



**SPC BENCHMARK 2™
EXECUTIVE SUMMARY**

**EMC CORPORATION
EMC VMAX 400K**

SPC-2™ V1.5

Submitted for Review: July 30, 2015

Submission Identifier: B00073

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

Test Sponsor and Contact Information	
Test Sponsor Primary Contact	EMC Corporation – http://www.emc.com Joseph Perry – joseph.perry@emc.com 176 South Street Hopkinton, MA 01748 Phone: (508) 293-7637 FAX: (508) 249-3064
Test Sponsor Alternate Contact	EMC Corporation - http://www.emc.com Wolfgang Klinger – wolfgang.klinger@emc.com 228 South Street Hopkinton, MA 01748 Phone: (508) 249-5829 FAX: (508) 249-3064
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	July 30, 2015
Date FDR was submitted to the SPC	July 30, 2015
Date the TSC will be available for shipment to customers	currently available
Date the TSC completed audit certification	July 28, 2015

Tested Storage Product (TSP) Description

The EMC VMAX 400K storage array is a highly scalable enterprise data services platform fundamentally changing what has been possible with enterprise storage by delivering new levels of automation, modernization and consolidation to customers. VMAX3 is a radically new approach to enterprise storage architecture, separating software-based data services from the underlying hardware, allowing the hallmark VMAX® capabilities – local replication, remote replication, and storage tiering – to extend to other platforms from EMC and third-party vendors. VMAX 400K also dramatically simplifies management at scale through service level objectives (SLOs), improving overall staff productivity and allowing customers to focus on the needs of the business, rather than the management of technology.

Built on the powerful Virtual Matrix Architecture with up to 384 multi-core processors, 16TB of low latency high bandwidth cache memory, and 4PB of usable capacity, VMAX 400K delivers extreme levels of performance, scale, and hyper consolidation for today's mission-critical hybrid cloud environments.

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.

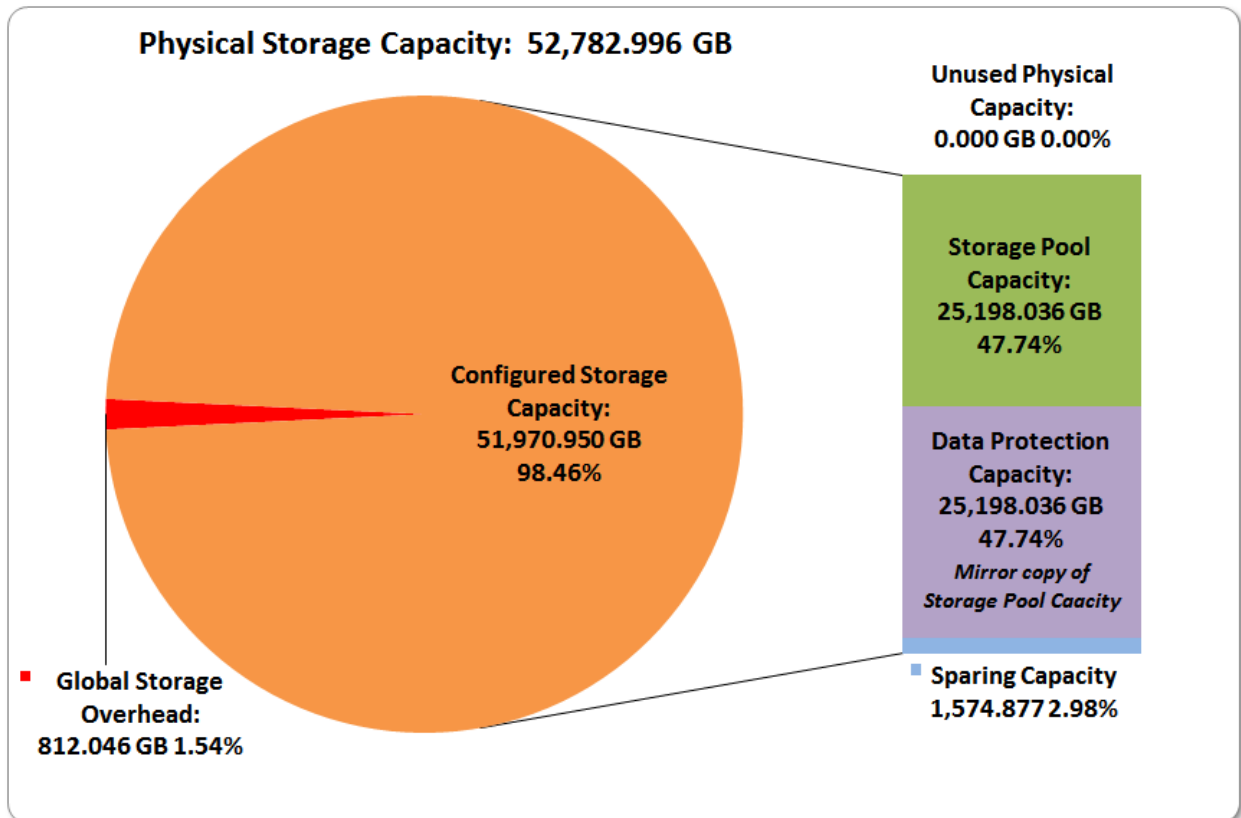
SPC-2 Reported Data (continued)

