SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

DATACORE SOFTWARE CORPORATION
DATACORE SANMELODY™ DISK SERVER *(iSCSI-STD. NIC)*

SPC-1 V1.8

Submitted for Review: November 12, 2004
Submission Identifier: A00036
Accepted: January 11, 2005

First Edition – October 2004

Trademarks

Notes

The following terms, used in this document, are defined as:

- Kilobyte (KB) is equal to 1,000 (10^3) bytes.
- Megabyte (MB) is equal to 1,000,000 (10^6) bytes.
- Gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.
- Terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.

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AUDIT CERTIFICATION

Roni Putra
DataCore Software Corporation
6300 NW 5th Way
Fort Lauderdale, FL 33309

October 26, 2004

The SPC Benchmark 1™ results listed below for the DataCore SANmelody™ Disk Server (iSCSI-Std. NIC) were produced in compliance with the SPC Benchmark 1™ V1.8 Remote Audit requirements.

SPC Benchmark 1™ V1.8 Results	
Tested Storage Configuration (TSC) Name: DataCore SANmelody™ Disk Server (iSCSI-Std. NIC)	
Metric	**Reported Result**
SPC-1 IOPS™	9,298.56
SPC-1 Price-Performance	$4.86/SPC-1 IOPS™
Total ASU Capacity	200 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$45,145.70

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with V1.8 of the SPC Benchmark 1™ specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified using information supplied by DataCore Software Corporation:
  - ✓ Physical Storage Capacity and requirements.
  - ✓ Configured Storage Capacity and requirements.
  - ✓ Addressable Storage Capacity and requirements.
  - ✓ Capacity of each Logical Volume and requirements.
  - ✓ Capacity of each Application Storage Unit (ASU) and requirements.
- An appropriate diagram of the Benchmark Configuration (BC)/Tested Storage Configuration (TSC).
- Listings and commands to configure the Benchmark Configuration/Tested Storage Configuration, including customer tunable parameters.

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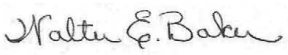
650.556.9384

- Commands and parameters used to configure the SPC-1 Workload Generator.
- The following Host System requirements were reviewed using documentation supplied by DataCore Software Corporation:
  - ✓ The type of Host System including the number of processors and main memory.
  - ✓ The presence and version number of the Workload Generator on the Host System.
  - ✓ The TSC boundary within the Host System.
- The Test Results Files and resultant Summary Results Files received from DataCore Software Corporation for each of following were authentic, accurate, and compliant with all of the requirements and constraints of Clauses 4 and 5 of the SPC-1 Benchmark Specification:
  - ✓ Data Persistence Test
  - ✓ Sustainability Test Phase
  - ✓ IOPS Test Phase
  - ✓ Response Time Ramp Test Phase
  - ✓ Repeatability Test
- There were no differences between the Tested Storage Configuration (TSC) used for the benchmark and Priced Storage Configuration.
- The final version of the pricing spreadsheet met all of the requirements and constraints of Clause 8 of the SPC-1 Benchmark Specification.
- The Full Disclosure Report (FDR) met all of the requirements in Clause 9 of the SPC-1 Benchmark Specification.

Audit Notes:

There were no additional audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

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LETTER OF GOOD FAITH

DataCore™ SOFTWARE

Date: August 19, 2004

From: Ziya Aral, Chief Technology Officer, DataCore Software

To: Walter Baker, SPC Auditor, Gradient Systems

Subject: SPC-1 Letter of Good Faith for the SANmelody iSCSI SPC-1™ configuration

DataCore Software is the SPC-1 Test Sponsor for the above listed product. To the best of our knowledge and belief, the required SPC-1 benchmark results and materials we have submitted for that product are complete, accurate, and in full compliance with V1.8 of the SPC-1 benchmark specification.

In addition, we have reported any items in the Benchmark Configuration and execution of the benchmark that affected the reported results even if the items are not explicitly required to be disclosed by the SPC-1 benchmark specification.

Signed: Date: August 19, 2004

Ziya Aral,
Chief Technology Officer,
DataCore Software

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	DataCore Software Corporation – http://www.datacore.com Roni Putra – roni.putra@datacore.com 6300 NW 5th Way Fort Lauderdale, FL 33309 Phone: (954) 377-6000 FAX: (954) 938-7953
Test Sponsor Alternate Contact	DataCore Software Corporation – http://www.datacore.com Dan Keller – dan.keller@datacore.com 6300 NW 5th Way Fort Lauderdale, FL 33309 Phone: (954) 377-6000 FAX: (954) 938-7953
Auditor	Storage Performance Council – http://www.storageperformance.org Walter E. Baker – AuditService@storageperformance.org 643 Bair Island Road, Suite 103 Redwood City, CA 94063 Phone: (650) 556-9384 FAX: (650) 556-9385

Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V1.8
SPC-1 Workload Generator revision number	V2.00.04a
Date Results were first used publicly	November 12, 2004
Date FDR was submitted to the SPC	November 12, 2004
Date the TSC is/was available for shipment to customers	March 8, 2004
Date the TSC completed audit certification	October 26, 2004

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: DataCore SANmelody™ Disk Server *(iSCSI-Std. NIC)*	
Metric	**Reported Result**
SPC-1 IOPS™	9,298.56
SPC-1 Price-Performance	$4.86/SPC-1 IOPS™
Total ASU Capacity	200 GB
Data Protection Level	Mirroring
Total TSC Price (including three-year maintenance)	$45,145.70-

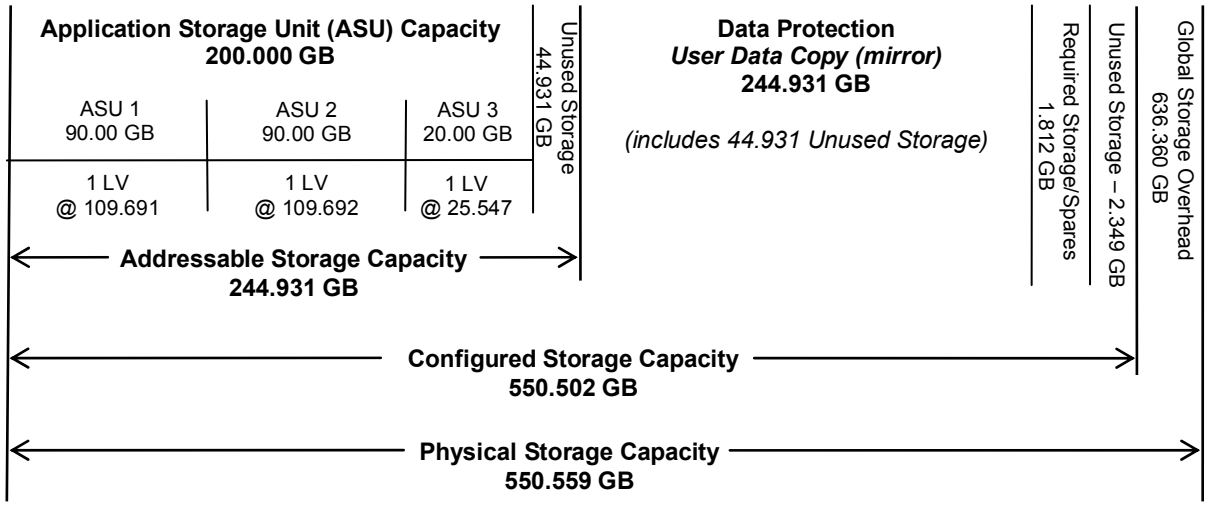
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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

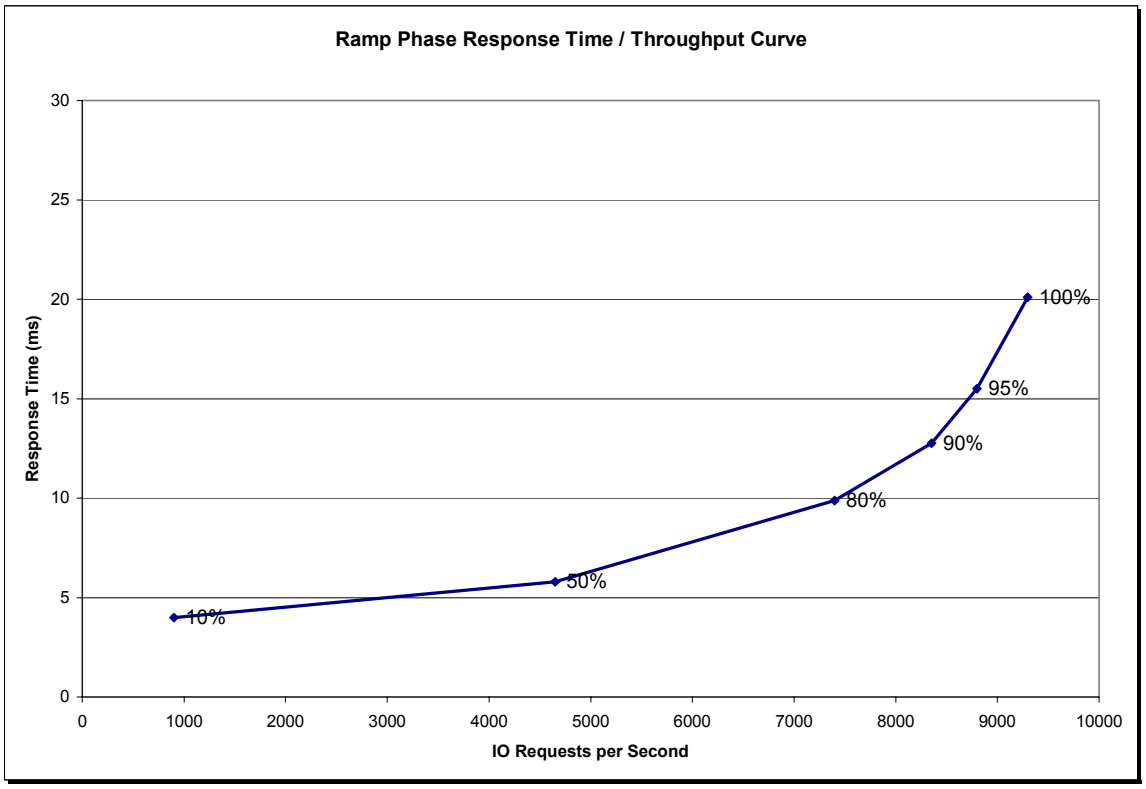
The following diagram documents the various storage capacities, used in this benchmark, and their relationships.



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 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	901.85	4,650.62	7,400.37	8,352.50	8,800.67	9,298.56
Average Response Time (ms):						
All ASUs	3.98	5.78	9.87	12.76	15.51	20.10
ASU-1	5.29	7.52	12.74	16.73	20.78	26.63
ASU-2	2.78	5.81	7.93	9.40	10.05	12.01
ASU-3	1.74	2.08	4.64	5.82	6.73	9.81
Reads	6.41	10.97	19.00	24.71	30.76	38.14
Writes	2.40	2.41	3.92	4.99	5.58	8.35

Tested Storage Configuration Pricing *(Priced Storage Configuration)*

ITEM	SOFTWARE	Qty	Unit Price	Extended Price
MDB-EWR-140-BSV	**DataCore SANmelody™** Category D - Base Software	1	$7,857.00	$7,857.00
MDP-EWR-140-FSV	**DataCore SANmelody Auto Provisioning Option** for Category D	1	$3,928.00	$3,928.00
S1087526	**Window 2000 Server Edition**	1	$932.95	$932.95
	Software Subtotal			**$12,717.95**
	SERVERS (see 3rd party quotes)	**Qty**	**Unit Price**	**Extended Price**
PowerEdge 2850	Dell PowerEdge 2600 Server, Dual Xeon 2.80GHZ CPU, 1.5GB DDR SDRAM **w/ Windows Server 2003 & 3 year Silver Support 4Hr Onsite** *[Disk Server]*	1	$3,516.00	$3,516.00
	CHANNELS, DISKS & ENCLOSURES (see 3rd party quotes)			
QLA2344-CK	Qlogic Fibre Channel Quad, 4 SFF LC Multimode Optic	1	$3,217.00	$3,217.00
FR10-F22-2S	JMR JBOD 10 Bay, Fibre Channel, black Fortra Rackmountable	3	$2,000.00	$6,000.00
ST318453FC	18.4GB Seagate Fibre Channel Disk, 15k rpm	24	$195.00	$4,680.00
ST336753FCO	36GB Seagate Fibre Channel Disk, 15k rpm	3	$288.00	$864.00
MDB-9-6-1	Fiber Media Interface Adaptor DB-9/SC (MIA Copper to Fiber)	4	$299.00	$1,196.00
N82E16833106202	Intel Pro1000 MT Dual Port Ethernet Adapter	4	$141.00	$564.00
I69-6008	Intel Pro1000 MT Desktop Ethernet Adapter	2	$41.99	$83.98
GCP0888905	Cat5 Ethernet cable, 5 ft.	5	$1.22	$6.10
GCFAZCL	SC:LC Fibre Multimode Duplex Fiber Optic Patch Cables, 5 meters, 62.5uM	4	$29.49	$117.96
	Servers, Channels, Disks & Enclosures Subtotal			**$20,245.04**
SM1-EWV-PLT-PY3	**3- year S/W + H/W Maintenance** (7x24x365 with 4hr response)			**$12,182.71**
	Total TSC Price (Including 3-year maintenance):			**$45,145.70**

The following TSC components were priced using third-party price quotations:

- Dell PowerEdge 2600 Server – SANmelody™ Disk Server system
- Qlogic HBA
- Intel Ethernet adapters
- Disk drives and chassis
- Fiber media interface adapters
- cables

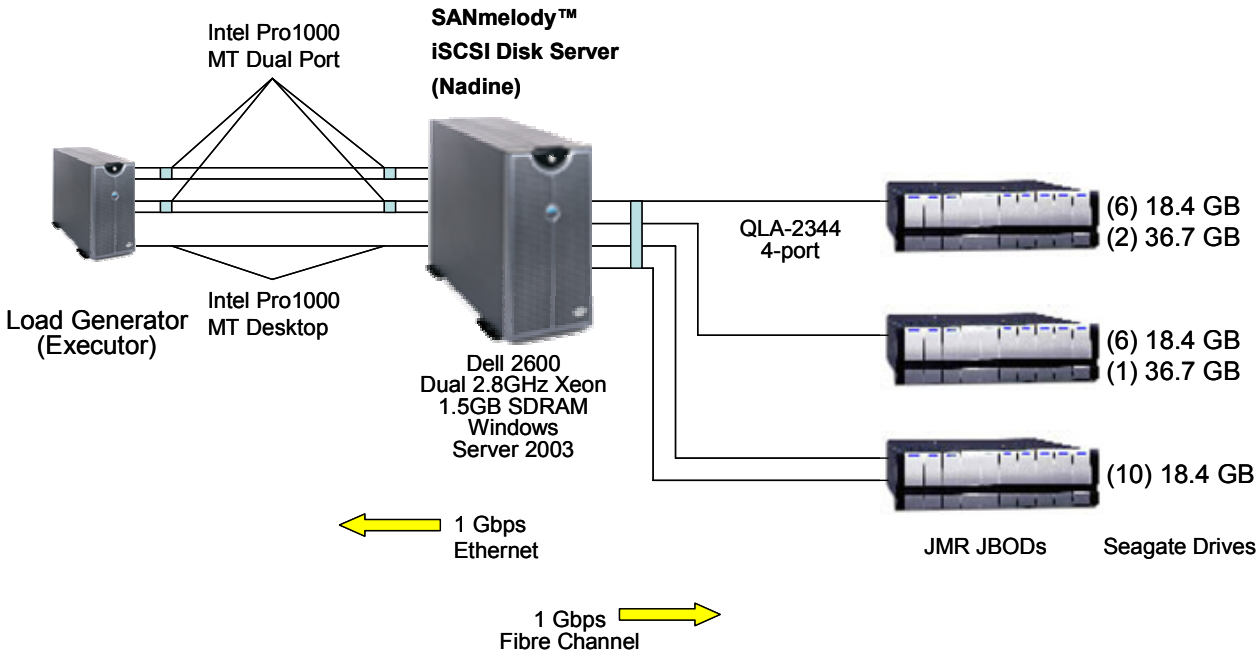
The third-party price quotations may be found in "Appendix D: Third-Party Price Quotations" on page 59.

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

There were no differences between the Tested Storage Configuration and the Priced Storage Configuration.

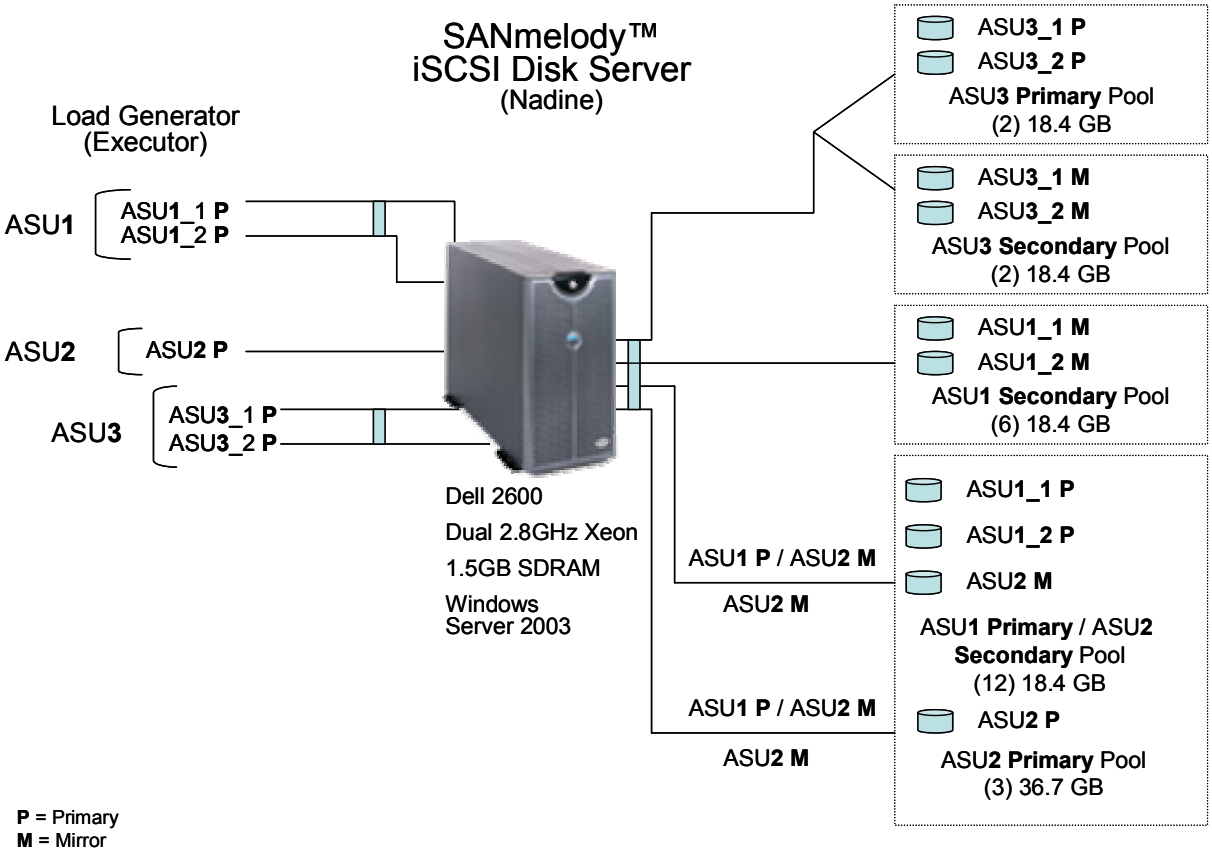
Benchmark Configuration/Tested Storage Configuration Diagram 1

The first Benchmark Configuration (BC)/Tested Storage Configuration (TSC) diagram illustrates the complete configuration.



Benchmark Configuration/Tested Storage Configuration Diagram 2

The second Benchmark Configuration (BC)/Tested Storage Configuration (TSC) diagram illustrates the relationships between the ASUs, Host System, storage pools/disk drives, and data paths.



