



Flash Memory Summit

Modeling and Measuring Demanding Transactional Workloads Using SPC-1

Stephen Daniel

Chair, Storage Performance Council
Steering Committee



What is the SPC

- 20 year old Industry Consortium to provide vendor neutral storage performance benchmarks
- 40+ Members include EMC, NetApp, IBM, HPE



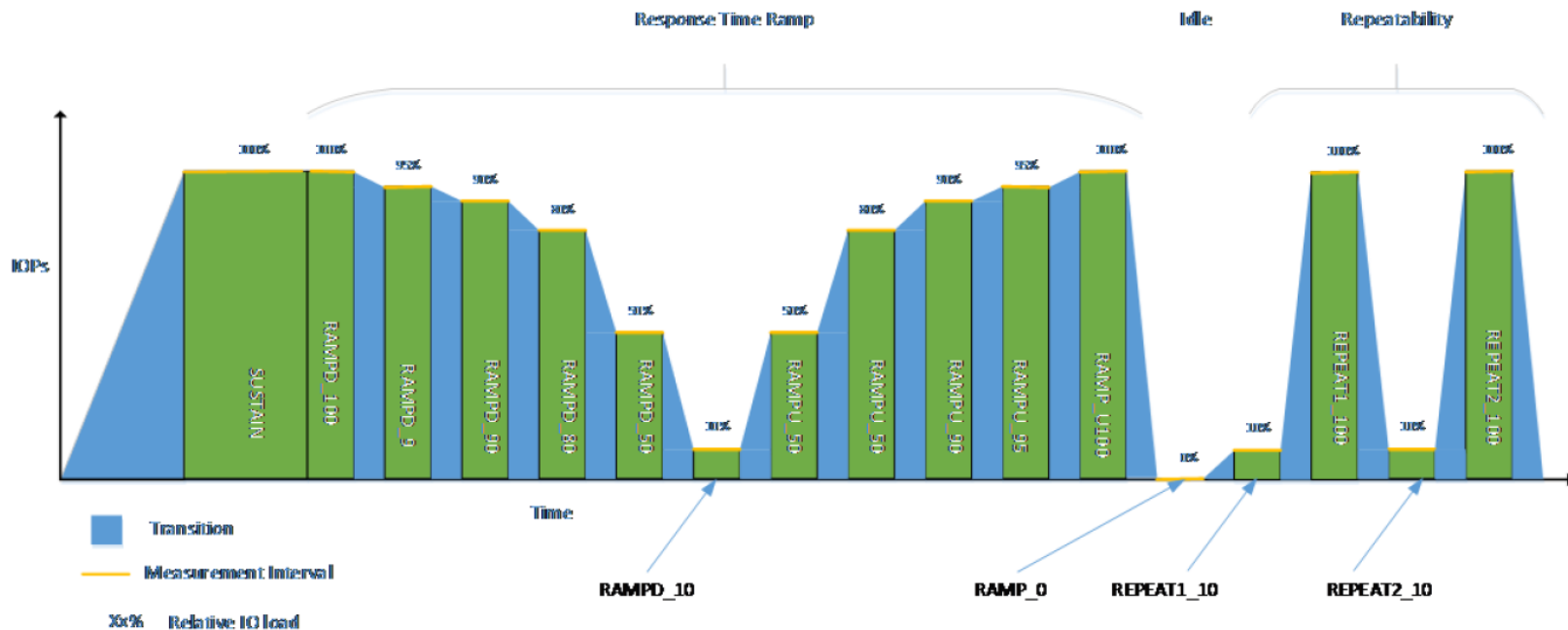
Elements of SPC-1

- Complex mixed workload
 - Mostly 8K random access, mixed with sequential
 - Time and space locality
 - Dedupable and compressible
- Intended to model a transactional workload



