology for data mobility and management as needed (see Figure 1).

With this service oriented approach for delivering technology solutions, Brocade and Hitachi Data Systems look at an organization's business to understand the infrastructure requirements, which in turn determine the technology and infrastructure services that should be deployed. These services must be flexible and robust if they are to deliver the solution elements when they are needed.

The advancements in storage technology in the areas of performance, data protection, data mobility and raw scalability can deliver the features and functions required in today's virtualized world. However, these advancements have also introduced a level of complexity that must be understood and structured to deliver an effective manageable solution. The services oriented solutions approach of Hitachi Data Systems and Brocade are designed to do just that.

Figure 1. Integrating VMware SRM with Hitachi Storage and Replication Technologies Implemented Across a Brocade Network Infrastructure



Current or future infrastructure requirements may include consolidation or collapsing of resources or offering virtual access to storage resources for different hosts and applications. Plans may also include the ability to enable virtual transport of data anywhere you need it. The combination of Brocade's Service Oriented Architecture and Services Oriented Storage Solutions from Hitachi Data Systems provides the ability to select the right infrastructure services when needed. This combination enables the design of robust business continuity solutions for disaster recovery with granular prioritization of a per VMware guest instance.

The integration of Hitachi Data Systems, VMware and Brocade solution elements provides industry leading end-to-end disaster recovery solutions with VMware virtualized applications.

The combination of Hitachi Universal Replicator or Hitachi TrueCopy® Extended Distance and Hitachi TrueCopy Synchronous with Hitachi Storage Replication Adapter and VMware's Site Recovery Manager

provides best-of-breed replication capability for virtualized applications. This replication capability works with Brocade's fabric infrastructure, including Brocade Fibre Channel host bus adapters (HBAs), quality of service (QoS) and local or extension networking offerings, to provide an industry leading end-to-end disaster recovery solution for VMware virtualized applications.

The VMware vCenter Site Recovery Manager (SRM) interfaces with the Hitachi Storage Replication Adapter to leverage market proven Hitachi replication technologies and deliver a robust business continuity and disaster recovery solution. The Hitachi Storage Replication Adapter provides a common interface for testing site recovery and actual site failover using either Hitachi in-system or remote replication solutions on both the Hitachi enterprise and modular storage families. Hitachi replication solutions provide nondisruptive, customer managed, host independent data replication solutions that create RAID protected copies of an organization's production data.

With more businesses moving to virtual computing environments, it has become increasingly important for VMware and its partners to deliver integrated solutions that provide dependable disaster recovery in virtual environments. VMware developed SRM, which integrates with Hitachi replication software through the Hitachi Storage Replication Adapter. When used in conjunction with Brocade Data Center Fabric (DCF) architecture, they provide a seamless solution for disaster recovery and business continuity.

The VMware SRM activates the Hitachi Storage Replication Adapter, which controls failover operations through powerful Hitachi replication software. The Brocade Fabric Infrastructure can be designed and implemented to provide the necessary connectivity for failover within a location using an 8Gb backbone, driven by Brocade DCX® Backbones, or to a remote location using Brocade's distance extension solutions, leveraging Traffic Isolation Zones (TiZ) to prioritize business critical data replication.

Prior to the release of QoS at the HBA level, QoS in the fabric was supported as part of the Brocade Adaptive Networking software license (Brocade Fabric Operating System® or FOS) to prioritize traffic within the switched infrastructure. The HBA product strategy is to extend many of the fabric-based services into the server, both physical and virtual, thereby supporting end-to-end fabric services. QoS is a unique feature currently supported on Brocade 8/4Gb Fibre Channel HBAs. Storage administrators who deploy the new QoS feature can categorize traffic flows between a given initiator/target pair to guarantee traffic isolation between multiple I/O flows. There are three priority levels (low, medium, high) to isolate traffic down to the VM level, thereby improving overall application performance and minimizing latency. QoS configuration information is maintained as part of the existing Fibre Channel zoning database and appears as normal Worldwide Name (WWN) zones. In order to distinguish between regular zoning configurations, QoS zones are prefixed with special notation to indicate high or low QoS level and an optional flow ID.

Next generation Brocade extension solutions provide an ideal foundation for building or expanding a high-performance SAN extension infrastructure for disaster recovery, data protection and data mobility storage solutions. They leverage cost effective IP WAN transport to extend open systems and mainframe disk and tape storage applications over distances that would otherwise be impossible, impractical or too expensive with standard Fibre Channel connections. Best-in-class Fibre Channel and FCIP switch port density, bandwidth and throughput address today's dynamic I/O and workload requirements and are designed to meet tomorrow's evolving requirements for virtual data centers. Brocade extension products enable replication and backup applications to send more data over FCIP links in less time, protecting high priority traffic and optimizing available WAN bandwidth.

