SPC BENCHMARK 1™
EXECUTIVE SUMMARY

DataCore Software Corporation
SANsymphony™ Network Edition

SPC-1 V1.7

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Executive Summary

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V 1.7
SPC-1 Workload Generator revision number	V 2.1
Date Results were first used publicly	August 08 2003
Date FDR was submitted to the SPC	August 08 2003
Date the TSC is/was available for shipment to customers	August 01 2003
Date the TSC completed audit certification	August 08 2003

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name : DataCore SANsymphony Network Edition	
Metric Reported	**Results**
SPC-1 IOPs	50,003.55
SPC-1 Price-Performance	$6.11/SPC-1 IOPS™
Total ASU Capacity	1,407GB
Data Protection Level	Mirroring
SPC-1 LRT	1.68 ms
Total TSC Price (including three-year maintenance)	$305,608

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. The Addressable Storage Capacity, which contains the Total ASU Capacity, was 1,825.36 GB. The Total ASU Capacity utilized 77.08% of the Addressable Storage Capacity. The actual Configured Storage Capacity was 4,022.66 GB, which included the user data copy required by a Data Protection Level of Mirroring. The Configured Storage Capacity utilized 99.63% of the priced Physical Storage Capacity of 4,037.43 GB.

A Data Protection Level of Mirroring configures two or more identical copies of user data, maintained on separate disks.

The **SPC-1 LRT™** metric is the Average Response Time measured at the 10% load point, as illustrated on the next page. SPC-1 LRT™ represents the Average Response Time measured on a lightly loaded Tested Storage Configuration (TSC).

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 100% load point cannot exceed 30 milliseconds or the benchmark measurement is invalid.

Ramp Phase Response Time / Throughput Curve
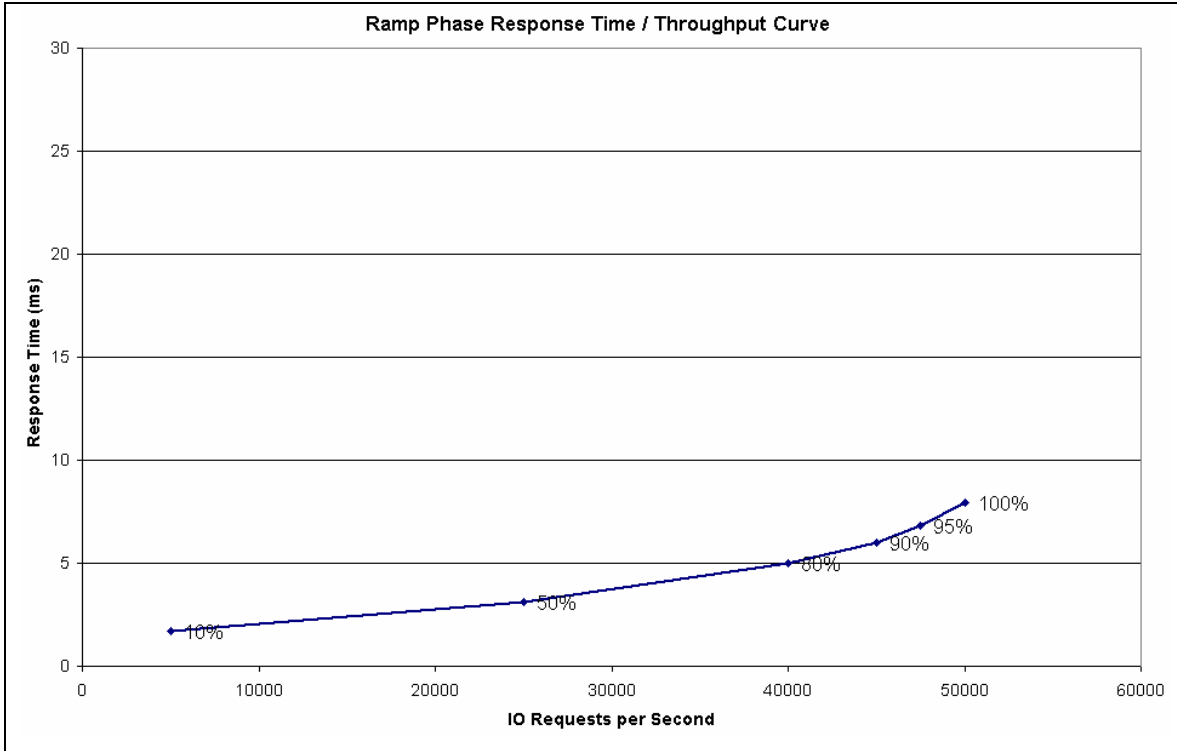
## Response Time – Throughput Data