Multi-Phased Benchmark

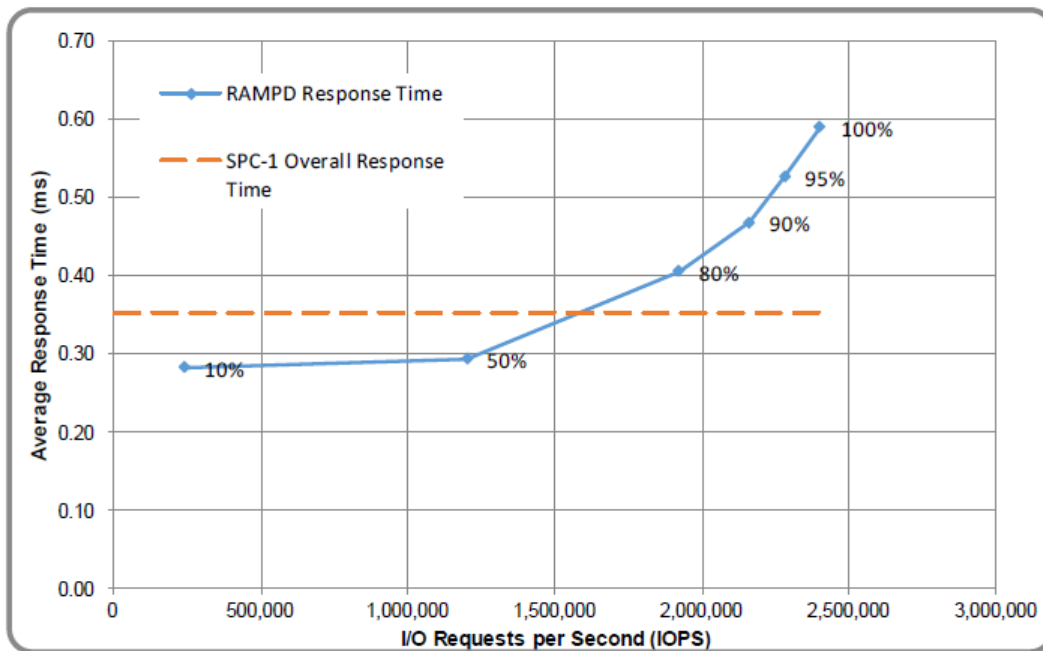
Figure 6-1 Test Execution Overview





Response Time at Various I/O Rates

Response Time and Throughput Graph



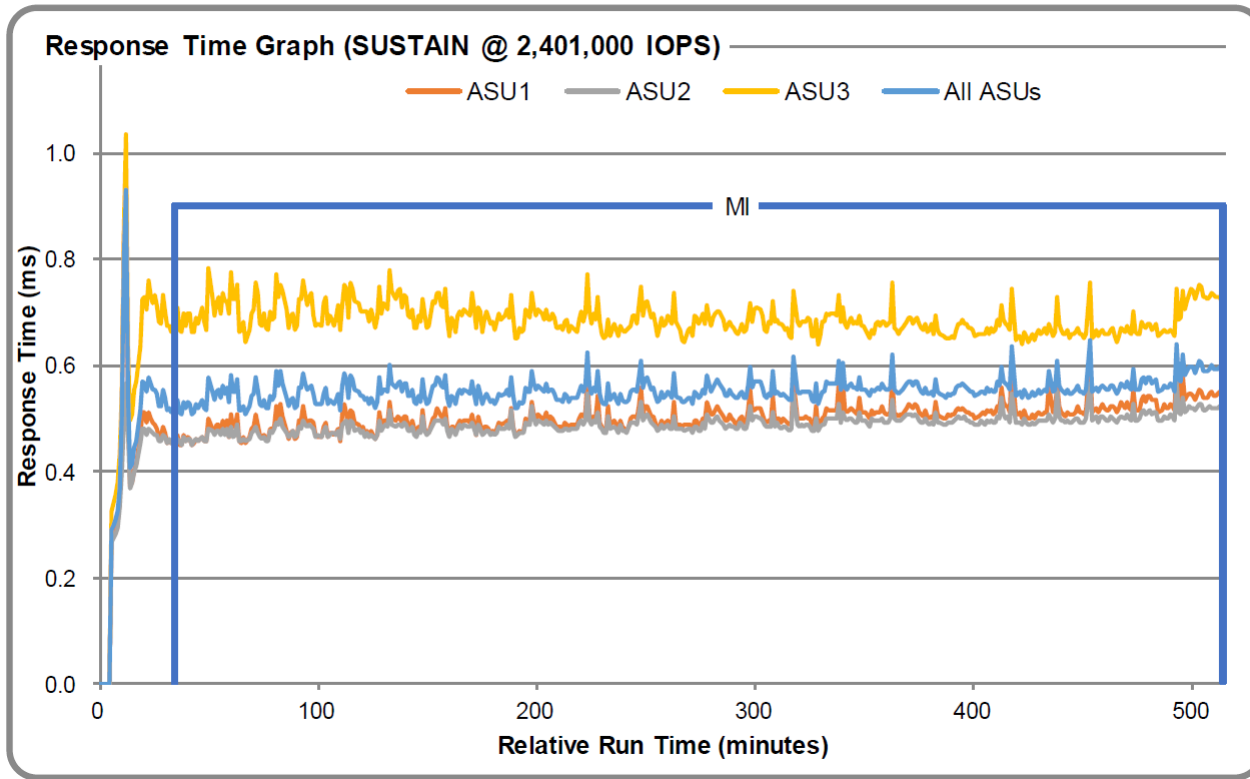


Elements of SPC-1

- Open Model
- Set the I/O rate, examine the response time
- Requires an 8-hour “SUSTAIN” test