Whether configured for simple point-to-point or comprehensive multisite SAN extension, the Brocade 7800 Extension Switch addresses the most demanding business continuity, compliance and global data access requirements. Up to 16 x 8Gb Fibre Channel ports and 6 x 1 Gigabit Ethernet (GbE) ports provide unmatched Fibre Channel and FCIP bandwidth, port density and throughput for maximum application performance over WAN links. Available in two configurations (the Brocade 7800 16/6 and the Brocade 7800 4/2), the Brocade

7800 supports a variety of architectures and deployment models to address current and future SAN extension requirements. A broad range of optional advanced extension and SAN fabric services are available to address the most challenging extension and storage networking requirements. Supporting up to 350ms round-trip time (RTT) of latency, the Brocade 7800 enables cost effective SAN extension solutions over distances up to 17,500 kilometers (nearly 11,000 miles).

Optional FCIP trunking combines multiple IP source and destination address pairs into a logical high bandwidth FCIP trunk spanning multiple physical ports to provide load balancing and network failure resiliency, delivering FCIP tunnel redundancy for lossless path failover and guaranteed in-order data delivery in the event of a failure.

Innovative extension technology maximizes throughput over distance using advanced compression, disk and tape protocol acceleration and FCIP networking technology. The next generation Brocade platforms introduce new performance and optimization technologies, including Adaptive Rate Limiting and FCIP QoS, that move more data faster and farther than ever before. Brocade extension solutions leverage the core technology of Brocade systems; the combination of technology leadership and proven capabilities enable a high-performance and highly reliable network infrastructure for disaster recovery and data protection.

Using proven software technology and industry leading storage hardware, Hitachi replication solutions automatically maintain duplicate copies of data at the local site and/or a remote site for failover testing and recovery. VMware Site Recovery Manager enables recovery testing on a scheduled or nonscheduled basis with potentially different, arbitrary times for each test. The Brocade infrastructure can deliver 8Gb from the backbone and throughout the fabric for movement of data within the local facility using the Brocade DCX Backbone, which is architected for 99.999 percent (five nines) availability, making it the ideal backbone choice for the SAN infrastructure supporting VMware SRM and Hitachi replication technology.

Another important capability of Hitachi Data Systems enterprise storage solutions in support of virtualized server environments is the industry leading storage virtualization capability of the Hitachi Universal Storage Platform® V and Hitachi Universal Storage Platform VM. This virtualization capability enables businesses to virtualize all of their storage, including third party storage, behind the Hitachi storage. This provides maximum flexibility in configuring and managing storage for virtualized server environments (see Appendix B for more on Storage Virtualization). These storage platforms also support thin provisioning to minimize the physical storage that has to be purchased before it is really needed. Both storage virtualization and dynamic (thin) provisioning are fully supported by Hitachi replication products in virtualized and nonvirtualized server environments.

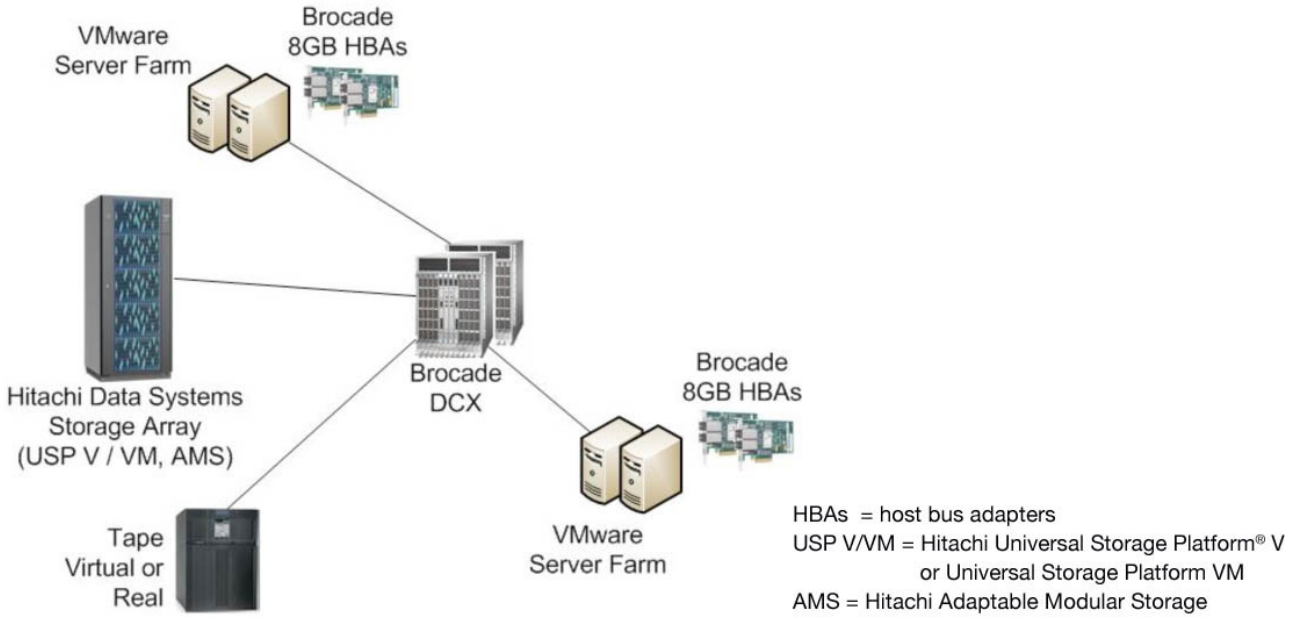
The combination of the technologies, products and services from these three companies provide several alternatives on how the replication and backup/recovery is configured.

