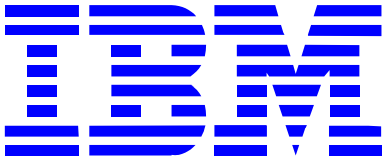

TPC Benchmark™ H Full Disclosure Report

IBM Power 780 Model 9179-MHB

Using

Sybase IQ Single Application Server Edition v.15.2 ESD #2

First Edition

December 15, 2010

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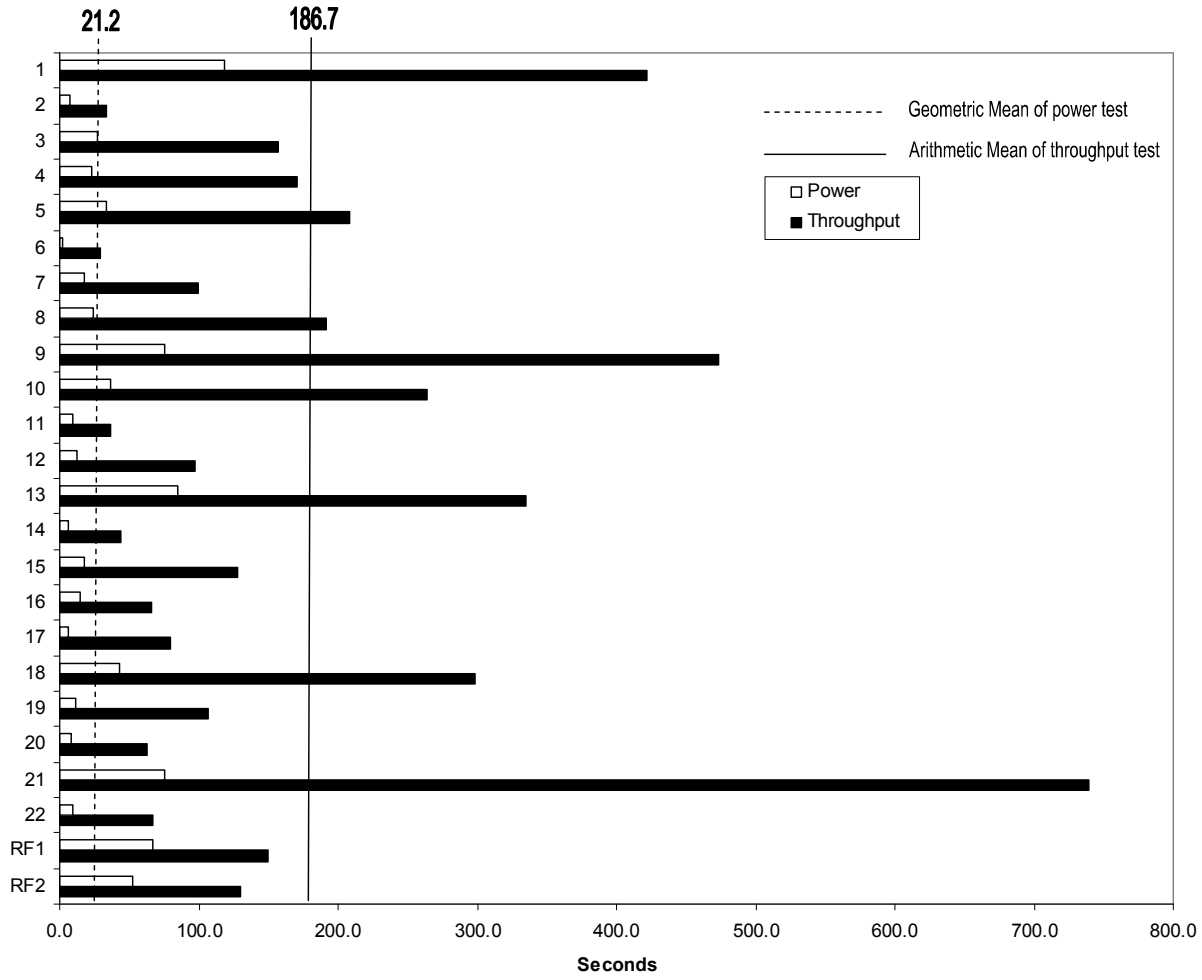
First Edition December 15, 2010

IBM
Power 780 Model 9179-MHB

TPC-H Rev 2.13.0
TPC Pricing Rev 1.5.0
Report Date: December 15, 2010

Total System Cost	Composite Query per Hour Rating	Price/Performance
$1,128,288 USD	164,747.2 QphH@1000GB	$6.85 USD $/QphH@1000GB

Database Size	Database Manager	Operating System	Other Software	Availability Date
1000GB	Sybase IQ Single Application Server Edition v.15.2 ESD #2	Red Hat Enterprise Linux 6	None	March 31, 2011



	Storage Redundancy Levels	
Database Load Time: 01:08:39	Base Tables	3
Load Includes Backup: N	Auxiliary Structures	3
Total Disk/Database Size: 3.97	DBMS Temporary Space	3
Memory/Database Size Percentage: 51.2%	OS and DBMS Software	0

System Configuration

1 IBM Power 780 Model 9179-MHB

Processors/Cores/Threads/Type	8/32/128 IBM POWER7 4.1GHz, 256KB L2/32MB L3 cache
Memory	512 GB
Disk Controllers	12 x IBM PCI-E 3Gb SAS Adapter
Disk Drawers	4 x IBM EXP 12S expansion drawer
Disk Drives	52 x 69GB SAS SSD; 3 x 146GB SAS HDD
Total Disk Storage	3,965.23 GB (GB is defined as 1024 * 1024 * 1024 bytes)