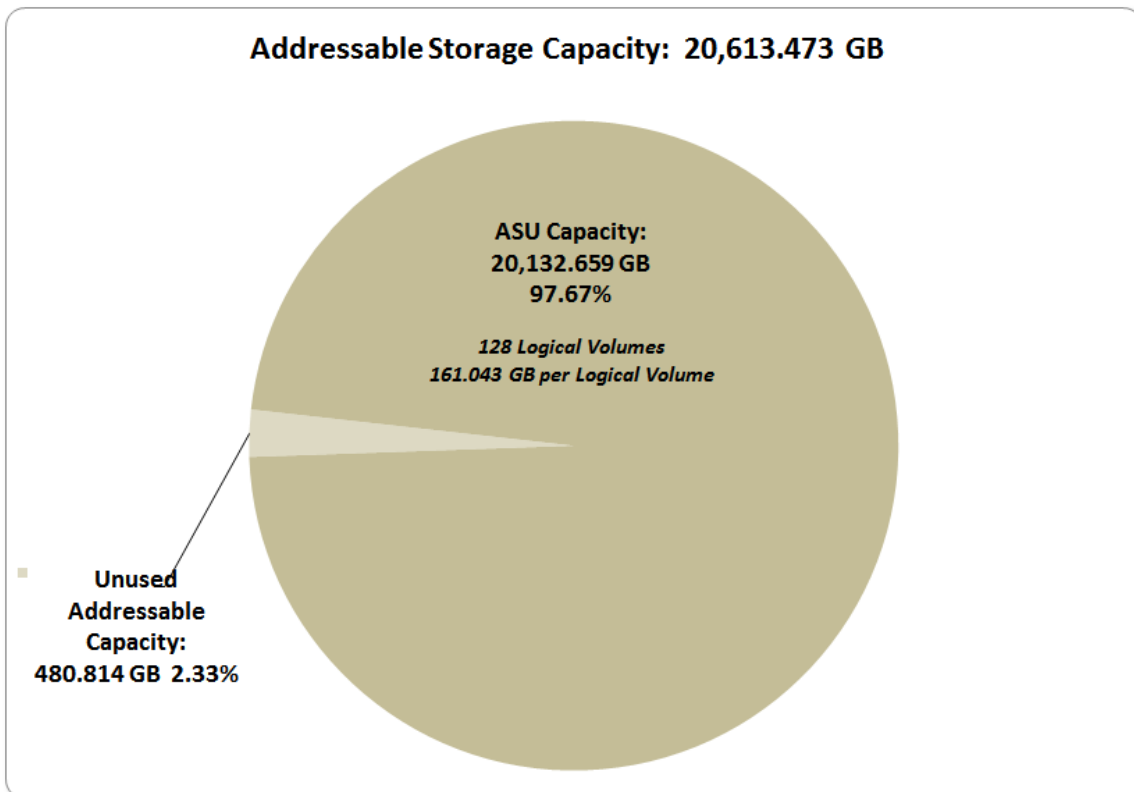
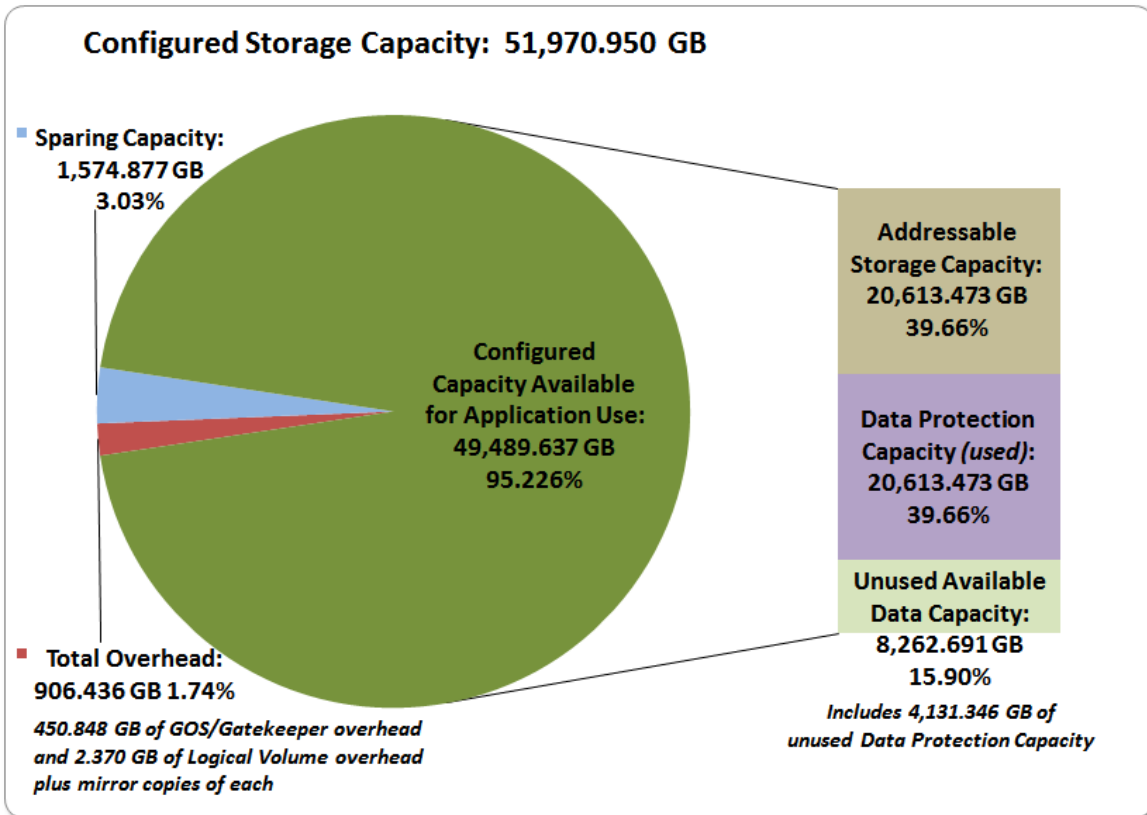
SPC-2 Reported Data				
EMC VMAX 400K				
SPC-2 MBPS™	SPC-2 Price-Performance	ASU Capacity (GB)	Total Price	Data Protection Level
55,643.78	\$33.58	20,132.659	\$1,868,567.85	Protected 2 (mirroring)
<i>The above SPC-2 MBPS™ value represents the aggregate data rate of all three SPC-2 workloads: Large File 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	53,093.09			\$35.19
Write Only:				
1024 KiB Transfer	38,105.72	1,600	23.82	
256 KiB Transfer	39,604.05	1,600	24.75	
Read-Write:				
1024 KiB Transfer	47,324.69	1,600	29.58	
256 KiB Transfer	50,631.77	1,600	31.64	
Read Only:				
1024 KiB Transfer	71,277.05	1,600	44.55	
256 KiB Transfer	71,615.24	1,600	44.76	
<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	66,652.61			\$28.03
1024 KiB Transfer Size				
4 I/Os Outstanding	55,871.95	1,600	34.92	
1 I/O Outstanding	70,807.38	1,600	44.25	
64 KiB Transfer Size				
4 I/Os Outstanding	69,816.93	1,600	43.64	
1 I/O Outstanding	70,114.20	1,600	43.82	
<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
	47,185.63	60,000	0.79	\$39.60

