SPC BENCHMARK 1™

EXECUTIVE SUMMARY

IBM CORPORATION

IBM SYSTEM STORAGE
SAN VOLUME CONTROLLER VERSION 4.3

SPC-1 V1.10.1

Submitted for Review: October 15, 2008
Submission Identifier: A00072

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

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Revision Information and Key Dates

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SPC-1 Specification revision number	V1.10.1
SPC-1 Workload Generator revision number	V2.00.04a
Date Results were first used publicly	October 15, 2008
Date the FDR was submitted to the SPC	October 15, 2008
Date the TSC is available for shipment to customers	currently available
Date the TSC completed audit certification	August 22, 2008

Tested Storage Product (TSP) Description

The IBM System Storage SAN Volume Controller (SVC) enables a single point of control for disparate, heterogeneous storage resources to help support improved business application availability and greater resource utilization. SAN Volume Controller is designed to pool storage volumes from IBM and non-IBM storage systems into a single reservoir of capacity for centralized management.

SAN Volume Controller combines hardware and software into an integrated, modular solution. Using IBM System x™ server technology in clustered pairs, SAN Volume Controller is designed to avoid potential single points of failure. SAN Volume Controller software is designed to operate as a highly available cluster supporting high performance and ease of use.

SAN Volume Controller is highly scalable. An "I/O Group" is formed by combining a redundant pair of System x servers. Each server includes a four-port 4 Gbps-capable host bus adapter (HBA), designed to allow the SAN Volume Controller to connect and operate at

up to 4 Gbps SAN fabric speed. Each I/O Group contains 8 GB of mirrored cache memory. Highly available I/O Groups are the basic configuration element of a SAN Volume Controller cluster. Adding I/O Groups to the cluster is designed to increase cluster performance and bandwidth.

SAN Volume Controller can scale out to support four I/O Groups, and it can scale up to support 1024 host servers. For every cluster, SAN Volume Controller support up to 4096 virtual disks.

Version 4.3 of SAN Volume Controller offers thin provisioning capability, configurable on a virtual disk basis. This SPC-1 Result demonstrates the performance of virtual disks configured for thin provisioning (referred to as Space Efficient virtual disks).

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: IBM System Storage SAN Volume Controller Version 4.3	
Metric	**Reported Result**
SPC-1 IOPS™	274,997.58
SPC-1 Price-Performance	$11.79/SPC-1 IOPS™
Total ASU Capacity	61,007.564 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$3,242,858.69

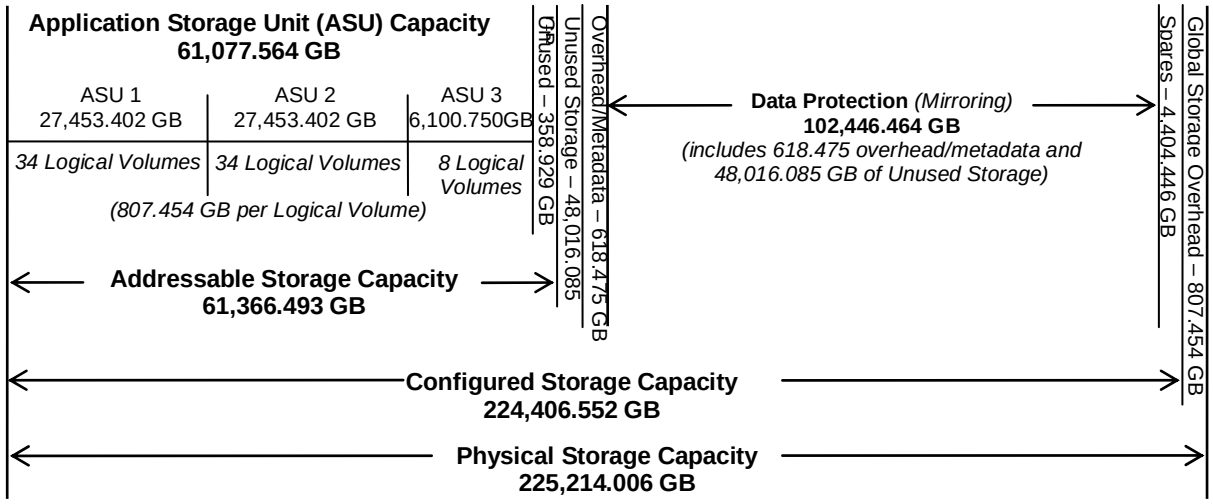
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