IBM
Power 780 Model 9179-MHB

TPC-H Rev. 2.13.0
TPC Pricing Rev 1.5.0

Report Date:
December 15, 2010

Description	Part Number	Brand	Price Source	Unit Price	Qty	Extended Price	3-Yr. Maint. Price
Server Hardware							
9179 Model MHB	9179-MHB	IBM	1	10,195	1	10,195	4,608
Integrated, 4 Port- 1Gb Virtual Ethernet	1803	IBM	1	699	4	2,796	
Operator Panel	1853	IBM	1	1,000	1	1,000	
146GB 15K RPM SFF SAS Disk Drive	1886	IBM	1	1,045	3	3,135	
69GB SFF SAS Solid State Drive	1890	IBM	1	6,811	20	136,220	45,360
69GB 3.5in SAS Solid State Drive	3586	IBM	1	6,811	32	217,952	72,576
SAS Cable (X) Adapter to SAS Enclosure,Dual Controller/Dual Path 3M	3661	IBM	1	197	4	788	
Serv Interface Cable- 2, 3, and 4 Enclosure	3671	IBM	1	2,000	1	2,000	
Serv Interface Cable- 3 and 4 Enclosure	3672	IBM	1	3,000	1	3,000	
Serv Interface Cable- 4 Enclosure	3673	IBM	1	4,000	1	4,000	
Processor Cable, Two, Three or Four Drawer System	3712	IBM	1	5,000	1	5,000	
Processor Cables, Three or Four Drawer System	3713	IBM	1	10,000	1	10,000	
Processor Cables, Four-Drawer System	3714	IBM	1	12,000	1	12,000	
3.86GHz/4.14GHz TurboCore Proc Card, 0/16 Core POWER7, 16 DDR3 Memory	4982	IBM	1	57,429	4	229,716	36,432
One Processor Activation for Processor Feature #4982	5469	IBM	1	8,375	32	268,000	92,160
System CEC Enclosure with IBM BEZEL, I/O Backplane, and System Midplane	5597	IBM	1	12,000	4	48,000	
0/64GB DDR3 Memory (4X16GB) DIMMS - 1066MHz - POWER7 CoD Memory	5601	IBM	1	7,720	8	61,760	
System AC Power Supply, 1725 W, for Redundant Power	5632	IBM	1	1,502	8	12,016	
Disk/Media Backplane	5652	IBM	1	4,000	4	16,000	
Service Processor	5664	IBM	1	4,000	2	8,000	
FSP/Clock Pass Through Card	5665	IBM	1	900	2	1,800	
SATA Slimline DVD-RAM Drive	5762	IBM	1	392	1	392	
EXP 12S Expansion Drawer	5886	IBM	1	6,484	4	25,936	19,200
PCIe 380MB Cache Dual - x4 3Gb SAS RAID Adapter	5903	IBM	1	2,880	4	11,520	
Power Control Cable (SPCN) - 3 meter	6006	IBM	1	52	1	52	
Power Cable -- Drawer to IBM PDU, 14-foot,250V/10A	6458	IBM	1	19	16	304	
Activation of 1 GB DDR3 POWER7 Memory	8212	IBM	1	245	12	2,940	
Activation of 100 GB DDR3 POWER7 Memory	8213	IBM	1	24,500	5	122,500	
TurboCore Mode Specify Code	9982	IBM	1	0	1	0	
7014-T42 Rack	7014-T42	IBM	1	3,970	1	3,970	888
Front Door (Black) for High Perforation	6069	IBM	1	550	1	550	
Side Panel (Black)	6098	IBM	1	150	2	300	
PDU to Wall Powercord 14', 200-240V/24A, UTG0247, PT#12	6654	IBM	1	240	4	960	
Power Dist Unit - Side Mount, Universal UTG0247 Connector	7188	IBM	1	1,000	3	3,000	
7042-C08 HMC 1:7042-C08 Deskside Hardw.Mgmt.Console	7042-C08	IBM	1	2,800	1	2,800	1,152
Internal Modem	0033	IBM	1	200	1	200	
Modem Cable - US/Canada and General Use	1025	IBM	1	17	1	17	
PCIe1Gb Ethernet UTP 2Port	5767	IBM	1	682	1	682	
Full Width Quiet Touch Keyboard -- USB, US English, #103P	5951	IBM	1	107	1	107	
Power Cord (6-foot), To Wall (125V, 15A), Plug Type #4	6470	IBM	1	18	1	18	
Ethernet Cable, 15m, Hardware Management Console to System Unit	7802	IBM	1	33	1	33	
USB Mouse	8845	IBM	1	39	1	39	
HMC Software Support - 1 Year	0612	IBM	1	250	3		750
Acer A181HLB 18.5" Wide LED Monitor (2 spares)	2146072	CDW	4	90	3	270	
					Subtotal	1,229,968	273,126
Server Software							
Sybase IQ 15.2		Sybase	2	2,595	32	83,040	
Sybase Maintenance Renewal -3 Year		Sybase	2	1,713	32		54,816
Red Hat Enterprise Linux 6 for Power Premium 1 Year		Red Hat	3	16,340	3	49,020	
					Subtotal	132,060	54,816
					Total	1,362,028	327,942
IBM Dollar Volume Discount (See Note 1.)			1			541,004	
Sybase IQ Discount (See Note 2.)	15.00%		2			20,678	
					Three-Year Cost of Ownership USD:		1,128,288
					QphH		164,747
					$ USD/QphH		$6.85

Pricing: 1 - IBM; 2 - Sybase; 3 - Red Hat; 4 - CDW
Note 1: Discount based on IBM guidance applies to all Hardware line items where Pricing=1.
Note 2: Discount based on Sybase guidance applies to all line items where Pricing=2.
Pricing is for this system or one of similar size.
Audited by Francois Raab, InfoSizing, Inc. (www.sizing.com)

Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed components. For complete details, see the pricing sections of the TPC benchmark specifications. If you find that stated prices are not available according to these terms, please inform the TPC at pricing @ tpc.org. Thank you.

Numerical Quantities Summary

Measurement Results

Database Scale Factor	=	1000
Total Data Storage/Database Size	=	3.97
Start of Database Load	=	12/03/10 11:08:21
End of Database Load	=	12/03/10 12:17:00
Database Load Time	=	01:08:39
Query Streams for Throughput Test	=	9
TPC-H Power	=	170,206.4
TPC-H Throughput	=	159,463.1
TPC-H Composite Query-per-Hour Metric (QphH@1000GB)	=	164,747.2
Total System Price Over 3 years	=	$1,128,288 USD
TPC-H Price Performance Metric ($/QphH@1000GB)	=	$6.85 USD

Measurement Intervals

Measurement Interval in Throughput Test (Ts)	=	4,470

Duration of Stream Execution

Stream ID	Seed	Query Start Query End	Total Time (sec)	RF1 Start RF1 End	RF2 Start RF2 End
Stream00	1203121700	2010-12-03 15:16:24 2010-12-03 15:27:31	667	2010-12-03 15:15:15 2010-12-03 15:16:22	2010-12-03 15:27:32 2010-12-03 15:28:25
Stream01	1203121701	2010-12-03 15:28:25 2010-12-03 16:41:15	4370	2010-12-03 15:29:25 2010-12-03 15:31:44	2010-12-03 15:31:45 2010-12-03 15:33:21
Stream02	1203121702	2010-12-03 15:28:25 2010-12-03 16:33:28	3903	2010-12-03 15:33:21 2010-12-03 15:35:54	2010-12-03 15:35:54 2010-12-03 15:37:27
Stream03	1203121703	2010-12-03 15:28:25 2010-12-03 16:42:55	4470	2010-12-03 15:37:28 2010-12-03 15:39:59	2010-12-03 15:39:59 2010-12-03 15:41:18
Stream04	1203121704	2010-12-03 15:28:25 2010-12-03 16:39:27	4262	2010-12-03 15:41:19 2010-12-03 15:43:30	2010-12-03 15:43:30 2010-12-03 15:45:08
Stream05	1203121705	2010-12-03 15:28:25 2010-12-03 16:33:49	3924	2010-12-03 15:45:08 2010-12-03 15:47:31	2010-12-03 15:47:32 2010-12-03 15:49:27
Stream06	1203121706	2010-12-03 15:28:25 2010-12-03 16:35:47	4042	2010-12-03 15:49:27 2010-12-03 15:51:23	2010-12-03 15:51:23 2010-12-03 15:52:58
Stream07	1203121707	2010-12-03 15:28:25 2010-12-03 16:35:04	3999	2010-12-03 15:52:58 2010-12-03 15:55:20	2010-12-03 15:55:20 2010-12-03 15:56:57
Stream08	1203121708	2010-12-03 15:28:25 2010-12-03 16:36:13	4068	2010-12-03 15:56:57 2010-12-03 16:00:13	2010-12-03 16:00:13 2010-12-03 16:06:50
Stream09	1203121709	2010-12-03 15:28:25 2010-12-03 16:34:02	3937	2010-12-03 16:06:51 2010-12-03 16:09:51	2010-12-03 16:09:51 2010-12-03 16:11:30

TPC-H Timing Intervals (in seconds)

