



ORACLE®

SPC BENCHMARK 2™

EXECUTIVE SUMMARY

ORACLE CORPORATION

ORACLE ZFS STORAGE ZS5-2

SPC-2™ V1.6

SUBMITTED FOR REVIEW: MARCH 29, 2017

SUBMISSION IDENTIFIER: B12002

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	Oracle – http://www.oracle.com Steven Johnson – steven.a.johnson@oracle.com 500 Eldorado Blvd. Broomfield, CO 80021 Phone: (303) 272-9476
Test Sponsor Alternate Contact	Oracle – http://www.oracle.com Jason Schaffer – jason.schaffer@oracle.com 500 Eldorado Blvd. Broomfield, CO 80021 Phone: (303) 272-4743
Auditor	InfoSizing – http://www.sizing.com/ Doug Johnson – doug@sizing.com 63 Lourdes Drive Leominster, MA 01453 Phone: (978) 343-6562

Revision Information and Key Dates

Revision Information and Key Dates	
SPC-2 Specification revision number	V1.6
SPC-2 Workload Generator revision number	V1.2.0
Date Results were first used publicly	March 29, 2017
Date FDR was submitted to the SPC	March 29, 2017
Date the TSC will be available for shipment to customers	April 5, 2017
Date the TSC completed audit certification	March 28, 2017

Tested Storage Product Description

Oracle ZFS Storage Appliance ZS5-2 is a high-performance, unified NAS/SAN system that provides converged cloud storage enabling on-premises storage to seamlessly access public cloud services and features industry-leading Oracle Database integration, in a cost-effective high-availability configuration. Dynamic caching between DRAM, flash cache, all flash, HDD, and cloud storage allows these systems to deliver extreme performance and superior efficiency for demanding enterprise applications and unpredictable cloud workloads. The ZFS Storage ZS5-2 offers simplified set up and management combined with advanced, intuitive management and fine-grained analytics tools. Through deep co-engineering integration, Oracle Database sends cues to the Oracle ZFS Storage Appliance ZS5-2 system, allowing it to intelligently process database I/O and automatically and dynamically tune itself for optimal performance. The ZFS Storage ZS5-2 can scale to 1.5 TB Memory, 72 CPU cores, and 3 PB capacity, with up to 204 TB of Flash Cache in a high-availability configuration. ZFS Storage Appliances deliver full suite of data services such as file, block and object protocols including connectivity over Ethernet, InfiniBand; data reduction technologies such as compression, deduplication, thin provisioning and advanced security options.

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
 - Currency Used
 - Target Country
- 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.

Data Protection Level of Protected 2 using **Mirroring**, which configures two or more identical copies of user data.