Benchmark Configuration/Tested Storage Configuration Details

Host System:	Tested Storage Configuration (TSC):
HS-1: *Dell PowerEdge 2600*	***Host System Adapters:*** 1 – Intel Pro1000 MT Desktop Ethernet Adapter 2 – Intel Pro1000 MT Dual Port Ethernet Adapter
2 – Intel 3.0 GHz Xeon CPUs	
512 KB L2 cache per CPU	**SC-1: *DataCore SANmelody™ Disk Server***
1.5 GB main memory	Dell PowerEdge 2850 Server with: 2 – Intel 2.8 GHz Xeon CPUs 512 KB L2 cache per CPU 1.5 GB main memory 1 – QLogic QLA-2344 4-port HBA 1 – Intel Pro1000 MT Desktop Ethernet Adapter 2 – Intel Pro1000 MT Dual Port Ethernet Adapter Microsoft Windows Server™ 2003, Standard Edition
Microsoft Windows Server™ 2003, Standard Edition	
WG	
	5 – 1 Gbps Ethernet front-end ports
	4 – 1 Gbps FC backend ports
	3 – JMR JBOD 10 Bay Enclosures
	24 – 18.4 GB, 15k rpm Seagate disk drives
	3 – 36.7 GB, 15k rpm Seagate disk drives

CONFIGURATION INFORMATION

Benchmark Configuration (BC)/Tested Storage Configuration (TSC) Diagram

Clause 9.2.4.4.1

A one page Benchmark Configuration (BC)/Tested Storage Configuration (TSC) diagram shall be included in the Executive Summary…

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 13 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Storage Network Configuration

Clause 9.2.4.4.2

If a storage network is employed in the BC/TSC, the FDR shall contain a topology diagram… . This diagram should include, but is not limited to the following components:

1. *Storage Controller and Domain Controllers (see Clause 9.2.4.4.1)*
2. *Host Systems (see Clause 9.2.4.4.1)*
3. *Routers and Bridges*
4. *Hubs and Switches*
5. *HBAs to Host Systems and Front End Port to Storage Controllers*

Additionally the diagram shall:

- *Illustrate the physical connection between components.*
- *Describe the type of each physical connection.*
- *Describe the network protocol used over each physical connection.*
- *The maximum theoretical transfer rate of each class of interconnect used in the configuration.*
- *Correlate with the BC Configuration Diagram in Clause 9.2.4.4.1.*

The Test Sponsor shall additionally supply (referenced in an appendix) a wiring diagram of the physical connections and physical port assignments used in the storage network. The diagram should allow anyone to exactly replicate the physical configuration of the storage network.

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) was configured with local storage and, as such, did not employ a storage network.

Host System Configuration

Clause 9.2.4.4.3

The FDR shall minimally contain, for each Host System running the Workload Generator, a listing of the following:

1. *Number and type of CPUs.*
2. *Main memory capacity.*
3. *Cache memory capacity.*
4. *Number and type of disk controllers or Host Bus Adapters.*

The details of the Host System configuration may be found on page 13 *(Benchmark Configuration/Tested Storage Configuration Diagram).*

Customer Tunable Parameters and Options

Clause 9.2.4.5.1

All Benchmark Configuration (BC) components with customer tunable parameter and options that have been altered from their default values must be listed in the FDR. The FDR entry for each of those components must include both the name of the component and the altered value of the parameter or option.

"Appendix A: Customer Tunable Parameters and Options" on page 51 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.2.4.5.2

The FDR must include sufficient information to recreate the logical representation of the TSC. In addition to customer tunable parameters and options (Clause 4.2.4.5.3), that information must include, at a minimum, a diagram and/or description of the following:

- *All physical components that comprise the TSC. Those components are also illustrated in the Benchmark Configuration (BC) diagram in Clause 9.2.4.4.1 and, if applicable, the Storage Network Configuration Diagram in Clause 9.2.4.4.2.*
- *The logical representation of the TSC, configured from the above components that will be presented to the Workload Generator.*

In addition the FDR may include listings of scripts and/or commands used to configure the physical components that comprise the TSC.

"Appendix B: Tested Storage Configuration (TSC) Creation" on page 54 contains the detailed information that describes how to create and configure the logical TSC. Also included in that information is a description of the static physical storage allocation option (auto-provisioning), which was used to ensure all physical storage had been pre-allocated prior to the benchmark measurement and no subsequent physical storage allocation occurred during the benchmark measurement.

SPC-1 Workload Generator Storage Configuration

Clause 9.2.4.5.3

The FDR must include all SPC-1 Workload Generator storage configuration commands and parameters.

The SPC-1 Workload Generator storage configuration commands and parameters for this measurement appear in "Appendix B: " on page 54.

DATA REPOSITORY

Definitions

Total ASU Capacity: The total storage capacity read and written in the course of executing the SPC-1 benchmark.

Application Storage Unit (ASU): The logical interface between the storage and SPC-1 Workload Generator. The three ASUs (Data, User, and Log) are typically implemented on one or more Logical Volume.

Logical Volume: The division of Addressable Storage Capacity into individually addressable logical units of storage used in the SPC-1 benchmark. Each Logical Volume is implemented as a single, contiguous address space.

Addressable Storage Capacity: The total storage (sum of Logical Volumes) that can be read and written by application programs such as the SPC-1 Workload Generator.

Configured Storage Capacity: This capacity includes the Addressable Storage Capacity and any other storage (parity disks, hot spares, etc.) necessary to implement the Addressable Storage Capacity.

Physical Storage Capacity: The formatted capacity of all storage devices physically present in the Tested Storage Configuration (TSC).

Data Protection Overhead: The storage capacity required to implement the ECC data protection.

Required Storage: The amount of Configured Storage Capacity required to implement the Addressable Storage Configuration, excluding the storage required for the three ASUs.

Global Storage Overhead: The amount of Physical Storage Capacity that is required for storage subsystem use and unavailable for use by application programs.

Total Unused Storage: The amount of storage capacity available for use by application programs but not included in the Total ASU Capacity.

Storage Capacities and Relationships

Two tables and an illustration documenting the storage capacities and relationships of the SPC-1 Storage Hierarchy (Clause 2.1) shall be included in the FDR.

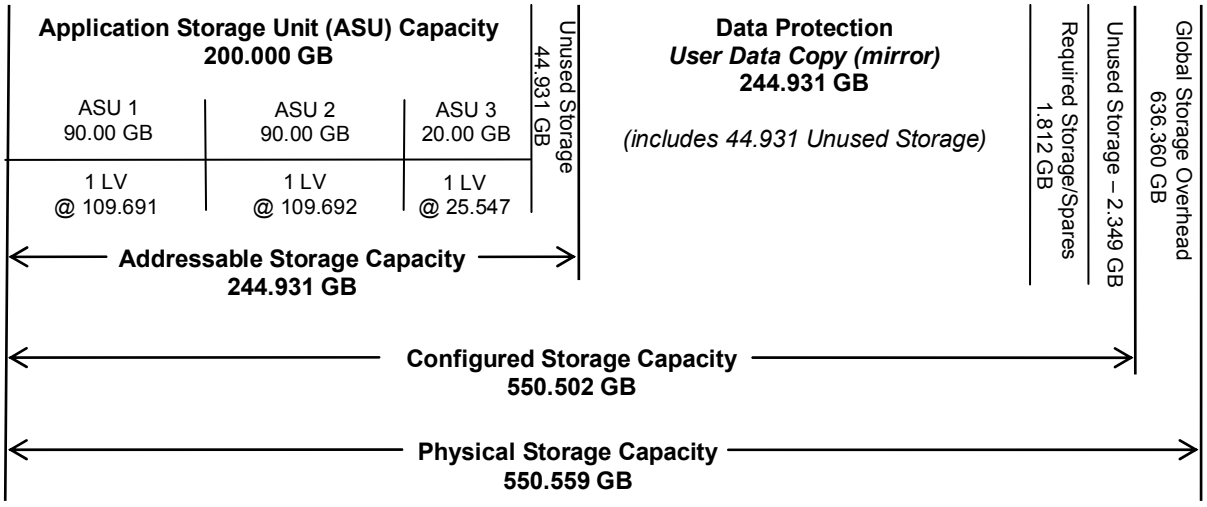
SPC-1 Storage Capacities

SPC-1 Storage Capacities		
Storage Hierarchy Component	**Units**	**Capacity**
Total ASU Capacity	Gigabytes (GB)	200.000
Addressable Storage Capacity	Gigabytes (GB)	244.931
Configured Storage Capacity	Gigabytes (GB)	550.502
Physical Storage Capacity	Gigabytes (GB)	550.559
Data Protection Overhead (mirror)	Gigabytes (GB)	244.931
Required Storage	Gigabytes (GB)	1.811
Global Storage Overhead	Gigabytes (GB)	0.056
Total Unused Storage	Gigabytes (GB)	148.690

The Physical Storage Capacity consisted of 550.559 GB distributed over 24 disk drives each with a formatted capacity of 18.35197 GB and 3 disk drives each with a formatted capacity of 36.70393 GB. There was 0.000 GB (0.00 %) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 0.056 GB (0.01 %) of Physical Storage Capacity. There was 58.828 GB (10.68%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 81.66% of the Addressable Storage Capacity resulting in 44.931 GB (18.34%) of Unused Storage within the Addressable Storage Capacity.

SPC-1 Storage Capacities and Relationships Illustration

The various storage capacities configured in the benchmark result are illustrated below (not to scale).



SPC-1 Storage Hierarchy Ratios

	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	81.66%	36.33%	36.33%
Required for Data Protection (Mirroring)		44.49%	44.49%
Addressable Storage Capacity		44.49%	44.49%
Required Storage		0.33%	0.33%
Configured Storage Capacity			99.99%
Global Storage Overhead			0.01%
Unused Storage	18.33%	10.68%	0.00%

Logical Volume Capacity and ASU Mapping

Clause 9.2.4.6.2

A table illustrating the capacity of each ASU and the mapping of Logical Volumes to ASUs shall be provided in the FDR. Logical Volumes shall be sequenced in the table from top to bottom per its position in the contiguous address space of each ASU. The capacity of each Logical Volume shall be stated. … In conjunction with this table, the Test Sponsor shall provide a complete description of the type of data protection (see Clause 2.4.5) used on each Logical Volume.

Logical Volume Capacity and Mapping		
ASU-1 (90 GB)	**ASU-2 (90 GB)**	**ASU-3 (20 GB)**
1 Logical Volume 109.691GB per Logical Volume (90 GB used/Logical Volume)	1 Logical Volume 109.692 GB per Logical Volume (90 GB used/Logical Volume)	1 Logical Volume 25.547 GB per Logical Volume (20 GB used/Logical Volume)

The Data Protection Level used for all Logical Volumes was Mirroring as described on page 10. See "ASU Configuration" in the **IOPS Test Results File** for more detailed configuration information.

SPC-1 BENCHMARK EXECUTION RESULTS

Definitions

Average Response Time: *The sum of the Response Times for all Measured I/O Requests divided by the total number of Measured I/O Requests.*

I/O Request Throughput: *The total number of Measured I/O requests in an SPC-1 Test Run divided by the duration of the Measurement Interval in seconds.*

Measurement Interval: *The finite and contiguous time period, after the Tested Storage Configuration (TSC) has reached Steady State, when data is collected by a Test Sponsor to generate an SPC-1 test result or support an SPC-1 test result.*

Steady State: *The consistent and sustainable throughput of the TSC. During this period the load presented to the TSC by the Workload Generator is constant. Comment: Steady Stated is achieved only after caches in the TSC have filled and as a result the I/O Request throughput of the TSC has stabilized.*

Test: *A collection of Test Phases or Test Runs sharing a common objective.*

Test Phase: *A collection of one or more SPC-1 Test Runs sharing a common objective and intended to be run in a specific sequence.*

Test Run: *The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up period, Shut-Down period, and Ramp-Down period as illustrated in the Figure 5-1 below. All SPC-1 Test Runs shall have a Steady State period and a Measurement Interval.*

The SPC-1 benchmark consists of the following Tests, Test Phases, and Test Runs:

- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2
- **Primary Metrics Test**
  - Sustainability Test Phase and Test Run
  - IOPS Test Phase and Test Run
  - Response Time Ramp Test Phase
    - 95% of IOPS Test Run
    - 90% of IOPS Test Run
    - 80% of IOPS Test Run
    - 50% of IOPS Test Run
    - 10% of IOPS Test Run (LRT)
- **Repeatability Test**
  - Repeatability Test Phase 1
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run
  - Repeatability Test Phase 2
    - 10% of IOPS Test Run (LRT)
    - IOPS Test Run

Each Test is an atomic unit that must be executed from start to finish before any other Test, Test Phase, or Test Run may be executed. The Tests may be executed in any sequence.

The results from each Test, Test Phase, and Test Run are listed below along with a more detailed explanation of each component.

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.2.1

The Sustainability Test Phase consists of one Test Run at the 100% load point with a Measurement Interval of three (3) hours. The intent is to demonstrate a sustained maximum I/O Request Throughput as well as insuring the Tested Storage Configuration (TSC) has reached steady state prior to measuring the maximum I/O Request Throughput (SPC-1™ IOPS).

The reported I/O Request Throughput of the Sustainability Test Run must be within 5% of the reported SPC-1™ IOPS primary metric. The Average Response Time measured in Sustainability Test Run cannot exceed thirty (30) milliseconds.

Clause 9.2.4.7.1

For the Sustainability Test Phase the FDR shall contain:

1. *A Data Rate Distribution (data table and graph).*
2. *I/O Request Throughput Distribution (data table and graph).*
3. *The human readable Test Run Results File produced by the Workload Generator.*
4. *A listing or screen image of all input parameters supplied to the Workload Generator.*
5. *The Measured Intensity Multiplier for each I/O stream.*
6. *The variability of the Measured Intensity Multiplier, as defined in Clause 5.3.13.3.*

SPC-1 Workload Generator Input Parameters

The following SPC-1 Workload Generator input parameters were used for the Sustainability, IOPS, and Response Time Ramp Test Runs :

java metrics –b 186 –t 10980 –r 780

The last 180 seconds of the specified 10,980 seconds were deleted resulting in a reported 10,800 second Measurement Interval for the Sustainability Test Run.

Sustainability Test Results File

A link to the test results file generated from the Sustainability Test Run is listed below.

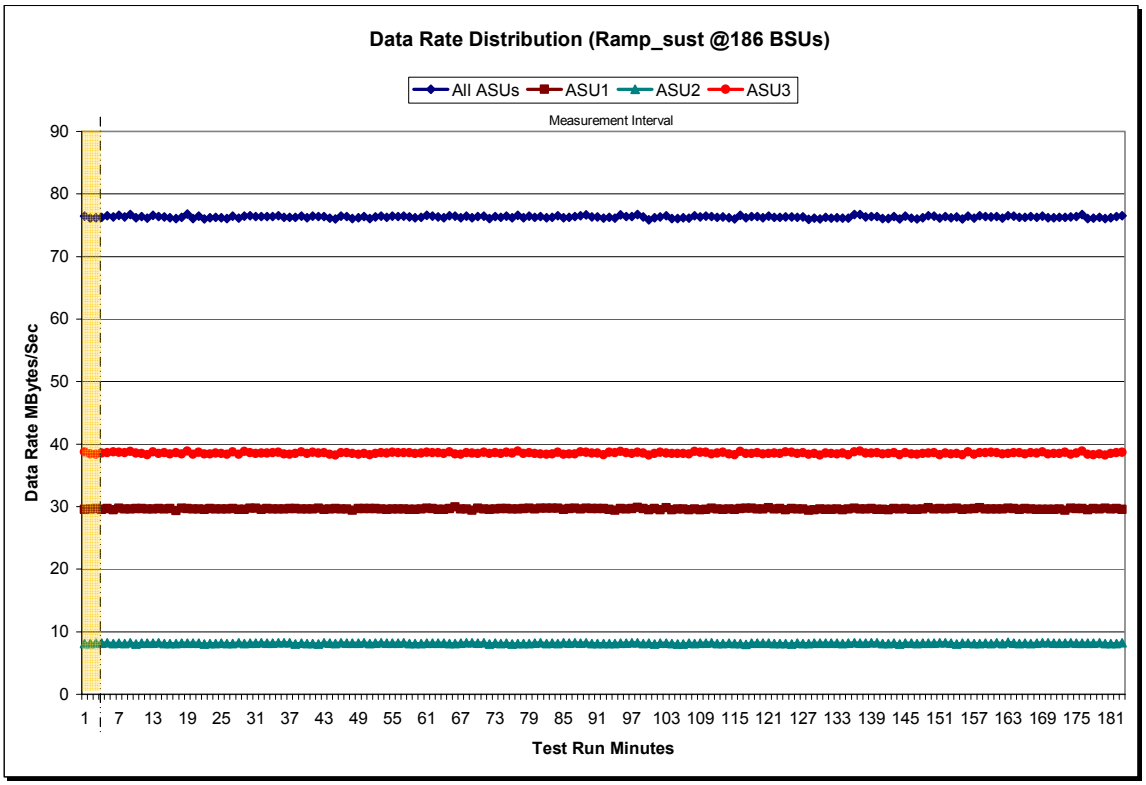
Sustainability Test Results File

Sustainability – Data Rate Distribution Data *(MB/second)*

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	10:07:20	10:10:20	0-2	0:03:00
Measurement Interval	10:10:20	13:10:20	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	76.45	29.55	8.12	38.77	63	76.22	29.55	8.19	38.48	126	76.32	29.62	8.09	38.60
1	76.13	29.58	8.11	38.43	64	76.55	29.69	8.09	38.77	127	75.94	29.44	8.12	38.37
2	76.17	29.68	8.15	38.34	65	76.48	29.90	8.13	38.45	128	76.13	29.49	8.16	38.48
3	76.28	29.57	8.15	38.56	66	76.18	29.64	8.17	38.37	129	75.99	29.61	8.14	38.24
4	76.54	29.69	8.25	38.60	67	76.46	29.62	8.21	38.63	130	76.29	29.58	8.16	38.55
5	76.33	29.50	8.09	38.73	68	76.21	29.44	8.21	38.57	131	76.16	29.52	8.14	38.49
6	76.56	29.74	8.14	38.68	69	76.40	29.76	8.17	38.47	132	76.18	29.59	8.16	38.43
7	76.32	29.62	8.10	38.59	70	76.47	29.62	8.20	38.65	133	76.13	29.46	8.10	38.57
8	76.69	29.61	8.26	38.82	71	76.06	29.52	8.05	38.50	134	76.12	29.62	8.18	38.31
9	76.22	29.66	8.02	38.54	72	76.39	29.60	8.19	38.60	135	76.70	29.73	8.25	38.72
10	76.38	29.68	8.19	38.51	73	76.29	29.68	8.13	38.48	136	76.68	29.63	8.20	38.86
11	76.10	29.61	8.18	38.31	74	76.46	29.65	8.15	38.66	137	76.34	29.62	8.19	38.53
12	76.56	29.62	8.20	38.74	75	76.21	29.61	8.06	38.54	138	76.40	29.65	8.21	38.54
13	76.39	29.67	8.26	38.47	76	76.56	29.60	8.10	38.85	139	76.41	29.56	8.21	38.65
14	76.34	29.62	8.11	38.61	77	76.23	29.67	8.09	38.47	140	76.10	29.55	8.11	38.44
15	76.20	29.65	8.13	38.42	78	76.48	29.77	8.09	38.62	141	76.05	29.48	8.10	38.47
16	76.08	29.37	8.09	38.63	79	76.24	29.62	8.14	38.48	142	76.42	29.67	8.16	38.59
17	76.29	29.72	8.17	38.41	80	76.40	29.73	8.23	38.43	143	76.01	29.64	8.06	38.32
18	76.75	29.71	8.18	38.87	81	76.18	29.71	8.11	38.36	144	76.43	29.67	8.14	38.62
19	76.09	29.60	8.15	38.34	82	76.29	29.74	8.16	38.39	145	76.15	29.54	8.16	38.45
20	76.44	29.59	8.19	38.66	83	76.54	29.71	8.11	38.71	146	76.01	29.57	8.09	38.35
21	75.99	29.56	8.03	38.40	84	76.19	29.57	8.23	38.39	147	76.22	29.59	8.16	38.47
22	76.18	29.66	8.10	38.42	85	76.26	29.68	8.18	38.39	148	76.53	29.80	8.17	38.56
23	76.28	29.63	8.12	38.53	86	76.41	29.74	8.22	38.46	149	76.43	29.60	8.19	38.65
24	76.22	29.62	8.15	38.46	87	76.55	29.63	8.18	38.74	150	76.16	29.69	8.21	38.27
25	76.08	29.62	8.13	38.33	88	76.68	29.76	8.22	38.70	151	76.38	29.61	8.24	38.54
26	76.49	29.66	8.10	38.72	89	76.31	29.65	8.08	38.58	152	76.21	29.66	8.15	38.40
27	76.15	29.56	8.22	38.36	90	76.34	29.67	8.13	38.55	153	76.30	29.75	8.06	38.48
28	76.45	29.54	8.10	38.81	91	76.13	29.70	8.11	38.32	154	76.02	29.57	8.13	38.32
29	76.54	29.74	8.17	38.63	92	76.29	29.52	8.10	38.67	155	76.48	29.60	8.15	38.73
30	76.40	29.74	8.16	38.51	93	76.12	29.43	8.08	38.62	156	76.12	29.65	8.10	38.37
31	76.36	29.57	8.22	38.58	94	76.68	29.68	8.16	38.84	157	76.51	29.82	8.10	38.59
32	76.39	29.68	8.14	38.57	95	76.42	29.62	8.16	38.64	158	76.40	29.63	8.18	38.59
33	76.37	29.62	8.17	38.59	96	76.40	29.71	8.23	38.46	159	76.34	29.61	8.08	38.65
34	76.51	29.63	8.21	38.67	97	76.70	29.84	8.21	38.65	160	76.42	29.62	8.20	38.60
35	76.26	29.60	8.25	38.41	98	76.35	29.69	8.12	38.54	161	76.16	29.63	8.09	38.44
36	76.29	29.71	8.20	38.38	99	75.89	29.49	8.15	38.25	162	76.54	29.77	8.29	38.48
37	76.24	29.68	8.06	38.49	100	76.20	29.69	8.01	38.50	163	76.46	29.68	8.19	38.59
38	76.47	29.58	8.13	38.76	101	76.30	29.49	8.15	38.67	164	76.29	29.56	8.09	38.64
39	76.22	29.58	8.11	38.52	102	76.50	29.79	8.18	38.53	165	76.28	29.68	8.16	38.45
40	76.43	29.62	8.10	38.71	103	76.06	29.48	8.10	38.48	166	76.38	29.61	8.13	38.65
41	76.39	29.76	8.06	38.57	104	76.10	29.60	8.03	38.47	167	76.26	29.58	8.15	38.54
42	76.39	29.56	8.24	38.59	105	76.17	29.64	8.04	38.48	168	76.48	29.53	8.21	38.74
43	76.14	29.61	8.15	38.38	106	76.12	29.51	8.19	38.43	169	76.21	29.55	8.21	38.45
44	76.03	29.66	8.11	38.25	107	76.54	29.63	8.12	38.78	170	76.20	29.58	8.15	38.47
45	76.45	29.62	8.23	38.59	108	76.32	29.47	8.17	38.69	171	76.27	29.64	8.14	38.49
46	76.38	29.61	8.14	38.62	109	76.43	29.58	8.18	38.68	172	76.27	29.43	8.18	38.66
47	76.06	29.42	8.14	38.49	110	76.36	29.76	8.20	38.40	173	76.31	29.75	8.20	38.35
48	76.21	29.70	8.15	38.36	111	76.29	29.63	8.09	38.57	174	76.37	29.71	8.13	38.53
49	76.37	29.70	8.20	38.47	112	76.34	29.53	8.10	38.71	175	76.72	29.66	8.17	38.90
50	76.04	29.68	8.08	38.28	113	76.20	29.62	8.15	38.43	176	76.06	29.51	8.18	38.37
51	76.32	29.65	8.20	38.47	114	76.02	29.57	8.13	38.33	177	76.11	29.68	8.13	38.30
52	76.43	29.61	8.23	38.59	115	76.60	29.67	8.11	38.83	178	76.25	29.58	8.22	38.45
53	76.24	29.54	8.15	38.55	116	76.22	29.74	8.00	38.48	179	76.06	29.71	8.10	38.24
54	76.45	29.61	8.15	38.69	117	76.37	29.75	8.15	38.47	180	76.21	29.63	8.07	38.51
55	76.41	29.60	8.19	38.63	118	76.41	29.60	8.18	38.62	181	76.40	29.70	8.10	38.60
56	76.44	29.61	8.22	38.60	119	76.18	29.64	8.15	38.40	182	76.50	29.55	8.23	38.71
57	76.34	29.58	8.12	38.64	120	76.43	29.78	8.18	38.47					
58	76.17	29.56	8.13	38.49	121	76.24	29.60	8.08	38.56					
59	76.28	29.62	8.11	38.56	122	76.28	29.69	8.09	38.50					
60	76.59	29.75	8.16	38.68	123	76.31	29.46	8.10	38.75					
61	76.46	29.70	8.14	38.62	124	76.34	29.65	8.01	38.67					
62	76.33	29.54	8.15	38.64	125	76.26	29.61	8.18	38.48					