Response Time - Throughput

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	4,997.33	25,002.16	40,008.03	45,016.78	47,495.03	50,003.55
Average Response Time (ms):						
All ASUs	1.68	3.13	5.00	6.03	6.80	7.97
ASU-1	2.04	4.19	6.85	8.21	9.19	10.14
ASU-2	2.01	2.80	3.94	4.59	5.08	5.84
ASU-3	0.78	1.03	1.53	2.04	2.50	4.30
Reads	3.19	6.57	10.70	12.73	14.18	15.44
Writes	0.70	0.89	1.28	1.66	2.00	3.11

Tested Storage Configuration Pricing

Part Number	Description	Units	Unit Cost	%age Discount	Final Price
JYD-EWV-501-BU1	DELL PE4600 2x3GHz 12GB DELL PE4600 2x2.8GHz 6GB DELL PE2600 2x3GHz 6GB 3 x Windows Server 2003 Enterprise Edition 22 x JMR Fortra 10-drive 1Gbit JBOD 220xSeagate 18GBx15K RPM FC Drive 22 x QLogic QL2310 (Single port HBA) 11 x QLogic QL2342 (Dual port HBA) 4 x QLogic QL2344 (Quad port HBA) 27 x Copper –Fibre MIA 3 x QLogic SANbox-2 16-port switch 1 x McData 4500 Sphereon 24-port switch 74 x 5M Fibre channel cables 2 x 72" Rack	1	$170,637	No discount	$170,637
JYD-EWV-GLD-BU1	24x7 4-hour response H/W maintenance (1 year)	3	$14,096	No discount	$42,288
HWI-MVV-520-BVS	Hardware Installation & Integration	1	$11,500	No discount	$11,500
Hardware + Installation + H/W Maintenance Subtotal					$224,425
SSM-EWB-520-BM1	SANsymphony Network Edition + Network Mirroring Bundle	3	$23,490	25%	$52,853
SSM-EWB-GLD-BM1	SANsymphony Maintenance	3	$4,698	No discount	$14,094
NMV-EWB-520-FS1	Network Managed Volumes (NMV)	3	$4,995	25%	$11,239
NMV-EWB-520-FS1	NMV Maintenance	3	$999	No discount	$2,997
Software + Software Maintenance Subtotal					$81,183
Hardware + Software + Installation + Maintenance					$305,608

