SPC BENCHMARK 1C™

EXECUTIVE SUMMARY

SEAGATE TECHNOLOGY LLC

SEAGATE ST600MX0004 600GB 15K 6GBPS SAS 2.5" SSHD HYBRID

SPC-1C™ V1.5

Submitted for Review: October 29, 2013
Submission Identifier: C00018

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

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Test Sponsor Primary Contact	Seagate Technology LLC – http://www.seagate.com Craig Parris – craig.parris@seagate.com 1280 Disc Drive Shakopee, MN 55379 Phone: (952) 402-2418
Test Sponsor Alternate Contact	Seagate Technology LLC – http://www.seagate.com Barbara Craig– barbara.j.craig@seagate.com 1280 Disc Drive Shakopee, MN 55379 Phone: (952) 402-2804
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

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SPC-1C Specification revision number	V1.5
SPC-1C Workload Generator revision number	V1.2.0
Date Results were first used publicly	October 29, 2013
Date the FDR was submitted to the SPC	October 29, 2013
Date the TSC is available for shipment to customers	January 15, 2014
Date the TSC completed audit certification	October 23, 2013

Tested Storage Product (TSP) Description

The amount of information that is gathered and stored by businesses continues to grow exponentially. In addition to the demand for increased storage, there are increasing requirements to quickly and effectively store and access data. Today, conventional hard disk drives and solid-state storage technology are utilized to achieve specific objectives within the data center. Conventional hard disk drives continue to be the most common storage media offering high density and basic performance in a cost-effective solution. Solid-state storage solutions enable businesses to achieve optimal input/output (IO) through variable read/write capabilities for performance intensive applications and workloads.

Seagate is now offering a new technology: hybrid drives. These drives combine a cache of NAND flash and conventional media to accelerate hard disk drive performance - enabling higher IO performance while leveraging the capacity and cost of spinning media for primary storage.

Seagate is introducing 6 Gbps SAS 2.5-inch hybrid drives - namely Enterprise Turbo SSHD - the first generation of 15K-RPM hybrid drives from Seagate. Ideal for medium businesses or the distributed large enterprise, the Enterprise Turbo SSHD provides cost-effective performance and density in a small form factor hard disk drive.

In addition to the solid-state-based cache, these new drive offerings provide optimal 6 Gbps hot-swap SAS capability for your high-performance and high-availability server and storage environments. Hard drive functionality and 6 Gbps SAS performance of these new hybrid drives are enabled when used with traditional Enterprise servers and internal RAID controllers

Summary of Results

SPC-1C Reported Data	
Tested Storage Product (TSP) Name: Seagate ST600MX0004 600GB 15K 6Gbps SAS 2.5" SSHD Hybrid	
Metric	**Reported Result**
SPC-1C Submission Identifier	C00018
SPC-1C IOPS™	7,197.38
Total ASU Capacity	10,792.364 GB
Data Protection Level	Protected 1 *(RAID-5)*
Total Price	$24,602.00
Pricing Currency	U.S. Dollars
Target Country for availability, sales and support	USA

SPC-1C Submission Identifier is the unique identifier assigned to this specific SPC-1C Result.

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

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

A **Data Protection Level** of **Protected 1** using ***RAID-5*** by distributing check data corresponding to user data across multiple disk in the form of bit-by-bite parity.