Stream ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Stream00	118.2	7.8	27.5	23.3	33.9	2.5	18.1	23.6	75.4	36.7	9.3	12.5
Stream01	200.2	15.6	205.3	61.4	219.6	13.5	92.3	152.8	355.9	146.6	36.4	128.8
Stream02	454.4	40.8	184.5	216.7	175.9	82.1	189.2	199.9	341.4	291.1	21.5	168.2
Stream03	423.8	41.1	27.5	226.1	202.6	16.8	94.7	143.6	619.5	305.9	60.3	12.7
Stream04	453.0	28.4	70.6	170.6	183.9	46.0	52.5	184.5	509.2	426.4	31.1	88.9
Stream05	442.9	40.7	188.6	93.3	239.4	13.7	84.0	303.9	382.7	243.6	32.1	87.4
Stream06	495.1	35.2	190.8	304.0	232.2	14.4	142.8	185.6	529.0	177.3	74.8	106.9
Stream07	428.5	22.8	206.3	161.8	196.2	12.4	87.1	230.7	583.2	178.0	17.6	73.4
Stream08	417.3	25.4	165.3	163.8	254.2	46.8	102.8	188.2	621.3	347.3	15.4	132.8
Stream09	483.5	48.3	172.3	135.4	168.1	20.6	49.9	133.8	318.6	256.5	44.1	76.3
Minimum	200.2	15.6	27.5	61.4	168.1	12.4	49.9	133.8	318.6	146.6	15.4	12.7
Average	422.1	33.1	156.8	170.3	208.0	29.6	99.5	191.4	473.4	263.6	37.0	97.3
Maximum	495.1	48.3	206.3	304.0	254.2	82.1	189.2	303.9	621.3	426.4	74.8	168.2

Stream ID	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	RF1	RF2
Stream00	84.5	6.3	18.2	14.2	5.9	43.4	11.9	8.8	75.3	9.6	66.7	52.5
Stream01	393.7	46.6	114.4	56.6	42.7	333.2	35.0	103.0	1577.5	38.4	139.2	96.1
Stream02	301.8	29.0	138.0	76.0	28.9	262.8	95.1	50.3	521.2	34.1	153.1	92.8
Stream03	126.2	68.6	175.1	14.4	106.6	382.1	20.2	82.7	1250.6	68.8	151.0	79.5
Stream04	191.6	41.6	101.2	86.7	112.9	351.2	419.3	18.7	657.2	35.8	131.6	97.7
Stream05	423.8	52.2	123.3	68.1	35.2	286.6	116.7	57.9	538.6	69.1	143.1	115.0
Stream06	386.4	37.8	120.2	69.2	63.5	282.9	25.5	56.3	446.2	65.5	116.0	94.8
Stream07	289.9	26.9	67.1	110.2	174.8	317.5	79.1	50.6	608.3	76.5	141.7	97.0
Stream08	332.1	59.5	180.2	66.2	103.0	120.7	111.4	111.1	426.9	76.3	195.3	397.4
Stream09	570.5	32.0	127.6	46.2	49.3	348.1	57.0	33.6	624.2	140.3	179.8	99.6
Minimum	126.2	26.9	67.1	14.4	28.9	120.7	20.2	18.7	426.9	34.1	116.0	79.5
Average	335.1	43.8	127.5	66.0	79.7	298.3	106.6	62.7	739.0	67.2	150.1	130.0
Maximum	570.5	68.6	180.2	110.2	174.8	382.1	419.3	111.1	1577.5	140.3	195.3	397.4

Abstract

This report documents the full disclosure information required by the TPC Benchmark™ H Standard Specification Revision 2.13.0 dated November 11, 2010 for measurements on the IBM Power 780 Model 9179-MHB.

The software used includes Red Hat Enterprise Linux 6 operating system with Sybase IQ Single Application Server Edition v.15.2 ESD #2.

Preface

TPC Benchmark™ H Standard Specification was developed by the Transaction Processing Performance Council (TPC). It was released on February 26, 1999, and most recently revised (Revision 2.13.0) on November 11, 2010. This is the full disclosure report for benchmark testing of the IBM Power 780 Model 9179-MHB according to the TPC Benchmark™ H Standard Specification.

TPC Benchmark™ H is a Decision Support benchmark. It is a suite of business oriented queries and concurrent updates. The queries and the data populating the database have been chosen to have broad industry-wide relevance while maintaining a sufficient degree of ease of implementation. This benchmark illustrates Decision Support systems that:

- Examine large volumes of data;
- Execute queries with a high degree of complexity;
- Give answers to critical business questions.

TPC-H evaluates the performance of various decision support systems by the execution of sets of queries against a standard database under controlled conditions. The TPC-H queries:

- Give answers to real-world business questions;
- Simulate generated ad-hoc queries (e.g., via a point and click GUI interface);
- Are far more complex than most OLTP transactions;
- Include a rich breadth of operators and selectivity constraints;
- Generate intensive activity on the part of the database server component of the system under test;
- Are executed against a database complying to specific population and scaling requirements;
- Are implemented with constraints derived from staying closely synchronized with an on-line production database.

The TPC-H operations are modeled as follows:

- The database is continuously available 24 hours a day, 7 days a week, for ad-hoc queries from multiple end users and data modifications against all tables, except possibly during infrequent (e.g., once a month) maintenance sessions;
- The TPC-H database tracks, possibly with some delay, the state of the OLTP database through on-going refresh functions which batch together a number of modifications impacting some part of the decision support database;
- Due to the world-wide nature of the business data stored in the TPC-H database, the queries and the refresh functions may be executed against the database at any time, especially in relation to each other. In addition, this mix of queries and refresh functions is subject to specific ACIDity requirements, since queries and refresh functions may execute concurrently;

- To achieve the optimal compromise between performance and operational requirements, the database administrator can set, once and for all, the locking levels and the concurrent scheduling rules for queries and refresh functions.

The minimum database required to run the benchmark holds business data from 10,000 suppliers. It contains almost ten million rows representing a raw storage capacity of about 1 gigabyte. Compliant benchmark implementations may also use one of the larger permissible database populations (e.g., 100 gigabytes), as defined in Clause 4.1.3.

The performance metric reported by TPC-H is called the TPC-H Composite Query-per-Hour Performance Metric (QphH@Size), and reflects multiple aspects of the capability of the system to process queries. These aspects include the selected database size against which the queries are executed, the query processing power when queries are submitted by a single stream, and the query throughput when queries are submitted by multiple concurrent users. The TPC-H Price/Performance metric is expressed as $/QphH@Size. To be compliant with the TPC-H standard, all references to TPC-H results for a given configuration must include all required reporting components (see Clause 5.4.6). The TPC believes that comparisons of TPC-H results measured against different database sizes are misleading and discourages such comparisons.

The TPC-H database must be implemented using a commercially available database management system (DBMS) and the queries executed via an interface using dynamic SQL. The specification provides for variants of SQL, as implementers are not required to have implemented a specific SQL standard in full.

TPC-H uses terminology and metrics that are similar to other benchmarks, originated by the TPC and others. Such similarity in terminology does not in any way imply that TPC-H results are comparable to other benchmarks. The only benchmark results comparable to TPC-H are other TPC-H results compliant with the same revision.

Despite the fact that this benchmark offers a rich environment representative of many decision support systems, this benchmark does not reflect the entire range of decision support requirements. In addition, the extent to which a customer can achieve the results reported by a vendor is highly dependent on how closely TPC-H approximates the customer application. The relative performance of systems derived from this benchmark does not necessarily hold for other workloads or environments. Extrapolations to any other environment are not recommended.

Benchmark results are highly dependent upon workload, specific application requirements, and systems design and implementation. Relative system performance will vary as a result of these and other factors. Therefore, TPC-H should not be used as a substitute for a specific customer application benchmarking when critical capacity planning and/or product evaluation decisions are contemplated.

Benchmark sponsors are permitted several possible system designs, provided that they adhere to the model described in Clause 6. A full disclosure report (FDR) of the implementation details, as specified in Clause 8, must be made available along with the reported results.

1.0 General Items

1.1. Benchmark Sponsor

A statement identifying the benchmark sponsor(s) and other participating companies must be provided

This benchmark was sponsored by International Business Machines Corporation.

