# SPC Benchmark 2™
# Executive Summary

# Oracle Corporation
# Oracle ZFS Storage ZS4-4 Appliance

## SPC-2™ V1.5

**Submitted for Review:  March 17, 2015**
**Submission Identifier:  B00072**

## EXECUTIVE SUMMARY

### Test Sponsor and Contact Information

| Test Sponsor and Contact Information | |
|---|---|
| **Test Sponsor Primary Contact** | Oracle Corporation – http://www.oracle.com<br>Steven Johnson – Steven.A.Johnson@oracle.com<br>500 Eldorado  Blvd.<br>Broomfield, CO 80021<br>Phone:  (303) 272-9476 |
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| **Auditor** | Storage Performance Council – http://www.storageperformance.org<br>Walter E. Baker –  AuditService@StoragePerformance.org<br>643 Bair Island Road, Suite 103<br>Redwood City, CA 94063<br>Phone:  (650) 556-9384<br>FAX:  (650) 556-9385 |

### Revision Information and Key Dates

| Revision Information and Key Dates | |
|---|---|
| **SPC-2 Specification revision number** | V1.5 |
| **SPC-2 Workload Generator revision number** | V1.2 |
| **Date Results were first used publicly** | March 17, 2015 |
| **Date FDR was submitted to the SPC** | March 17, 2015 |
| **Date the TSC will be available for shipment to customers** | currently available |
| **Date the TSC completed audit certification** | March 16, 2015 |

### Tested Storage Product (TSP) Description

Oracle's ZFS Storage ZS4-4 is a high-performance storage system that offers enterprise-class SAN and NAS capabilities with industry-leading Oracle Database integration, in a cost-effective high-availability configuration. The ZFS Storage ZS4-4 offers simplified set up and management combined with industry-leading storage analytics and a performance-optimized platform that uses specialized Read and Write Flash-bases SSD caching devices. The ZFS Storage ZS4-4 can scale to 1.5 TB Memory, 120 CPU cores, and 3,500 TB capacity, with up to 12.8 TB of Flash Cache in a high-availability configuration. ZFS Storage Appliances deliver additional economic value bundled data services such as file- and block-level protocols including connectivity over InfiniBand, Compression, Deduplication, Thin provisioning, DTrace Analytics, Virus Scan, Snapshots, Triple Mirror, Triple Parity RAID, Phone-home, NDMP, Clustering, etc."