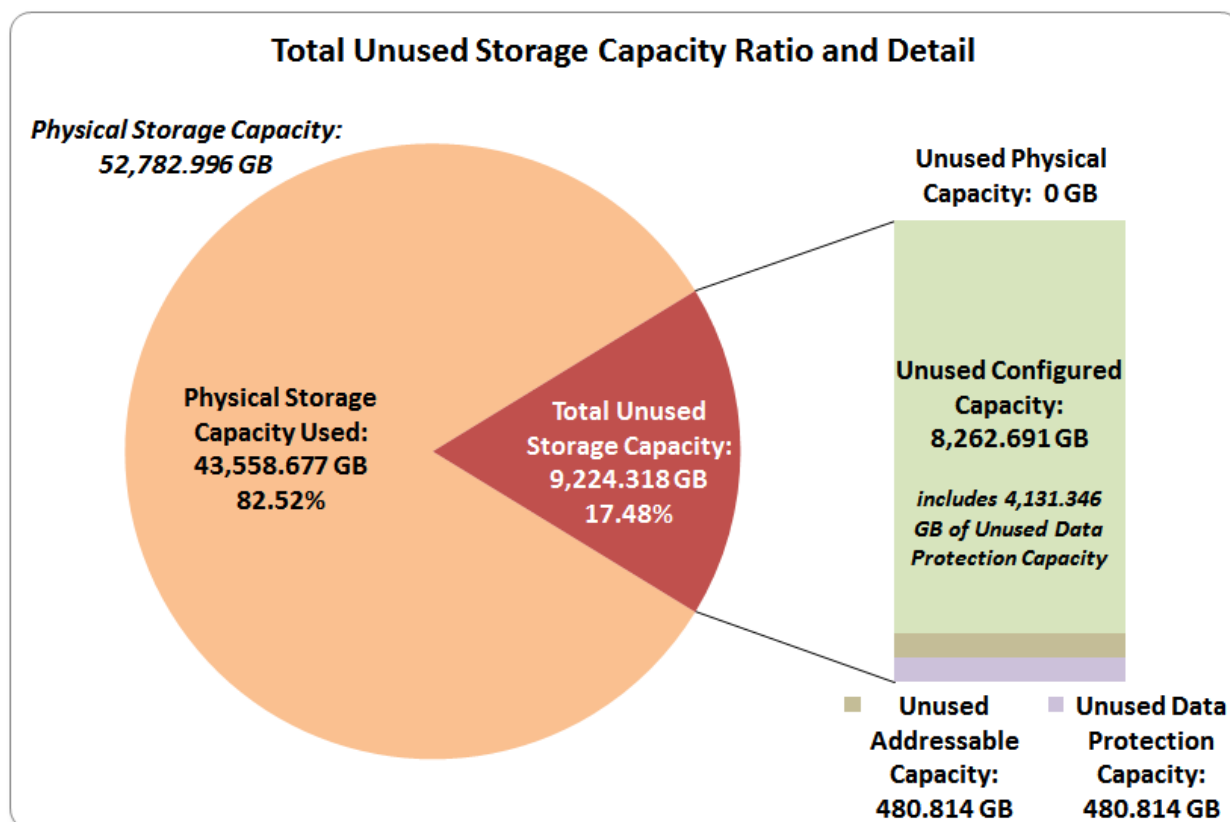
Storage Capacities and Relationships

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.







SPC-2 Storage Capacity Utilization	
Application Utilization	38.14%
Protected Application Utilization	77.14%
Unused Storage Ratio	17.48%

Application Utilization: Total ASU Capacity (20,132.659 GB) divided by Physical Storage Capacity (52,782.996 GB).

Protected Application Utilization: Total ASU Capacity (20,132.659 GB) plus total Data Protection Capacity (25,198.036 GB) minus unused Data Protection Capacity (4,612.159 GB) divided by Physical Storage Capacity (52,782.996 GB).

Unused Storage Ratio: Total Unused Capacity (GB) divided by Physical Storage Capacity (52,782.996 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

