SPC BENCHMARK 1™
FULL DISCLOSURE REPORT

DATACORE SOFTWARE CORPORATION
DATACORE PARALLEL SERVER

SPC-1 V1.14

Submitted for Review: February 26, 2016
Submission Identifier: A00167
Revised: March 3, 2016

First Edition – February 2016

Trademarks

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AUDIT CERTIFICATION

Ben Treiber
DataCore Software Corporation
Worldwide Headquarters
Corporate Park
6300 NW 5th Way
Fort Lauderdale, FL 33309

February 25, 2016

The SPC Benchmark 1™ Reported Data listed below for the DataCore Parallel Server was produced in compliance with the SPC Benchmark 1™ v1.14 Remote Audit requirements.

SPC Benchmark 1™ v1.14 Reported Data	
Tested Storage Product (TSP) Name: DataCore Parallel Server	
Metric	**Reported Result**
SPC-1 IOPS™	1,510,090.52
SPC-1 Price-Performance	$0.09/SPC-1 IOPS™
Total ASU Capacity	2,920.000 GB
Data Protection Level	Protected 1 *(Mirroring)*
Total Price (including three-year maintenance)	$136,758.88
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

The following SPC Benchmark 1™ Remote Audit requirements were reviewed and found compliant with 1.14 of the SPC Benchmark 1™ specification:

- A Letter of Good Faith, signed by a senior executive.
- The following Data Repository storage items were verified by 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.

643 Bair Island Road, Suite 103
Redwood City, CA 94062
AuditService@storageperformance.org
650.556.9380

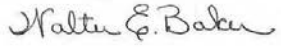
AUDIT CERTIFICATION *(CONT.)*

- The total Application Storage Unit (ASU) Capacity was filled with random data, using an auditor approved tool, prior to execution of the SPC-1 Tests.
- 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 that were changed from default values.
- SPC-1 Workload Generator commands and parameters used for the audited SPC Test Runs.
- The following Host System requirements were verified by information supplied by DataCore Software Corporation:
  - ✓ The type of Host Systems including the number of processors and main memory.
  - ✓ The presence and version number of the SPC-1 Workload Generator on each Host System.
  - ✓ The TSC boundary within each Host System.
- The execution of each Test, Test Phase, and Test Run was found compliant with all of the requirements and constraints of Clauses 4, 5, and 11 of the SPC-1 Benchmark Specification.
- 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) and Priced Storage Configuration.
- The submitted pricing information 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.
- This successfully audited SPC measurement is not subject to an SPC Confidential Review.

Audit Notes:

There were no audit notes or exceptions.

Respectfully,



Walter E. Baker
SPC Auditor

643 Bair Island Road, Suite 103
Redwood City, CA 94062
AuditService@storageperformance.org
650.556.9380

LETTER OF GOOD FAITH

DataCore™
SOFTWARE

Date: December 10, 2015

From: Roni Putra
DataCore Software Corporation
Worldwide Headquarters
Corporate Park
6300 NW 5th Way
Ft. Lauderdale, FL 33309
Phone: (954)-377-6000
FAX: (954) 938-7953

To: Walter E. Baker
SPC Auditor
Storage Performance Council (SPC)
643 Bair Island Road, Suite 103
Redwood City, CA 94063-2755
Phone: 650.556.9380 x111
FAX: 650.556.9385

Subject: SPC-1 Letter of Good Faith for DataCore Parallel Server on Lenovo x3650-M5 (DataCore Parallel Server)

DataCore Software Corporation 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 V1.14 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:

December 10th, 2015

Roni Putra, Vice President and CTO
DataCore Software Corporation

Date of Signature

DataCore Software Corporation
6300 NW 5th Way
Fort Lauderdale, FL 33309
T 954.377.6000 **F** 954.938.7953
info@datacore.com

www.datacore.com

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	DataCore Software Corporation – http://www.datacore.com Ben Treiber – ben.treiber@datacore.com Worldwide Headquarters Corporate Park 6300 NW 5th Way Ft. Lauderdale, FL 33309 Phone: (954) 377-6000 FAX: (954) 938-7953
Test Sponsor Alternate Contact	DataCore Software Corporation – http://www.datacore.com Roni Putra – roni.putra@datacore.com Worldwide Headquarters Corporate Park 6300 NW 5th Way Ft. 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	V1.14
SPC-1 Workload Generator revision number	V2.3.0
Date Results were first used publicly	February 26, 2016
Date the FDR was submitted to the SPC	February 26, 2016
Date the revised FDR was submitted to the SPC Revised pricing spreadsheet *(page 17)* server line item description (IBM->Lenovo) Added reference pricing notes *(page 18)* Corrected part number *(pages 22 and 26)* Samsung 120 GB SSD Revised third-party quotation *(page 101)* server line item description (IBM->Lenovo)	March 3, 2016
Date the Priced Storage Configuration is available for shipment to customers	May 16, 2016
Date the TSC completed audit certification	February 25, 2016

Tested Storage Product (TSP) Description

DataCore Parallel Server is a software product targeted for use when high IOPS and low latency are the primary requirements. This software is focused on improving I/O performance of hyper-converged and storage server systems with multi-processor, multi-core architectures. As this benchmark result on the Lenovo x3650-M5 demonstrates, by employing parallel processing, the software balances load and better utilizes memory, compute and storage resources to accelerate the I/O between the application and the storage subsystem. This parallel I/O architecture further enhances the system's ability to host many virtual machines or process intensive and mixed workloads typical of database and other transaction oriented applications.

DataCore Parallel Server is available to its Server OEM partners today and will be made available to all customers in Q2, 2016.

Summary of Results

SPC-1 Reported Data	
Tested Storage Product (TSP) Name: DataCore Parallel Server	
Metric	**Reported Result**
SPC-1 IOPS™	1,510,090.52
SPC-1 Price-Performance™	$0.09/SPC-1 IOPS™
Total ASU Capacity	2,920.000 GB
Data Protection Level	Protected 1 *(Mirroring)*
Total Price	$136,758.88
Currency Used	U.S. Dollars
Target Country for availability, sales and support	USA

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

SPC-1 Price-Performance™ is the ratio of **Total Price** to **SPC-1 IOPS™**.

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

A **Data Protection Level** of **Protected 1** using ***Mirroring*** configures two or more identical copies of user data.

> ***Protected 1:*** *The single point of failure of any* ***storage device*** *in the configuration will not result in permanent loss of access to or integrity of the SPC-1 Data Repository.*

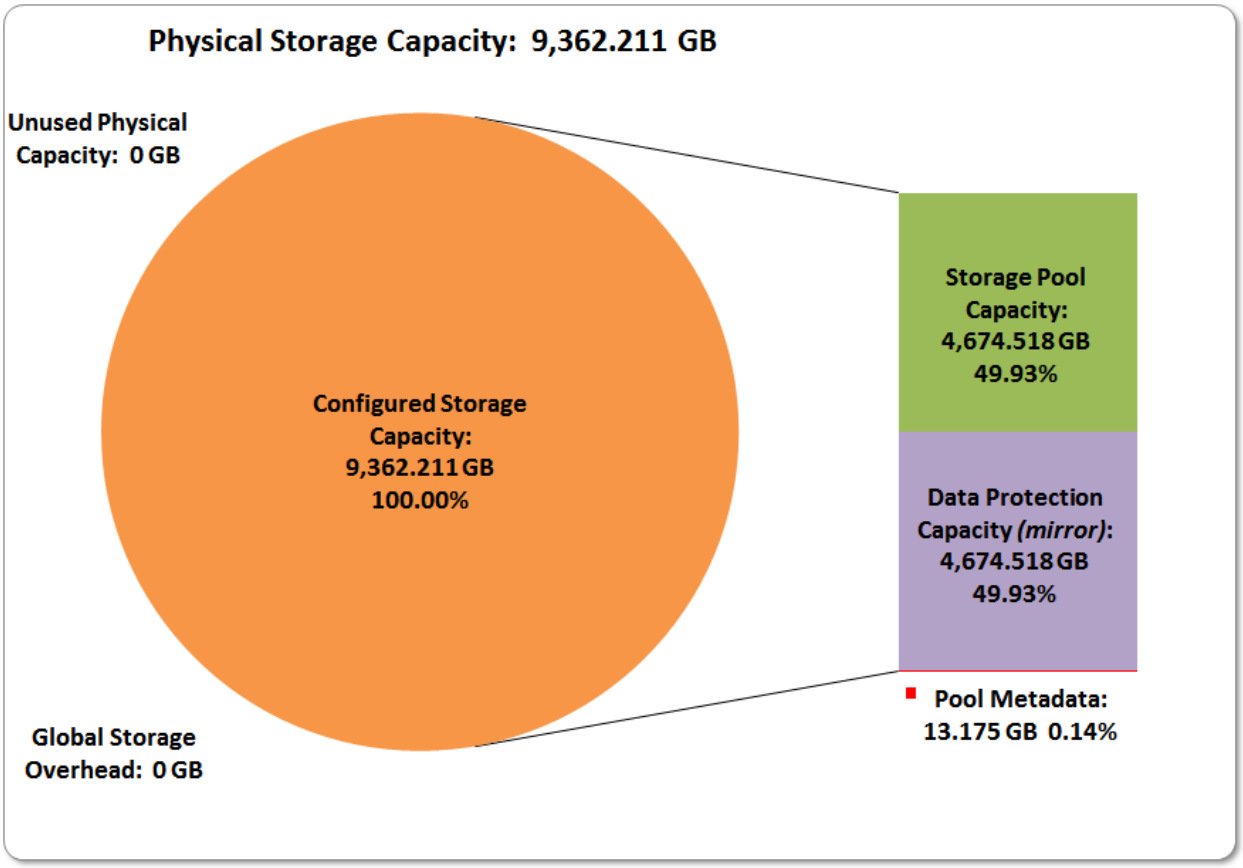
Total Price includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page 17.

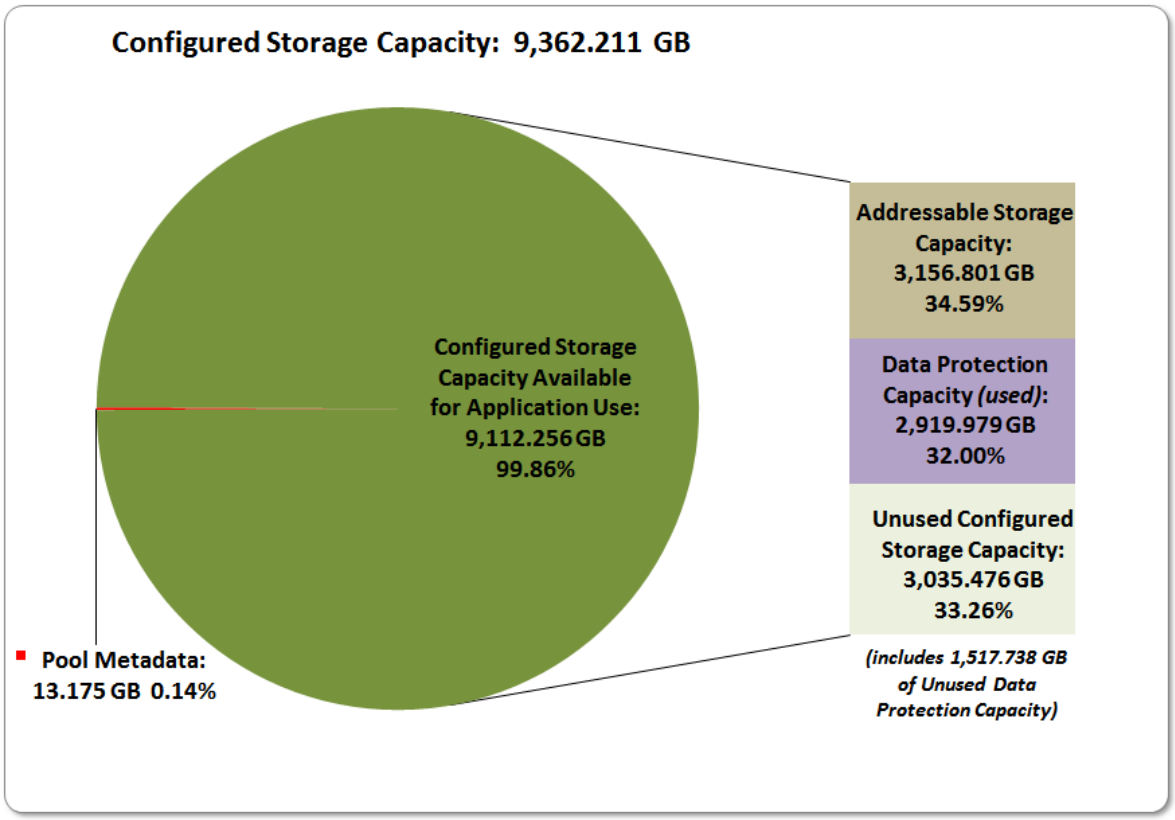
Currency Used is formal name for the currency used in calculating the **Total Price** and **SPC-1 Price-Performance™**. That currency may be the local currency of the **Target Country** or the currency of a difference country *(non-local currency)*.

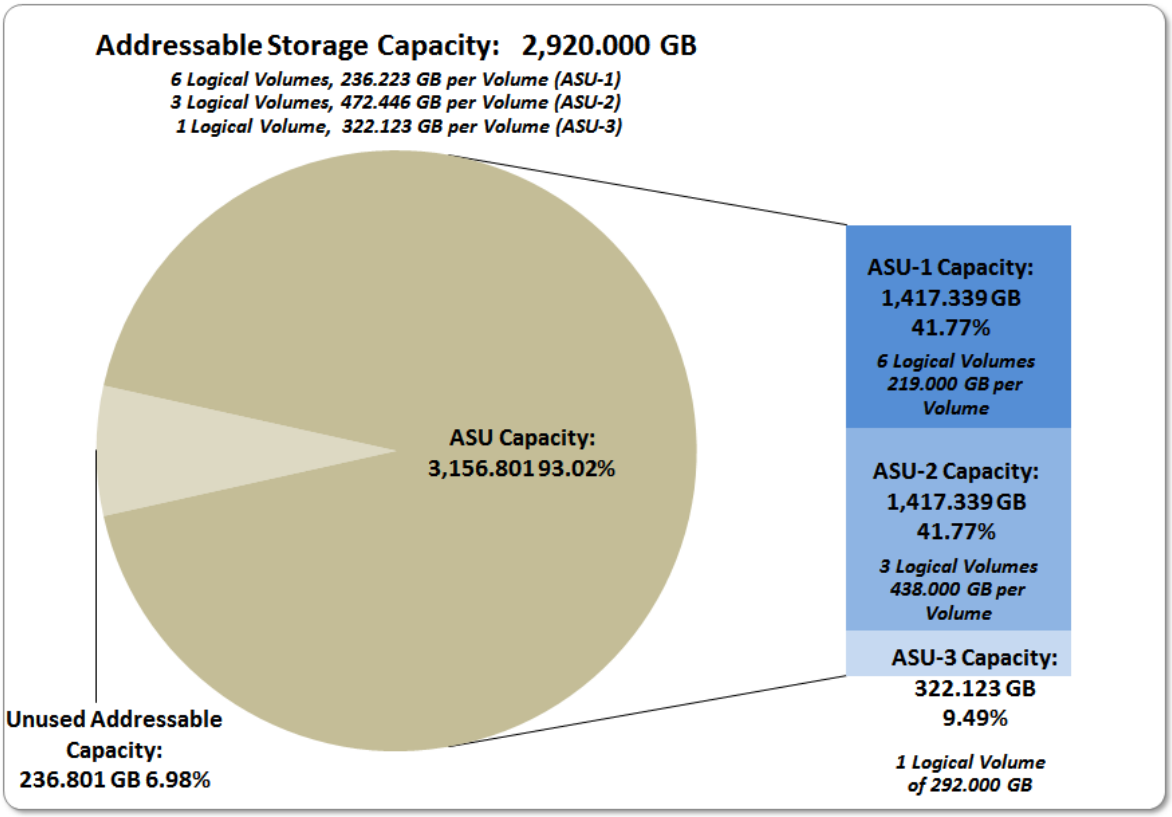
The **Target Country** is the country in which the Priced Storage Configuration is available for sale and in which the required hardware maintenance and software support is provided either directly from the Test Sponsor or indirectly via a third-party supplier.

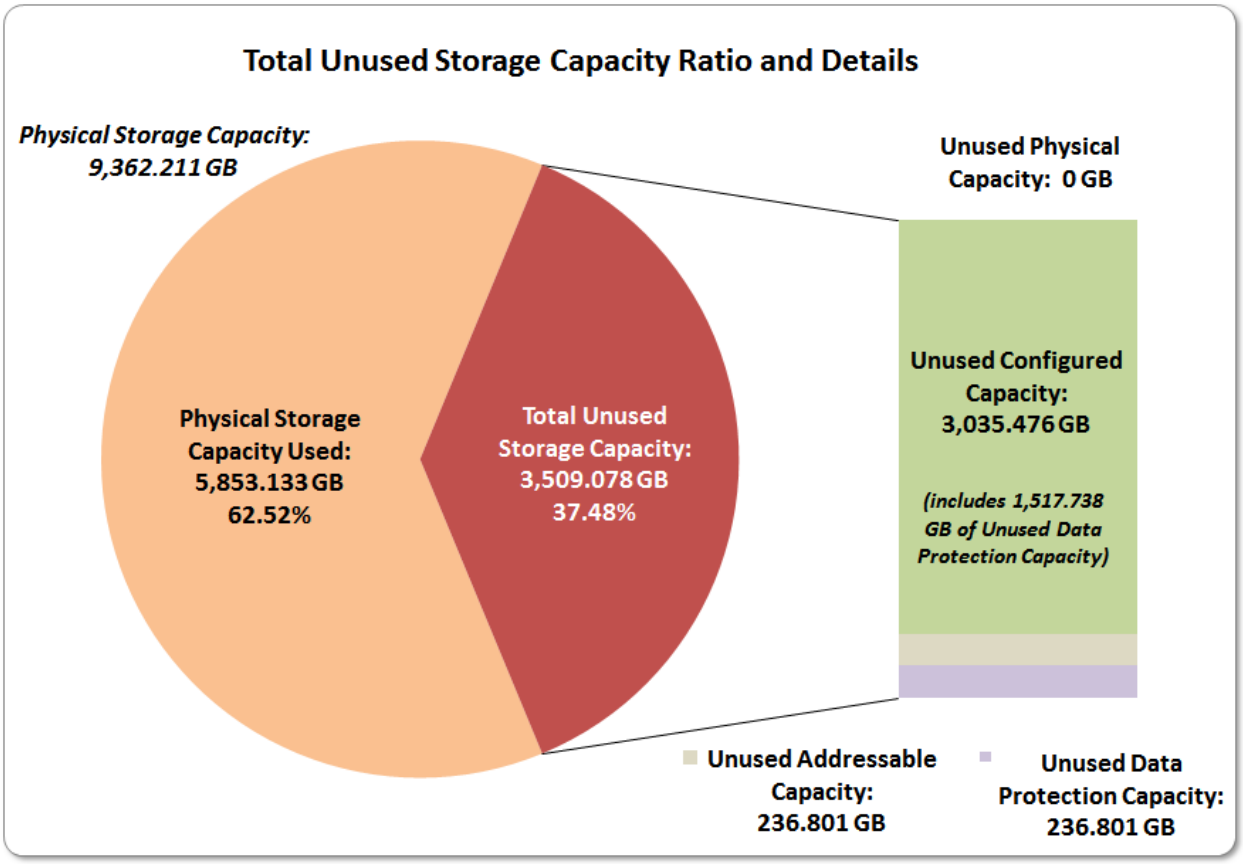
Storage Capacities, Relationships, and Utilization

The following four charts and table document the various storage capacities, used in this benchmark, and their relationships, as well as the storage utilization values required to be reported.




Configured Storage Capacity: 9,362.211 GB
Configured Storage Capacity Available for Application Use: 9,112.256 GB 99.86%
Pool Metadata: 13.175 GB 0.14%
Addressable Storage Capacity: 3,156.801 GB 34.59%
Data Protection Capacity (used): 2,919.979 GB 32.00%
Unused Configured Storage Capacity: 3,035.476 GB 33.26%
(includes 1,517.738 GB of Unused Data Protection Capacity)


Addressable Storage Capacity: 2,920.000 GB
6 Logical Volumes, 236.223 GB per Volume (ASU-1)
3 Logical Volumes, 472.446 GB per Volume (ASU-2)
1 Logical Volume, 322.123 GB per Volume (ASU-3)
ASU Capacity: 3,156.801 93.02%
Unused Addressable Capacity: 236.801 GB 6.98%
ASU-1 Capacity: 1,417.339 GB 41.77%
6 Logical Volumes 219.000 GB per Volume
ASU-2 Capacity: 1,417.339 GB 41.77%
3 Logical Volumes 438.000 GB per Volume
ASU-3 Capacity: 322.123 GB 9.49%
1 Logical Volume of 292.000 GB



SPC-1 Storage Capacity Utilization	
Application Utilization	31.19%
Protected Application Utilization	62.38%
Unused Storage Ratio	37.48%

Application Utilization: Total ASU Capacity *(2,920.000 GB)* divided by Physical Storage Capacity *(9,362.211 GB)*.

Protected Application Utilization: (Total ASU Capacity *(2,920.000 GB)* plus total Data Protection Capacity *(4,674.518 GB)* minus unused Data Protection Capacity *(1,754.539 GB)*) divided by Physical Storage Capacity *(9,362.211 GB)*.

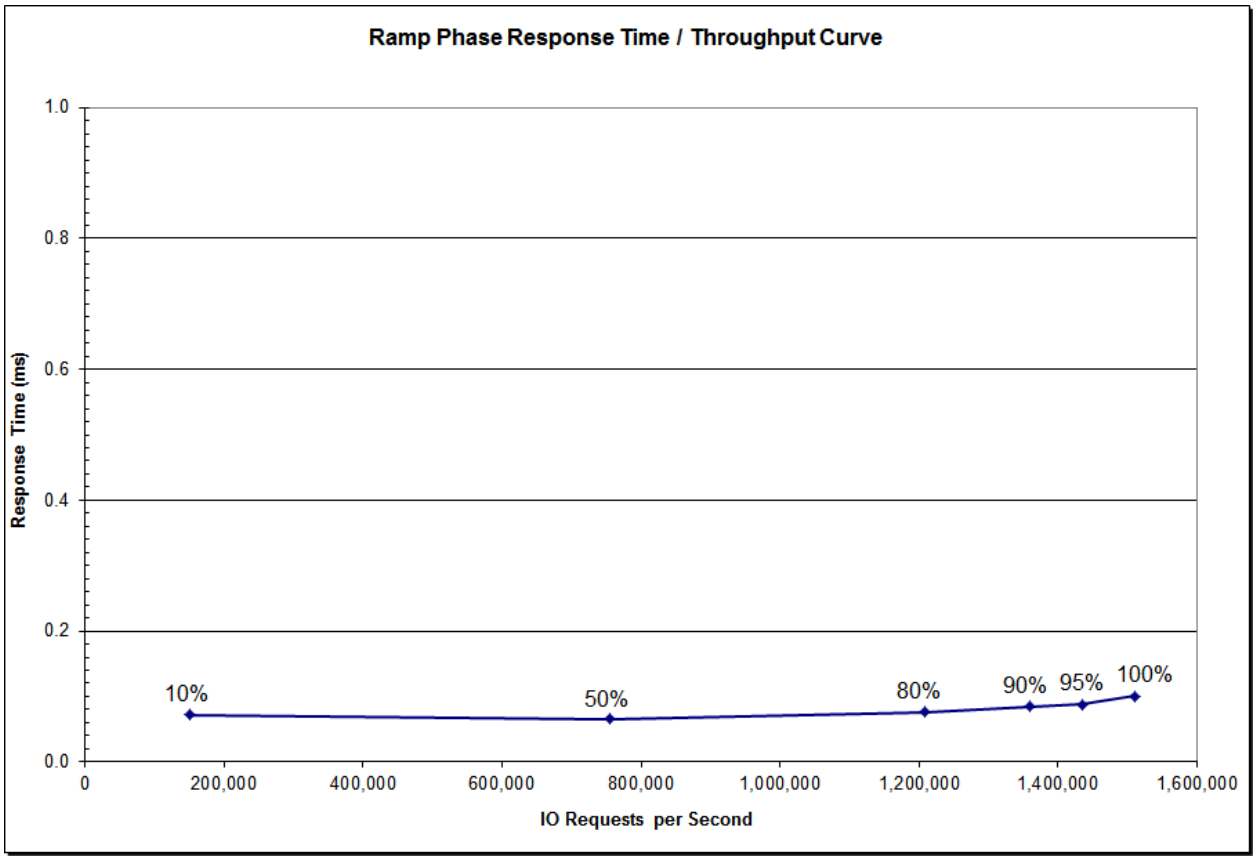
Unused Storage Ratio: Total Unused Capacity *(3,509.078 GB)* divided by Physical Storage Capacity *(9,362.211 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 29-30.

