SPC Benchmark 2™

Executive Summary

Kaminario, Inc.

Kaminario K2

(K2F00000700)

SPC-2™ V1.5

Submitted for Review: November 20, 2013

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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

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	November 20, 2013
Date FDR was submitted to the SPC	November 20, 2013
Date the TSC will be available for shipment to customers	currently available
Date the TSC completed audit certification	November 18, 2013

Tested Storage Product (TSP) Description

Kaminario K2 is an enterprise class general purpose MLC Flash array that eliminates I/O and throughput bottlenecks and dramatically reduces latency to accelerate applications. The K2 is consistently fast, highly available, cost effective, and easy to deploy storage. The K2 is a fundamentally better way to store performance sensitive data.

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 **K-RAID,** which consists of RAID 10 during normal operation, where half of the SSD storage is allocated for data mirroring. During failures, the data is mirrored to the KMS storage capacity (HDDs)..

> **Protected 1:** *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.
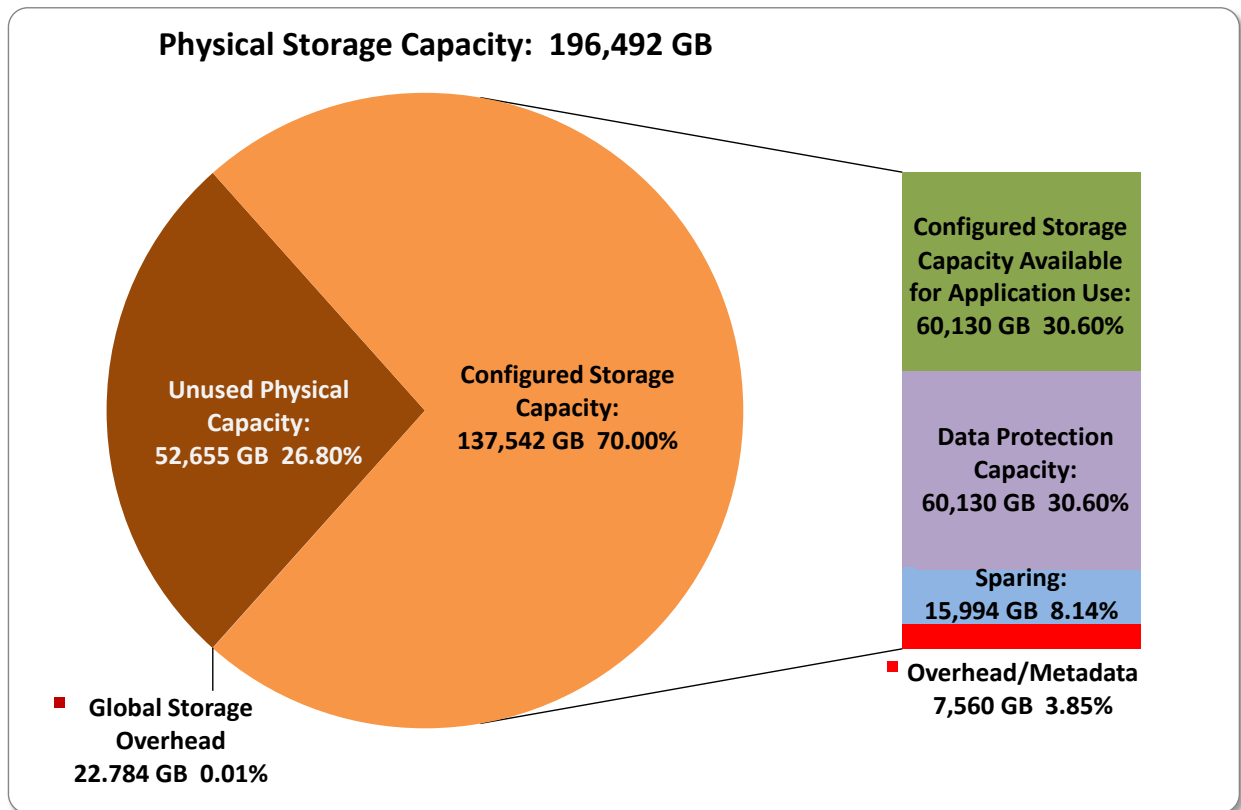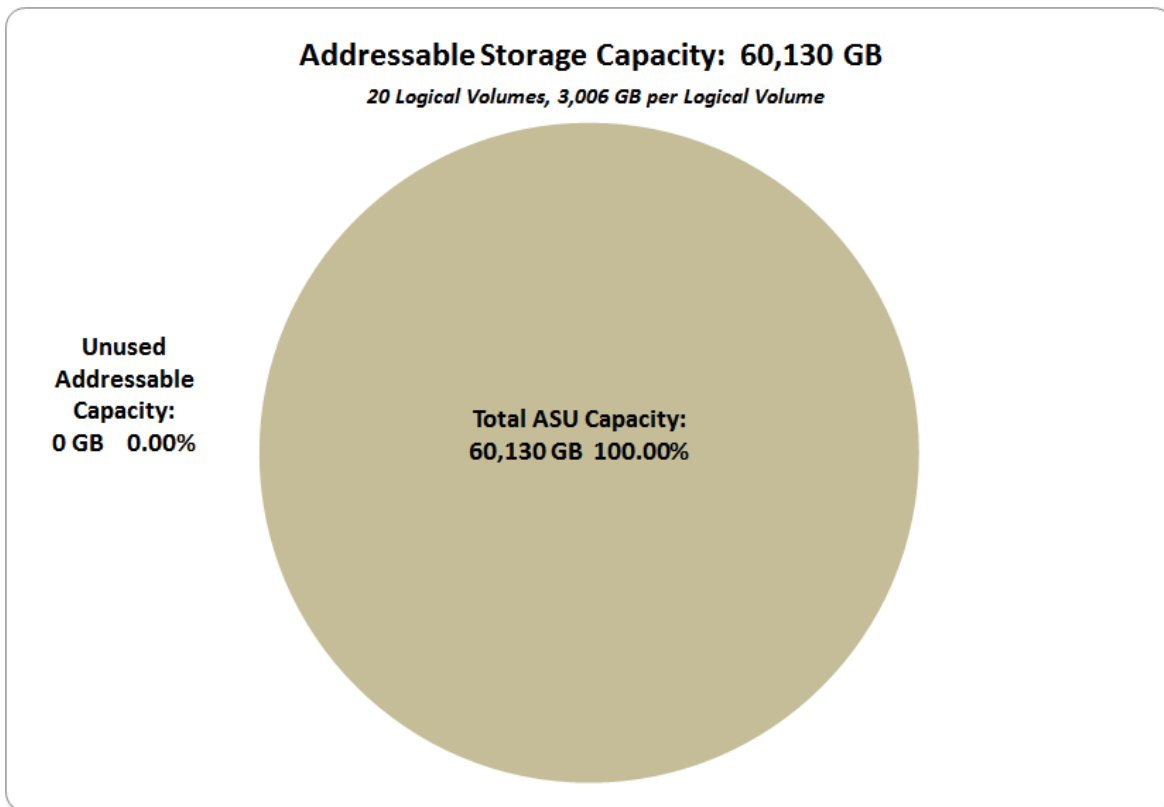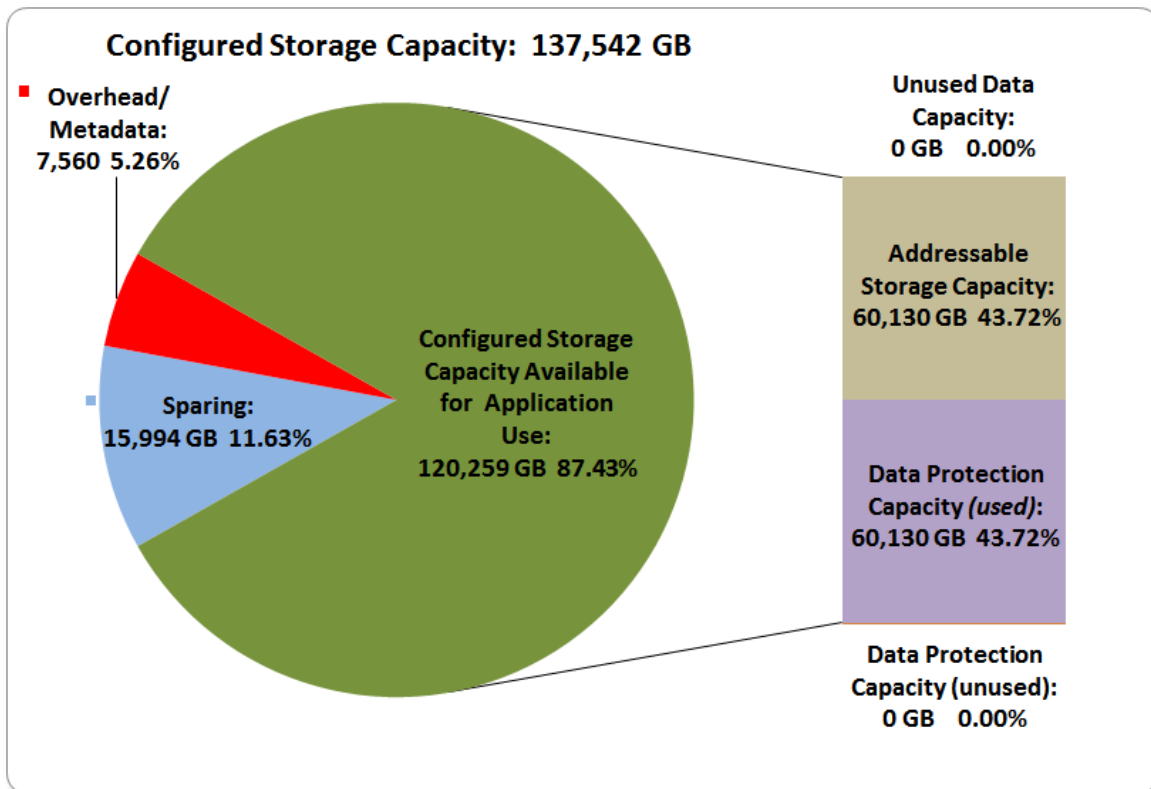
SPC-2 Reported Data *(continued)*

