SPC BENCHMARK 2™
EXECUTIVE SUMMARY

NETAPP, INC.
NETAPP E-SERIES E5660 STORAGE ARRAY

SPC-2™ V1.5

Submitted for Review: September 10, 2015
Submission Identifier: B00074

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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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-2 Specification revision number	V1.5
SPC-2 Workload Generator revision number	V1.2
Date Results were first used publicly	September 10, 2015
Date FDR was submitted to the SPC	September 10, 2015
Date the TSC will be available for shipment to customers	currently available
Date the TSC completed audit certification	September 4, 2015

Tested Storage Product (TSP) Description

The NetApp® E5600 SAN storage array brings together extreme performance, enterprise-grade reliability and availability to create a system optimized for variety of workloads. The E5600 storage array is designed for bandwidth-intensive applications, high-performance file systems, high-IOPS databases and mixed workloads, latency-sensitive workloads – supporting them all with equal ease due to its high throughput architecture and adaptive caching algorithms.

The E5600 storage array is modular in architecture and offers flexible integrated storage (E5612, E5624, and E5660) and expansion (DE1600, DE5600, and DE6600) shelf options as per the performance, capacity, and density requirements of supported workloads. The E5600 storage array supports flexible capacity optimized, performance optimized, and latency optimized drives for storage. Additionally, the E5600 storage array can be seamlessly expanded to 384 drives to a maximum raw capacity of 2.3PB. The E5600 storage array provides flexible host interface options for direct-attached and SAN protocols – SAS, Fiber Channel, iSCSI, and Infiniband.

The E5600 storage array's core architecture has been proven in the world's most demanding and complex computing environments. Its field-proven design is the culmination of over 20 years of industry knowledge focused on designing enterprise-class storage. The fully redundant E-Series storage array is architected to provide the highest levels of enterprise-proven reliability, availability, and data protection.

SPC-2 Reported Data

SPC-2 Reported Data consists of three groups of information:

- The following SPC-2 Primary Metrics, which characterize the overall benchmark result:
  - SPC-2 MBPS™
  - SPC-2 Price Performance
  - Application Storage Unit (ASU) Capacity
- Supplemental data to the SPC-2 Primary Metrics.
  - Total Price
  - Data Protection Level
- Reported Data for each SPC Test: Large File Processing (LFP), Large Database Query (LDQ), and Video on Demand Delivery (VOD) Test.

SPC-2 MBPS™ represents the aggregate data rate, in megabytes per second, of all three SPC-2 workloads: Large File Processing (LFP), Large Database Query (LDQ), and Video on Demand (VOD).

SPC-2 Price-Performance™ is the ratio of **Total Price** to **SPC-2 MBPS™**.

ASU *(Application Storage Unit)* **Capacity** represents the total storage capacity available to be read and written in the course of executing the SPC-2 benchmark.

Total Price includes the cost of the Priced Storage Configuration plus three years of hardware maintenance and software support as detailed on page on page 9.

Data Protection Level of **Protected 2** using ***RAID-6***, which provides double-party RAID protection again data loss.

> ***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-2 Data Repository.*

Currency Used is formal name for the currency used in calculating the **Total Price** and **SPC-2 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.