1.2. Parameter Settings

Settings must be provided for all customer-tunable parameters and options which have been changed from the defaults found in actual products, including but not limited to:

- *Data Base tuning options;*
- *Optimizer/Query execution options;*
- *Query Processing tool/language configuration parameters;*
- *Recovery/commit options;*
- *Consistency/locking options;*
- *Operating system and configuration parameters;*
- *Configuration parameters and options for any other software component incorporated into the pricing structure;*
- *Compiler optimization options.*

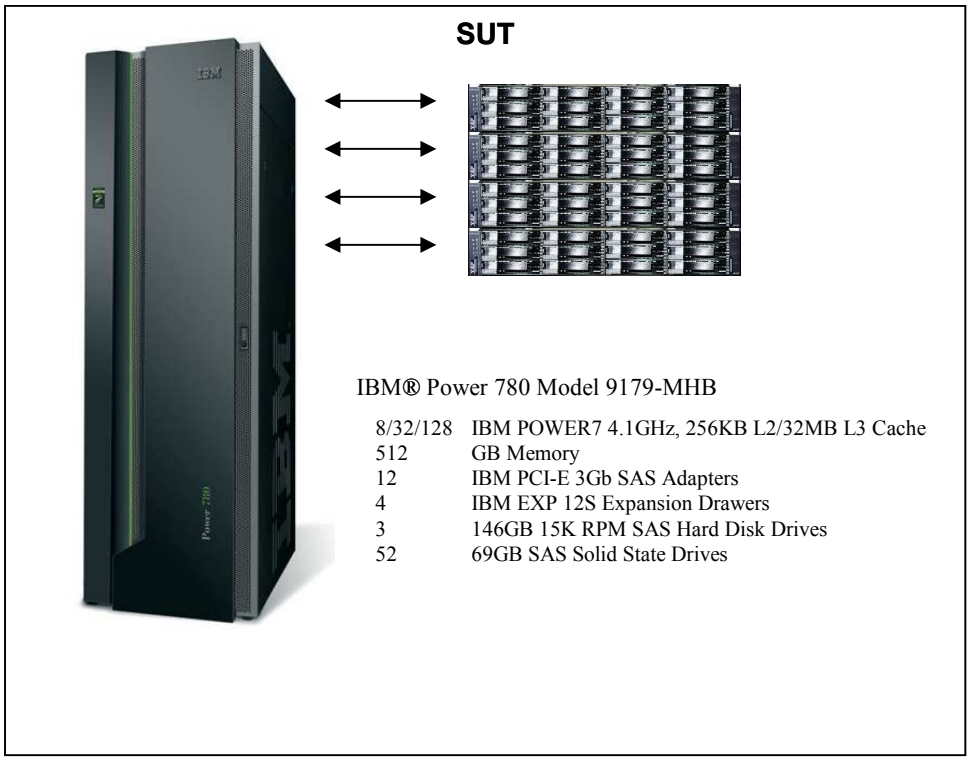
The Supporting Files Archive contains the tuning and configuration options used.

1.3. Configuration Diagrams

Diagrams of both measured and priced configurations must be provided, accompanied by a description of the differences. This includes, but is not limited to:

- *Total number of nodes used, total number and type of processors used/total number of cores used/total number of threads used (including sizes of L2 and L3 caches)*
- *Size of allocated memory, and any specific mapping/partitioning of memory unique to the test*
- *Number and type of disk units (and controllers, if applicable).*
- *Number of channels or bus connections to disk units, including the protocol type*
- *Number of LAN (e.g. Ethernet) connections, including routers, work stations, terminals, etc., that were physically used in the test or are incorporated into the pricing structure*
- *Type and run-time execution location of software components (e.g. DBMS, query processing tools/languages, middle-ware components, software drivers, etc.)*

IBM Power 780 Model 9179-MHB Benchmark Configuration:



The measured and priced configurations are identical.

2.0 Supporting Files Index Table

An index for all files and/or directories included in the Supporting Files Archive as required by Clauses 8.3.2 through 8.3.8 must be provided in the report.

Clause	Description	Archive File	Pathname
1	DB creation scripts	benchmark_scripts.zip	SupportingFiles/Clause1/db_creation/
	RAID configuration	benchmark_scripts.zip	SupportingFiles/Clause1/mdadm.conf
	RAW device configuration	benchmark_scripts.zip	SupportingFiles/Clause1/raw_devs.txt
	OS tuning parameters	benchmark_scripts.zip	SupportingFiles/Clause1/os_tune.txt
	I/O scheduler selection	benchmark_scripts.zip	SupportingFiles/Clause1/iosched.txt
	Volume group information	benchmark_scripts.zip	SupportingFiles/Clause1/volgroup.txt
2	Query validation text	benchmark_scripts.zip	SupportingFiles/Clause2/q*.sql
	Query validation output	benchmark_scripts.zip	SupportingFiles/Clause2/q*.out
	Query substitution parameters	benchmark_scripts.zip	SupportingFiles/Clause2/opts.*
	Query substitution seeds	benchmark_scripts.zip	SupportingFiles/Clause2/stream_seeds
	Refresh function details	benchmark_scripts.zip	SupportingFiles/Clause2/create_refresh_functions.sql
3	ACID test scripts	benchmark_scripts.zip	SupportingFiles/Clause3/scripts/
	ACID test results	benchmark_scripts.zip	SupportingFiles/Clause3/results/
4	DB load scripts	benchmark_scripts.zip	SupportingFiles/Clause4/scripts/
	DB load query text	benchmark_scripts.zip	SupportingFiles/Clause4/sql/
5	Execution log	benchmark_scripts.zip	SupportingFiles/Clause5/console_log
	Refresh streams query text	benchmark_scripts.zip	SupportingFiles/Clause5/update_*
6	Implementation scripts	benchmark_scripts.zip	SupportingFiles/Clause6/

3.0 Clause 1: Logical Database Design Related Items

3.1. Table Definitions

Listings must be provided for all table definition statements and all other statements used to set-up the test and qualification databases.

The Supporting Files Archive contains the table definitions used.

3.2. Database Organization

The physical organization of tables and indices within the test and qualification databases must be disclosed. If the column ordering of any table is different from that specified in Clause 1.4, it must be noted.

The Supporting Files Archive contains the index definitions used.

3.3. Horizontal Partitioning

Horizontal partitioning of tables and rows in the test and qualification databases (see Clause 1.5.4) must be disclosed.

Horizontal partitioning was used for the lineitem and orders tables. The Supporting Files Archive contains the partitioning definitions used.

3.4. Replication

Any replication of physical objects must be disclosed and must conform to the requirements of Clause 1.5.7.

No replication was used.

4.0 Clause 2: Query and Refresh Function Related Items

4.1. Query Language

The query language used to implement the queries must be identified (e.g.,"RALF/SQL-Plus").

SQL was the query language used.

4.2. QGen Version

The version number, release number, modification number and patch level of QGen must be disclosed.

The supplied QGen version 2.13.0 was used.

4.3. Query Text

The executable query text used for query validation must be reported in the supporting files archive along with the corresponding output data generated during the execution of the query text against the qualification database. If minor modifications (see Clause 2.2.3) have been applied to any functional query definitions or approved variants in order to obtain executable query text, these modifications must be disclosed and justified. The justification for a particular minor query modification can apply collectively to all queries for which it has been used.

The Supporting Files Archive contains the query text and the output of the executed query text.

The functional query definitions and variants used in this disclosure use the following minor query modifications.

1. In Q1, Q4, Q5, Q6, Q10, Q12, Q14, Q15 and Q20, the “dateadd” function is used to perform date arithmetic
2. In Q2, Q3, Q10, Q18 and Q21, the “top” function is used to restrict the number of output rows
3. In Q7, Q8 and Q9, the “year” function is used to extract part of a date
4. The semicolon ';' is used as a command delimiter

4.4. Query Substitution Parameters and Seeds

All query substitution parameters used during the performance test must be disclosed in tabular format, along with the seeds used to generate these parameters.