## 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 8.

**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.
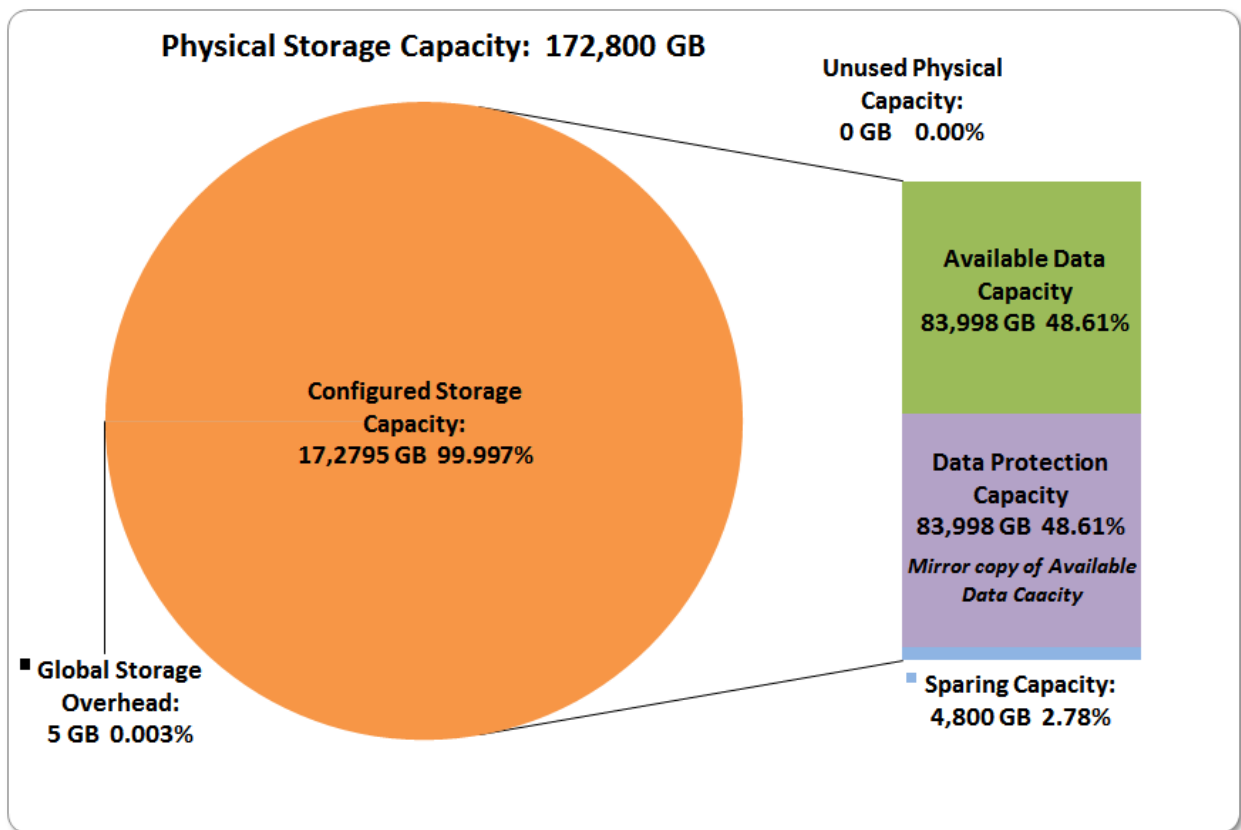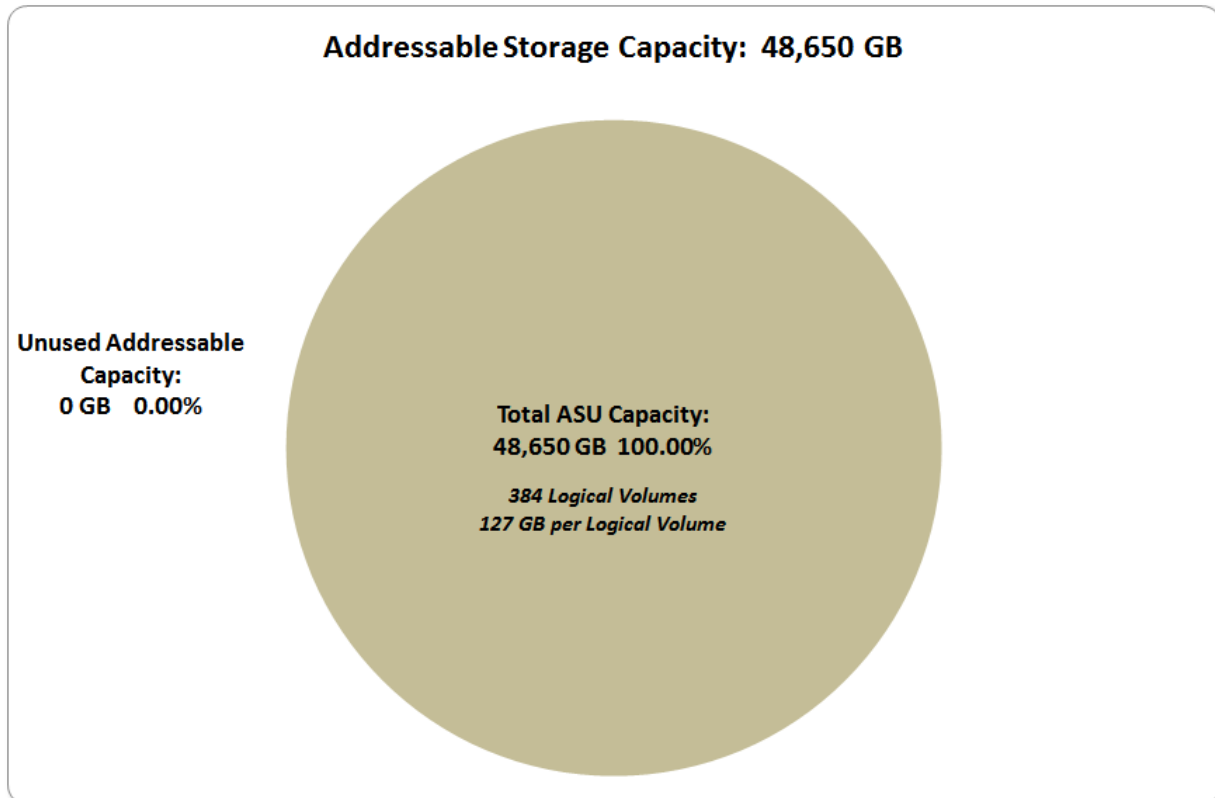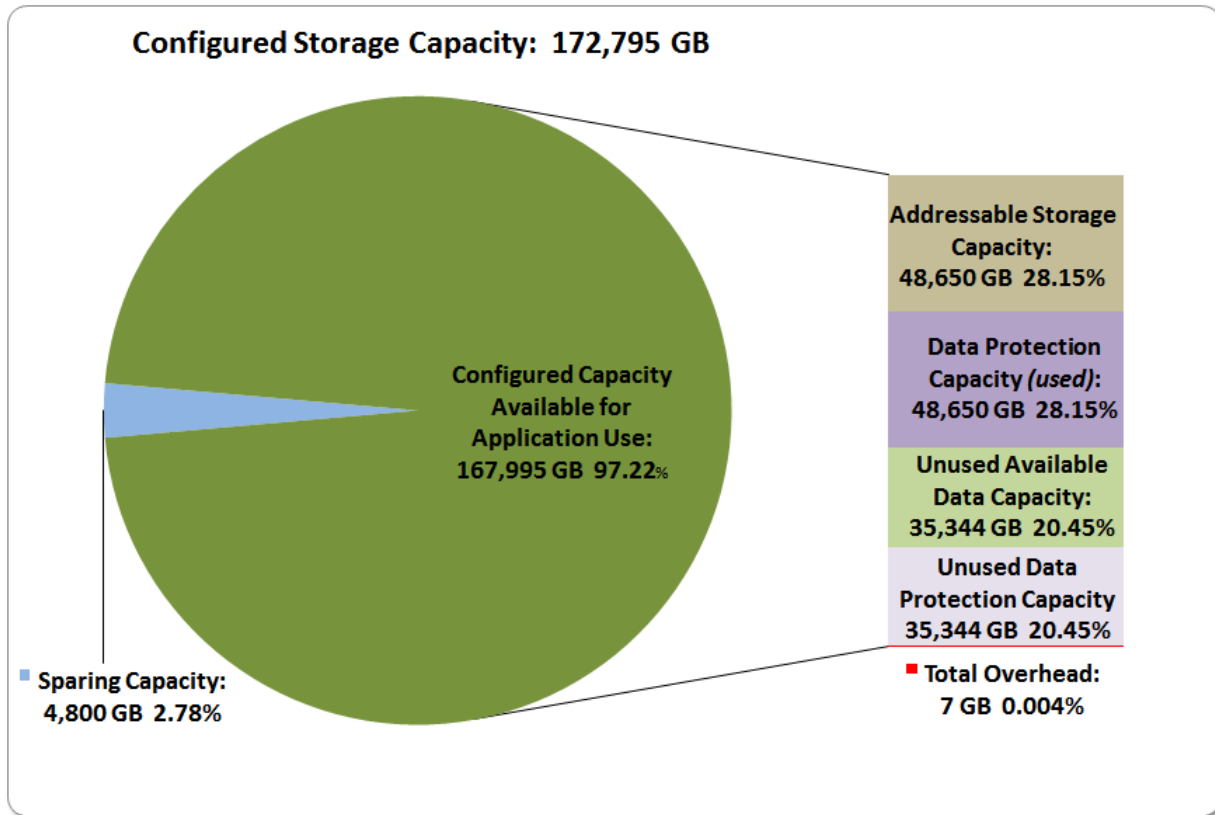
## SPC-2 Reported Data *(continued)*