Single Site

Replication and failover within a single site can provide protection in case of equipment or software failure, while also providing the capability to test failover and failback procedures without the challenges of remote connectivity. This configuration could include multiple virtual server farms sharing a single Hitachi storage system, a single virtual server farm sharing multiple Hitachi storage systems or multiple virtual server farms with multiple Hitachi storage systems. In each case, the ability to leverage the technologies of these companies ensures the availability of data in case of a problem or outage of one or more elements of the configuration.

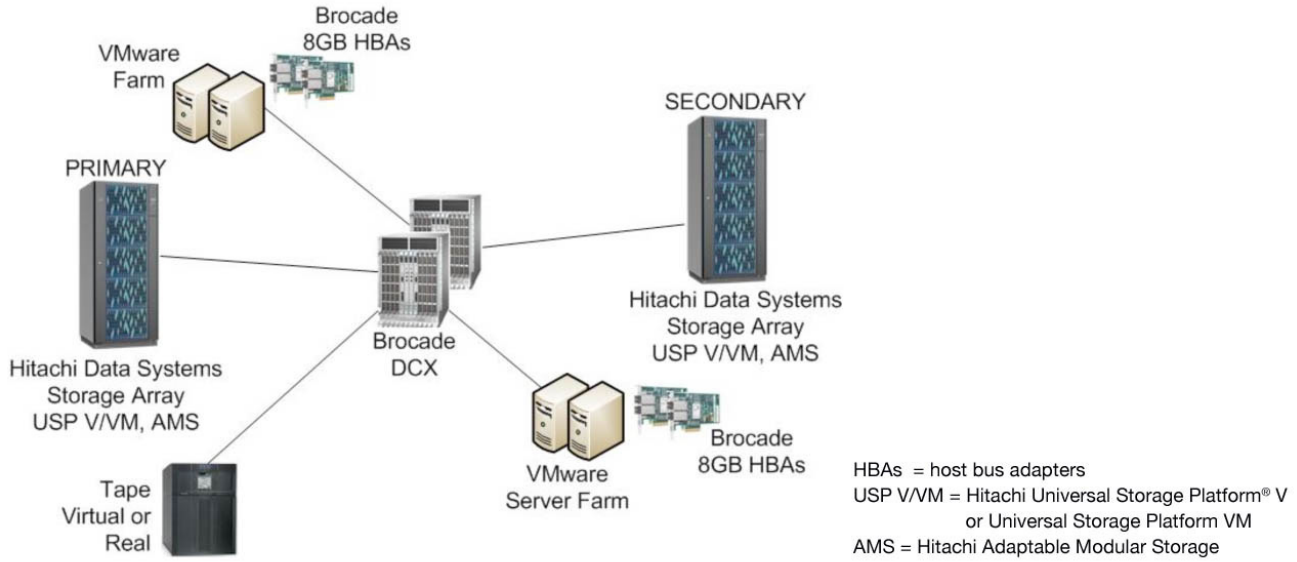
A common configuration in the local site is multiple virtual servers sharing a single storage system, as shown in Figure 2. In this configuration, the requirement is to handle a server failure. VMware must recognize the failure or outage, fail over to the backup server or server farm and ensure that the backup server has access to the storage of the failing server. This is all handled within VMware and will not be discussed in this paper.

Figure 2. Single Site with One Storage System Shared by Multiple Server Farms



Another common configuration exists where virtual servers share two or more storage systems (see Figure 3). We assume that the storage systems are configured so that the primary system replicates the data to the alternate system using Hitachi TrueCopy Synchronous software. In this case, VMware recognizes the storage error and re-directs the I/O requests that were accessing the failing storage to the alternate storage system. With the servers connected to both the primary and alternate storage systems through the Brocade DCX Backbone fabric and using VMware's SRM in conjunction with the Hitachi Storage Replication Adapter, VMware is able to make the switchover almost transparently. Hitachi TrueCopy Synchronous ensures that the data on both storage systems is the same through its synchronous operation. A write on the primary storage system is not considered complete until the same data is written on the secondary storage system and confirmation of the secondary write is received by the primary storage system.