The Supporting Files Archive contains the substitution parameters and seeds used in the performance tests.

4.5. Isolation Level

The isolation level used to run the queries must be disclosed. If the isolation level does not map closely to one of the isolation levels defined in Clause 3.4, additional descriptive detail must be provided.

The isolation level used to run the queries was Level 3.

4.6. Refresh Functions

The details of how the refresh functions were implemented must be reported in the supporting files archive (including source code of any non-commercial program used).

The Supporting Files Archive contains the source code for the refresh functions.

5.0 Clause 3: Database System Properties Related Items

The results of the ACID tests must be disclosed along with a description of how the ACID requirements were met. All code (including queries, stored procedures, etc.) used to test the ACID requirements and their entire output must be reported in the supporting files archive.

All ACID tests were conducted according to specification. The Atomicity, Isolation, Consistency and Durability tests were performed on the IBM Power 780 Model 9179-MHB. The Supporting Files Archive contains the source code for the ACID tests and the output from the ACID tests.

5.1. Atomicity Requirements

The system under test must guarantee that transactions are atomic; the system will either perform all individual operations on the data, or will assure that no partially-completed operations leave any effects on the data.

5.1.1. Atomicity of Completed Transaction

Perform the ACID transaction for a randomly selected set of input data and verify that the appropriate rows have been changed in the ORDER, LINEITEM, and HISTORY tables.

The following steps were performed to verify the atomicity of completed transactions:

1. The total price from the ORDER table and the extended price from the LINEITEM table were retrieved for a randomly selected orderkey, o_key, and l_linenumber, l_key. The number of records in the HISTORY table with selected o_key, l_key was also retrieved.
2. The ACID transaction T1 was executed for the Orderkey used in Step 1.
3. The ACID transaction committed.
4. The total price and the extended price were retrieved for the same orderkey used in step 1 and step 2. It was verified that: T1.EXTENDEDPRICE = OLD.EXTENDEDPRICE + ((T1.DELTA) * (OLD.EXTENDEDPRICE/OLD.QUANTITY)), T1.TOTALPRICE = OLD.TOTALPRICE + ((T1.EXTENDEDPRICE-OLD.EXTENDEDPRICE)*(1-DISCOUNT)*(1+TAX)), and that the number of records in the history table with o_key, l_key used in step 1 had increased by 1.

5.1.2. Atomicity of Aborted Transactions

Perform the ACID transaction for a randomly selected set of input data, substituting a ROLLBACK of the transaction for the COMMIT of the transaction. Verify that the appropriate rows have not been changed in the ORDER, LINEITEM, and HISTORY tables.

The following steps were performed to verify the atomicity of the aborted ACID transaction:

1. The total price from the ORDER table and the extended price from the LINEITEM table were retrieved for a random Orderkey. The number of records in the HISTORY table was also retrieved.
2. The ACID transaction was executed for the Orderkey used in step 1.
3. The transaction was rolled back.

4. The total price and the extended price were retrieved for the same orderkey used in step 1 and step 2. It was verified that the extended price and the total price were the same as in step 1. The number of records in the HISTORY table was retrieved again and verified to be the same as in step1.

5.2. Consistency Requirements

Consistency is the property of the application that requires any execution of transactions to take the database from one consistent state to another.

5.2.1. Consistency Condition

A consistent state for the TPC-H database is defined to exist when:

O_TOTALPRICE = SUM(trunc(trunc(L_EXTENDEDPRICE(1-L_DISCOUNT),2)*(1+L_TAX),2))*

for each ORDERS and LINEITEM defined by (O_ORDERKEY=L_ORDERKEY)

The following queries were executed before and after a measurement to show that the database was always in a consistent state both initially and after a measurement. Check the implementation if

```
SELECT sum ("truncate" ("truncate"( round(cast(l_extendedprice as numeric(26,16)),2) *
            (1 - round(cast(l_discount as numeric(26,16)),2)),2) *
            (1 + round(cast(l_tax as numeric(26,16)),2)) , 2))
        FROM lineitem WHERE l_orderkey = o_key;
```

is equal to o_total of order table.

5.2.2. Consistency Tests

Verify that the ORDERS and LINEITEM tables are initially consistent as defined in Clause 3.3.2.1, based on a random sample of at least 10 distinct values of O_ORDERKEY.

The queries defined in 5.2.1, "Consistency Condition" were run after initial database build and prior to executing the ACID transaction. The queries showed that the database is in a consistent state.

After executing 10 streams of 100 ACID transactions each, the queries defined in 5.2.1, "Consistency Condition" were run again. The queries showed that the database was still in a consistent state.

5.3. Isolation Requirements

5.3.1. Isolation Test 1

This test demonstrates isolation for the read-write conflict of a read-write transaction and a read-only transaction when the read-write transaction is committed.

The following steps were performed to satisfy the test of isolation for a read-only and a read-write committed transaction:

1. 1st session: Started an ACID transaction with a randomly selected O_KEY, L_KEY and DELTA. The transaction was delayed for 10 seconds just prior to the Commit.
2. 2nd session: Started an ACID query for the same O_KEY as in the ACID transaction. The query completed without blocking and did not see any of the uncommitted changes made by the ACID transaction.

3. 1st session: the ACID transaction resumed and successfully completed the Commit.

5.3.2. Isolation Test 2

This test demonstrates isolation for the read-write conflict of read-write transaction and read-only transaction when the read-write transaction is rolled back.

The following steps were performed to satisfy the test of isolation for read-only and a rolled back read-write transaction:

1. 1st session: Performed the ACID transaction for a random O_KEY, L_KEY and DELTA. The transaction was delayed for 10 seconds just prior to the Rollback.
2. 2nd session: Started an ACID query for the same O_KEY as in the ACID transaction. The query completed without blocking and did not see any of the uncommitted changes made by the ACID transaction.
3. 1st session: the ACID transaction resumed and successfully completed the Rollback.

5.3.3. Isolation Test 3

This test demonstrates isolation for the write-write conflict of two update transactions when the first transaction is committed.

The following steps were performed to verify isolation of two refresh transactions:

1. 1st session: Started an ACID transaction T1 for a randomly selected O_KEY, L_KEY and DELTA. The transaction was delayed for 30 seconds just prior to the COMMIT.
2. 2nd session: Started a second ACID transaction T2 for the same O_KEY, L_KEY, and for a randomly selected DELTA2. This transaction was forced to wait.
3. 1st session: The ACID transaction T1 was released and the Commit was executed, releasing the record. With the LINEITEM record now released, the ACID transaction T2 completed.
4. Verified that:

   T2.L_EXTENDEDPRICE = T1.L_EXTENDEDPRICE +
   (DELTA*(T1.L_EXTENDEDPRICE)/T1.L_QUANTITY)

5.3.4. Isolation Test 4

This test demonstrates isolation for write-write conflict of two update transactions when the first transaction is rolled back.

The following steps were performed to verify the isolation of two ACID transactions after the first one is rolled back:

1. 1st session: Started an ACID transaction T1 for a randomly selected O_KEY, L_KEY, and DELTA. The transaction was delayed for 30 seconds just prior to the rollback.
2. 2nd session: Started a second ACID transaction T2 for the same O_KEY, L_KEY used by the 1st session. This transaction was forced to wait.
3. 1st session: Rollback the ACID transaction T1. With the LINEITEM record now released, the ACID transaction T2 completed.

4. Verified that T2.L_EXTENDEDPRICE = T1.L_EXTENDEDPRICE

5.3.5. Isolation Test 5

This test demonstrates the ability of read and write transactions affecting different database tables to make progress concurrently.

