SPC BENCHMARK 2/ENERGY™
EXECUTIVE SUMMARY

IBM CORPORATION
IBM XIV® STORAGE SYSTEM GEN3

SPC-2/E™ V1.4

Submitted for Review: October 19, 2011
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EXECUTIVE SUMMARY

Test Sponsor and Contact Information

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Revision Information and Key Dates

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SPC-2 Specification revision number	V1.4
SPC-2 Workload Generator revision number	V1.0
Date Results were first used publicly	October 19, 2011
Date FDR was submitted to the SPC	October 19, 2011
Date the TSC will be available for shipment to customers	October 31, 2011
Date the TSC completed audit certification	October 19, 2011

Tested Storage Product (TSP) Description

The IBM XIV® Storage System Gen3 is a versatile, high-end disk storage solution with an innovative grid architecture that can provide clients excellent performance and scalability while significantly reducing costs and complexity. XIV includes automated data placement that needs no tuning as application workloads change.

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™
  - Application Storage Unit (ASU) Capacity
- Supplemental data to the SPC-2 Primary Metrics.
  - Total Price
  - Data Protection Level
- Reported Data for each SPC-2 Test: Large File Processing (LFP), Large Database Query (LDQ), and Video on Demand Delivery (VOD) Test.

| SPC-2 Reported Data				
IBM XIV ® Storage System				
SPC-2 MBPS™	**SPC-2 Price-Performance**	**ASU Capacity (GB)**	**Total Price**	**Data Protection Level**
7,467.99	$152.34	154,618.823	$1,137,641.30	Protected *(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	8,259.94			$137.73
Write Only:				
1024 KiB Transfer	6,724.35	576	11.67	
256 KiB Transfer	6,766.87	576	11.75	
Read-Write:				
1024 KiB Transfer	8,246.33	576	14.32	
256 KiB Transfer	8,197.50	576	14.23	
Read Only:				
1024 KiB Transfer	9,416.48	576	16.35	
256 KiB Transfer	10,208.08	576	17.72	
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	9,740.03			$116.80
1024 KiB Transfer Size				
4 I/Os Outstanding	9,496.90	576	16.49	
1 I/O Outstanding	9,422.03	576	16.36	
64 KiB Transfer Size				
4 I/Os Outstanding	10,069.26	576	17.48	
1 I/O Outstanding	9,971.93	576	17.31	
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**
	4,404.00	5,600	0.79	$258.32

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).

ASU (Application Storage Unit) **Capacity** represents the total storage capacity read and written in the course of executing the SPC-2 benchmark.

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

Storage Capacities and Relationships

The following diagram *(not to scale)* 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.
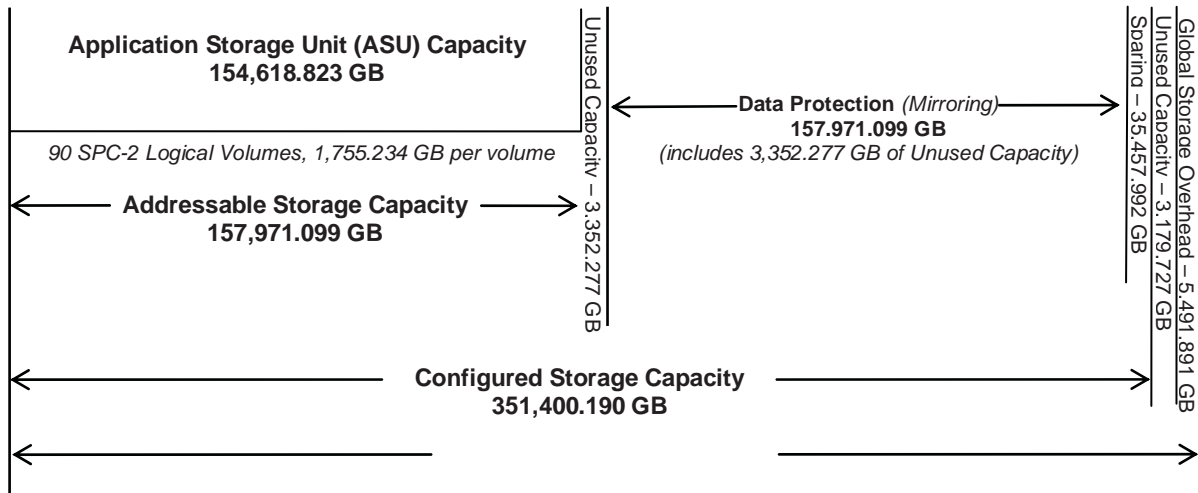
SPC-1 Storage Capacity Utilization	
Application Utilization	42.94%
Protected Application Utilization	85.55%
Unused Storage Ratio	2.75%