Figure 3. Single Site with Virtual Server Farms Sharing Two Storage Systems

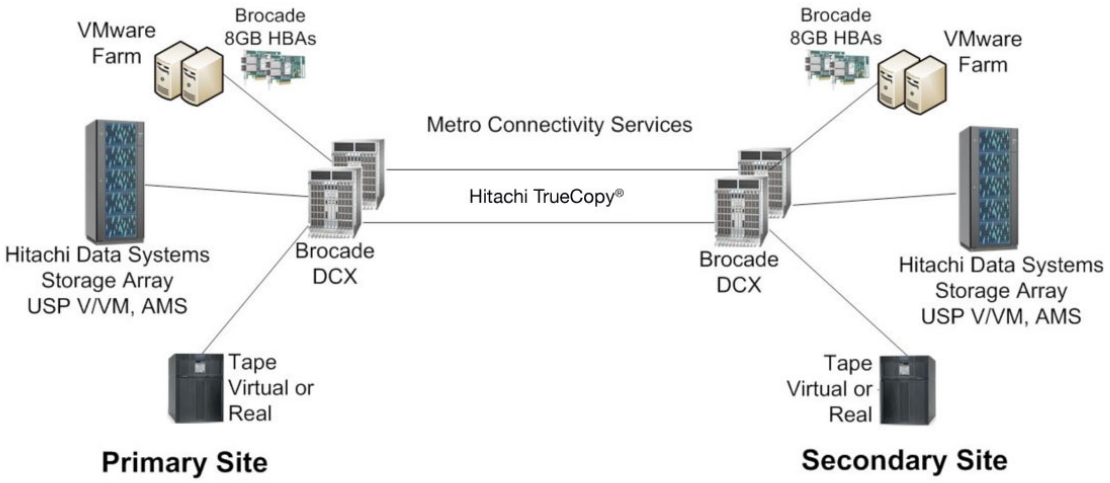


As a result, the application is not notified that the write completed until the primary storage system receives the confirmation from the secondary system and then notifies that virtual machine and application. This ensures that if a need for failover occurs, the data on the secondary storage system is identical to what was on the primary storage system.

Dual Site — Within a Metropolitan Area

In a dual site metropolitan configuration, the primary site and the remote site are within a metropolitan area — that is, no more than 20 miles apart. Brocade Fibre Channel products can inherently support distance extension of up to 20 miles over fiber on a per port basis. The Brocade DCX Backbones in each site can be connected to the corresponding director in the other site over fiber (see Figure 4).

Figure 4. Dual Site with a Business Continuity Solution[1]



HBAs = host bus adapters
USP V/VM = Hitachi Universal Storage Platform® V or Universal Storage Platform VM
AMS = Hitachi Adaptable Modular Storage
Hitachi TrueCopy® = Hitachi TrueCopy® Synchronous software

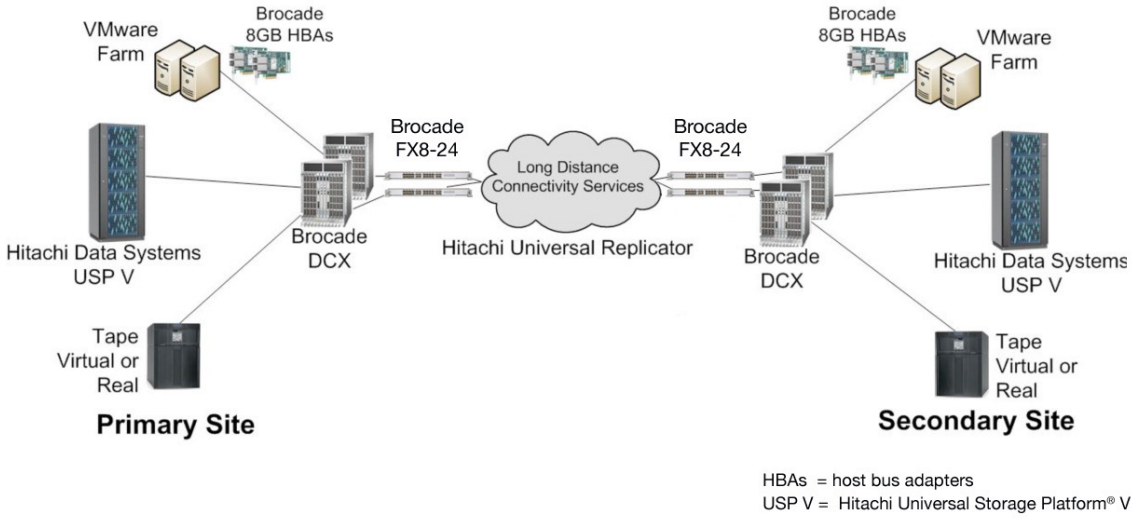
In this implementation the Hitachi storage systems can be connected with TrueCopy Synchronous replication software. The decision is typically based on the business' tolerance for longer RPO, or how many transactions being out of sync the business can tolerate. If the implementation is based on TrueCopy Synchronous, then failover to the remote site is almost immediate due to the capabilities of VMware with SRM and the Hitachi Storage Replication Adapter.