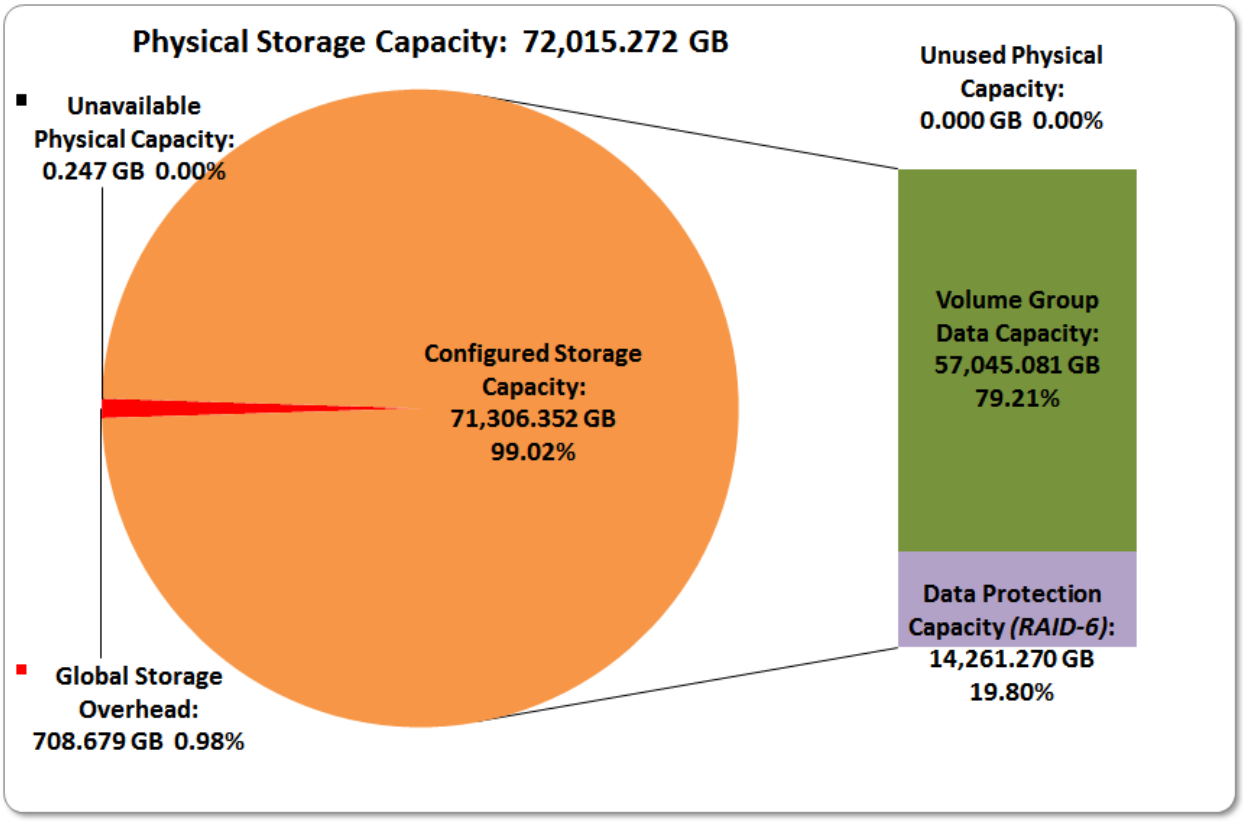
SPC-2 Reported Data *(continued)*

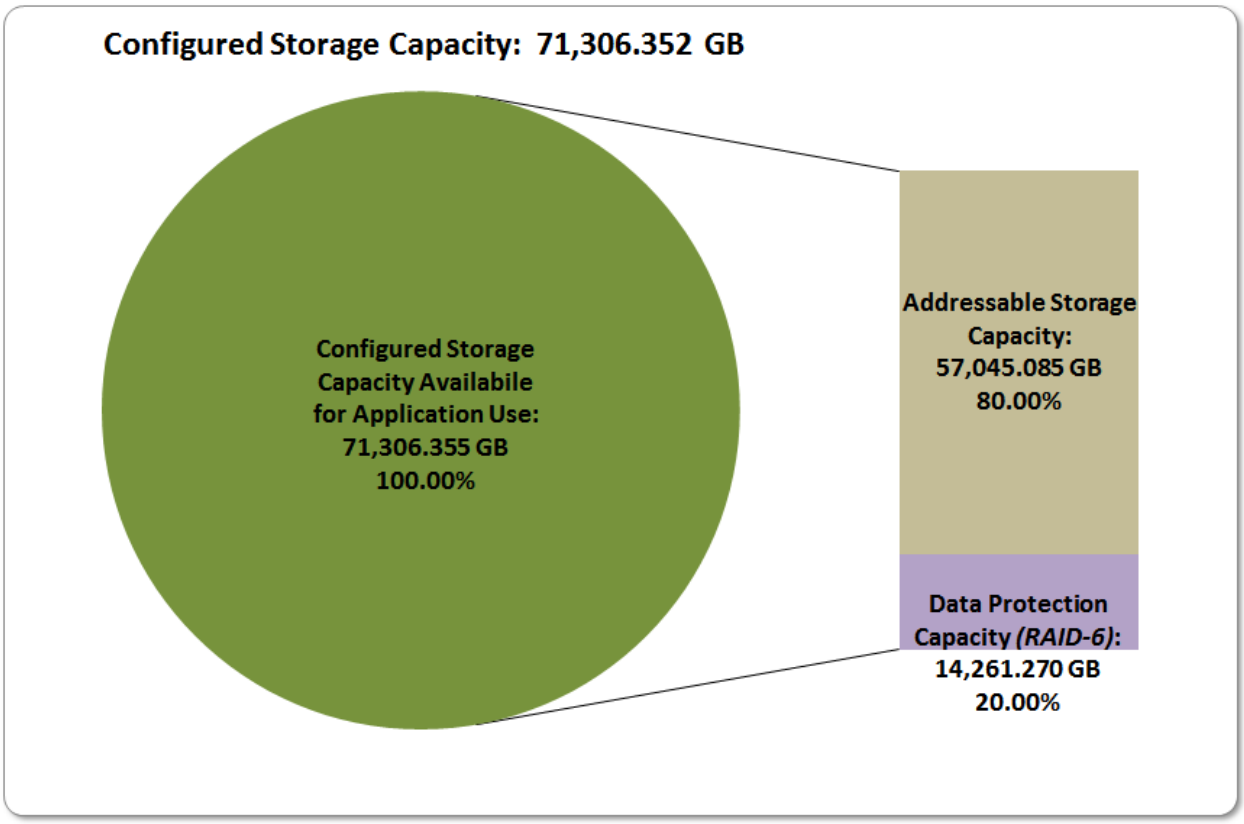
SPC-2 Reported Data				
NetApp E-Series E5660 Storage Array				
SPC-2 MBPS™	**SPC-2 Price-Performance**	**ASU Capacity (GB)**	**Total Price**	**Data Protection Level**
8,236.16	$14.74	57,045.085	$121,409.42	Protected 2 *(RAID-6)*
The above SPC-2 MBPS™ value represents the aggregate data rate of all three SPC-2 workloads: Large File Processing (LFP), Large Database Query (LDQ), and Video On Demand (VOD)				
Currency Used:		**"Target Country":**		
U.S. dollars		USA		
SPC-2 Large File Processing (LFP) Reported Data				
	Data Rate *(MB/second)*	**Number of Streams**	**Data Rate per Stream**	**Price-Performance**
LFP Composite	9,060.42			$13.40
Write Only:				
1024 KiB Transfer	6,974.15	96	72.65	
256 KiB Transfer	6,872.73	96	71.59	
Read-Write:				
1024 KiB Transfer	9,278.57	96	96.65	
256 KiB Transfer	9,225.22	96	96.10	
Read Only:				
1024 KiB Transfer	10,995.86	96	114.54	
256 KiB Transfer	11,015.99	96	114.75	
The above SPC-2 Data Rate value for LFP Composite represents the aggregate performance of all three LFP Test Phases: (Write Only, Read-Write, and Read Only).				
SPC-2 Large Database Query (LDQ) Reported Data				
	Data Rate *(MB/second)*	**Number of Streams**	**Data Rate per Stream**	**Price-Performance**
LDQ Composite	11,086.72			$10.95
1024 KiB Transfer Size				
4 I/Os Outstanding	12,642.47	12	1,053.54	
1 I/O Outstanding	10,947.25	96	114.03	
64 KiB Transfer Size				
4 I/Os Outstanding	11,699.38	12	974.95	
1 I/O Outstanding	9,057.79	96	94.35	
The above SPC-2 Data Rate value for LDQ Composite represents the aggregate performance of the two LDQ Test Phases: (1024 KiB and 64 KiB Transfer Sizes).				
SPC-2 Video On Demand (VOD) Reported Data				
	Data Rate *(MB/second)*	**Number of Streams**	**Data Rate per Stream**	**Price-Performance**
	4,561.32	5,800	0.79	$26.62