Benchmark Configuration/Tested Storage Configuration Diagram

The first figure illustrates the physical connections between the SANsymphony Storage Domain Servers (SDS nodes), the QLogic 2Gbit 16-port FC switches and the 22x10-drive 1Gbit JBODs and benchmark load generators.
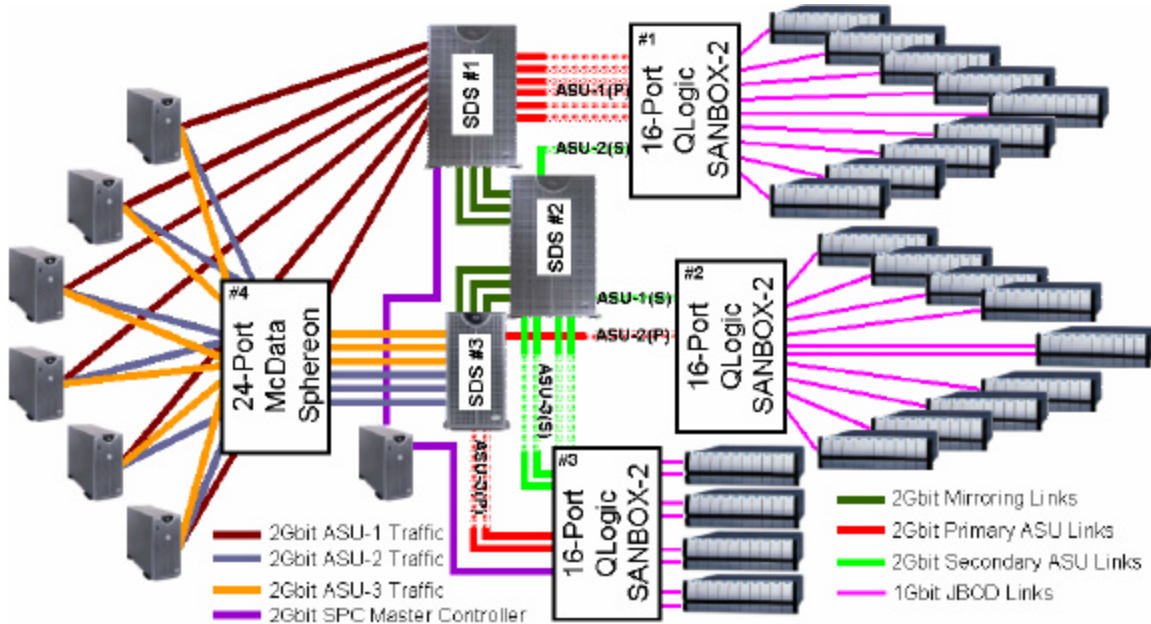

Tested Storage Configuration (physical)

It's easier to explain all the connections by looking at the configuration in two halves:

1. The front-end connections between the six slave Host Systems, the single master Host System and the SANsymphony nodes; SDS#1 and SDS#3.

2. The back-end connections between physical storage and the three SDS nodes.

The next figure shows the logical connections for the front-end configuration:
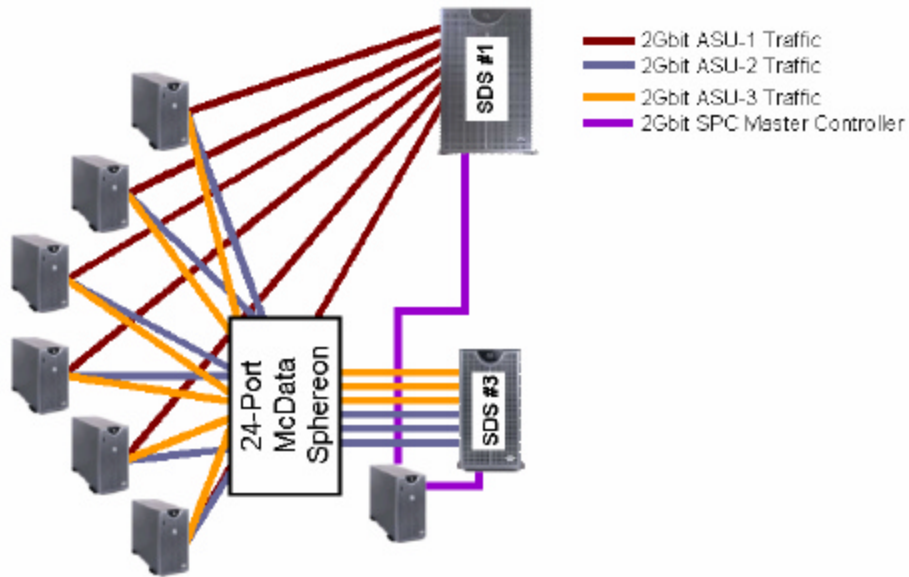
Front-end (Logical)

The configuration consists of:

1. Six slave Host Systems running the SPC-1 Workload Generator. Each slave Host System has three connections, one connection direct to SDS#1 for ASU-1 traffic, and two connections to the switch for ASU-2 and ASU-3 traffic.