> ***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-1C Data Repository.*

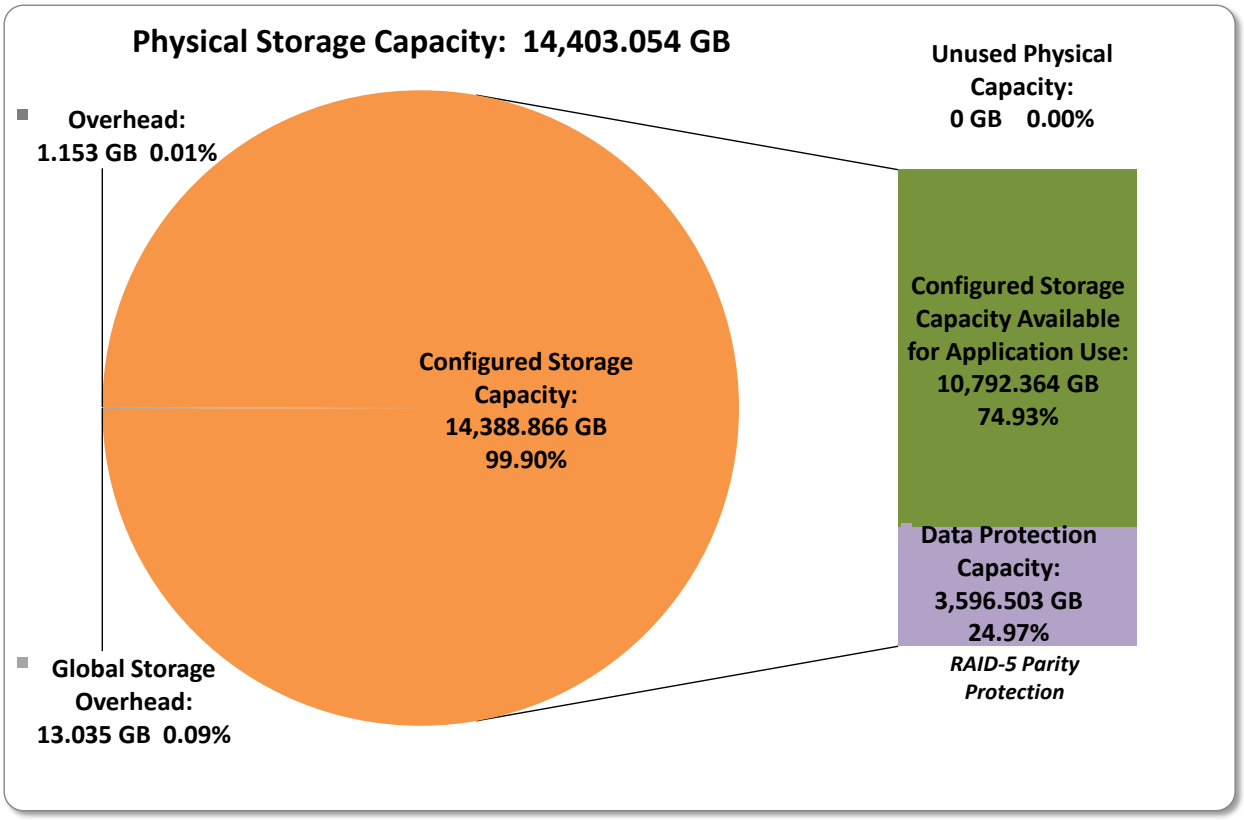
Total Price includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page 8.