1. 1st session: Started an ACID transaction, T1, for a randomly selected O_KEY, L_KEY and DELTA. The ACID transaction was suspended prior to COMMIT.
2. 2nd session: Started a second ACID transaction, T2, which selected random values of PS_PARTKEY and PS_SUPPKEY and returned all columns of the PARTSUPP table for which PS_PARTKEY and PS_SUPPKEY were equal to the selected values.
3. T2 completed.
4. T1 was allowed to complete.
5. It was verified that the appropriate rows in the ORDERS, LINEITEM and HISTORY tables have been changed.

5.3.6. Isolation Test 6

This test demonstrates that the continuous submission of arbitrary (read-only) queries against one or more tables of the database does not indefinitely delay update transactions affecting those tables from making progress.

1. 1st session: A transaction T1, which executed TPC-H query 1 with a randomly selected DELTA was started.
2. 2nd session: Before T1 completed, an ACID transaction T2, with randomly selected values of O_KEY, L_KEY and DELTA, was started.
3. T2 completed and appropriate rows in the ORDERS, LINEITEM and HISTORY tables had been changed.
4. T1 completed executing query 1.

5.4. Durability Requirements

The SUT must guarantee durability: the ability to preserve the effects of committed transactions and ensure database consistency after recovery from any one of the failures listed in Clause 3.5.3.

5.4.1. Permanent Failure of Single Durable Medium and Loss of System Power

These tests were combined and conducted on the qualification database. The following steps were performed:

1. The consistency condition described in section 5.2.1 was verified.
2. The current count of the total number of records in the HISTORY table was determined giving hist1.
3. A test to run ACID transactions on each of 10 execution streams was started such that each stream executes a different set of transactions.

4. At least 100 ACID transactions were completed from each of the execution streams.
5. While ACID transactions continued to be executed by all execution streams, one of the disks containing Sybase database table data and database indices was removed from the enclosure and one of the disks containing the Sybase transaction log recovery data was removed from the enclosure. Because the disks were in RAID 1 configuration the execution streams continued running ACID transactions.
6. One of the SAS adapters was removed. Because the disks were in RAID 1 configuration with each disk in the RAID 1 pair using a different controller the applications continued running the ACID transactions.
7. The system was powered down by switching off the power for all system components.
8. The system was powered back on, rebooted and the database was restarted.
9. Step 2 was performed giving hist2. It was verified that hist2 – hist1 was greater than or equal to the number of records in the success file.
10. The consistency condition described in section 5.2.1 was verified.

5.4.2. Failure of Storage Controller, and Loss of System Power

The test was combined with 5.4.1.

6.0 Clause 4: Scaling and Database Population Related Items

6.1. Cardinality of Tables

The cardinality (e.g., the number of rows) of each table of the test database, as it existed at the completion of the database load (see Clause 4.2.5), must be disclosed.

The following table contains the TPC Benchmark™ H defined tables and the number of rows for each table as they existed upon build completion:

Table	Rows
Lineitem	5,999,989,709
Orders	1,500,000,000
Customer	150,000,000
Supplier	10,000,000
Part	200,000,000
Partsupp	800,000,000
Nation	25
Region	5

6.2. Distribution of Tables and Logs

The distribution of tables and logs across all media must be explicitly depicted for the tested and priced systems.

Sybase IQ Single Application Server Edition v.15.2 ESD #2 was configured on an IBM Power 780 Model 9179-MHB server. The system had

- 12 IBM PCI-E 3Gb SAS adapters
- 4 IBM EXP 12S expansion drawers
- 52 69GB SAS solid state drives
- 3 146GB 15K RPM SAS hard disk drives

The database tables and indexes are allocated across the solid state drives in RAID 1 arrays. The database log and auxiliary structures are allocated across 2 SAS hard disk drives in a RAID 1 array.

Controller	Disk Count	Raid Level	Size (GB)	Content
30/3B	16	1	496 51	DB Main DB Temp
31/32	2	1	62 6.4	DB Main DB Temp

Controller	Disk Count	Raid Level	Size (GB)	Content
3C/3D	6	1	186 19.1	DB Main DB Temp
46/51	16	1	496 GB 51 GB	DB Main DB Temp
47/48	6	1	186 19.1	DB Main DB Temp
52/53	6	1	186 19.1	DB Main DB Temp
46/51	2	1	136.7	DB Log, DB Auxiliary Data

6.3. Mapping of Database Partitions/Replications

The mapping of database partitions/replications must be explicitly described.

The lineitem and orders tables were partitioned by year. The database was not replicated.

6.4. Implementation of RAID

Implementations may use data redundancy mechanism(s). The type of data redundancy mechanism(s) and any configuration parameters (e.g., RAID level used) must be disclosed for each device.

	RAID Level	Storage Redundancy Level
Base Tables	1	3
Auxiliary Data Structures	1	3
DBMS Temporary Space	1	3
OS and DBMS Software	n/a	0

6.5. DBGen Modifications

The version number, release number, modification number, and patch level of DBGen must be disclosed. Any modifications to the DBGen (see Clause 4.2.1) source code (see Appendix D) must be reported in the in the supporting files archive.

The supplied DBGen version 2.13.0 was used.

6.6. Database Loading

The database load time for the test database (see Clause 4.3) must be disclosed.

The database load time was 01:08:39.

6.7. Data Storage Ratio

The data storage ratio must be disclosed. It is computed by dividing the total data storage of the priced configuration (expressed in GB) by the size chosen for the test database as defined in clause 4.1.3.1. Let r be the ratio. The reported value for r must be rounded to the nearest 0.01.

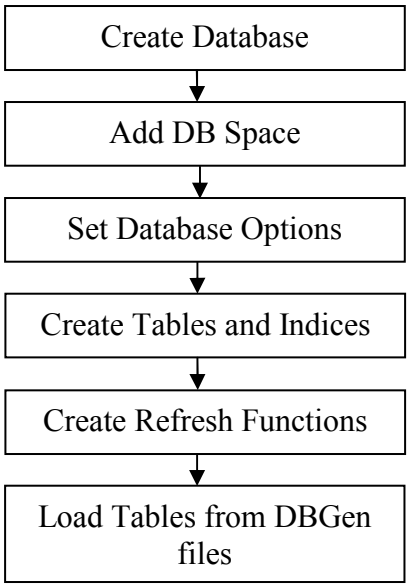
The calculation of the data storage ratio is shown in the following table:

Disk Type	Number of Disks	Space per Disk	Sub-Total Disk Space	Database Size	Data Storage Ratio
146GB HDD	3	136.73 GB	410.20 GB		
69GB SSD	52	68.37 GB	3,555.03 GB		
Total			3,965.23 GB	1,000 GB	3.97

6.8. Database Load Details

The details of the database load must be reported in the supporting file archive. Disclosure of the load procedure includes all steps, scripts, input and configuration files required to completely reproduce the test and qualification databases.

The database was loaded from files generated by DBGen. The Supporting Files Archive contains the scripts used to load the database. The following is a basic diagram of the steps involved:



6.9. Qualification and Test Database Differences

Any differences between the configuration of the qualification database and the test database must be disclosed.

The qualification database and test database were created using functionally equivalent scripts.

6.10. Memory to Database Size Percentage

The memory to database size percentage must be disclosed. It is computed by multiplying by 100 the total memory size priced on the SUT (see clause 6.2.1) and diving this number by the size chosen for the test database as defined in Clause 4.1.3.1.

The memory to database size percentage is 51.2%.

7.0 Clause 5: Performance Metrics and Execution Rules Related Items

7.1. System Activity between Load and Performance Tests

Any system activity on the SUT that takes place between the conclusion of the load test and the beginning of the performance test must be fully reported in the supporting files archive including listings of scripts, command logs and system activity.