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.*

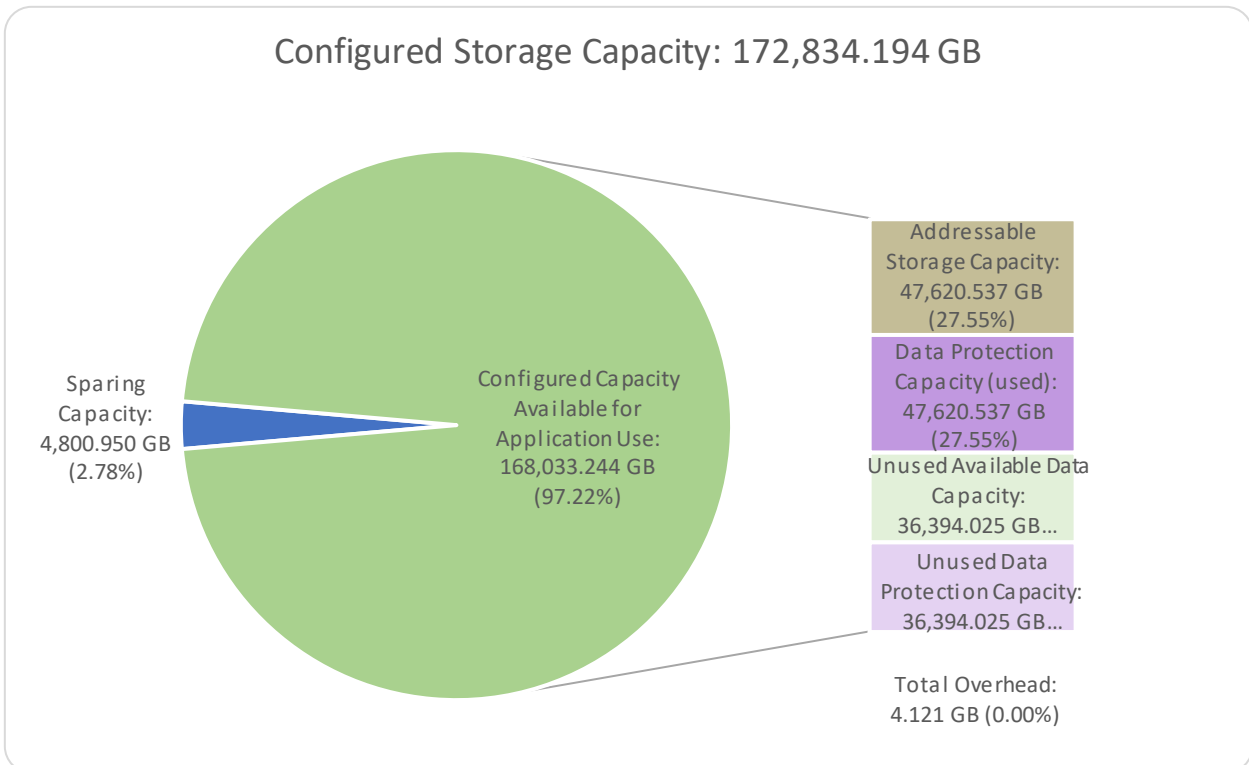
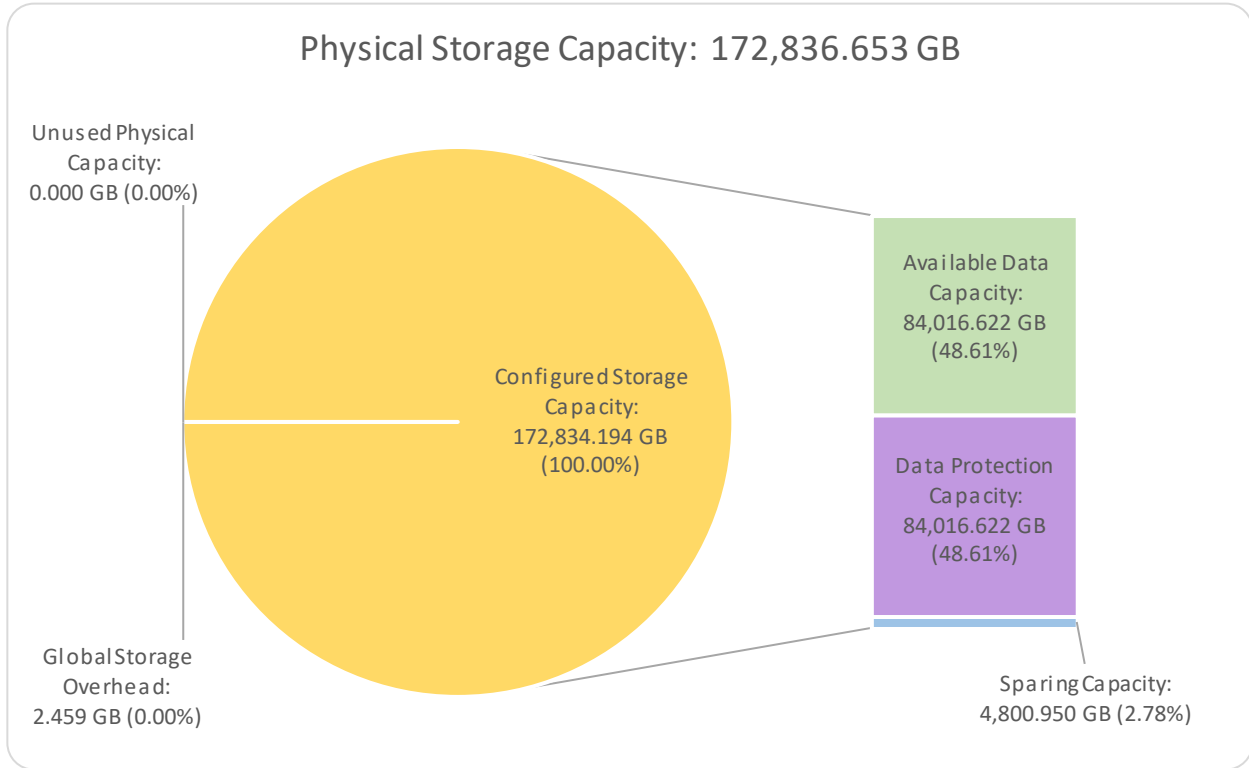
Currency Used is formal name for the currency used in calculating the **Total Price** and **SPC-2 Price-Performance™**. That currency may be the local currency of the **Target Country** or the currency of a difference country (*non-local currency*).