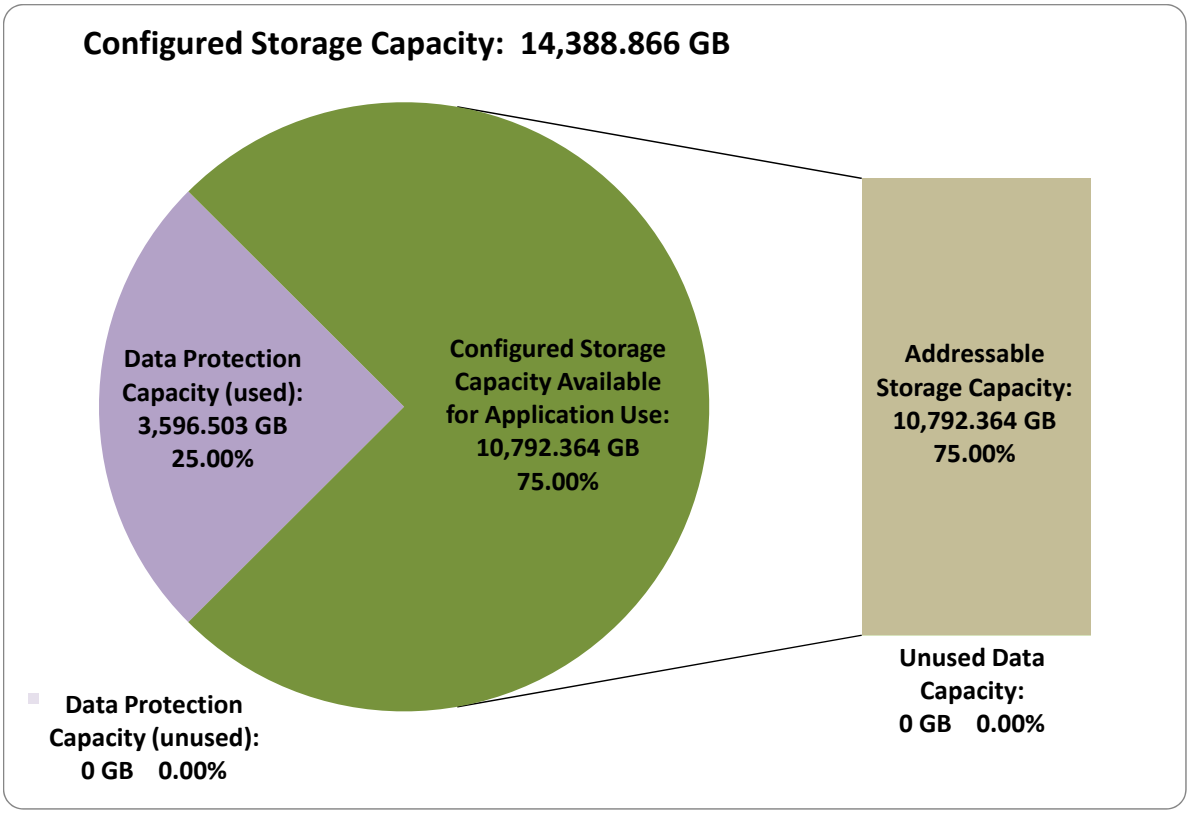
Pricing Currency is formal name for the currency used in calculating the **Total Price**. That currency may be the local currency of the **Target Country** or the currency of a difference country *(non-local currency).*