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	151,015.28	755,021.11	1,208,010.08	1,358,971.78	1,434,547.41	1,510,090.52
Average Response Time (ms):						
All ASUs	0.07	0.07	0.08	0.08	0.09	0.10
ASU-1	0.08	0.06	0.08	0.09	0.09	0.11
ASU-2	0.16	0.18	0.19	0.22	0.23	0.24
ASU-3	0.02	0.02	0.02	0.02	0.02	0.02
Reads	0.15	0.15	0.17	0.19	0.20	0.23
Writes	0.02	0.01	0.01	0.01	0.01	0.01

Priced Storage Configuration Pricing

Part ID	Description	Qty	List Price	Total List Price	Curvature Price	Total Price
5462AC1	LENOVO SYSTEM X3650 M5 2.5 SFF 8 BAY HOT SWAP	1	$ 3,150.00	$ 3,150.00	$ 2,205.00	$ 2,205.00
E5-2699V3	INTEL XEON E5-2699V3 CPU, 2.3GHZ, 18-CORE, 45MB, 2133MHZ, 145W	2	$ 5,799.00	$ 11,598.00	$ 4,059.30	$ 8,118.60
HEATSINK	LENOVO HEATSINK	2	$ 150.00	$ 300.00	$ 105.00	$ 210.00
SYSTEM FAN	LENOVO SYSTEM FAN	6	$ 95.00	$ 570.00	$ 66.50	$ 399.00
46W0800	32GB (1X32GB), PC4-17000, DDR4, 1.2V, LRDIMM	24	$ 999.00	$ 23,976.00	$ 699.30	$ 16,783.20
ST300MM0006	300GB 10K.6 SAS 2.5" 6G HDD	1	$ 250.00	$ 250.00	$ 175.00	$ 175.00
MZ-75E250B/AM	SAMSUNG 850 EVO 250 GB 2.5" INTERNAL SOLID STATE DRIVE - SATA	1	$ 149.99	$ 149.99	$ 104.99	$ 104.99
HUC156030CSS200	HDD, 300GB, 12G, SAS, 15K, SFF, WESTERN DIGITAL	8	$ 289.75	$ 2,318.00	$ 202.83	$ 1,622.64
46C9114	SERVER RAID M1215 SAS/SATA CONTROLLER	2	$ 225.00	$ 450.00	$ 157.50	$ 315.00
R18-04281	WINSVRCAL 2012 SNGL OLP NL USRCAL	1	$ 883.00	$ 883.00	$ 794.70	$ 794.70
P73-06285	OLP SNGL LANG WIN SVR STD 2012R2 NL 2PROC	1	$ 38.00	$ 38.00	$ 34.20	$ 34.20
DELL-PV-MD1220	DELL POWERVAULT MD1220 SAS STORAGE ARRAY - (24) 2.5" DRIVE BAYS, INCLUDES (2) 6GB SAS EMM CONTROLLERS (3DJRJ), BEZEL, AND (2) 600W POWER SUPPLIES (T307M). INCL DELL PROSUPPORT 3YR 24X7 4HR WARRANTY	1	$ 8,711.00	$ 8,711.00	$ 6,097.70	$ 6,097.70
LSI00343	AVAGO SAS 9300-8E HOST BUST ADAPTER	1	$ 675.00	$ 675.00	$ 472.50	$ 472.50
LSI00407	AVAGO MEGARAID SAS 9341-8I	1	$ 335.00	$ 335.00	$ 234.50	$ 234.50
2282600-R	ADAPTEC SAS EXTERNAL CABLE 6FT	1	$ 69.00	$ 69.00	$ 48.30	$ 48.30
00FK936	LENOVO SYSTEM X 900W HIGH EFFICIENCY PLATINUM AC POWER SUPPLY - 900 W - 120 V AC, 230 V AC	2	$ 399.00	$ 798.00	$ 279.30	$ 558.60
G176J	ASSEMBLY,CARRIER,HARD DRIVE SAS-SATAU,2.5,V2	24	$ 45.00	$ 1,080.00	$ 31.50	$ 756.00
00NR851	- LENOVO SERVICE/SUPPORT - 3 YEAR EXTENDED SERVICE - SERVICE - 24 X 7 X 4 HOUR - ON-SITE - MAINTENANCE - PARTS & LABOR - PHYSICAL SERVICE (SEE NOTE 3)	1	$ 810.00	$ 810.00	$ 688.50	$ 688.50
00LW731	LENOVO REMOTE TECHNICAL SUPPORT - 3 YEAR - 24 X 7 X 2 HOUR - TECHNICAL - ELECTRONIC SERVICE (SEE NOTE 3)	1	$ 1,375.00	$ 1,375.00	$ 1,168.75	$ 1,168.75
MZ-7KM120E	SSD, 120GB, 6Gb/s, SATA, 2.5"/SFF, SAMSUNG	22	$ 189.99	$ 4,179.78	$ 132.99	$ 2,925.78
00FK676	LENOVO SYSTEM X3650 M5 PLUS 8X2.5' HDD ASSEMBLY KIT	3	$ 249.00	$ 747.00	$ 174.30	$ 522.90
00FK658	LENOVO SYSTEM X3650 M5 REAR 2X2.5' HDD KIT	1	$ 379.00	$ 379.00	$ 265.30	$ 265.30
MZ-7KM240E	SSD, 240GB, 6GB, SATA, SFF, SAMSUNG	18	$ 239.99	$ 4,319.82	$ 167.99	$ 3,023.82
00E7600 L38552	2.5-INCH SFF DRIVE TRAY CADDY FOR IBM/LENOVO X3650 M5 (SEE NOTE 4)	25	$ 119.00	$ 2,975.00	$ 83.30	$ 2,082.50
			Net List Price:	$ 70,136.59	Net Cost:	$ 49,607.48
					Tax:	$ -
					Freight:	$ -
					Grand Total 3rd Party:	$ 49,607.48

Part ID	Description	Qty	List Price	Total List Price	Discounted Price	Total Price
PSS-EWR-100-BSV	DataCore Parallel Server Software	1	$ 71,144.00	$ 71,144.00	$ 56,915.20	$ 56,915.20
PSS-EWR-TGD-BSV	DataCore Parallel Server Software - 3 year Maintenance (SEE NOTE 6)	1	$ 35,572.00	$ 35,572.00	$ 30,236.20	$ 30,236.20
			Net List Price:	$176,852.59	Net Cost:	$ 87,151.40
					Tax:	$ -
					Freight:	$ -
					Grand Total DataCore:	$ 87,151.40

nd Total 3rd Party Hardware, Software and DataCore Software:	$ 136,758.88

Priced Storage Configuration Pricing *(continued)*

NOTES:

1. **DISCOUNT CLARIFICATION** - This quote reflects a 10% discount on software, a 30% discount on hardware, and a 15% discount on services and support. These discounts are unconditional.

2. **OPERATING SYSTEM DOWNGRADE** - With the purchase of an Open Business Windows 2012 license, you are eligible for downgrade rights. The Windows 2012 downgrade process is detailed through this link: https://www.microsoft.com/OEM/en/licensing/sblicensing/Pages/downgrade_rights.aspx#fbid=De_8hM07v15

3. **LENOVO SUPPORT** - Lenovo support covers all hardware components, including hard drives or solid state drives, as long as a Service pack is attached. Service level is determined by selected Service pack. In this case, 4HR on-site repair. The technical warranty refers to the service level of remote technical support. This service is over the phone/internet as it is remote. In this case, the service level is 2HR response. All service is provided directly from Lenovo.

4. **LENOVO DRIVE TRAY** - Lenovo drive trays are typically bundled with hard drives and don't have an individual part number. These are Lenovo OEM trays and will come installed on all hard drives.

5. **DELL WARRANTY** - Dell ProSupport is wholly provided by Dell directly. ProSupport is 4HR response after initial problem diagnosis after basic troubleshooting steps. After diagnosis, a Dell

6. **PARALLEL SERVER SOFTWARE MAINTENANCE** - Maintenance purchase (SKU # PSS-EWR-TGD-BSV) includes the following for 3 years:

- Three years, Web, email, chat and phone access to support.
- Coverage hours are 24 hours a day, 7 days a week, 365 days per year.
- Response goals based on customer indicated severity levels.
- Critical Severity 1 1 Hour response
- Medium Severity 2 4 Hour response
- Low Severity 3 Next business day response
- Product updates and upgrades.

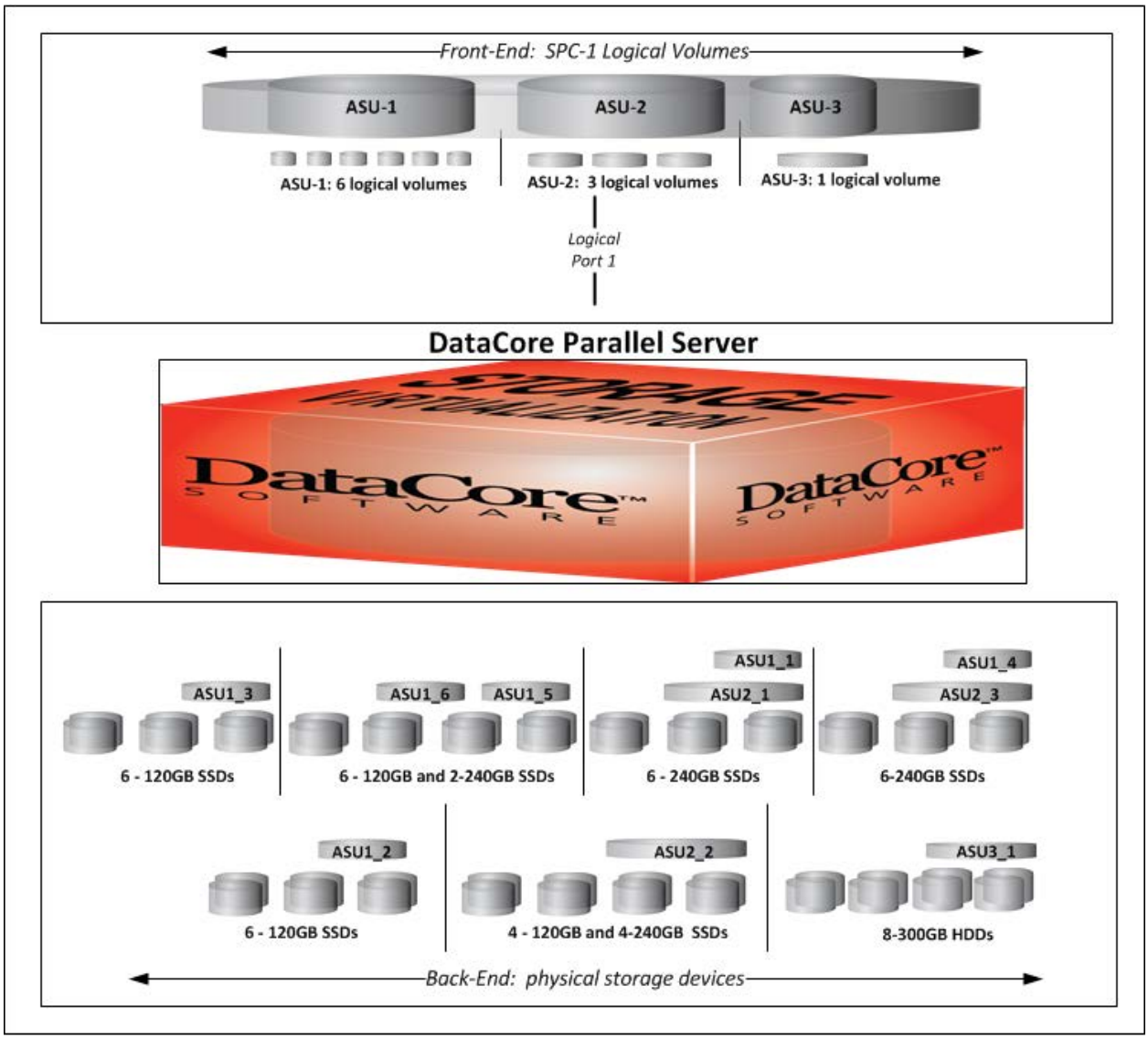
The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems within four (4) hours.
- Onsite presence of a qualified maintenance engineer or provision of a customer replaceable part within four (4) hours of the above acknowledgement for any hardware failure that results in an inoperative Price Storage Configuration that can be remedied by the repair or replacement of a Priced Storage Configuration component.

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

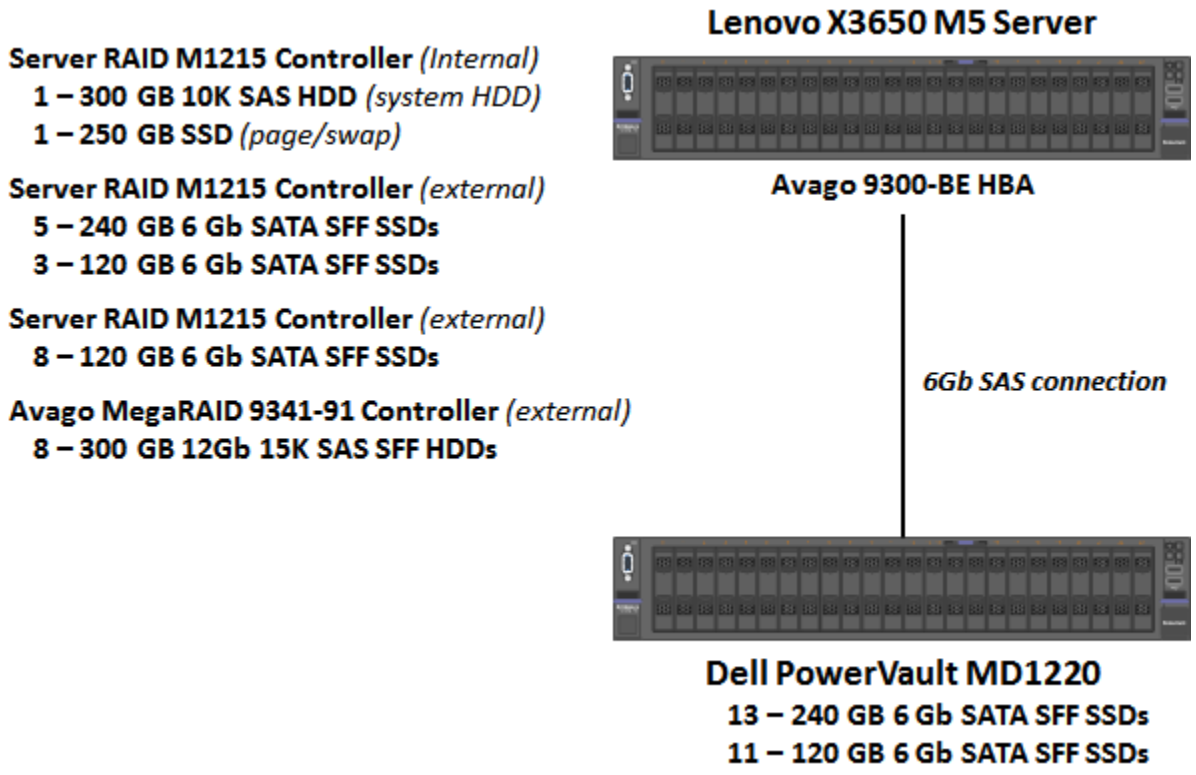
There were no differences between the Tested Storage Configuration and the Priced Storage Configuration.

Priced Storage Configuration Diagram *(logical)*



Key	
Front-End: SPC-1 Logical Volumes	ASU-1: 6 logical volumes *(ASU1_1-ASU1_6)* 236.223 GB per logical volume ASU-2: 3 logical volumes *(ASU2_1-ASU2_3)* 472.446 GB per logical volume ASU-3: 1 logical volume *(ASU3_1)* 322.123 GB per logical volume
Back-End physical storage devices	SSD Pool 1: 6 SSDs *(3 mirrored 120GB SSDs)* SSD Pool 2: 6 SSDs *(3 mirrored 120GB SSDs)* SSD Pool 3: 8 SSDs *(3 mirrored 120GB SSDs and 1 mirrored 240GB SSD)* SSD Pool 4: 6 SSDs *(3 mirrored 240GB SSDs)* SSD Pool 5: 8 SSDs *(2 mirrored 120GB SSDs and 2 mirrored 240GB SSDs)* SSD Pool 6: 6 SSDs *(3 mirrored 240GB SSDs)* HDD Pool 1: 8 HDDs *(4 mirrored 300 GB HDDs)*

Priced Storage Configuration Diagram *(physical)*



Priced Storage Configuration Components

Priced Storage Configuration
DataCore Parallel Server
1 – Lenovo X3650 M5 Server, with: 2 – Intel® Xeon® 2.30 GHz E5-2699 V3 processors each with 18 cores, 45 MB Intel Smart Cache 768 GB main memory *(566,231 MB configured for DataCore Parallel Server)* Windows 2008 R2 Enterprise Server w/SP1 PCIe
1 – Server RAID M1215 SAS/SATA Controller *(internal)*
2 – Server RAID M1215 SAS/SATA Controllers *(external)*
1 – Avago MegaRAID SAS 9341-8i Controller *(external)*
1 – Avago 9300-8E HBA
1 – 300 GB 10K SAS 2.5" 6G HDD *(system HDD)* *(connected to the internal M1215 Controller)*
1 – 250 GB 2.5" SSD *(page/swap) (Samsung 850 EVO MZ-75E250B/AM),* *(connected to the internal M1215 Controller)*
5 – 240 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM240HAGR-0E005)* *(connected to external M1215 Controller 1)*
3 – 120 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM120HAFD-0E005)* *(connected to external M1215 Controller 1)*
8 – 120 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM120HAFD-0E005)* *(connected to external M1215 Controller 2)*
8 – 300 GB 12Gb 15K SAS SFF HDDs *(Ultrastar C15K600)* *(connected to external* MegaRAID *9341-8i Controller)*
1 – Dell PowerVault MD1220 Storage Array 13 - 240 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM240HAGR-0E005)* 11 - 120 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM120HAFD-0E005)*

In each of the following sections of this document, the appropriate Full Disclosure Report requirement, from the SPC-1 benchmark specification, is stated in italics followed by the information to fulfill the stated requirement.

CONFIGURATION INFORMATION

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

Clause 9.4.3.4.1

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

The Benchmark Configuration (BC)/Tested Storage Configuration (TSC) is illustrated on page 24 *(Benchmark Configuration/Tested Storage Configuration Diagram)*.

Storage Network Configuration

Clause 9.4.3.4.1

…

5. *If the TSC contains network storage, the diagram will include the network configuration. If a single diagram is not sufficient to illustrate both the Benchmark Configuration and network configuration in sufficient detail, the Benchmark Configuration diagram will include a high-level network illustration as shown in Figure 9-8. In that case, a separate, detailed network configuration diagram will also be included as described in Clause 9.4.3.4.2.*

Clause 9.4.3.4.2

If a storage network was configured as a part of the Tested Storage Configuration and the Benchmark Configuration diagram described in Clause 9.4.3.4.1 contains a high-level illustration of the network configuration, the Executive Summary will contain a one page topology diagram of the storage network as illustrated in Figure 9-9.

The Tested Storage Configuration (TSC) was configured with direct-attached storage.

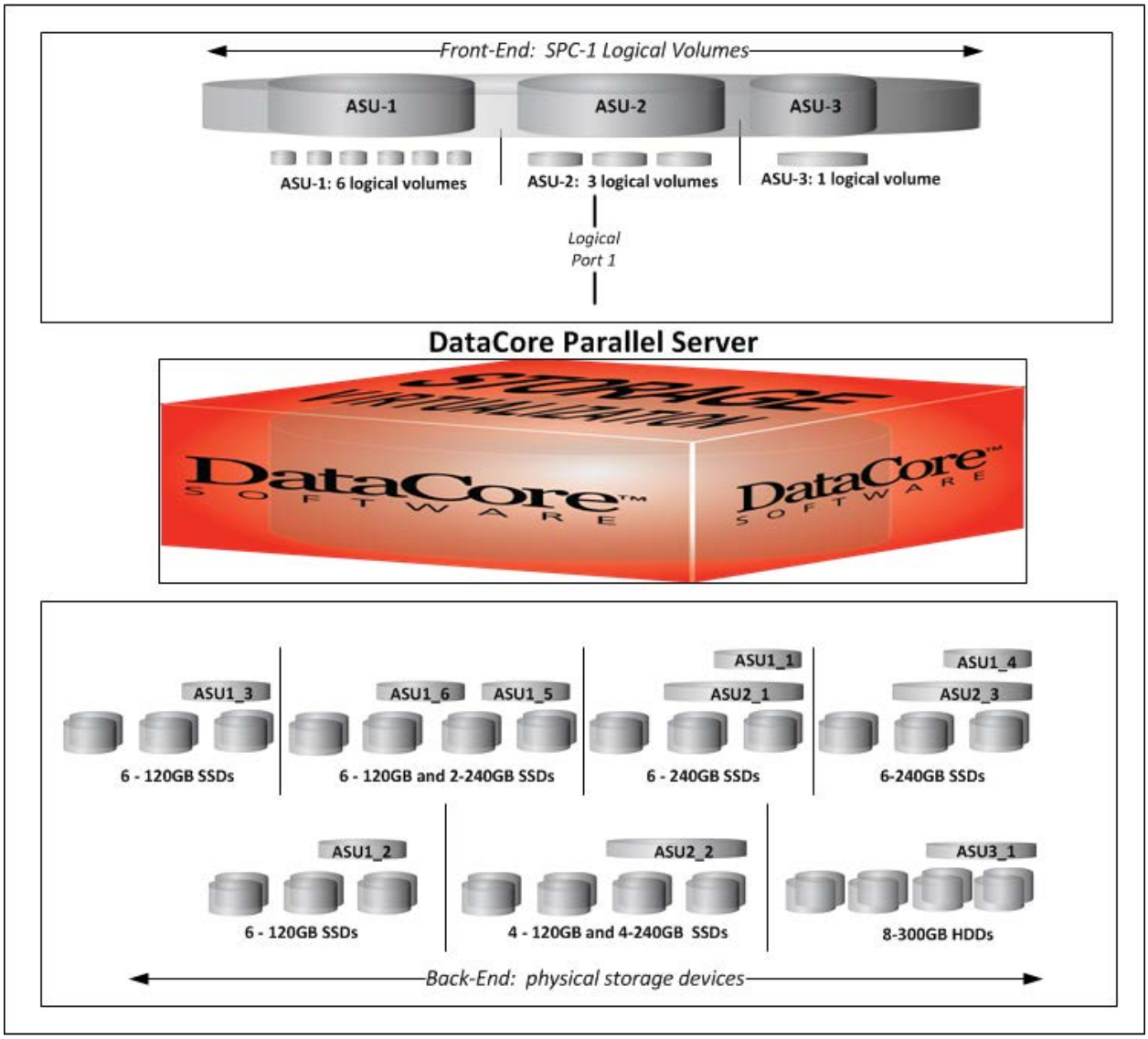
Host System(s) and Tested Storage Configuration (TSC) Table of Components

Clause 9.4.3.4.3

The FDR will contain a table that lists the major components of each Host System and the Tested Storage Configuration (TSC).

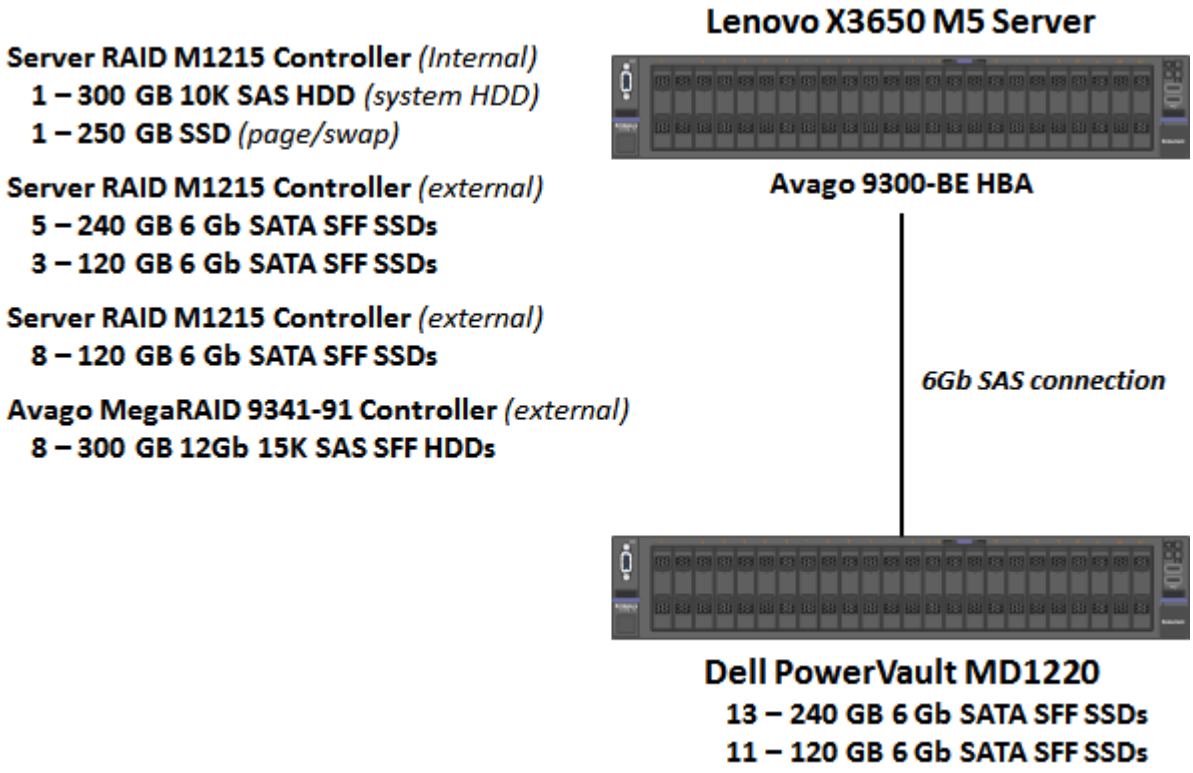
The Host System(s) and TSC table of components may be found on page 26 *(Host System and Tested Storage Configuration Components)*.