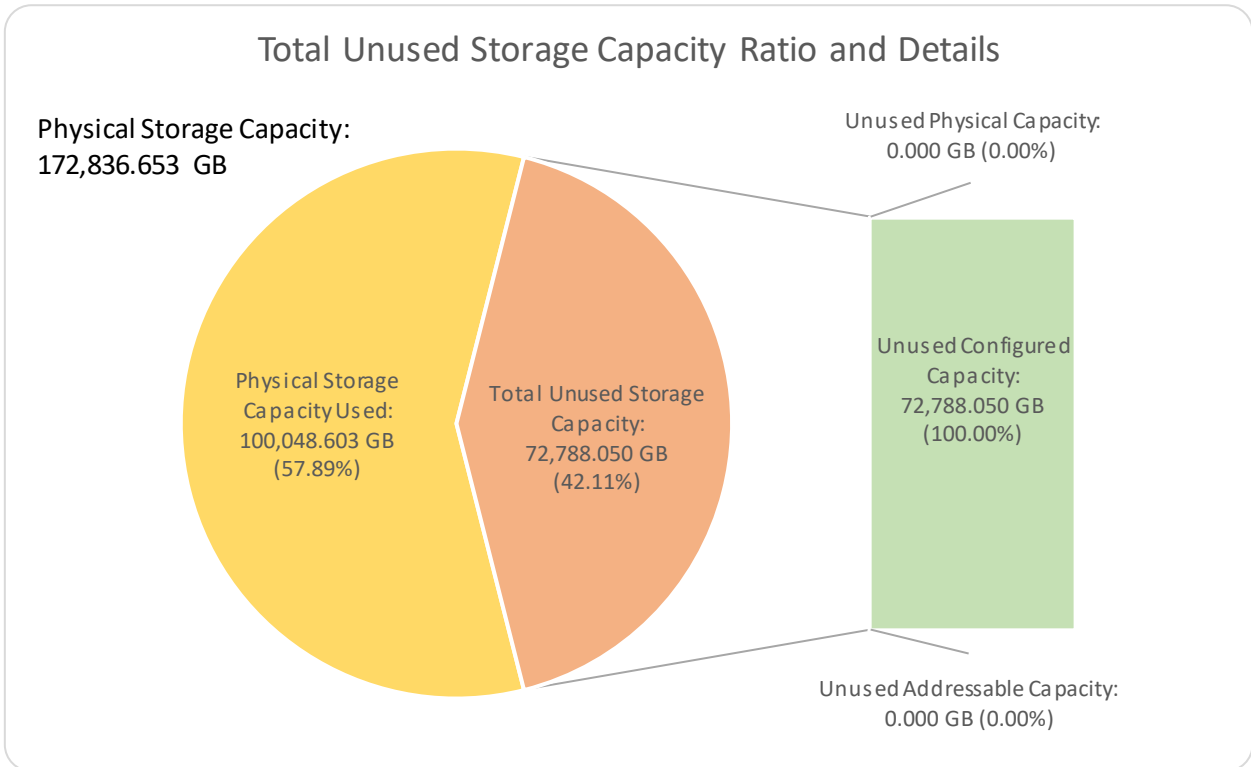
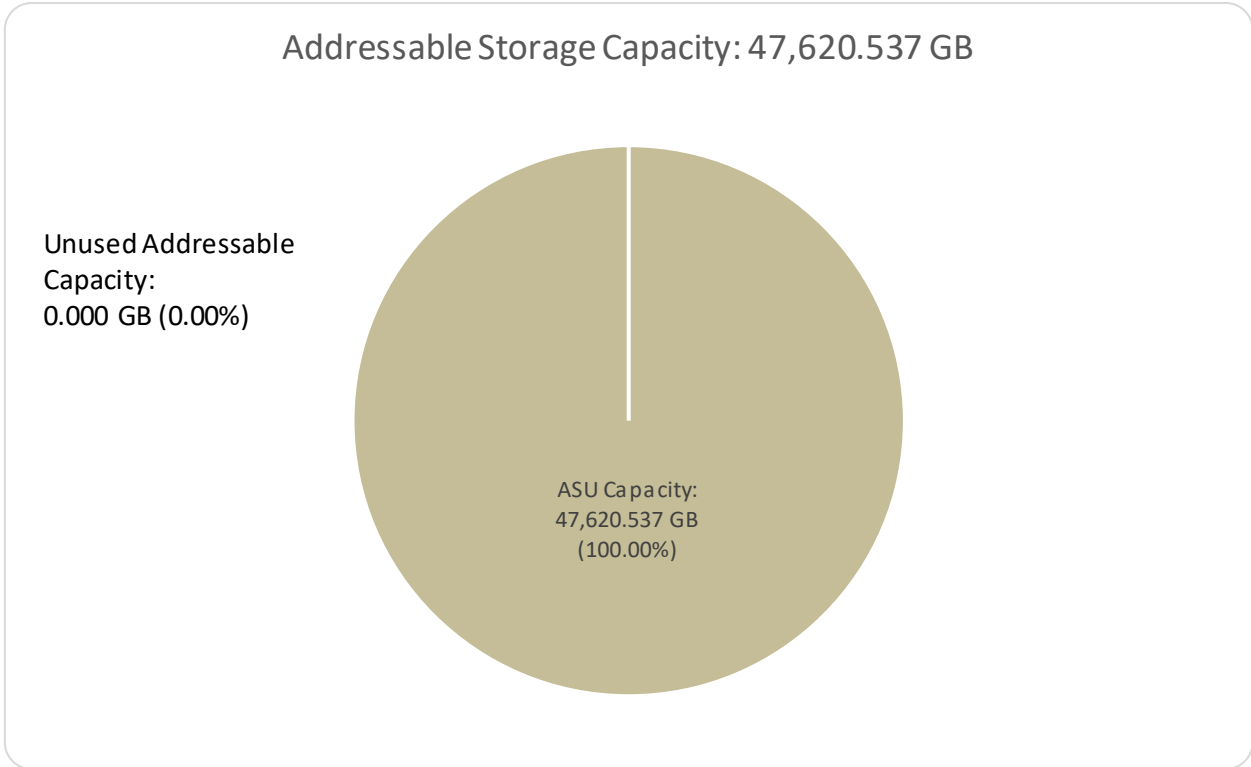
The **Target Country** is the country in which the Priced Storage Configuration is available for sale and in which the required hardware maintenance and software support is provided either directly from the Test Sponsor or indirectly via a third-party supplier.