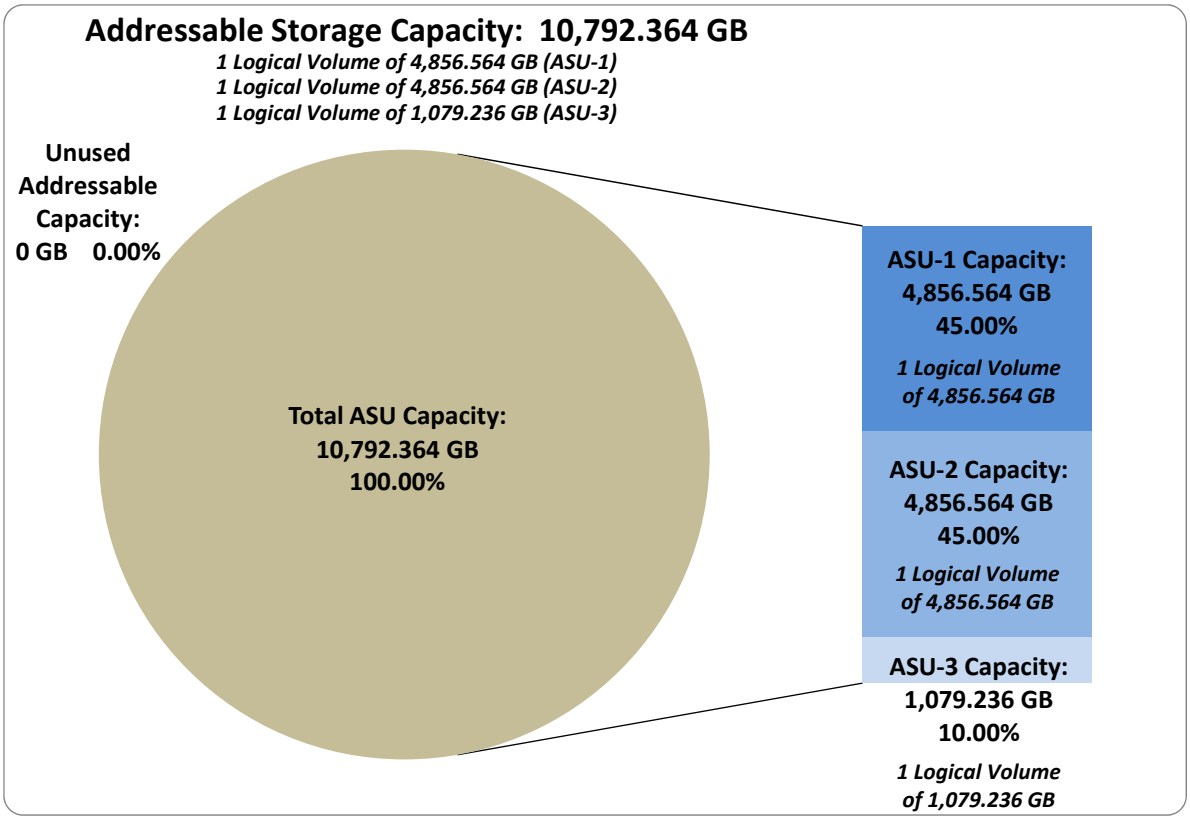
The **Target Country** is the country in which the Priced Storage Configuration is available for sale and in which the required hardware maintenance and