Sustainability – Data Rate Distribution Graph

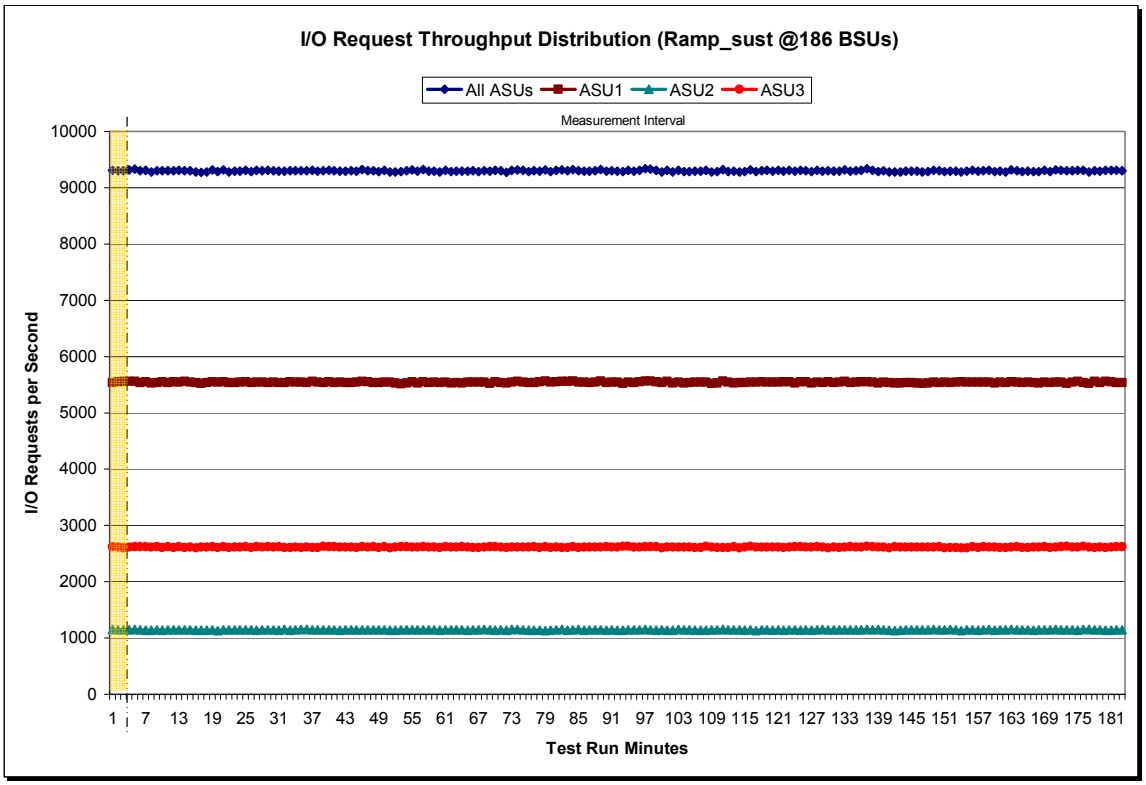


Sustainability – I/O Request Throughput Distribution Data

	Start	Stop	Interval	Duration
Ramp-Up/Start-Up	10:07:20	10:10:20	0-2	0:03:00
Measurement Interval	10:10:20	13:10:20	3-182	3:00:00

Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3	Interval	All ASUs	ASU1	ASU2	ASU3
0	9,305.27	5,538.38	1,149.20	2,617.68	63	9,295.48	5,530.63	1,144.78	2,620.07	126	9,285.85	5,529.97	1,141.10	2,614.78
1	9,303.57	5,547.60	1,144.83	2,611.13	64	9,295.75	5,542.40	1,140.42	2,612.93	127	9,309.70	5,541.88	1,145.93	2,621.88
2	9,300.47	5,556.93	1,143.45	2,600.08	65	9,301.75	5,546.38	1,145.88	2,609.48	128	9,296.83	5,536.28	1,150.28	2,610.27
3	9,315.48	5,555.53	1,146.98	2,612.97	66	9,285.57	5,540.48	1,141.45	2,603.63	129	9,298.68	5,550.27	1,146.65	2,601.77
4	9,332.70	5,557.23	1,154.50	2,620.97	67	9,301.37	5,541.23	1,148.88	2,611.25	130	9,294.07	5,537.90	1,144.55	2,611.62
5	9,302.80	5,535.80	1,147.03	2,619.97	68	9,294.77	5,524.17	1,147.02	2,623.58	131	9,296.58	5,546.03	1,142.25	2,608.30
6	9,307.05	5,550.05	1,136.28	2,620.72	69	9,311.97	5,551.48	1,140.50	2,619.98	132	9,314.73	5,560.10	1,143.55	2,611.08
7	9,281.68	5,528.90	1,138.88	2,613.90	70	9,303.87	5,539.07	1,148.20	2,616.60	133	9,296.93	5,533.77	1,142.87	2,620.30
8	9,304.57	5,534.25	1,147.40	2,622.92	71	9,275.72	5,530.22	1,138.07	2,607.43	134	9,302.33	5,540.98	1,147.17	2,614.18
9	9,300.15	5,553.40	1,139.77	2,606.98	72	9,309.75	5,541.92	1,152.85	2,614.98	135	9,311.62	5,552.67	1,143.43	2,615.52
10	9,298.22	5,533.82	1,147.30	2,617.10	73	9,317.83	5,556.73	1,148.80	2,612.30	136	9,337.22	5,554.13	1,155.03	2,628.05
11	9,302.78	5,549.60	1,146.97	2,606.22	74	9,307.37	5,545.25	1,147.60	2,614.52	137	9,307.05	5,543.87	1,144.65	2,618.53
12	9,312.22	5,546.70	1,144.15	2,621.37	75	9,285.53	5,534.88	1,139.30	2,611.35	138	9,290.40	5,529.17	1,150.95	2,610.28
13	9,304.85	5,556.67	1,145.18	2,603.00	76	9,298.08	5,535.07	1,140.30	2,622.72	139	9,303.62	5,545.88	1,147.15	2,610.58
14	9,300.95	5,541.53	1,144.95	2,614.47	77	9,291.43	5,548.98	1,138.27	2,604.18	140	9,277.67	5,535.77	1,140.92	2,600.98
15	9,280.05	5,538.75	1,140.85	2,600.45	78	9,314.63	5,563.38	1,131.80	2,619.45	141	9,277.35	5,527.17	1,130.97	2,619.22
16	9,275.57	5,525.03	1,137.42	2,613.12	79	9,284.37	5,540.88	1,134.97	2,608.52	142	9,281.85	5,530.18	1,140.32	2,611.35
17	9,281.32	5,533.02	1,137.37	2,610.93	80	9,307.55	5,548.65	1,148.02	2,610.88	143	9,292.82	5,536.45	1,144.28	2,612.08
18	9,318.23	5,549.10	1,148.15	2,620.98	81	9,315.13	5,557.13	1,148.32	2,609.68	144	9,295.55	5,538.55	1,142.97	2,614.03
19	9,284.53	5,546.63	1,131.78	2,606.12	82	9,301.52	5,555.28	1,140.55	2,605.68	145	9,291.13	5,531.35	1,148.17	2,611.62
20	9,314.92	5,547.50	1,145.83	2,621.58	83	9,324.35	5,561.63	1,142.67	2,620.05	146	9,278.62	5,520.03	1,143.87	2,614.72
21	9,283.63	5,533.25	1,145.00	2,605.38	84	9,298.43	5,541.22	1,148.62	2,608.60	147	9,284.13	5,531.70	1,142.60	2,609.83
22	9,294.78	5,537.83	1,143.83	2,613.12	85	9,296.58	5,546.62	1,138.63	2,611.33	148	9,307.97	5,545.48	1,149.65	2,612.83
23	9,297.60	5,545.30	1,141.75	2,610.55	86	9,296.95	5,538.38	1,147.03	2,611.53	149	9,302.73	5,538.55	1,144.32	2,619.87
24	9,310.65	5,548.02	1,142.15	2,620.48	87	9,302.00	5,541.25	1,145.37	2,615.38	150	9,288.05	5,544.28	1,147.52	2,596.25
25	9,285.02	5,536.95	1,141.60	2,606.47	88	9,323.18	5,562.68	1,147.23	2,613.27	151	9,292.43	5,538.42	1,148.93	2,605.08
26	9,305.27	5,543.25	1,139.68	2,622.33	89	9,292.90	5,534.90	1,140.15	2,617.85	152	9,297.15	5,545.12	1,145.48	2,606.55
27	9,302.18	5,544.57	1,142.95	2,614.67	90	9,303.72	5,546.97	1,141.15	2,615.60	153	9,281.40	5,547.90	1,132.53	2,600.97
28	9,308.23	5,539.95	1,146.95	2,621.33	91	9,295.30	5,546.12	1,136.95	2,612.23	154	9,290.92	5,543.68	1,147.95	2,599.28
29	9,300.37	5,546.07	1,141.95	2,612.35	92	9,286.15	5,524.25	1,137.63	2,624.27	155	9,312.00	5,543.43	1,147.45	2,621.12
30	9,295.90	5,538.43	1,140.27	2,617.20	93	9,308.85	5,542.43	1,141.77	2,624.65	156	9,290.93	5,547.02	1,137.15	2,606.77
31	9,291.92	5,535.30	1,149.38	2,607.23	94	9,296.08	5,536.43	1,143.35	2,616.30	157	9,304.33	5,543.12	1,143.53	2,617.68
32	9,298.93	5,550.07	1,140.48	2,608.38	95	9,306.52	5,548.37	1,143.55	2,614.60	158	9,311.83	5,543.35	1,152.45	2,616.03
33	9,300.92	5,540.42	1,146.10	2,614.40	96	9,335.65	5,565.62	1,151.45	2,618.58	159	9,284.68	5,530.78	1,137.55	2,616.35
34	9,303.72	5,546.93	1,148.97	2,607.82	97	9,327.97	5,561.93	1,144.78	2,621.25	160	9,296.00	5,542.53	1,144.52	2,608.95
35	9,303.18	5,536.68	1,154.00	2,612.50	98	9,306.27	5,550.57	1,137.85	2,617.85	161	9,282.20	5,533.90	1,141.90	2,606.40
36	9,309.65	5,558.17	1,147.48	2,604.00	99	9,279.95	5,535.23	1,147.83	2,596.88	162	9,319.48	5,551.60	1,155.07	2,612.82
37	9,295.57	5,544.37	1,143.35	2,607.85	100	9,310.12	5,556.28	1,139.48	2,614.35	163	9,304.73	5,543.37	1,142.78	2,618.58
38	9,303.35	5,533.93	1,142.40	2,627.02	101	9,283.03	5,530.67	1,137.28	2,615.08	164	9,287.97	5,539.22	1,143.68	2,605.07
39	9,309.47	5,548.27	1,144.20	2,617.00	102	9,308.07	5,544.93	1,150.72	2,612.42	165	9,294.05	5,541.53	1,143.58	2,608.93
40	9,304.15	5,539.83	1,144.53	2,619.78	103	9,285.03	5,530.80	1,142.28	2,611.95	166	9,287.85	5,533.73	1,140.47	2,613.65
41	9,297.60	5,543.65	1,141.08	2,612.87	104	9,288.02	5,533.45	1,142.57	2,612.00	167	9,286.65	5,531.93	1,144.13	2,610.58
42	9,292.97	5,532.77	1,146.78	2,613.42	105	9,292.07	5,547.13	1,137.17	2,607.77	168	9,308.85	5,541.63	1,145.57	2,621.65
43	9,299.17	5,538.20	1,147.18	2,613.78	106	9,291.28	5,540.65	1,140.85	2,609.78	169	9,288.60	5,534.12	1,144.72	2,609.77
44	9,296.05	5,546.13	1,144.88	2,605.03	107	9,310.07	5,544.82	1,139.02	2,626.23	170	9,312.98	5,545.28	1,153.85	2,613.85
45	9,321.38	5,558.23	1,144.32	2,618.83	108	9,282.47	5,520.18	1,147.47	2,614.82	171	9,305.73	5,544.68	1,142.83	2,618.22
46	9,303.82	5,548.73	1,144.62	2,610.47	109	9,288.38	5,530.58	1,148.25	2,609.55	172	9,299.90	5,524.50	1,147.07	2,628.33
47	9,298.92	5,539.68	1,142.03	2,617.20	110	9,322.33	5,564.45	1,150.80	2,607.08	173	9,301.97	5,544.32	1,145.90	2,611.75
48	9,289.68	5,538.17	1,144.75	2,606.77	111	9,290.18	5,544.17	1,141.25	2,604.77	174	9,305.37	5,556.70	1,138.18	2,610.48
49	9,312.02	5,546.73	1,147.05	2,618.23	112	9,296.60	5,530.73	1,143.38	2,622.48	175	9,306.92	5,532.90	1,148.93	2,625.08
50	9,281.72	5,545.37	1,135.37	2,600.98	113	9,281.15	5,532.92	1,146.65	2,601.58	176	9,280.67	5,521.08	1,148.75	2,610.83
51	9,279.17	5,528.48	1,138.53	2,612.15	114	9,289.50	5,537.13	1,139.57	2,612.80	177	9,304.97	5,554.62	1,147.55	2,602.80
52	9,287.02	5,517.73	1,146.08	2,623.20	115	9,316.78	5,544.80	1,145.97	2,626.02	178	9,295.73	5,538.78	1,146.80	2,610.15
53	9,299.10	5,530.90	1,146.15	2,622.05	116	9,287.35	5,539.98	1,133.63	2,613.73	179	9,307.05	5,561.42	1,137.32	2,608.32
54	9,315.93	5,552.17	1,146.80	2,616.97	117	9,303.58	5,547.43	1,143.00	2,613.15	180	9,308.10	5,552.85	1,139.00	2,616.25
55	9,295.18	5,531.43	1,146.80	2,616.95	118	9,308.38	5,546.83	1,144.70	2,616.85	181	9,307.10	5,539.10	1,145.12	2,622.88
56	9,320.13	5,552.88	1,146.87	2,620.38	119	9,297.93	5,541.98	1,139.42	2,616.53	182	9,303.33	5,537.70	1,146.83	2,618.80
57	9,297.25	5,539.88	1,141.58	2,615.78	120	9,305.62	5,545.93	1,146.30	2,613.38	Average	9,299.43	5,542.01	1,143.85	2,613.58
58	9,296.43	5,541.80	1,143.78	2,610.85	121	9,297.80	5,547.32	1,140.98	2,609.50					
59	9,282.57	5,537.17	1,137.72	2,607.68	122	9,305.75	5,548.42	1,141.43	2,615.90					
60	9,306.02	5,544.02	1,144.50	2,617.50	123	9,295.48	5,531.23	1,142.40	2,621.85					
61	9,289.33	5,531.65	1,144.95	2,612.73	124	9,308.83	5,547.98	1,137.63	2,623.22					
62	9,297.80	5,534.75	1,147.77	2,615.28	125	9,304.25	5,547.35	1,142.18	2,614.72					

Sustainability – I/O Request Throughput Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0350	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.007	0.002	0.005	0.003	0.011	0.005	0.007	0.002

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

Primary Metrics Test – IOPS Test Phase

Clause 5.4.2.2

The IOPS Test Phase consists of one Test Run at the 100% load point with a Measurement Interval of ten (10) minutes. The IOPS Test Phase immediately follows the Sustainability Test Phase without any interruption or manual intervention.

The IOPS Test Run generates the SPC-1 IOPS™ primary metric, which is computed as the I/O Request Throughput for the Measurement Interval of the IOPS Test Run.

The Average Response Time is computed for the IOPS Test Run and cannot exceed 30 milliseconds. If the Average Response Time exceeds the 30 millisecond constraint, the measurement is invalid.

Clause 9.2.4.7.2

For the IOPS Test Phase the FDR shall contain:

1. *I/O Request Throughput Distribution (data and graph).*
2. *A Response Time Frequency Distribution.*
3. *An Average Response Time Distribution.*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied t the Workload Generator.*
6. *The total number of I/O Requests completed in the Measurement Interval as well as the number of I/O Requests with a Response Time less than or equal to 30 milliseconds and the number of I/O Requests with a Response Time greater than 30 milliseconds.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, and Response Time Ramp Test Runs are listed below:

java metrics –b 186 –t 10980 –r 780

The last 180 seconds of the specified 780 seconds were deleted resulting in a reported 600 second Measurement Interval for the IOPS Test Run.

IOPS Test Results File

A link to the test results file generated from the IOPS Test Run is listed below.

