SPC BENCHMARK 1/ENERGY™

EXECUTIVE SUMMARY

HEWLETT-PACKARD COMPANY

HP STORAGEWORKS 6400
ENTERPRISE VIRTUAL ARRAY

SPC-1/E™ V1.12

Submitted for Review: July 30, 2010
Submission Identifier: AE00003

EXECUTIVE SUMMARY

Test Sponsor and Contact Information

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Test Sponsor Primary Contact	Hewlett-Packard Company – http://www.hp.com Chuck Paridon – chuck.paridon@hp.com 8000 Foothills Blvd M/S 5785 Roseville, CA 95747-5785 Phone: (916) 785-5155 FAX: (916) 785-1648
Test Sponsor Alternate Contact	Hewlett-Packard Company – http://www.hp.com Brian Fridly – brian.fridly@hp.com 8000 Foothills Blvd M/S 5785 Roseville, CA 95747-5785 Phone: (916) 785-2006 FAX: (916) 785-1648
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

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SPC-1 Specification revision number	V1.12
SPC-1 Workload Generator revision number	V2.1.0
Date Results were first used publicly	July 30, 2010
Date the FDR was submitted to the SPC	July 30, 2010
Date the priced storage configuration is available for shipment to customers	currently available
Date the TSC completed audit certification	July 28, 2010

Tested Storage Product (TSP) Description

The HP StorageWorks 6400 Enterprise Virtual Array (EVA) is an enterprise class storage array system designed to aggregate and automate your array management tasks to manage more storage capacity with fewer resources. The EVA is designed specifically for customers in the business critical, enterprise marketplace and is a scalable, highly available and highly reliable "virtual" array storage solution. The EVA6400 saves time, space, and costs compared to traditionally architected storage. It is supported by a powerfully simple suite of management software making it easy to provision storage and to achieve the highest level of productivity.

The HP StorageWorks 6400 Enterprise Virtual Array family is designed for the data center where there is a critical need for improved storage utilization and scalability. The EVA meets application specific demands for transaction I/O performance for mid-range and enterprise customers. It provides easy capacity expansion, instantaneous replication and simplified storage administration. The Enterprise Virtual Array combined with HP StorageWorks Command View EVA software provides a comprehensive solution designed to simplify management and maximize performance.

Summary of Results

SPC-1 Results	
Tested Storage Configuration (TSC) Name: HP StorageWorks 6400 Enterprise Virtual Array	
Metric	**Reported Result**
SPC-1 IOPS™	16,741.16
SPC-1 Price-Performance	$7.28/SPC-1 IOPS™
Total ASU Capacity	347.892GB
Data Protection Level	Protected *(RAID-5)*
Total TSC Price (including three-year maintenance)	$121,835

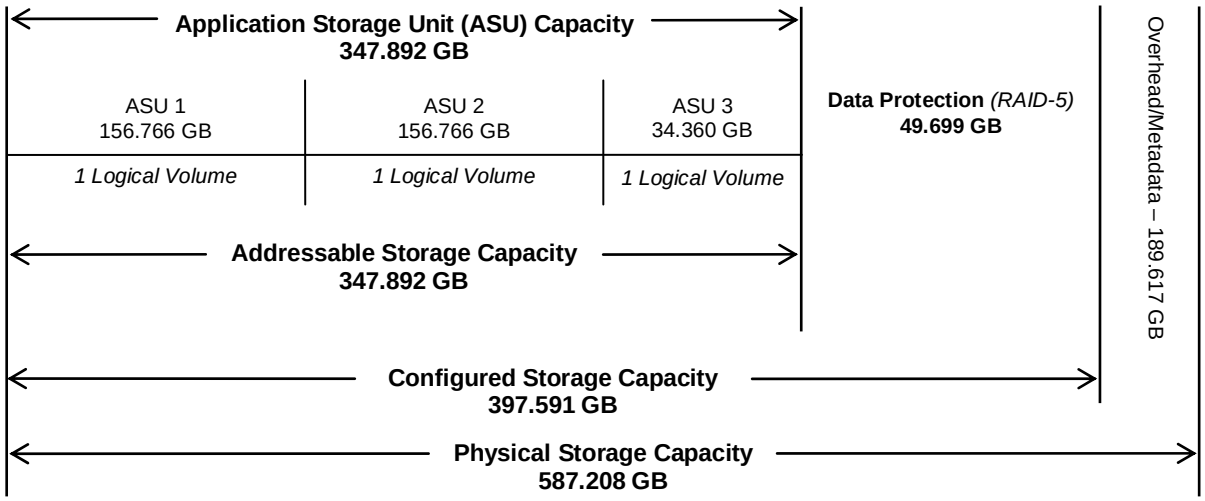
SPC-1 IOPS™ represents the maximum I/O Request Throughput at the 100% load point.