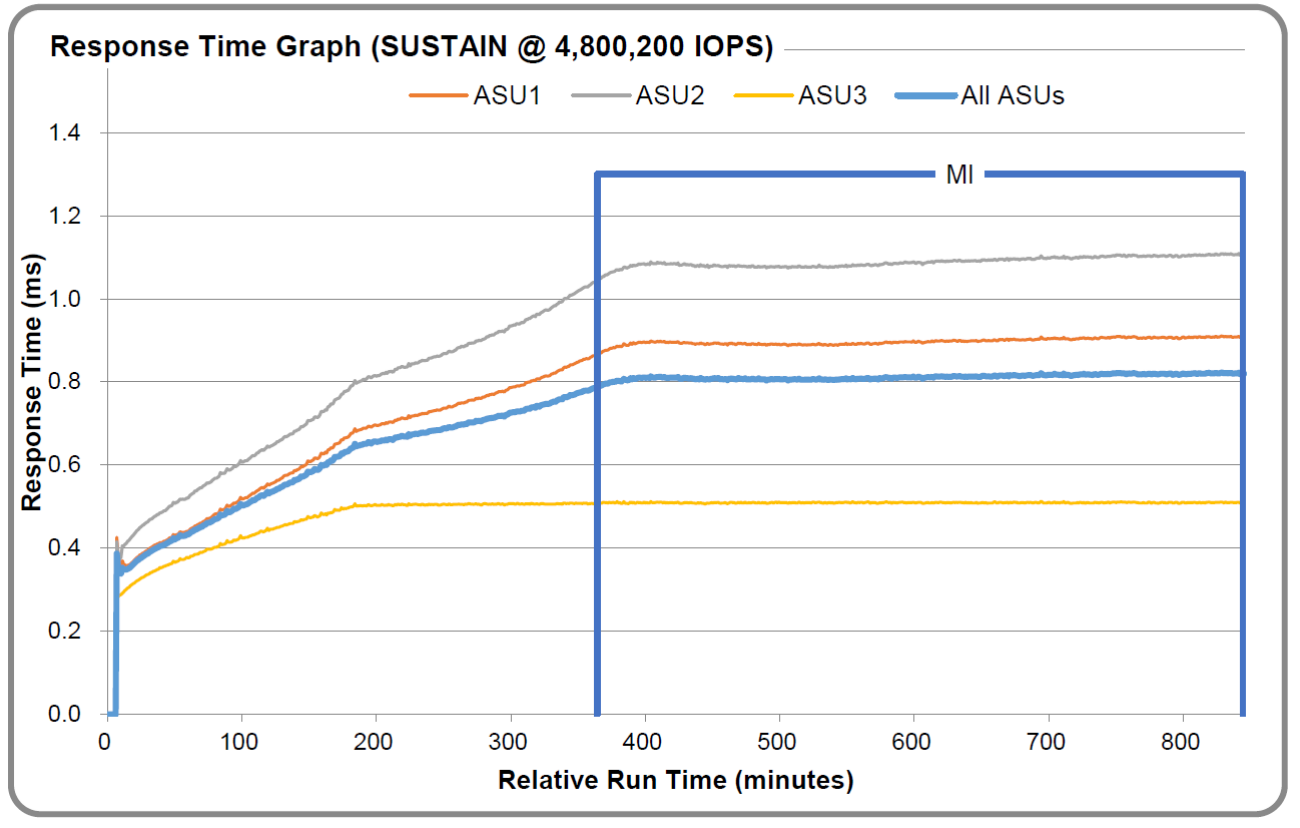


SUSTAIN - Response Time Graph



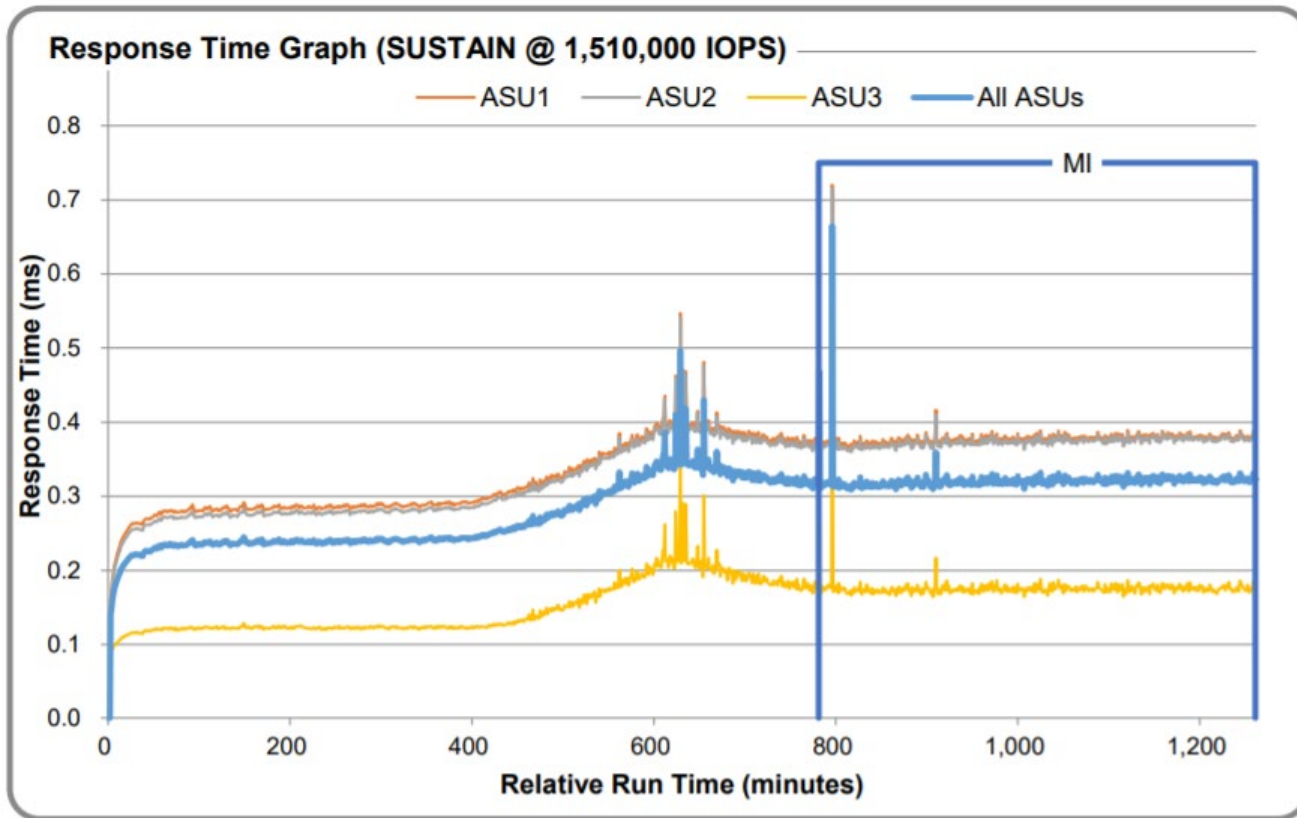