Product Description	Quantity	Unit List Price	Product List Price
VMAX 400K SYSTEM BAY 1 (3-Phase Power)	1	\$33,360.00	\$33,360.00
VMAX VG 120 SLT Drive Enclosure	16	\$25,300.00	\$404,800.00
VMAX 400K BASE Engine (512GB Cache)	1	\$437,830.00	\$437,830.00
VMAX 400K ADD Engine (512GB Cache)	7	\$394,045.00	\$2,758,315.00
VMAX400K 200GB FLASH SPARE Drives	8	\$3,905.00	\$31,240.00
VMAX400K 200GB FLASH R1 256 Drives	256	\$3,210.00	\$821,760.00
VMAX VG 5 METER CONTIGIB ETH CABLE	2	\$1,250.00	\$2,500.00
VMAX VG 3 METER CONTIGIB ETH CABLE	4	\$1,250.00	\$5,000.00
ADPTR AC 3PH 50A W3-4IN CONDUIT ADPTR	8	\$400.00	\$3,200.00
PWR Cable HBL-RSTOL 3-Phase	4	\$1,155.00	\$4,620.00
VMAX VG DIRECT 3-METER DAE Cable	16	\$1,285.00	\$20,560.00
VMAX VG 2 METER CONTIGIB ETH CABLE	1	\$1,250.00	\$1,250.00
VMAX 400K FABRIC Interconnect, consists of two SX6018 18-port Infiniband switches	1	\$46,560.00	\$46,560.00
VMAX VG SB1 Dual-Engine Hex Door Pair	1	\$3,000.00	\$3,000.00
VMAX VG SB2-8 Dual-Engine Hex Door Pair	3	\$3,000.00	\$9,000.00
VMAX VG SIDE PANELS	1	\$645.00	\$645.00
VMAX VG 8Gb FC I/O Module Pairs, 8 ports per pair	16	\$2,070.00	\$33,120.00
VMAX VG FLASH Vault Modules 700	8	\$17,860.00	\$142,880.00
VMAX VG ADD SYSTEM BAY (3-Phase Power)	3	\$13,890.00	\$41,670.00
Hardware Components (with 3-year Premium Support)			\$4,801,310.00
HYPERMAX OS 0-50TB	25	\$1,425.00	\$35,625.00
HYPERMAX OS BASE NEW 400K	1	\$28,570.00	\$28,570.00
Software Components (with 3-year Premium Support)			\$64,195.00
VMAX Installation	1		\$4,440.00
VMAX Installation Add-On	3		\$1,740.00
Installation			\$6,180.00
EMULEX LP12002-E dual port 8Gb FC HBA	64	\$505.00	\$32,320.00
5M FC Cables	128	\$23.99	\$3,070.72
3rd Party Components			\$35,390.72

Priced Storage Configuration Pricing (continued)

Product Category	Product List Price	Discount	Discounted Price
Hardware Sub-total	\$4,801,310.00	62%	\$1,802,891.91
Software Sub-total	\$64,195.00	62%	\$24,105.22
Services Sub-total	\$6,180.00	0%	\$6,180.00
3rd Party Sub-total	\$35,390.72	0%	\$35,390.72
Grand Total	\$4,907,075.72		\$1,868,567.85

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

64 – Emulex LPe12002-E Dual Port 8Gb FC HBAs



128 – 8 Gbps FC connections
 (2 connections per HBA)
 (8 connections per server)
 (16 connections per VMAX 400 Engine)



- 8 – VMAX 400K Engines (base plus 7), each with 512 GB cache (4,096 GB total)**
- 4 – 2x4 lane 6Gb SAS I/O Modules (8 2x4 lane connections)**
 (32 modules total, 64x4 lane connections total and used)
- 16 – 8-port 8Gb FC I/O Module pairs w/SPFs**
 (4 modules and 32 ports per VMAX 400K Engine)
 (32 modules total, 128 ports total and used)
- 1 – VMAX 400K FABRIC Interconnect (2 – 18-port InfiniBand switches)**
- 8 – VMAX VG FLASH Vault Modules**
- 16 – VMAX VG 120 SLT Drive Enclosures**
 (8 Drive Enclosures with 17 Flash Drives, including 1 spare)
 (8 Drive Enclosures with 16 Flash Drives)
- 264 – VMAX 400K 200 GB Flash Drives**
- 4 – VMAX 400K System Bays and PDUs (2 VMAX 400K Engines per bay)**

EMC VMAX 400K

Priced Storage Configuration Components

Priced Storage Configuration
64 – Emulex LightPulse LPe12002-E Dual Port 8Gb FC HBAs
EMC VMAX 400K
8 – VMAX 400K Engines (<i>base plus 7</i>), each with 512 GB cache (<i>4,096 GB total</i>)
4 – 2x4 lane 6Gb SAS I/O Modules (<i>8 2x4 lane connections</i>) (<i>32 modules total, 64x4 lane connections total and used</i>)
16 – 8 port 8Gb FC I/O Module pairs (<i>SFPs included</i>) (<i>4 modules and 32 ports per VMAX 400K Engine,</i> <i>32 modules total, 128 ports total and used</i>)
1 – VMAX 400K FABRIC Interconnect (<i>consists of 2 SX6018 18-port Infiniband switches</i>)
8 – VMAX VG FLASH Vault Modules 700
16 – VMAX VG 120 SLT Drive Enclosures (<i>8 Drive Enclosures with 17 Flash Drives, including 1 spare,</i> <i>8 Drive Enclosures with 16 Flash Drives</i>)
8 – VMAX 400K 200 GB FLASH SPARE Drives
256 – VMAX 400K 200 GB FLASH R1 Drives
4 – VMAX 400K System Bays and PDUs (<i>3-phase power</i>)