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 ***RAID-5*** which provides data protection by distributing check data corresponding to user data across multiple disks in the form of bit-by-bit parity.

Storage Capacities and Relationships

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	59.25%
Protected Application Utilization	67.71%
Unused Storage Ratio	0.00%

Application Utilization: Total ASU Capacity *(347.892 GB)* divided by Physical Storage Capacity *(587.208 GB)*.

Protected Application Utilization: Total ASU Capacity *(347.892 GB)* plus total Data Protection Capacity *(49.699 GB)* minus unused Data Protection Capacity *(0.000 GB)* divided by Physical Storage Capacity *(587.208 GB)*.

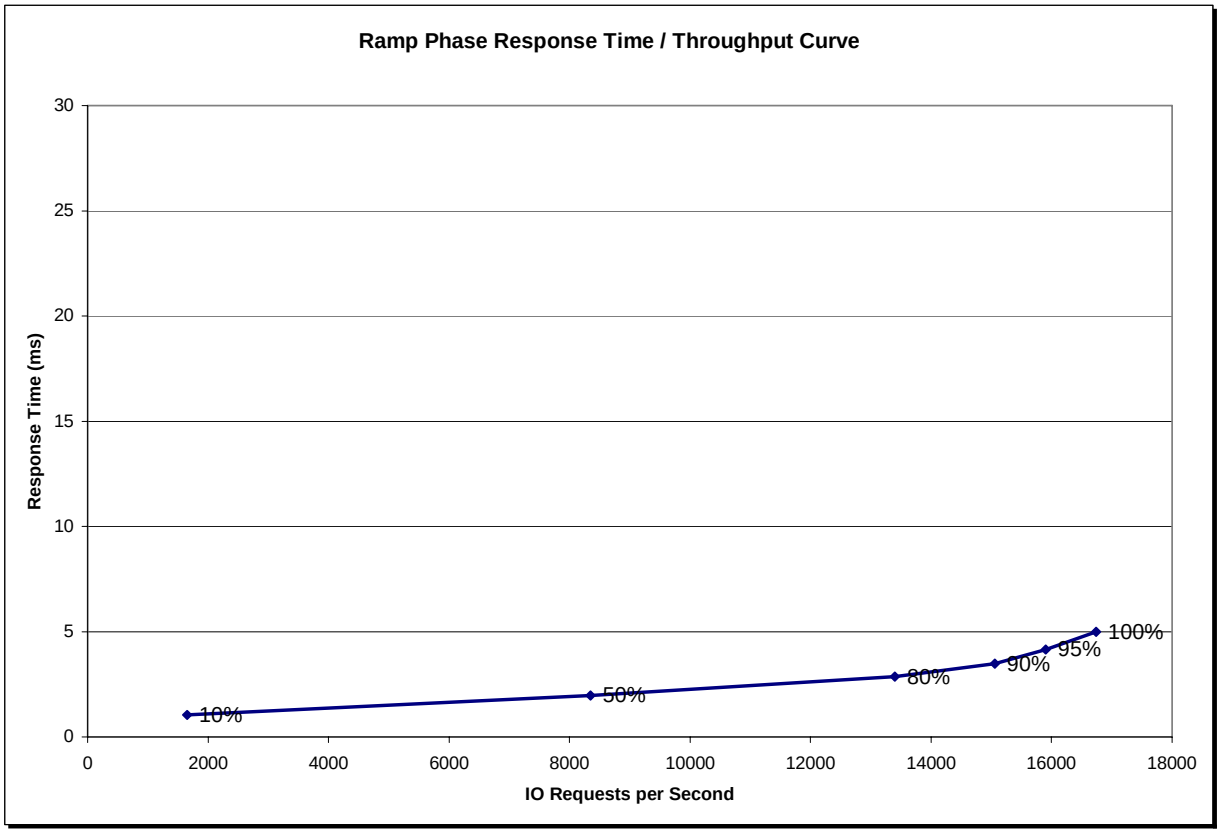
Unused Storage Ratio: Total unused capacity *(0.000 GB)* divided by Physical Storage Capacity *(587.208 GB)*. The Unused Storage Ratio cannot exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 22-23 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	1,651.13	8,351.11	13,402.02	15,060.81	15,907.01	16,741.16
Average Response Time (ms):						
All ASUs	1.05	1.96	2.86	3.47	4.16	5.00
ASU-1	1.00	1.95	2.86	3.36	3.87	4.51
ASU-2	1.10	2.26	3.29	4.01	4.79	5.67
ASU-3	1.14	1.85	2.68	3.47	4.50	5.74
Reads	0.95	2.14	3.15	3.52	3.78	4.06
Writes	1.11	1.84	2.68	3.44	4.41	5.61