Application Utilization: Total ASU Capacity *(154,618.823 GB)* divided by Physical Storage Capacity *(360,071.808 GB)*

Protected Application Utilization: (Total ASU Capacity *(154,618.823 GB)* plus total Data Protection Capacity *(157,971.099 GB)* minus unused Data Protection Capacity *(3,352.277 GB)* divided by Physical Storage Capacity *(360,071.808 GB)*.

Unused Storage Ratio: Total Unused Capacity *(9,884.280 GB)* divided by Physical Storage Capacity *(360,071.808 GB)* and may not exceed 45%.

Detailed information for the various storage capacities and utilizations is available on pages 22-23 in the Full Disclosure Report.

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

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

SPC-2/E Reported Data

The initial temperature, recorded during the first one minute of the SPC-2/E Idle Test was 72F. The final temperature, recorded during the last one minute of the SPC-2/E Large Database Query (LDQ) Test was 67F.

Power Environment

Average RMS Voltage: 209.83   Average Power Factor: 0.978

	Usage Profile			Nominal			
	Hours of Use per Day			Power	Traffic	Ratio	Heat
	Heavy	Moderate	Idle	watts	MBPS	MBPS/w	BTU/hr
Low Daily Usage:	0	8	16	6049.33	2185.53	0.36	20,640.91
Medium Daily Usage:	4	14	6	6134.88	5129.80	0.84	20,932.84
High Daily Usage:	18	6	0	6209.13	7512.21	1.21	21,186.16

	Composite Metrics:	6,131.11	4,942.51	0.81
Annual Energy Use, kWh:	53,708.55			
Energy Cost, $/kWh:	$ 0.12	Annual Energy Cost, $:	$ 6,445.03	

HEAVY SPC-2 Workload: 6,220.98W at a data rate of 7,830.75 MB/s.

MODERATE SPC-2 Workload: 6,556.58W at a data rate of 6,556.58 MB/s

IDLE SPC-2 Workload: 5,987.20W at data rate of zero (0).

The above usage profile describes conditions in environments that respectively impose light *(Low Daily Usage)*, moderate *(Medium Daily Usage)*, and extensive *(High Daily Usage)* demands on the Tested Storage Configuration (TSC). The data in this profile represents the combined results of all three SPC-2 workloads: Large File Processing (LFP), Large Database Query (LDQ) and Video on Demand Delivery (VOD).

The detailed SPC-2/E Reported Data and associated charts for each workload, including the Idle Test, are available in the associated SPC-2/E Full Disclosure Report (FDR), in the sections of that document, which are listed below:

- SPC-2/E Idle Test chart
- SPC-2/E Large File Processing (LFP) Reported Data table and associated charts
- SPC-2/E Large Database Query (LDQ) Reported Data table and associated charts
- SPC-2/E Video on Demand Delivery (VOD) Reported Data table and associated charts

The definitions, listed below, for the remaining items in the above SPC-2/E Reported Data table, are identical for the SPC-2/E Reported Data tables for each of the three individual SPC-2 workloads: LFP, LDQ and VOD.

AVERAGE RMS VOLTAGE: The average supply voltage applied to the Tested Storage Product (TSP) as measured during the Measurement Intervals of the SPC-2 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-2 Tests.

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

NOMINAL TRAFFIC, MBPS: The average data rate over the course of a day *(24 hours)*, taking into account hourly load variations.

NOMINAL MBPS/W: The overall efficiency with which the reported data rate 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 MBPS/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**).

