



**IBM System Storage Proven Test Results:
Xsigo Systems VP780 I/O Director**

Executive Summary

This paper describes the results of testing conducted to verify that the operation of the Xsigo I/O Director meets the requirements of the IBM System Storage Proven certification program.

Test results were compiled over a period of four weeks at the IBM Innovation Center in San Mateo, California, in accordance with a test plan that was jointly created by IBM and Xsigo technical representatives. Elements of the test plan included:

- **Breadth:** 47 separate tests comprising hardware/software combinations drawn from seven separate IBM hardware product families and ten different software environments.
- **Duration:** Multiple elements of the testing incorporated continuous 72 hour operation under various conditions.
- **All phases of operation:** Testing conducted across all standard operating conditions including installation, management, and maintenance.
- **Stress:** Stress and performance testing were conducted to simulate large-scale environments.

Summary of Results

Test results met the requirement for IBM TotalStorage certification. All test conditions were passed, verifying broad interoperability, functionality to specification, and full data integrity. In addition, Xsigo met all criteria necessary to complete IBM's System Storage Proven program.

Table 1: Overview of Results

Device Tested	Results
IBM System Storage Disk Systems:	
DS8000	PASSED
DS6000	PASSED
DS4700	PASSED
DS4400	PASSED
SAN Volume Controller	PASSED
IBM Server Systems:	
System x3550	PASSED
BladeCenter HS21	PASSED
IBM System Storage Tape Systems:	
TS3200 with Tivoli Storage Manager	PASSED

Table 2: IBM System x3550 Host Server

Storage Device Tested	Operating Environment Tested	Results
IBM DS4400 Series	Windows Server 2003 with SP2 (32 bit) Windows Server 2003 with SP2 (64 bit)	PASSED
IBM DS4700 Series	RHEL Linux 4.0 2.6.9.42-ELsmp (32 bit)	PASSED
IBM DS6000 Series	Windows Server 2003 with SP2 (64 bit) RHEL Linux 4.0 2.6.9.42-ELsmp (32 bit)	PASSED
IBM DS8000 Series	Windows Server 2003 with SP2 (32 bit) Windows Server 2003 with SP2 (64 bit) RHEL Linux 4.0 2.6.9.42-ELsmp (32 bit)	PASSED
IBM SVC	Windows Server Enterprise Edition 2003 with Microsoft Cluster Server	PASSED
IBM TS3200 Tape Library	Windows Server 2003 with SP2 (32 bit)	PASSED

Table 3: IBM BladeCenter HS21 Host Server

Storage Device Tested	Operating Environment Tested	Results
IBM DS4700 Series	Windows Server 2003 with SP2 (64 bit)	PASSED
IBM DS6000 Series	RHEL Linux 4.0 2.6.9.42-ELsmp (32 bit)	PASSED

Test Methodology

The IBM System Storage Proven validation process was divided into three distinct phases:

- **Phase One:** Single-Path Storage I/O
- **Phase Two:** Multi-Path Storage I/O
- **Phase Three:** Host-Side Failover

In each of the three phases Xsigo and IBM performed a battery of tests, including:

- vHBA installation and configuration
- Xsigo Fibre Channel I/O Module performance
- Name server registration
- Zone server registration and fabric zoning
- Storage array data path with no data corruption
- QoS applied to vHBAs
- Basic stress, scalability, and performance testing
- vHBA interoperability testing with the IBM equipment listed previously