Dual Site — Replication between Enterprise Storage Systems over Extended Distance

The implementation of a dual site over extended distance replication configuration is a little more complex. Because of the distance, replication must be asynchronous and is based on either Hitachi Universal Replicator software for the Hitachi Universal Storage Platform V or Universal Storage Platform VM, or on Hitachi TrueCopy Extended Distance software for Hitachi Adaptable Modular Storage. The Brocade DCX Backbone infrastructure must be extended to provide the required connectivity for disaster recovery with asynchronous replication and recovery automation. The Brocade DCX can be extended either by adding distance routing capability to the Brocade DCX with the distance extension blade Brocade FX8-24 Extension Blade (see Figure 5) or by adding Brocade 7800 Extension Switches (see Figure 6). The combination of the Brocade extended distance capability and Hitachi replication with Hitachi Universal Replicator ensures that the data is replicated securely with the assurance that the data will be available and usable at the remote location when needed.

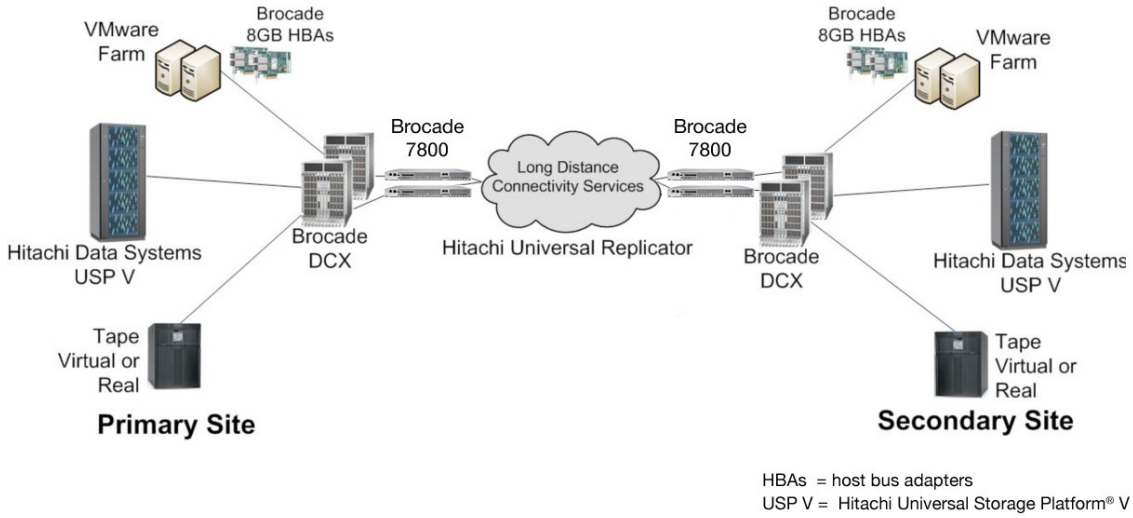
[1] The connection between sites in a metro environment could also be asynchronous, using Hitachi Universal Replicator with the Hitachi Universal Storage Platform V or the Universal Storage Platform VM, or using Hitachi TrueCopy Extended Distance with the Hitachi Adaptable Modular Storage family. This would introduce a very small RPO.

Figure 5. Disaster Recovery Solution with Long Distance Connectivity Support in the Brocade DCX Backbone



Hitachi Universal Replicator uses “pull” and “journaling” technology to get the data from the primary storage system to the secondary storage system. With this technology, the storage system at the remote site manages the replication, allowing the storage system at the primary site to use its resources for processing production work. The use of journals to manage the replication not only allows the storage systems to keep track of what has changed, but also what has actually been replicated.

Figure 6. Disaster Recovery Long Distance Connectivity Support Using Brocade 7800 Extension Switches

