SPC BENCHMARK 1™
EXECUTIVE SUMMARY

KAMINARIO, INC.
KAMINARIO K2-D *(1875K-1.1)*

SPC-1 V1.12

Submitted for Review: July 30, 2012
Submission Identifier: A00118

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
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Revision Information and Key Dates

Revision Information and Key Dates	
SPC-1 Specification revision number	V1.12
SPC-1 Workload Generator revision number	V2.3.0.0
Date Results were first used publicly	July 30, 2012
Date the FDR was submitted to the SPC	July 30, 2012
Date the Priced Storage Configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	July 26, 2012

Tested Storage Product (TSP) Description

Kaminario's K2 all Solid-state SAN storage solution offers extreme performance, high availability, scalability, and simplicity in installation, management, and configuration.

K2 is geared towards latency sensitive and I/O intensive critical business applications that standard storage solutions cannot support. It is based on Kaminario's Scale-out Performance Architecture™ (SPEAR), which is a grid of modular, industry standard blade-based servers, running as Kaminario I/O Directors and Data Nodes and controlled by the Kaminario Storage System Management.

Summary of Results

| SPC-1 Reported Data	
Tested Storage Product (TSP) Name: Kaminario K2-D *(1875K-1.1)*	
Metric	**Reported Result**
SPC-1 IOPS™	1,219,973.91
SPC-1 Price-Performance	$0.40/SPC-1 IOPS™
Total ASU Capacity	1,159.830 GB
Data Protection Level	Protected *(Mirroring)*
Total TSC Price (including three-year maintenance)	$490,760.00

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

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

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

Storage Capacities, Relationships, and Utilization

The following diagram 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.
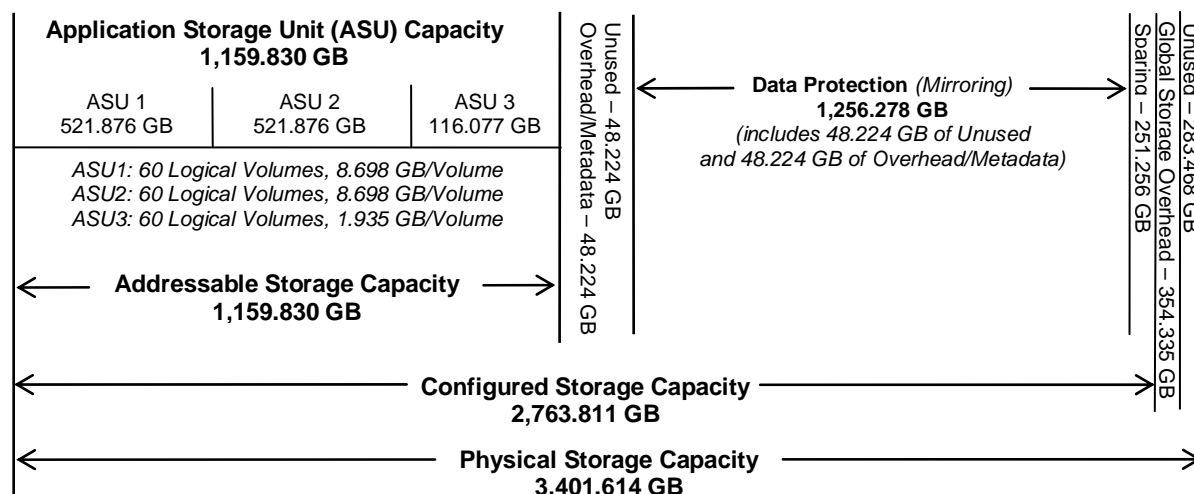
SPC-1 Storage Capacity Utilization	
Application Utilization	34.10%
Protected Application Utilization	69.61%
Unused Storage Ratio	11.17%

Application Utilization: Total ASU Capacity *(1,159.830 GB)* divided by Physical Storage Capacity *(3,401.614 GB)*

Protected Application Utilization: Total ASU Capacity *(1,159.830 GB)* plus total Data Protection Capacity *(1,256.278 GB)* minus unused Data Protection Capacity *(48.224 GB)* divided by Physical Storage Capacity *(3,401.614 GB)*