2. One Host System runs the SPC-1 load generator as the "master" and doesn't actually generate any work, but it does need to see the ASU-1, ASU-2 and ASU-3 devices presented by SDS#1 and SDS#3. In the diagram it's shown as directly connected to both SDS#1 and SDS#3. Physically, the SDS#3 connection was via one of the 16-port switches used in the back-end.

3. SDS #1 has six point-to-point connections with the hosts and carries all the ASU-1 traffic.

4. SDS#3 has six connections to the switch; three of the connections carried ASU-2 traffic, while the other three connections carried ASU-3 traffic.

For the sake of simplicity, SDS #2 is not shown on the front-end diagram because it only provides mirror targets for SDS #1 and SDS #3 so has no direct connections to the hosts.

The second figure illustrates the back-end configuration (i.e. the collection of hardware that corresponds to a conventional storage array.)
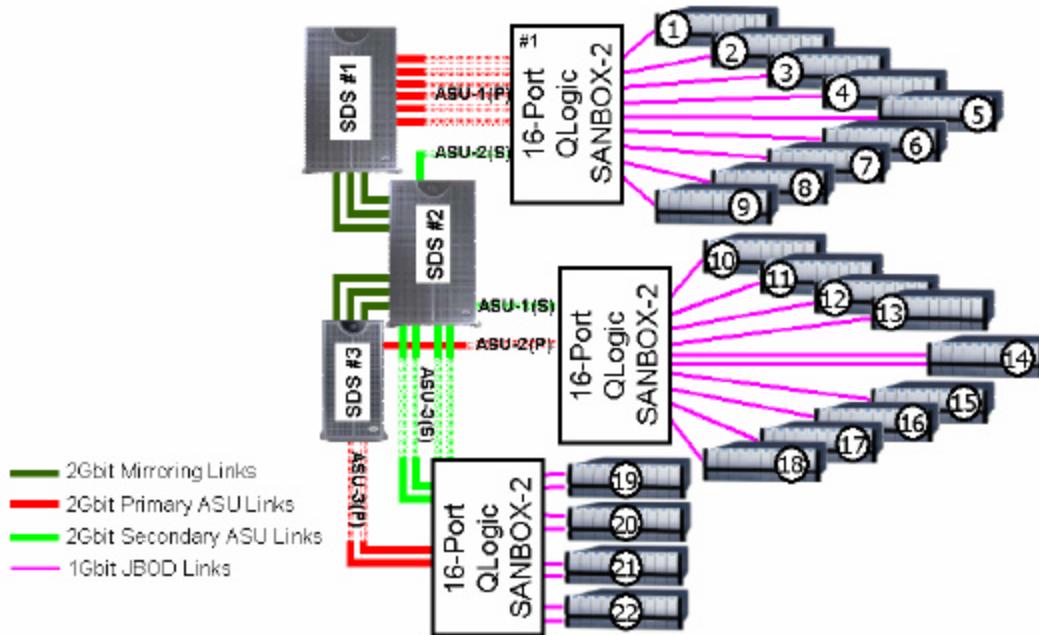
Back-end Configuration

The drives are housed in standard 10-drive enclosures featuring a dual 1Gbit Fibre loop. Of the 22 enclosures in the configuration only enclosures 14,19,20,21 and 22 are dual connected with five drives on each loop. The other 17 enclosures each have 10 drives on a single loop.

The following table illustrates the assignment of drives and enclosures to the SDS nodes.