SUSTAIN - Response Time Graph





SUSTAIN - Response Time Graph





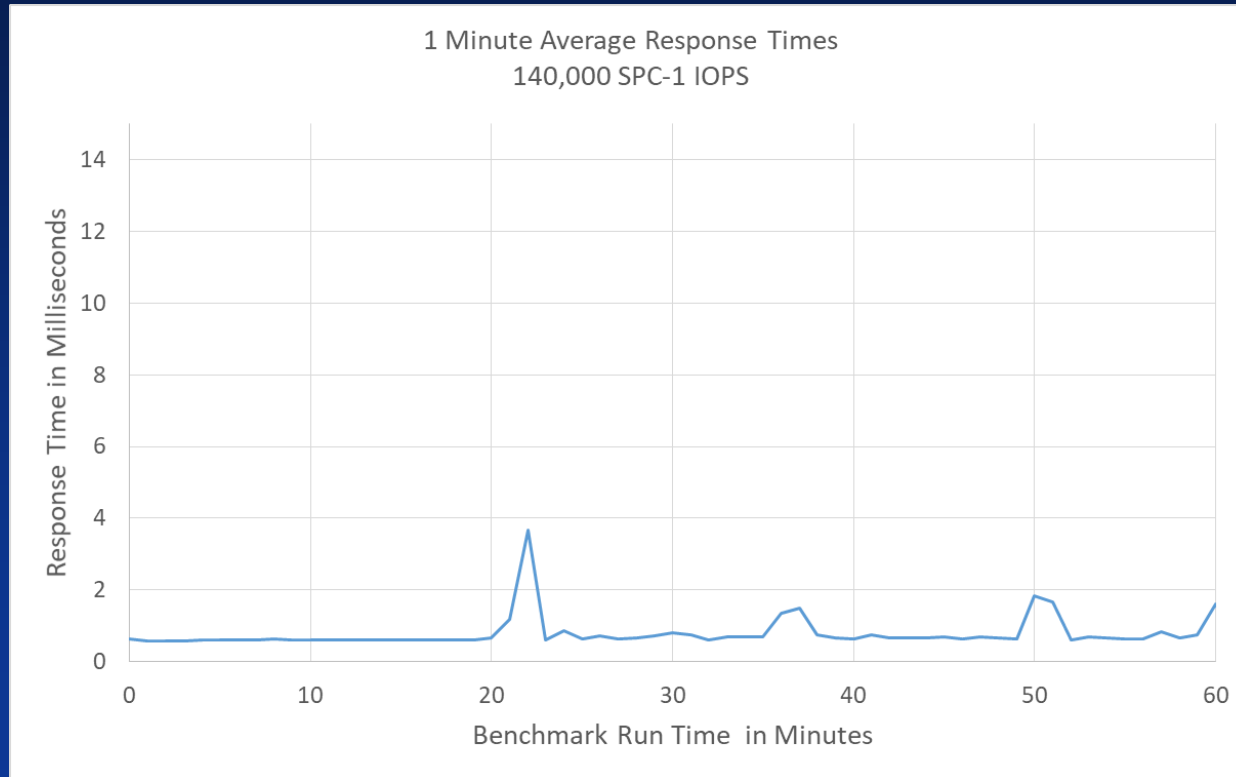
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Vendor X

- A mid-range AFA that has not published SPC-1
- Capable of 200K IOPS with VDBENCH

