LAN-Free Backup for High Availability SANs

A New Set of Open SAN Supported Solutions

December 18, 2001

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Introduction

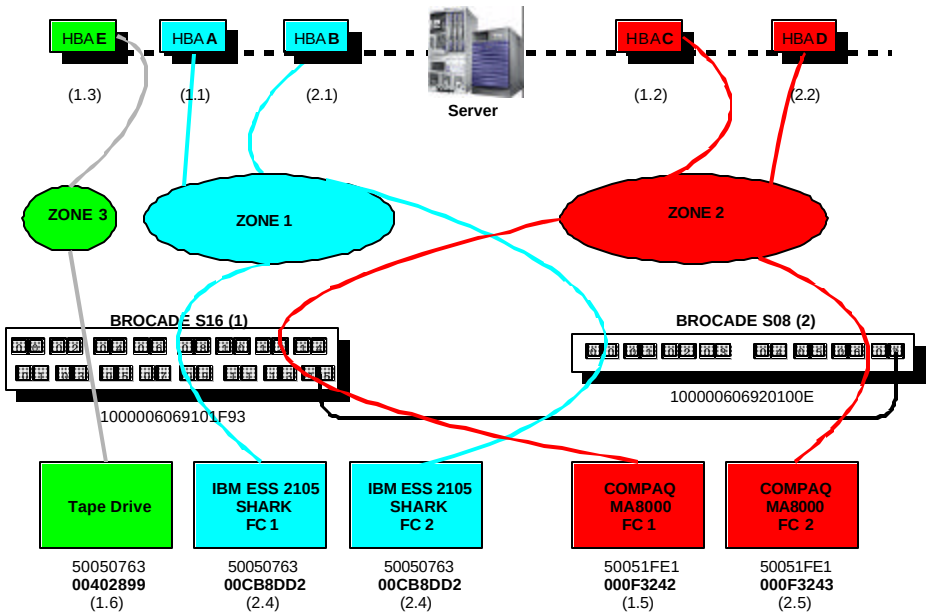
These six companies - Brocade Communications Systems Inc, Compaq Computer Corporation, Emulex Corporation, IBM Corporation (including the IBM-Tivoli software division), JNI Corporation, and QLogic Corporation, are all members of the Supported Solutions Forum (SSF) of the Storage Networking Industry Association (SNIA). We have cooperated to successfully qualify five new open SAN solutions. These solutions incorporate products from each company, and are fully supported by each company.

The principal characteristics of these solutions are:

- Homogeneous fabric using cascaded switches
- Disk storage in separate fabric zones
- Complete path failover for disk accesses
- Tape storage in a separate fabric zone
- Choice of two competing backup software applications for performing LAN-free backup

All of these solutions satisfy the SSF criteria for "Competitive Solution Sets", since they contain competing disk storage. In addition, four of these solutions taken together satisfy the SSF criteria of being a "Companion Solution Set", since each solution uses a different vendor's tape backup software, but the same hardware configuration.

The objective in creating and qualifying these solutions and registering them with the SNIA-SSF is to provide our customers with interoperable multivendor storage networking options that have high value and solve real world business problems. This solution set is composed of multivendor disk storage, tape storage, and multivendor tape backup software, all running on a Brocade fabric. The following graphic depicts these solutions:



Background

On July 6, 2000, Compaq and IBM announced a strategic agreement to accelerate customer acceptance of open storage networking solutions. As part of the agreement, both companies committed to interoperability of each company's storage hardware and software. Further, the companies will share their knowledge with the industry to help create standards for open storage networking solutions such as Storage Area Networks (SANs), making storage networks more flexible and easier to deploy and manage.

One of the key areas of cooperation critical to the success of this alliance has been the work done by both companies' storage engineering teams to develop and agree to a joint interoperability test plan. Objectives of this test plan include:

- Providing a sequence of planned interoperable test activities to be performed
- Defining the scope, objective and method of the interoperable tests to be performed
- Prove interoperability of Compaq and IBM storage devices attached to a common SAN fabric
- Document the proven interoperable solutions for successful, reliable operation of the Open SAN environment and attached devices

This mutually developed interoperable test plan includes functional, stress and exception tests that will be performed, and test cases that will be applied to induce errors and/or evaluate failure recovery and performance.