Priced Storage Configuration Pricing

Description	Qty	Unit Price	Discount	Extended Price with discount
IBM XIV Storage System Model GEN3	1	$183,195.00	70.00%	$54,958.50
2TB Interface Module w/12 2 TB drives	6	$122,430.00	70.00%	$220,374.00
2TB Data Module w/12 2 TB drives	9	$122,430.00	70.00%	$330,561.00
Modem	1	$1,000.00	70.00%	$300.00
US/CA/LA/AP 60A pin cord	1	$3,000.00	70.00%	$900.00
Module Software License	15	$41,800.00	60.00%	$250,800.00
Module Software Maintenance (3 years)	15	$16,720.00	60.00%	$100,320.00
Monthly maintenance (XIV hardware)	36	$8,511.00	70.00%	$91,918.80
8 Gbps FC switch w/24 port active, 24 SFPs	2	$12,870.00	20.00%	$20,592.00
3 year warranty extension (switch)	2	$2,330.00	20.00%	$3,728.00
Short wave 25 m fibre channel cable	36	$189.00	20.00%	$5,443.20
HBA (dual port 8 Gbps FC)	18	$4,583.00	30.00%	$57,745.80
Total price				**$1,137,641.30**

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 Priced Storage Configuration.
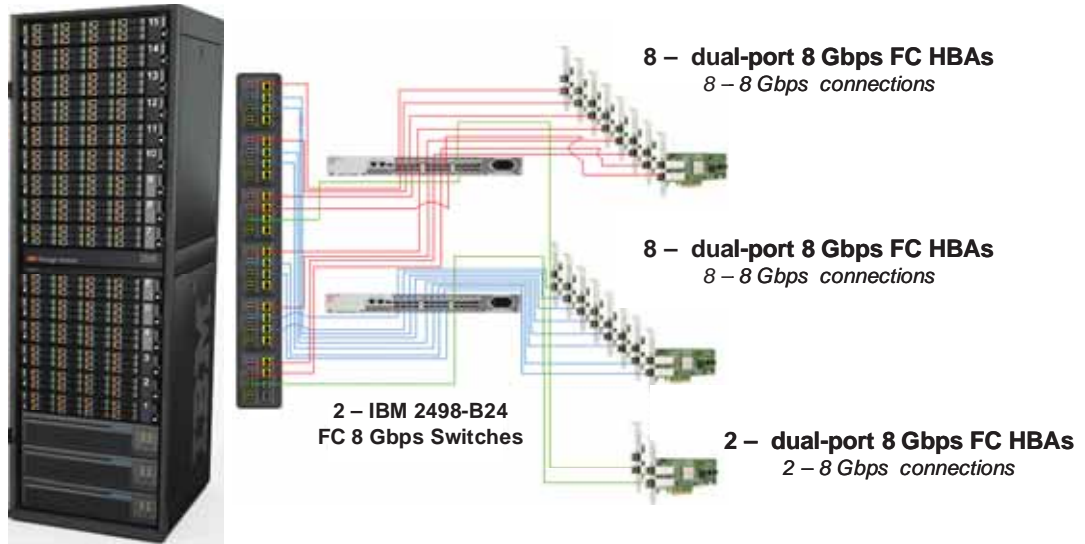
Priced Storage Configuration Diagram

IBM XIV® Storage System

6 – 2TB Interface Modules

9 – 2TB Data Modules
  (12 – disk drives/module)

180 – 2 TB 7200 RPM SAS disk drives

8 – dual-port 8 Gbps FC HBAs
  8 – 8 Gbps connections

8 – dual-port 8 Gbps FC HBAs
  8 – 8 Gbps connections

2 – dual-port 8 Gbps FC HBAs
  2 – 8 Gbps connections

**2 – IBM 2498-B24
FC 8 Gbps Switches**

Priced Configuration Components

Priced Storage Configuration
18 – dual-port 8 Gbps FC HBAs

IBM XIV® Storage System
360 GiB memory/cache
  6 – 2 TB Interface Modules
  9 – 2 TB Data Modules
24 – 8 Gbps FC front-end connections *(18 used)*
30 – 4x6 Gbps SAS backend connections *(30 used)*

180 – 2 TB 7200 RPM SAS disk drive   *(12 per interface and data module)*
2 – IBM 2498-B24 FC 8Gbps switches
36 – Short Wave 25m fibre channel cables