Total ASU (Application Storage Unit) **Capacity** represents the total storage capacity read and written in the course of executing the SPC-1 benchmark.

A **Data Protection Level** of "Mirroring" configures two or more identical copies of user data.

Storage Capacities and Relationships

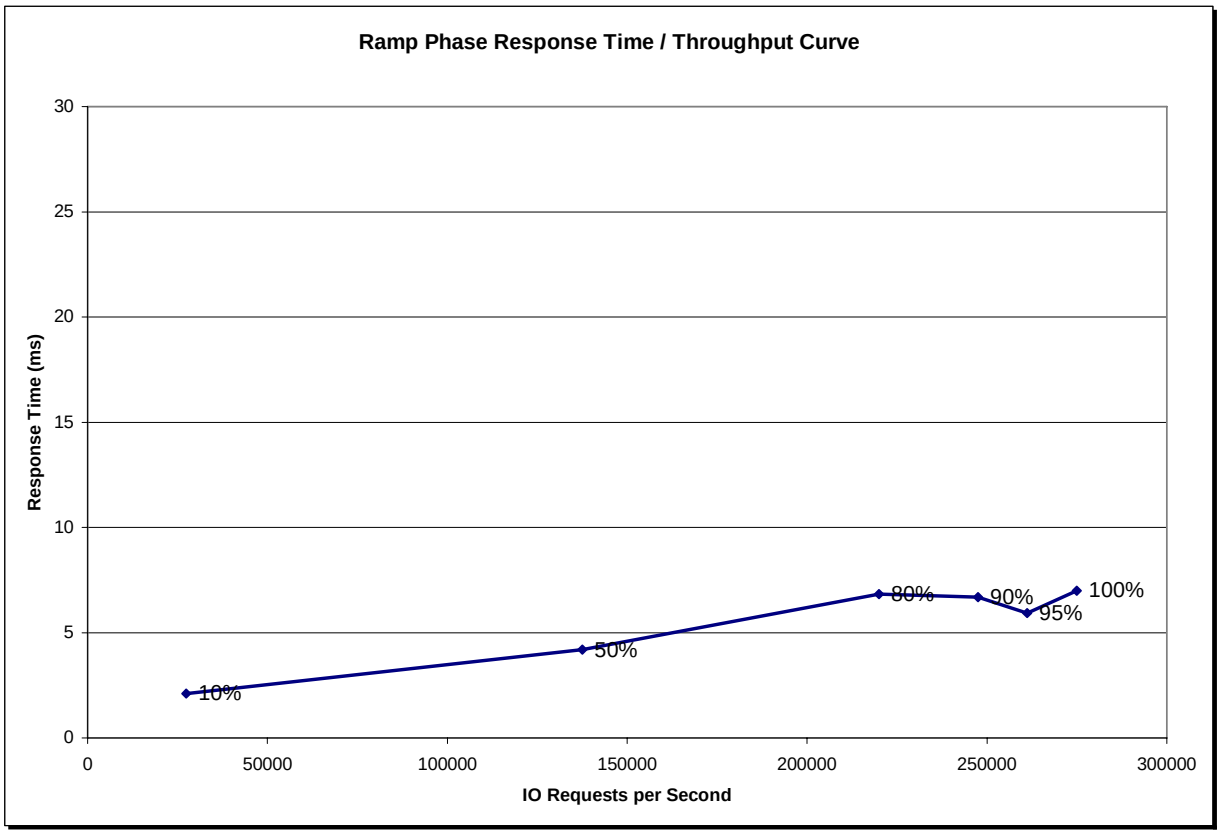
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



Response Time – Throughput Curve

The Response Time-Throughput Curve illustrates the Average Response Time (milliseconds) and I/O Request Throughput at 100%, 95%, 90%, 80%, 50%, and 10% of the workload level used to generate the SPC-1 IOPS™ metric.