SPC-2 Reported Data				
Kaminario K2 K2F00000700				
SPC-2 MBPS™	**SPC-2 Price-Performance**	**ASU Capacity (GB)**	**Total Price**	**Data Protection Level**
33,477.03	$29.79	60,129.542	$997,348.00	Protected 2 *(K-RAID)*
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	31,884.08			$31.28
Write Only:				
1024 KiB Transfer	26,086.14	85	306.90	
256 KiB Transfer	26,363.90	200	131.82	
Read-Write:				
1024 KiB Transfer	30,496.95	160	190.61	
256 KiB Transfer	32,081.35	460	69.74	
Read Only:				
1024 KiB Transfer	34,591.57	130	266.09	
256 KiB Transfer	41,684.59	475	87.76	
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	37,089.66			$26.89
1024 KiB Transfer Size				
4 I/Os Outstanding	30,131.38	35	860.90	
1 I/O Outstanding	34,692.16	135	256.98	
64 KiB Transfer Size				
4 I/Os Outstanding	42,855.61	460	93.16	
1 I/O Outstanding	40,679.48	1,350	30.13	
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**
	31,457.36	40,000	0.79	$31.70

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.

Physical Storage Capacity: 196,492 GB

Unused Physical Capacity:
52,655 GB 26.80%

Configured Storage Capacity:
137,542 GB 70.00%

Global Storage Overhead
22.784 GB 0.01%

Configured Storage Capacity Available for Application Use:
60,130 GB 30.60%

Data Protection Capacity:
60,130 GB 30.60%

Sparing:
15,994 GB 8.14%

Overhead/Metadata
7,560 GB 3.85%

Configured Storage Capacity: 137,542 GB

Overhead/
Metadata:
7,560 5.26%

Sparing:
15,994 GB 11.63%

Configured Storage
Capacity Available
for Application
Use:
120,259 GB 87.43%

Unused Data
Capacity:
0 GB   0.00%

Addressable
Storage Capacity:
60,130 GB 43.72%

Data Protection
Capacity *(used)*:
60,130 GB 43.72%

Data Protection
Capacity (unused):
0 GB   0.00%

Addressable Storage Capacity: 60,130 GB