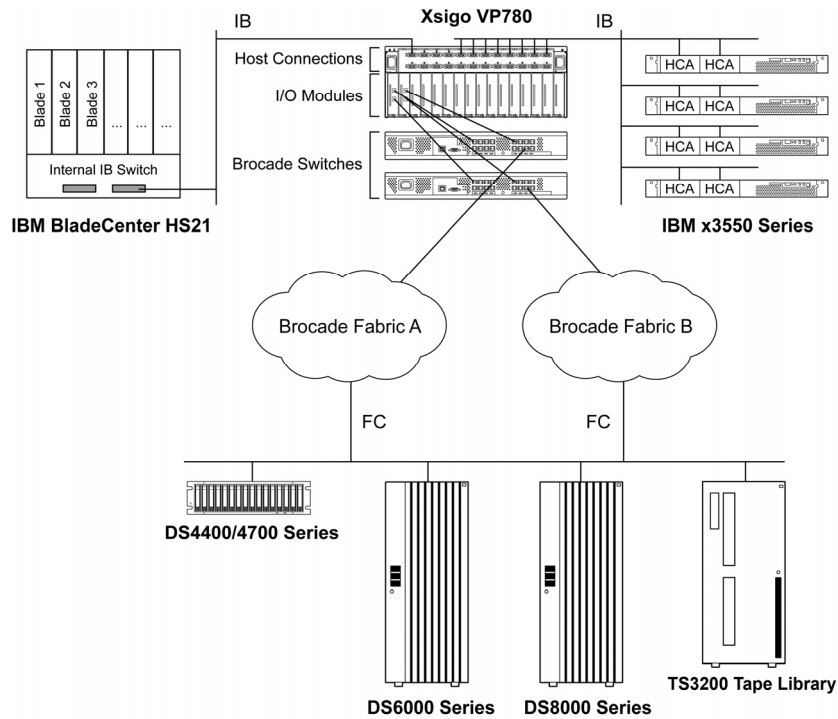
Phase One: Single-Path Storage I/O

The Xsigo I/O Director was configured with two Xsigo 4-Gigabit Fibre Channel I/O modules and redundant InfiniBand connections to different servers. The two 4-Gigabit Fibre Channel modules connected directly into a Brocade SAN switch fabric. To support redundancy within a single Xsigo chassis, each I/O module connected to a different Brocade leaf switch.

Two kinds of servers were used in the InfiniBand network:

- **IBM x3550 Series:** The PCI Express slots were populated with Xsigo Host Channel Adapters (HCAs). Each HCA connected to the Xsigo InfiniBand fabric through a dedicated InfiniBand cable.
- **IBM BladeCenter HS21:** Each BladeCenter server contained an internal Cisco 4x InfiniBand HCA Expansion Card that interconnected to an internal Cisco Systems 4x InfiniBand Switch Module. The Xsigo InfiniBand fabric connected directly to the internal Cisco InfiniBand switch module.

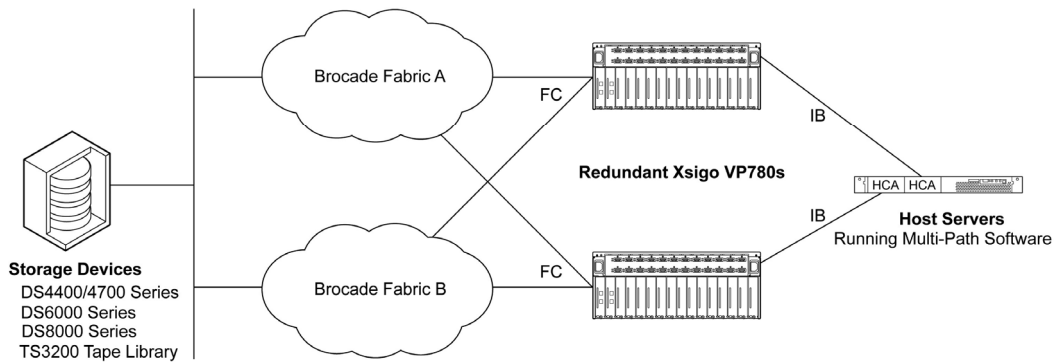
Figure 1: Single-Path Storage I/O Topology



Phase Two: Multi-Path Storage I/O

Multi-path I/O solutions such as IBM Redundant Disk Array (RDAC) and IBM Subsystem Device Driver (SDD) are often employed with dual SAN fabrics to improve resilience and protect against failure in the storage network. Xsigo's I/O Director supports high availability in the Fibre Channel environment by creating two vHBAs and then running multi-pathing software such as RDAC or SDD on the host. The purpose of Phase Two testing was to validate the Xsigo I/O Director's response in a multi-path failover scenario.