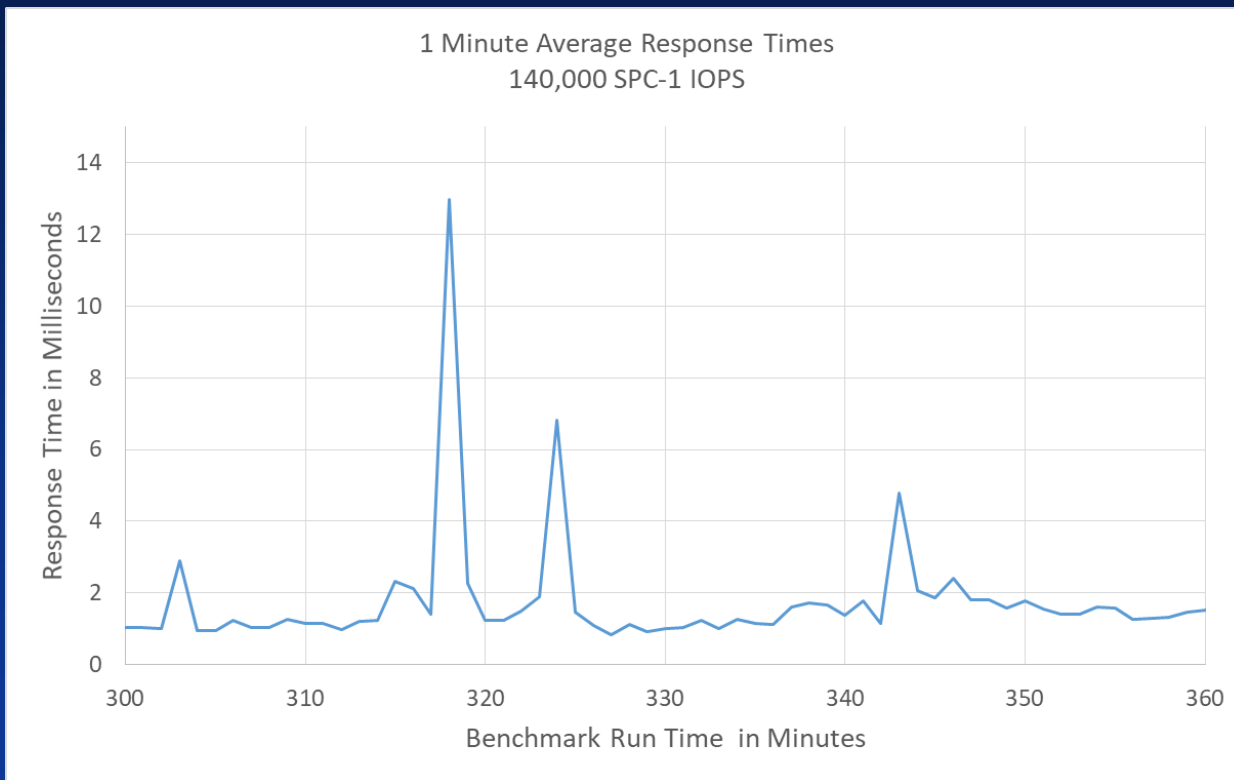


Hour 1 of Vendor X on SPC-1



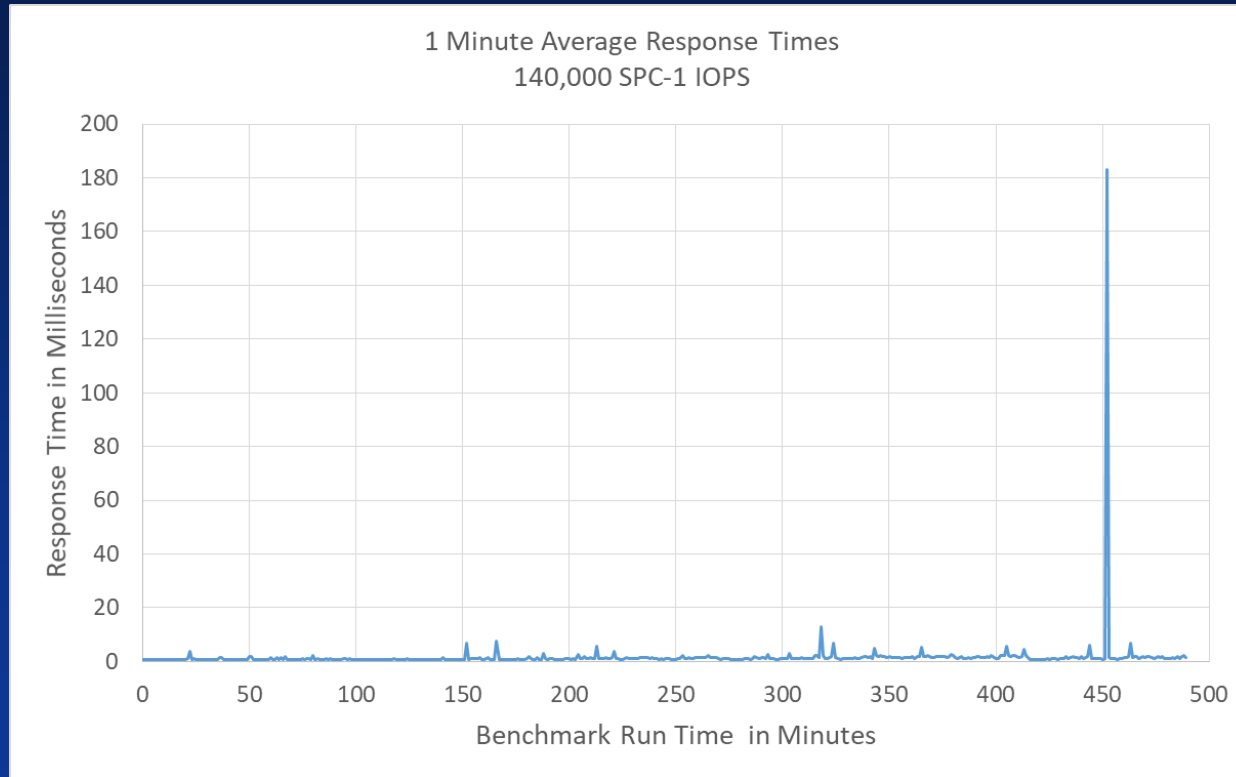


Hour 6 of Vendor X on SPC-1





8-Hour SPC-1 SUSTAIN on Vendor X





SPC-1 Full Disclosure Report

- Each result documented with a Full Disclosure Report (FDR)
- Discloses lots of secondary metrics
- Contains all the information needed to reproduce the result



Data Reduction in SPC-1

Physical Free Space Metrics

The following table lists the Physical Free Space as measured at each of the required points during test execution. If space optimization techniques were not used, “NA” is reported.

Physical Free Space Measurement	Free Space (GB)
After Logical Volume Creation	214,457.80
After ASU Pre-Fill	103,811.17
After Repeatability Test Phase	92,844.16

Space Optimization Metrics