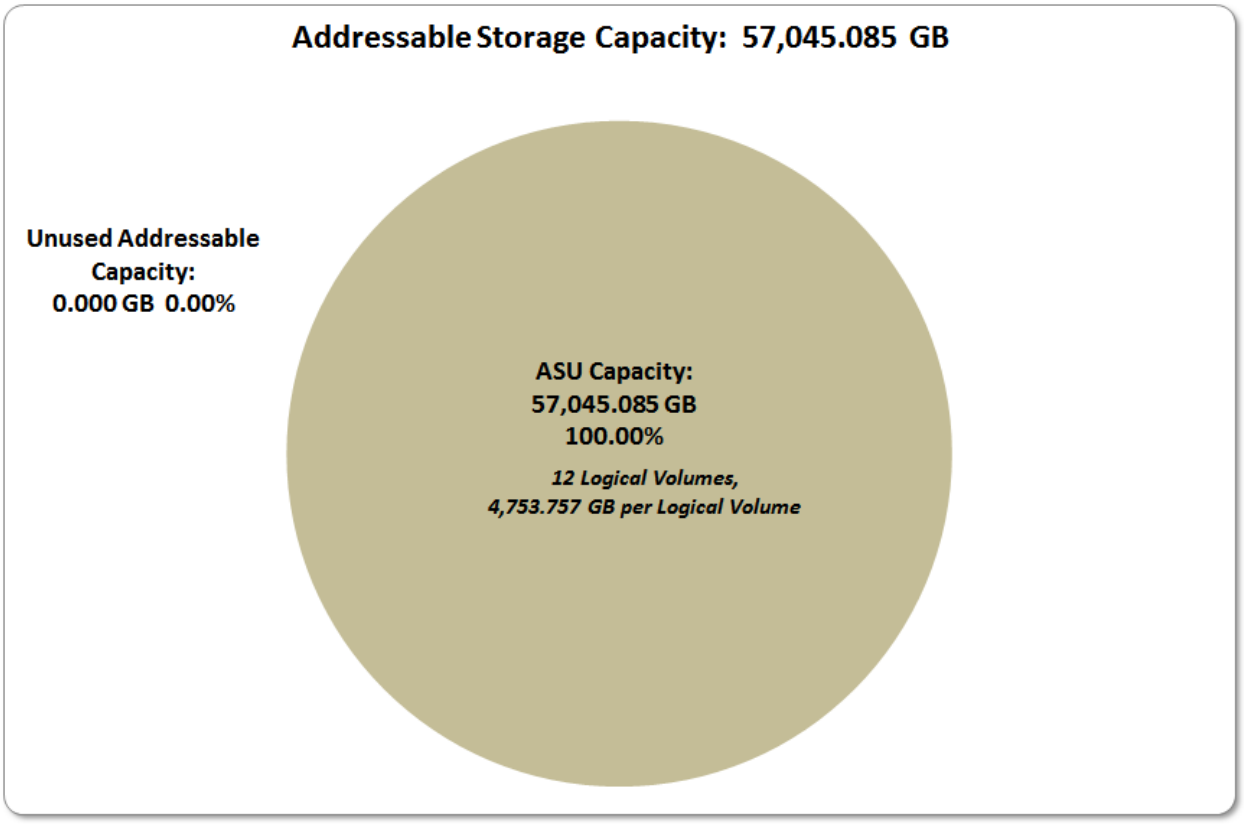
Storage Capacities and Relationships

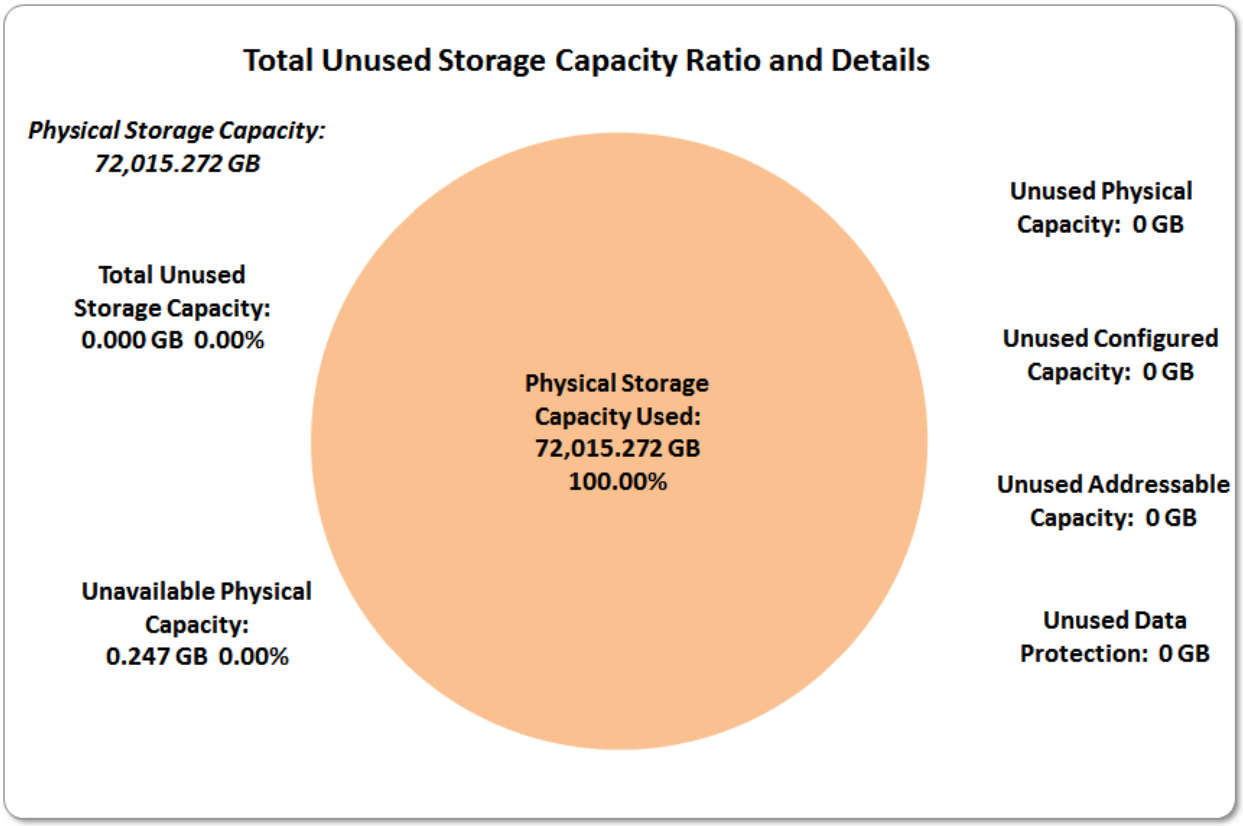
The following four charts and table document the various storage capacities, used in this benchmark, and their relationships, as well as the storage utilization values required to be reported.

The capacity values in each of the following four charts are listed as integer values, for readability, rather than the decimal values listed elsewhere in this document.