Benchmark Configuration/Tested Storage Configuration Diagram *(logical)*



Key	
Front-End: SPC-1 Logical Volumes	ASU-1: 6 logical volumes *(ASU1_1-ASU1_6)* 236.223 GB per logical volume ASU-2: 3 logical volumes *(ASU2_1-ASU2_3)* 472.446 GB per logical volume ASU-3: 1 logical volume *(ASU3_1)* 322.123 GB per logical volume
Back-End physical storage devices	SSD Pool 1: 6 SSDs *(3 mirrored 120GB SSDs)* SSD Pool 2: 6 SSDs *(3 mirrored 120GB SSDs)* SSD Pool 3: 8 SSDs *(3 mirrored 120GB SSDs and 1 mirrored 240GB SSD)* SSD Pool 4: 6 SSDs *(3 mirrored 240GB SSDs)* SSD Pool 5: 8 SSDs *(2 mirrored 120GB SSDs and 2 mirrored 240GB SSDs)* SSD Pool 6: 6 SSDs *(3 mirrored 240GB SSDs)* HDD Pool 1: 8 HDDs *(4 mirrored 300 GB HDDs)*

Benchmark Configuration/Tested Storage Configuration Diagram *(physical)*



Host System and Tested Storage Configuration Components

Priced Storage Configuration
DataCore Parallel Server
1 – Lenovo X3650 M5 Server, with: 2 – Intel® Xeon® 2.30 GHz E5-2699 V3 processors each with 18 cores, 45 MB Intel Smart Cache 768 GB main memory *(566,231 MB configured for DataCore Parallel Server)* Windows 2008 R2 Enterprise Server w/SP1 PCIe
1 – Server RAID M1215 SAS/SATA Controller *(internal)*
2 – Server RAID M1215 SAS/SATA Controllers *(external)*
1 – Avago MegaRAID SAS 9341-8i Controller *(external)*
1 – Avago 9300-8E HBA
1 – 300 GB 10K SAS 2.5" 6G HDD *(system HDD)* *(connected to the internal M1215 Controller)*
1 – 250 GB 2.5" SSD *(page/swap) (Samsung 850 EVO MZ-75E250B/AM),* *(connected to the internal M1215 Controller)*
5 – 240 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM240HAGR-0E005)* *(connected to external M1215 Controller 1)*
3 – 120 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM120HAFD-0E005)* *(connected to external M1215 Controller 1)*
8 – 120 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM120HAFD-0E005)* *(connected to external M1215 Controller 2)*
8 – 300 GB 12Gb 15K SAS SFF HDDs *(Ultrastar C15K600)* *(connected to external* MegaRAID *9341-8i Controller)*
1 – Dell PowerVault MD1220 Storage Array 13 - 240 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM240HAGR-0E005)* 11 - 120 GB, 6 Gb SATA SFF SSDs *(SAMSUNG MZ7KM120HAFD-0E005)*

Customer Tunable Parameters and Options

Clause 9.4.3.5.1

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. If the parameter name is not self-explanatory to a knowledgeable practitioner, a brief description of the parameter's use must also be included in the FDR entry.

Appendix B: Customer Tunable Parameters and Options on page 81 contains the customer tunable parameters and options that have been altered from their default values for this benchmark.

Tested Storage Configuration (TSC) Description

Clause 9.4.3.5.2

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 BC Configuration Diagram in Clause 9.2.4.4.1 and/or 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.*
- *Listings of scripts used to create the logical representation of the TSC.*
- *If scripts were not used, a description of the process used with sufficient detail to recreate the logical representation of the TSC.*

Appendix C: Tested Storage Configuration (TSC) Creation on page 85 contains the detailed information that describes how to create and configure the logical TSC.

SPC-1 Workload Generator Storage Configuration

Clause 9.4.3.5.3

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 D: SPC-1 Workload Generator Storage Commands and Parameters on page 92.

ASU Pre-Fill

Clause 5.3.3

Each of the three SPC-1 ASUs (ASU-1, ASU-2 and ASU-3) is required to be completely filled with specified content prior to the execution of audited SPC-1 Tests. The content is required to consist of random data pattern such as that produced by an SPC recommended tool.

The configuration file used to complete the required ASU pre-fill appears in Appendix D: SPC-1 Workload Generator Storage Commands and Parameters on page 92.

SPC-1 DATA REPOSITORY

This portion of the Full Disclosure Report presents the detailed information that fully documents the various SPC-1 storage capacities and mappings used in the Tested Storage Configuration. SPC-1 Data Repository Definitions on page 77 contains definitions of terms specific to the SPC-1 Data Repository.

Storage Capacities and Relationships

Clause 9.4.3.6.1

Two tables and four charts documenting the storage capacities and relationships of the SPC-1 Storage Hierarchy (Clause 2.1) shall be included in the FDR. … The capacity value in each chart may be listed as an integer value, for readability, rather than the decimal value listed in the table below.

SPC-1 Storage Capacities

The Physical Storage Capacity consisted of 9,362.211 GB distributed over:

- 22 solid state devices (SSDs), each with a formatted capacity of 120.032 GB
- 18 solid state devices (SSDs), each with a formatted capacity of 240.055 GB
- 8 disk drives (HDDs), each with a formatted capacity 300.066 GB.

There was 0 GB (0%) of Unused Storage within the Physical Storage Capacity. Global Storage Overhead consisted of 0 GB (0%) of the Physical Storage Capacity. There was 3,035.476 GB (32.42%) of Unused Storage within the Configured Storage Capacity. The Total ASU Capacity utilized 92.50% of the Addressable Storage Capacity resulting in 236.801 GB (7.50%) of Unused Storage within the Addressable Storage Capacity. The Data Protection *(Mirroring)* capacity was 4,674.518 GB of which 2,920.000 GB was utilized. The total Unused Storage capacity was 3,509.078 GB.

Note: The configured Storage Devices may include additional storage capacity reserved for system overhead, which is not accessible for application use. That storage capacity may not be included in the value presented for Physical Storage Capacity.

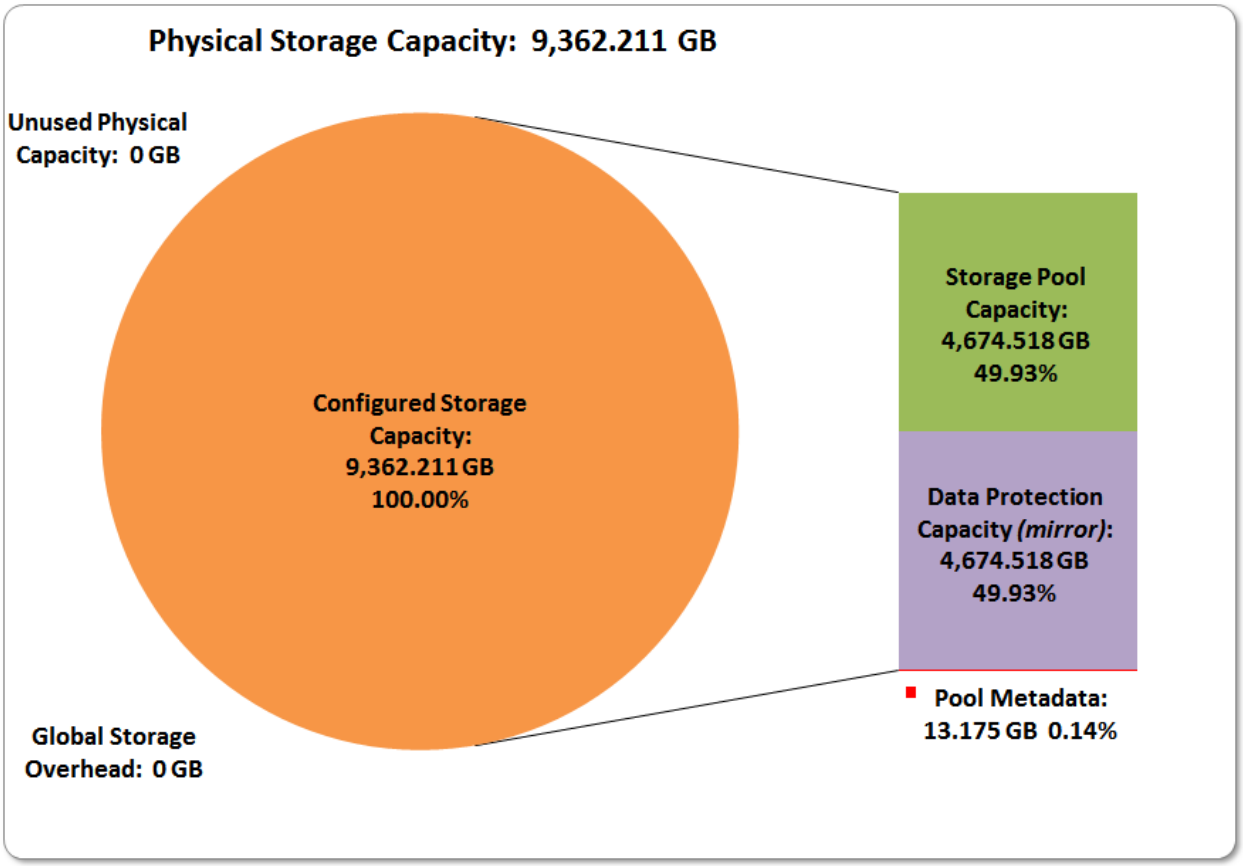
SPC-1 Storage Capacities

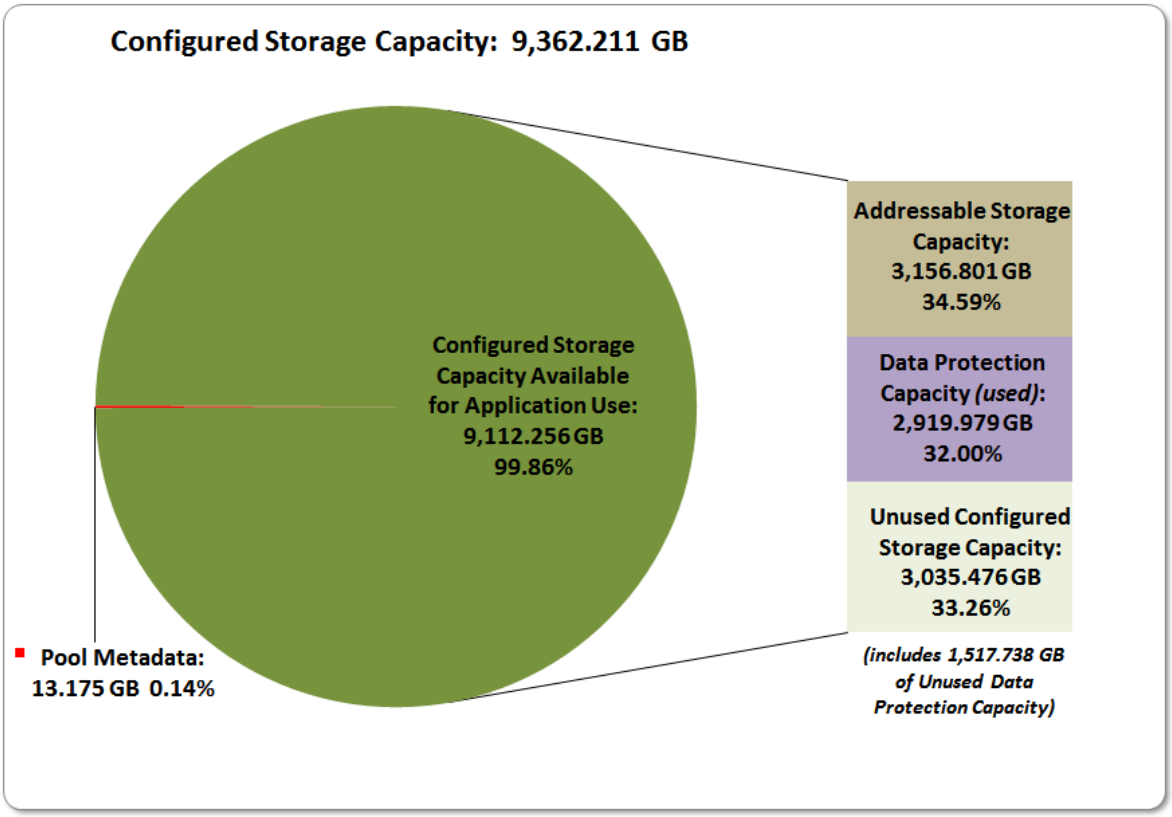
Storage Hierarchy Component	Units	Capacity
Total ASU Capacity	Gigabytes (GB)	2,920.000
Addressable Storage Capacity	Gigabytes (GB)	3,156.801
Configured Storage Capacity	Gigabytes (GB)	9,362.211
Physical Storage Capacity	Gigabytes (GB)	9,362.211
Data Protection *(Mirroring)*	Gigabytes (GB)	4,674.518
Required Storage *(metadata)*	Gigabytes (GB)	13.175
Global Storage Overhead	Gigabytes (GB)	0.000
Total Unused Storage	Gigabytes (GB)	3,509.078

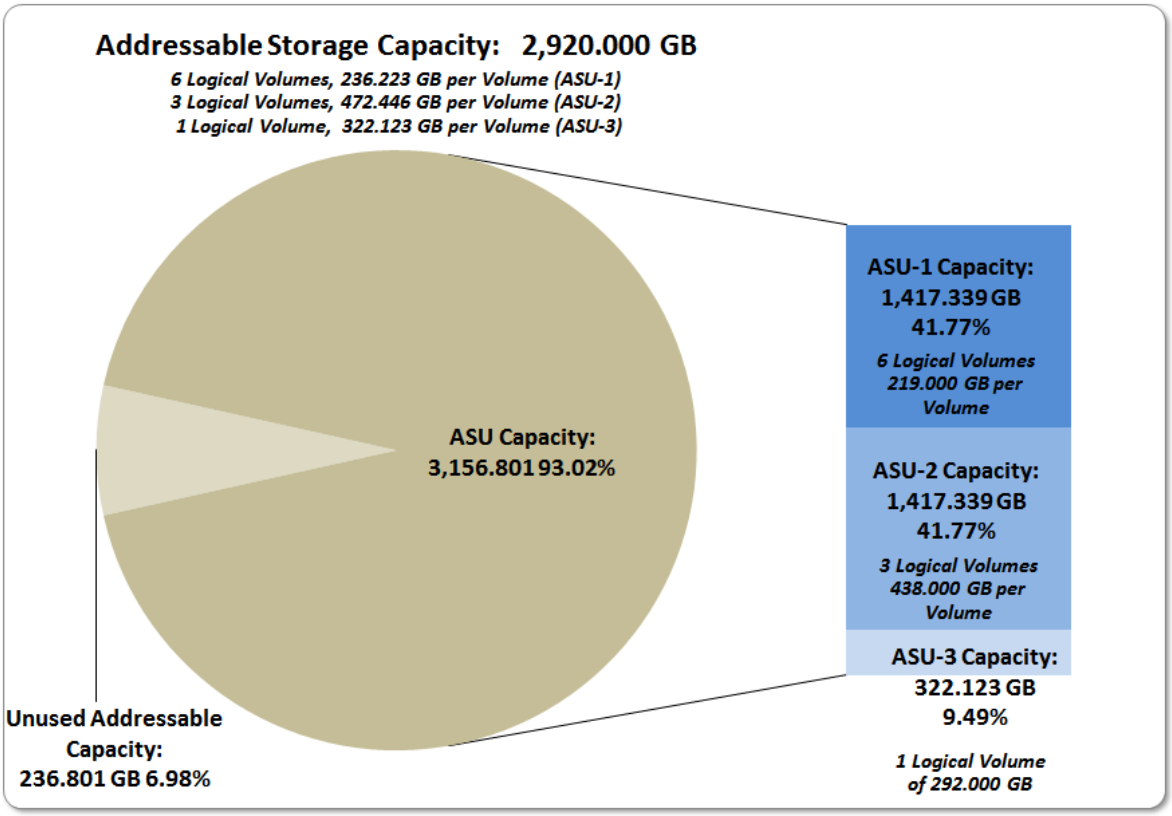
SPC-1 Storage Hierarchy Ratios

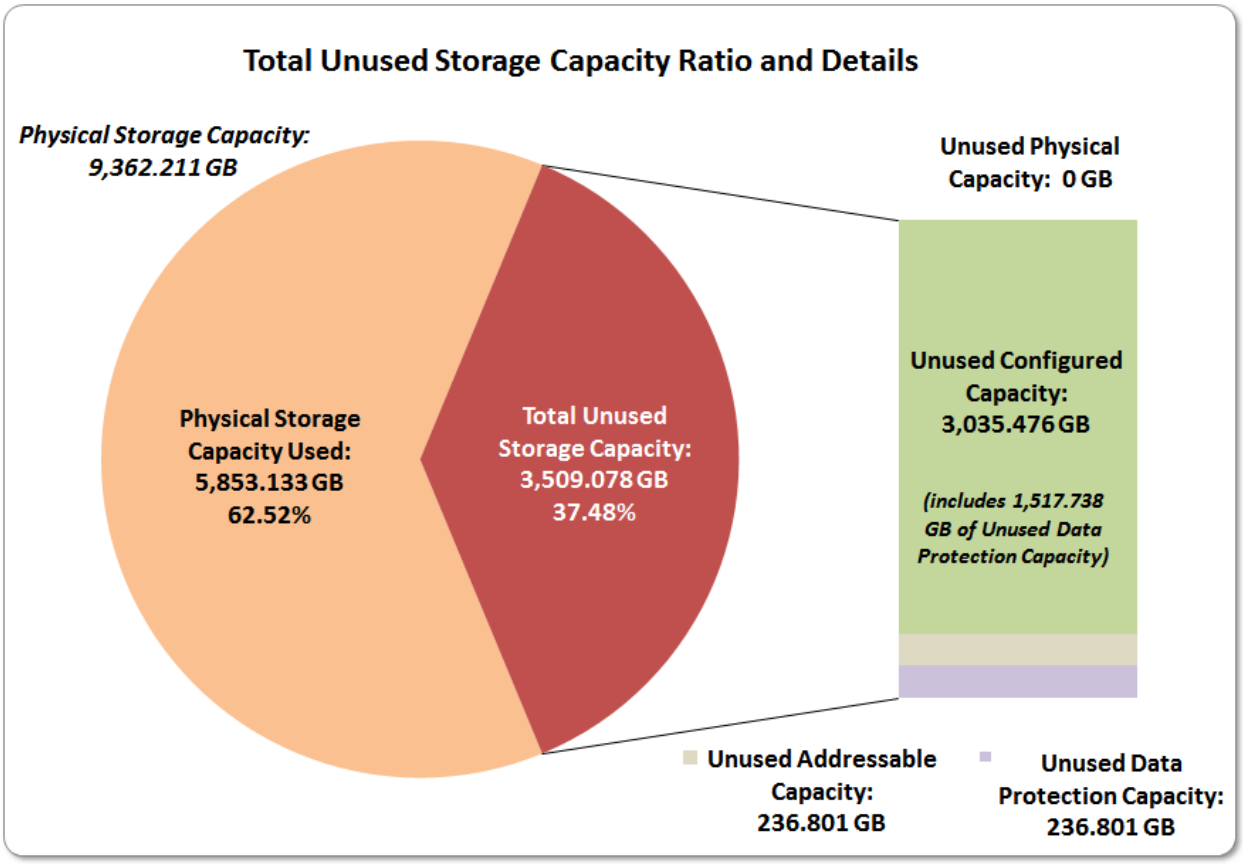
	Addressable Storage Capacity	Configured Storage Capacity	Physical Storage Capacity
Total ASU Capacity	92.50%	31.19%	31.19%
Required for Data Protection *(Mirroring)*		49.93%	49.93%
Addressable Storage Capacity		33.72%	33.72%
Required Storage *(metadata)*		0.14%	0.14%
Configured Storage Capacity			100.00%
Global Storage Overhead			0.00%
Unused Storage:			
Addressable	7.50%		
Configured		32.42%	
Physical			0.00%

SPC-1 Storage Capacity Charts




Configured Storage Capacity: 9,362.211 GB
Configured Storage Capacity Available for Application Use: 9,112.256 GB 99.86%
Pool Metadata: 13.175 GB 0.14%
Addressable Storage Capacity: 3,156.801 GB 34.59%
Data Protection Capacity (used): 2,919.979 GB 32.00%
Unused Configured Storage Capacity: 3,035.476 GB 33.26%
(includes 1,517.738 GB of Unused Data Protection Capacity)


Addressable Storage Capacity: 2,920.000 GB
6 Logical Volumes, 236.223 GB per Volume (ASU-1)
3 Logical Volumes, 472.446 GB per Volume (ASU-2)
1 Logical Volume, 322.123 GB per Volume (ASU-3)
ASU Capacity: 3,156.801 93.02%
Unused Addressable Capacity: 236.801 GB 6.98%
ASU-1 Capacity: 1,417.339 GB 41.77%
6 Logical Volumes 219.000 GB per Volume
ASU-2 Capacity: 1,417.339 GB 41.77%
3 Logical Volumes 438.000 GB per Volume
ASU-3 Capacity: 322.123 GB 9.49%
1 Logical Volume of 292.000 GB



Storage Capacity Utilization

Clause 9.4.3.6.2

The FDR will include a table illustrating the storage capacity utilization values defined for Application Utilization (Clause 2.8.1), Protected Application Utilization (Clause 2.8.2), and Unused Storage Ratio (Clause 2.8.3).

Clause 2.8.1

Application Utilization is defined as Total ASU Capacity divided by Physical Storage Capacity.

Clause 2.8.2

Protected Application Utilization is defined as (Total ASU Capacity plus total Data Protection Capacity minus unused Data Protection Capacity) divided by Physical Storage Capacity.

Clause 2.8.3

Unused Storage Ratio is defined as Total Unused Capacity divided by Physical Storage Capacity and may not exceed 45%.

SPC-1 Storage Capacity Utilization	
Application Utilization	31.19%
Protected Application Utilization	62.38%
Unused Storage Ratio	37.48%

Logical Volume Capacity and ASU Mapping

Clause 9.4.3.6.3

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 (1,314.000 GB)
6 Logical Volumes 236.223 GB per Logical Volume (219.000 GB used per Logical Volume)
ASU-2 (1,314.000 GB)
3 Logical Volumes 472.446 GB per Logical Volume (438.000 GB used per Logical Volume)
ASU-3 (292.000 GB)
1 Logical Volume 322.123 GB per Logical Volume (292.000 GB used per Logical Volume)

The Data Protection Level used for all Logical Volumes was **Protected 1** using ***Mirroring*** as described on page 12. See "ASU Configuration" in the **IOPS Test Results File** for more detailed configuration information.

SPC-1 BENCHMARK EXECUTION RESULTS

This portion of the Full Disclosure Report documents the results of the various SPC-1 Tests, Test Phases, and Test Runs. An SPC-1 glossary on page 77 contains definitions of terms specific to the SPC-1 Tests, Test Phases, and Test Runs.

Clause 5.4.3

The Tests must be executed in the following sequence: Primary Metrics, Repeatability, and Data Persistence. That required sequence must be uninterrupted from the start of Primary Metrics to the completion of Persistence Test Run 1. Uninterrupted means the Benchmark Configuration shall not be power cycled, restarted, disturbed, altered, or adjusted during the above measurement sequence. If the required sequence is interrupted other than for the Host System/TSC power cycle between the two Persistence Test Runs, the measurement is invalid.

SPC-1 Tests, Test Phases, and Test Runs

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

- **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
- **Data Persistence Test**
  - Data Persistence Test Run 1
  - Data Persistence Test Run 2

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

"Ramp-Up" Test Runs

Clause 5.3.13

In order to warm-up caches or perform the initial ASU data migration in a multi-tier configuration, a Test Sponsor may perform a series of "Ramp-Up" Test Runs as a substitute for an initial, gradual Ramp-Up.

Clause 5.3.13.3

The "Ramp-Up" Test Runs will immediately precede the Primary Metrics Test as part of the uninterrupted SPC-1 measurement sequence.

Clause 9.4.3.7.1

If a series of "Ramp-Up" Test Runs were included in the SPC-1 measurement sequence, the FDR shall report the duration (ramp-up and measurement interval), BSU level, SPC-1 IOPS and average response time for each "Ramp-Up" Test Run in an appropriate table.

There were no "Ramp-Up" Test Runs executed.

Primary Metrics Test – Sustainability Test Phase

Clause 5.4.4.1.1

The Sustainability Test Phase has exactly one Test Run and shall demonstrate the maximum sustainable I/O Request Throughput within at least a continuous eight (8) hour Measurement Interval. This Test Phase also serves to insure that the TSC has reached Steady State prior to reporting the final maximum I/O Request Throughput result (SPC-1 IOPS™).

Clause 5.4.4.1.2

The computed I/O Request Throughput of the Sustainability Test must be within 5% of the reported SPC-1 IOPS™ result.

Clause 5.4.4.1.4

The Average Response Time, as defined in Clause 5.1.1, will be computed and reported for the Sustainability Test Run and cannot exceed 30 milliseconds. If the Average Response time exceeds that 30-milliseconds constraint, the measurement is invalid.

Clause 9.4.3.7.2

For the Sustainability Test Phase the FDR shall contain:

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

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 94.