	SDS#1	SDS#2	SDS#3
Enclosures 1-9	Shared	Shared	No access
Enclosures 10-13	No Access	No Access	Assigned
Drives 1-5 Enclosure 14	No Access	No Access	Assigned
Drives 6-10 Enclosure 14	No Access	Assigned	No Access
Enclosures 15-18	No Access	Assigned	No Access
Enclosures 19-20	No Access	Assigned	No Access
Enclosures 21-22	No Access	No Access	Assigned

The physical storage used in the benchmark was configured using SANsymphony Network Managed Volumes. The process is effectively a two-step process. First, physical resources (i.e. disks) are assigned to resource pools, and second, logical volumes are created from the resource pools. The following table illustrates the mappings:

Resource Pool	Physical mapping	Logical volumes
Network Volume Pool #1	90x 18.3GB Drives	ASU-1 ASU-2 (User Data Copy)
Network Volume Pool #2	45x 18.3GB Drives	ASU-2
Network Volume Pool #3	45x 18.3GB Drives	ASU-1 (User Data Copy)
Network Volume Pool #4	20x 18.3GB Drives	ASU-3
Network Volume Pool #5	20x 18.3GB Drives	ASU-3 (User Data Copy)

The next figure illustrates the way in which the physical drives are distributed and used for the various ASU volumes.
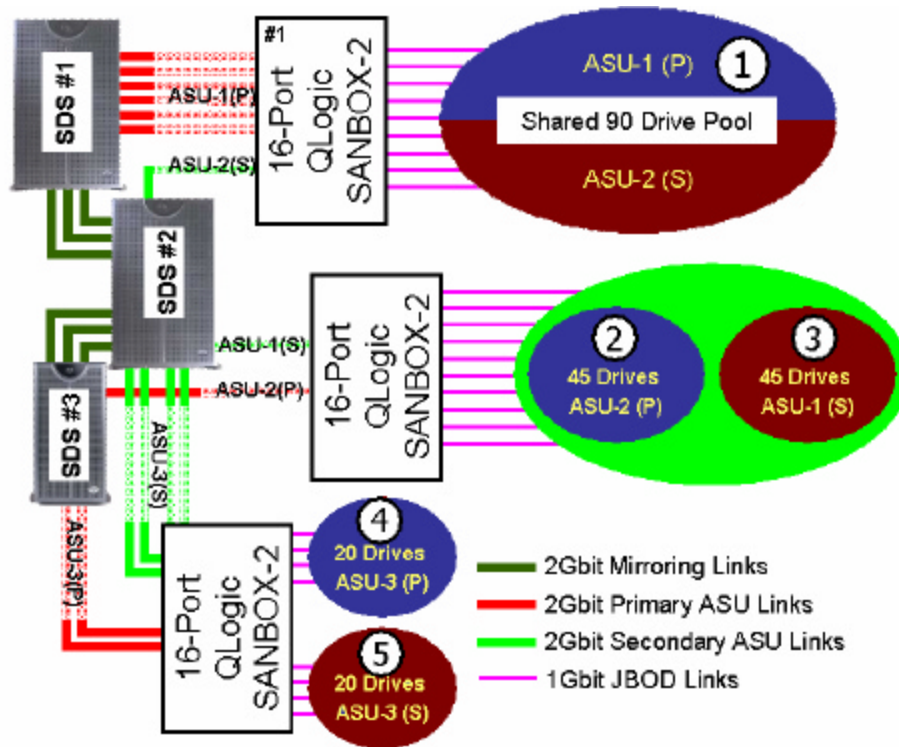
Storage Pool Configuration (logical)

The 220 drives used in the benchmark were split into five logical pools serving the primary and secondary ASU LUNs. The drives are allocated to Network Managed Volume (NMV) pools as follows:

1. Pool 1: Consists of 90 drives taken from 9x10-drive JBODs attached to switch #1. SDS #1 and SDS #2 share this pool. Using NMVs, ASU-1(P) and ASU-2(S) are striped across all 90 drives in 1MB chunks.

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2. Pool 2: 45 drives taken from 4x10-drive JBODs and half of a fifth JBOD attached to switch #2. This pool is allocated exclusively to SDS#3 and contains the primary copy of ASU-2.