Configured Storage Capacity: 71,306.352 GB
Configured Storage Capacity Availabile for Application Use: 71,306.355 GB 100.00%
Addressable Storage Capacity: 57,045.085 GB 80.00%
Data Protection Capacity (RAID-6): 14,261.270 GB 20.00%


Addressable Storage Capacity: 57,045.085 GB
Unused Addressable Capacity: 0.000 GB 0.00%
ASU Capacity: 57,045.085 GB 100.00%
12 Logical Volumes, 4,753.757 GB per Logical Volume



SPC-2 Storage Capacity Utilization	
Application Utilization	79.21%
Protected Application Utilization	99.02%
Unused Storage Ratio	0.00%

Application Utilization: Total ASU Capacity *(57,045.085 GB)* divided by Physical Storage Capacity *(72,015.272 GB)*.

Protected Application Utilization: Total ASU Capacity *(57,045.085 GB)* plus total Data Protection Capacity *(14,261.270 GB)* minus unused Data Protection Capacity *(0.000 GB)* divided by Physical Storage Capacity *(72,015.272 GB)*.

Unused Storage Ratio: Total Unused Capacity *(0.000 GB)* divided by Physical Storage Capacity *(72,015.272 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 26-27 in the Full Disclosure Report.

Priced Storage Configuration Pricing

Part number	Description	Quantity	Unit List Price	Extended LP
E5600A-12GB-R6-C	E5600 Controller, 12GB Cache No Host Interface Card	2	19,500.00	39,000.00
X-56016-00-R6-C	E5600 Host Interface Card, 16Gb FC, 4-ports	2	2,425.00	4,850.00
X-48619-00-R6-C	E5600 Battery	2	460.00	920.00
E-X5680A-R6-C	E5600 4U-60 Storage Enclosure, No drives, 2 PSUs	1	19,060.00	19,060.00
E-X4049A-R6-C	Disk Drive, 600GB, 10k SAS, FDE	120	665.00	79,800.00
E-X5680A-DM-R6-C	DE6600 4U-60 Storage Expansion Enclosure, No drives, 2 PSUs	1	19,060.00	19,060.00
E-X30030A-R6-C	DE6600 ESM, Expansion Service Module	2	2,630.00	5,260.00
X-48895-00-R6-C	SFP, Unified, 10Gb iSCSI/16Gb FC	16	600.00	9,600.00
X-24936-00-R6-C	miniSAS cable, 2 meter	4	125.00	500.00
OS-SANTRICITY-CAP2-0P-C	SANtricity OS Enable, Per 0.1TB, Performance Storage	720	52.00	37,440.00
	NetApp Hardware / Software Subtotal			**215,490.00**
CS-A2-4R-VA	Support, 3-yr 24/7, 4 hour on-site	1		**17,081.00**
ServerSupply QLE2672-CK	QLE2672-CK Qlogic HBA, 16Gb FC, 2-ports	4	1,235.00	4,940.00
CDW 1148024	Tripp Lite, OM3 Optical cable, 2 meter	8	22.99	183.92
	Third-Party Subtotal			**5,123.92**

Description	Extended LP	Discount	Discounted Price
NetApp Hardware/Software Subtotal	215,490.00	50%	107,745.00
Support	17,081.00	50%	8,540.50
Third-Party Subtotal	5,123.92	0%	5,123.92
Totals	**237,694.92**		**121,409.42**