Auditor requested queries were run against the database to verify correctness of the database load. The database server was stopped, caches were dropped and the database server was restarted. The Supporting Files Archive contains the scripts and logs of the activity that occurred.

7.2. Steps in the Power Test

The details of the steps followed to implement the power test (e.g., system boot, database restart, etc.) must be disclosed.

The following steps were used to implement the power test:

1. RF1 Refresh Function
2. Stream 00 Execution
3. RF2 Refresh Function

7.3. Timing Intervals for Each Query and Refresh Function

The timing intervals (see Clause 5.3.7) for each query and for both refresh functions must be reported for the power test.

See Numerical Quantities Summary in the Executive Summary.

7.4. Number of Streams for the Throughput Test

The number of query streams used for the throughput test must be disclosed.

See Numerical Quantities Summary in the Executive Summary.

7.5. Start and End Date/Times for Each Query Stream

The start time and finish time for each query stream for the throughput test must be disclosed.

See Numerical Quantities Summary in the Executive Summary.

7.6. Total Elapsed Time for the Measurement Interval

The total elapsed time of the measurement interval (see Clause 5.3.6) must be disclosed for the throughput test.

See Numerical Quantities Summary in the Executive Summary.

7.7. Refresh Function Start Date/Time and Finish Date/Time

The start time and finish time for each refresh function in the refresh stream for the throughput test must be disclosed.

See Numerical Quantities Summary in the Executive Summary

7.8. Performance Metrics

The computed performance metric, related numerical quantities and price/performance metric must be disclosed.

See Numerical Quantities Summary in the Executive Summary.

7.9. The Performance Metric and Numerical Quantities from Both Runs

The performance metric (QphH@Size) and the numerical quantities (TPC-H Power@Size and TPC-H Throughput@Size) from both runs must be disclosed.

	TPC-H Power@1000GB	TPC-H Through-put@1000GB	QphH@1000GB
Run 1	170,871.4	162,665.4	166,717.9
Run 2	170,206.4	159,463.1	164,747.2

7.10. System Activity between Tests

Any activity on the SUT that takes place between the conclusion of Run1 and the beginning of Run2 must be fully disclosed including system activity, listings of scripts or command logs along with any system reboots or database restarts.

The database server was stopped, caches were dropped and the database server was restarted.

7.11. Query Output Validation Test

The output of the Query Output Validation Test must be reported in the supporting files archive.

The Supporting Files Archive contains the Query Output Validation Test output.

8.0 Clause 6: SUT and Driver Implementation Related Items

8.1. Driver

A detailed textual description of how the driver performs its functions, how its various components interact and any product functionalities or environmental settings on which it relies and all related source code, scripts and configuration files must be reported in the supporting files archive. The information provided should be sufficient for an independent reconstruction of the driver.

The Supporting Files Archive contains the source code used for the driver and all scripts used in connection with it.

The run_tpch script is used to execute the TPC-H benchmark. The run_tpch script is invoked with the desired run scope ("all" for complete execution of the benchmark) and the number of query streams to execute for the throughput test. The execution of the run_tpch script will create and load the database, run the power test and throughput test sequences and generate reports.

Each power test submits the SQL for execution of the power update stream. The power test waits for RF1 to complete and then executes the power test query stream. After completion of the power test query stream the update stream executes RF2 and the power test waits for completion of the update stream.

Each throughput test submits the 9 query streams for execution in parallel. After waiting 60 seconds, the throughput refresh stream is submitted for execution. The throughput test then waits for completion of all streams.

8.2. Implementation Specific Layer

If an implementation specific layer is used, then a detailed description of how it performs its functions, how its various components interact and any product functionalities or environmental setting on which it relies must be disclosed.

The performance tests are executed using the dbisqlc and iqisql utilities. The dbisqlc and iqisql utilities are Sybase-provided utilities which allow SQL statements to be executed against a Sybase IQ database. The dbisqlc and iqisql utilities are invoked from the command line on the SUT. They read input from files containing SQL statements and sends results to stdout. The dbisqlc utility uses information in the .odbc.ini file to connect to the database while iqisql uses information in the interfaces file to connect to the database.

The ACID tests are performed using the dbtest utility. The dbtest utility is a Sybase-provided utility, similar to dbisqlc, but providing additional scripting capabilities. It is invoked from the command-line on the SUT. It reads input from files that determine how and what to execute. It uses information in the .odbc.ini file to connect to the database.

8.3. Profile-Directed Optimization

If profile-directed optimization as described in Clause 5.2.9 is used, such used must be disclosed.

Profile-directed optimization was not used.

9.0 Clause 9: Audit Related Items

The auditor's agency name, address, phone number, and attestation letter with a brief audit summary report indicating compliance must be included in the full disclosure report. A statement should be included specifying whom to contact in order to obtain further information regarding the audit process.

This implementation of the TPC Benchmark H was audited by Francois Raab of InfoSizing, a certified TPC-H auditor. Further information regarding the audit process may be obtained from:

Francois Raab
InfoSizing
125 West Monroe Street
Colorado Springs, CO 80907
(719) 473-7555

INFO SIZING

TPC TRANSACTION PROCESSING PERFORMANCE COUNCIL CERTIFIED AUDITOR

Raymond J. Venditti
IBM Linux Performance
11501 Burnet Road
Austin, TX 78758

Peter Thawley
Sr. Director, Engineering
One Sybase Drive
Dublin, CA 94583

December 10, 2010

I verified the TPC Benchmark™ H performance of the following configuration:

Platform:	**IBM Power 780 Model 9179-MHB**
Database Manager:	**Sybase IQ Enterprise Edition v15.2**
Operating System:	**Red Hat Enterprise Linux 6**

The results were:

CPU (Speed)	Memory	Disks	**QphH@1,000GB**
IBM Power 780 Model 9179-MHB			
8 x IBM POWER7 (4.1GHz)	512GB (32MB L3)	52 x 69GB SAS SSD 3 x 146GB 15krpm SAS.	**164,747.2**

In my opinion, this performance result was produced in compliance with the TPC's requirements for the benchmark. The following verification items were given special attention:

- The database records were defined with the proper layout and size
- The database population was generated using DBGEN
- The database was properly scaled to 1,000GB and populated accordingly
- The compliance of the database auxiliary data structures was verified
- The database load time was correctly measured and reported

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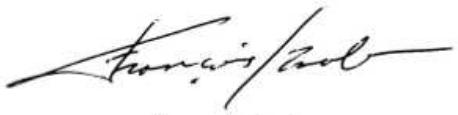
- The required ACID properties were verified and met
- The query input variables were generated by QGEN
- The query text was produced using minor modifications and no query variant
- The execution of the queries against the SF1 database produced compliant answers
- A compliant implementation specific layer was used to drive the tests
- The throughput tests involved 9 query streams
- The ratio between the longest and the shortest query was such that no query timings were adjusted
- The execution times for queries and refresh functions were correctly measured and reported
- The repeatability of the measured results was verified
- The system pricing was verified for major components and maintenance
- The major pages from the FDR were verified for accuracy

Additional Audit Notes:

None.

Respectfully Yours,



François Raab
President

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Appendix - A Pricing Information

International Business Machines Corporation

11501 BURNETT RD
AUSTIN TX 78758

December 8, 2010

Below is the quote requested for the IBM Power 780 System.