3. Pool 3: 45 drives taken from 4x10-drive JBODs and half of a fifth JBOD attached to switch #2. This pool is allocated exclusively to SDS#2 and contains the mirror of ASU-1.

4. Pool 4: 20 drives taken from dual-attached 2x10-drive JBODs attached to switch #3. This pool is allocated exclusively to SDS#3 and contains the primary copy of ASU-3.

5. Pool 5: Consists of 20 drives taken from dual-attached 2x10-drive JBODs attached to switch #3. This pool is allocated exclusively to SDS#2 and contains the mirror of ASU-3.

The ASU volumes are assigned as follows:

	SDS #1	SDS #2	SDS #3
ASU #1	Primary	Mirror	
ASU #2		Mirror	Primary
ASU #3		Mirror	Primary

Hardware Configuration Details

As seen in the previous diagrams, DataCore used three off-the-shelf Intel-based servers as Storage Domain Servers. The configurations for the three SDS nodes are as follows:

	SDS #1	SDS #2	SDS #3
Nodename	**Charger**	**Super**	**Executor**
Platform	Dell PowerEdge 4600	Dell PowerEdge 4600	Dell PowerEdge 2600
Processor	2x3.0GHz XEON	2x2.8GHz XEON	2x3.0GHz XEON
System RAM	12GB	6GB	6GB
QLogic 2310 HBA			Two (2x 2Gbit ports)
QLogic 2342 HBA	Four (8x 2Gbit ports)	Four (8x 2Gbit ports)	Three (6x 2Gbit ports)
QLogic 2344 HBA	Two (8x 2Gbit ports)	One (4x 2Gbit ports)	One (4x 2Gbit ports)
Software			
Operating System	Windows Server 2003 Enterprise Edition		
SANsymphony	Network Edition		
Network Mirroring	Yes		
Network Managed Volumes	Yes		

For SDS nodes, the system RAM is equivalent to cache on a conventional array, although some is required for the operating system and SANsymphony leaving approximately 21GB of memory available for caching.

SDS #1 has six 2Gbit connections to the workload generators, all dedicated to ASU-1 traffic as point-to-point links. SDS#3 has 6x2Gbit connections to the switch. Three of those connections carry ASU-2 traffic, while the other three connections carry ASU-3 traffic.

Storage

The storage consists of twenty-two identical 10-drive enclosures manufactured by JMR Corporation. These JBODs only support 1Gbit transfer rates, so all switch-JBOD connections are 1Gbit even though the switches support 2Gbit transfer rates. Each connection from a JBOD to a switch required a copper-Fibre Media Interface Adapter (MIA) for a total of 27 MIAs in the configuration.

Each JBOD is fully populated with Seagate Cheetah X15 15K RPM 18.3GB disk drives (Seagate P/N # ST318453FC.)

Switching Infrastructure

A total of four 2Gbit Fibre Channel switches were used. The three switches on the "back end" of the configuration were identical 16-port Qlogic SANbox-2 devices, while the "front-end" used to connect the host systems to ASU-2 and ASU-3 was a 24-port McData Sphereon 4500 device.

SPC-1 Host Systems

The hardware/software configuration of each of the six Host systems was identical:

Host system	
Platform	Dell PowerEdge 2300
Processor	2x1.2GHz Pentium III
Processor Cache	L1-32KB (16/16 I/D) L2-256KB (unified)
System RAM	1GB
QLogic 2310 HBA	Three (provides 3x2Gbit ports)
Software	
Operating System	Windows Server 2003 Standard Edition
SPC-1 Workload Generator	Version 2.1

Each of the Host systems uses a separate 2Gbit link for traffic to each ASU.

The seventh Host system which acted as the as the master, was identically configured with the exception of the number of QL2310 HBAs. Only two were required; one to access LUNs served by SDS#1 and one to access LUNs served by SDS#3.