In addition to the joint interoperability test plan, both Compaq and IBM committed to provide servers, operating systems, host bus adapters, SAN switches, and selected ISV software into a shared interoperability test lab. Because of the extent of the equipment and facilities required for this joint Compaq and IBM interoperability test lab, the companies agreed to set up two distinct SANs. One SAN is located at Compaq facilities in Colorado Springs, Colorado, and one at IBM facilities in Tucson, Arizona. Both labs or SANs will complement each other, with no intention of mirroring the other SAN, which allows for a greater range of Compaq and IBM equipment to be tested. Each facility shares interoperability test results with the other. These labs or SANs are designed to simulate an enterprise IT environment that includes Compaq or IBM equipment or both, with a focus on testing disk-to-disk data replication, disk-to-tape backup and other interoperable storage solutions.

This on-going interoperability effort allows customers to acquire the industry's most advanced storage solutions from either Compaq or IBM, or both, and be assured that their investments will participate in an open storage area network (Open SAN) infrastructure for increased business velocity. This will provide customers more choice, flexibility and greater investment protection as they make future storage acquisition decisions. Also, storage solutions acquired by customers from Compaq and IBM may be upgraded to help them participate and interoperate in an Open SAN environment. This increases the value of these previous investments.

Interoperability Delivery

This SSF registration submission identifies five interoperable storage environments each consisting of a Server, its operating system, HBA's, Fibre Channel Fabric, Disk and for four of the specified and tested environments Tape storage. The functional aspects of the environments addressed are.

1. Both Compaq and IBM storage subsystems shared in a single Open SAN infrastructure utilizing co-branded Brocade fabric switches. The Compaq and IBM storage subsystems operate on separate zones within the SAN.

2. Easy Open SAN data migration between Compaq and IBM storage subsystem via a single shared server running either Windows 2000/NT, or Solaris.

3. Path fail-over capability when using Secure Path for Compaq's RAID array and IBM's Subsystem Device Driver (SDD) for the IBM storage system on a single shared server running Windows NT, or Solaris. Each storage subsystem is connected to the server via independent Host Bus Adapters (HBAs).

4. Simultaneous enterprise backup from both Compaq and IBM storage subsystems utilizing a single shared server and Compaq Enterprise Backup Solution (EBS) with Veritas NetBackup, or Veritas BackupExec or Tivoli Storage Manager (see detailed support matrix that follows for tested software) to a common tape library.

Complete Interoperability Support Matrix

As of 11/19/2001

Operating System	Window NT V4.0 SP6	Window NT V4.0 SP6a	Window 2000 SP1	Sun Solaris V8.0	Sun Solaris V7.0
Host Bus Adapter (ESS 2105)	Qlogic QLA 2200F v7.05.02 BIOS v1.61	Emulex LP8000 64Bit/33Mhz PCI to FC HBA for Windows – 176479-B21 (DS-KGPSA-CB)	Qlogic QLA 2200F v7.05.02 BIOS v1.61	Emulex LP8000 - Driver : 4.10g Firmware : 3.81a1 1 GB HBA	JNI 64bit SBUS – 123503-001 (DS-SWSA4-PC)
Host Bus Adapter (MA Zone)	Emulex LP8000 64Bit/33Mhz PCI to FC HBA for Windows – 176479-B21 (DS-KGPSA-CB)	Emulex LP8000 64Bit/33Mhz PCI to FC HBA for Windows Driver 4.10d FW 3.82a1	Emulex LP8000 64Bit/33Mhz PCI to FC HBA for Windows – 176479-B21 (DS-KGPSA-CB)	SBUS - JNI FC641063N , PCI - JNI FCI1063N 1 GB HBAs	JNI 32 PCI Bus-380576-001 (SWSA4-PC)
Switch	Brocade Fibre Channel Switch Silkworm 2250 Type 5.4, Kernel v5.3.1, Fabric OS v2.1.7	Brocade Fibre Channel Switch Silkworm 2250 FW 2.1.4F	Brocade Fibre Channel Switch Silkworm 2250 Type 5.4, Kernel v5.3.1, Fabric OS v2.1.7	Brocade Fibre Channel Switch Silkworm 2400 FW 2.2.1a	Brocade Fibre Channel Switch Silkworm 2250 Type 5.4, Kernel v5.3.1, Fabric OS v2.1.7
Compaq Solutions Platform Kit	StorageWorks Solution Software v8.5c	StorageWorks Solution Software v8.6	StorageWorks Solution Software v8.5c	StorageWorks Solution Software v8.5c or v8.6	StorageWorks Solution Software v8.5c
Compaq Multipath	Secure Path v3.1	Secure Path v3.1	Secure Path v3.1	Secure Path v3.1	Secure Path v3.1
IBM Multipath	Subsystem Device Driver (SDD) 1.3.0.1	Subsystem Device Driver (SDD) 1.3.0.1	Subsystem Device Driver (SDD) 1.3.0.0	Subsystem Device Driver (SDD) 1.2.0.5	Subsystem Device Driver (SDD) 1.2.0.5
Compaq-IBM MultiPath Coexistence	Supported	Supported		Supported	Supported
Path Fail	Supported	Supported	Supported	Supported	Supported