| SPC-2 Reported Data | | | | |
|---|---|---|---|---|
| **Oracle ZFS Storage ZS4-4 Appliance** | | | | |
| **SPC-2 MBPS™** | **SPC-2 Price-Performance** | **ASU Capacity (GB)** | **Total Price** | **Data Protection Level** |
| 31,486.23 | $17.09 | 48,649.759 | $538,049.73 | Protected 2 *(Mirroring)* |
| *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)* | | | | |
| **SPC-2 Large File Processing (LFP) Reported Data** | | | | |
| | **Data Rate *(MB/second)*** | **Number of Streams** | **Data Rate per Stream** | **Price-Performance** |
| LFP Composite | 21,180.92 | | | $25.40 |
| Write Only: | | | | |
| 1024 KiB Transfer | 15,845.30 | 512 | 30.95 | |
| 256 KiB Transfer | 4,096.04 | 1,024 | 4.00 | |
| Read-Write: | | | | |
| 1024 KiB Transfer | 23,034.46 | 2,048 | 11.25 | |
| 256 KiB Transfer | 6,569.90 | 1,024 | 6.42 | |
| Read Only: | | | | |
| 1024 KiB Transfer | 38,820.79 | 256 | 151.64 | |
| 256 KiB Transfer | 38,719.00 | 1,024 | 37.81 | |
| *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 | 37,101.85 | | | $14.50 |
| 1024 KiB Transfer Size | | | | |
| 4 I/Os Outstanding | 39,110.30 | 256 | 152.77 | |
| 1 I/O Outstanding | 39,007.21 | 256 | 152.37 | |
| 64 KiB Transfer Size | | | | |
| 4 I/Os Outstanding | 35,376.78 | 512 | 69.10 | |
| 1 I/O Outstanding | 34,913.09 | 1,024 | 34.09 | |
| *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** |
| | 36,175.91 | 46,000 | 0.79 | $14.87 |