The following table lists the required space optimization metrics. If space optimization techniques were not used, “NA” is reported.

Metric	Value
SPC-1 Space Optimization Ratio	1.50
SPC-1 Space Effectiveness Ratio	1.15

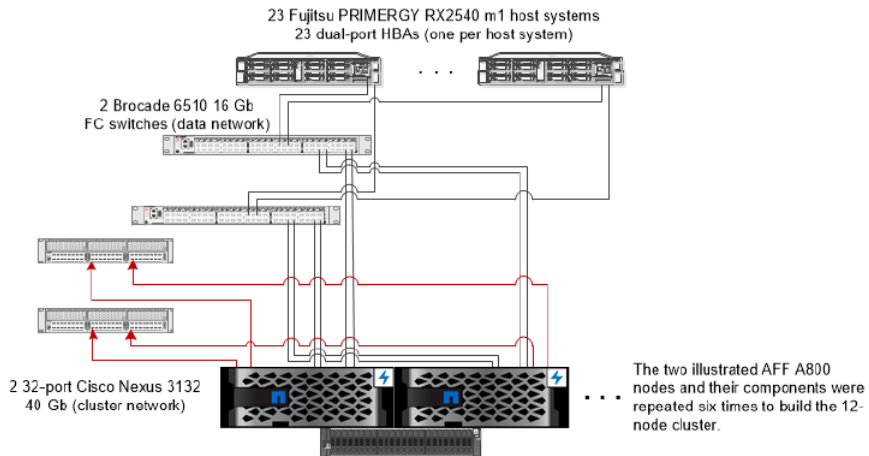


Description of System Under Test

EXECUTIVE SUMMARY

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Benchmark Configuration Diagram



NotApp AFF A800 storage system
6 HA controller pairs (12 storage nodes total)

- This cluster includes:
- 1 TB memory/cache per HA pair
 - 24 x 1.9 TB internal NVMe SSDs per HA pair (144 total)
 - 2 QLogic 2672 16 Gb HBA Initiators per server (23 total)
 - 2 Emulex LPe32004 32 Gb HBA Targets per HA pair (12 total)
 - 2 Cisco Nexus 3132 40 Gb 32-port switches (cluster network)
 - 2 Brocade 6510 16 Gb FC 48-port switches (data network)