SPC-1/E Reported Data

The initial SPC-1/E energy extension temperature, recorded during the first one minute of the Idle Test was 73.50F. The final SPC-1/E energy extension temperature, recorded during the last one minute of the Primary Metrics Test was 73.62F.

Power Environment

Average RMS Voltage:	**210.15**	**Average Power Factor:**	**0.819**

Usage Profile

	Hours of Use per Day			Nominal	Nominal	Nominal	Nominal
	Heavy	Moderate	Idle	Power, W	Traffic, IOPS	IOPS/W	Heat, BTU/hr
Low Daily Usage:	0	8	16	**465.00**	**2783.70**	**5.99**	**1,586.63**
Medium Daily Usage:	4	14	6	**468.07**	**7105.15**	**15.18**	**1,597.10**
High Daily Usage:	18	6	0	**471.86**	**12139.29**	**25.73**	**1,610.04**
			Composite Metrics:	**468.31**	**7,342.71**	**15.68**	

Annual Energy Use, kWh:	**4,102.40**		
Energy Cost, $/kWh:	$ 0.12	**Annual Energy Cost, $:**	**$ 492.29**

The above usage profile describes conditions in environments that respectively impose light ("low"), moderate ("medium"), and extensive ("high") demands on the Tested Storage Configuration (TSC).

HEAVY SPC-1 Workload: 472.87W at 80% of maximum reported performance *(13,402.02 SPC-1 IOPS)*.

MODERATE SPC-1 Workload: 468.83W at 50% of maximum reported performance *(8,351.11 SPC-1 IOPS)*.

IDLE SPC-1 Workload: 463.09W at 0% of maximum reported performance *(0.00 SPC-1 IOPS)*.

AVERAGE RMS VOLTAGE: The average supply voltage applied to the Tested Storage Product (TSP) as measured during the Measurement Intervals of the SPC-1/E Tests.

AVERAGE POWER FACTOR: The ratio of average real power, in watts, to the average apparent power, in volt-amps flowing into the Tested Storage Product (TSP) during the Measurement Intervals of the SPC-1/E Tests.

NOMINAL POWER, W: The average power consumption over the course of a day *(24 hours)*, taking into account hourly load variations.

NOMINAL TRAFFIC, IOPS: The average level of I/O requests over the course of a day *(24 hours)*, taking into account hourly load variations.

NOMINAL IOPS/W: The overall efficiency with which I/O requests can be supported, reflected by the ratio of **NOMINAL TRAFFIC** versus the **NOMINAL POWER**.

NOMINAL HEAT, BTU/HR: The average amount of heat required to be dissipated over the course of a day *(24 hours)*, taking into account hourly load variations. *(1 watt = 3.412 BTU/hr)*

COMPOSITE METRICS: The aggregated **NOMINAL POWER**, **NOMINAL TRAFFIC**, and **NOMINAL IOPS/W** for all three environments: **LOW**, **MEDIUM**, and **HIGH DAILY USAGE**.