The Average Response Time measured at the any of the above load points cannot exceed 30 milliseconds or the benchmark measurement is invalid.



Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	27,494.04	137,482.69	220,017.32	247,468.74	261,207.70	274,997.58
Average Response Time (ms):						
All ASUs	2.11	4.20	6.83	6.70	5.94	6.99
ASU-1	2.83	5.00	8.07	7.88	7.17	8.32
ASU-2	2.16	5.20	8.50	8.56	7.80	9.07
ASU-3	0.56	2.06	3.49	3.36	2.51	3.27
Reads	4.58	7.66	12.20	12.05	11.40	12.97
Writes	0.50	1.95	3.34	3.21	2.38	3.11

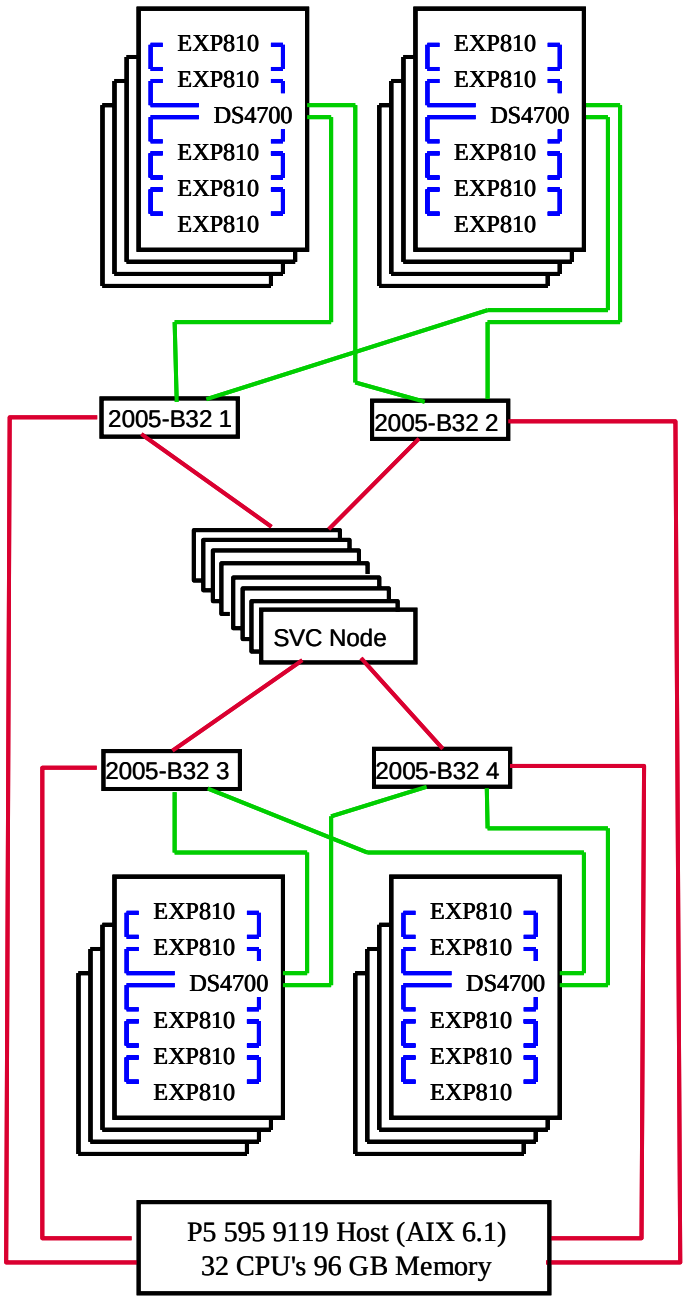
Tested Storage Configuration Pricing *(Priced Storage Configuration)*