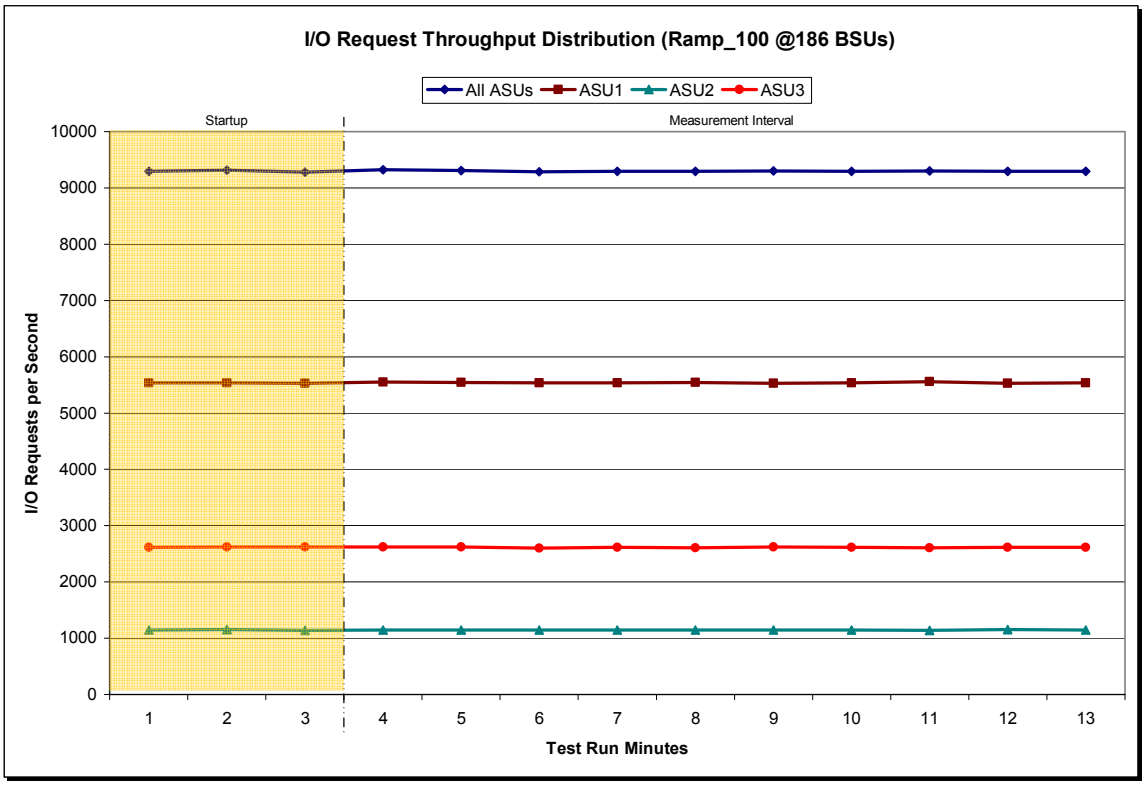
IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:13:25	13:16:26	0-2	0:03:01
Measurement Interval	13:16:26	13:26:26	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	9,297.90	5,539.78	1,144.02	2,614.10
1	9,315.42	5,537.72	1,155.28	2,622.42
2	9,282.22	5,526.02	1,134.13	2,622.07
3	9,323.42	5,552.88	1,147.72	2,622.82
4	9,306.57	5,542.55	1,143.58	2,620.43
5	9,285.08	5,538.02	1,145.28	2,601.78
6	9,294.68	5,537.78	1,142.42	2,614.48
7	9,295.33	5,545.37	1,141.18	2,608.78
8	9,298.72	5,531.68	1,148.20	2,618.83
9	9,292.13	5,537.88	1,141.60	2,612.65
10	9,303.55	5,559.05	1,140.38	2,604.12
11	9,293.68	5,528.88	1,150.72	2,614.08
12	9,292.42	5,536.78	1,142.50	2,613.13
Average	9,298.56	5,541.09	1,144.36	2,613.11

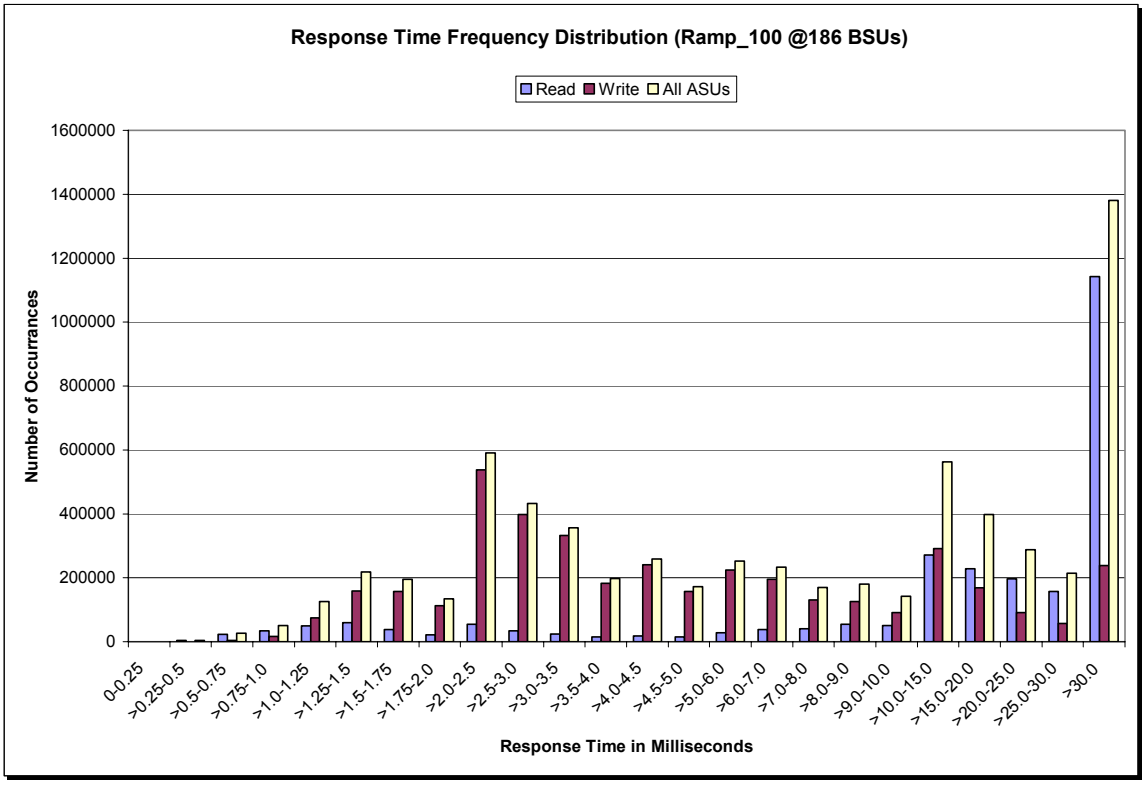
IOPS Test Run – I/O Request Throughput Distribution Graph



IOPS Test Run – Response Time Frequency Distribution Data

Response Time (ms)	0-0.25	>0.25-0.5	>0.5-0.75	>0.75-1.0	>1.0-1.25	>1.25-1.5	>1.5-1.75	>1.75-2.0
Read	6	3,722	23,066	34,179	49,799	59,563	38,037	21,896
Write	0	89	3,896	16,629	75,099	158,382	156,855	112,651
All ASUs	6	3,811	26,962	50,808	124,898	217,945	194,892	134,547
ASU1	2	1,604	13,396	27,414	69,658	121,964	106,163	72,333
ASU2	4	2,165	11,972	17,036	30,807	44,359	35,341	23,716
ASU3	0	42	1,594	6,358	24,433	51,622	53,388	38,498
Response Time (ms)	**>2.0-2.5**	**>2.5-3.0**	**>3.0-3.5**	**>3.5-4.0**	**>4.0-4.5**	**>4.5-5.0**	**>5.0-6.0**	**>6.0-7.0**
Read	53,884	34,364	24,358	14,862	17,727	14,853	27,804	38,422
Write	537,382	398,065	332,290	183,108	241,051	157,577	224,703	195,402
All ASUs	591,266	432,429	356,648	197,970	258,778	172,430	252,507	233,824
ASU1	310,605	217,721	166,341	88,836	109,576	72,724	103,920	98,747
ASU2	84,504	58,883	47,609	27,180	33,057	22,262	33,062	30,264
ASU3	196,157	155,825	142,698	81,954	116,145	77,444	115,525	104,813
Response Time (ms)	**>7.0-8.0**	**>8.0-9.0**	**>9.0-10.0**	**>10.0-15.0**	**>15.0-20.0**	**>20.0-25.0**	**>25.0-30.0**	**>30.0**
Read	40,054	54,650	50,296	271,197	228,347	196,586	157,003	1,142,516
Write	130,275	125,445	91,088	291,236	169,146	91,084	56,800	238,593
All ASUs	170,329	180,095	141,384	562,433	397,493	287,670	213,803	1,381,109
ASU1	77,237	86,968	72,524	325,851	254,154	206,140	161,554	1,158,176
ASU2	22,817	23,861	17,885	70,086	46,204	31,104	19,865	76,409
ASU3	70,275	69,266	50,975	166,496	97,135	50,426	32,384	146,524

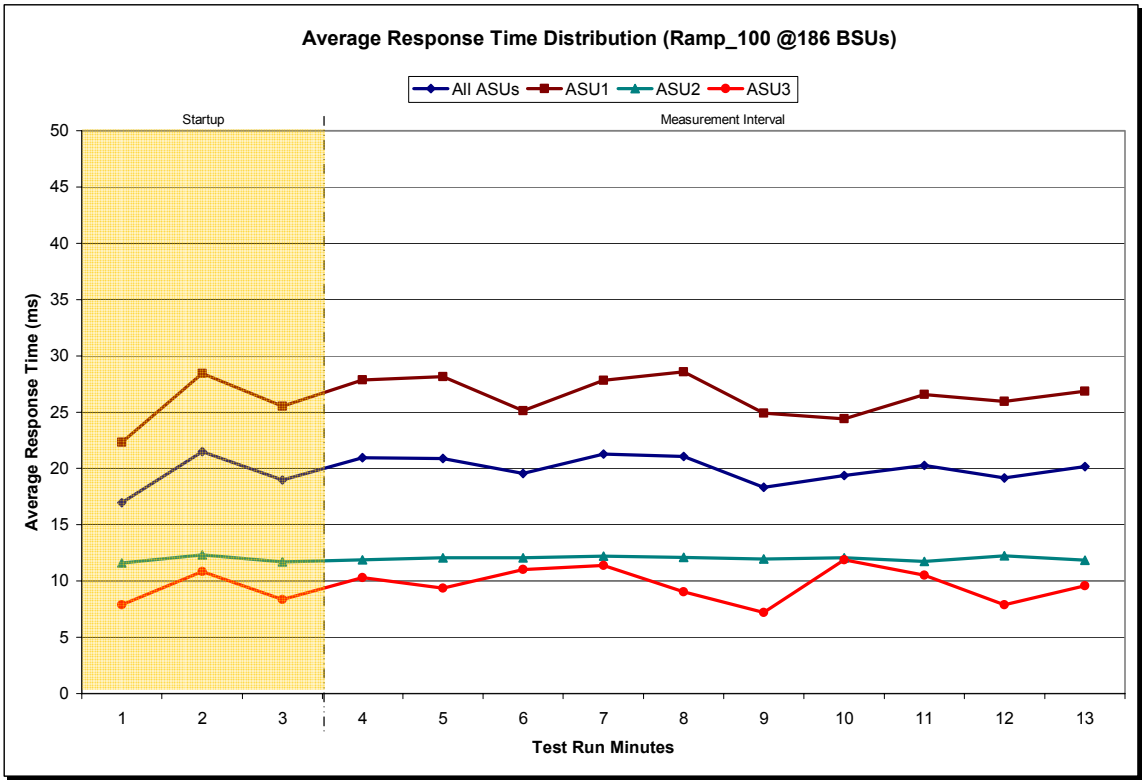
IOPS Test Run –Response Time Frequency Distribution Graph



IOPS Test Run – Average Response Time (ms) Distribution Data

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:13:25	13:16:26	0-2	0:03:01
Measurement Interval	13:16:26	13:26:26	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	16.95	22.33	11.60	7.88
1	21.49	28.44	12.32	10.85
2	18.98	25.52	11.69	8.34
3	20.96	27.87	11.87	10.29
4	20.87	28.14	12.05	9.35
5	19.56	25.14	12.06	11.00
6	21.28	27.83	12.21	11.38
7	21.07	28.58	12.08	9.03
8	18.33	24.92	11.96	7.19
9	19.37	24.41	12.07	11.88
10	20.26	26.56	11.75	10.53
11	19.17	25.95	12.22	7.88
12	20.15	26.85	11.86	9.56
Average	20.10	26.63	12.01	9.81

IOPS Test Run – Average Response Time (ms) Distribution Graph



IOPS Test Run – I/O Request Information

I/O Requests Completed in the Measurement Interval	I/O Requests Completed with Response Time = or < 30 ms	I/O Requests Completed with Response Time > 30 ms
6,584,037	6,370,234	1,381,109

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0350	0.2810	0.0699	0.2101	0.0179	0.0701	0.0351	0.2810
COV	0.008	0.002	0.004	0.003	0.008	0.006	0.006	0.002

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.2.3

The Response Time Ramp Test Phase consists of five Test Runs, one each at 95%, 90%, 80%, 50%, and 10% of the load point (100%) used to generate the SPC-1 IOPS™ primary metric. Each of the five Test Runs has a Measurement Interval of ten (10) minutes. The Response Time Ramp Test Phase immediately follows the IOPS Test Phase without any interruption or manual intervention.

The five Response Time Ramp Test Runs, in conjunction with the IOPS Test Run (100%), demonstrate the relationship between Average Response Time and I/O Request Throughput for the Tested Storage Configuration (TSC) as illustrated in the response time/throughput curve on page 11.

In addition, the Average Response Time measured during the 10% Test Run is the value for the SPC-1 LRT™ primary metric. That value represents the Average Response Time of a lightly loaded TSC.

Clause 9.2.4.7.3

The following content shall appear in the FDR for the Response Time Ramp Phase:

1. *A Response Time Ramp Distribution.*
2. *The human readable Test Run Results File produced by the Workload Generator for each Test Run within the Response Time Ramp Test Phase.*
3. *For the 10% Load Level Test Run (SPC-1 LRT™ metric) an Average Response Time Distribution.*
4. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, and Response Time Ramp Test Runs are listed below:

java metrics –b 186 –t 10980 –r 780

The last 180 seconds of the specified 780 seconds were deleted resulting in a reported 600 second Measurement Interval for each of the Response Time Ramp Test Runs.

Response Time Ramp Test Results File

A link to each test result file generated from each Response Time Ramp Test Run list listed below.

95% Load Level

90% Load Level

80% Load Level

50% Load Level

10% Load Level

Response Time Ramp Distribution (IOPS) Data

The five Test Runs that comprise the Response Time Ramp Phase are executed at 95%, 90%, 80%, 50%, and 10% of the Business Scaling Unit (BSU) load level used to produce the SPC-1 IOPS™ primary metric. The 100% BSU load level is included in the following Response Time Ramp data tables and graphs for completeness.

100% Load Level - 186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:13:25	13:16:26	0-2	0:03:01
Measurement Interval	13:16:26	13:26:26	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	9,297.90	5,539.78	1,144.02	2,614.10
1	9,315.42	5,537.72	1,155.28	2,622.42
2	9,282.22	5,526.02	1,134.13	2,622.07
3	9,323.42	5,552.88	1,147.72	2,622.82
4	9,306.57	5,542.55	1,143.58	2,620.43
5	9,285.08	5,538.02	1,145.28	2,601.78
6	9,294.68	5,537.78	1,142.42	2,614.48
7	9,295.33	5,545.37	1,141.18	2,608.78
8	9,298.72	5,531.68	1,148.20	2,618.83
9	9,292.13	5,537.88	1,141.60	2,612.65
10	9,303.55	5,559.05	1,140.38	2,604.12
11	9,293.68	5,528.88	1,150.72	2,614.08
12	9,292.42	5,536.78	1,142.50	2,613.13
Average	9,298.56	5,541.09	1,144.36	2,613.11

95% Load Level - 176 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:29:29	13:32:30	0-2	0:03:01
Measurement Interval	13:32:30	13:42:30	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	8,829.35	5,264.62	1,081.83	2,482.90
1	8,787.50	5,229.52	1,083.70	2,474.28
2	8,775.37	5,227.10	1,080.85	2,467.42
3	8,766.32	5,210.18	1,085.43	2,470.70
4	8,837.92	5,261.07	1,084.90	2,491.95
5	8,805.43	5,246.37	1,081.22	2,477.85
6	8,798.25	5,245.10	1,082.43	2,470.72
7	8,810.02	5,256.00	1,082.33	2,471.68
8	8,779.93	5,232.87	1,088.18	2,458.88
9	8,790.53	5,244.53	1,078.43	2,467.57
10	8,813.90	5,261.33	1,080.17	2,472.40
11	8,804.52	5,243.60	1,082.80	2,478.12
12	8,799.92	5,243.33	1,085.75	2,470.83
Average	8,800.67	5,244.44	1,083.17	2,473.07

90% Load Level - 167 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	13:45:33	13:48:34	0-2	0:03:01
Measurement Interval	13:48:34	13:58:34	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	8,362.28	4,975.92	1,035.22	2,351.15
1	8,349.28	4,990.45	1,020.55	2,338.28
2	8,333.53	4,978.33	1,020.62	2,334.58
3	8,350.60	4,969.25	1,024.83	2,356.52
4	8,356.13	4,975.78	1,036.60	2,343.75
5	8,355.17	4,962.63	1,028.08	2,364.45
6	8,345.58	4,979.85	1,025.82	2,339.92
7	8,356.40	4,981.62	1,022.35	2,352.43
8	8,344.85	4,973.57	1,022.65	2,348.63
9	8,358.42	4,987.37	1,029.25	2,341.80
10	8,355.87	4,979.15	1,031.50	2,345.22
11	8,352.25	4,971.23	1,029.82	2,351.20
12	8,349.75	4,988.32	1,020.18	2,341.25
Average	8,352.50	4,976.88	1,027.11	2,348.52

80% Load Level - 148 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:01:37	14:04:38	0-2	0:03:01
Measurement Interval	14:04:38	14:14:38	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	7,422.33	4,420.45	909.00	2,092.88
1	7,419.57	4,425.62	913.03	2,080.92
2	7,399.67	4,408.17	909.25	2,082.25
3	7,404.93	4,421.15	905.72	2,078.07
4	7,387.60	4,401.78	913.40	2,072.42
5	7,404.73	4,410.32	918.92	2,075.50
6	7,392.62	4,405.88	911.47	2,075.27
7	7,404.62	4,412.77	916.88	2,074.97
8	7,384.58	4,402.45	904.80	2,077.33
9	7,408.90	4,422.40	906.08	2,080.42
10	7,410.27	4,413.27	913.52	2,083.48
11	7,414.00	4,424.52	914.37	2,075.12
12	7,391.47	4,406.82	908.87	2,075.78
Average	7,400.37	4,412.14	911.40	2,076.84