20 Logical Volumes, 3,006 GB per Logical Volume

Unused
Addressable
Capacity:
0 GB   0.00%

Total ASU Capacity:
60,130 GB 100.00%

Total Unused Storage Capacity Ratio and Details

Physical Storage Capacity: 196,492 GB

Unused Configured Capacity: 0 GB

Physical Storage Capacity Used: 196,492 GB 78.87%

Total Unused Storage Capacity: 52,655 GB 21.13%

Unused Physical Capacity: 52,655 GB

Unused Addressable Capacity: 0 GB

Unused Data Protection: 0 GB

SPC-2 Storage Capacity Utilization	
Application Utilization	30.60%
Protected Application Utilization	61.20%
Unused Storage Ratio	26;80%

Application Utilization: Total ASU Capacity *(60,129.542 GB)* divided by Physical Storage Capacity *(196,491.768 GB)*.

Protected Application Utilization: Total ASU Capacity *(60,129.542 GB)* plus total Data Protection Capacity *(60,1129.542 GB)* minus unused Data Protection Capacity *(0.000 GB)* divided by Physical Storage Capacity *(196,491.768 GB)*.

Unused Storage Ratio: Total Unused Capacity *(52,655.440 GB)* divided by Physical Storage Capacity *(196,491.768 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 25-26 in the Full Disclosure Report.

Priced Storage Configuration Pricing

Quantity	Item	Description	Unit Price	Price
1	K2F000000700**	Kaminario K2 Flash 7 K-Blocks with 86.49TB total usable capacity		730,000.00
1	Three years maintenance	4 hours mission ciritcal		255,000.00
56	T54-M11FF-10	WesternWire FC cable LC-LC 3m	8.00	448.00
28	QME2572	QLogic QME2572 8Gbps Fibre Channel I/O Card	425.00	11,900.00
	Total System Price:			**997,348.00**

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.

K2F000000700** Line Item Components

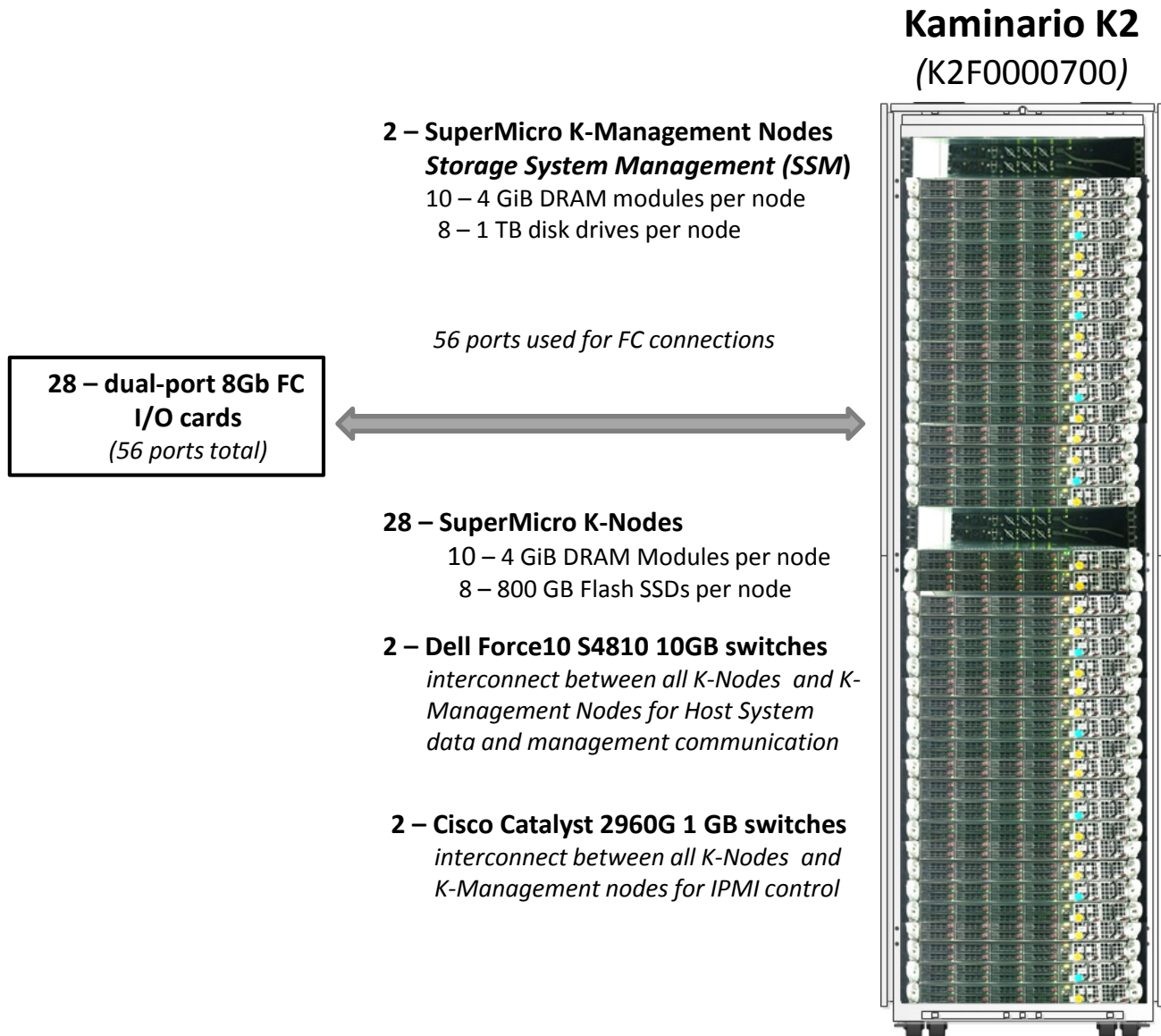The K2F line item in the above pricing includes the following components:

- **28 K-Nodes**: *SuperMicro SYS-1027R-72BRFTP1-EI007*:

  - Each K-Node includes eight 800 GB solid state storage devices (SSD), which provide the storage capacity for the primary and mirror SPC-1 ASUs.

  - Each K-node also runs an IO-director process responsible for exposing the data volumes to the Host Systems, connected via Fibre Channel.

- **2 K-Management Nodes, Storage System Management (SSM)** *SuperMicro SYS-1027R-72BRFTP1-EI007*.

  The SSM modules provide storage installation, configuration and monitoring functionality. Each SSM module included eight 1 TB HDDs that serve as spare backup capacity for the system.

- **2 Dell Force10 S4810 10GB switches** - Interconnects all K-nodes for the purpose of sending Host System data between the K-nodes and for supporting management communication.

- **2 Cisco Catalyst 2960G 1 GB switches** - Interconnects all K-nodes to the K-management node for the purpose IPMI protocol control over the K-nodes.

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

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

Kaminario K2
*(*K2F0000700*)*

2 – SuperMicro K-Management Nodes
Storage System Management (SSM)
10 – 4 GiB DRAM modules per node
8 – 1 TB disk drives per node

56 ports used for FC connections

**28 – dual-port 8Gb FC
I/O cards**
(56 ports total)

28 – SuperMicro K-Nodes
10 – 4 GiB DRAM Modules per node
8 – 800 GB Flash SSDs per node

2 – Dell Force10 S4810 10GB switches
*interconnect between all K-Nodes and K-Management Nodes for Host System
data and management communication*

2 – Cisco Catalyst 2960G 1 GB switches
*interconnect between all K-Nodes and
K-Management nodes for IPMI control*

Priced Storage Configuration Components

Priced Storage Configuration
28 – dual port QLogic 8 Gb FC I/O Cards *(56 ports total, 56 ports used)*

Kaminario K2 *(K2F00000700)*

28 – SuperMicro K-Nodes
   8 – 800 GB SSDs per node
  10 – 4 GiB DRAM modules per node

2 – SuperMicro K-Management Nodes
    Storage System Management (SSM)
  10 – 4 GiB DRAM modules per node
   8 – 1 TB disk drives per node

2 – Dell Force10 S4810 10GB switches
   (interconnect between all K-Nodes and K-Management Nodes
   for Host System data and management communication)

2 – Cisco Catalyst 2960G 1 GB switches
   (interconnect between all K-Nodes and K-Management nodes
   for IPMI control)

1 – 42U rack and 4 PDUs