## 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: 172,795 GB**

Configured Capacity
Available for
Application Use:
167,995 GB 97.22%

Sparing Capacity:
4,800 GB 2.78%

Addressable Storage
Capacity:
48,650 GB 28.15%

Data Protection
Capacity *(used)*:
48,650 GB 28.15%

Unused Available
Data Capacity:
35,344 GB 20.45%

Unused Data
Protection Capacity
35,344 GB 20.45%

Total Overhead:
7 GB 0.004%

**Addressable Storage Capacity: 48,650 GB**

Unused Addressable
Capacity:
0 GB   0.00%

Total ASU Capacity:
48,650 GB 100.00%

*384 Logical Volumes*
*127 GB per Logical Volume*

**Total Unused Storage Capacity Ratio and Detail**

*Physical Storage Capacity:*
*172,800 GB*

**Unused Physical Capacity: 0 GB**

**Physical Storage Capacity Used: 102,112 GB 59.09%**

**Total Unused Storage Capacity: 70,688GB 40.91%**

**Unused Configured Capacity: 70,688 GB**

*includes 35,344 GB of Unused Data Protection*

**Unused Addressable Capacity: 0 GB**

| SPC-2 Storage Capacity Utilization | |
|---|---|
| Application Utilization | 28.15% |
| Protected Application Utilization | 56.31% |
| Unused Storage Ratio | 40.91% |

**Application Utilization:** Total ASU Capacity *(48,649.759 GB)* divided by Physical Storage Capacity *(172,800.000 GB)*.

**Protected Application Utilization:** Total ASU Capacity *(48,649.759 GB)* plus total Data Protection Capacity *(83,997.610 GB)* minus unused Data Protection Capacity *(35,344.220 GB)* divided by Physical Storage Capacity *(172,800.000 GB)*.

**Unused Storage Ratio:** Total Unused Capacity *(70,688.440 GB)* divided by Physical Storage Capacity *(172,800.000 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