Sustainability Test Results File

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

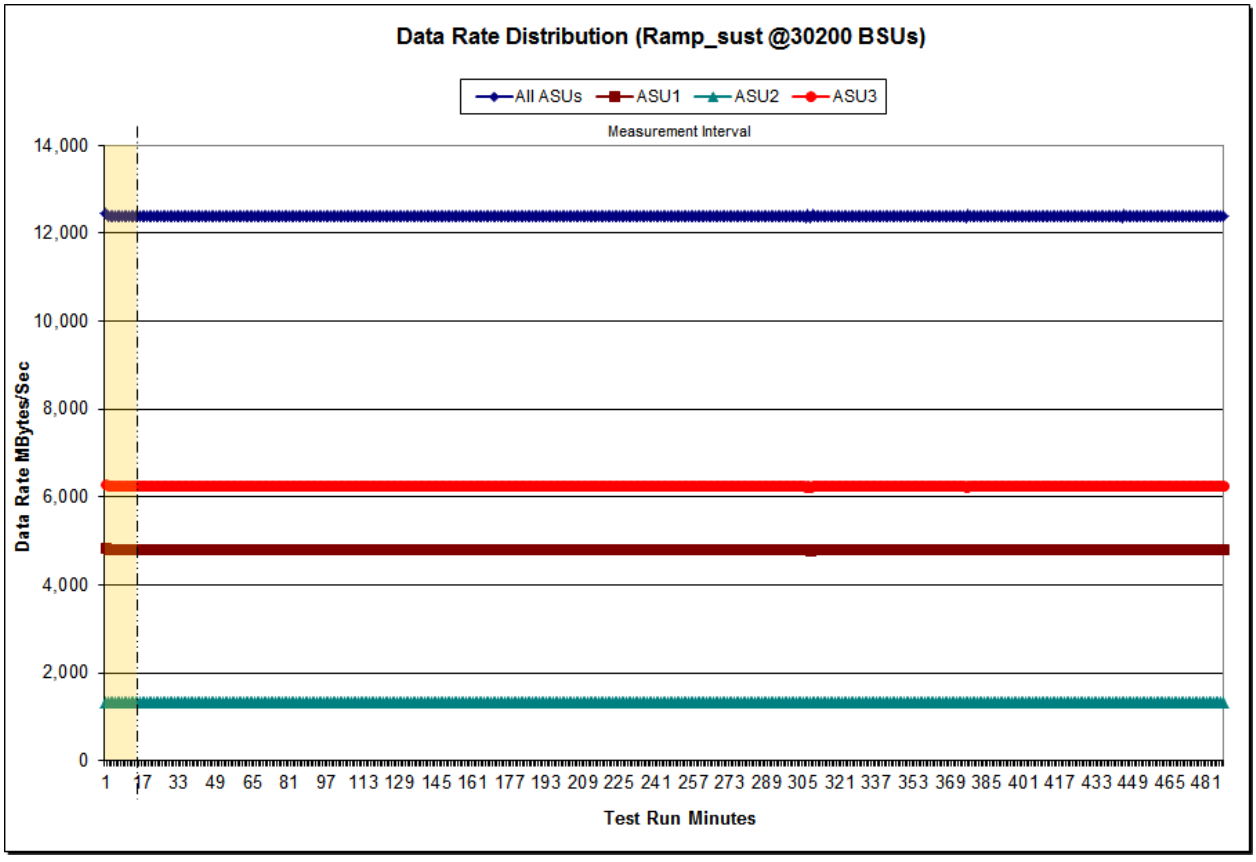
Sustainability Test Results File

Sustainability – Data Rate Distribution Data (MB/second)

The Sustainability Data Rate table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability Data Rate Table

Sustainability – Data Rate Distribution Graph

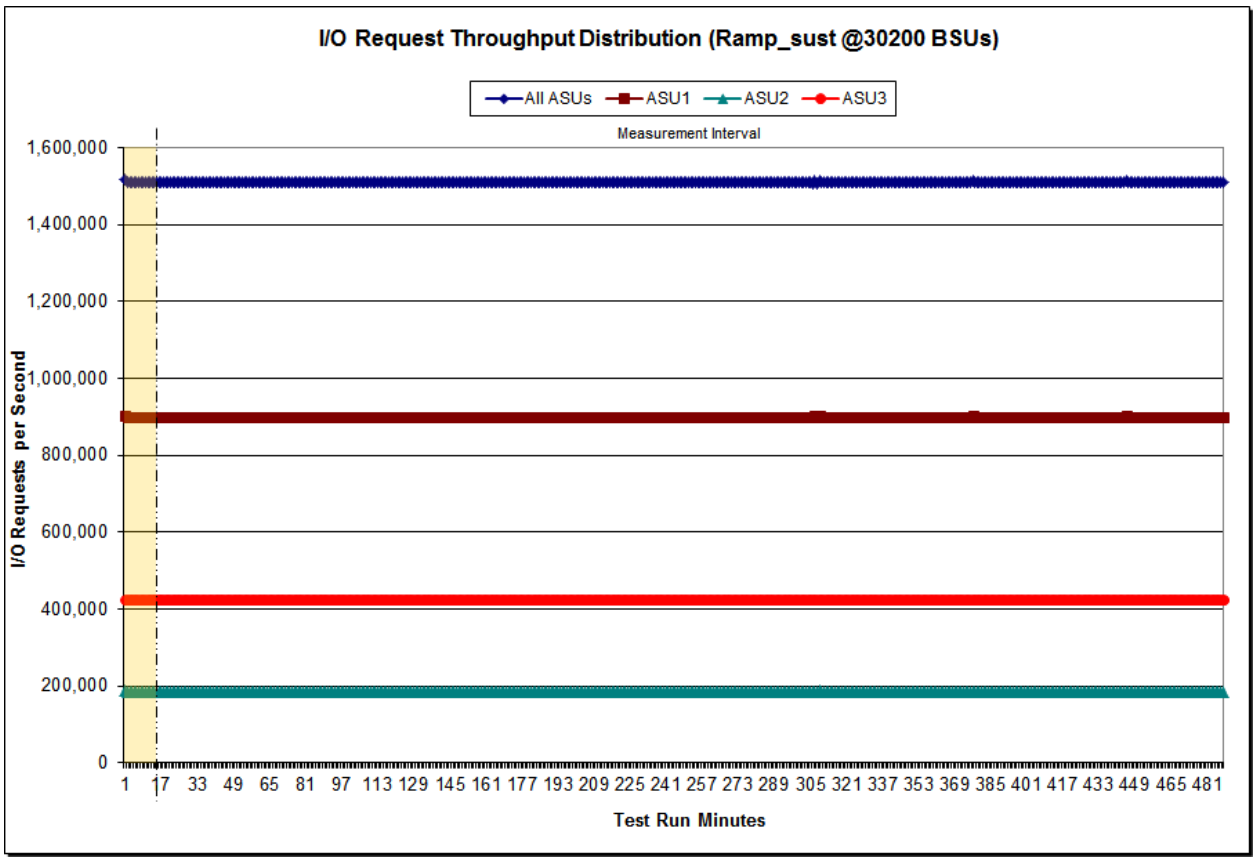


Sustainability – I/O Request Throughput Distribution Data

The Sustainability I/O Request Throughput table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability I/O Request Throughput Table

Sustainability – I/O Request Throughput Distribution Graph

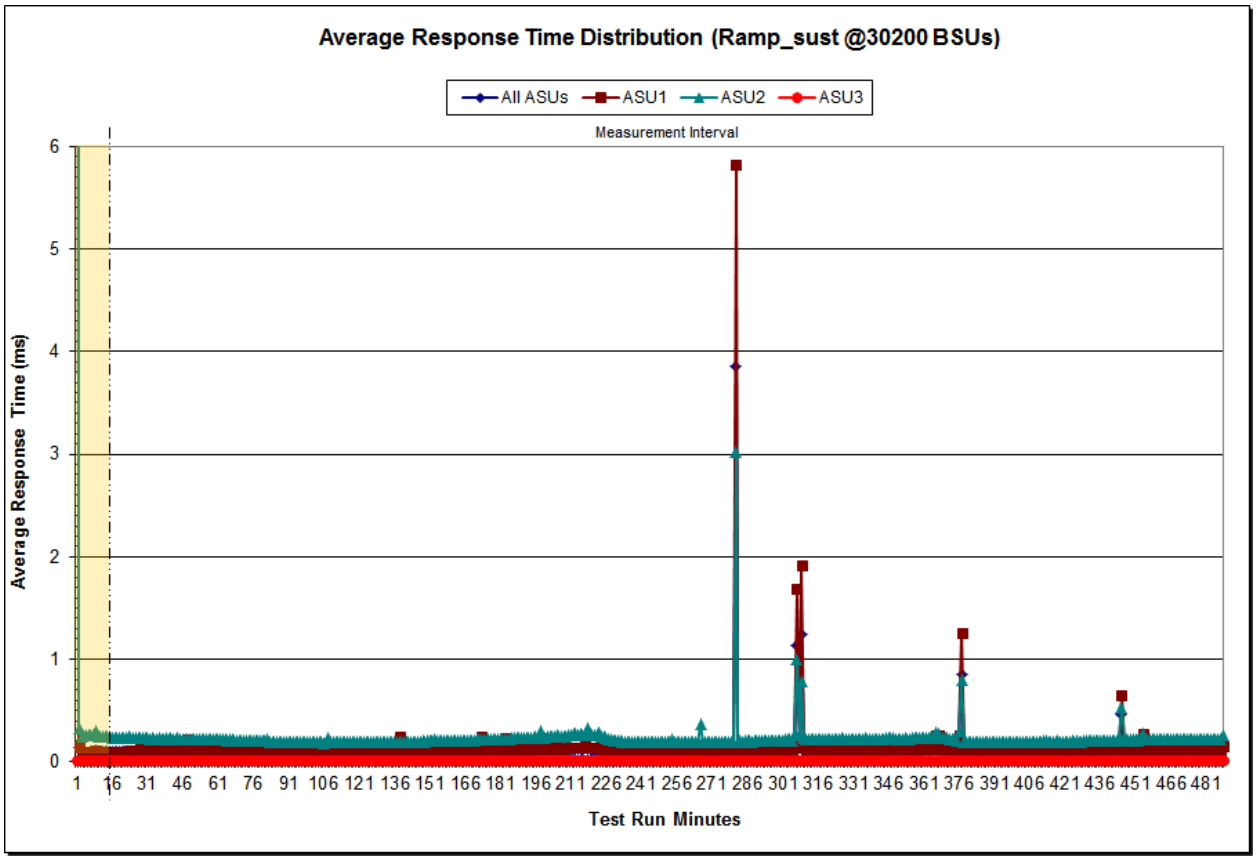


Sustainability – Average Response Time (ms) Distribution Data

The Sustainability Average Response Time table of data is not embedded in this document due to its size. The table is available via the following URL:

Sustainability Average Response Time Table

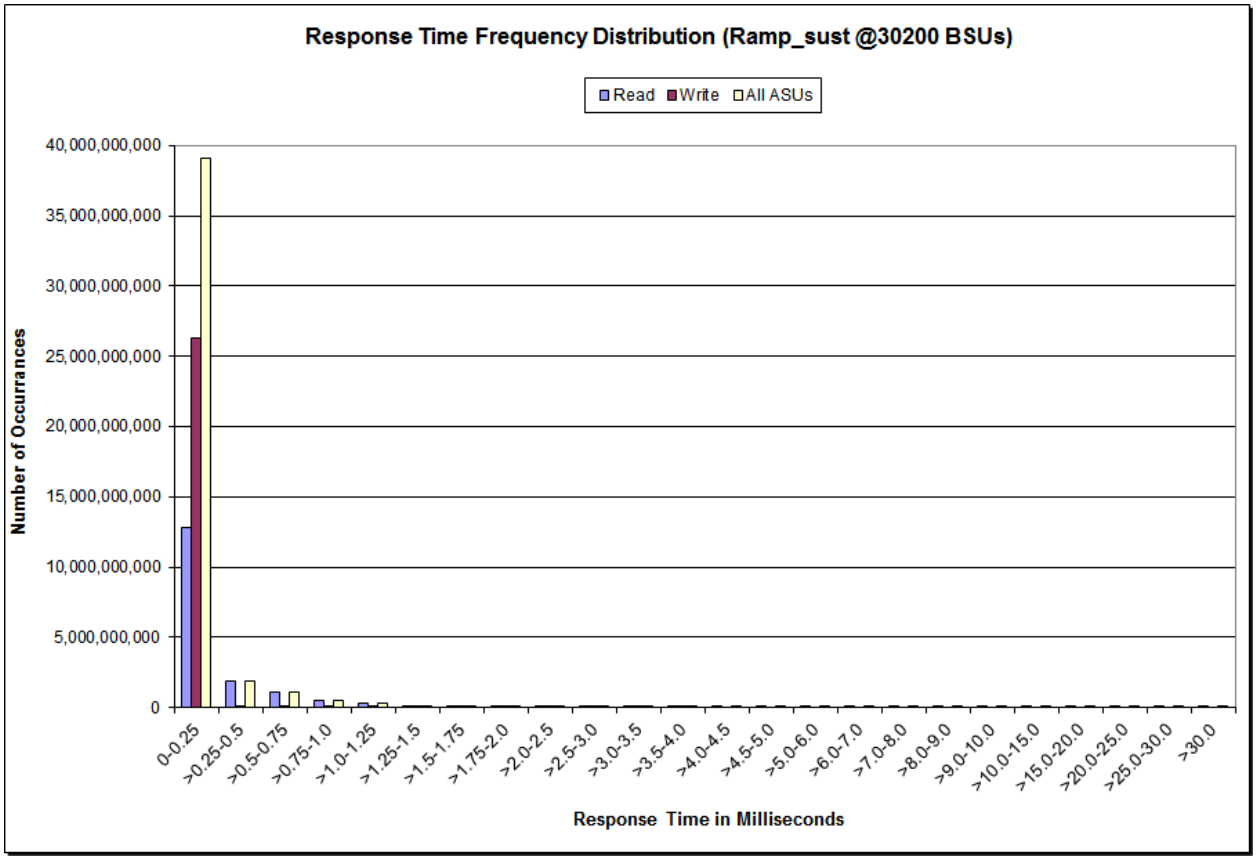
Sustainability – Average Response Time (ms) Distribution Graph



Sustainability – 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	12,774,502,076	1,872,126,323	1,088,179,045	509,104,736	271,261,997	163,452,646	107,405,676	76,654,495
Write	26,310,614,638	21,013,855	2,642,671	735,824	294,442	164,421	105,089	63,755
All ASUs	39,085,116,714	1,893,140,178	1,090,821,716	509,840,560	271,556,439	163,617,067	107,510,765	76,718,250
ASU1	22,785,451,128	1,340,214,463	774,745,728	369,007,702	199,522,944	120,319,070	78,416,784	55,245,303
ASU2	4,095,744,283	539,318,200	314,412,661	140,378,856	71,853,806	43,198,577	29,030,787	21,434,623
ASU3	12,203,921,303	13,607,515	1,663,327	454,002	179,689	99,420	63,194	38,324
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	101,704,498	62,070,160	39,168,215	24,755,179	15,864,725	10,707,354	12,918,353	6,721,025
Write	65,705	28,760	13,591	5,998	2,307	912	758	380
All ASUs	101,770,203	62,098,920	39,181,806	24,761,177	15,867,032	10,708,266	12,919,111	6,721,405
ASU1	71,881,756	42,830,562	26,442,990	16,283,829	10,064,024	6,574,646	7,726,547	3,853,885
ASU2	29,849,062	19,251,154	12,730,666	8,473,833	5,801,660	4,133,121	5,192,161	2,867,312
ASU3	39,385	17,204	8,150	3,515	1,348	499	403	208
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	3,897,797	2,365,463	1,494,789	2,540,587	541,370	268,447	213,699	3,919,431
Write	173	143	119	258	116	64	36	305
All ASUs	3,897,970	2,365,606	1,494,908	2,540,845	541,486	268,511	213,735	3,919,736
ASU1	2,174,984	1,315,074	838,182	1,493,876	376,710	204,735	172,616	3,341,249
ASU2	1,722,902	1,050,468	656,665	1,046,819	164,714	63,742	41,102	578,403
ASU3	84	64	61	150	62	34	17	84

Sustainability – Response Time Frequency Distribution Graph



Sustainability – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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.*

Clauses 5.1.10 and 5.3.15.2

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%.*

Clause 5.3.15.3

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

	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	02810
COV	0.001	0.000	0.000	0.000	0.001	0.000	0.001	0.000

Primary Metrics Test – IOPS Test Phase

Clause 5.4.4.2

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 9.4.3.7.3

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 to 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, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 94.

IOPS Test Results File

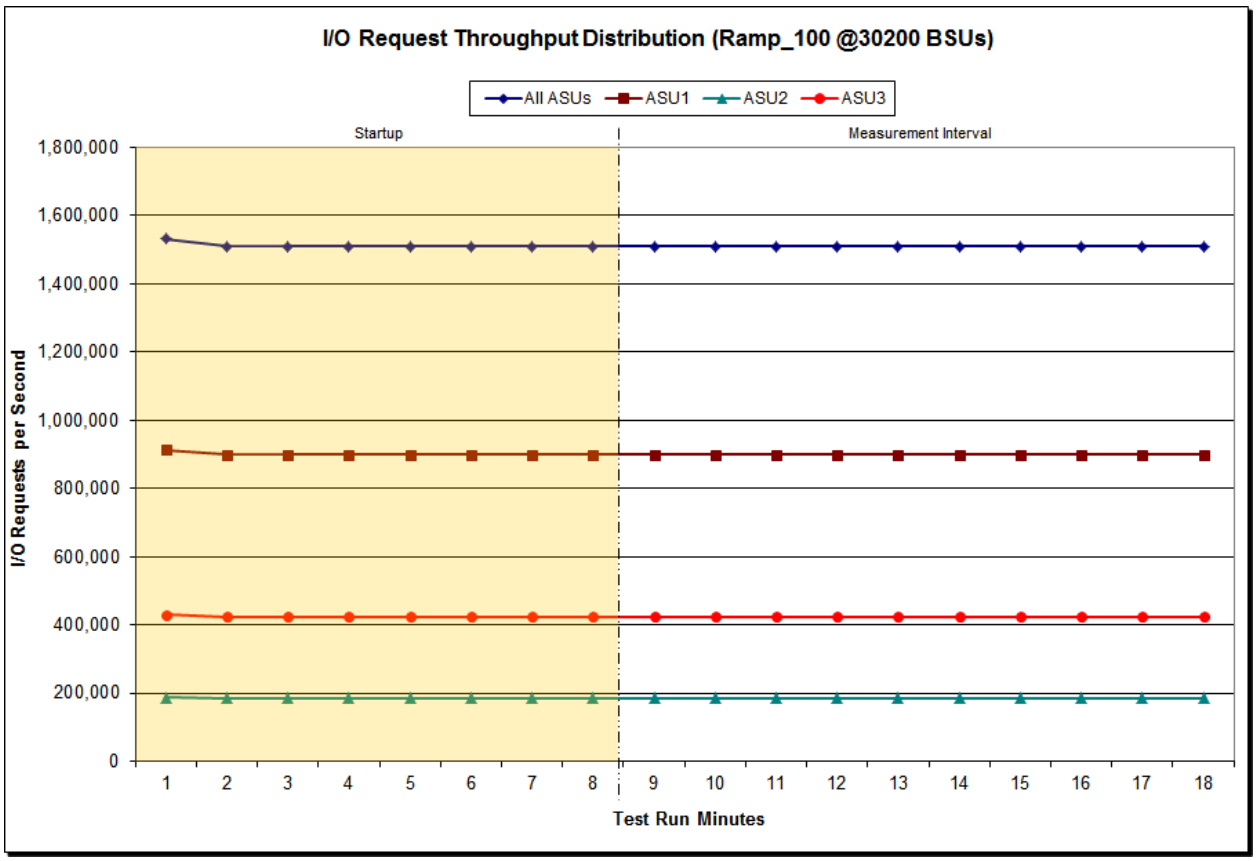
A link to the test results file generated from the IOPS Test Run is listed below.

IOPS Test Results File

IOPS Test Run – I/O Request Throughput Distribution Data

30,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:18:24	22:26:25	0-7	0:08:01
Measurement Interval	22:26:25	22:36:25	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,531,051.13	912,473.65	188,338.18	430,239.30
1	1,510,319.07	900,056.22	185,819.25	424,443.60
2	1,509,872.88	899,824.10	185,732.42	424,316.37
3	1,510,206.05	900,087.87	185,698.45	424,419.73
4	1,510,031.78	899,939.65	185,797.58	424,294.55
5	1,509,954.83	900,042.48	185,773.72	424,138.63
6	1,509,915.75	899,842.43	185,610.78	424,462.53
7	1,509,855.87	899,839.97	185,733.80	424,282.10
8	1,510,186.72	900,055.20	185,854.42	424,277.10
9	1,510,205.47	900,007.98	185,826.13	424,371.35
10	1,510,122.27	899,946.45	185,722.58	424,453.23
11	1,510,313.03	900,112.90	185,776.93	424,423.20
12	1,510,134.38	900,002.77	185,776.73	424,354.88
13	1,510,110.08	900,051.27	185,722.63	424,336.18
14	1,510,121.37	900,070.53	185,704.42	424,346.42
15	1,509,715.25	899,658.45	185,779.78	424,277.02
16	1,510,121.02	900,185.53	185,735.75	424,199.73
17	1,509,875.62	899,915.27	185,658.53	424,301.82
Average	***1,510,090.52***	***900,000.64***	***185,755.79***	***424,334.09***

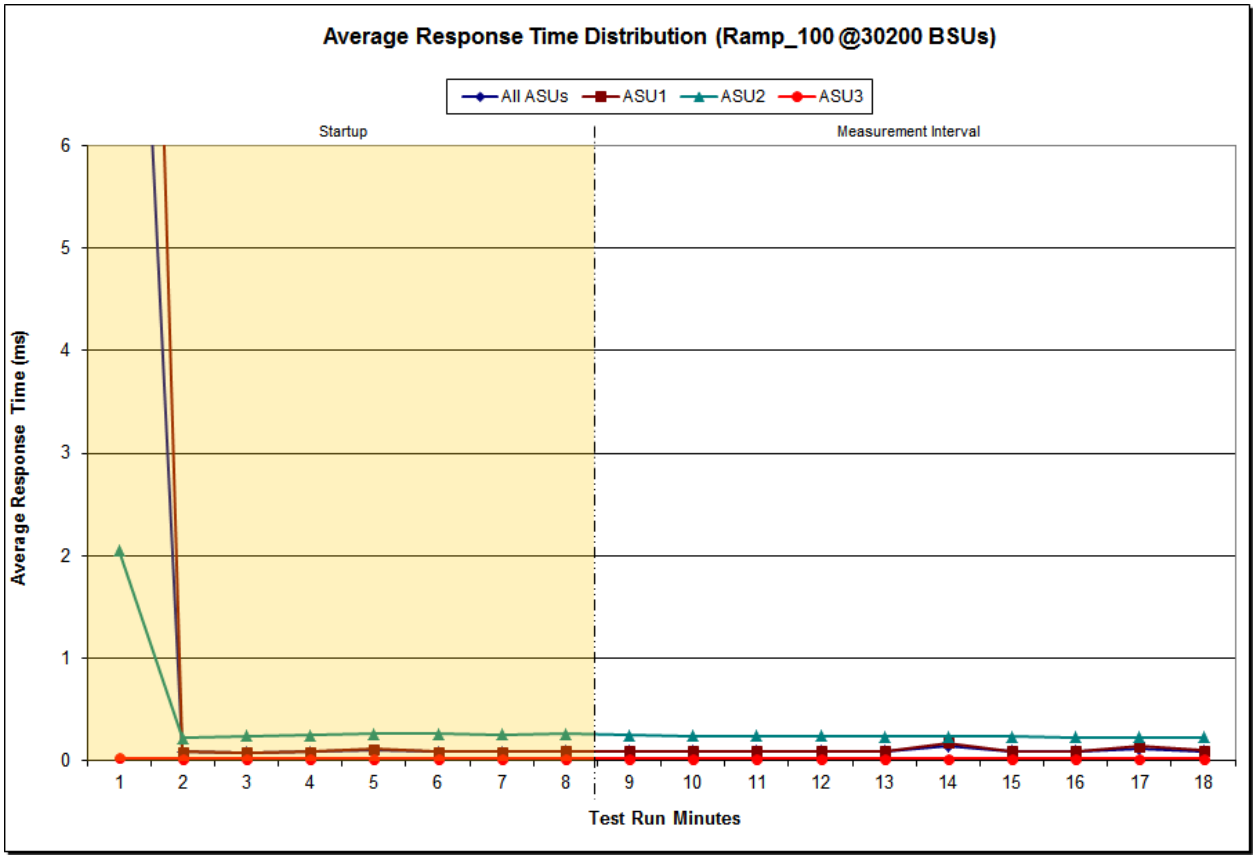
IOPS Test Run – I/O Request Throughput Distribution Graph



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

30,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:18:24	22:26:25	0-7	0:08:01
Measurement Interval	22:26:25	22:36:25	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	12.70	20.88	2.06	0.03
1	0.09	0.09	0.22	0.02
2	0.08	0.08	0.24	0.02
3	0.09	0.09	0.25	0.02
4	0.11	0.11	0.26	0.02
5	0.09	0.09	0.26	0.02
6	0.09	0.09	0.26	0.02
7	0.09	0.10	0.26	0.02
8	0.09	0.09	0.25	0.02
9	0.09	0.10	0.25	0.02
10	0.09	0.10	0.24	0.02
11	0.09	0.10	0.24	0.02
12	0.09	0.10	0.24	0.02
13	0.14	0.18	0.24	0.02
14	0.09	0.10	0.24	0.02
15	0.09	0.10	0.23	0.02
16	0.12	0.14	0.23	0.02
17	0.09	0.10	0.23	0.02
Average	***0.10***	***0.11***	***0.24***	***0.02***

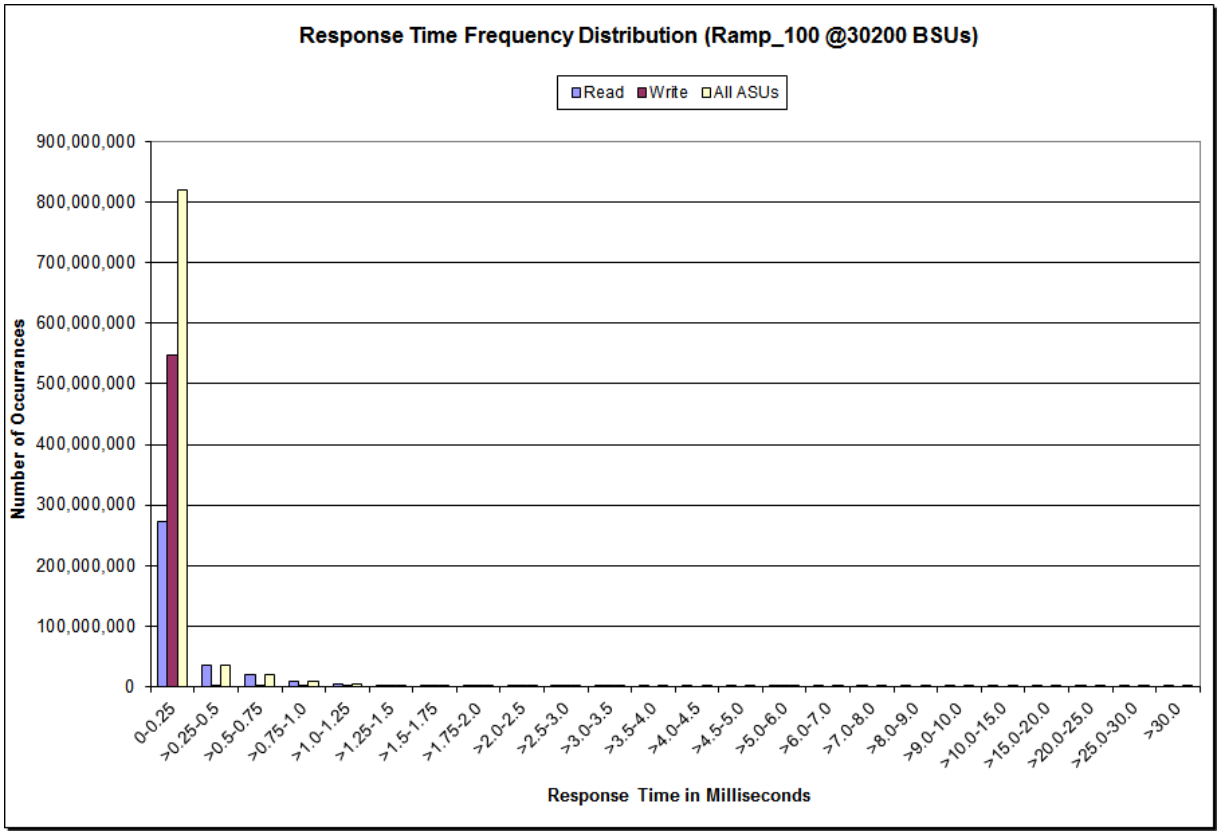
IOPS Test Run – Average Response Time (ms) Distribution Graph



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	272,240,828	35,554,054	20,728,613	9,869,046	5,420,549	3,334,482	2,235,441	1,619,082
Write	548,142,640	436,407	56,680	15,146	5,878	3,215	1,931	1,132
All ASUs	820,383,468	35,990,461	20,785,293	9,884,192	5,426,427	3,337,697	2,237,372	1,620,214
ASU1	481,906,012	24,735,427	14,002,036	6,764,719	3,797,071	2,345,908	1,556,912	1,102,629
ASU2	84,208,514	10,977,250	6,747,528	3,110,175	1,625,782	989,881	679,269	516,920
ASU3	254,268,942	277,784	35,729	9,298	3,574	1,908	1,191	665
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	2,169,712	1,338,243	865,600	558,077	366,521	252,142	310,671	156,527
Write	1,147	482	202	78	67	101	123	26
All ASUs	2,170,859	1,338,725	865,802	558,155	366,588	252,243	310,794	156,553
ASU1	1,420,241	826,136	503,659	298,938	175,950	111,814	128,996	56,714
ASU2	749,939	512,310	362,019	259,174	190,598	140,367	181,722	99,825
ASU3	679	279	124	43	40	62	76	14
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	83,488	42,090	21,411	23,775	3,458	3,224	3,394	59,667
Write	4	2	2	0	0	0	0	2
All ASUs	83,492	42,092	21,413	23,775	3,458	3,224	3,394	59,669
ASU1	29,782	17,598	10,435	14,198	3,281	3,186	3,371	59,632
ASU2	53,707	24,493	10,977	9,577	177	38	23	37
ASU3	3	1	1	0	0	0	0	0

IOPS Test Run –Response Time Frequency 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
905,925,360	950,865,691	59,669

IOPS Test Run – Measured Intensity Multiplier and Coefficient of Variation

Clause 3.4.3

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.*

Clauses 5.1.10 and 5.3.15.2

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%.*

Clause 5.3.15.3

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

	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	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000

Primary Metrics Test – Response Time Ramp Test Phase

Clause 5.4.4.3

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 16.