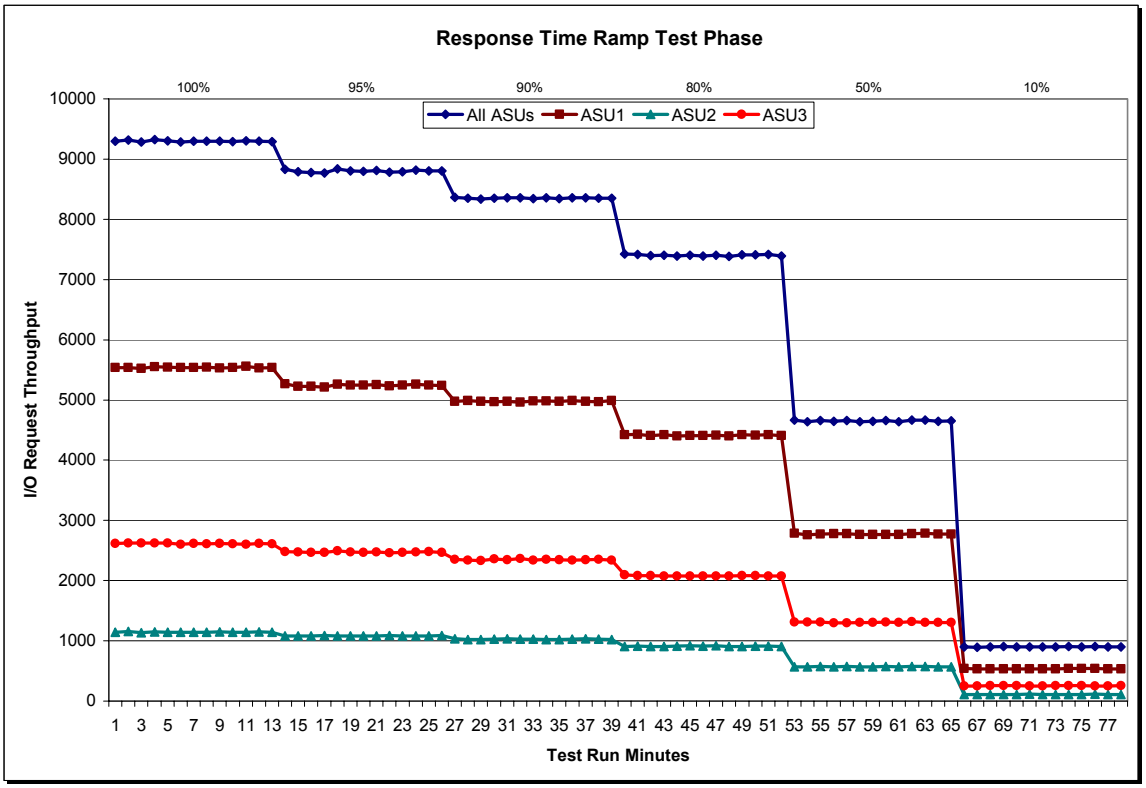
50% Load Level - 93 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:17:41	14:20:42	0-2	0:03:01
Measurement Interval	14:20:42	14:30:42	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	4,662.62	2,782.32	568.80	1,311.50
1	4,635.73	2,759.30	568.05	1,308.38
2	4,658.45	2,769.52	576.58	1,312.35
3	4,646.85	2,776.73	569.03	1,301.08
4	4,655.85	2,781.98	574.58	1,299.28
5	4,640.60	2,763.73	570.05	1,306.82
6	4,641.80	2,764.30	569.60	1,307.90
7	4,655.25	2,767.30	574.65	1,313.30
8	4,640.78	2,765.15	569.98	1,305.65
9	4,666.45	2,775.70	573.55	1,317.20
10	4,662.75	2,783.05	571.72	1,307.98
11	4,642.45	2,770.58	568.87	1,303.00
12	4,653.42	2,775.10	570.80	1,307.52
Average	4,650.62	2,772.36	571.28	1,306.97

10% Load Level - 18 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:33:45	14:36:46	0-2	0:03:01
Measurement Interval	14:36:46	14:46:46	3-12	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	901.50	538.57	111.25	251.68
1	894.65	533.78	109.18	251.68
2	899.75	533.15	110.95	255.65
3	904.85	536.52	111.53	256.80
4	901.60	535.43	111.43	254.73
5	899.88	534.63	111.78	253.47
6	897.47	533.73	111.08	252.65
7	901.45	534.45	109.70	257.30
8	906.68	542.03	110.92	253.73
9	902.62	538.85	109.92	253.85
10	904.33	538.97	112.05	253.32
11	897.47	536.27	109.08	252.12
12	902.10	536.07	110.57	255.47
Average	901.85	536.70	110.81	254.34

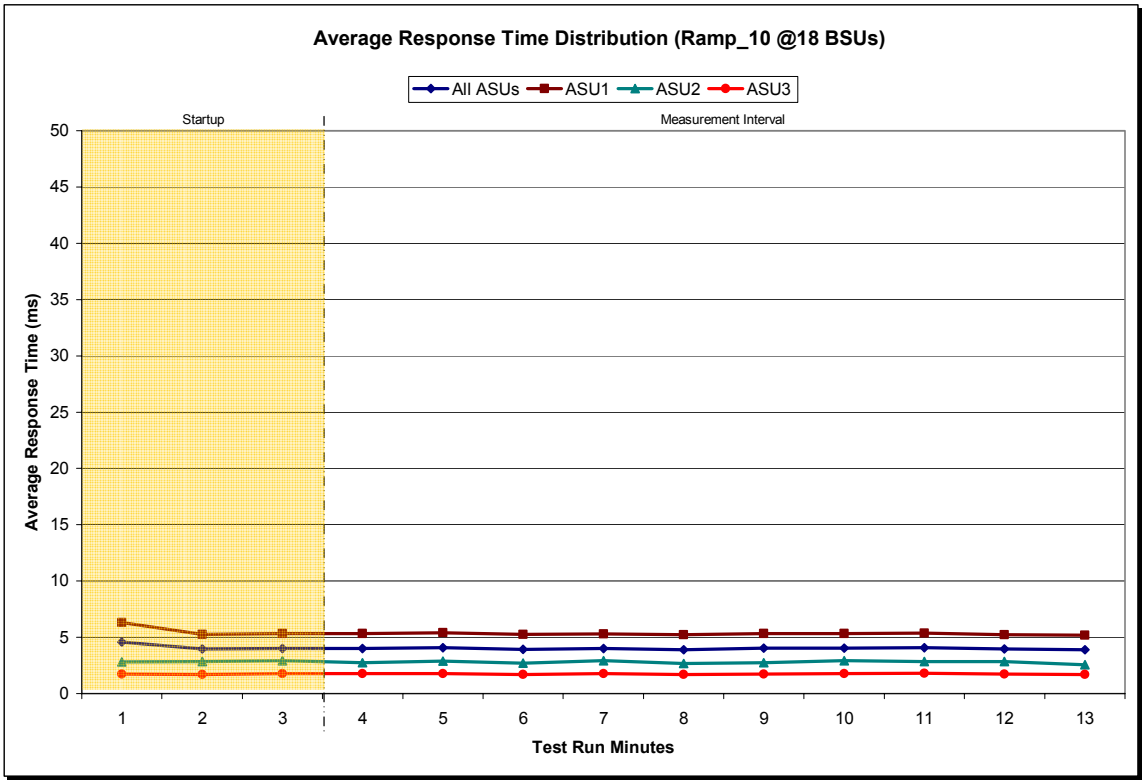
Response Time Ramp Distribution (IOPS) Graph



SPC-1 LRT™ Average Response Time (ms) Distribution Data

18 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:33:45	14:36:46	0-2	0:03:01
Measurement Interval	14:36:46	14:46:46	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4.58	6.29	2.81	1.72
1	3.95	5.24	2.84	1.70
2	4.01	5.32	2.92	1.77
3	4.00	5.32	2.73	1.78
4	4.06	5.40	2.87	1.76
5	3.94	5.25	2.71	1.71
6	4.00	5.28	2.90	1.76
7	3.89	5.21	2.66	1.68
8	4.01	5.34	2.73	1.74
9	4.03	5.33	2.91	1.75
10	4.05	5.35	2.86	1.81
11	3.95	5.22	2.83	1.72
12	3.88	5.19	2.55	1.70
Average	3.98	5.29	2.78	1.74

SPC-1 LRT™ Average Response Time (ms) Distribution Graph



SPC-1 LRT™ (10%) – Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0350	0.2809	0.0702	0.2091	0.0180	0.0699	0.0349	0.2819
COV	0.012	0.006	0.014	0.007	0.021	0.019	0.022	0.006

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

Repeatability Test

Clause 5.4.3

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ and SPC-1 LRT™ primary metrics generated in earlier Test Runs.

There are two identical Repeatability Test Phases. Each Test Phase contains two Test Runs. Each of the Test Runs will have a Measurement Interval of no less than ten (10) minutes. The two Test Runs in each Test Phase will be executed without interruption or any type of manual intervention.

The first Test Run in each Test Phase is executed at the 10% load point. The Average Response Time from each of the Test Runs is compared to the SPC-1 LRT™ primary metric. Each Average Response Time value must be less than the SPC-1 LRT™ primary metric plus 5%.

The second Test Run in each Test Phase is executed at the 100% load point. The I/O Request Throughput from the Test Runs is compared to the SPC-1 IOPS™ primary metric. Each I/O Request Throughput value must be greater than the SPC-1 IOPS™ primary metric minus 5%. In addition, the Average Response Time for each Test Run cannot exceed 30 milliseconds.

If any of the above constraints are not met, the benchmark measurement is invalid.

Clause 9.2.4.7.3

The following content shall appear in the FDR for each Test Run in the two Repeatability Test Phases:

1. *A table containing the results of the two Repeatability Test Phases. The content, appearance, and format of the table are specified in Table 9-11.*
2. *An I/O Request Throughput Distribution (data and graph).*
3. *An Average Response Time Distribution (data and graph).*
4. *The human readable Test Run Results File produced by the Workload Generator.*
5. *A listing or screen image of all input parameters supplied to the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Repeatability Test Runs are listed below:

java repeat1 –b 186 –t 780

java repeat2 –b 186 –t 780

The last 180 seconds of the specified 780 seconds were deleted resulting in a reported 600 second Measurement Interval for each of Repeatability Test Runs.

Repeatability Test Results File

The values for the SPC-1 IOPS™, SPC-1 LRT™, and the Repeatability Test measurements are listed below.

	SPC-1 IOPS™	SPC-1 LRT™
Primary Metrics	***9,298.56***	***3.98***
Repeatability Test Phase 1	9,302.03	3.96
Repeatability Test Phase 2	9,299.77	3.99

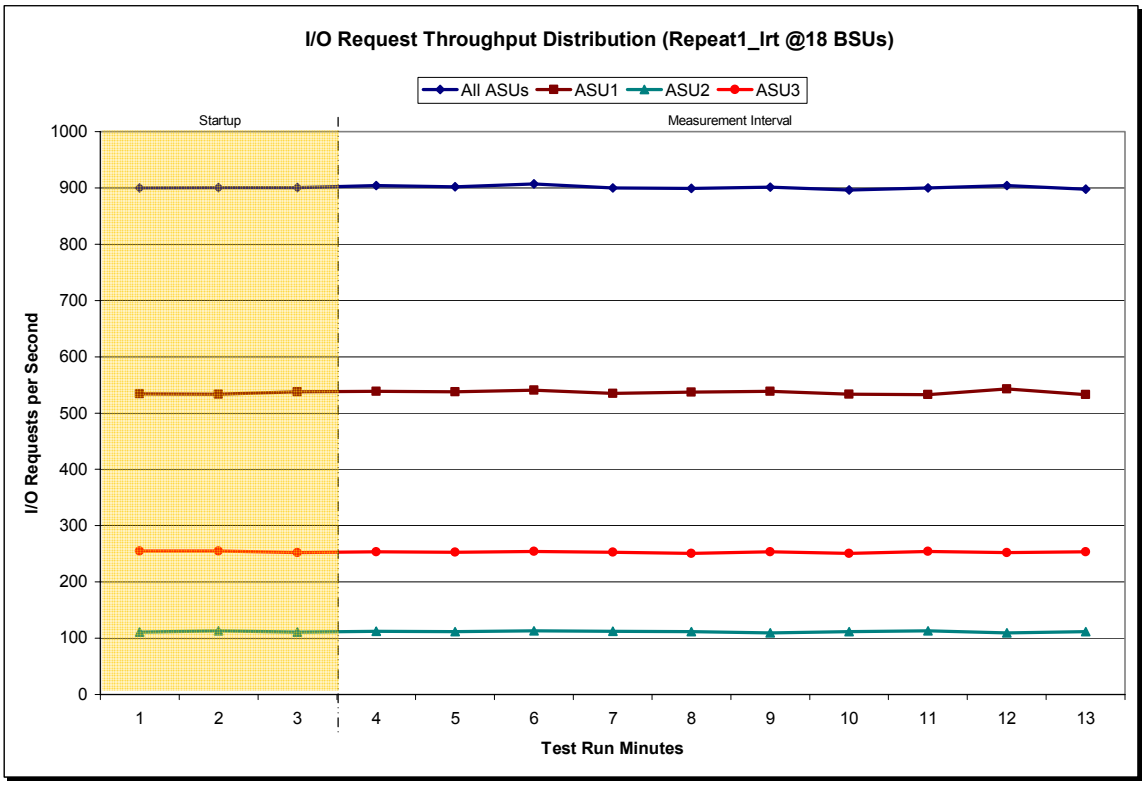
A link to the test result file generated from each Repeatability Test Run list is listed below.

Repeatability Test Phase 1, Test Run 1 (LRT)
Repeatability Test Phase 1, Test Run 2 (IOPS)
Repeatability Test Phase 2, Test Run 1 (LRT)
Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

18 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:49:52	14:52:52	0-2	0:03:00
Measurement Interval	14:52:52	15:02:52	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	899.92	533.93	110.80	255.18
1	900.67	533.13	112.75	254.78
2	900.73	537.98	110.57	252.18
3	904.48	538.75	112.43	253.30
4	902.10	537.55	111.73	252.82
5	907.08	540.58	112.72	253.78
6	899.88	534.83	112.62	252.43
7	899.37	537.28	111.85	250.23
8	901.27	538.22	109.58	253.47
9	896.00	533.57	111.85	250.58
10	899.62	532.55	112.68	254.38
11	904.18	542.62	109.30	252.27
12	897.77	532.78	111.35	253.63
Average	901.18	536.87	111.61	252.69

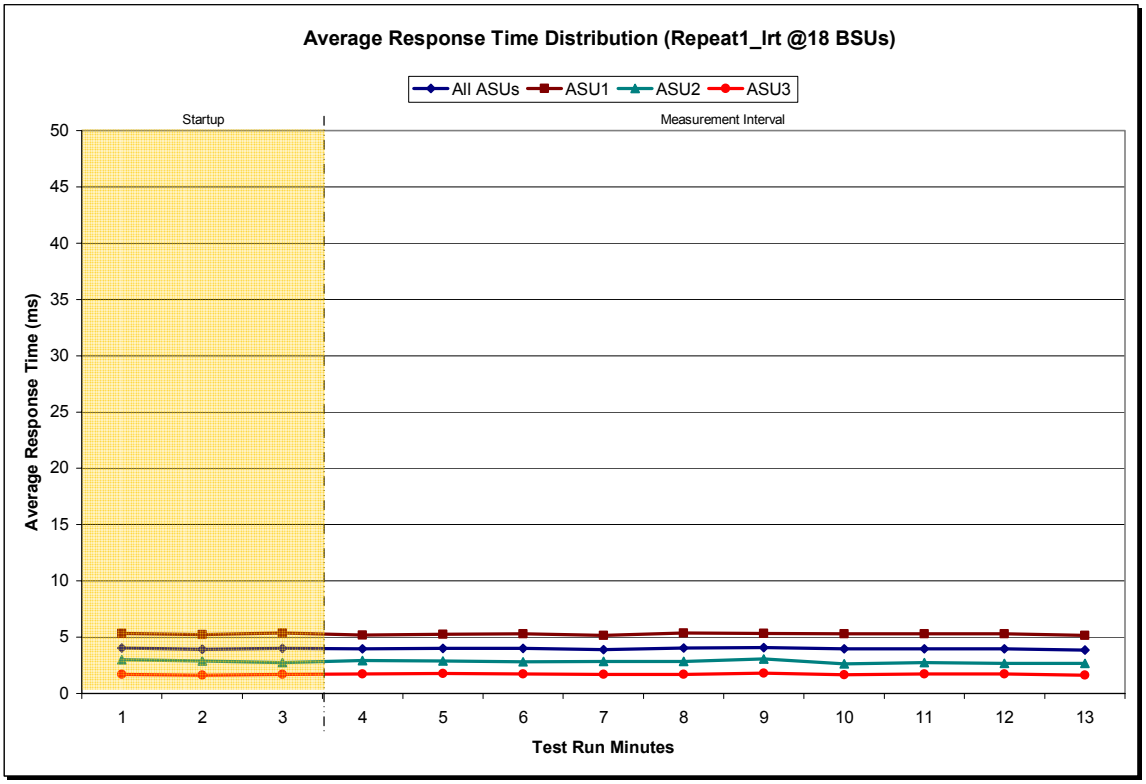
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



Repeatability 1 LRT –Average Response Time (ms) Distribution Data

18 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	14:49:52	14:52:52	0-2	0:03:00
Measurement Interval	14:52:52	15:02:52	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	4.02	5.34	2.99	1.70
1	3.91	5.22	2.87	1.64
2	4.01	5.35	2.75	1.71
3	3.94	5.19	2.93	1.74
4	3.99	5.27	2.88	1.75
5	3.98	5.28	2.81	1.74
6	3.90	5.16	2.85	1.70
7	4.02	5.36	2.83	1.70
8	4.07	5.34	3.06	1.82
9	3.96	5.30	2.64	1.67
10	3.97	5.30	2.73	1.72
11	3.97	5.28	2.66	1.73
12	3.85	5.16	2.66	1.60
Average	3.96	5.26	2.81	1.72

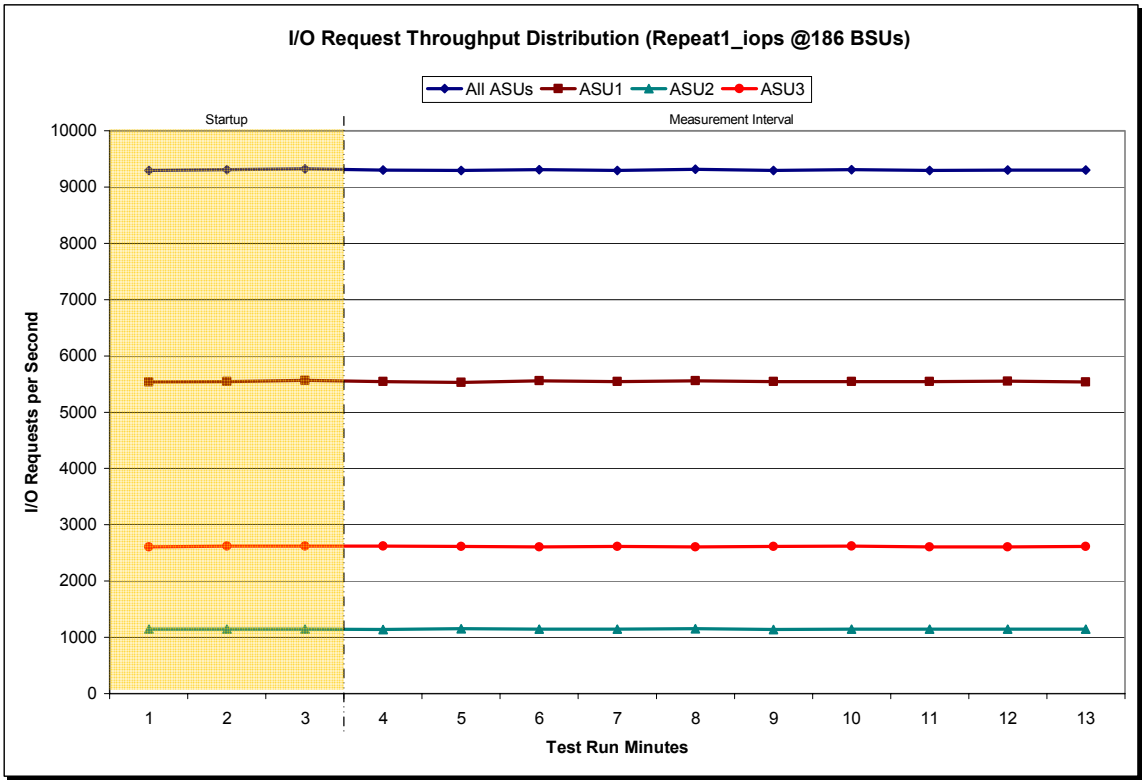
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:05:55	15:08:56	0-2	0:03:01
Measurement Interval	15:08:56	15:18:56	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	9,292.25	5,537.32	1,147.48	2,607.45
1	9,311.47	5,546.65	1,147.68	2,617.13
2	9,326.00	5,561.98	1,145.08	2,618.93
3	9,299.58	5,540.30	1,137.87	2,621.42
4	9,295.00	5,530.48	1,149.05	2,615.47
5	9,310.73	5,555.58	1,147.55	2,607.60
6	9,295.18	5,541.63	1,143.42	2,610.13
7	9,317.62	5,557.48	1,151.02	2,609.12
8	9,296.57	5,545.60	1,140.93	2,610.03
9	9,309.68	5,542.88	1,146.18	2,620.62
10	9,293.27	5,542.38	1,142.72	2,608.17
11	9,303.78	5,550.08	1,144.35	2,609.35
12	9,298.90	5,539.93	1,147.00	2,611.97
Average	9,302.03	5,544.64	1,145.01	2,612.39