Unused Storage Ratio: Total Unused Capacity *(379.916 GB)* divided by Physical Storage Capacity *(3,401.614 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 22-24 in the 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.
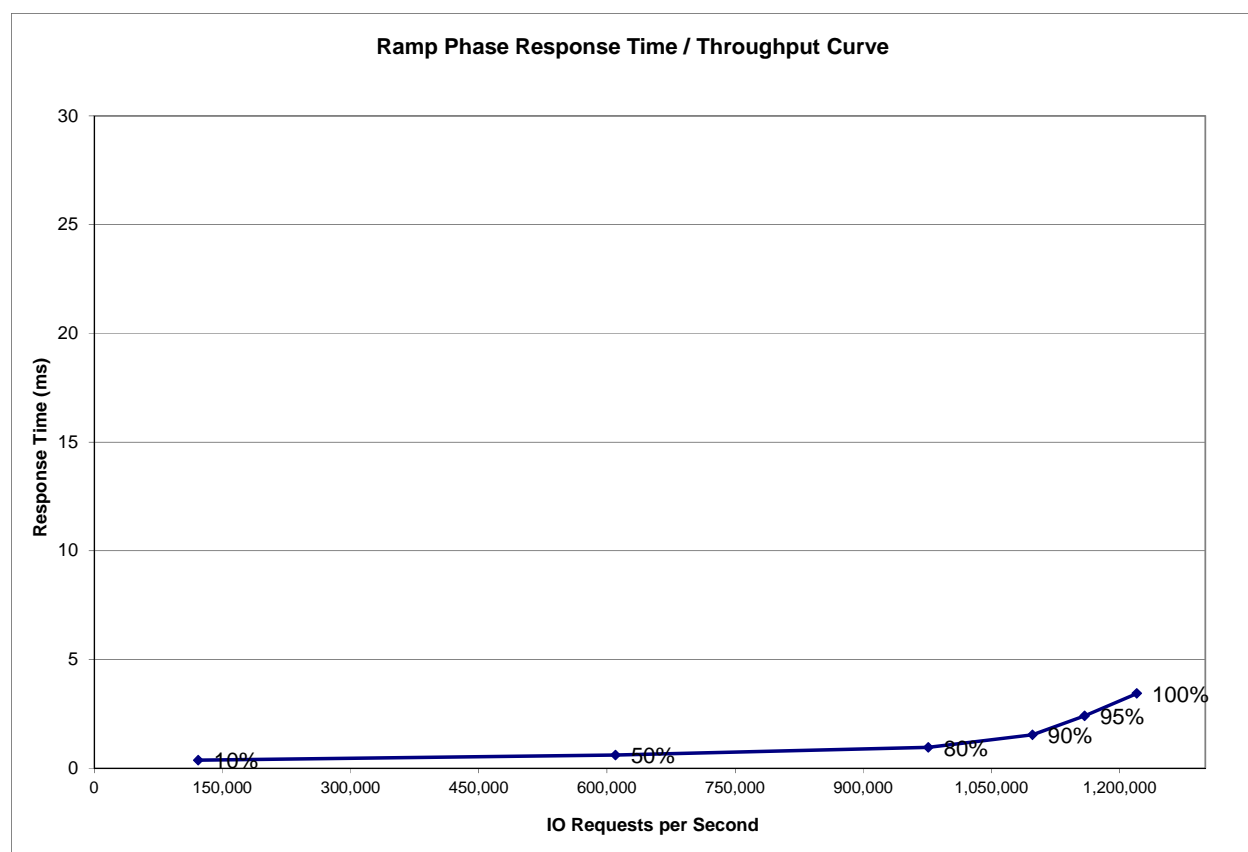
Response Time – Throughput Data

	10% Load	50% Load	80% Load	90% Load	95% Load	100% Load
I/O Request Throughput	122,005.05	610,008.96	975,990.20	1,097,983.77	1,159,017.29	1,219,973.91
Average Response Time (ms):						
All ASUs	0.37	0.60	0.96	1.53	2.40	3.44
ASU-1	0.34	0.57	0.91	1.46	2.31	3.26
ASU-2	0.36	0.59	0.95	1.58	2.48	3.67
ASU-3	0.42	0.66	1.05	1.67	2.58	3.71
Reads	0.33	0.55	0.89	1.45	2.30	3.29
Writes	0.39	0.63	1.00	1.59	2.47	3.53

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 Pricing

Quantity	Item	Description	Unit Price	Price
1	K2D-1875000-1.1**	1.8M IOPS and 1.1TB	$350,000	$350,000
1	Three years maintenance	4 hours mission ciritcal	$105,000	$105,000
70	T54-M11FF-10	WesternWire FC cable LC-LC 3m	$8	$560
20	QME2572*	QLogic QME2572 8Gbps Fibre Channel I/O Card	$425	$8,500
5	Brocade 300 FC8*	Brocade 300 FC8 (8/16/24 Port)	$5,340	$26,700

Total System Price:				$490,760

Third-party components with an appropriate quote in Appendix F of the Full Disclosure Report.