software support is provided either directly from the Test Sponsor or indirectly via a third-party supplier.

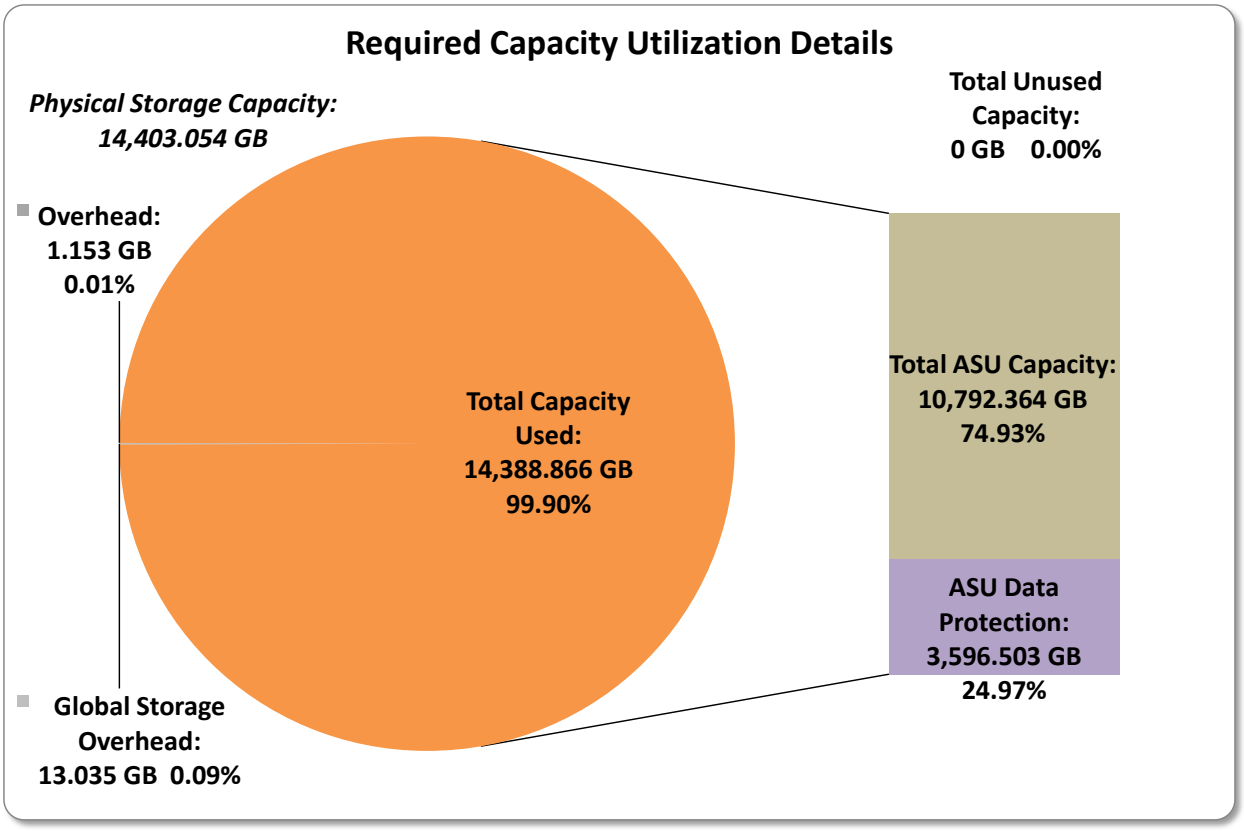
Storage Capacities, Relationships, and Utilization