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

Clause 9.4.3.7.4

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, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 94.

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 table and graph for completeness.

100% Load Level: 30,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:18:24	22:26:25	0-7	0:08:01
Measurement Interval	22:26:25	22:36:25	8-17	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	1,531,051.13	912,473.65	188,338.18	430,239.30
1	1,510,319.07	900,056.22	185,819.25	424,443.60
2	1,509,872.88	899,824.10	185,732.42	424,316.37
3	1,510,206.05	900,087.87	185,698.45	424,419.73
4	1,510,031.78	899,939.65	185,797.58	424,294.55
5	1,509,954.83	900,042.48	185,773.72	424,138.63
6	1,509,915.75	899,842.43	185,610.78	424,462.53
7	1,509,855.87	899,839.97	185,733.80	424,282.10
8	1,510,186.72	900,055.20	185,854.42	424,277.10
9	1,510,205.47	900,007.98	185,826.13	424,371.35
10	1,510,122.27	899,946.45	185,722.58	424,453.23
11	1,510,313.03	900,112.90	185,776.93	424,423.20
12	1,510,134.38	900,002.77	185,776.73	424,354.88
13	1,510,110.08	900,051.27	185,722.63	424,336.18
14	1,510,121.37	900,070.53	185,704.42	424,346.42
15	1,509,715.25	899,658.45	185,779.78	424,277.02
16	1,510,121.02	900,185.53	185,735.75	424,199.73
17	1,509,875.62	899,915.27	185,658.53	424,301.82
Average	***1,510,090.52***	***900,000.64***	***185,755.79***	***424,334.09***

95% Load Level: 28,690 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	22:47:48	22:55:49	0-7	0:08:01
Measurement Interval	22:55:49	23:05:49	8-17	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	1,435,243.32	855,337.65	176,561.83	403,343.83
1	1,434,605.32	855,054.13	176,466.48	403,084.70
2	1,434,324.55	854,855.93	176,406.00	403,062.62
3	1,434,329.77	854,877.50	176,391.52	403,060.75
4	1,434,473.83	854,888.45	176,443.57	403,141.82
5	1,434,468.95	854,902.48	176,494.12	403,072.35
6	1,434,556.22	854,882.52	176,452.67	403,221.03
7	1,434,654.43	855,013.02	176,496.95	403,144.47
8	1,434,689.62	855,115.32	176,458.55	403,115.75
9	1,434,524.17	854,921.58	176,380.70	403,221.88
10	1,434,499.68	854,943.92	176,460.80	403,094.97
11	1,434,538.63	855,105.05	176,374.67	403,058.92
12	1,434,608.30	854,954.17	176,469.50	403,184.63
13	1,434,382.42	854,824.70	176,468.22	403,089.50
14	1,434,229.80	854,775.18	176,403.15	403,051.47
15	1,434,725.88	855,048.33	176,456.72	403,220.83
16	1,434,452.35	854,981.37	176,464.83	403,006.15
17	1,434,823.25	855,063.72	176,569.77	403,189.77
Average	***1,434,547.41***	***854,973.33***	***176,450.69***	***403,123.39***

90% Load Level: 27,180 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:16:41	23:24:42	0-7	0:08:01
Measurement Interval	23:24:42	23:34:42	8-17	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	1,359,384.35	810,187.77	167,214.57	381,982.02
1	1,359,002.52	809,941.95	167,205.23	381,855.33
2	1,359,002.95	810,012.80	167,112.25	381,877.90
3	1,358,738.22	809,770.22	167,113.38	381,854.62
4	1,359,022.28	809,992.83	167,067.27	381,962.18
5	1,358,837.15	809,838.50	167,156.23	381,842.42
6	1,359,046.82	809,986.35	167,156.75	381,903.72
7	1,359,078.30	809,965.63	167,177.58	381,935.08
8	1,359,088.45	809,999.78	167,176.55	381,912.12
9	1,358,807.43	809,807.60	167,232.20	381,767.63
10	1,358,875.30	809,851.08	167,182.62	381,841.60
11	1,358,954.83	809,868.08	167,201.45	381,885.30
12	1,359,148.63	810,134.50	167,191.95	381,822.18
13	1,358,993.78	809,956.37	167,119.33	381,918.08
14	1,358,791.77	809,748.32	167,235.70	381,807.75
15	1,359,002.57	809,995.72	167,153.05	381,853.80
16	1,359,042.05	809,992.30	167,196.60	381,853.15
17	1,359,012.93	809,860.72	167,192.28	381,959.93
Average	***1,358,971.78***	***809,921.45***	***167,188.17***	***381,862.16***

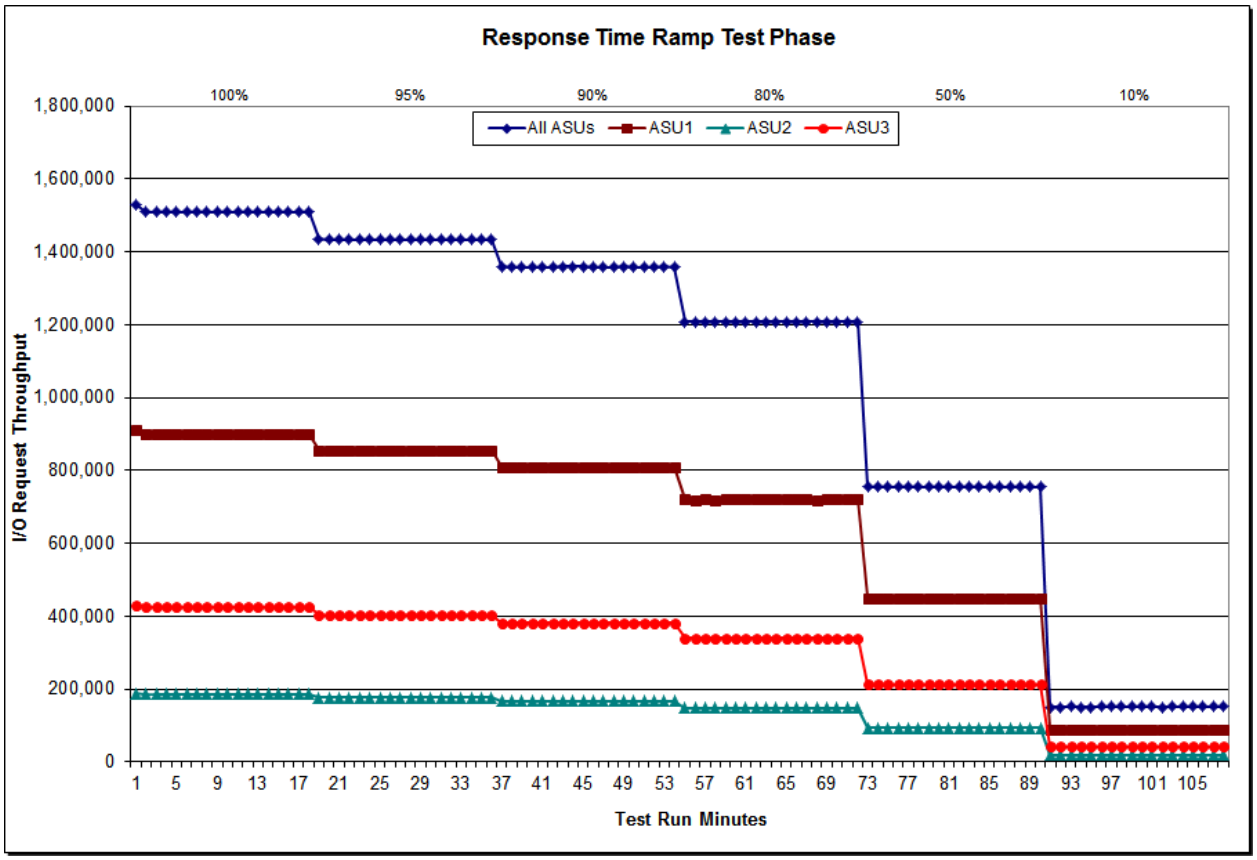
80% Load Level: 24,160 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	23:44:27	23:52:28	0-7	0:08:01
Measurement Interval	23:52:28	0:02:28	8-17	0:10:00

(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3
0	1,208,366.12	720,244.62	148,646.50	339,475.00
1	1,207,901.57	719,871.38	148,556.03	339,474.15
2	1,208,106.45	720,017.60	148,597.68	339,491.17
3	1,207,825.25	719,831.92	148,589.65	339,403.68
4	1,207,837.07	720,016.10	148,523.33	339,297.63
5	1,208,000.05	720,011.90	148,615.95	339,372.20
6	1,208,285.28	720,091.82	148,656.00	339,537.47
7	1,207,910.75	719,940.03	148,554.23	339,416.48
8	1,208,126.85	720,073.50	148,616.67	339,436.68
9	1,208,009.95	720,045.58	148,571.43	339,392.93
10	1,208,104.45	720,108.95	148,489.25	339,506.25
11	1,207,738.42	719,919.87	148,500.65	339,317.90
12	1,208,133.95	720,114.95	148,612.95	339,406.05
13	1,207,798.28	719,828.23	148,618.02	339,352.03
14	1,207,879.65	719,945.70	148,661.95	339,272.00
15	1,208,105.88	720,058.95	148,598.62	339,448.32
16	1,208,120.37	720,080.10	148,593.57	339,446.70
17	1,208,082.97	720,119.30	148,566.72	339,396.95
Average	***1,208,010.08***	***720,029.51***	***148,582.98***	***339,397.58***

Response Time Ramp Distribution (IOPS) Data *(continued)*

50% Load Level: 15,100 BSUs	Start	Stop	Interval	Duration	10% Load Level: 3,020 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:09:02	0:17:03	0-7	0:08:01	Start-Up/Ramp-Up	0:28:57	0:36:58	0-7	0:08:01
Measurement Interval	0:17:03	0:27:03	8-17	0:10:00	Measurement Interval	0:36:58	0:46:58	8-17	0:10:00
(60 second intervals)	All ASUs	ASU-1	ASU-2	ASU-3	*(60 second intervals)*	All ASUs	ASU-1	ASU-2	ASU-3
0	755,077.15	449,898.80	92,978.18	212,200.17	0	150,942.35	89,958.17	18,588.18	42,396.00
1	755,011.33	449,994.57	92,838.47	212,178.30	1	150,970.53	89,985.63	18,569.25	42,415.65
2	754,935.87	449,862.97	92,876.00	212,196.90	2	150,998.62	89,988.00	18,548.07	42,462.55
3	754,968.50	449,884.77	92,881.92	212,201.82	3	150,962.92	89,955.80	18,612.82	42,394.30
4	754,955.95	449,873.87	92,858.27	212,223.82	4	150,964.48	89,993.45	18,558.23	42,412.80
5	755,062.12	449,993.07	92,893.77	212,175.28	5	151,011.22	90,015.20	18,563.98	42,432.03
6	755,081.58	449,961.47	92,896.55	212,223.57	6	151,036.87	90,003.73	18,575.68	42,457.45
7	755,118.82	449,949.87	92,888.97	212,279.98	7	151,004.40	90,020.63	18,547.53	42,436.23
8	755,048.32	449,922.50	92,934.55	212,191.27	8	151,037.87	90,023.78	18,575.53	42,438.55
9	755,168.55	450,022.73	92,887.63	212,258.18	9	151,030.55	90,020.63	18,582.42	42,427.50
10	755,118.98	450,022.70	92,892.03	212,204.25	10	151,002.32	90,021.90	18,556.10	42,424.32
11	755,101.62	450,062.12	92,837.87	212,201.63	11	150,959.97	89,995.40	18,562.88	42,401.68
12	754,966.95	449,892.40	92,851.10	212,223.45	12	150,994.45	89,993.35	18,582.88	42,418.22
13	754,987.27	450,024.58	92,803.53	212,159.15	13	150,983.97	90,008.75	18,570.03	42,405.18
14	754,905.12	450,036.33	92,860.17	212,008.62	14	151,056.43	90,022.72	18,587.92	42,445.80
15	754,953.45	450,028.03	92,808.37	212,117.05	15	151,007.13	90,002.02	18,562.70	42,442.42
16	***755,135.37***	***450,044.90***	***92,893.82***	***212,196.65***	***16***	***151,058.90***	***90,073.98***	***18,577.13***	***42,407.78***
17	***754,825.47***	***449,817.13***	***92,840.22***	***212,168.12***	***17***	***151,021.23***	***90,018.32***	***18,534.27***	***42,468.65***
Average	***755,021.11***	***449,987.34***	***92,860.93***	***212,172.84***	***Average***	***151,015.28***	***90,018.09***	***18,569.19***	***42,428.01***

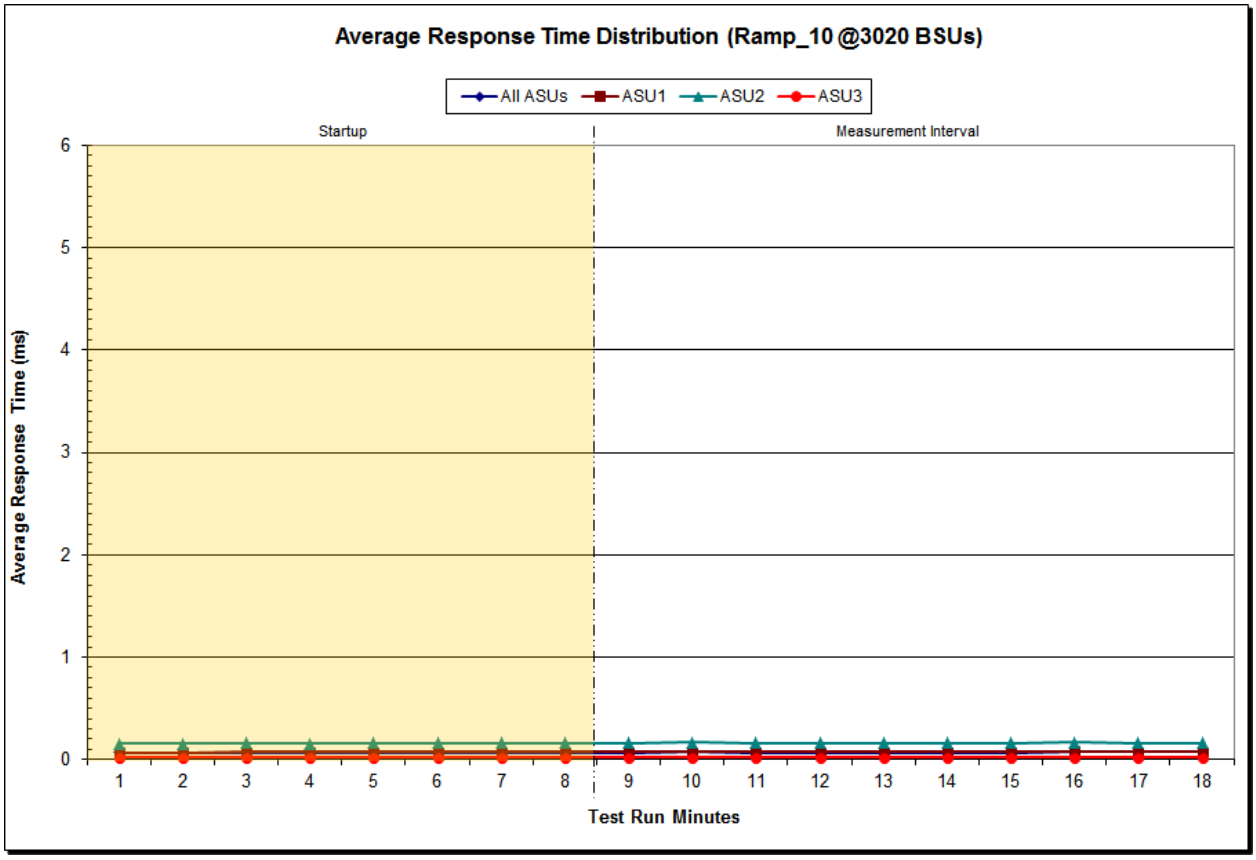
Response Time Ramp Distribution (IOPS) Graph



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

3,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:28:57	0:36:58	0-7	0:08:01
Measurement Interval	0:36:58	0:46:58	7-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.07	0.07	0.16	0.02
1	0.07	0.07	0.16	0.02
2	0.07	0.07	0.16	0.02
3	0.07	0.07	0.16	0.02
4	0.07	0.07	0.16	0.02
5	0.07	0.07	0.16	0.02
6	0.07	0.07	0.16	0.02
7	0.07	0.07	0.16	0.02
8	0.07	0.07	0.16	0.02
9	0.07	0.08	0.17	0.02
10	0.07	0.07	0.16	0.02
11	0.07	0.07	0.16	0.02
12	0.07	0.07	0.16	0.02
13	0.07	0.07	0.16	0.02
14	0.07	0.08	0.16	0.02
15	0.07	0.08	0.17	0.02
16	0.07	0.08	0.16	0.02
17	0.07	0.08	0.17	0.02
Average	***0.07***	***0.08***	***0.16***	***0.02***

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



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

Clause 3.4.3

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.*

Clauses 5.1.10 and 5.3.15.2

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%.*

Clause 5.3.15.3

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

	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	0.2811	0.0700	0.2099	0.0180	0.0700	0.0350	0.2810
COV	0.002	0.001	0.001	0.001	0.003	0.001	0.002	0.000

Repeatability Test

Clause 5.4.5

The Repeatability Test demonstrates the repeatability and reproducibility of the SPC-1 IOPS™ primary metric and the SPC-1 LRT™ metric 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™ metric. Each Average Response Time value must be less than the SPC-1 LRT™ metric plus 5% or less than the SPC-1 LRT™ metric plus one (1) millisecond (ms).

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 9.4.3.7.5

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 Repeatability Test.*
2. *An I/O Request Throughput Distribution graph and table.*
3. *An Average Response Time Distribution graph and table.*
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 Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 94.

Repeatability Test Results File

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

	SPC-1 IOPS™
Primary Metrics	***1,510,090.52***
Repeatability Test Phase 1	1,510,039.46
Repeatability Test Phase 2	1,510,061.58

The SPC-1 IOPS™ values in the above table were generated using 100% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 IOPS™ must greater than 95% of the reported SPC-1 IOPS™ Primary Metric.

	SPC-1 LRT™
Primary Metrics	***0.07***
Repeatability Test Phase 1	0.07
Repeatability Test Phase 2	0.07

The average response time values in the SPC-1 LRT™ column were generated using 10% of the specified Business Scaling Unit (BSU) load level. Each of the Repeatability Test Phase values for SPC-1 LRT™ must be less than 105% of the reported SPC-1 LRT™ Primary Metric or less than the reported SPC-1 LRT™ Primary Metric plus one (1) millisecond (ms).

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

Repeatability Test Phase 1, Test Run 1 (LRT)

Repeatability Test Phase 1, Test Run 2 (IOPS)

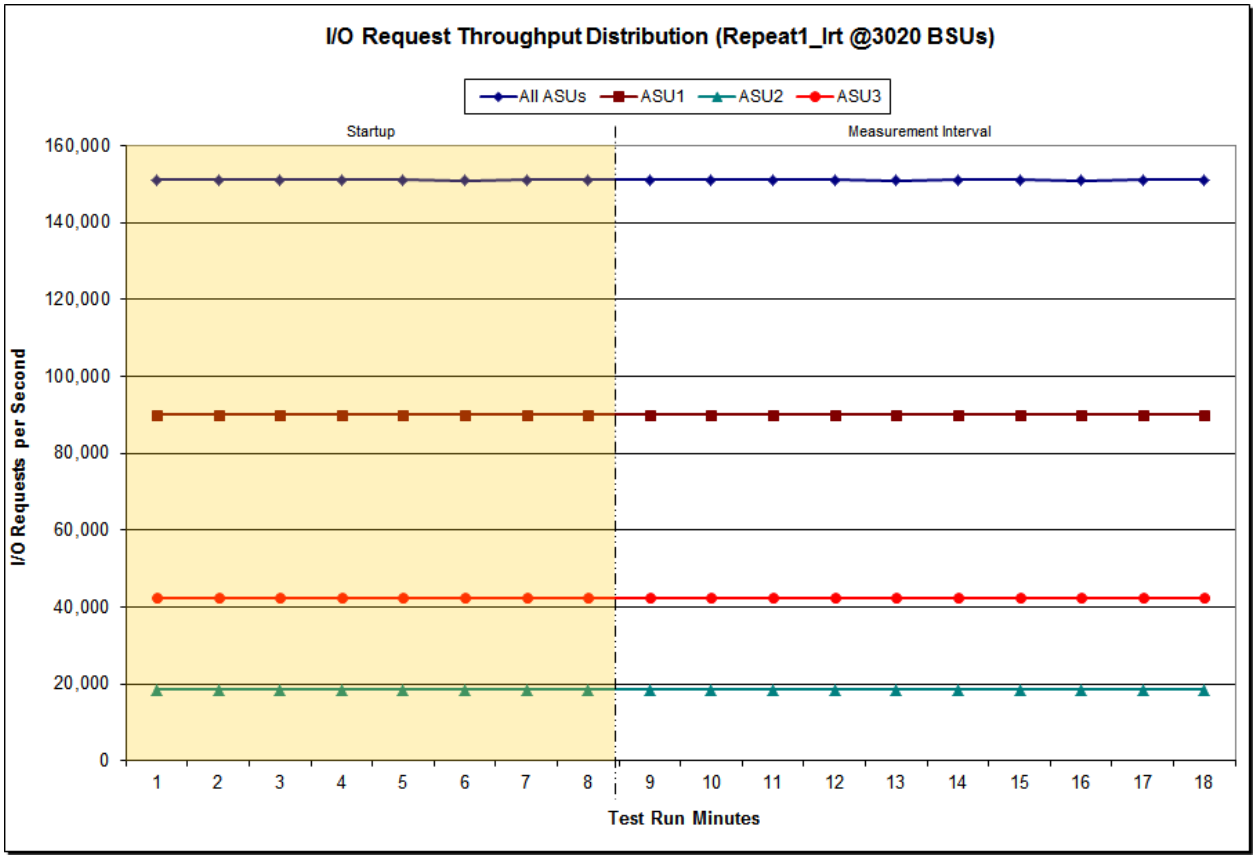
Repeatability Test Phase 2, Test Run 1 (LRT)

Repeatability Test Phase 2, Test Run 2 (IOPS)

Repeatability 1 LRT – I/O Request Throughput Distribution Data

3,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:49:46	0:57:46	0-7	0:08:00
Measurement Interval	0:57:46	1:07:46	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	151,086.07	90,018.15	18,589.75	42,478.17
1	150,991.58	89,973.45	18,573.10	42,445.03
2	150,988.28	89,942.97	18,577.30	42,468.02
3	150,996.62	89,941.40	18,597.37	42,457.85
4	151,060.68	90,036.23	18,560.22	42,464.23
5	150,950.95	89,985.27	18,576.75	42,388.93
6	151,041.18	90,049.65	18,569.17	42,422.37
7	150,968.70	89,950.48	18,560.52	42,457.70
8	151,054.27	90,004.97	18,564.50	42,484.80
9	151,022.80	90,017.35	18,573.72	42,431.73
10	151,062.35	90,017.65	18,584.07	42,460.63
11	151,007.97	89,949.82	18,579.18	42,478.97
12	150,926.65	89,962.48	18,578.52	42,385.65
13	150,990.28	89,983.15	18,592.18	42,414.95
14	150,989.07	89,967.20	18,563.65	42,458.22
15	150,903.82	89,949.38	18,586.75	42,367.68
16	150,996.43	89,979.28	18,561.50	42,455.65
17	150,966.47	89,990.38	18,584.43	42,391.65
Average	***150,992.01***	***89,982.17***	***18,576.85***	***42,432.99***