The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems with four (4) hours.

- Onsite presence of a qualified maintenance engineer or provision of a customer replaceable part within four (4) hours of the above acknowledgement for any hardware failure that results in an inoperative Priced Storage Configuration that can be remedied by the repair or replacement of a Priced Storage Configuration component.
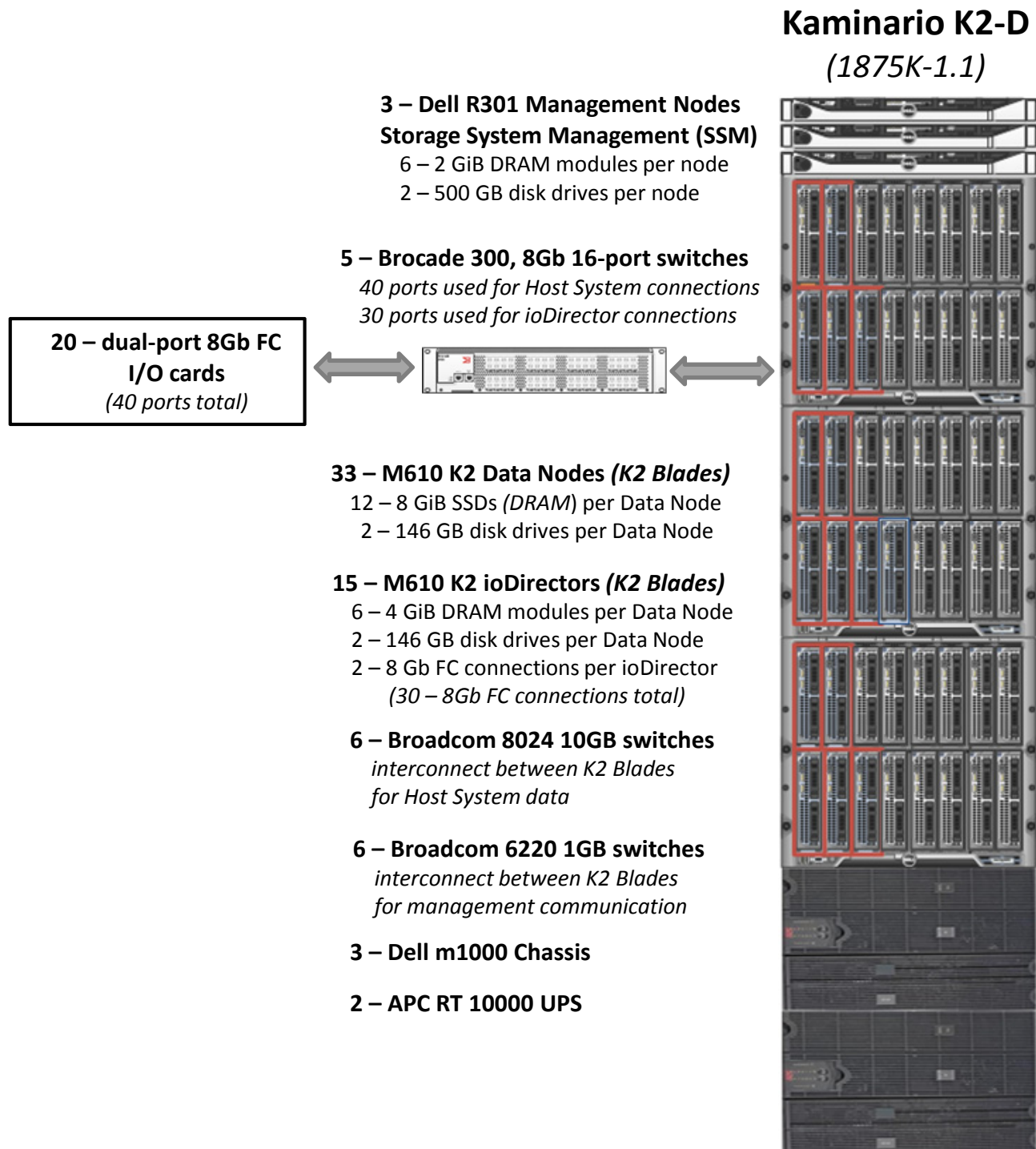
**K2D-1875000-1.1 Line Item Components

The K2D line item in the above pricing includes the following components:

- **K2 Blades:** The K2 blade servers consist of DataNodes and ioDirectors as detailed below.