Price of System Under Test

Storage Configuration Pricing

Part No.	Description	Source	Qty	Unit Price	Ext. Price	Disc.	Disc. Price	
Hardware & Software								
AFF-A800-100-	AFF A800, HA, CTL, AC PS, 100G, -C		1	6	250,120.00	1,500,720.00	50%	750,360.00
X4001A-12-C	Drive Pack, 12X1.9TB, NVMe, SSD, -C		1	12	44,460.00	533,520.00	50%	266,760.00
SW-FLASH-02-C	ONTAP, Per-0.1TB, Flash-C (BASE BNDL: OS + Protocols)		1	2,736	1,095.00	2,995,920.00	50%	1,497,960.00
X-6510-48-16G	Switch, Brocade 6510 48-Pt FF Ent 16G SWL SFPs		1	2	17,179.00	34,358.00	50%	17,179.00
X190001	Switch, Cisco Nexus 3132Q-X, 32 QSFP+ ports, low		1	2	13,000.00	26,000.00	50%	13,000.00
X66100-1	Cable, Direct Attach CU SFP+, 40Gb, 1m		1	2	50.00	100.00	50%	50.00
FXE10-10M2y	Cable, Cntrl-Switch, 2m, Pair, LC/LC, Op		2	48	33.56	1,610.88	0%	1,610.88
FXE10-10M10y	Cable, Host-Switch, 10m, Pair, LC/LC, Op		2	46	43.88	2,018.48	0%	2,018.48
Qlogic 2672	HBA Initiator, Qlogic 16Gig 2port		3	23	989.99	22,769.77	0%	22,769.77
X1135A-C	HBA Target, Emulex LPe32004, 4-port FCP Target-Init		1	12	6,790.00	81,480.00	50%	40,740.00
X66100-5	Cable, Direct Attach CU SFP+, 40Gb, 5m		1	24	75.00	1,800.00	50%	900.00
X8712C-EN-R6-	PDU, 1-Phase, 24 Outlet, 30A, NEMA, -C, R6		1	2	115.80	231.60	50%	115.80
X870E-EN-R6-C	Cab, Lighted, Empty, No PDU, No Rails, EN, -C		1	1	1,947.71	1,947.71	50%	973.86
X8778-R6-C	Mounting Bracket, Tie-Down, 32X0, -C, R6		1	12	21.38	256.56	50%	128.28
Hardware & Software Subtotal							2,614,566.07	
Support & Maintenance								
CS-O2-4HR-VA	SupportEdge Premium 4hr Onsite, VA		1	6	52,545.00	315,270.00	50%	157,635.00
Support & Maintenance Subtotal							157,635.00	
SPC-1 Total System Price							2,772,201.07	
SPC-1 IOPS™							2,401,171	
SPC-1 Price-Performance™ (\$/SPC-1 KIOPS™)							1,154.53	
SPC-1 ASU Capacity (GB)							182,674	
SPC-1 ASU Price (\$/GB)							15.18	



SPC Publications are Audited

AUDIT CERTIFICATION



Mr. Jim Laing
NetApp, Inc.
7301 Kit Creek Road
Research Triangle Park, NC 27709

July 3, 2018

I verified the SPC Benchmark 1™ (SPC-1™ V3.6) test execution and performance results of the following Tested Storage Product:

NetApp® AFF A800

The results were:

SPC-1 IOPS™	2,401,171
SPC-1 Price-Performance™	\$1,164.53/SPC-1 KIOPS™
SPC-1 IOPS™ Response Time	0.590 ms
SPC-1 Overall Response Time	0.351 ms
SPC-1 ASU Capacity	182,674 GB
SPC-1 Space Effectiveness Ratio	1.76
SPC-1 ASU Price	\$15.18/GB
SPC-1 Total System Price	\$2,772,201.07

In my opinion, these performance results were produced in compliance with the SPC requirements for the benchmark.

The testing was executed using the SPC-1 Toolkit Version v3.0.2-1-g823a. The audit process was conducted in accordance with the SPC Policies and met the requirements for the benchmark.

A Letter of Good Faith was issued by the Test Sponsor, stating the accuracy and completeness of the documentation and testing data provided in support of the audit of this result.

A Full Disclosure Report for this result was prepared by InfoSizing, reviewed and approved by the Test Sponsor, and can be found at www.spcresults.org under the Submission Identifier A32007.



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Questions and Answers

- Comments?
- Suggestions on how to improve?

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