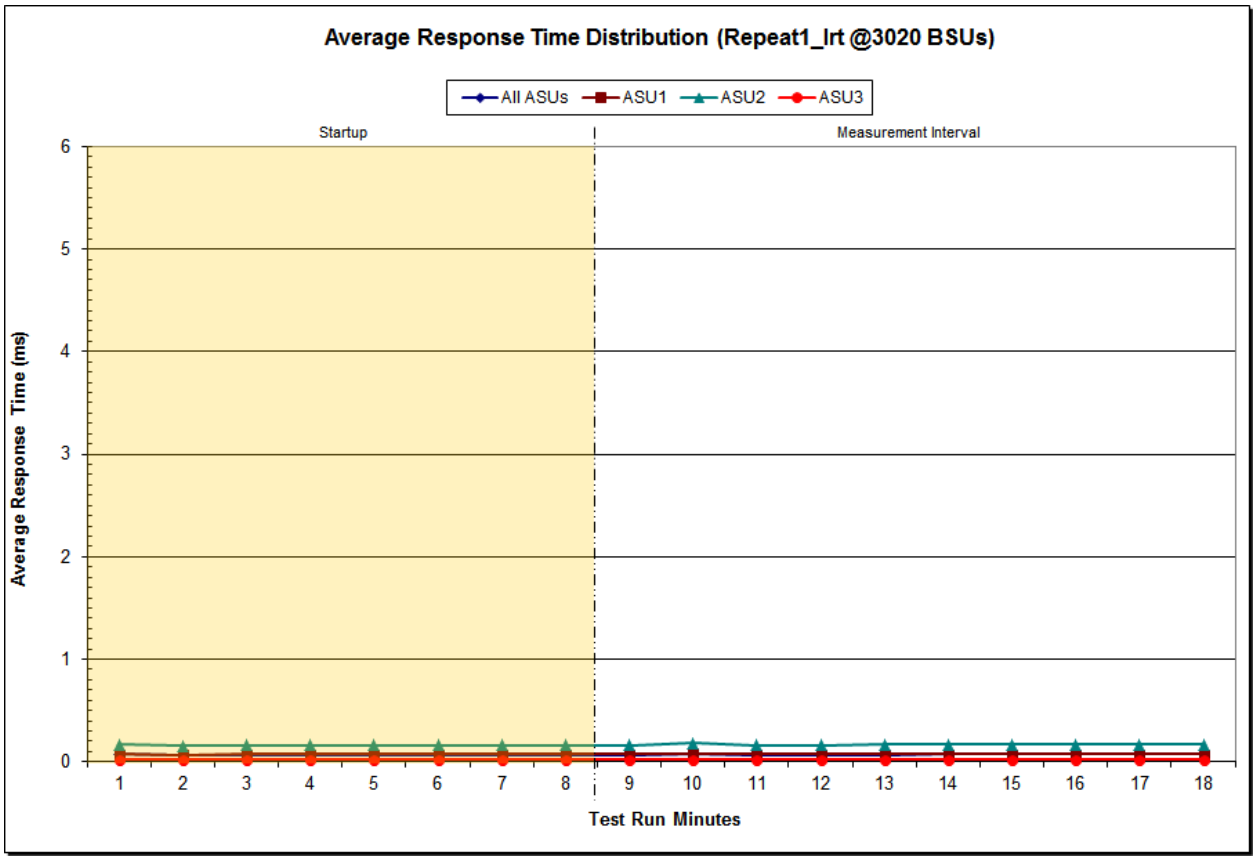
Repeatability 1 LRT – I/O Request Throughput Distribution Graph



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

3,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	0:49:46	0:57:46	0-7	0:08:00
Measurement Interval	0:57:46	1:07:46	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.07	0.07	0.17	0.02
1	0.07	0.07	0.15	0.02
2	0.07	0.07	0.16	0.02
3	0.07	0.07	0.16	0.02
4	0.07	0.07	0.16	0.02
5	0.07	0.07	0.16	0.02
6	0.07	0.07	0.16	0.02
7	0.07	0.07	0.17	0.02
8	0.07	0.07	0.16	0.02
9	0.08	0.08	0.18	0.02
10	0.07	0.07	0.17	0.02
11	0.07	0.07	0.16	0.02
12	0.07	0.07	0.17	0.02
13	0.07	0.07	0.17	0.02
14	0.07	0.08	0.17	0.02
15	0.07	0.07	0.17	0.02
16	0.07	0.08	0.17	0.02
17	0.07	0.08	0.17	0.02
Average	***0.07***	***0.08***	***0.17***	***0.02***

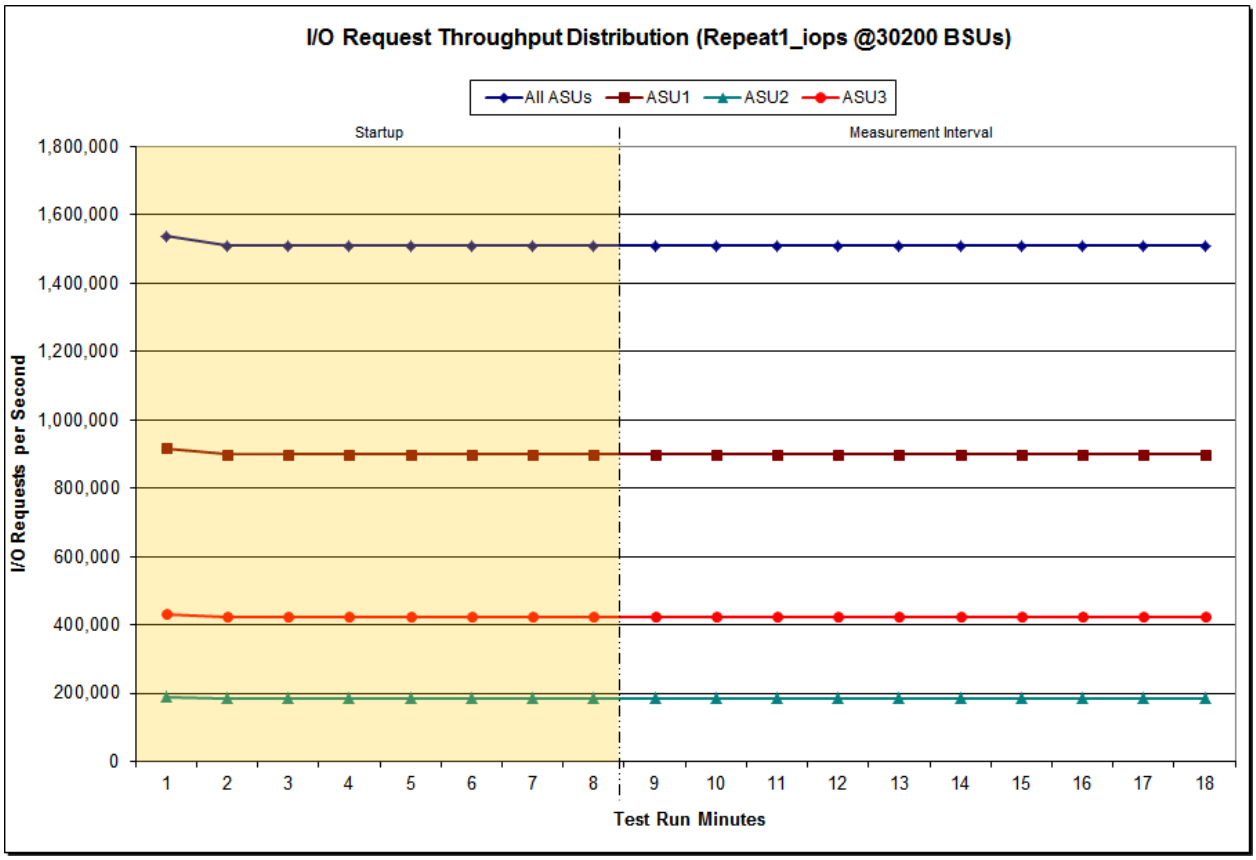
Repeatability 1 LRT –Average Response Time (ms) Distribution Graph



Repeatability 1 IOPS – I/O Request Throughput Distribution Data

30,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:18:59	1:27:00	0-7	0:08:01
Measurement Interval	1:27:00	1:37:00	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,538,182.95	916,759.22	189,223.18	432,200.55
1	1,510,180.80	900,125.30	185,707.32	424,348.18
2	1,509,768.00	899,943.02	185,592.23	424,232.75
3	1,509,934.58	899,894.55	185,635.53	424,404.50
4	1,509,810.95	899,834.72	185,799.90	424,176.33
5	1,510,166.37	900,025.48	185,766.55	424,374.33
6	1,510,234.47	900,063.40	185,715.67	424,455.40
7	1,509,931.03	899,877.82	185,738.25	424,314.97
8	1,509,869.87	899,907.58	185,613.07	424,349.22
9	1,509,932.63	899,875.13	185,763.72	424,293.78
10	1,510,117.18	899,985.87	185,783.87	424,347.45
11	1,509,930.17	899,967.92	185,676.55	424,285.70
12	1,509,789.03	899,880.62	185,747.88	424,160.53
13	1,510,044.70	899,948.35	185,803.68	424,292.67
14	1,510,235.22	900,125.98	185,710.38	424,398.85
15	1,510,315.33	900,029.93	185,719.83	424,565.57
16	1,510,189.65	900,092.35	185,724.28	424,373.02
17	1,509,970.80	899,999.53	185,740.75	424,230.52
Average	***1,510,039.46***	***899,981.33***	***185,728.40***	***424,329.73***

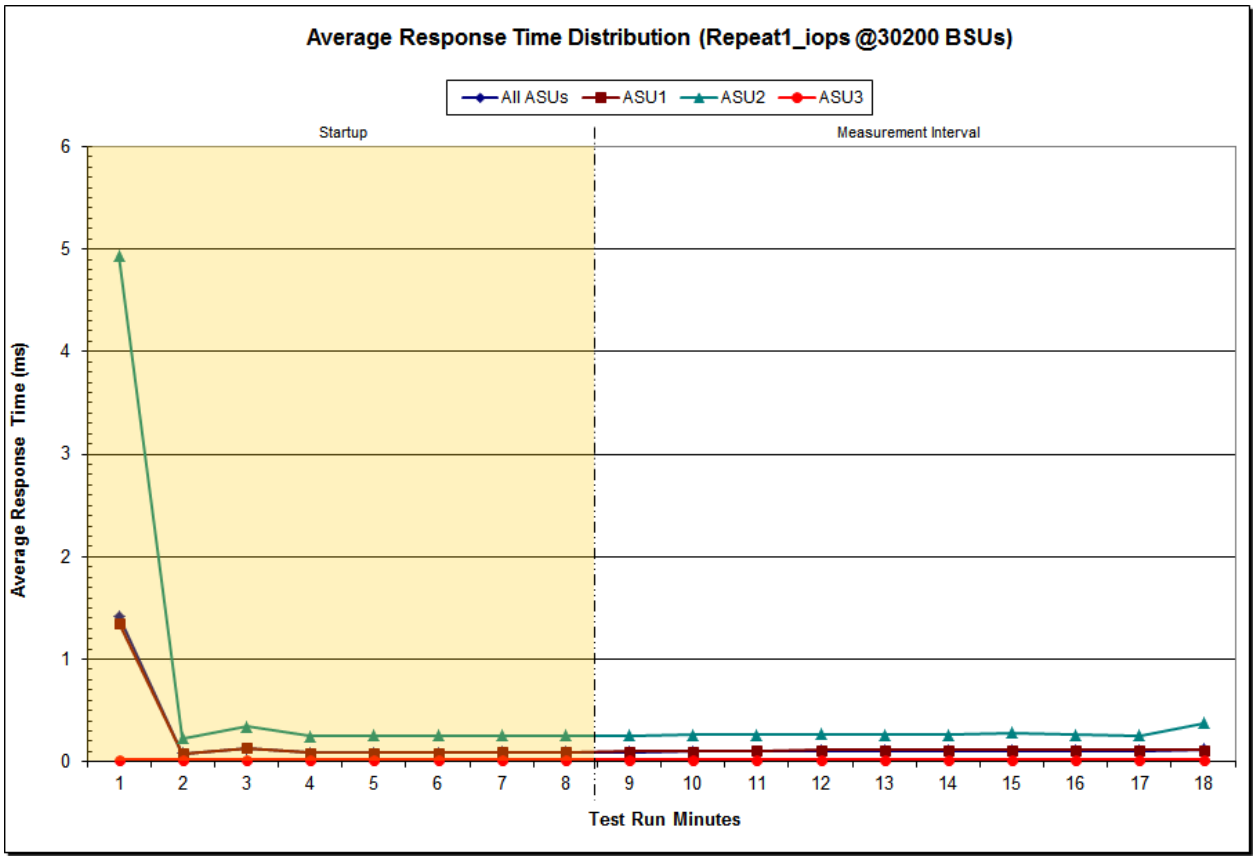
Repeatability 1 IOPS – I/O Request Throughput Distribution Graph



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

30,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:18:59	1:27:00	0-7	0:08:01
Measurement Interval	1:27:00	1:37:00	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.42	1.35	4.94	0.02
1	0.08	0.08	0.23	0.02
2	0.13	0.13	0.35	0.02
3	0.09	0.09	0.25	0.02
4	0.09	0.09	0.26	0.02
5	0.09	0.09	0.26	0.02
6	0.09	0.09	0.26	0.02
7	0.09	0.10	0.26	0.02
8	0.10	0.10	0.26	0.02
9	0.10	0.10	0.26	0.02
10	0.10	0.11	0.27	0.02
11	0.11	0.11	0.27	0.02
12	0.11	0.11	0.26	0.02
13	0.11	0.11	0.26	0.02
14	0.11	0.12	0.29	0.02
15	0.11	0.12	0.26	0.02
16	0.11	0.12	0.26	0.02
17	0.12	0.12	0.38	0.02
Average	***0.11***	***0.11***	***0.28***	***0.02***

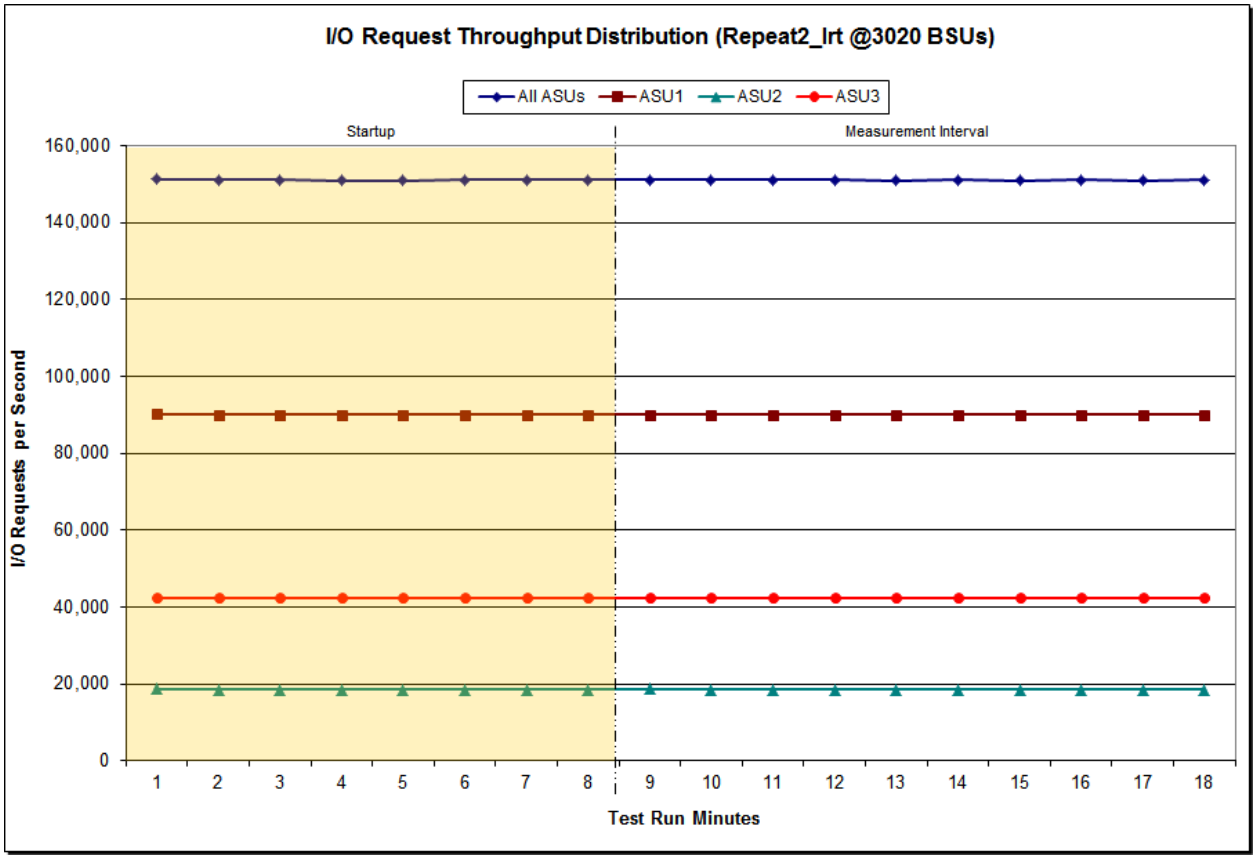
Repeatability 1 IOPS –Average Response Time (ms) Distribution Graph



Repeatability 2 LRT – I/O Request Throughput Distribution Data

3,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:40:16	1:48:16	0-7	0:08:00
Measurement Interval	1:48:16	1:58:16	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	151,202.12	90,109.97	18,639.38	42,452.77
1	151,056.23	90,037.60	18,596.47	42,422.17
2	151,013.35	90,039.15	18,563.75	42,410.45
3	150,958.87	89,975.12	18,550.08	42,433.67
4	150,946.90	89,980.17	18,568.23	42,398.50
5	151,056.32	90,009.98	18,579.37	42,466.97
6	150,987.75	89,997.32	18,566.75	42,423.68
7	151,040.57	90,059.45	18,565.43	42,415.68
8	151,033.22	90,004.83	18,614.52	42,413.87
9	151,046.95	89,988.37	18,577.40	42,481.18
10	151,054.80	90,010.65	18,570.40	42,473.75
11	151,038.70	90,009.83	18,563.70	42,465.17
12	150,947.67	89,995.10	18,581.00	42,371.57
13	151,027.95	90,013.78	18,551.23	42,462.93
14	150,870.73	89,907.22	18,576.85	42,386.67
15	150,972.88	90,000.43	18,554.20	42,418.25
16	150,929.07	89,952.62	18,531.75	42,444.70
17	151,092.33	90,052.67	18,567.67	42,472.00
Average	***151,001.43***	***89,993.55***	***18,568.87***	***42,439.01***

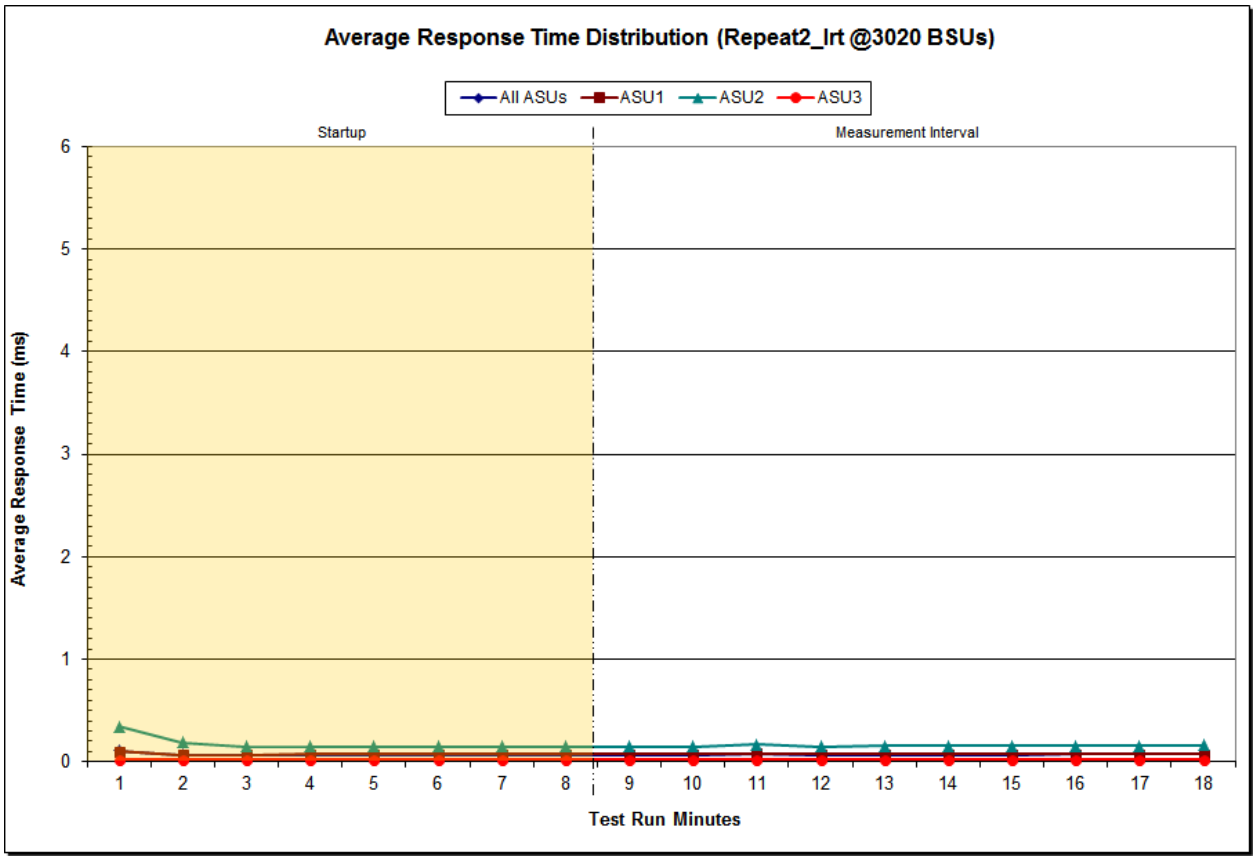
Repeatability 2 LRT – I/O Request Throughput Distribution Graph



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

3,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	1:40:16	1:48:16	0-7	0:08:00
Measurement Interval	1:48:16	1:58:16	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	0.11	0.10	0.35	0.02
1	0.07	0.07	0.19	0.02
2	0.07	0.07	0.15	0.02
3	0.07	0.07	0.15	0.02
4	0.07	0.07	0.15	0.02
5	0.07	0.07	0.15	0.02
6	0.07	0.07	0.15	0.02
7	0.07	0.07	0.15	0.02
8	0.07	0.07	0.15	0.02
9	0.07	0.07	0.15	0.02
10	0.08	0.08	0.17	0.02
11	0.07	0.08	0.15	0.02
12	0.07	0.08	0.15	0.02
13	0.07	0.08	0.16	0.02
14	0.07	0.08	0.16	0.02
15	0.07	0.08	0.16	0.02
16	0.07	0.08	0.16	0.02
17	0.07	0.08	0.16	0.02
Average	***0.07***	***0.08***	***0.16***	***0.02***

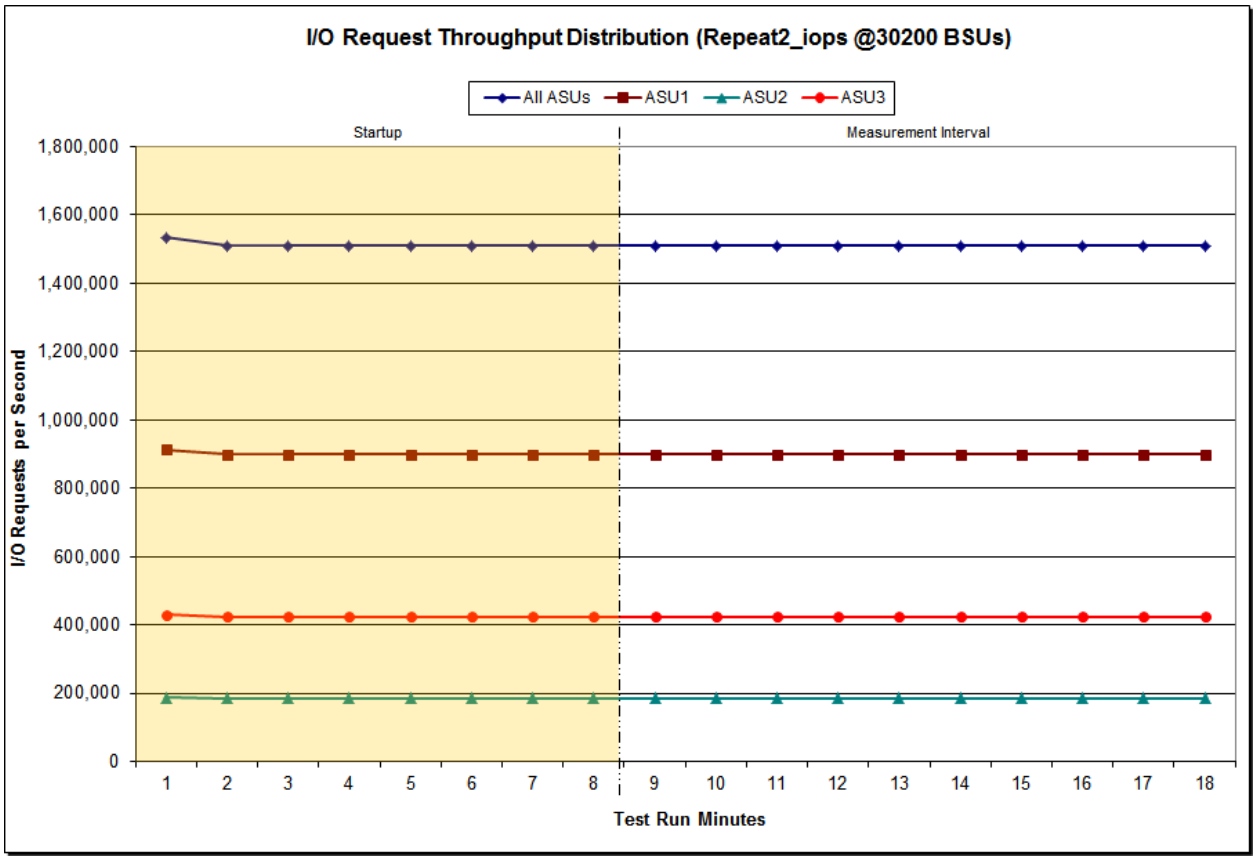
Repeatability 2 LRT –Average Response Time (ms) Distribution Graph