- **33 – M610 K2 DataNodes:** Each DataNode included twelve 8 GiB solid state storage devices (DRAM), which provided the storage capacity for the mirrored SPC-1 data repository. In addition, each DataNode included two 146 GB disk drives that provided a mirrored, backup copy of the SPC-1 data repository.

- **15 – M610 K2 ioDirectors:** The ioDirectors are responsible for exposing the data volumes to the Host Systems, connected via Fibre Channel. Each ioDirector included six 4 GiB DRAM modules for caching and metadata. Each ioDirector also included two 146 GB disk drives for backup and metadata.

- **6 Broadcom 8024 10GB switches:** Interconnects all blades for the purpose of sending Host System data between the blades.

- **6 Broadcom 6220 1GB switches:** Interconnects all blades for the purpose of supporting management communication between the blades.

- **6 Brocade 8GB FC switches:** Provides FC ports to external Host Systems.

- **3 – Dell m1000 chassis:** Chassis to hold the blades and switches.

- **3 – Dell R310 Management Nodes, Storage System Management (SSM):** The SSM modules provide storage installation, configuration and monitoring functionality. Each SSM module included six 2 GiB DRAM modules and two 500 GB disk drives for metadata.

- **2 – APC RT 10000 UPSs:** A pair of Uninterruptible Power Supplies that can deliver power to the entire K2 configuration, allowing a graceful shutdown without loss of data or data integrity.

- **1 – Rack:** Used to house all of the above components.

Priced Storage Configuration Diagram

Kaminario K2-D
(1875K-1.1)

3 – Dell R301 Management Nodes
Storage System Management (SSM)
6 – 2 GiB DRAM modules per node
2 – 500 GB disk drives per node

5 – Brocade 300, 8Gb 16-port switches
40 ports used for Host System connections
30 ports used for ioDirector connections

20 – dual-port 8Gb FC
I/O cards
(40 ports total)

33 – M610 K2 Data Nodes *(K2 Blades)*
12 – 8 GiB SSDs *(DRAM)* per Data Node
2 – 146 GB disk drives per Data Node

15 – M610 K2 ioDirectors *(K2 Blades)*
6 – 4 GiB DRAM modules per Data Node
2 – 146 GB disk drives per Data Node
2 – 8 Gb FC connections per ioDirector
(30 – 8Gb FC connections total)

6 – Broadcom 8024 10GB switches
interconnect between K2 Blades
for Host System data

6 – Broadcom 6220 1GB switches
interconnect between K2 Blades
for management communication

3 – Dell m1000 Chassis

2 – APC RT 10000 UPS

Priced Storage Configuration Components

Priced Storage Configuration:
20 – dual port QLogic8 Gb FC I/O Cards *(40 ports total, 40 ports used)*
5 –Brocade 300, 8 Gb switches with SFPs *(16 active ports per switch, 80 total)*   *(40 ports for Host System connections, 30 ports for ioDirector connections)*

Kaminario K2-D *(1875K-1.1)*
 33 – M610 K2 DataNodes *(K2 Blades)*
        12 – 8 GiB solid state storage devices (DRAM) per DataNode
         2 – 146 GB disk drives per DataNode
 15 – M610 K2 ioDirectors *(K2 Blades)*
        6 – 4 GiB DRAM modules per ioDirector
        2 – 146 GB disk drives per ioDirector
        2 – 8 Gb FC connections per ioDirector *(30 total, 30 used)*
 3 – Dell R310 Management Nodes
        Storage System Management (SSM)
        6 – 2 GiB DRAM modules per Management Node
        2 – 500 GB disk drives per Management Node
 6 – Broadcom 8024 10GB switches
        (interconnect between K2 Blades for Host System data)
 6 – Broadcom 6220 1GB switches
        (interconnect between K2 Blades for management communication)
 6 – Brocade 8GB FC switches *(provides FC front-end ports)*
        (6 ports available per switch, 5 ports used per switch)
 3 – Dell m1000 Chassis *(holds the K2 Blades and switches)*
 2 – APC RT 10000 UPS
 1 – Rack