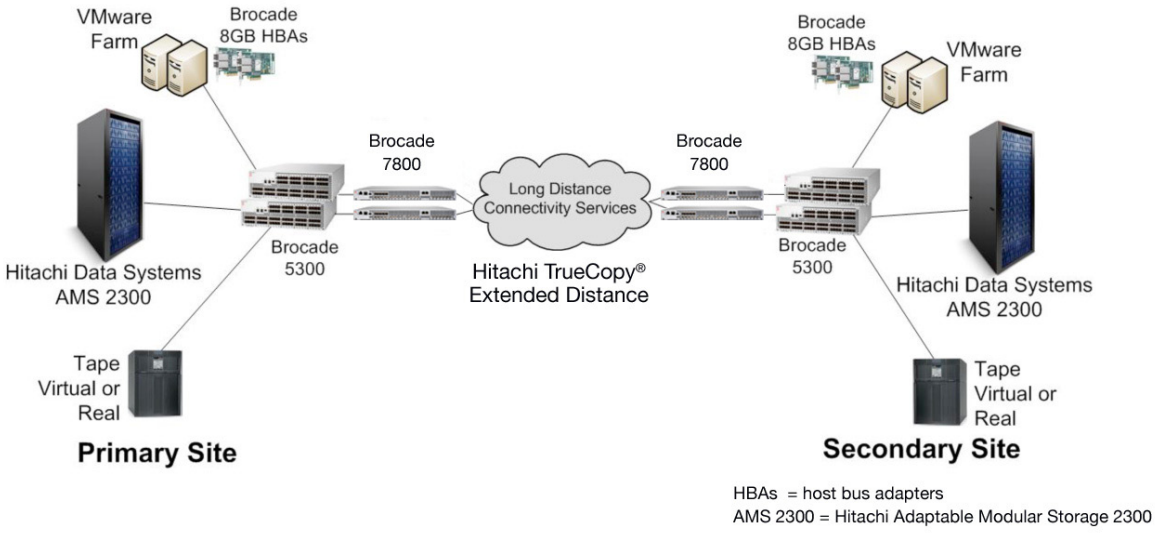


This means that if the connection between the sites is lost for a short time, replication can be restarted from where it stopped, rather than having to do a full restart and do a full volume copy to ensure the secondary site is in sync with the primary site.

Dual Site — Replication between Modular Storage Systems over Extended Distance

Just as with the enterprise storage systems, a dual site over extended distance replication configuration for modular storage systems must be asynchronous. For the Hitachi Adaptable Modular Storage family the replication is done using Hitachi TrueCopy Extended Distance software (see Figure 7). When using modular storage, it is common to use Brocade switches, such as the Brocade 5300, to provide the storage network infrastructure. When replicating over distances greater than 20 miles and using switches for the infrastructure the switches must be connected through a storage router such as the Brocade 7800 to provide the distance extension capability for the replication.

Figure 7. Disaster Recovery Long Distance with Adaptable Modular Storage and Brocade 5300 Switches and 7800 Extension Switches



Summary

Brocade, Hitachi Data Systems and VMware, as industry leaders in storage, data mobility and server virtualization, have worked together to provide a strategic business continuity solution for disaster recovery in virtualized server environments. As the leader in server virtualization, VMware understands the importance of enabling businesses to fail over and continue processing if a component should fail or if there is a disaster. The development of VMware Site Recovery Manager provides functionality for managing virtualized servers in the face of such problems.

VMware has teamed with Hitachi Data Systems to link the virtualized server environment and storage system together. This linkage not only enables the replication of data to the secondary storage system, but also ensures that the data will be available for continued processing either locally or at the remote site. The Hitachi Storage Replication Adapter also provides a common interface for testing of site recovery and actual site failover. The Hitachi Storage Replication Adapter links VMware's SRM application to system-based replication, providing the critical link so that when the virtual servers fail over they will have access to the data they need to continue processing the critical applications.

The addition of a Brocade infrastructure based on Brocade DCX Backbones provides the glue to tie the virtual server environment and the storage together. For a single site or between metropolitan distance sites, the Brocade DCX moves data over Fibre Channel, providing high-performance, secure movement of data. Between remote sites, the combination of the Brocade DCX Backbone and data routing capability of the

Brocade DCX with the Brocade FX8-24 Extension Blade and/or the Brocade 7800 provides reliable, secure connectivity.

This strategic service oriented solution set can fulfill the business requirements for data mobility, data protection and disaster recovery for critical applications.

Appendix A — Configuring the Connectivity Infrastructure

The connectivity infrastructure components for a **single site or metropolitan distance dual site** implementation include:

- Brocade DCX Backbone — provides SAN backbone infrastructure
- Hitachi Universal Storage Platform® V, Universal Storage Platform VM or Adaptable Modular Storage
- Hitachi Storage Replication Adapter
- VMware with vCenter and Site Recovery Manager (SRM)

If a remote failover or recovery site is located at a long distance — that is, farther away than a metro distance failover site, 20 miles — the following additional items are required:

- Brocade 7800 Extension Switch — provides SAN extension over FCIP for replication to remote facility (or Brocade FX8-24 Extension Blade)
- Brocade FOS traffic shaping with traffic isolation using Traffic Isolation Zone (TiZ)
- Border layer routers connecting to WAN

Single Site or Metro Distance SAN Configuration (at each site)

At each site the components of the connectivity infrastructure must be configured as outlined below.

Set Up and Configure the DCX Backbone

Setting up the Brocade DCX includes configuration activities, such as:

- Set passwords
- Configure management IP address(es)
- Upgrade firmware to latest level
- Domain ID

Configure VMware Site Replication Manager (SRM)

VMware SRM is a disaster recovery solution that enables quick and effective failover of virtual servers. To set up SRM and integrate with Hitachi storage replication, the following must be performed:

- Install VMware Virtual Center
- Install VMware SRM
- Configure SRM

Configure the Hitachi TrueCopy® Synchronous Software and Hitachi Storage Replication Adapter

Hitachi TrueCopy Synchronous provides synchronous data replication between Hitachi storage systems. With its synchronous operation, TrueCopy can be operated at distances up to 20 miles.