Repeatability 2 IOPS – I/O Request Throughput Distribution Data

30,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:09:21	2:17:22	0-7	0:08:01
Measurement Interval	2:17:22	2:27:22	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1,534,087.27	914,261.93	188,720.40	431,104.93
1	1,509,904.85	899,893.47	185,722.87	424,288.52
2	1,509,995.02	899,920.93	185,669.53	424,404.55
3	1,510,216.05	900,102.97	185,742.72	424,370.37
4	1,510,063.95	899,841.48	185,749.03	424,473.43
5	1,510,083.55	899,948.25	185,763.28	424,372.02
6	1,509,763.77	899,766.18	185,781.53	424,216.05
7	1,509,831.45	899,766.88	185,822.72	424,241.85
8	1,510,181.40	899,892.52	185,772.98	424,515.90
9	1,509,912.52	899,908.07	185,769.53	424,234.92
10	1,510,159.30	900,085.95	185,645.68	424,427.67
11	1,510,309.52	900,137.83	185,808.05	424,363.63
12	1,509,747.73	899,700.37	185,789.35	424,258.02
13	1,510,001.07	900,057.92	185,713.22	424,229.93
14	1,510,238.45	899,973.53	185,792.60	424,472.32
15	1,510,230.92	900,096.57	185,774.03	424,360.32
16	1,509,922.85	900,020.45	185,658.22	424,244.18
17	1,509,912.00	899,951.85	185,704.33	424,255.82
Average	***1,510,061.58***	***899,982.51***	***185,742.80***	***424,336.27***

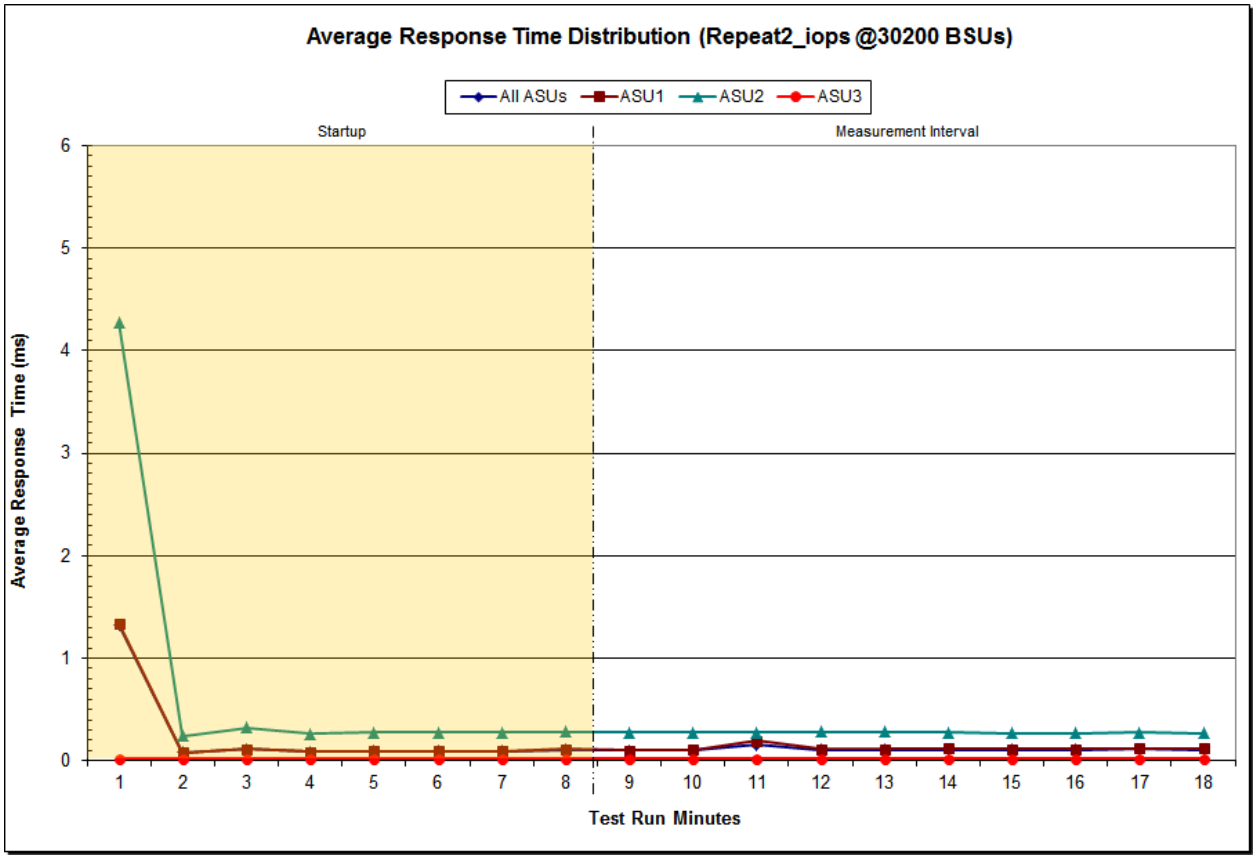
Repeatability 2 IOPS – I/O Request Throughput Distribution Graph



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

30,200 BSUs	Start	Stop	Interval	Duration
Start-Up/Ramp-Up	2:09:21	2:17:22	0-7	0:08:01
Measurement Interval	2:17:22	2:27:22	8-17	0:10:00
60 second intervals	**All ASUs**	**ASU1**	**ASU2**	**ASU3**
0	1.33	1.34	4.27	0.02
1	0.08	0.08	0.24	0.02
2	0.11	0.11	0.32	0.02
3	0.09	0.09	0.27	0.02
4	0.09	0.09	0.27	0.02
5	0.10	0.10	0.27	0.02
6	0.10	0.10	0.28	0.02
7	0.11	0.11	0.28	0.02
8	0.10	0.10	0.28	0.02
9	0.10	0.11	0.28	0.02
10	0.15	0.19	0.28	0.02
11	0.11	0.12	0.28	0.02
12	0.11	0.12	0.28	0.02
13	0.11	0.12	0.28	0.02
14	0.11	0.12	0.27	0.02
15	0.11	0.12	0.27	0.02
16	0.11	0.12	0.28	0.02
17	0.11	0.12	0.27	0.02
Average	***0.11***	***0.12***	***0.28***	***0.02***

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



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

Clause 3.4.3

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.*

Clauses5.1.10 and 5.3.15.2

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%.*

Clause 5.3.15.3

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

	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	0.002	0.001	0.001	0.001	0.002	0.001	0.002	0.001

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	0.2810	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000

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	0.0350	0.2809	0.0701	0.2100	0.0180	0.0700	0.0350	0.2811
COV	0.002	0.000	0.001	0.000	0.002	0.002	0.002	0.001

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	0.0700	0.2100	0.0180	0.0700	0.0350	0.2810
COV	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000

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 IOPS™ 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 Tested Storage Configuration (TSC) 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 9.4.3.8

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, a table 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 (may be contained in an appendix).*

SPC-1 Workload Generator Input Parameters

The SPC-1 Workload Generator input parameters for the Sustainability, IOPS, Response Time Ramp, Repeatability, and Persistence Test Runs are documented in Appendix E: SPC-1 Workload Generator Input Parameters on Page 94.

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	362,282,144
Total Number of Logical Blocks Verified	185,568,144
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 9.4.3.9

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 for the Priced Storage Configuration must be the date at which all components are committed to be available.

The DataCore Parallel Server as documented in this Full Disclosure Report will become available on May 16, 2016 for customer purchase and shipment.

PRICING INFORMATION

Clause 9.4.3.3.6

The Executive Summary shall contain a pricing spreadsheet as documented in Clause 8.3.1.

Pricing information may be found in the Priced Storage Configuration Pricing section on page 17.

TESTED STORAGE CONFIGURATION (TSC) AND PRICED STORAGE CONFIGURATION DIFFERENCES

Clause 9.4.3.3.8

The Executive Summary shall contain a list of all differences between the Tested Storage Configuration (TSC) and the Priced Storage Configuration.

A list of all differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration may be found in the Executive Summary portion of this document on page 17.

ANOMALIES OR IRREGULARITIES

Clause 9.4.3.10

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 Parallel Server.

APPENDIX A: SPC-1 GLOSSARY

"Decimal" *(powers of ten)* Measurement Units

In the storage industry, the terms "kilo", "mega", "giga", "tera", "peta", and "exa" are commonly used prefixes for computing performance and capacity. For the purposes of the SPC workload definitions, all of the following terms are defined in "powers of ten" measurement units.

A kilobyte (KB) is equal to 1,000 (10^3) bytes.

A megabyte (MB) is equal to 1,000,000 (10^6) bytes.

A gigabyte (GB) is equal to 1,000,000,000 (10^9) bytes.

A terabyte (TB) is equal to 1,000,000,000,000 (10^{12}) bytes.

A petabyte (PB) is equal to 1,000,000,000,000,000 (10^{15}) bytes

An exabyte (EB) is equal to 1,000,000,000,000,000,000 (10^{18}) bytes

"Binary" *(powers of two)* Measurement Units

The sizes reported by many operating system components use "powers of two" measurement units rather than "power of ten" units. The following standardized definitions and terms are also valid and may be used in this document.

A kibibyte (KiB) is equal to 1,024 (2^{10}) bytes.

A mebibyte (MiB) is equal to 1,048,576 (2^{20}) bytes.

A gigibyte (GiB) is equal to 1,073,741,824 (2^{30}) bytes.

A tebibyte (TiB) is equal to 1,099,511,627,776 (2^{40}) bytes.

A pebibyte (PiB) is equal to 1,125,899,906,842,624 (2^{50}) bytes.

An exbibyte (EiB) is equal to 1,152,921,504,606,846,967 (2^{60}) bytes.

SPC-1 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 selected level of 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.

SPC-1 Data Protection Levels

Protected 1: The single point of failure of any ***storage device*** in the configuration will not result in permanent loss of access to or integrity of the SPC-1 Data Repository.

Protected 2: The single point of failure of any ***component*** in the configuration will not result in permanent loss of access to or integrity of the SPC-1 Data Repository.

SPC-1 Test Execution 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.

Completed I/O Request: An I/O Request with a Start Time and a Completion Time (see "I/O Completion Types" below).

Completion Time: The time recorded by the Workload Generator when an I/O Request is satisfied by the TSC as signaled by System Software.

Data Rate: The data transferred in all Measured I/O Requests in an SPC-1 Test Run divided by the length of the Test Run in seconds.

Expected I/O Count: For any given I/O Stream and Test Phase, the product of 50 times the BSU level, the duration of the Test Phase in seconds, and the Intensity Multiplier for that I/O Stream.

Failed I/O Request: Any I/O Request issued by the Workload Generator that could not be completed or was signaled as failed by System Software. A Failed I/O Request has no Completion Time (see "I/O Completion Types" below).

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.

In-Flight I/O Request: An I/O Request issued by the I/O Command Generator to the TSC that has a recorded Start Time, but does not complete within the Measurement Interval (see "I/O Completion Types" below).

Measured I/O Request: A Completed I/O Request with a Completion Time occurring within the Measurement Interval (see "I/O Completion Types" below).

Measured Intensity Multiplier: The percentage of all Measured I/O Requests that were issued by a given I/O Stream.

Measurement Interval: The finite and contiguous time period, after the 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.

Ramp-Up: The time required for the Benchmark Configuration (BC) to produce Steady State throughput after the Workload Generator begins submitting I/O Requests to the TSC for execution.

Ramp-Down: The time required for the BC to complete all I/O Requests issued by the Workload Generator. The Ramp-Down period begins when the Workload Generator ceases to issue new I/O Requests to the TSC.

Response Time: The Response Time of a Measured I/O Request is its Completion Time minus its Start Time.

Start Time: The time recorded by the Workload Generator when an I/O Request is submitted, by the Workload Generator, to the System Software for execution on the Tested Storage Configuration (TSC).

Start-Up: The period that begins after the Workload Generator starts to submit I/O requests to the TSC and ends at the beginning of the Measurement Interval.

Shut-Down: The period between the end of the Measurement Interval and the time when all I/O Requests issued by the Workload Generator have completed or failed.

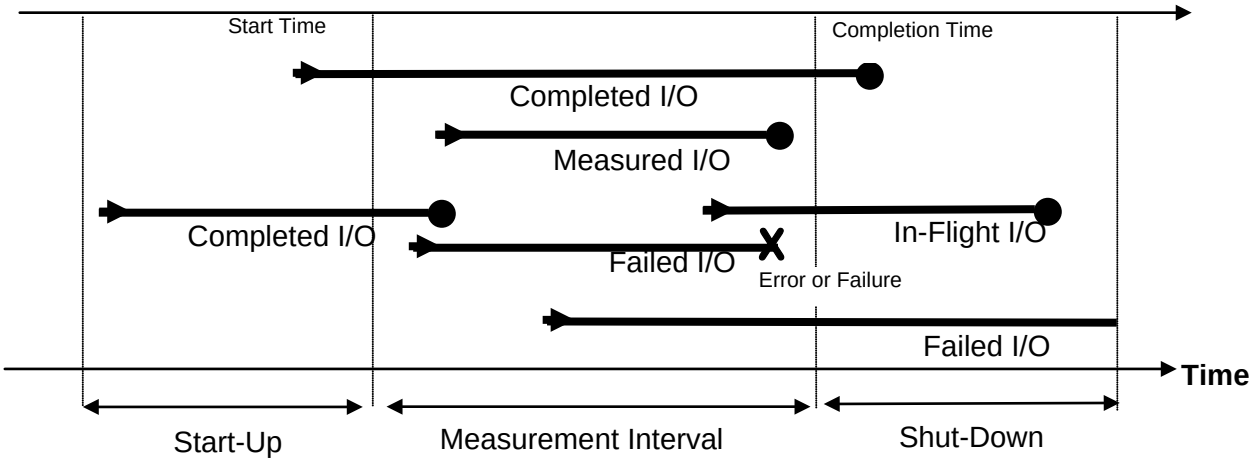
Steady State: The consistent and sustainable throughput of the TSC. During this period the load presented to the TSC by the Workload Generator is constant.

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

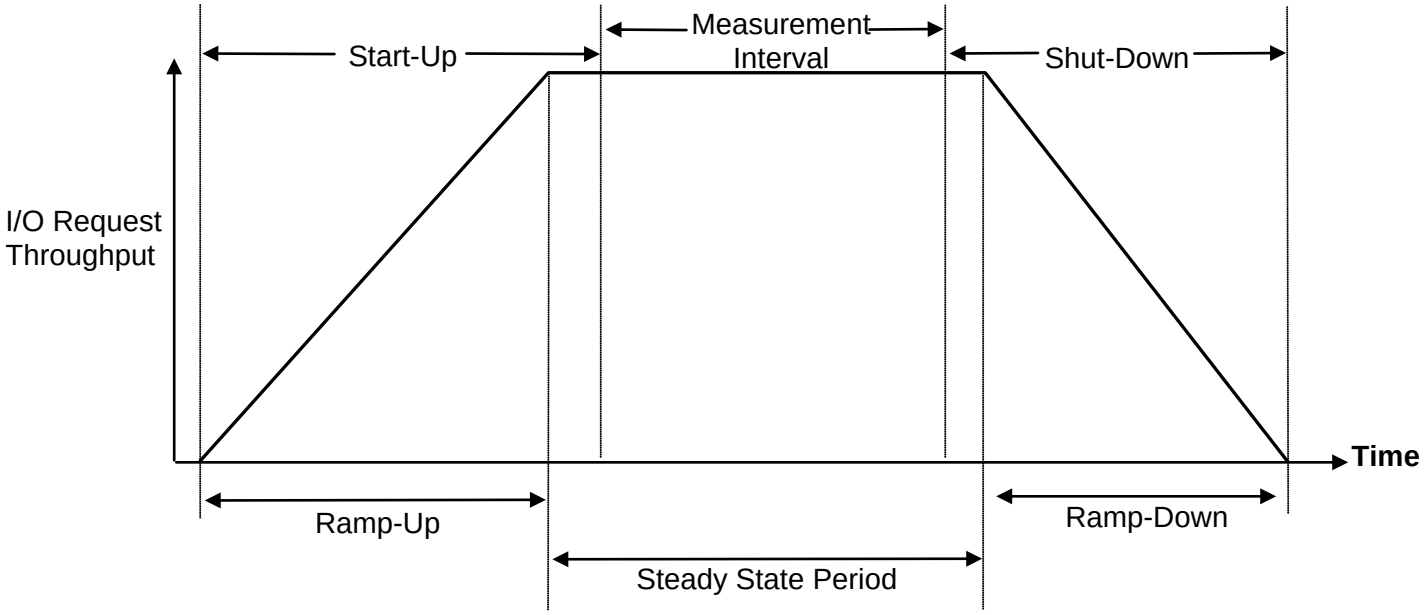
Test Run: The execution of SPC-1 for the purpose of producing or supporting an SPC-1 test result. SPC-1 Test Runs may have a finite and measured Ramp-Up period, Start-Up period, Shut-Down period, and Ramp-Down period as illustrated in the "SPC-1 Test Run Components" below. All SPC-1 Test Runs shall have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

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.

I/O Completion Types



SPC-1 Test Run Components



APPENDIX B: CUSTOMER TUNABLE PARAMETERS AND OPTIONS

Windows 2008 Server Registry Settings

The following Windows 2008 Server registry settings were either changed from their default values or added if they did not exist. Settings changed from their default values will have the default value listed in parenthesis and new settings will be annotated with "(new)".

SANsymphony-V PMF parameters

[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsPMF\Parameters]
(will be applied to the system)

- **LoopbackSid=dword:00000bb8** ***(new)***
  Enables ParallelIO Processing.
- **LoopbackCount=dword:00*100000* *(new)***
  Sets maximum number of concurrent ParallelIO operations.

SANsymphony-V Cache Settings for defined Virtual Disks

[HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsCache\Parameters]
(will be applied to each virtual disk)

- **WriteSizeStop=dword:00000000** ***(00040000)***
  Maximum amount of dirty data (cache memory locations that have changed but not committed to the backend) in the cache.
- **ReadAhead=dword:00000000** ***(00000001)***
  Enable prefetching. Setting means no prefetching
- **IoQueueCount=dword:000003fe** ***(00000020)***
  Max number of outstanding IOs to the backend
- **WriteQueueCount=dword:000000b4 (default=IoQueueCount setting)**
  Max number of outstanding writes to the backend
- **IoQueueSize=dword:00036000** ***(00002000)***
  Max number of blocks that can be outstanding to the backend
- **WriteQueueSize=dword:00014054 (default=IoQueueSize setting)**
  Max number of write blocks that can be outstanding to the backend
- **AllowRewrite=dword:00000001** ***(00000000)***
  Enable rewrite. When set, an initiator can overwrite dirty data.
- **CmdPoolSize=dword:00010000** ***(new)***
  Number of storage commands that may be simultaneously in progress (global to the entire storage node)
- **MaxLowWaterMark=dword:00000400** ***(new)***
  Point at which the cache is critically short of available blocks and will begin to return busy status to requests.

- **WriteThruLowWaterMark=dword:00010000** ***(new)***
  Point at which the cache will begin to process all write requests by synchronizing them with the backend. (begins writethrough)
- **WorkerMode=dword:0000000a (new)**
  Indicates how many backend worker threads should be used

SANsymphony-V Cache settings for defined specific Virtual Disks

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsCache\Parameters\V.{c49b331b-a59f-11e5-adfd-9abe94f9da67}-00000001

ASU1_2=""

- **IoQueueCount=dword:000000c8** ***(00000020)***
  Max number of outstanding IOs to the backend
- **IoQueueSize=dword:00075000** ***(00002000)***
  Max number of blocks that can be outstanding to the backend
- **WriteQueueCount=dword:00000028** ***(IoQueueCount)***
  Max number of outstanding writes to the backend
- **WriteQueueSize=dword:00075000** ***(IoQueueSize)***
  Max number of write blocks that can be outstanding to the backend

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsCache\Parameters\V.{c49b331f-a59f-11e5-adfd-9abe94f9da67}-00000001

ASU1_3=""

- **IoQueueCount=dword:000000b4** ***(00000020)***
  Max number of outstanding IOs to the backend
- **IoQueueSize=dword:00075000** ***(00002000)***
  Max number of blocks that can be outstanding to the backend
- **WriteQueueCount=dword:00000018** ***(IoQueueCount)***
  Max number of outstanding writes to the backend
- **WriteQueueSize=dword:00075000** ***(IoQueueSize)***
  Max number of write blocks that can be outstanding to the backend

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsCache\Parameters\V.{c49b332e-a59f-11e5-adfd-9abe94f9da67}-00000001

ASU2_2=""

- **IoQueueCount=dword:000000c8** ***(00000020)***
  Max number of outstanding IOs to the backend
- **IoQueueSize=dword:00075000** ***(00002000)***
  Max number of blocks that can be outstanding to the backend

- **WriteQueueCount=dword:00000020** ***(IoQueueCount)***
  Max number of outstanding writes to the backend
- **WriteQueueSize=dword:00075000** ***(IoQueueSize)***
  Max number of write blocks that can be outstanding to the backend

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsCache\Parameters\V.{af9fd150-9dd6-11e5-b29d-9abe94f9da67}-00000004

ASU3_1=""

- **IoQueueCount=dword:00000003** ***(00000020)***
  Max number of outstanding IOs to the backend
- **IoQueueSize=dword:00075000** ***(00002000)***
  Max number of blocks that can be outstanding to the backend
- **WriteQueueCount=dword:00000003** ***(IoQueueCount)***
  Max number of outstanding writes to the backend
- **WriteQueueSize=dword:00075000** ***(IoQueueSize)***
  Max number of write blocks that can be outstanding to the backend

SANsymphony-V Poller settings

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsPoll\Parameters

- **LoadHighWaterMark=dword:00000002** ***(00000028)***
  Determines when a new scheduler instance is spawned.
- **LoadLowWaterMark=dword:00000001** ***(0000000a)***
  Determines when a scheduler instance is retired.
- **MinPollers=dword:00000000** ***(00000002) (new)***[1]
  Minimum number of schedulers
- **MaxPollers=dword:00000000** ***(0000000a) (new)***[1]
  Allows max schedulers to increase to 31 and addition of logical Ports to increase to 31
- **MaxIdleLoops=dword:04000001 (b2d05e00) (new)** [1]
  Determines when a scheduler instance should be considered idle.

SANsymphony-V settings for Pools

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsPool\Parameters

- **ChunkListBucketCount=dword:00020000** ***(00000400) (new)***[1]
  Allow Pool driver's ChunkList hash table size to be changed
- **EnableAsyncIo=dword:00000000 (00000001) (new)** [1]

  Enables the use of system worker threadsfor issuing IOs to a physical disk.

SANsymphony-V settings for specific Pools

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsPool\Parameters\MaxActiveIOsPerDisk
(Set per pool by specifying the Pool's GUID)

- **{af9fd150-9dd6-11e5-b29d-9abe94f9da67}=dword:00000003** ***(00000020)***
  HDD_Pool1*, 3 IOs per disk in this pool*
- **{c49b331b-a59f-11e5-adfd-9abe94f9da67}=dword:00000030** ***(00000020)***
  SSD_Pool1*, 48 IOs per disk in this pool*
- **{c49b331f-a59f-11e5-adfd-9abe94f9da67}=dword:00000030** ***(00000020)***
  SSD_Pool2*, 48 IOs per disk in this pool*
- **{c49b3323-a59f-11e5-adfd-9abe94f9da67}=dword:00000030** ***(00000020)***
  SSD_Pool3*, 48 IOs per disk in this pool*
- **{c49b3329-a59f-11e5-adfd-9abe94f9da67}=dword:00000030** ***(00000020)***
  SSD_Pool4*, 48 IOs per disk in this pool*
- **{c49b332e-a59f-11e5-adfd-9abe94f9da67}=dword:00000030** ***(00000020)***
  SSD_Pool5*, 48 IOs per disk in this pool*

HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\services\DcsPool\Parameters\KickWorkerOnIoCompletion
(Set per pool by specifying the Pool's GUID)

- **{c49b331b-a59f-11e5-adfd-9abe94f9da67}=dword:00000001** ***(00000000)***
  SSD_Pool1*, Notify scheduler on physical disk IO completion.*
- **{c49b331f-a59f-11e5-adfd-9abe94f9da67}=dword:00000001** ***(00000000)***
  SSD_Pool2*, Notify scheduler on physical disk IO completion.*
- **{c49b3323-a59f-11e5-adfd-9abe94f9da67}=dword:00000001** ***(00000000)***
  SSD_Pool3*, Notify scheduler on physical disk IO completion.*
- **{c49b3329-a59f-11e5-adfd-9abe94f9da67}=dword:00000001** ***(00000000)***
  SSD_Pool4*, Notify scheduler on physical disk IO completion.*
- **{c49b332e-a59f-11e5-adfd-9abe94f9da67}=dword:00000001** ***(00000000)***
  SSD_Pool5*, Notify scheduler on physical disk IO completion.*
- **{c49b3333-a59f-11e5-adfd-9abe94f9da67}=dword:00000001** ***(00000000)***
  SSD_Pool6*, Notify scheduler on physical disk IO completion.*

NOTE:

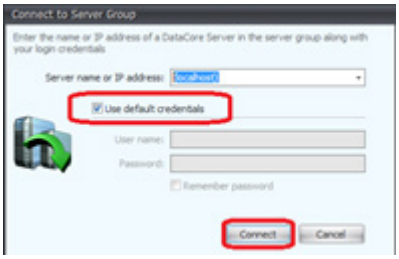
[1]On initial inspection using the registry editor, these registry entries will be absent. In their absence, the software will use the default values (given in parenthesis). The user must add those entries with the values documented to override these defaults.