SPC-2 Reported Data				
Oracle ZFS Storage ZS5-2				
SPC-2 MBPS™	SPC-2 Price-Performance	ASU Capacity (GB)	Total Price	Data Protection Level
19,610.36	\$12.93	47,620.537	\$253,556.77	Protected 2 (Mirroring)
<i>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).</i>				
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	14,391.46			\$17.62
Write Only:				
1024 KiB Transfer	11,462.78	3,072	3.73	
256 KiB Transfer	2,639.78	3,072	0.86	
Read-Write:				
1024 KiB Transfer	14,548.74	3,072	4.74	
256 KiB Transfer	4,853.68	3,072	1.58	
Read Only:				
1024 KiB Transfer	26,355.99	3,072	8.58	
256 KiB Transfer	26,487.79	3,072	8.62	
<i>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).</i>				
SPC-2 Large Database Query (LDQ) Reported Data				
	Data Rate (MB/second)	Number of Streams	Data Rate per Stream	Price-Performance
LDQ Composite	24,778.76			\$10.23
1024 KiB Transfer Size				
4 I/Os Outstanding	26,859.43	3,072	8.74	
1 I/O Outstanding	26,495.44	3,072	8.62	
64 KiB Transfer Size				
4 I/Os Outstanding	23,325.23	3,072	7.59	
1 I/O Outstanding	22,434.96	3,072	7.30	
<i>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).</i>				
SPC-2 Video On Demand (VOD) Reported Data				
	Data Rate (MB/second)	Number of Streams	Data Rate per Stream	Price-Performance
	19,660.85	25,000	0.79	\$12.90

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.





SPC-2 Storage Capacity Utilization	
Application Utilization	27.55%
Protected Application Utilization	55.11%
Unused Storage Ratio	42.11%

Application Utilization: Total ASU Capacity (*47,620.537 GB*) divided by Physical Storage Capacity (*172,836.653 GB*).