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: 14,388.866 GB
Data Protection Capacity (used): 3,596.503 GB 25.00%
Configured Storage Capacity Available for Application Use: 10,792.364 GB 75.00%
Addressable Storage Capacity: 10,792.364 GB 75.00%
Unused Data Capacity: 0 GB 0.00%
Data Protection Capacity (unused): 0 GB 0.00%


Addressable Storage Capacity: 10,792.364 GB
1 Logical Volume of 4,856.564 GB (ASU-1)
1 Logical Volume of 4,856.564 GB (ASU-2)
1 Logical Volume of 1,079.236 GB (ASU-3)
Unused Addressable Capacity: 0 GB 0.00%
Total ASU Capacity: 10,792.364 GB 100.00%
ASU-1 Capacity: 4,856.564 GB 45.00%
1 Logical Volume of 4,856.564 GB
ASU-2 Capacity: 4,856.564 GB 45.00%
1 Logical Volume of 4,856.564 GB
ASU-3 Capacity: 1,079.236 GB 10.00%
1 Logical Volume of 1,079.236 GB



The Tested Storage Configuration (TSC) must be configured so that there is either no Unused Storage or that the sum of Total ASU Capacity and storage required for data protection equals 50% (+-1 GiB) of the Physical Storage Capacity.

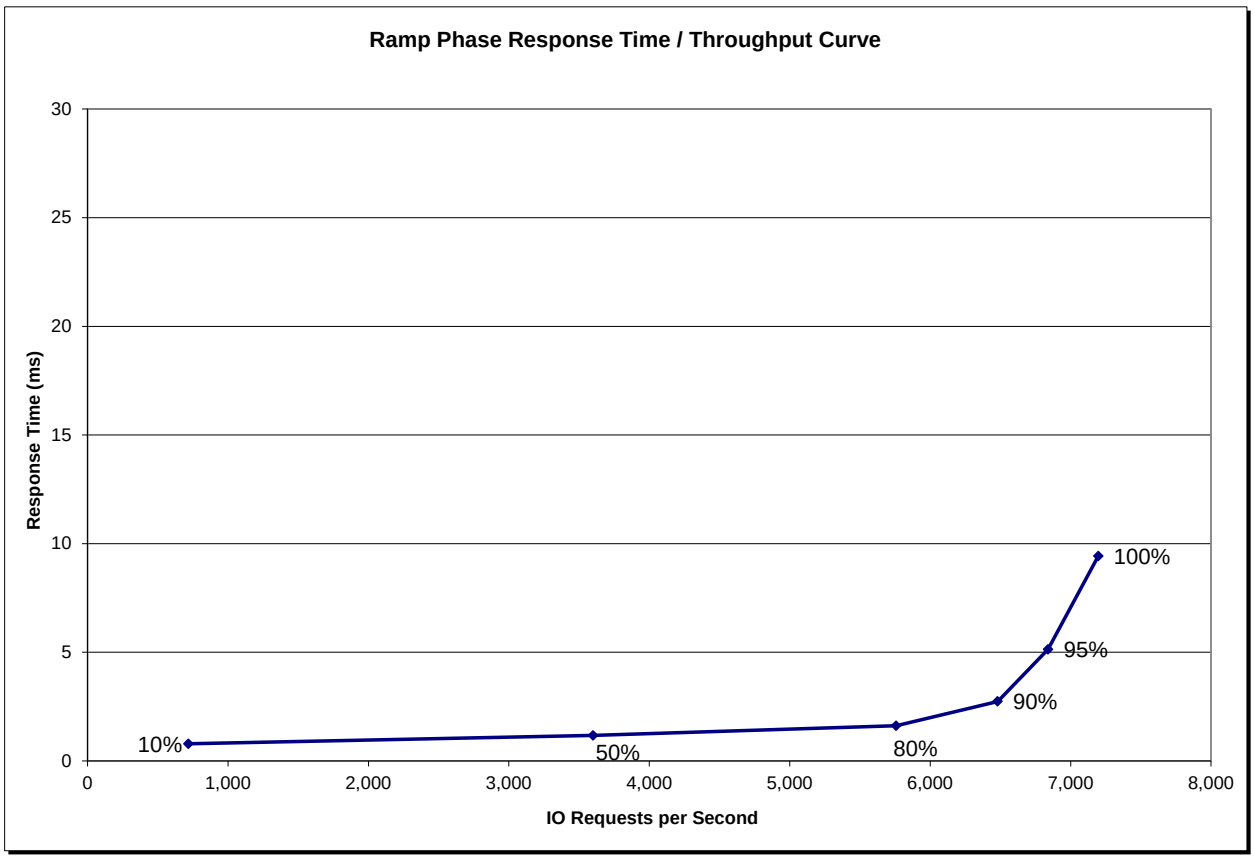
The TSC met the "100% utilization" requirement since it did not include any Unused Storage.

Detailed information for the various storage capacities and utilizations is available on pages 20-21 of the corresponding SPC-1C Full Disclosure Report.

Response Time – Throughput Curve

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

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



Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	719.23	3,599.79	5,758.04	6,480.52	6,839.46	7,197.38
Average Response Time (ms):						
All ASUs	0.79	1.17	1.62	2.74	5.13	9.43
ASU-1	1.03	1.53	2.12	3.53	6.28	10.95
ASU-2	1.24	1.80	2.47	4.28	8.46	15.88
ASU-3	0.08	0.13	0.18	0.38	1.25	3.37
Reads	1.89	2.79	3.85	6.53	11.95	21.20
Writes	0.07	0.12	0.17	0.27	0.69	1.76