Operating System	Window NT V4.0 SP6	Window NT V4.0 SP6a	Window 2000 SP1	Sun Solaris V8.0	Sun Solaris V7.0
IBM Disk Storage	ESS2105 (Shark)	ESS2105 (Shark)	ESS2105 (Shark)	ESS2105 (Shark)	ESS2105 (Shark)
Compaq Disk Storage	MA8000	MA8000	MA8000	MA8000	MA8000
Tape subsystem	Compaq TL891 FW lvl 5.14	IBM 3590 E11 with FW F25985	Compaq TL891FWlvl 5.14	IBM 3590 E11 with FW F25985	
Cluster Software	Microsoft Enterprise Edition Clustering Software (MSCS)				Veritas Cluster Server v1.1.2
Disk-to-Disk Migration	Supported	Supported	Supported	Supported	Supported
Single Server Common EBS	Veritas BackupExec	Veritas BackupExec Tivoli Storage Manager v4.1.3	Veritas Netbackup v3.4	Veritas Netbackup v3.4 Tivoli Storage Manager 4.1	
Dual Server Common EBS	Veritas Netbackup v3.4 Tivoli Storage Manager v4.1.1 Non-clustered		Veritas Netbackup v3.4 Tivoli Storage Manager v4.1.1 Non-clustered		
Volume Management	Enterprise Volume Manager v1.1a		Enterprise Volume Manager v1.1a		

Details of testing that supports these new environments

The test results and test process used to validate this new environment and further details of the configuration are contained in the attachment 1 test report.

LAN-Free Backup for High Availability SANs

Summary

With interoperability, customers will enjoy choices, flexibility, substantially reduced costs and greater speed of deployment with an open network infrastructure that is transparent to their business applications, file systems, operating systems, server platforms, and even tape libraries and network interconnect devices. By providing a complete portfolio of optimized storage technologies that will work together seamlessly, Compaq and IBM are demonstrating the Open SAN is a reality today enabling customers the opportunity to create competitive business advantage. Customers will be able to use the industry's most advanced storage solutions, while being assured their investments will be protected today and in the future.

LAN-Free Backup for High Availability SANs

Attachment 1
COMPAQ/IBM Interoperability Test Report

Date: **November 16, 2001**

Locations: **IBM Test Labs Tucson, Arizona**
Compaq Test Labs, Colorado Springs, Colorado

Testers: **Stoup, Jeremy, IBM**
Bunn, Brian, IBM
Herman, Michael, Compaq

Purpose of Document

This document describes the test results and the interoperability support for:

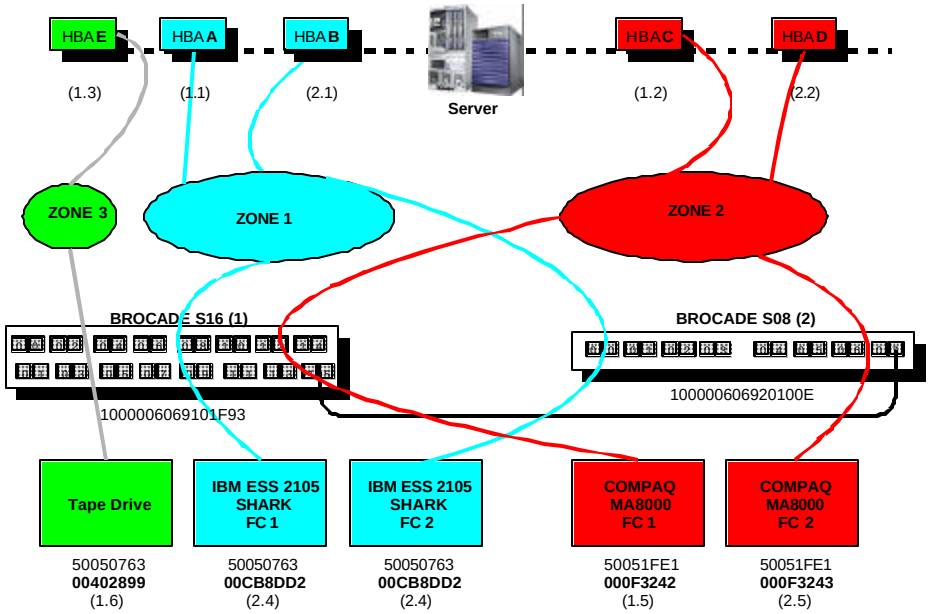
- Data Migration and Data Transfer
- Common tape backup and restore
- Path-fail

Details of Test Environment

For detailed configuration information see the matrix in the attached SSF submission white paper.