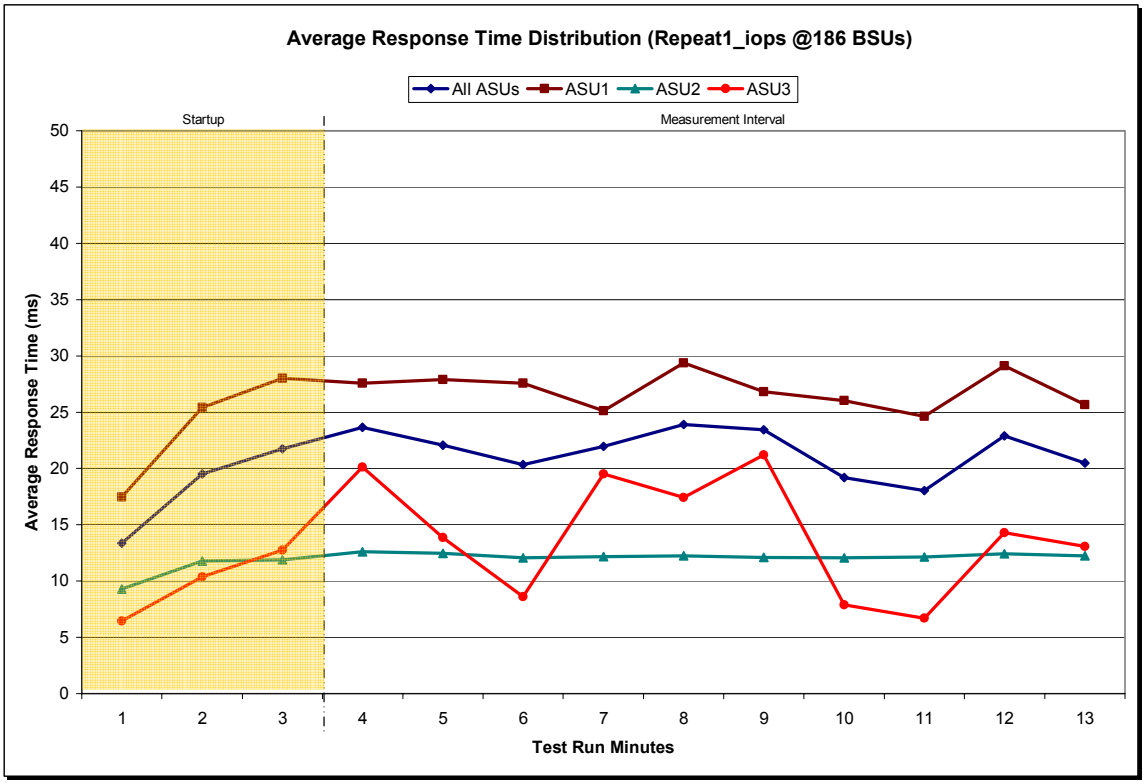
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



Repeatability 1 IOPS –Average Response Time (ms) Distribution Data

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:05:55	15:08:56	0-2	0:03:01
Measurement Interval	15:08:56	15:18:56	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	13.35	17.45	9.30	6.43
1	19.50	25.41	11.77	10.37
2	21.74	28.00	11.88	12.76
3	23.65	27.58	12.62	20.13
4	22.05	27.91	12.45	13.87
5	20.34	27.57	12.06	8.61
6	21.95	25.13	12.16	19.51
7	23.92	29.37	12.24	17.44
8	23.43	26.82	12.08	21.20
9	19.20	26.02	12.07	7.89
10	18.05	24.61	12.13	6.70
11	22.91	29.12	12.42	14.28
12	20.48	25.68	12.25	13.07
Average	21.60	26.98	12.25	14.27

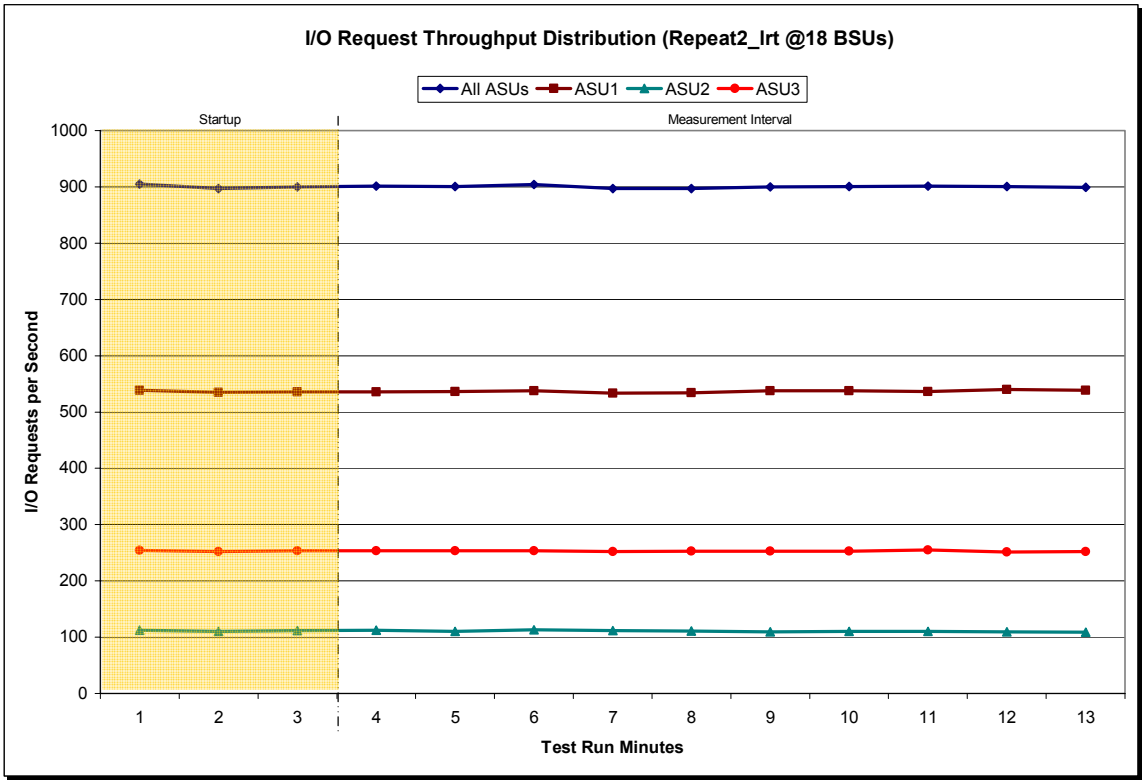
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

18 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:22:03	15:25:03	0-2	0:03:00
Measurement Interval	15:25:03	15:35:03	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	905.30	538.57	112.47	254.27
1	897.28	535.25	110.40	251.63
2	900.20	535.40	111.38	253.42
3	901.23	535.82	112.10	253.32
4	900.62	536.53	110.38	253.70
5	904.40	537.87	112.77	253.77
6	896.82	533.35	111.80	251.67
7	897.15	534.00	110.55	252.60
8	899.78	537.90	109.37	252.52
9	900.88	537.98	110.07	252.83
10	901.52	536.68	110.17	254.67
11	900.83	540.02	109.27	251.55
12	899.30	538.60	108.70	252.00
Average	900.25	536.88	110.52	252.86

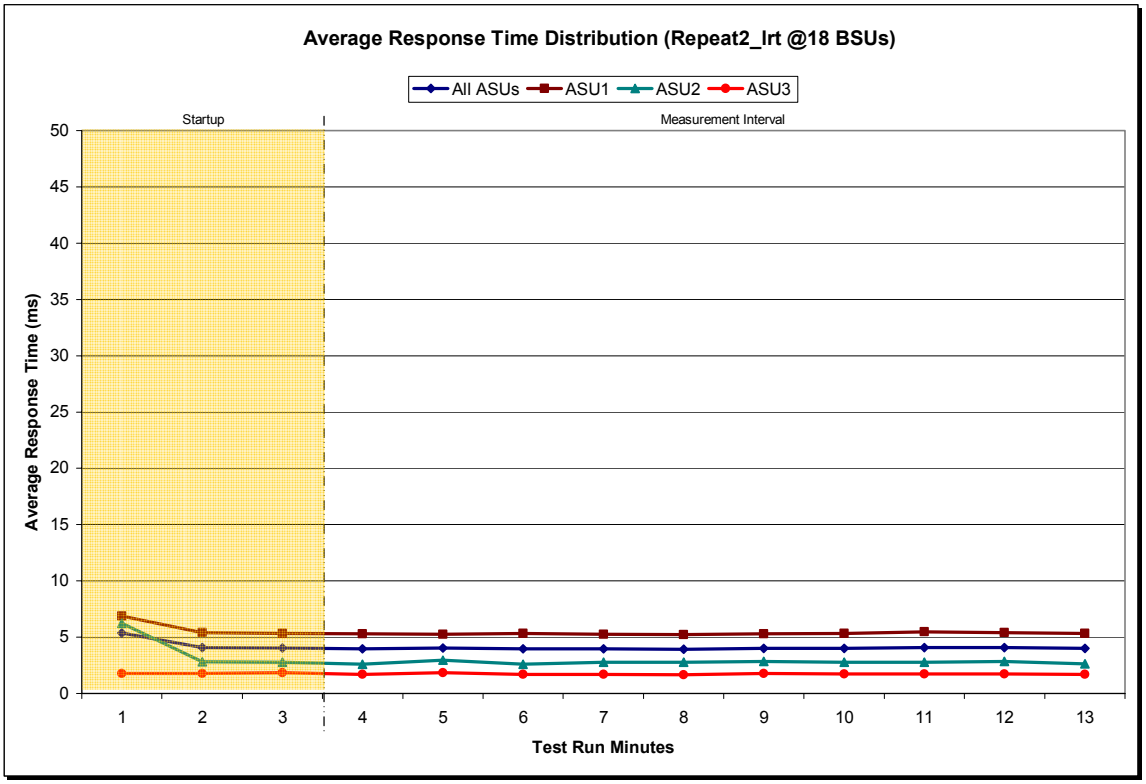
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



Repeatability 2 LRT –Average Response Time (ms) Distribution Data

18 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:22:03	15:25:03	0-2	0:03:00
Measurement Interval	15:25:03	15:35:03	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	5.35	6.87	6.23	1.75
1	4.05	5.39	2.82	1.75
2	4.04	5.33	2.79	1.85
3	3.95	5.30	2.61	1.69
4	4.02	5.27	2.97	1.84
5	3.96	5.32	2.59	1.70
6	3.94	5.25	2.77	1.70
7	3.92	5.21	2.77	1.67
8	4.00	5.28	2.86	1.75
9	4.00	5.31	2.77	1.74
10	4.08	5.47	2.75	1.72
11	4.07	5.41	2.84	1.73
12	3.99	5.34	2.64	1.69
Average	3.99	5.32	2.76	1.72

Repeatability 2 LRT –Average Response Time (ms) Distribution Graph

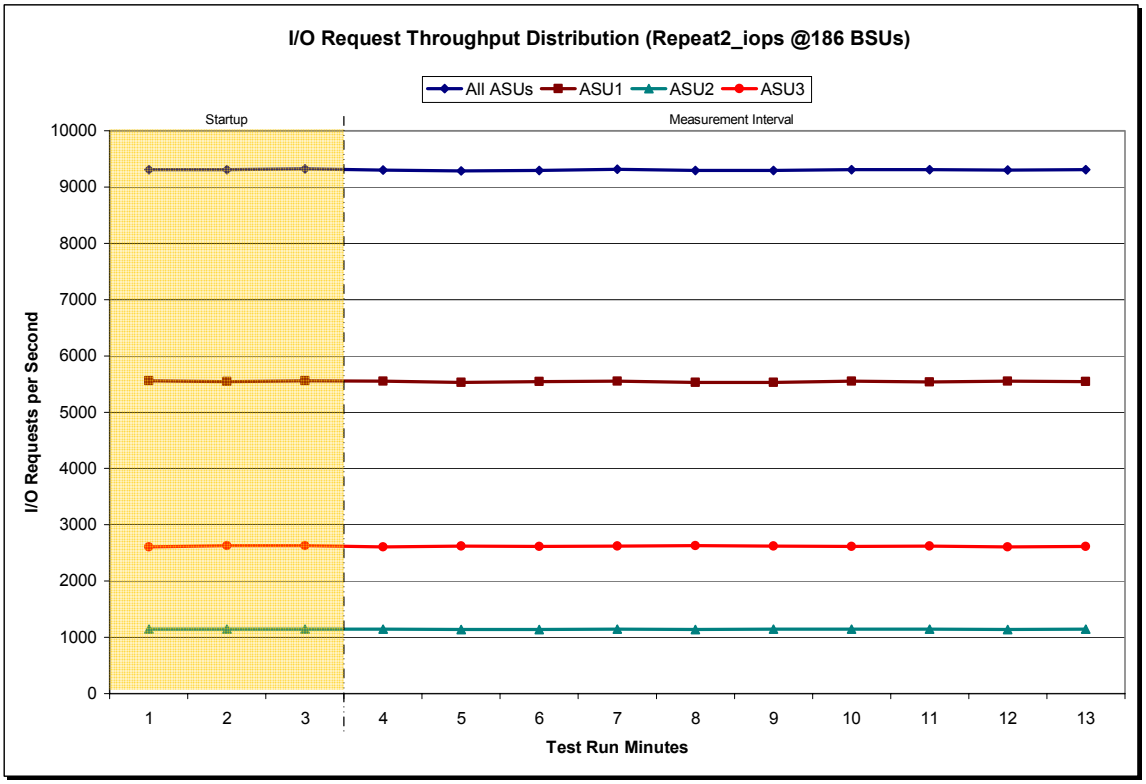


Repeatability 2 IOPS – I/O Request Throughput Distribution Data

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:38:06	15:41:07	0-2	0:03:01
Measurement Interval	15:41:07	15:51:07	3-12	0:10:00

60 second intervals	All ASUs	ASU1	ASU2	ASU3
0	9,310.38	5,559.82	1,143.15	2,607.42
1	9,310.73	5,540.15	1,143.63	2,626.95
2	9,326.70	5,557.63	1,142.10	2,626.97
3	9,298.45	5,550.40	1,145.12	2,602.93
4	9,288.00	5,530.40	1,140.20	2,617.40
5	9,293.23	5,544.88	1,135.07	2,613.28
6	9,314.62	5,551.82	1,141.72	2,621.08
7	9,291.18	5,528.85	1,136.83	2,625.50
8	9,293.80	5,530.80	1,141.50	2,621.50
9	9,308.23	5,551.73	1,143.53	2,612.97
10	9,305.48	5,535.52	1,148.00	2,621.97
11	9,298.38	5,552.18	1,138.90	2,607.30
12	9,306.27	5,546.17	1,144.92	2,615.18
Average	9,299.77	5,542.28	1,141.58	2,615.91

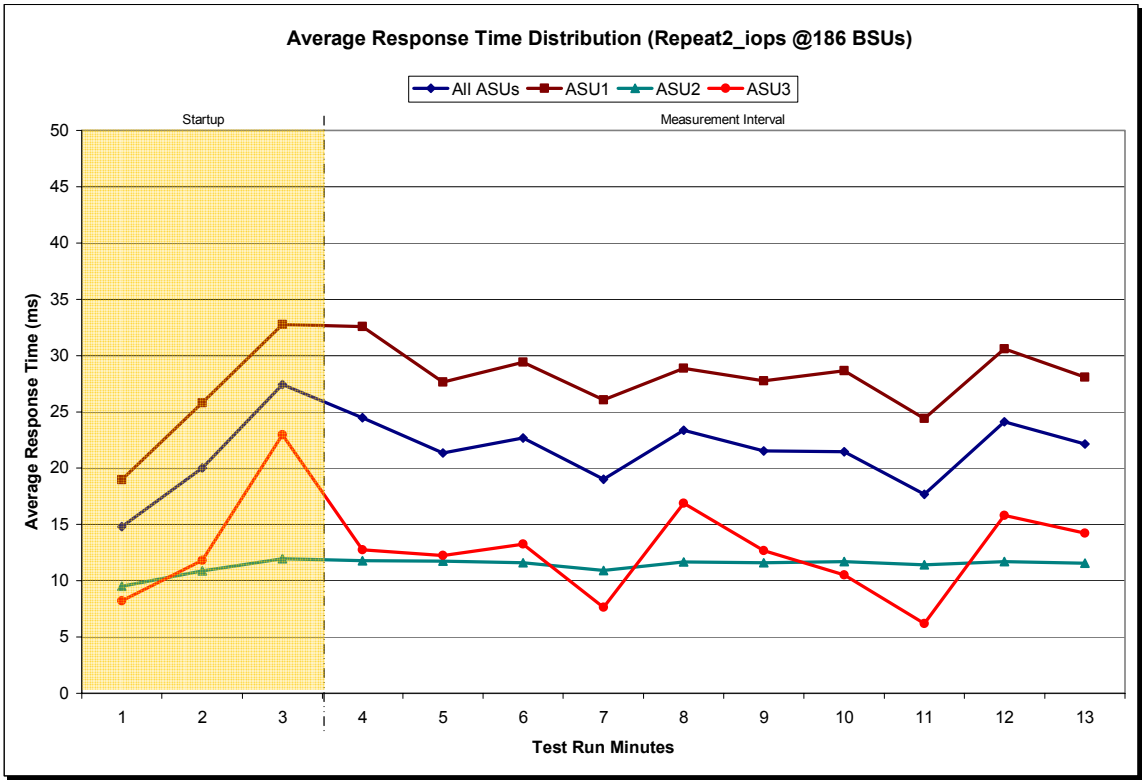
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



Repeatability 2 IOPS –Average Response Time (ms) Distribution Data

186 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	15:38:06	15:41:07	0-2	0:03:01
Measurement Interval	15:41:07	15:51:07	3-12	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	14.80	18.98	9.50	8.22
1	20.03	25.81	10.85	11.81
2	27.44	32.74	11.96	22.96
3	24.47	32.59	11.76	12.74
4	21.36	27.66	11.74	12.26
5	22.69	29.41	11.61	13.26
6	19.02	26.06	10.89	7.64
7	23.38	28.88	11.65	16.87
8	21.52	27.75	11.61	12.69
9	21.46	28.64	11.71	10.49
10	17.67	24.41	11.40	6.19
11	24.13	30.59	11.70	15.79
12	22.14	28.06	11.54	14.23
Average	21.78	28.40	11.56	12.22

Repeatability 2 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 1 (LRT)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0352	0.2807	0.0696	0.2104	0.0179	0.0703	0.0354	0.2805
COV	0.018	0.007	0.018	0.012	0.029	0.018	0.022	0.005

IM – Intensity Multiplier: *The ratio of I/Os for each I/O stream relative to the total I/Os for all I/O streams (ASU1-1 – ASU3-1) as required by the benchmark specification.*

MIM – Measured Intensity Multiplier: *The Measured Intensity Multiplier represents the ratio of measured I/Os for each I/O stream relative to the total I/Os measured for all I/O streams (ASU1-1 – ASU3-1). This value may differ from the corresponding Expected Intensity Multiplier by no more than 5%.*

COV – Coefficient of Variation: *This measure of variation for the Measured Intensity Multiplier cannot exceed 0.2.*

Repeatability 1 (IOPS)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0350	0.2808	0.0701	0.2101	0.0180	0.0701	0.0354	0.2805
COV	0.006	0.002	0.006	0.002	0.007	0.004	0.022	0.005

Repeatability 2 (LRT)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0352	0.2806	0.0705	0.2097	0.0181	0.0697	0.0351	0.2811
COV	0.015	0.007	0.016	0.012	0.020	0.020	0.024	0.004

Repeatability 2 (IOPS)
Measured Intensity Multiplier and Coefficient of Variation

	ASU1-1	ASU1-2	ASU1-3	ASU1-4	ASU2-1	ASU2-2	ASU2-3	ASU3-1
IM	*0.0350*	*0.2810*	*0.0700*	*0.2100*	*0.0180*	*0.0700*	*0.0350*	*0.2810*
MIM	0.0350	0.2810	0.0701	0.2100	0.0179	0.0698	0.0350	0.2812
COV	0.006	0.002	0.003	0.003	0.012	0.004	0.007	0.003

Data Persistence Test

Clause 6

The Data Persistence Test demonstrates the Tested Storage Configuration (TSC):

- *Is capable of maintain data integrity across a power cycle.*
- *Ensures the transfer of data between Logical Volumes and host systems occurs without corruption or loss.*

The SPC-1 Workload Generator will write 16 block I/O requests at random over the total Addressable Storage Capacity of the TSC for ten (10) minutes at a minimum of 25% of the load used to generate the SPC-1 IOP™ primary metric. The bit pattern selected to be written to each block as well as the address of the block will be retained in a log file.

The Benchmark Configuration will be shutdown and restarted using a power off/power on cycle at the end of the above sequence of write operations. In addition, any caches employing battery backup must be flushed/emptied.

The SPC-1 Workload Generator will then use the above log file to verify each block written contains the correct bit pattern.