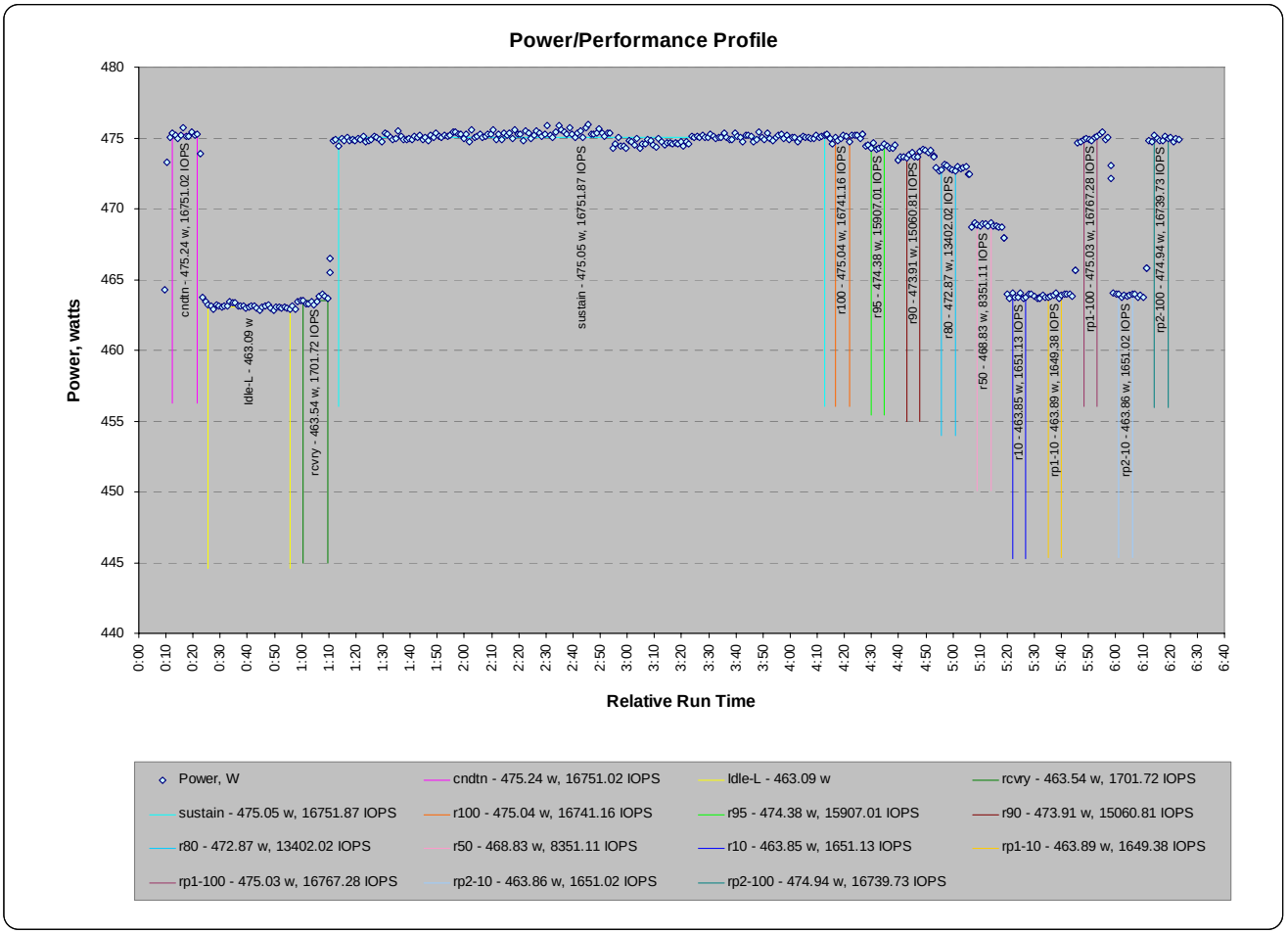
ANNUAL ENERGY USE, KWH: An estimate of the average energy use across the three environments over the course of a year and computed as (**NOMINAL POWER** * 24 *0.365).

ENERGY COST, $/KWH: A standardized energy cost per kilowatt hour.

ANNUAL ENERGY COST: An estimate of the annual energy use across the three environments over the course of a year and computed as (**ANNUAL ENERGY USE** * **ENERGY COST**).

SPC-1/E Power/Performance Profile

The SPC-1/E Power/Performance Profile chart provides a complete "at a glance" illustration and report for each SPC-1/E execution component. The power consumption at each step is reported and, where appropriate the measured SPC-1 performance *(SPC-1 IOPS™)* is also reported.