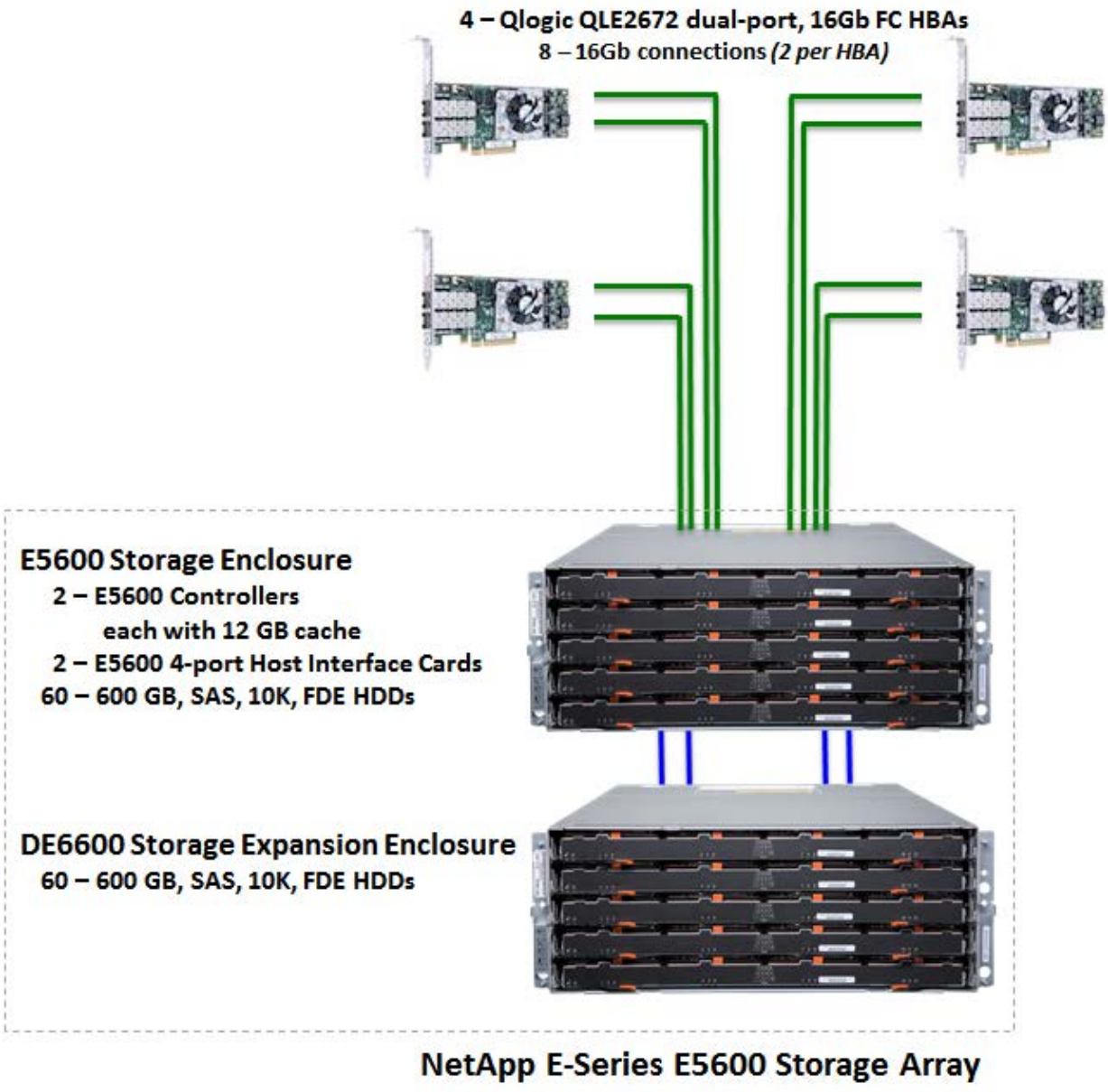
The following pricing includes the following:

- Acknowledgement of new and existing hardware and/or software problems within four hours.
- Onsite presence of a qualified maintenance engineer or provision of a customer replaceable part within four hours of the above acknowledgement for any hardware failure that results in an inoperative Priced Storage Configuration component.

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

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

Priced Storage Configuration Diagram



Priced Storage Configuration Components

Priced Storage Configuration
4 – QLogic QLE2672 dual-port, 16Gb, FC HBAs
NetApp E-Series E5660 Storage Array 1 – E5600 Storage Enclosure with 2 – controllers, each with 12 GB cache *(24 GB total)* 2 – 4-port Host Interface Cards *(1 card/4 ports per controller, 8 ports total and used)* 5 – 6 Gb SAS connections per controller *(10 connections total and used)* 60 – 600 GB, SAS, 10K FDE HDDs
1 – DE6600 Storage Expansion Enclosure with 60 – 600 GB, SAS, 10K FDE HDDs