Clause 9.2.4.8

The following content shall appear in this section of the FDR:

1. *A listing or screen image of all input parameters supplied to the Workload Generator.*
2. *For the successful Data Persistence Test Run, able illustrating key results. The content, appearance, and format of this table are specified in Table 9-12. Information displayed in this table shall be obtained from the Test Run Results File referenced below in #3.*
3. *For the successful Data Persistence Test Run, the human readable Test Run Results File produced by the Workload Generator.*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Data Persistence Test are listed below:

java persist1 –b 186

java persist2

Data Persistence Test Results File

A link to each test result file generated from each Data Persistence Test is listed below.

Persistence 1 Test Results File

Persistence 2 Test Results File

Data Persistence Test Results

Data Persistence Test Results	
Data Persistence Test Run Number: 1	
Total Number of Logical Blocks Written	21,911,856
Total Number of Logical Blocks Verified	14,474,576
Total Number of Logical Blocks that Failed Verification	0
Time Duration for Writing Test Logical Blocks	10 minutes
Size in Bytes of each Logical Block	512
Number of Failed I/O Requests in the process of the Test	0

In some cases the same address was the target of multiple writes, which resulted in more Logical Blocks Written than Logical Blocks Verified. In the case of multiple writes to the same address, the pattern written and verified must be associated with the last write to that address.

PRICED STORAGE CONFIGURATION AVAILABILITY DATE

Clause 9.2.4.9

The committed delivery data for general availability (Availability Date) of all products that comprise the Priced Storage Configuration must be reported. When the Priced Storage Configuration includes products or components with different availability dates, the reported Availability Date must be the date at which all components are committed to be available.

The FDR shall state: "The Priced Storage Configuration, as documented in this Full Disclosure Report will be available for shipment to customers on MMMM DD, YYYY." Where Priced Storage Configuration is the TSC Configuration Name as described in Clause 9.2.4.3.3 and MMMM is the alphanumeric month, DD is the numeric day, and YYYY is the numeric year of the date that the Priced Storage Configuration, as documented, is available for shipment to customers as described above.

The DataCore SANmelody™ Disk Server (iSCSI-Std. NIC), as documented in this Full Disclosure Report became available for customer purchase and shipment on March 8, 2004.

PRICING INFORMATION

Clause 9.2.4.11

A statement of the respective calculations for pricing must be included.

Pricing information may found in the Tested Storage Configuration Pricing section on page 12.

ANOMALIES OR IRREGULARITIES

Clause 9.2.4.10

The FDR shall include a clear and complete description of any anomalies or irregularities encountered in the course of executing the SPC-1 benchmark that may in any way call into question the accuracy, verifiability, or authenticity of information published in this FDR.

There were no anomalies or irregularities encountered during the SPC-1 Remote Audit of the DataCore SANmelody™ Disk Server (iSCSI-Std. NIC).

APPENDIX A: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters

AllowRewrite
Default = (not present)
SPC-1 = 1

HashTableSize
Default =
SPC1 = 100000

IoQueueSize
Default =
SPC-1 = 200000

IoQueueCount
Default =
SPC-1 = a0

ReadAhead
Default = 1
SPC-1 = C000

ReadAheadCount
Default = (not present)
SPC-1 = 2328

WriteRequeue
Default = (not present)
SPC-1 = 1

WriteSizeStop
Default =
SPC-1 = 80000

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters/ V.{f2e4643b-d101-11d8-a3a1-505054503030}-00000004]

IoQueueCount
Default = (not present)
SPC-1 = 20

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters/ V.{f2e4644a-d101-11d8-a3a1-505054503030}-00000001]

IoQueueCount
Default = (not present)
SPC-1 = 48

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters/
V.{f2e4644a-d101-11d8-a3a1-505054503030}-00000002]

IoQueueCount
Default = (not present)
SPC-1 = 48

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters/
V.{f2e46451-d101-11d8-a3a1-505054503030}-00000002]

IoQueueCount
Default = (not present)
SPC-1 = 80

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters/
V.{f2e46455-d101-11d8-a3a1-505054503030}-00000005]

IoQueueCount
Default = (not present)
SPC-1 = 40

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters/
V.{f2e46455-d101-11d8-a3a1-505054503030}-00000006]

IoQueueCount
Default = (not present)
SPC-1 = 40

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters/
V.{f2e46456-d101-11d8-a3a1-505054503030}-00000005]

IoQueueCount
Default = (not present)
SPC-1 = 40

HKLM/CurrentControlSet/System/Services/DCSCache/Parameters/
V.{f2e46456-d101-11d8-a3a1-505054503030}-00000006]

IoQueueCount
Default = (not present)
SPC-1 = 40

HKLM/CurrentControlSet/System/Services/DCSPoll/Parameters

HighWaterMarkPercentage
Default = 28
SPC-1 = 2

LowWaterMarkPercentage
Default = A
SPC-1 = 0

MaxPollers
Default = (not present)
SPC-1 = 3

HKLM/CurrentControlSet/System/Services/DCSSp/Parameters

LunQueueDepth
Default = 100
SPC-1 = 20

HKLM/CurrentControlSet/System/Services/DCSSp/Parameters/210000E08B0B89F9

LunDistribution
Default = 0
SPC-1 = 1

HKLM/CurrentControlSet/System/Services/DCSSp/Parameters/210100E08B2B89F9

LunDistribution
Default = 0
SPC-1 = 1

HKLM/CurrentControlSet/System/Services/DCSSp/Parameters/210100E08B4B89F9

LunDistribution
Default = 0
SPC-1 = 1

HKLM/CurrentControlSet/System/Services/DCSSp/Parameters/210100E08B8B89F9

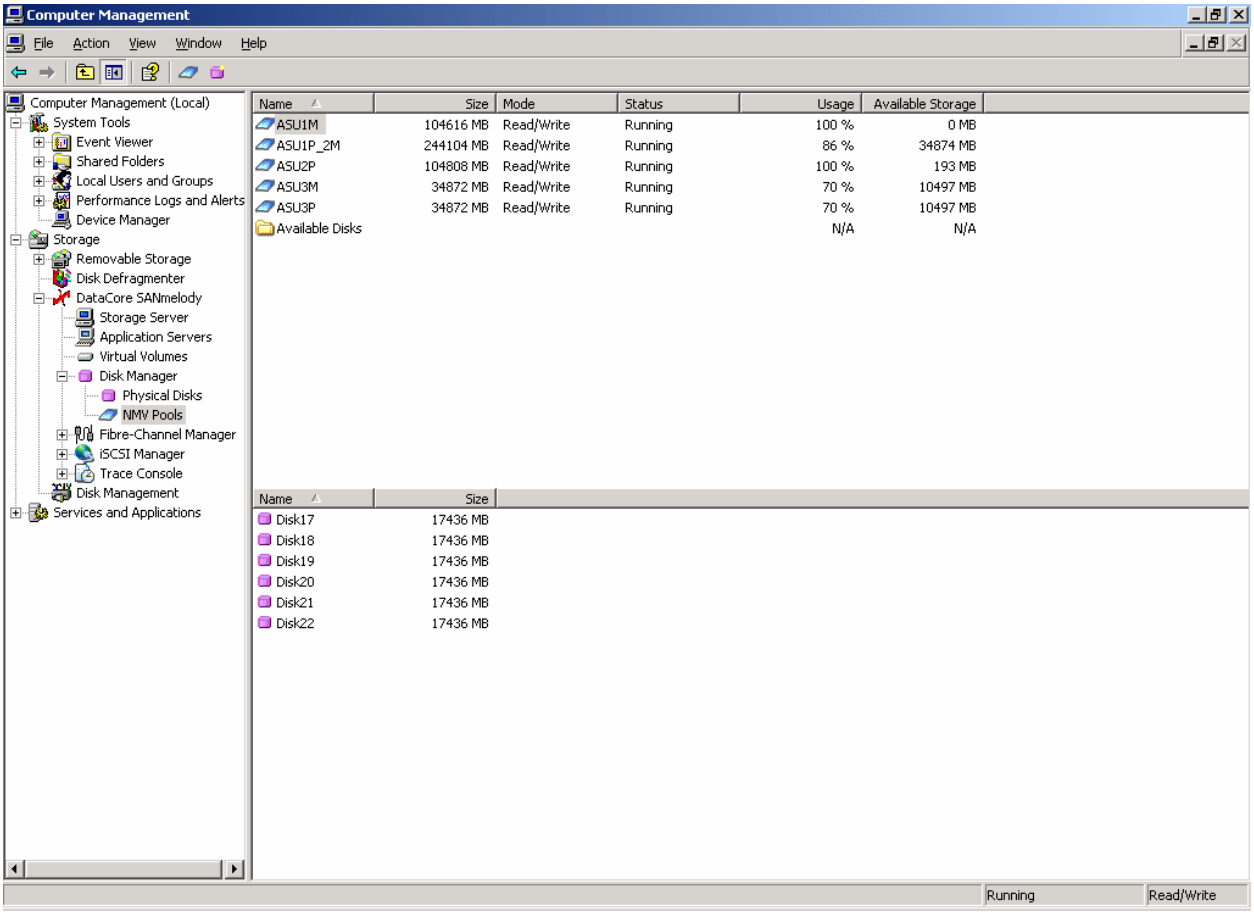
LunDistribution
Default = 0
SPC-1 = 1

Note: All values in hexadecimal unless otherwise stated

APPENDIX B: TESTED STORAGE CONFIGURATION (TSC) CREATION

Storage Pool Creation

The screenshot below shows the NMV (network managed volume) snap-in. This is where pools are created from the attached storage devices and the SANmelody™ server creates logical volumes from the pool.



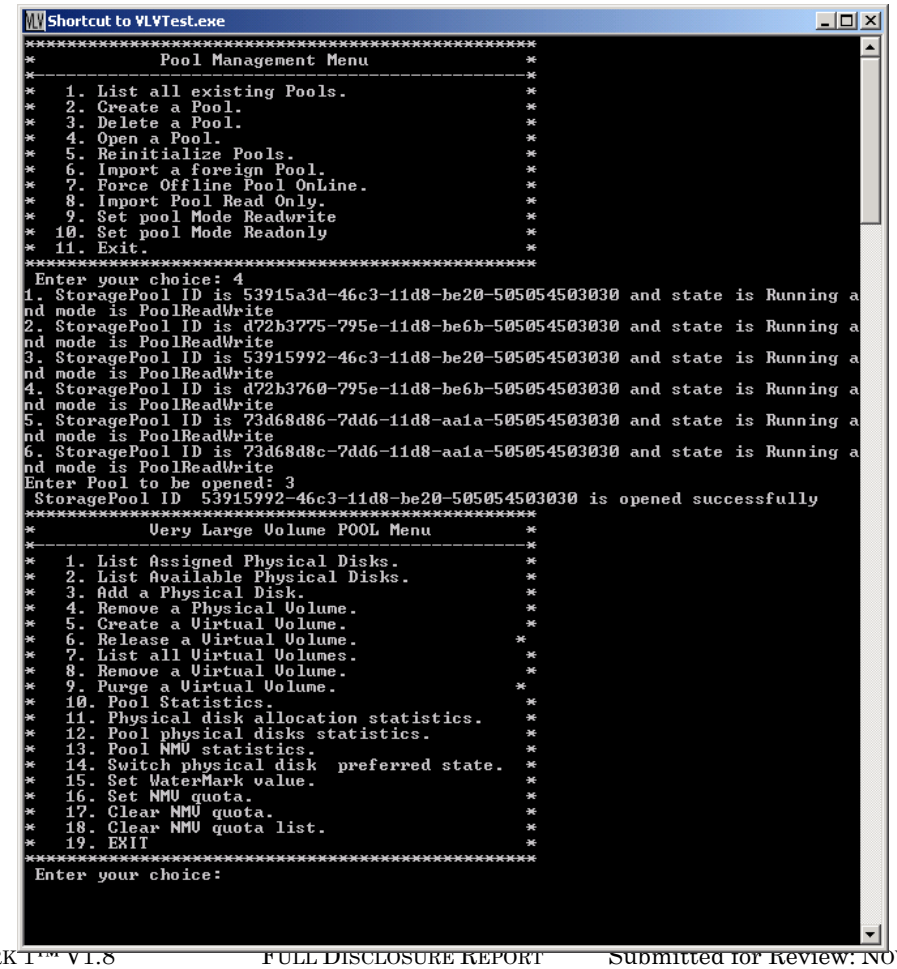
Pre-Allocated Logical Volume Creation

The DataCore Network Managed Volumes (NMVs) used in this benchmark utilized the "static physical allocation" option (auto-provisioning). All of the logical volumes assigned to ASU-1, ASU-2, and ASU-3 were backed by statically assigned physical storage. The ability to statically allocate the physical storage to logical volumes is an advanced feature of DataCore NMVs.

When each logical volume is created, its maximum size is specified to the Network Managed Volume subsystem in 512 byte blocks. That value is then used to assign that amount of physical storage for the logical volume. No subsequent physical storage allocation takes place for the logical volume.

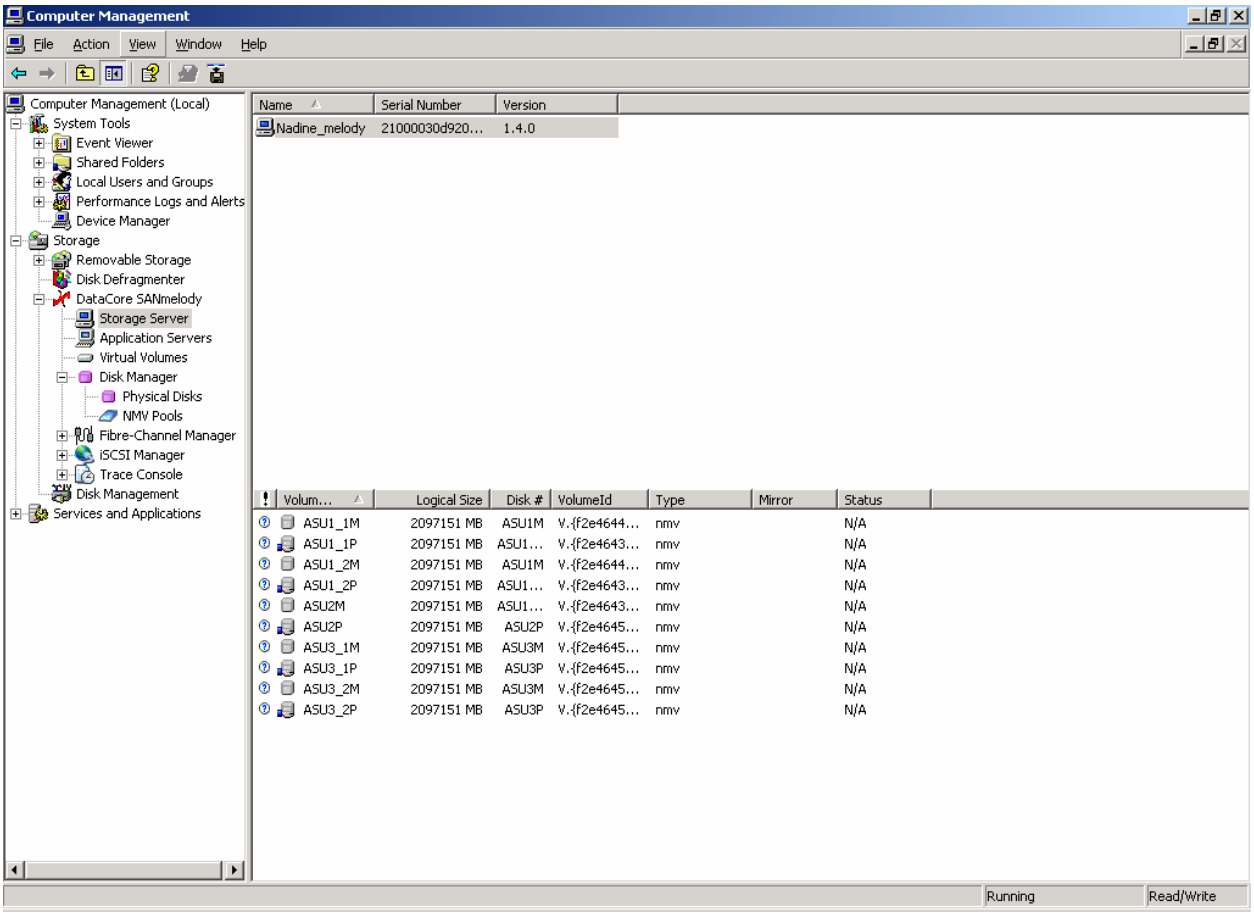
The next screenshot displays the command line to create pre-allocated logical volumes. The appropriate pool is selected and a logical volume of the desired size is created *(option 5 from the illustrated menu).*

In addition to static allocation, another advance feature of DataCore Network Managed Volumes used in this SPC-1 benchmark is fault tolerance (RAID 1). Two logical volumes of equal size are created internally and the Network Managed Volume subsystem presents a sing RAID 1 volume to the SPC-1 Workload Generator. The primary volume will receive both reads and writes. The secondary volume will receive only writes. The RAID 1 relationship is stored in memory by the Network Managed Volume subsystem.



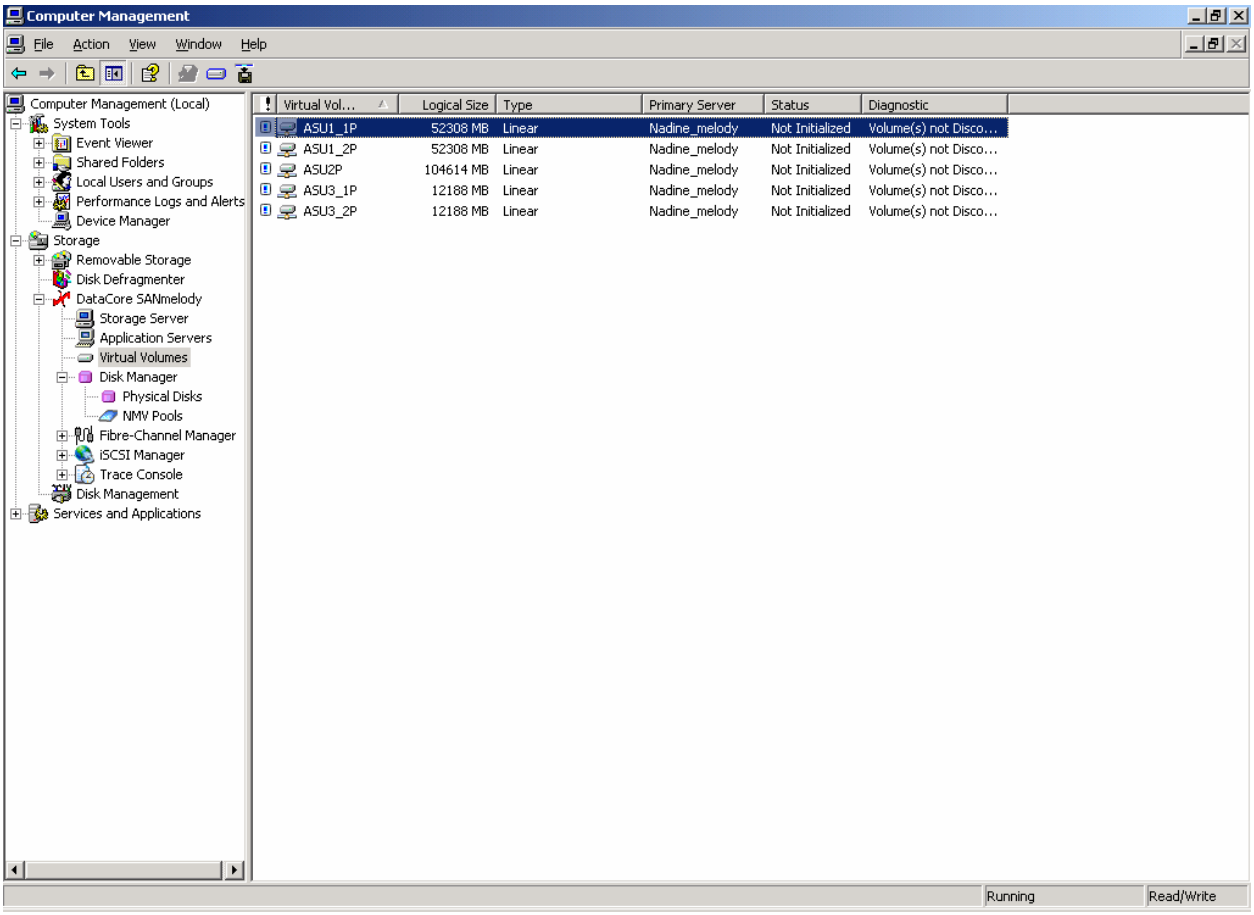
Storage Server – Logical Volume Availability

The Storage Server snap-in is illustrated below, which lists the logical volumes available to the SANmelody™ server. The default size of a NMV (Network Managed Volume) is 2 TB, but the snap-in does not reflect the actual size of pre-allocated volumes. During the creation of a virtual volume the pre-allocated size determines the amount of storage served to the SPC-1 Workload Generator, as illustrated in the next screenshot.