Zoning Environment

The Brocade switches were configured to support three zones, with dedicated ports defined for each zone. The specified server was connected with five HBAs as specified in the matrices to the Brocade switches. Zones were configured with dedicated HBAs and isolated from other zones. An ISL link between Brocade switches was active.

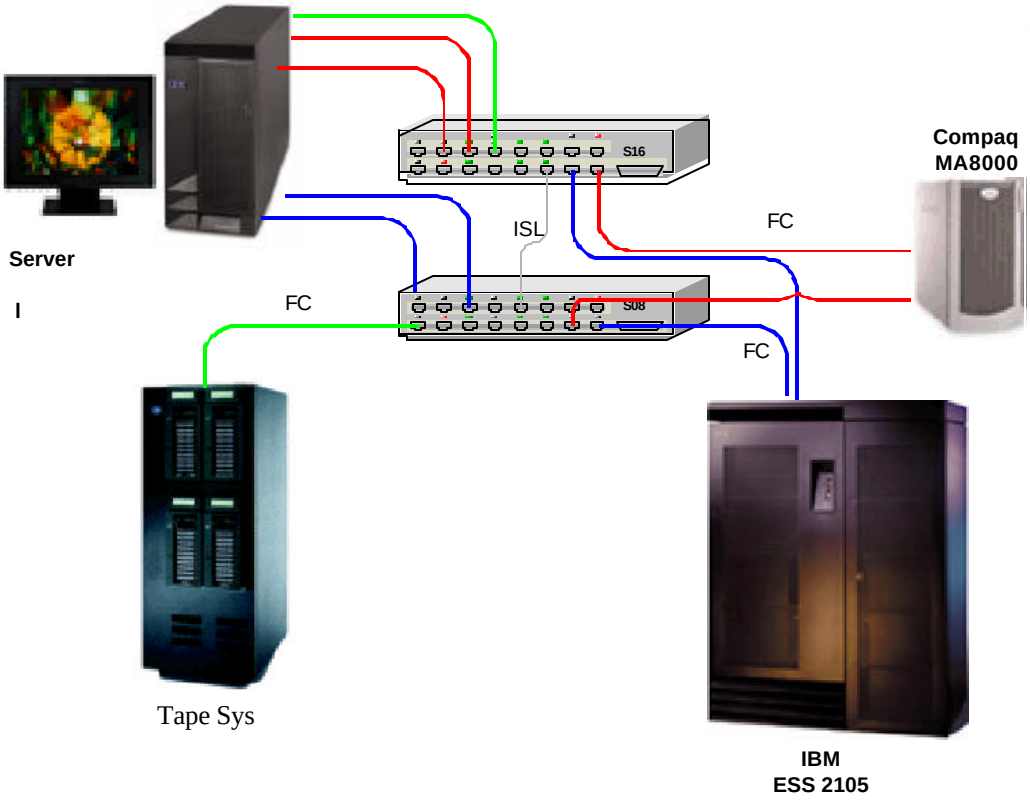


Note: The Brocade switch and port number are designated by the value in parentheses, i.e., (2.1)

The IBM ESS 2105 zone was connected to ports in each switch, and configured in a separate zone for redundancy.

The Compaq MA8000 was connected to ports in each switch, and configured in a separate zone for redundancy.

The tape unit was configured with a single fibre connection and connected to zone 3 with an assigned (dedicated) HBA.



TEST RESULTS SUMMARY

A series of data transfers from disk to disk and disk to tape were performed in order to validate data throughput and verify backup and restore. Path failover was forced and correct recovery verified. The following tests and measurements were performed:

Test Results: Tests Completed Successfully

Setup and Configuration Module

SETUP	TEST	PASS / FAIL	DEFINITION
Setup01	Install and Configure the Brocade Switch	**P**	Install by following the supplied documentation and using the Configuration Wizard
Setup02	Attach Devices and configure LUNs	**P**	Attach and verify connectivity, Configure LUNS
Setup03	Reboot Switch(es)	**P**	Reboot Switch and verify previously configured LUNs are still defined.
Setup04	Reboot Server	**P**	Reboot Server and verify previously configured LUNs are still defined.