The following activities must be performed to configure TrueCopy:

- Verify the Hitachi TrueCopy Synchronous license is installed on the Hitachi storage system
- Configure the port modes on the Hitachi storage systems
- Define P-Vols and S-Vols

- Install Hitachi RAID Manager Command Control Interface on both local and remote VMware SRM server
- Install Hitachi Storage Replication Adapter for Hitachi storage system
- Configure Hitachi TrueCopy Synchronous using Hitachi Open Remote Copy Manager (HORCM)

Dual Site with Long Distance Connectivity (at each site)

In addition to those elements described in the above section, the connectivity infrastructure components for a long distance remote implementation also include:

- Brocade 7800 – provides distance routing over FCIP for replication to remote facility
- FOS traffic shaping with traffic isolation using TiZ
- Border layer routers connecting to WAN

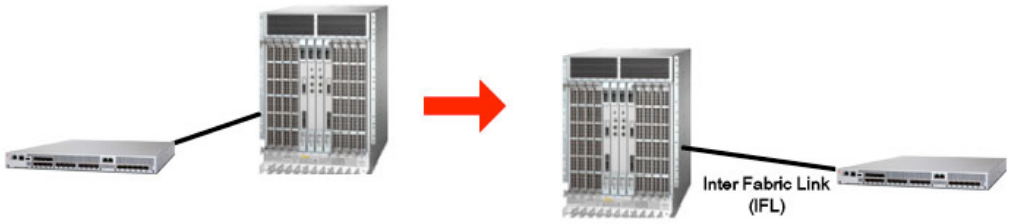
In addition to the elements described above, these additional components of the connectivity infrastructure must be configured at each site as described below. See implementation guides for detailed configuration assistance:

Set Up the Brocade 7800 Extension Switch(es)

In addition to the basic setup activities shown for the Brocade DCX setting up the Brocade 7800 (as shown in Appendix A – Figure 1) or FX8-24 includes configuration activities, such as:

- Configure Ex_Port(s)
- Configure VE_Port(s)
- Configure FCIP tunnel

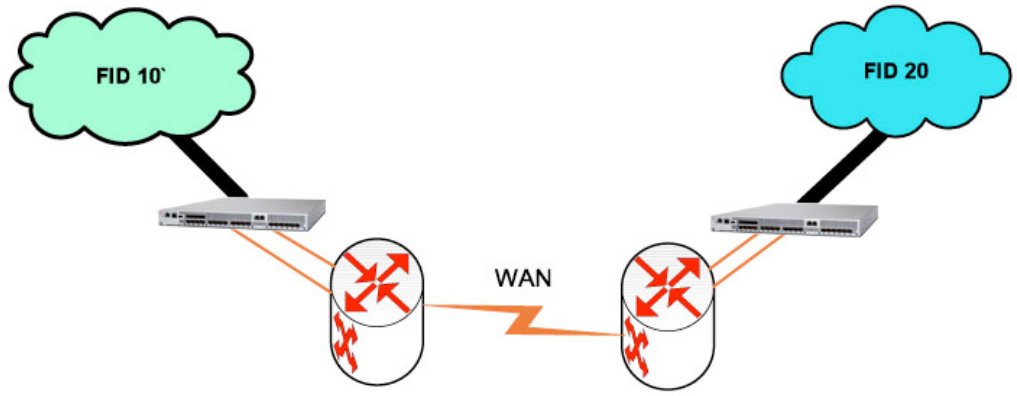
Appendix A – Figure 1. Connecting the Ex_Port on the Brocade 7800 to the Brocade DCX Backbone



With site-to-site connectivity in place, for example with border layer routers such as the Brocade NetIron MLX, connecting to the WAN at each site, the FCIP tunnel must be configured to connect the two sites as shown in Appendix A – Figure 2.

(For details on how to set up Brocade NetIron MLX consult the product documentation.)

Appendix A – Figure 2. Connecting the Routing Fabric over the WAN



Configure Routers to Provide Fault Isolation between Fabrics at Each Site

By routing between the fabrics at each site (instead of expanding the fabrics across sites) fabric isolation is achieved and any disruption to a fabric at one site is isolated and does not impact the fabric at the other site (see Appendix A – Figure 3).

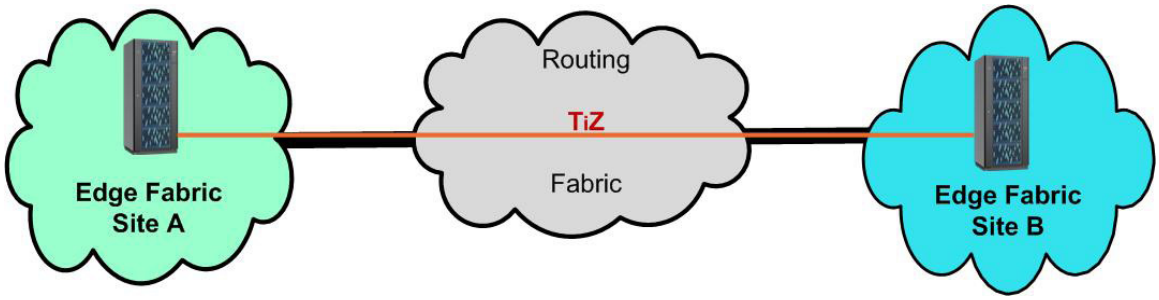
Appendix A – Figure 3. Routing between the Two Sites

Configure Traffic Isolation to Guarantee Bandwidth for Replication Traffic

By segregating replication traffic from other traffic between sites (such as backup vaulting traffic) the required bandwidth for replication traffic is guaranteed.