Virtual Volume Creation

The Virtual Volume snap-in, illustrated below, shows the logical volumes available to the SANmelody™ software and used to create virtual volumes for presentation to the SPC-1 Workload Generator. At this point, each virtual volume will be sized to match its pre-allocated size.



APPENDIX C: SPC-1 WORKLOAD GENERATOR STORAGE COMMANDS AND PARAMETERS

Master configuration file ("SPC1.cfg"):

```
host=master
slaves=(ex1,ex2)
#
sd=asu1_1,lun=\\.\x:,size=90g
sd=asu2_1,lun=\\.\y:,size=90g
sd=asu3_1,lun=\\.\z:,size=20g
```

Slave 1 configuration file:

```
host=ex1
master=localhost
#
sd=asu1_1,lun=\\.\x:,size=90g
sd=asu2_1,lun=\\.\y:,size=90g
sd=asu3_1,lun=\\.\z:,size=20g
```

Slave 2 configuration file:

```
host=ex2
master=localhost
#
sd=asu1_1,lun=\\.\x:,size=90g
sd=asu2_1,lun=\\.\y:,size=90g
sd=asu3_1,lun=\\.\z:,size=20g
```

APPENDIX D: THIRD-PARTY PRICE QUOTATIONS

Dell PowerEdge 2600: SANmelody™ Disk Server system *(page 1)*:

Oct 26 04 03:01p DataCore Software Corp. 954-938-7953 p.1

Dell - Client & Enterprise Solutions, Software, Peripherals, Services Page 1 of 2

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Description

PowerEdge 2600
Date & Time: October 26, 2004 2:48:54 PM

SYSTEM COMPONENTS

PowerEdge 2600 Qty 1
Intel® Xeon™ processor, 2.8GHz, 512K Cache, 533MHz Front Side Bus, Windows Server 2003 Standard Edition with 5 Client Licenses Unit Price $4,116.00
Save $600 on select PowerEdge 2600 servers through the Small Business division. - $600.00
Special offer

Catalog Number: 4

Module	Description	Product Code	Sku	Id
PowerEdge 2600	Intel® Xeon™ processor, 2.8GHz, 512K Cache, 533MHz Front Side Bus	26285	[221-2319]	1
Operating System	Windows Server 2003 Standard Edition with 5 Client Licenses	W2K3SVR	[420-2965]	11
Additional Processors	Intel® Xeon™ Processor, 2.8GHz, 512K Cache, 533MHz Front Side Bus	2P285	[311-2642]	2
Memory	1.5GB DDR SDRAM (6X256MB)	15GB6D	[311-3024]	3
Keyboard	NO KEYBOARD OPTION	N	[310-3281]	4
Monitors	No Monitor Option	N	[320-0058]	5
1st Hard Drive	36GB 10K RPM Ultra 320 SCSI Hard Drive	3610320	[340-6863]	8
Floppy	3.5 in, 1.44MB, Floppy Drive	FD	[340-3640]	10
Mouse	No Mouse Option	N	[310-0024]	12
CD-ROM	24X IDE CD-ROM	CD24X	[313-1281]	16
BackPlanes	1X6 Hot-Pluggable Backplane,PE2600	1X6BKPL	[311-1839]	18
Documentation	Electronic Documentation,P2600	EDOCS	[310-0438]	21
Factory Configurations	Drives attached to embedded SCSI controller, No RAID	MSN	[340-6468]	27
Chassis Style	Tower Chassis Orientation,P2600	TOWER	[310-1720]	28
Hardware Support Services	3Yr Same Day 4Hr Response Parts + Onsite Labor (7 Days x 24 Hours)	W3Y7X24	[960-1305] [980-4200] [980-4202]	29

http://ecomm.dell.com/dellstore/PopUps/popup_print_cart.aspx?c=us&cs=04&l=en&s=b... 10/26/2004

Dell PowerEdge 2600: SANmelody™ Disk Server system *(page 2)*:

Oct 26 04 03:02p DataCore Software Corp. 954-938-7953 p.2

Dell - Client & Enterprise Solutions, Software, Peripherals, Services Page 2 of 2

Installation Support Services	No Installation Assessment	NOINSTL	[900-9997]	32
Power Supplies	Non-Redundant Power Supply,PE2600	NREDPWR	[310-1727]	36
Mail- In Rebate	None	NONE	[463-1832]	81
Technical Sales Representative Contact	Yes	TSRYES	[462-9388]	192

TOTAL: $3,516.00

Additional Discounts and Coupons

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Limited time offer! -$0.00

	Total Price
Sub-total	**$3,516.00**
Shipping	--
Tax	--
Total Price	--

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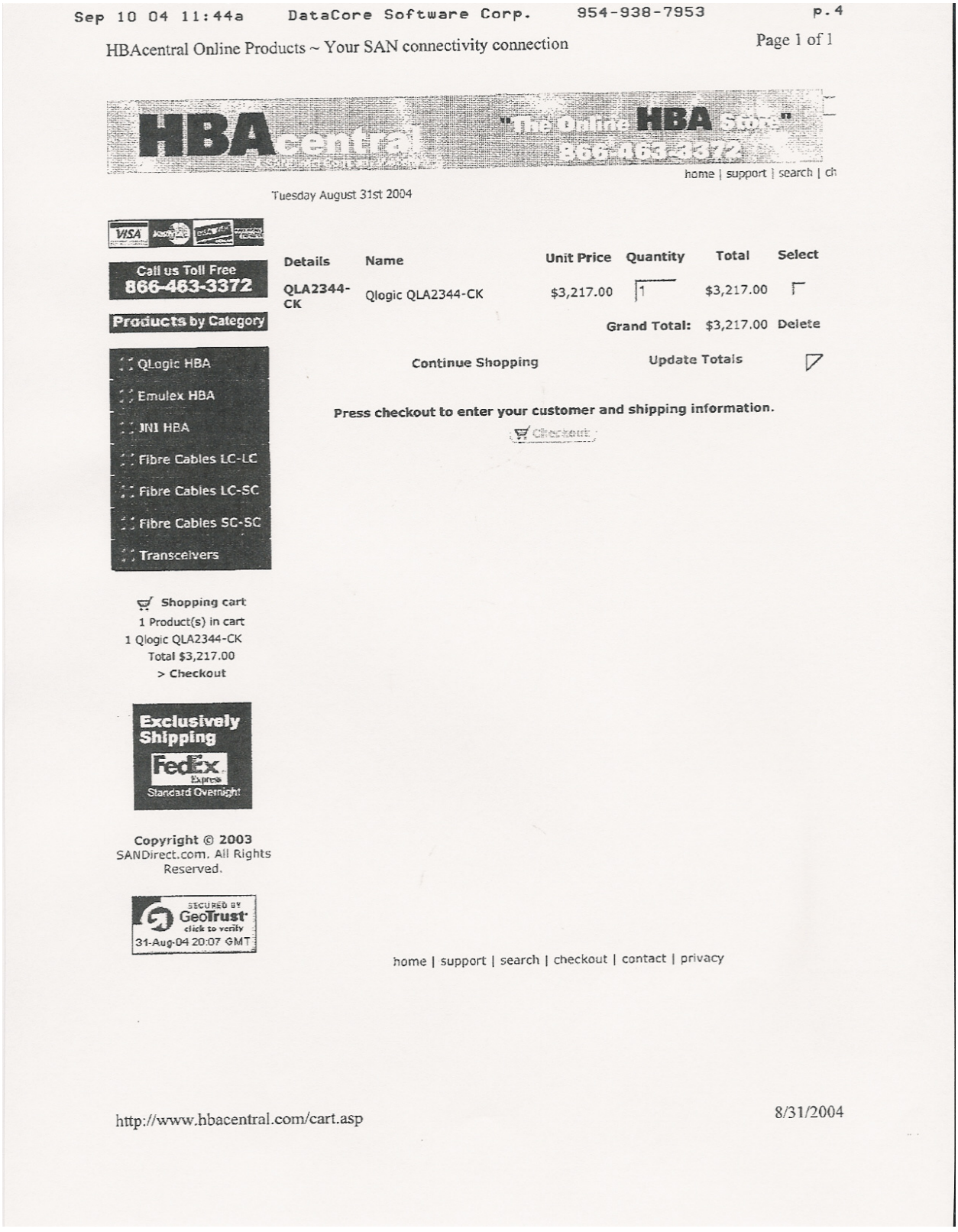
Qlogic QLA2344 HBA



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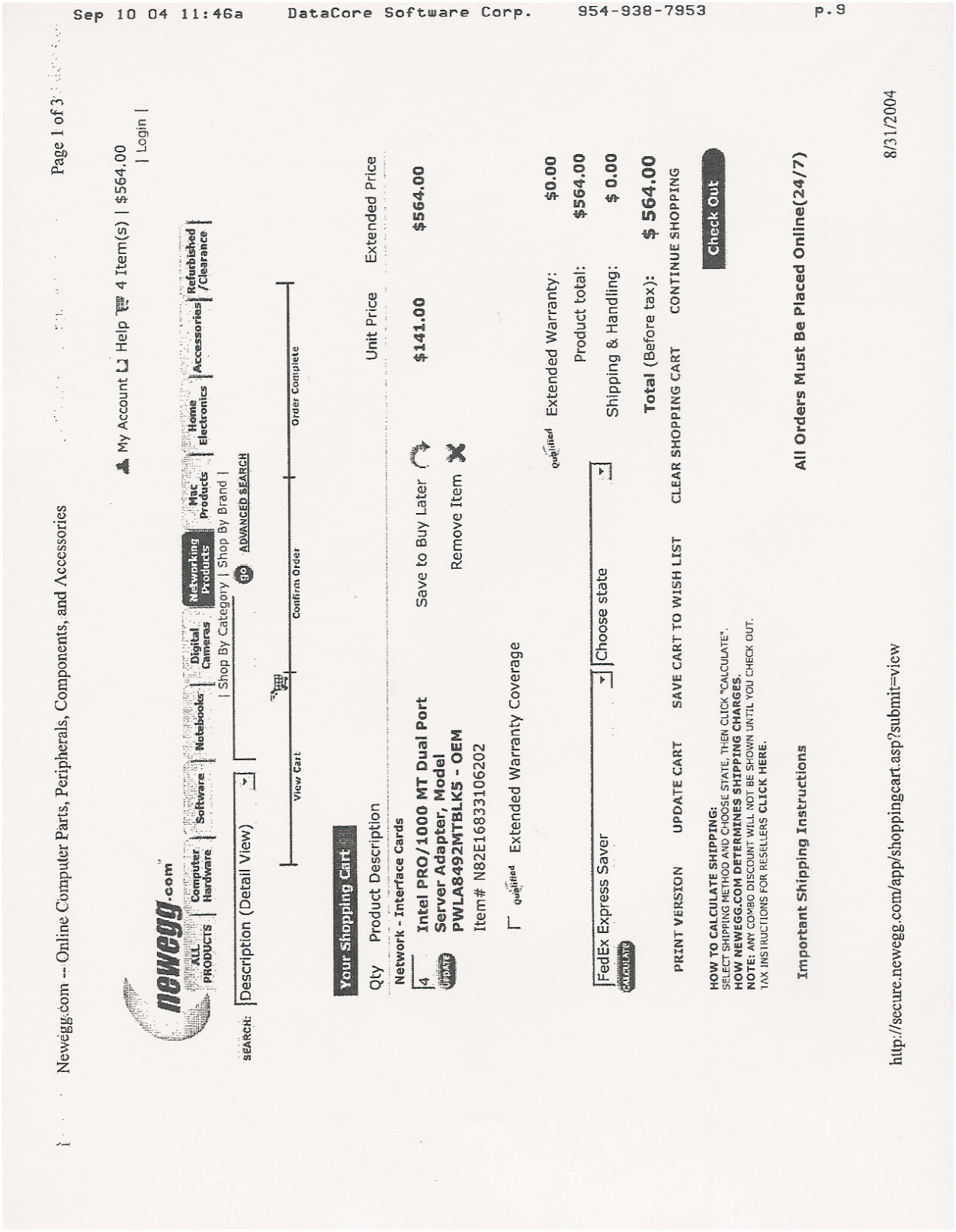
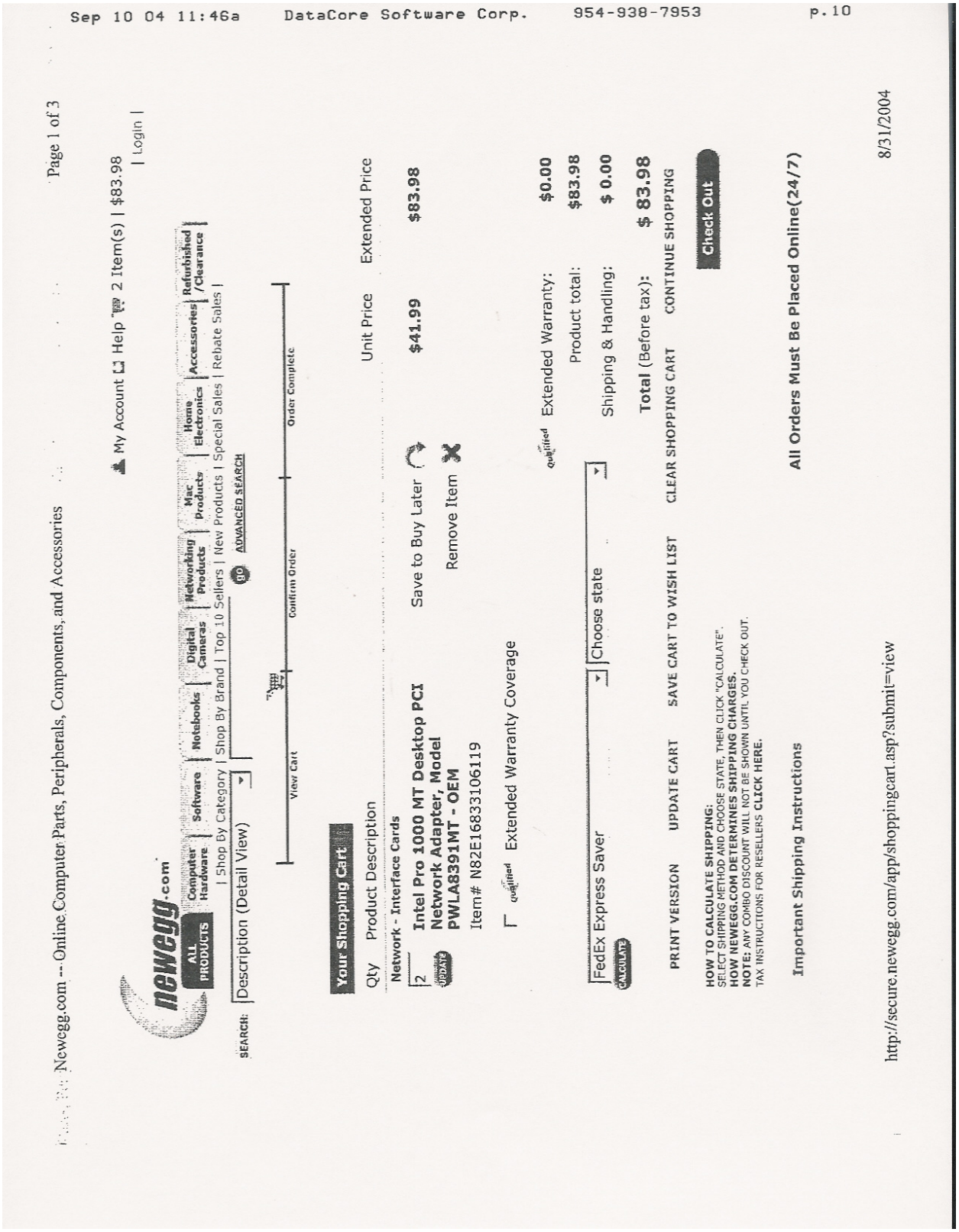
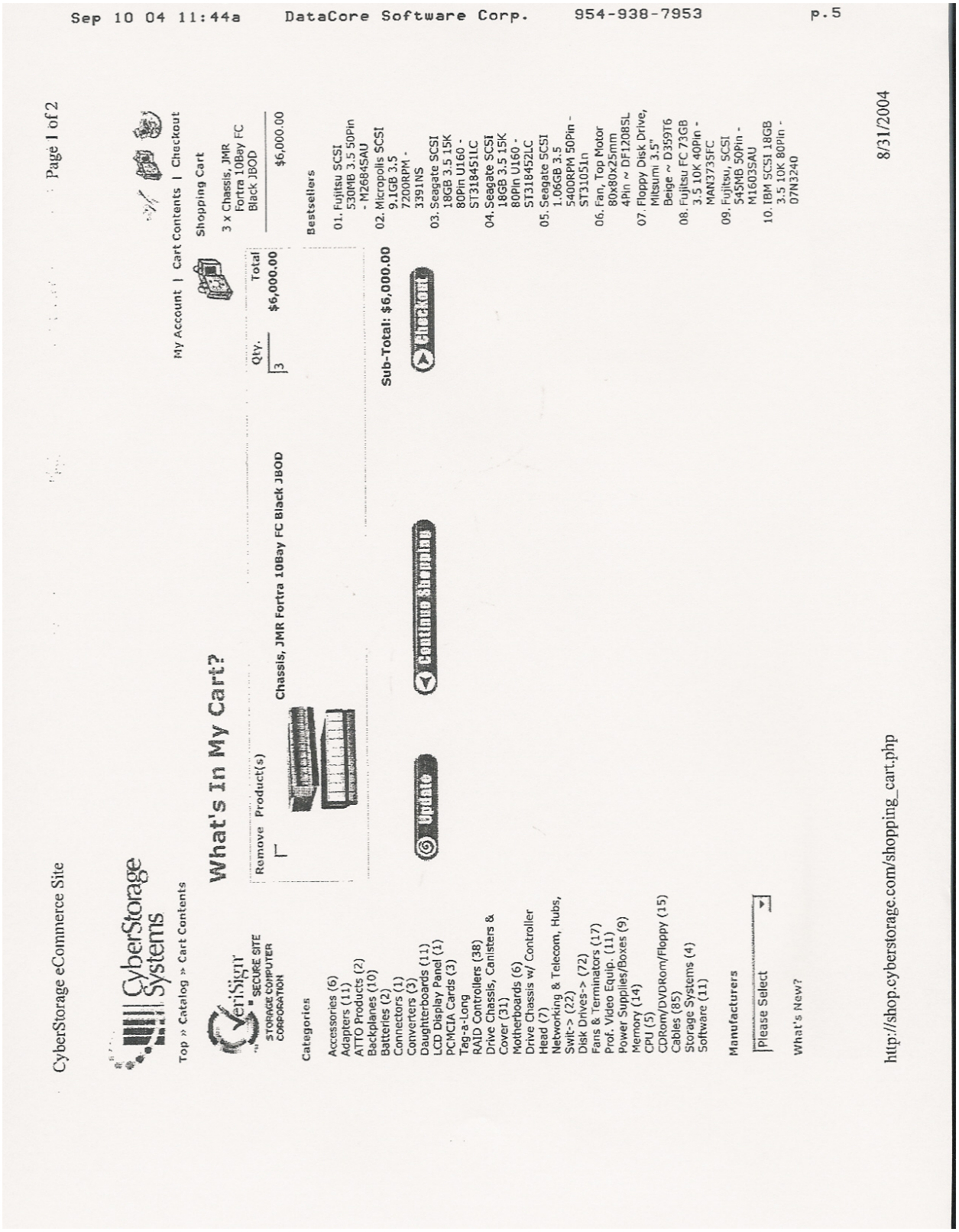


Intel Pro1000 MT Desktop Ethernet Adapter



JMR 10Bay Fibre Channel Chassis



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	Code	Product	Quantity	Price/Ea.	Total
Edit Remove	GCPO8889	Standard CAT 5e Patch Cord Cable Length: 5 foot Cable Color: Black	5 Update	$1.22	$6.10

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CAT5e & CAT6 PATCH CABLES | CISCO TYPE | COMPONENTS | COMPUTER | FIBRE CHANNEL | FIBER OPTICS | FIRE WIRE | IEEE-488 | KVM Switches and Cables | LINE CORD | PRINTER | SCSI | USB

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	Code	Product	Quantity	Price/Ea.	Total
Edit Remove	GCFAZCL	SC to LC Multimode Duplex Fiber Optic Patch Cable Cable Length: 3 meter Micron Size: 62.5µM	4 Update	$29.49	$117.96

Total: $117.96

Order FAQ

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