Priced Storage Configuration Pricing

Quantity	Product Number		Description	List Price	Ext Price	Discount	Ext. Net Price
1	AF002A		HP Universal Rack 10642 G2 Shock Rack	$1,489	$1,489	27%	$1,087
1	AF002A	001	Factory Express Base Racking	$300	$300	27%	$219
1	AP884A		HP EVA6400 for Storage Rack	$21,820	$21,820	27%	$15,929
1	AP884A	0D1	Factory integrated	$0	$0	27%	$0
2	AG638B		HP M6412-A Fibre Channel Drive Enclosure	$3,890	$7,780	27%	$5,679
2	AG638B	0D1	Factory integrated	$0	$0	27%	$0
8	AR055A		HP EVA M6412 72GB 4Gb FC 2-port SSD	$10,125	$81,000	27%	$59,130
8	AR055A	0D1	Factory integrated	$0	$0	27%	$0
2	252663-D72		HP 24A High Voltage US/JP Modular PDU	$299	$598	27%	$437
2	252663-D72	0D2	Factory horizontal mount of PDU	$0	$0	27%	$0
1	AF062A		HP 10K G2 600mm Stabilizer Kit	$229	$229	27%	$167
1	AF062A	B01	Include with complete system	$0	$0	27%	$0
1	AF054A		HP 10642 G2 Sidepanel Kit	$359	$359	27%	$262
1	AF054A	0D1	Factory integrated	$0	$0	27%	$0
1	T5494EAE		HP CV EVA V9.2 RSM V5.1 E-Media Kit	$125	$125	27%	$91
1	TA646AAE		HP Command View EVA6400 Unlimited E-LTU	$28,000	$28,000	27%	$20,440
1	HA110A3		HP 3y Support Plus 24 SVC	$0	$0	27%	$0
1	HA110A3	4R2	EVA 6400 Command View EVA Unlim LTU Supp	$14,373	$14,373	27%	$10,492
8	HA110A3	9BC	EVA M6412 72GB FC 2 port SSD Support	$199	$1,592	27%	$1,162
1	HA110A3	9DP	EVA 6400 Array Support	$2,084	$2,084	27%	$1,521
2	HA110A3	9DS	EVA M6412A FC Drive Enclosure Support	$532	$1,064	27%	$777
2	456972	B21	HP BLc Emulex LPe1205 8Gb FC HBA Opt	$849	$1,698	12%	$1,494
4	AJ716A		HP 8Gb Shortwave B-series FC SFP	$57	$228	12%	$201
1	581874	005	HP S-Buy DL120 G6 X3440 NHP SATA US Svr	$1,189	$1,189	8%	$1,094
1	AP767A		HP StorageWorks PCIe 4Gb FC Single Port HBA	$1,105	$1,105	8%	$1,017
5	AJ836A		HP 5m Multi-mode OM3 LC/LC FC Cable	$95	$475	27%	$347
4	AJ706A		HP EVA Loopback Connector	$99	$396	27%	$289
					$165,904		**$121,835**