Appendix A – Figure 4 illustrates an example of how one of the two FCIP tunnels is reserved for data replication between the two Hitachi storage systems. The other FCIP tunnel is shared by other intersite traffic.

Appendix A – Figure 4. Traffic Isolation Zones in the Routing Fabric



Configure Hitachi Universal Replicator Software

Hitachi Universal Replicator provides advanced data replication between Hitachi storage systems. With its asynchronous mode using both cache and journal volumes, Universal Replicator can virtually be operated over any distance.

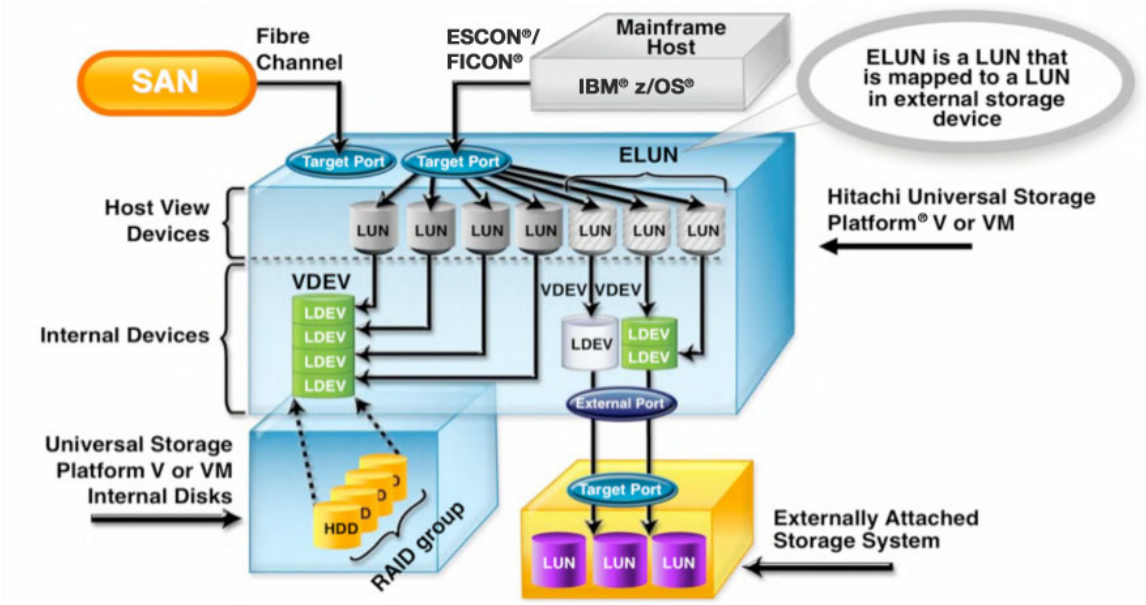
The following activities must be performed to configure Universal Replicator:

- Verify the Universal Replicator license is installed on the Hitachi storage systems.
- Configure the port modes on the Hitachi storage systems.
- Define P-Vols and S-Vols and journal volume.

Appendix B — Storage Virtualization

Unlike server-based or SAN-based virtualization, Hitachi enterprise storage systems — that is, Hitachi Universal Storage Platform® V and Universal Storage Platform VM — offer fully featured, controller-based storage virtualization with extensive support for heterogeneous storage. This allows the entire data center to be managed as one virtual disk drive from a single interface. Virtualization is handled through the Hitachi storage controller for both internal and externally attached heterogeneous storage. The Hitachi Universal Storage Platform V consolidates both NAS and SAN, and uses one set of GUI-based tools to securely migrate, configure, automate, monitor and manage that storage (see Appendix B – Figure 1).

Appendix B – Figure 1. Managing the Entire Data Center as One Virtual Disk Drive from a Single Interface



The Hitachi approach to virtualization can help reduce costs and simplify the storage infrastructure. With the Universal Storage Platform V, organizations can now attach, combine, migrate, replicate and universally manage as much as 247 petabytes of external, heterogeneous storage from Hitachi Data Systems, EMC, IBM, HP and other suppliers, with rates up to 4 million I/O operations per second (IOPS).

Hitachi Data Systems Corporation

Corporate Headquarters 750 Central Expressway, Santa Clara, California 95050-2627 USA
Contact Information: + 1 408 970 1000 www.hds.com / info@hds.com

Asia Pacific and Americas 750 Central Expressway, Santa Clara, California 95050-2627 USA
Contact Information: + 1 408 970 1000 www.hds.com / info@hds.com

Europe Headquarters Sefton Park, Stoke Poges, Buckinghamshire SL2 4HD United Kingdom
Contact Information: + 44 (0) 1753 618000 www.hds.com / info.emea@hds.com