Disk Access and Data Transfer Module

DISK ACCESS	TEST	PASS / FAIL	DEFINITION
Access01	Data transfer	**P**	Start I/O using exerciser utility to initiate data transfer / data creation.
Access02	Stress test	**P**	Utilizing I/O exerciser: run I/O for 48 hours

Backup & Restore Test Module

BACKUP	TEST	PASS / FAIL	DEFINITION
Backup01	Install TSM	**P**	Install TSM to perform backup and restore functions
Backup02	Install Veritas	**P**	Install Veritas to perform backup and restore functions
Backup03	Backup	**P**	Backup files located on ESS LUN to a tape drive 3590
Backup04	Restore	**P**	After deleting the files on ESS, restore files from tape to the ESS. Verify that the process completed with no I/O errors

Test Results Reporting Log (*continued)*

Error and Recovery Module

ERROR	TEST	PASS / FAIL	DEFINITION
Error01	Power Off Switch	**P**	Power off one switch and verify alternate path fail-over for SAN operation **Results:** @iteration 64; Power off Brocade#1; Path interruption detected and recovered by SDD. SPM shift to Controller B. Recovery **Successful** @iteration 121; Power off Brocade#2; Path interruption detected and recovered by SDD. SPM shift to Controller A. Recovery **Successful**
Error02	FC Link failure	**P**	Disconnect/reinsert FC connections to observe that it didn't cause data integrity or any unrecoverable errors **Results:** @ iteration 132 Remove ESS2105 FC link (1,1) Remove MA8000 FC link (1,2) Recovery **Successful**
Error03	Switch Fail-over	**P**	In a redundant path configuration force switch fail-over **Results:** @iteration 142 ; Power off switch #2 Detected by switch #1, I/O halted, recovery initiated, switch #1 assumed control. Recovery **Successful**
Error04	Reboot host	**P**	Reboot the server and verify that the previously configured LUNs are accessible. **Results:** @iteration 154 – Initiate server shutdown and reboot sequence. **Successful**

ERROR	TEST	PASS / FAIL	DEFINITION
Error05	The device must be able to recover from a connection loss	**P** **P** **P**	3 types of connection loss must be verified: **Link failure Test:** Pull any Fibre cable anywhere in the configuration. Desired Result: Continued I/O without failure. **Port failure Test:** Pull a GBIC from any switch. Desired Result: Continued I/O operations without failure. **Switch failure Test:** Turn off any switch in the fabric. Desired result: Continued I/O operations without failure
Error06	The device must be able to maintain stability during topology changes.	**P** **P** **P**	**Test:** Add/remove new elements to the fabric: 1. New zones 2. New initiators 3. New targets **Desired results:** Continued I/O operations without failures. **Successful**
Error07	The device must be able to maintain stability after the loss of the principle switch.	**P** **P**	**Test:** 1. Shut off the primary switch. 2. Shut off the secondary switch. **Desired results:** Continued IO operations without failures. **Successful**

ERROR	TEST	PASS / FAIL	DEFINITION
Error08	The device must be able to maintain stability during a zone change in another configuration.	**P**	**Test:** Remove a member of some other (non-primary) zone. **Desired result:** Continued I/O operations in the zone configuration.
Error09	The device must be able to maintain stability during the addition of an initiator and target in another configuration.	**P**	**Test:** Add a new initiator and target member to some other zone. **Desired result:** Continued I/O operations in the zone configuration.
Error10	The device must be able to maintain stability while the fabric is fully populated and all devices have initiated I/O.	**P**	**Test:** Ensure that all ports in the fabric are connected to an initiator or target. Initiate continues load through all ports. **Desired results:** Continued I/O without failures for a period of 24 hours. **Result:** 3.4 terabytes transferred over 121 hour period. **Successful**
Error11	If the device will be acting as an **initiator** then the device must be able to discover a large number of targets and maintain this list through a series of fabric errors. Targets must not be dropped after topology reconfiguration or a device re-login.	**P** **P**	**Test:** Present a set of LUNS from a target to an initiator. Allow that platform to discover new LUNS. **Desired result:** Platform sees, accesses, and generates IO to the new LUNS permanently. **Test:** Once IO is generated from the initiator to the targets perform path fail-over by disconnecting one of the paths. **Desired Result:** I/O fails over to the alternate path.