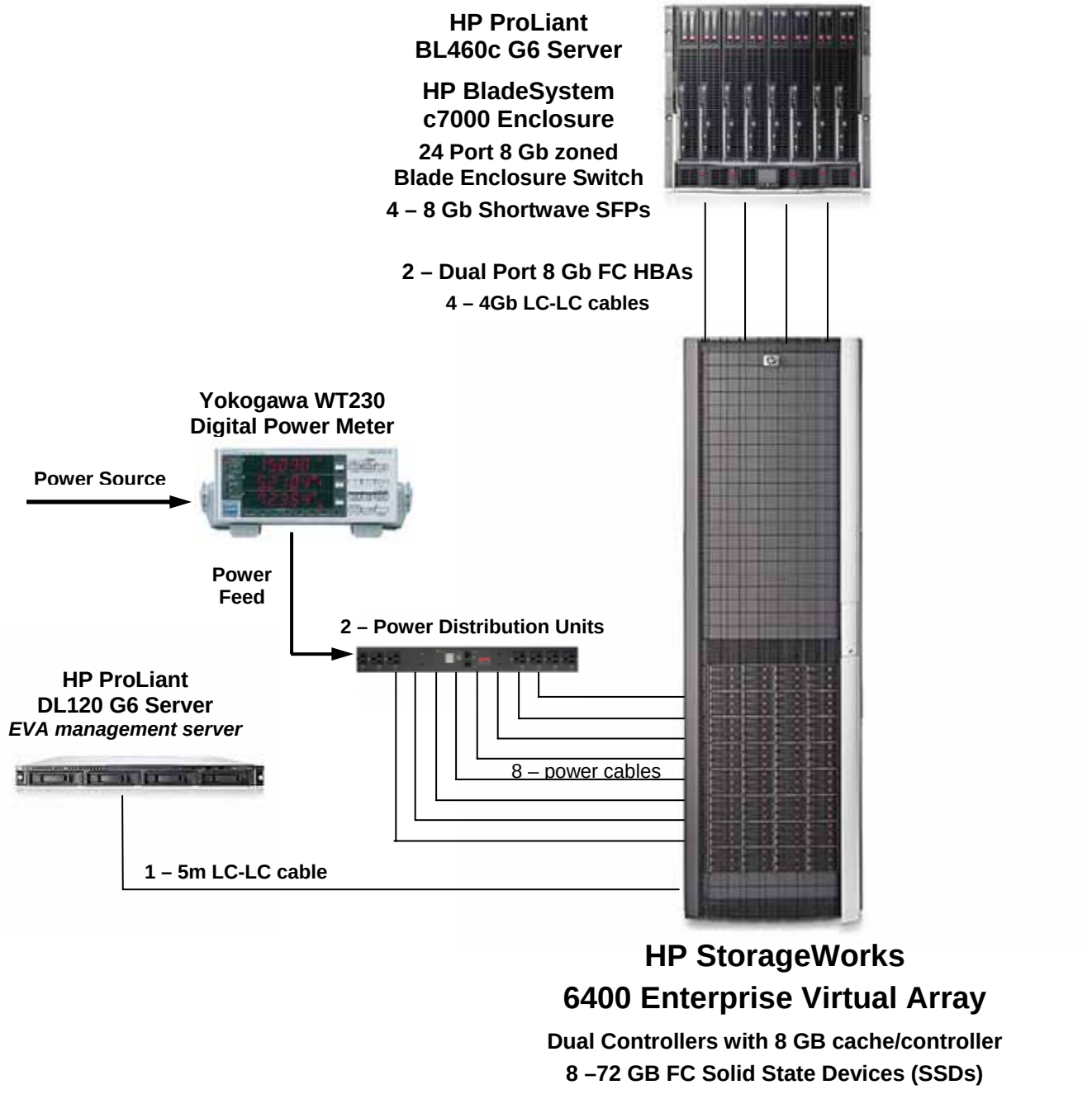
The above pricing includes hardware maintenance and software support for three years, 7 days per week, 24 hours per day. The hardware maintenance and software support provides the following:

- Acknowledgement of new and existing problems with four (4) hours.
- Onsite present 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 Price Storage Configuration that can be remedied by the repair or replacement of a Priced Storage Configuration component.

Differences between the Tested Storage Configuration (TSC) and Priced Storage Configuration

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

Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Diagram



Benchmark Configuration (BC)/Tested Storage Configuration (TSC)/ Priced Storage Configuration Components

Host System:	Tested Storage Configuration (TSC)
1 – HP ProLiant BL460c G6 Server **1 – HP BladeSystem c7000 Enclosure**	2 – Dual Port 8 Gb FC HBAs
	4 – 8 Gb Shortwave FC SFPs
2 – Intel® Xeon® 5500 series 2.4 Ghz processors, each processor with: 4 cores, 128 KB L1 cache,1024 KB L2 cache 8192 KB L3 cache	**HP StorageWorks 6400 Enterprise Virtual Array** Dual Controllers with 8 GB cache/controller *(16 GB total)* dual power supplies for each controller *(4 total)*
8 GB main memory	4 – 4 Gb FC front-end physical connections *(4 used)*
Microsoft Windows Server 2003 R2 Enterprise x64	2 – 4 Gb FC backend physical connection *(2 used)*
24 Port, 8 Gb zoned Blade Enclosure switch	1 – HP Universal Rack
PCI Blade	2 – HP Fibre Channel Drive Enclosures dual power supplies for each drive enclosure *(4 total)*
Other BC components:	
1 – HP ProLiant DL120 G6 Server *(EVA management server)*	8 –72 GB FC Solid State Devices *(SSDs)*
1 – Yokogawa WT230 Digital Power Meter	HP StorageWorks Command View EVA
2 – Power Distribution Units (PDUs)	