Protected Application Utilization: Total ASU Capacity (*47,620.537 GB*) plus total Data Protection Capacity (*84,016.622 GB*) minus unused Data Protection Capacity (*36,394.025 GB*) divided by Physical Storage Capacity (*172,836.653 GB*).

Unused Storage Ratio: Total Unused Capacity (*72,788.050 GB*) divided by Physical Storage Capacity (*172,836.653 GB*) and may not exceed 45%.

Priced Storage Configuration Pricing

Part Number	Description	Quantity	US List	Total List	Discount	Net Price
7112310	Oracle ZFS Storage ZS5-2: controller	2	\$22,878	\$45,756	40.00%	\$27,454
7111036	One 16 GB DDR4-2133 DIMM (for factory installation)	48	\$394	\$18,912	20.00%	\$15,130
7110371	Oracle Storage 12 Gb SAS-3 HBA PCIe, low profile: 16 Port (for factory installation)	2	\$1,183	\$2,366	40.00%	\$1,420
7113645	Cable: 3 meters, mini SAS HD to mini SAS HD (for factory installation)	16	\$110	\$1,760	40.00%	\$1,056
7104073	Oracle Dual Port QDR InfiniBand Adapter M3 (for factory installation)	6	\$2,740	\$16,440	40.00%	\$9,864
7105174	QSFP to QSFP passive copper cable: 3 meter (for factory installation)	12	\$180	\$2,160	40.00%	\$1,296
SR-JUMP-1MC13	Power cord: Sun Rack 2 jumper, 1 meter, C14RA plug, C13 connector, 13 A (for factory installation)	4	\$29	\$116	40.00%	\$70
7113126	Oracle Storage Drive Enclosure DE3-24P: base chassis (for factory installation)	12	\$3,706	\$44,472	40.00%	\$26,683
7111102	One 600 GB 10000 rpm 2.5-inch SAS-3 HDD with marlin bracket (for factory installation)	288	\$384	\$110,592	40.00%	\$66,355
7113644	Cable: 1 meter, mini SAS HD to mini SAS HD (for factory installation)	16	\$122	\$1,952	40.00%	\$1,171
SR-JUMP-1MC13	Power cord: Sun Rack 2 jumper, 1 meter, C14RA plug, C13 connector, 13 A (for factory installation)	24	\$29	\$696	40.00%	\$418
X2821A-Z-N	Sun Datacenter Switch IB-36 is a 1RU 36 port managed QDR InfiniBand Switch. The switch utilizes standard QSFP connectors. Comes with redundant power supplies.	2	\$14,980	\$29,960	40.00%	\$17,976
X2121A-3M-N	QSFP to QSFP passive copper cable:	16	\$180	\$2,880	40.00%	\$1,728
XSR-JUMP-1MC13	Jumper Cable Kit: 1 x 1m C13.	4	\$29	\$116	40.00%	\$70
SR-1242-N	Sun Rack II, 42U, 1200mm depth, 600mm width, empty shipping only (do not install product inside the rack while it is on this pallet)	1	\$2,149	\$2,149	20.00%	\$1,719.20
	Jumper Cable Start Up Kit: qty 10 of 1 meter C13 plugs + qty 10 of 2 meter C13 plugs + qty 2 1 meter C19 plugs + Qty 2 2meter C19 plugs	1	\$198	\$198	20.00%	\$158
7104074	Oracle Dual Port QDR InfiniBand Adapter	8	2740	21920	0.4	13152
	Oracle Premium Support for Systems: 1-Year 7/24, 2 hour response time.	3	\$0	\$109,204	0.00%	\$67,118
	TOTALS			\$412,549		\$253,557