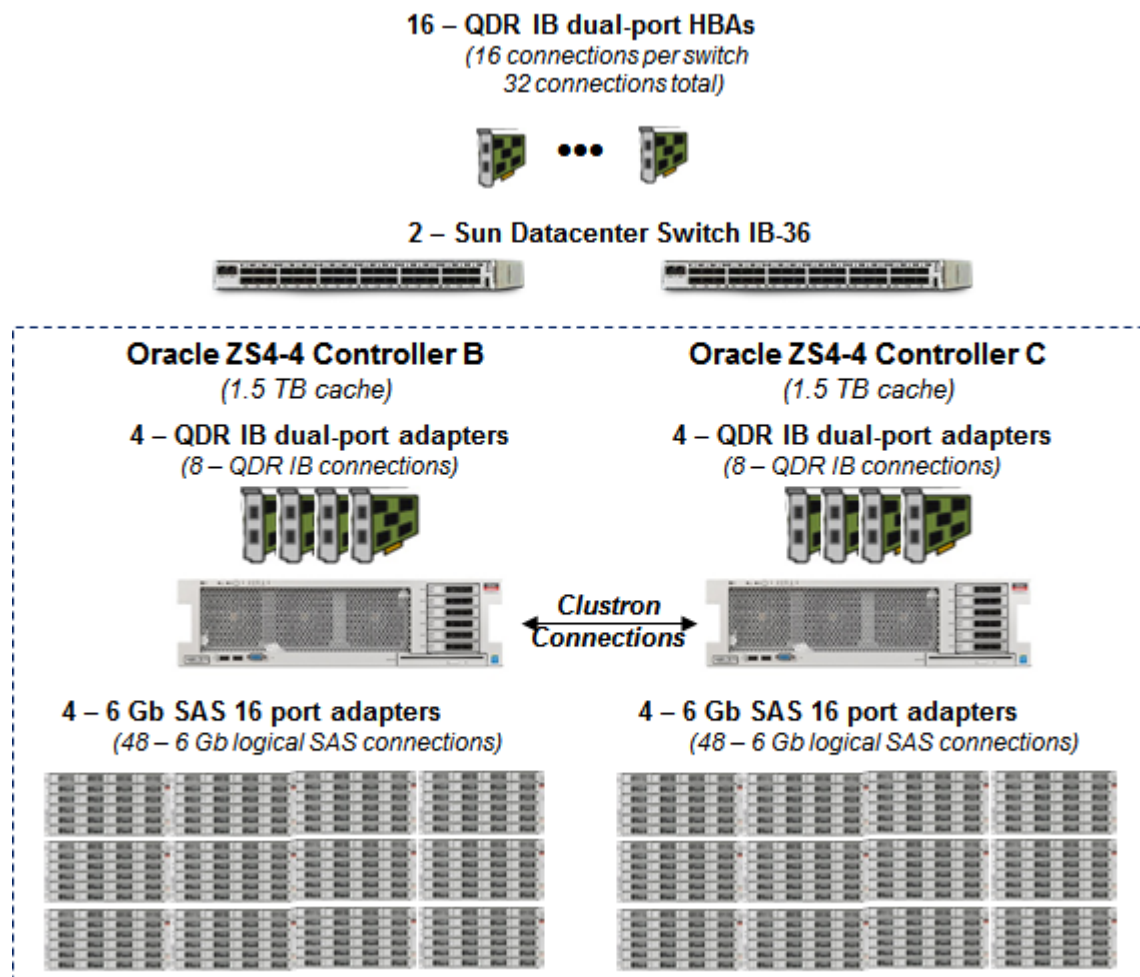| Part Number | Description | Quantity | US List | Total List | Discount | Net Price |
|---|---|---|---|---|---|---|
| 7110766 | Oracle ZFS Storage ZS4-4: controller (for factory installation) | 2 | 81,826.00 | 163,652.00 | 40.00% | 98,191.20 |
| 7106824 | One 16GB DDR3-1600 DIMM (for factory installation) | 192 | 286.00 | 54,912.00 | 20.00% | 43,929.60 |
| 7103790 | SAS PCIE 6Gbs 16 port (for factory installation) | 4 | 1,167.00 | 4,668.00 | 40.00% | 2,800.80 |
| 7104728 | Cable: 3 meters, mini SAS to mini SAS HD (for factory installtion) | 16 | 186.00 | 2,976.00 | 40.00% | 1,785.60 |
| 7104073 | Oracle Dual Port QDR InfiniBand Adapter M3 (for factory installation) | 8 | 2,740.00 | 21,920.00 | 40.00% | 13,152.00 |
| SR-JUMP-1MC13 | Power cord: Sun Rack 2 jumper, 1 meter, C14RA plug, C13 connector, 13 A (for factory installation) | 4 | 29.00 | 116.00 | 40.00% | 69.60 |
| 7103910 | Oracle Storage Drive Enclosure DE2-24P: base chassis (for factory installation) | 24 | 4,071.00 | 97,704.00 | 40.00% | 58,622.40 |
| 7103911 | One 300 GB 10000 rpm 2.5 inch SAS-2 HDD with evo bracket (for factory installation) | 576 | 345.00 | 198,720.00 | 40.00% | 119,232.00 |
| SR-JUMP-1MC13 | Power cord: Sun Rack 2 jumper, 1 meter, C14RA plug, C13 connector, 13 A (for factory installation) | 48 | 29.00 | 1,392.00 | 40.00% | 835.20 |
| 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 | 14,980.00 | 29,960.00 | 40.00% | 17,976.00 |
| 7107048 | Rack Rail Kit | 2 | 1,066.00 | 2,132.00 | 40.00% | 1,279.20 |
| X2121A-1M-N | QSFP to QSFP passive copper cable: 1 meter | 16 | 140.00 | 2,240.00 | 40.00% | 1,344.00 |
| XSR-JUMP-1MC13-N | Jumper Cable Kit: 1 x 1m C13. | 4 | 29.00 | 116.00 | 40.00% | 69.60 |
| 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) | 2 | 2,149.00 | 4,298.00 | 20.00% | 3,438.40 |
| SR-10K-L630-N | Sun Rack II 10kVA PDU, Single Phase, 48 Supplied Amps Max, NEMA L6-30P on 4m captive cords, Data Center Two 30A NEMA L6-30R (30A breakers), 42 C13 and 6 C19 Outlets in 6 Groups, Current Metering. | 2 | 900.00 | 1,800.00 | 20.00% | 1,440.00 |
| SR-JUMPKIT-N | 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 | 2 | 198.00 | 396.00 | 20.00% | 316.80 |
| 7104074 | Oracle Dual Port QDR InfiniBand Adapter M3 | 16 | 2,740.00 | 43,840.00 | 40.00% | 26,304.00 |
| X2121A-5M-N | QSFP to QSFP passive copper cable: 5 meters | 32 | 252.00 | 8,064.00 | 40.00% | 4,838.40 |
| | Oracle Premium Support for Systems: 1-Year 7/24, 2 hour response time. | 3 | | 230,006.16 | | 142,424.93 |
| | **TOTALS** | | | **868,912.16** | | **538,049.73** |