ERROR	TEST	PASS / FAIL	DEFINITION
Error12	If the device will be acting as a **target** then it must present a constant number of data volumes after multiple logins and topology changes. These volumes could be disks, LUNs, or tape drives.	**P** **P**	**Test:** Present a set of LUNS from an initiator to a target. Allow that platform to discover new LUNS. **Desired result:** Platform sees, accesses, and generates IO to the new LUNS permanently. **Test:** Once IO is generated from the initiator to the targets perform path fail-over by disconnecting one of the paths. **Desired Result:** I/O fails over to the alternate path.
Error13	Tests for Stability during fail over The device must be able to maintain stability during an ISL fail over in a separate configuration	**P**	**Test:** Pull an ISL on any switch in fabric. **Desired Result:** All ZONES continue I/O without failures. **Results:** @Iteration 320 Recovery < 4 minutes. Restore ISL without service interruption. **Successful** NOTE: All ISL's in the fabric pertain to all ZONES. You cannot pull an ISL without affecting all ZONES. This test must be done on a Fabric With the test bed configured and running I/O.
Error14	The device must be able to maintain stability during a port fail over in a separate configuration	**P**	**Test:** Remove a GBIC in some other Zone. **Desired Result:** Zone continues without failures. **Result:** @Iteration 327 Zone 3 **Successful**
Error15	The device must be able to maintain stability during an initiator fail over on the server side. This must also be true when the fail over involves server side software and/or when a cluster configuration is involved	**P**	**Test:** Pull the fibre from an HBA on any/all platforms. **Desired Result:** All platforms should perform path fail-over allowing I/O to continue. **Result:** @Iteration 542 Pulled each HBA at server incrementally. Detected and recovered. **Successful**

ERROR	TEST	PASS / FAIL	DEFINITION
Error16	The device must be able to maintain stability during a storage controller fail over. This must be true in the case where specific software is being used or when a cluster configuration is being used on the servers connecting to the controllers	**P**	**Test:** Shutdown one member of any/all HSG80 controller pairs in the Compaq Zones. **Desired Results:** All platforms should perform path fail-over to allow I/O to continue. **Result:** @Iteration 681 initiated *shutdown other controller* from MA8000 console. **Successful**

Performance Results Test Module

Performance	TEST	PASS / FAIL	DEFINITION
Perf01	Data transfer	**P**	Perform the I/O operations with each unique server / connection combination. Monitor and save throughput rate and compare the results.
Perf02	Backup/Restore	**P**	Perform the same Backup/Restore operations with each unique server/connection combination. Monitor and save throughput rate and compare the results.

Attachment 2

Interoperability Matrix Definitions

Switch – A detailed description of the type of switch that both the ESS2105 and the MA were connected to in the interoperability configuration. The switch used was a Brocade Silkworm 2250. Compaq and IBM sell their own branded version of the Brocade switch. No matter the brand of the switch, interoperability is only supported for the specific levels of switch hardware and software indicated in the interoperability matrix.

Compaq Solution Platform Kit – Version of Storage Works Command Console used to control the MA in each respective operating system environment listed on the interoperability matrix.

Compaq Multipath – Version of Secure Path software used for path fail support on the MA for each respective operating system listed on the interoperability matrix.

IBM Multipath – Version of IBM's Subsystem Device Driver (SDD) software used for path fail support on the ESS 2105 for operating system listed on the interoperability matrix.

Path Fail – Path Fail was tested on LP8000 HBA in both zones in separate tests.

Disk-to-Disk Migration – Allows a drag and drop copy operation of a LUN from the ESS2015 to the MA8000 or vice versa.

Operating Systems – The specific OS used in the interoperability test environment. It is anticipated that environments will work across numerous server platforms types, but was only tested only a specific set of server platforms. Servers specifically used for testing included Compaq Proliant 8500R, IBM Netfinity 5500, IBM M80 RS/6000, and Sun E4500.

Host Bus Adapters – Each storage system was attached to the server with the storage in common zones and the host HBAs in separate zones. Two HBAs were used for each storage system (a total of four HBA in the configuration) to support path fail capabilities and the HBAs within a zone were the same type, e.g. for the Shark zone both HBAs were Qlogic 2200F and for the MA zone both HBAs were Emulex LP8000 in the Windows NT configuration. Different HBAs within the same zone are not supported.