Figure 2: Multi-Path Storage I/O Topology

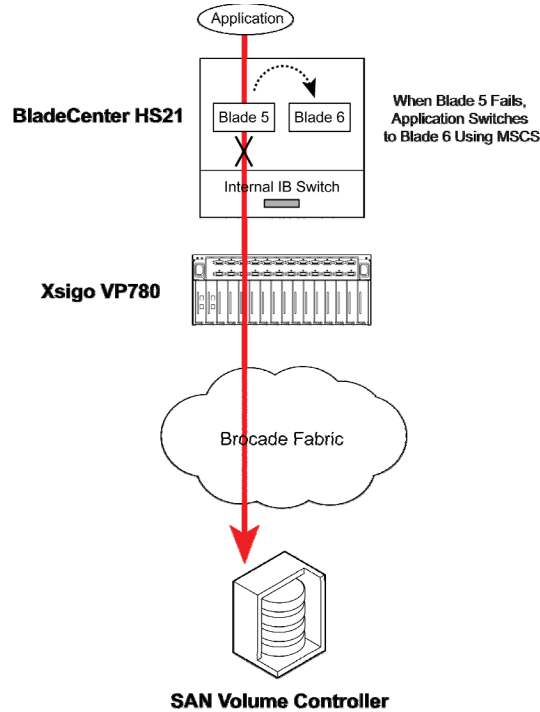


Each server HCA was connected to a single Xsigo chassis through the InfiniBand fabric. Traffic was communicated through separate SAN fabrics, ultimately terminating at a single IBM disk or tape system. RDAC and SDD managed the LUN path information across the multi-switch fabric. We brought the primary path down and verified traffic to ensure rapid failover to the redundant data path.

Phase Three: Host-Side Failover

High-availability (HA) cluster solutions such as Microsoft Cluster Server (MSCS) improve the availability of mission critical application environments such as Microsoft Exchange Server. Phase Three testing consisted of a Blade server failure within a single BladeCenter chassis. Similar to the first two phases, we attached the BladeCenter cluster to the Xsigo chassis via a redundant InfiniBand fabric. The Xsigo I/O Director was then connected to a SAN Volume Controller.

Figure 3: Host-Side Failover Topology



Conclusion

72 hours of continuous I/O stress testing were performed on each combination of IBM servers and storage devices identified in Tables 1-3. The Xsigo I/O Director passed all the tests identified in the joint test plan and met the requirements for IBM System Storage Proven qualification.

Project Members:

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Appendix A: Equipment Details

Test Equipment and Software Versions

Xsigo Equipment	
Xsigo VP780	XgOS V1.0.0
Xsigo host software	Window 2003 Server with SP2 (32bit) Window 2003 Server with SP2 (64bit) RHEL Linux 4.0 2.6.9.42-ELsmp (32bit)
Two Xsigo 2 x 4Gb Fibre Channel I/O modules	
Four Xsigo dual-port HCA cards, PCI-Express ¹	
IBM Storage Equipment	
IBM DS4400 Series	6.12.56.00 Firmware
IBM DS4700 Series	6.16.88.00 Firmware
IBM DS6000 Series	5.2.200.1547 Firmware
IBM DS8000 Series	6.1.740.20 Firmware
IBM SAN Volume Controller (SVC)	2-Node cluster version 2145 firmware 4.1.0.1
IBM Tape Server TS3200	5770 Firmware
IBM Multi-Path Software	
IBM Subsystem Device Driver (SDD) ²	1.6.3.0-2 Firmware
IBM Redundant Disk Array Controller (RDAC) ³	9.0.1 Firmware
IBM Host Servers	
IBM x3550 servers	Window 2003 Server with SP2 (32bit) Window 2003 Server with SP2 (64bit) RHEL Linux 4.0 2.6.9.42-ELsmp (32bit)
IBM BladeCenter HS21 server	Window 2003 Server with SP2 (64bit) RHEL Linux 4.0 2.6.9.42-ELsmp (32bit)
SAN Switch Fabric	
Brocade switches	5.2.1b Firmware N_Port ID Virtualization (NPIV) enables multiple Fibre Channel initiators to login and occupy a single physical port. Switch device must be running a version of OS that supports NPIV.
Test Applications	
IOMeter	For SCSI block level traffic generation.
DT	Data Test (DT) to perform I/O testing.
Microsoft Cluster Server (MSCS)	
IBM Tivoli Storage Manager (TSM)	For Windows testing and the IBM Tape Server TS3200.
Microsoft Cluster Server (MSCS)	Windows 2003

¹ Installed into the IBM x3550 servers

² Supports the IBM DS6000/DS8000 Series and operates in active/active mode. All LUNs are owned by all controllers. Any controller can access any LUN.

³ Supports the IBM DS4400/DS4700 Series and operates in active/passive mode. A specific LUN is assigned to a specific controller. If one controller fails, the other controller accesses LUNs using a trespass maneuver.