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

**16 – QDR IB dual-port HBAs**
*(16 connections per switch*
*32 connections total)*

**2 – Sun Datacenter Switch IB-36**

**Oracle ZS4-4 Controller B**
*(1.5 TB cache)*

**4 – QDR IB dual-port adapters**
*(8 – QDR IB connections)*

**Oracle ZS4-4 Controller C**
*(1.5 TB cache)*

**4 – QDR IB dual-port adapters**
*(8 – QDR IB connections)*

*Clustron*
*Connections*

**4 – 6 Gb SAS 16 port adapters**
*(48 – 6 Gb logical SAS connections)*

**4 – 6 Gb SAS 16 port adapters**
*(48 – 6 Gb logical SAS connections)*

## Oracle ZFS Storage ZS4-4 Appliance

**2 – Oracle ZFS ZS4-4 controllers** *(cluster configuration)*
*(1.5 TB cache per controller, 3 TB total)*

**8 – QDR IB dual-port HBAs** *(4 HBAs per controller)*
*(8 – QDR connections per controller, 16 total, 16 used)*

**8 –SAS PCIe 6 Gb 16 port adapters** *(4 adapters per controller)*
*(64 – 6 Gb logical SAS connections per controller, 128 total, 96 used)*

**24 – Sun disk shelf base** *(2 SAS I/O modules per base)*

**576 – 300 GB 10K RPM 2.5" SAS-2 Disk Drives**

**2 – Sun Rack II 42U**

**2 – Sun Rack II 10kVA PDUs**

## Priced Storage Configuration Components

| Priced Storage Configuration |
|---|
| 16 – Oracle Dual Port QDR InfiniBand Adapters M3 |
| 2 – Sun Datacenter 36-port QDR InfiniBand Switches (IB-36) |
| **Oracle ZFS Storage ZS4-4 Appliance** |
| 2 – Oracle ZFS ZS4-4 controllers *(cluster configuration)* <br>    1.5 GiB cache/memory per controller *(3 GiB total)* |
| 8 – Oracle Dual Port QDR InfiniBand Adapters M3 <br>    *(4 adapters per controller)* |
| 8 – QDR InfiniBand front-end connections per controller <br>    *(16 – QDR InfiniBand front-end connections total, 16 used)* |
| 8 – SAS PCIe 6 Gb 16 port adapters <br>    *(4 adapters per controller)* <br>    *(2 adapters per controller included with base unit)* <br>    4 physical SAS ports per adapter <br>    4 logical SAS connections per physical port <br>   16 logical SAS connections per adapter <br>   16 physical SAS ports per controller <br>   64 logical SAS connections per controller <br>    *(128 logical connections total, 96 used)* |
| 24 – Oracle Storage Drive Enclosures <br>    each with 2 SAS I/O modules, 2 AC PSUs and 2 cooling fans |
| 576 – 300 GB 10K RPM 2.5" SAS-2 disk drives <br>    *(24 disk drives per enclosure)* |
| 2 – Sun Rack II, 42U |
| 2 – Sun Rack II 10kVA PDU, single phase, <br>    48 supported amps max |

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