Server Hardware	PN/FC	Unit Price	Qty	Ext. Price	3 -Yr. Maint
IBM Power 780	9179-MHB	10,195	1	10,105	4,608
Integrated, 4 port – 1Gb virtual Ethernet	1803	699	4	2,796	
Operator Panel	1853	1,000	1	1, 000	
146 GB 15K RPM SFF SAS Disk Drive	1886	1,045	3	3,135	
69GB SFF SAS Solid State Drive	1890	6,811	20	136,220	45,306
69GB 3.5 in SAS Solid State Drive	3586	6,811	32	217,952	72,576
SAS Cable (X) Adpt to SAS Enc. DC, DP 3M	3661	197	4	788	
Serv Interface Cable 2, 3, and 4 enclosure	3671	2,000	1	2,000	
Serv Interface Cable 3 and 4 enclosure	3672	3,000	1	3,000	
Serv Interface Cable 4 enclosure	3673	4,000	1	4,000	
Processor cables, two, three, and four drawer	3712	5,000	1	5,000	
Processor cables, three, and four drawer	3713	10,000	1	10,000	
Processor cables, four drawer	3714	12,000	1	12,000	
3.86GHz TurboCore Proc Card 0/16C 16 DDR3	4982	57,429	4	229,716	36,432
One Processor Act for Proc Feature #4982	5469	8,375	32	268,000	92,160
System CEC Enclosure, I/O Bkpln, Syst Mdpln	5597	12,000	4	48,000	
64GB (4x16GB) DDR3 DIMMs, 1066MHz	5601	7,720	8	61,760	
System AC Power Supply, 1725W Redundant	5632	1,502	8	12,016	
Disk Media Backplane	5652	4,000	4	16,000	
Service Processor	5664	4,000	2	8,000	
FSP/Clock Pass Through Card	5665	900	2	1,800	
SATA Slimline DVD-ROM Drive	5762	392	1	392	
EXP 12S Expansion Drawer	5886	6,484	4	25,936	19,200
PCIe 380MB Cache Dual x4 3Gb SAS Raid Adp	5903	2,880	4	11,520	
Power Control Cable (SPCN) 3Meter	6006	52	1	52	
Power Cable Drwr to IBM PDU 14ft 250V/10A	6458	19	16	304	
Activation of 1GB DDR3 POWER7 Mem	8212	245	12	2,940	
Activation of 100GB DDR3 POWER7 Mem	8213	24,500	5	122,500	
IBM T42 U Standard Rack	7014-T42	3,970	1	3,970	
Front Door	6069	550	1	550	
Side Panel	6089	150	2	300	
PDU to Wall Power cord 14'	6654	240	4	960	
Power dist unit Side mount UTG0247 Connect	7188	1,000	3	3,000	
Deskside Hardware Management Console	7042-C08	2,800	1	2,800	
Internal Modem	0033	200	1	200	
Modem cable	1025	17	1	17	
PCIe 1Gb Ethernet UTP 2 port	5767	682	1	682	
IBM Quiet Touch USB Keyboard	5951	107	1	107	
Power cord 6ft to wall	6470	18	1	18	
Ethernet cable 15m	7802	33	1	33	
USB mouse	8845	39	1	39	
HMC Software Support 1 Year	0612	250	3	750	

Total Cost	$1,502,824
Total IBM Discount	$541,004
Three Year Cost of Ownership USD	$961,820

For additional information, please contact me directly:
Dan Hebrank
IBM Sales & Distribution, STG Sales
1-314-283-4674
http://www.ibm.com/products

For:

Quotation for Software and Support

Company IBM
Contact Ray Venditti
Phone (512) 286-9064
Fax venditti@us.ibm.com
Address 11500 Burnet Road, Austin, TX 78758

SYBASE Sales Rep: Anne Belt
Phone: 925-236-4108
Fax: 925-236-6178
Sybase Inc. 1 Sybase Drive, Dublin, CA 94568

	Catalogue Number	Product Description	License Type	Machine	P/S	List Price Per Unit	Quantity	Price	Discount	Extended Price
1	11545	Sybase IQ Single App Svr, per cpu core	CP	Linux on POWER	P	2,595	32	83,040	12,456	70,584.00
3	98477	3 yr support Single App Svr, per cpu core				1,713	32	54,816	8,222	46,593.60
4		Discounts:								
5		15.00%								
6										
7										
8										
9										
10										
11										
12										

Quote Date: ***12/1/10***
Valid thru: ***1/31/11***

Total 117,177.60

Licence + 3 year support

Payment terms : Net 30 Days

QUOTE FORM
NORTH AMERICA

Red Hat Inc.
1801 Varsity Drive
Raleigh, North Carolina 27606 USA
919-754-3700 | www.redhat.com

redhat.

Client Information	
Company name: Ibm ("Client" or "you") Contact name: Telephone: Fax: E-Mail:	**Red Hat Sales Representative:** Name: David Rodriguez Phone: (919) 754-4343 Fax: (980) 233-6049 E-Mail: drodrigu@redhat.com
Ship-to address: 11501 Burnet Rd Austin, TX 78758 USA	
Bill-to address: 11501 Burnet Rd Austin, TX 78758 USA	Quote Reference #: 879379 Quote Expiration Date: 12/17/2010

Purchase Summary

Qty	Unit*	Term	SKU	Subscription or Services Purchased	Per Unit Fee	Per Unit Prorated Fee (USD)	Total Fee (USD)
1	System	3 Year(s)	RH0330307	Red Hat Enterprise Linux for IBM POWER, Premium (8 sockets)	16,340.00	49,020.00	49,020.00
						Total:	(USD) 49,020.00

*As defined in the applicable appendice(s).

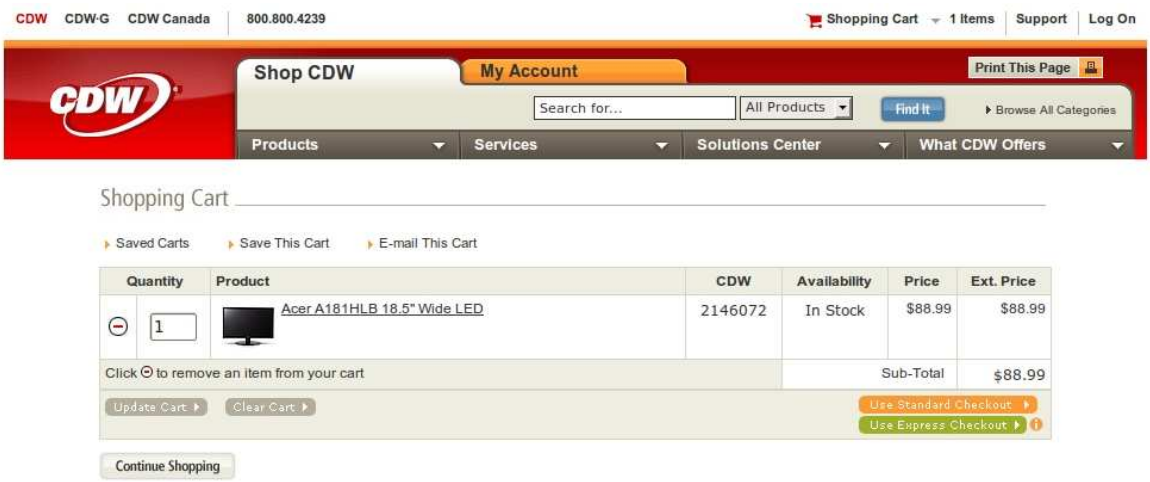
Applicable Agreement

This Order Form incorporates the Red Hat Enterprise Agreement at http://www.redhat.com/licenses/us.html, and the applicable appendices as indicated in the table below (the "Agreement").

Payment Terms: Pending Credit Approval

Applicable Appendices	Appendices	Location
(mark all that apply)		
X	Appendix 1: Subscription Services	See attached, if not attached, then available at http://www.redhat.com/licenses/rhel_us_appendix1.html
	Appendix 2: Learning Services, Training Units and Consulting Units	See attached, if not attached, then available at http://www.redhat.com/licenses/rhel_us_appendix2.html
	Appendix 3: Professional Services	See attached
	Appendix 4: Other Programs or Services	See attached

Additional Terms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