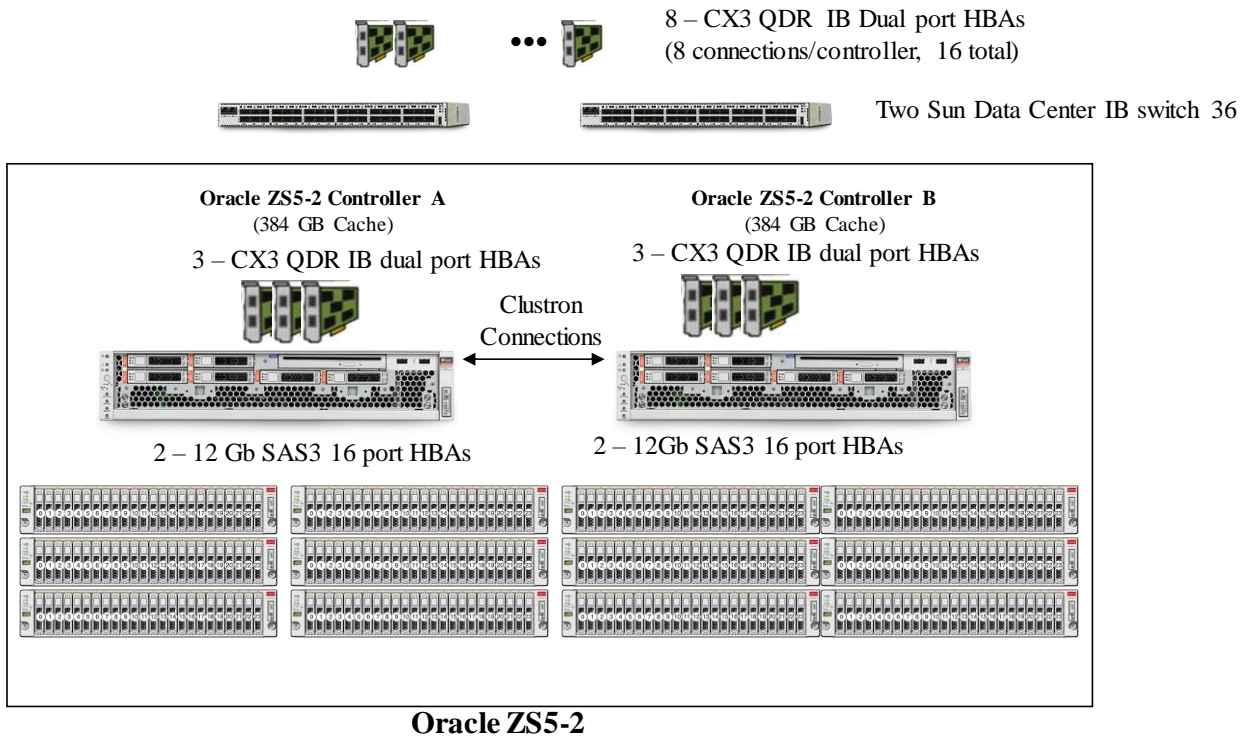
The above pricing includes the following:

- 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 Tested Storage Configuration and Priced Storage Configuration

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

Priced Storage Configuration Diagram



- 288 – 600 GB 10K RPM SAS Disk Drives
- 2 – Oracle ZFS ZS5-2 controllers (Cluster configuration) 384 GB cache per controller
- 6 – QDR IB dual-port HBAs (3 HBAs per controller) 6 – QDR connections per controller, 12 total, 12 used
- 4 – 12 Gb SAS3 16-port HBAs(2 HBAs per controller)(8 –12 Gb SAS3 connections per controller, 16 total, 16 used)
- 12 –Oracle Storage Drive Enclosure DE3-24P
- 288 – 600 GB 10K RPM SAS3 Disk Drives
- 1 –Sun Rack II 42U
- 1 –Sun Rack II 10kVA PDU

Priced Storage Configuration Components

Priced Storage Configuration
8 – Oracle Dual Port QDR IB Adapter M3 CX-3 (2 per host)
2 – Sun Datacenter Switch IB-36 QDR
Oracle ZFS Storage ZS5-2 2 – Oracle ZFS ZS5-2 controllers (cluster configuration) 384 GiB cache/memory per controller (768 GiB total)
6 – Oracle Dual Port QDR IB Adapter M3 CX-3 (3 per controller) providing: 6 – QDR InfiniBand front-end connections per controller <i>(12 – QDR InfiniBand front-end connections total, 12 used)</i>
4 – Oracle Storage 12 Gb SAS-3 16-port adapters (2 per controller) providing: <i>(2 adapters per controller)</i> <i>(1 adapter per controller included with base unit)</i> 4 physical SAS ports per adapter 4 logical SAS connections per physical port 16 logical SAS connections per adapter 8 physical SAS ports per controller 32 logical SAS connections per controller <i>(64 logical connections total, 64 used)</i>
12 – Oracle Storage Drive Enclosures DE3-24P
288 – 600 GB 10K RPM SAS3 disk drives <i>(24 disk drives per enclosure)</i>