Appendix B: Summary of Tests Conducted

Description	Result
Install Xsigo drivers on RHEL Linux. Confirm vHBA is functional	PASSED
Install Xsigo drivers on Window Server 2003 (32/64bit). Confirm vHBA is functional	PASSED
Configured multiple vHBAs connected to multiple FC ports	PASSED
Move vHBA to another server	PASSED
Reboot server with vHBAs configured	PASSED
Reboot Xsigo system with vHBA configured	PASSED
Disconnect and reconnect server extender cable	PASSED
Confirm Worldwide Node Name (WWNN) on vHBAs	PASSED
Confirm Worldwide Port Name (WWPN) on vHBAs	PASSED

Fibre Channel I/O Module

Description	Result
Shutdown and start Xsigo Fibre Channel I/O module	PASSED
Confirm that the Xsigo Fibre Channel I/O Module can correctly negotiate point to point with a fabric switch	PASSED
Confirm that the Xsigo Fibre Channel I/O Module can correctly negotiate speed, and link at the expected speed when hard configured.	PASSED
Confirm that the Xsigo Fibre Channel I/O Module correctly reports online and offline status	PASSED
FLOGIN / PLOGIN of virtual WWNs to fabric switch port	PASSED

Name Server

Description	Result
Verify basic local fabric device registration	PASSED
Verify device registration after fabric switch reboot	PASSED
Verify device registration after Xsigo system reboot	PASSED
Verify device registration when fabric switches are disabled and enabled	PASSED
Verify basic device registration when a fabric switch-connected Xsigo port is moved	PASSED
Verify basic device registration when a Xsigo-connected server is rebooted	PASSED
Verify registration of symbolic name data	PASSED

Zone Server

Description	Result
Activate zoneset node WWN zoning in the fabric	PASSED
Activate zoneset then change zoneset in fabric	PASSED
Verify that vHBAs are fully functional in a fabric zone when targets and vHBA are moved	PASSED
Verify that a local device coming online sends the correct RSCNs when fabric zoning is enabled	PASSED
Verify that a local device going offline sends the correct RSCNs when fabric zoning is enabled	PASSED
Zone enforcement and overlapping	PASSED
Zone enforcement - two vHBAs on one server, same fabric, same targets	PASSED

Storage Array Data Path

Description	Result
Verify that a vHBA can send I/O to array ports with no data corruption	PASSED
Verify that multiple vHBAs can send I/O to array ports with no data corruption	PASSED
Verify that the Xsigo System can transmit Medusa data patterns designed to stress Fibre Channel, PCI , and chipset without error using multiple I/O block sizes	PASSED

Quality of Service

Description	Result
Verify that QOS can be applied to vHBAs	PASSED
Verify that with QOS set to a value below the server / vHBAs max throughput to a given target that no data corruption occurs	PASSED
Verify that with QOS set on two vHBAs one getting a high value and the other getting a low value that the low value vHBA does not get starved	PASSED

Stress

Description	Result
Verify that the Xsigo system can transmit error free I/O for 12 hours of continuous operation	PASSED
Verify that the Xsigo system can transmit error free I/O for 24 hours of continuous operation	PASSED
Verify that the Xsigo system can transmit error free I/O for 72 hours of continuous operation	PASSED

Scalability

Description	Result
Verify that the maximum number of vHBAs can be added to a server	PASSED
Verify that the maximum number of vHBAs can be configured on all available servers	PASSED
Verify that the Xsigo system can repeatedly configure and delete 128 vHBAs	PASSED
Verify that the Xsigo System can send I/O from servers while the max number of vHBAs are configured	PASSED

MPIO

Description	Result
Verify correct functionality with two vHBAs configured on the same server and bound to different FC ports on the same Xsigo Fibre Channel I/O Module.	PASSED
Verify correct functionality with two vHBAs configured on the same server and bound to different FC ports on two Xsigo Fibre Channel I/O Modules.	PASSED
Verify correct functionality with two vHBAs configured on the same server and bound to different FC ports on two Xsigo Fibre Channel I/O modules, on two Xsigo chassis.	PASSED
Verify correct functionality of IBM SDD/RDAC MPIO software with two vHBAs in a server.	PASSED

Performance

Description	Result
Test Configuration: Block size=1MB Read/Write =50/50 Random/Sequential=100% Sequential	PASSED

Description	Result
Test Duration: 1 hour	
Test Configuration: Block size=4 MB Read/Write = 50/50 Random/Sequential =100% sequential Test Duration: 1 hour	PASSED

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