APPENDIX C: TESTED STORAGE CONFIGURATION (TSC) CREATION

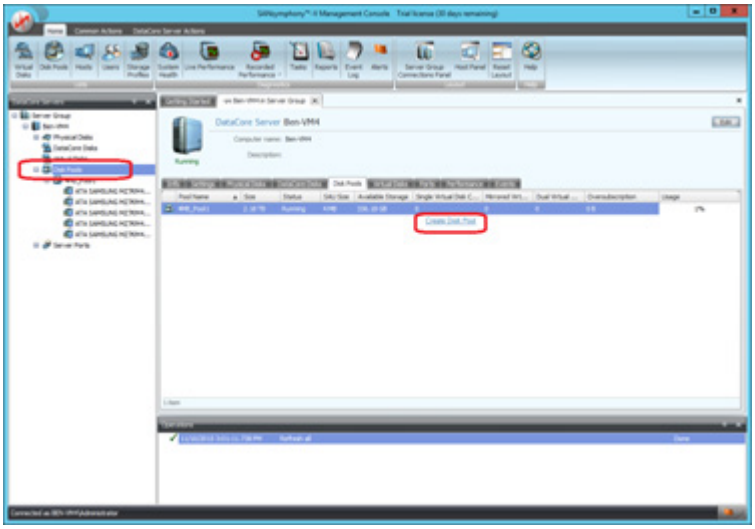
1. **Install DataCore Parallel Server Software:**
   The software installation is performed by running a self-extracting executable file

   After installation, the Management Console can be accessed from the Windows "start" menu or by using the desktop shortcut with the DataCore logo. Online help for using the Management Console is located at http://www.datacore.com/SSV-Webhelp/ *(refer the help topic, SANSymphony-V Management Console for more information).*

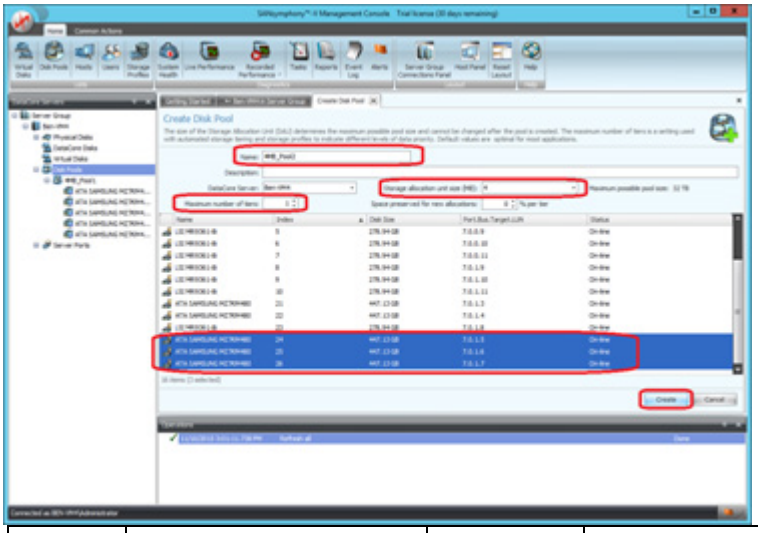
2. Open and log in to the Management Console using the following steps. At the end of this step, you will be logged into the management and configuration console:
   a. On the system desktop, double-click on the "SANsymphony-V" icon to start the management console.
   b. Select the "Use default credentials checkbox and click Connect to proceed to the management console:



3. Create pools from managed physical disk resources with the following steps:
   a. In the management console, click **Disk Pools** in the left panel labeled **DataCore Servers**, then click **Create Disk Pool** in the main panel to initiate the next step.



b. On the subsequent screen, in the main panel, complete the **Name:**, **Storage allocation unit size (MB):**, set the **Maximum number of tiers:** to 1, and select the proper type and amount of physical disks in accordance with the table listed below the following screenshot. Click the **Create** button to create the pool after selecting the disks. *(Note: **4MB_Pool1** has been created as an example).* Repeat this step for each of the 7 pools that are to be created:

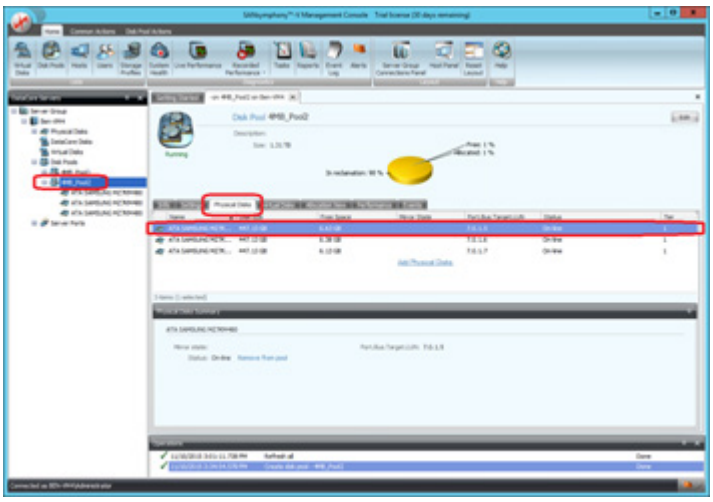


Pool Number	PoolName	Storage Allocation Unit Size(MB)	Number of physical Disks to select (in lower panel)	Type of Physical Disk (from "Name" column in lower panel)
1	SSD_Pool1	4	3	ATA SAMSUNG MZ7KM120
2	SSD_Pool2	4	3	ATA SAMSUNG MZ7KM120
3	SSD_Pool3*	4	3	ATA SAMSUNG MZ7KM120
			1	ATA SAMSUNG MZ7KM240
4	SSD_Pool4	4	3	ATA SAMSUNG MZ7KM240
5	SSD_Pool5*	4	2	ATA SAMSUNG MZ7KM120
			2	ATA SAMSUNG MZ7KM240
6	SSD_Pool6	4	3	ATA SAMSUNG MZ7KM240
7	HDD_Pool1	32	4	HGST HUC156030CSS200

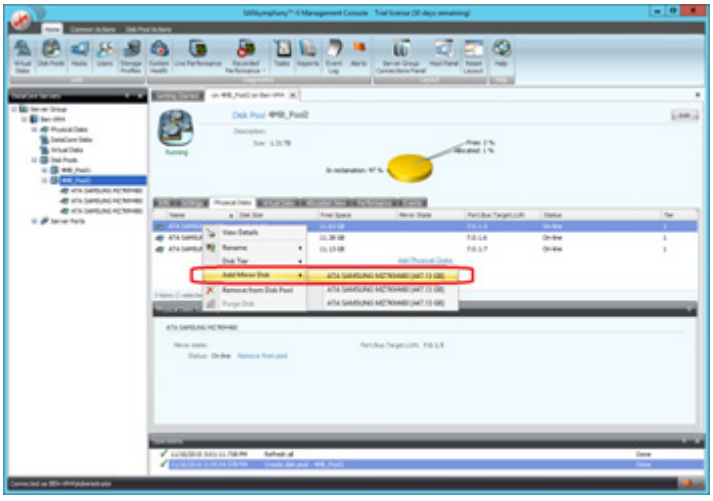
*Note that pool3 and pool5 are made up of different disk types and quantities as indicated in the split rows of the "Number of physical Disks to select" column. Click and hold the [Ctrl] key when using the mouse to select these disks individually from the lower panel.

4. Mirror each pooled physical disk in each pool created in step **3b** by performing step **4a** for each pool, then step **4b** for each disk in the pool.

   a. Select the pool. In the management console, click on a disk pool in the left panel, then click the tab labeled **Physical Disks** in the main panel and then select a disk in the panel below that tab.



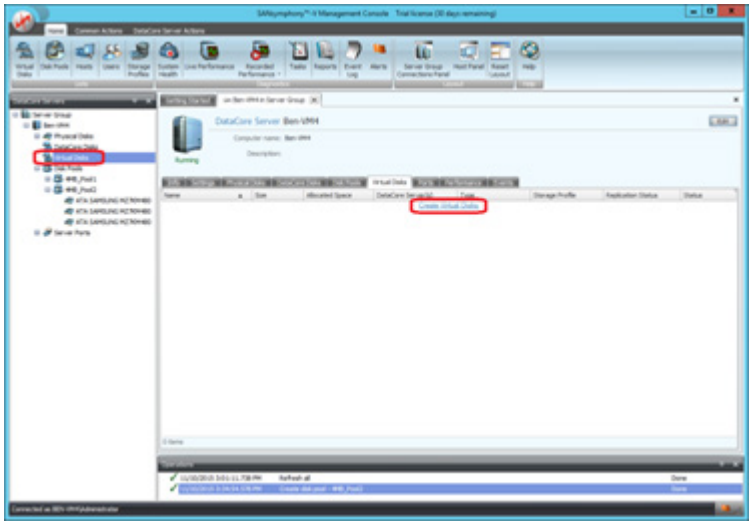
   b. Right-click on the disk (**Name** column) and select **Add Mirror Disk** and select a disk of the same type to mirror to.



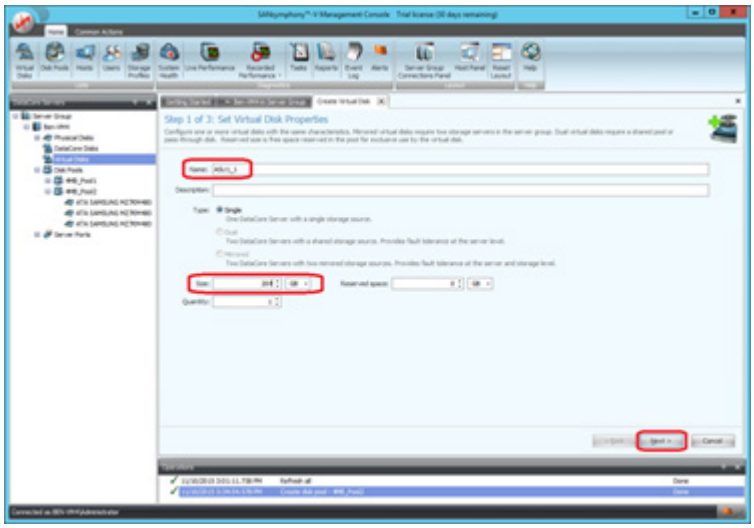
5. Create 10 Virtual Disks repeating steps **5a** through **5d** 10 times, once for each of the virtual disks to be created, using the details in the following table. The virtual disks created in this step will be mapped and are the SPC-1 Logical Volumes use to define the SPC-1 ASUs.

Virtual Disk Number	Name:	Size: (GB)	Source Pool:
1	ASU1_1	220	SSD_Pool4
2	ASU1_2	220	SSD_Pool1
3	ASU1_3	220	SSD_Pool2
4	ASU1_4	220	SSD_Pool6
5	ASU1_5	220	SSD_Pool3
6	ASU1_6	220	SSD_Pool3
7	ASU2_1	440	SSD_Pool4
8	ASU2_2	440	SSD_Pool5
9	ASU2_3	440	SSD_Pool6
10	ASU3_1	300	HDD_Pool1

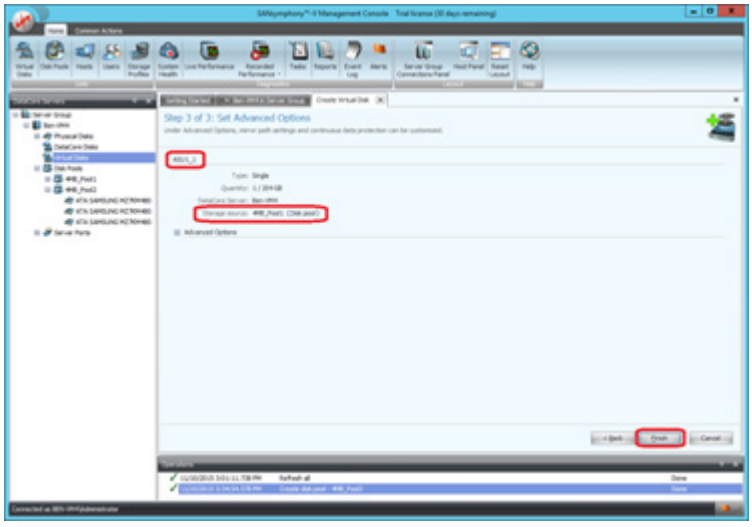
a. In the management console, click **Virtual Disks** in the left panel labeled **DataCore Servers**, then click **Create Virtual Disks** in the main panel.



b. On the subsequent screen, complete the **Name:** and the **Size (GB):** as described in the table above. Click the **Next** button to proceed to the next step. *(Note: **ASU1_1** is being created as an example)*:



c. On the subsequent screen, set the storage source by clicking on the appropriate entry *(Refer to the above table in step 5.)* under the **Pool Name** column and proceed to the next step by clicking the **Next** button,



6. Use the Windows 2008 Server registry editor to make the changes documented in *Appendix B: Customer Tunable Parameters and Options* on page 81.
7. Double-click the desktop icon labeled "SANsymphony-V cmdlet shell to open it and execute the script **MapVDs.ps1**. This script maps the virtual disks created in step 5 to the host via logical ports.

MapVDs.ps1

```
Connect-DcsServer

Write-Host "ASU1_1"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU1_1 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Write-Host "ASU1_2"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU1_2 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Write-Host "ASU1_3"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU1_3 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Write-Host "ASU1_4"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU1_4 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Write-Host "ASU1_5"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU1_5 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Write-Host "ASU1_6"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU1_6 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Write-Host "ASU2_1"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU2_1 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Write-Host "ASU2_2"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU2_2 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5
```

```
Write-Host "ASU2_3"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU2_3 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Write-Host "ASU3_1"
Serve-DcsVirtualDisk -Machine x3650spc2 -VirtualDisk ASU3_1 -InitiatorPort "Loopback
Port 1" -TargetPort "Loopback Port 1"

Start-Sleep -seconds 5

Disconnect-DcsServer
```

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

ASU Pre-Fill

The content of command and parameter file, used in this benchmark to execute the required ASU pre-fill, is listed below.

```
compratio=1
sd=default,threads=8
sd=asu1_1,lun=\\.\PhysicalDrive50,threads=4
sd=asu1_2,lun=\\.\PhysicalDrive51,threads=4
sd=asu1_3,lun=\\.\PhysicalDrive52,threads=4
sd=asu1_4,lun=\\.\PhysicalDrive53,threads=4
sd=asu1_5,lun=\\.\PhysicalDrive54,threads=4
sd=asu1_6,lun=\\.\PhysicalDrive55,threads=4
sd=asu2_1,lun=\\.\PhysicalDrive56,threads=4
sd=asu2_2,lun=\\.\PhysicalDrive57,threads=4
sd=asu2_3,lun=\\.\PhysicalDrive58,threads=4
sd=asu3_1,lun=\\.\PhysicalDrive59,threads=4
wd=default,rdpct=0,seek=-1,xfersize=512k
wd=wd1,sd=asu1_1
wd=wd2,sd=asu1_2
wd=wd3,sd=asu1_3
wd=wd4,sd=asu1_4
wd=wd5,sd=asu1_5
wd=wd6,sd=asu1_6
wd=wd7,sd=asu2_1
wd=wd8,sd=asu2_2
wd=wd9,sd=asu2_3
wd=wd10,sd=asu3_1
rd=asuprefill,wd=wd*,iorate=max,elapsed=24h,interval=60
```

Primary Metrics, Repeatability and Persistence Tests

The content of SPC-1 Workload Generator command and parameter files used in this benchmark to execute the Primary Metrics *(Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase)* and Repeatability *(Repeatability Test Phase 1 and Repeatability Test Phase 2)* Tests are listed below.

```
javaparms="-Xmx2048m"
sd=asu1_1,lun=\\.\PhysicalDrive50,size=219g
sd=asu1_2,lun=\\.\PhysicalDrive51,size=219g
sd=asu1_3,lun=\\.\PhysicalDrive52,size=219g
sd=asu1_4,lun=\\.\PhysicalDrive53,size=219g
sd=asu1_5,lun=\\.\PhysicalDrive54,size=219g
sd=asu1_6,lun=\\.\PhysicalDrive55,size=219g
sd=asu2_1,lun=\\.\PhysicalDrive56,size=438g
sd=asu2_2,lun=\\.\PhysicalDrive57,size=438g
sd=asu2_3,lun=\\.\PhysicalDrive58,size=438g
sd=asu3_1,lun=\\.\PhysicalDrive59,size=292g
```

APPENDIX E: SPC-1 WORKLOAD GENERATOR INPUT PARAMETERS

The 'master' script, **RunBench.bat**, was executed to:

- Set various benchmark-related environment variables (**config.bat**).
- Generate the first set of storage configuration information required for audit.
- Invoke the **RunSPC1.bat** script, with the appropriate arguments, to execute the following in an uninterrupted sequence:
  - Terminate any pre-existing Slave JVMs prior to executing the ASU pre-fill or SPC-1 Test Run.
  - Start the required number of Slave JVMs and bind each Slave JVM to a set of CPUs located on the same NUMA node. The number of CPUs in the set and the specific affinity mask is dynamically determined based on the benchmark configuration under test. A value of 6 CPUs per set was used.
  - Execute the following, based invocation arguments:
    - The required ASU pre-fill.
    - The Primary Metrics Test *(Sustainability Test Phase, IOPS Test Phase, and Response Time Ramp Test Phase)*.
    - The Repeatability Test *(Repeatability Test Phase 1 and Repeatability Test Phase 2)*.
    - The SPC-1 Persistence Test Run 1 *(write phase)*.

The **Persist2.bat** script was then invoked to execute the SPC-1 Persistence Test Run 2 *(read phase)* after completion of the required TSC power off/power on cycle. In addition, the script generated the second set of storage configuration information required for audit.

RunBench.bat

```
rem mode con: cols=160 lines=60
rem
rem Change to benchmark results folder
rem
cd C:\BenchmarkRun
rem
rem Set parameters
rem
set exec=
set rate=30200
set sustain=28800
if exist config.bat call config.bat
rem
rem Get storage information before run
rem
powershell.exe c:\BenchMarkRun\GetInfo.ps1 -NoLogo > psOutputStart.txt
c:\spc\tools\sas3ircu.exe 0 display > LSI_HBA_InfoStart.txt
"c:\Program Files (x86)\MegaRAID Storage Manager\storcli.exe" /call show >
LSI_RAID_InfoStart.txt
rem
rem PreFill ASU space with vdbench
rem
call RunSPC1 prefill
```

```
rem
java -version
rem
rem Metrics sustainability -
rem
call RunSPC1 metrics -b %rate% -s 480 -t %sustain%
rem
rem Repeatability Runs
rem
call RunSPC1 repeat1 -b %rate% -s 480
Rem
call RunSPC1 repeat2 -b %rate% -s 480
rem
rem Persist runs
rem
set /a persistrate=rate/10
call RunSPC1 persist1 -b %persistrate%
rem
rem Run persist2 after power cycle
rem
@pause
```

config.bat

```
set rate=30200
set sustain=28800
set javaparms=-Xmx512m -XX:+UseG1GC

rem set setsize=6
```

RunSPC1.bat

```
@echo off
@setlocal enabledelayedexpansion

set setsize=6

set exec=
set javaparms=

cd c:\BenchmarkRun

set /a numas=%HIGHESTNUMANODENUMBER%+1
if "%numas%"=="1" set /a numas=2

set /a cpus=NUMBER_OF_PROCESSORS
if "%cpus%"=="36" set /a cpus=72
if "%cpus%"=="60" set /a cpus=120

set /a cpus=cpus/numas
if "%cpus%"=="28" set setsize=4
if "%cpus%"=="32" set setsize=4

if exist config.bat call config.bat

set cmd=%0
if exist %cmd%.bat set cmd=%cmd%.bat

if "%1"=="-d" (
    set exec=echo
    shift
```

```
)

:kill
if "%exec%"=="" (
    tskill java >nul: 2>&1
    if not errorlevel 1 goto :kill
)

if "%1"=="kill" goto :eof

set /a x=%1
if not "%x%"=="0" (
    set setsize=%x%
    shift
)

set /a sets=cpus/setsize
set /a v=sets*setsize

if not "%v%"=="%cpus%" (
    echo Error: CPU count is not a multiple of the set size
    goto :eof
)

set x=%1
if "%x:~0,1%"=="-" (
    set javaparms=%1
    shift
)

set output=output
if "%1"=="range" set output=rangetest
if "%1"=="metrics" set output=metrics
if "%1"=="persist1" set output=persistence1
if "%1"=="persist2" set output=persistence2
if "%1"=="repeat1" set output=repeatability1
if "%1"=="repeat2" set output=repeatability2
if "%1"=="prefill" set output=prefill.out

set bsu=0
if "%2"=="-b" set /a bsu=%3
set /a jvms="(bsu+99)/100"

if "%1"=="persist1" set /a jvms=0
if "%1"=="persist2" set /a jvms=0
if "%1"=="prefill" set /a jvms=0

if exist %output% rmdir /s /q %output%
mkdir %output%

for /f delims^=^"^ tokens^=2 %%i in ('findstr javaparms= spc1.cfg') do set
javaparms=%%i !javaparms!

set slaves=

for /L %%i in (1,1,%jvms%) do (
    mkdir %output%\h%%i >nul: 2>&1

    (
        echo Master=%COMPUTERNAME%
        echo Host=h%%i
        findstr sd= spc1.cfg
    ) > %output%\h%%i\h%%i.cfg
```

```
    set /a numa=%%i"%%"numas
    set /a setnum=%%i/numas"%%"sets

    for /f "delims=" %%i in ('findstr /b /c:"!setsize!:!setnum! " %cmd%') do set
mask=%%i
    set mask=!mask:~6!

    %exec% start /low /node !numa! /affinity !mask! java %javaparms% spc1 -f
%output%\h%%i\h%%i.cfg -o %output%\h%%i

    set slaves=!slaves!,h%%i
)

set slaves=(%slaves:~1%)

if "%1"=="prefill" (
    (
        echo compratio=1
        echo sd=default,threads=8

        for /f "delims=, tokens=1,2" %%i in ('findstr sd= spc1.cfg') do (
            echo %%i,%%j,threads=4
        )

        echo wd=default,rdpct=0,seek=-1,xfersize=512k
        set /a wd=1

        for /f "delims==, tokens=2" %%i in ('findstr sd= spc1.cfg') do (
            echo wd=wd!wd!,sd=%%i
            set /a wd=wd+1
        )

        echo rd=asuprefill,wd=wd*,iorate=max,elapsed=24h,interval=60
    ) > prefill.cfg

    %exec% call C:\spc\vdbench\vdbench.bat -f prefill.cfg -o %output%

    move /y prefill.cfg %output% >nul:
    goto :done
)

(
    findstr javaparms= spc1.cfg
    if not "%jvms%"=="0" (
        echo host=master
        echo slaves=!slaves!
    )
    findstr sd= spc1.cfg
) > spc1.multi

move /y spc1.multi spc1.cfg >nul:
copy /y spc1.cfg %output% > nul:

%exec% java %javaparms% -Xmx2048m %1 %2 %3 %4 %5 %6 %7 %8 %9

:done
if "%exec%"=="" (
    tskill java >nul: 2>&1
    if not errorlevel 1 goto :done
)

goto :eof
```

```
1:0   000000001
1:1   000000002
1:2   000000004
1:3   000000008
1:4   000000010
1:5   000000020
1:6   000000040
1:7   000000080
1:8   000000100
1:9   000000200
1:10  000000400
1:11  000000800
1:12  000001000
1:13  000002000
1:14  000003000
1:15  000004000
1:16  000010000
1:17  000020000
1:18  000040000
1:19  000080000
1:20  000100000
1:21  000200000
1:22  000400000
1:23  000800000
1:24  001000000
1:25  002000000
1:26  004000000
1:27  008000000
1:28  010000000
1:29  020000000
1:30  040000000
1:31  080000000
1:32  100000000
1:33  200000000
1:34  400000000
1:35  800000000

2:0   000000003
2:1   00000000C
2:2   000000030
2:3   0000000C0
2:4   000000300
2:5   000000C00
2:6   000003000
2:7   00000C000
2:8   000030000
2:9   0000C0000
2:10  000300000
2:11  000C00000
2:12  003000000
2:13  00c000000
2:14  030000000
2:15  0c0000000
2:16  300000000
2:17  c00000000

3:0   000000007
3:1   000000038
3:2   0000001c0
3:3   000000e00
3:4   000007000
3:5   000038000
```

```
3:6   0001C0000
3:7   000e00000
3:8   007000000
3:9   038000000
3:10  1c0000000
3:11  e00000000

4:0   00000000f
4:1   0000000f0
4:2   000000f00
4:3   00000f000
4:4   0000f0000
4:5   000f00000
4:6   00f000000
4:7   0f0000000
4:8   f00000000

6:0   00000003f
6:1   000000fC0
6:2   00003f000
6:3   000fC0000
6:4   03f000000
6:5   fC0000000

7:0   00000007f
7:1   000003f80
7:2   0001fc000
7:3   00fe00000
7:4   7f0000000

8:0   0000000ff
8:1   00000ff00
8:2   000ff0000
8:3   0ff000000

9:0   0000001ff
9:1   00003fe00
9:2   007fc0000
9:3   ff8000000

12:0  000000fff
12:1  000fff000
12:2  fff000000

14:0  000003fff
14:1  00fffc000

18:0  00003ffff
18:1  ffffc0000
```

Persist2.bat

```
rem mode con: cols=160 lines=70
cd c:\BenchmarkRun
if exist config.bat call config.bat
rem Run second Persist command to validate contents of storage
rem Run persist2 after power cycle
call RunSPC1 persist2
powershell.exe c:\BenchMarkRun\GetInfo.ps1 -NoLogo > psOutputEnd.txt
c:\spc\tools\sas3ircu.exe 0 display > LSI_HBA_InfoEnd.txt
"c:\Program Files (x86)\MegaRAID Storage Manager\storcli.exe" /call show >
LSI_RAID_InfoEnd.txt
@pause
```

APPENDIX F: THIRD-PARTY QUOTATION

Priced Storage Configuration

The third-party quotation is not embedded in this document due it size and format. The quotation is available via the following hyperlink:

Third-Party Quotation