Component	Comments	Quantity	Unit Price	Unit Maint	List w/ Maint	% discount	Total Price
SVC 3550 Storage Engine (2145-8G4)		8	16,500.00	6,696.00	185,568.00	30	129,897.60
UPS (2145-8G4 8115)		8	1,250.00	2,592.00	30,736.00	30	21,515.20
Master Console (2145-8G4 4001)		1	7,499.00	3,816.00	11,315.00	30	7,920.50
SVC Software license (base)	up to 100 TB	1	332,000.00	132,800.00	464,800.00	30	325,360.00
19 inch rack (7014-T42)		9	3,970.00	1,512.00	49,338.00	50	24,669.00
32 port fibre channel switch (2005-B32)	w/ 32 SFP, 32 ports enabled	4	38,573.00	2,657.00	164,920.00	20	131,936.00
DS 4700 with 16 15K RPM drives (146 GB)	w/ 4 SFP, 2 5m cables	16	45,243.00	11,250.00	903,888.00	37	569,449.44
EXP810 with 16 15K RPM drives (146 GB)	w/ 4 SFP, 2 1m cables	80	34,544.00	4,320.00	3,109,120.00	37	1,958,745.60
Ethernet switch (73P-2413)		2	135.99	30.00	331.98	42	192.55
Short wave 5m fibre channel cable (1814-70A 5605)		32	129.00		4,128.00	20	3,302.40
Short wave 25 m fibre channel cable (1814-70A 5625)		32	189.00		6,048.00	20	4,838.40
Ethernet 1.5 m cable (1814-70A 3802)		8	17.00		136.00	0	136.00
Ethernet 10 m cable (1814-70A 3804)		32	29.00		928.00	0	928.00
2 Gbit P5 595 adapter (5716)		32	1,999.00		63,968.00	0	63,968.00
Total Price							**3,242,858.69**

Differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration

The TSC was configured with 1,534 active disk drives and the Priced Storage Configuration contained 1,536 disk drives. Adding two disk drives to the TSC would not have resulted in a negative impact to the reported SPC-1 performance.

Benchmark Configuration/Tested Storage Configuration Diagram



Notes:

All storage is managed by each node (single image).

Each EXP810 and DS4700 has 16 disks (total of 1536). Disks are 146 GB, 15K RPM.

Each switch has one zone for node-to-storage traffic, two zones for node-to-host traffic (even nodes to half of fcs's, odd nodes to half of fcs's).

Represents 1 FC path per line drawn
Represents 4 FC paths per line drawn
Represents 8 FC paths per line drawn

Benchmark Configuration/Tested Storage Configuration Components

Host Systems:	Tested Storage Configuration (TSC):
UID=HS-1	32 – 4 Gbit P5 595 HBAs
IBM P5 595 Model 9119	***UID=SC-1/2/3/4/5/6/7/8:*** 8 – System Storage SAN Volume Controllers per controller: 2 GB memory/cache 4 – 4 Gbit FC front-end physical connections *(32 total)* 4 – Backend physical connection pairs *(32 total pairs, 64 connections)*
32 – 1.9 GHz CPUs – 2 CPUs/POWER5 chip 32 KB L1 cache, 960 KB L2 cache, and 18 MB L3 cache per CPU	
96 GB main memory	
AIX 5.3	
PCI-X/RIO	4 – 32 port FC switches
WG	2 – Ethernet switches
	16 – DS4700 enclosures 80 – EXP810 enclosures 1,536 – 146 GB, 15K RPM disk drives *(16 disk drives per enclosure)*
	9 – 19 inch racks
	8 – UPS