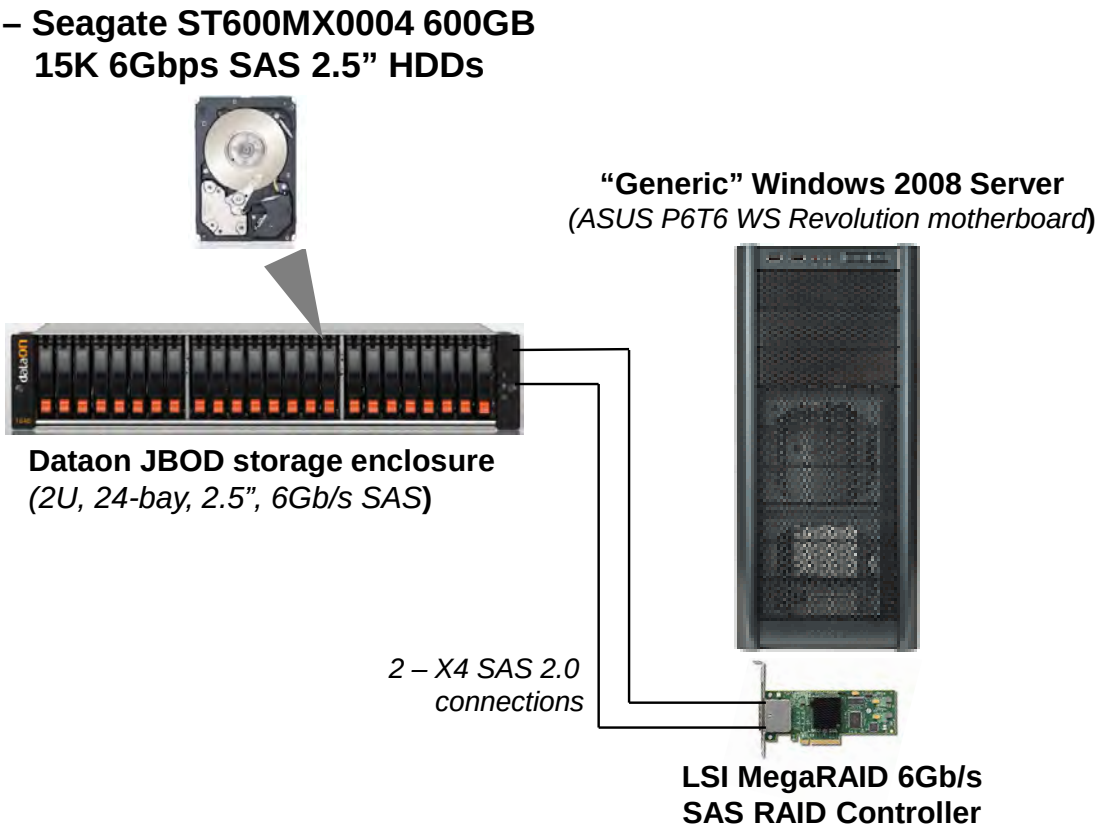
Priced Storage Configuration Pricing

Description	Part Numbers	Qty	Price	Extended Price
600GB SAS 2.5" SSHD	ST600MX0004	24	$812.00	$19,488.00
6Gb SAS RAID Controller	LSI SAS 9265-8i	1	$700.00	$700.00
Storage Enclosure JBOD	DNS-1640D	1	$4,295.00	$4,295.00
SAS 2.0 1M Cable	MiniSAS	2	$59.50	$119.00
			Total	**$24,602.00**

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

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

Benchmark Configuration/Tested Storage Configuration Diagram



Host System and Tested Storage Configuration Components

Host System	Tested Storage Configuration (TSC)
"Generic" Windows 2008 Server ASUS P6T6 WS Revolution motherboard 1 – Intel® Xeon® Processor X5570 4 Cores, 2.93 GHz, 8 MB Intel® Smart Cache	1 – LSI MegaRAID 6Gb/s SAS 9265-8i RAID controller with 1 GB cache
	1 – PCIe 2.0 x8 front-end connection
12 GB main memory	2 – 6Gb SAS backend connections *(failover mode) (4 lanes/connection,2 connections used)*
Windows Server 2008 R2	**24 – Seagate ST600MX0004 600GB 15K 6Gbps SAS 2.5" SSHD Hybrid HDDs**
PCIe 2.0	
	1 – Dataon DNS-1640 (JBOD) storage enclosure *(2U 24-bay 2.5" 6Gb/s SAS)*
	2 –SAS 2.0 1m cables