
HP Integrity Superdome 2

using

HP-UX 11i v3

and

**Oracle Database 11g R2 Enterprise Edition with Partitioning
and Oracle Automatic Storage Management**

TPC Benchmark™ H Full Disclosure Report

First Edition

April 26, 2010



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

All performance data contained in this report was obtained in a rigorously controlled environment. Results obtained in other operating environments may vary significantly. No warranty of system performance or price/performance is expressed or implied in this report.

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Overview

This report documents the methodology and results of the TPC Benchmark™ H test conducted on the HP Integrity Superdome 2, in conformance with the requirements of the TPC Benchmark™ H Standard Specification, Revision 2.10.0. The operating system used for the benchmark was HP-UX 11i v3 September 2010 Update; the DBMS was Oracle Database 11g R2 Enterprise Edition with Partitioning and Oracle Automatic Storage Management.

Standard and Executive Summary Statements

The pages following this preface contain the Executive Summary and Numerical Quantities Summary of the benchmark results.

Auditor

The benchmark configuration, environment and methodology used to produce and validate the test results and the pricing model used to calculate the cost per QphH was audited by Francois Raab, InfoSizing (www.sizing.com), to verify compliance with the relevant TPC specifications.

TPC Benchmark H Overview

The TPC Benchmark™ H (TPC-H) is a decision support benchmark. It consists of a suite of business oriented ad-hoc queries and concurrent data modifications. 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 updates 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 updates 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 updates may be executed against the database at any time, especially in relation to each other. In addition, this mix of queries and updates is subject to specific ACIDity requirements, since queries and updates 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 updates.

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 GB. Compliant benchmark implementations may also use one of the larger permissible database populations (e.g. 1000 GB), as defined in Clause 4.1.3.

The performance metrics reported by TPC-H measure multiple aspects of the capability of the system to process queries. The TPC-H metric at the selected size (QphH@Size) is the performance metric. 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 5.4.7). 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.

General Implementation Guidelines

The purpose of TPC benchmarks is to provide relevant, objective performance data to industry users. To achieve that purpose, TPC benchmark specifications require that benchmark tests be implemented with systems, products, technologies and pricing that:

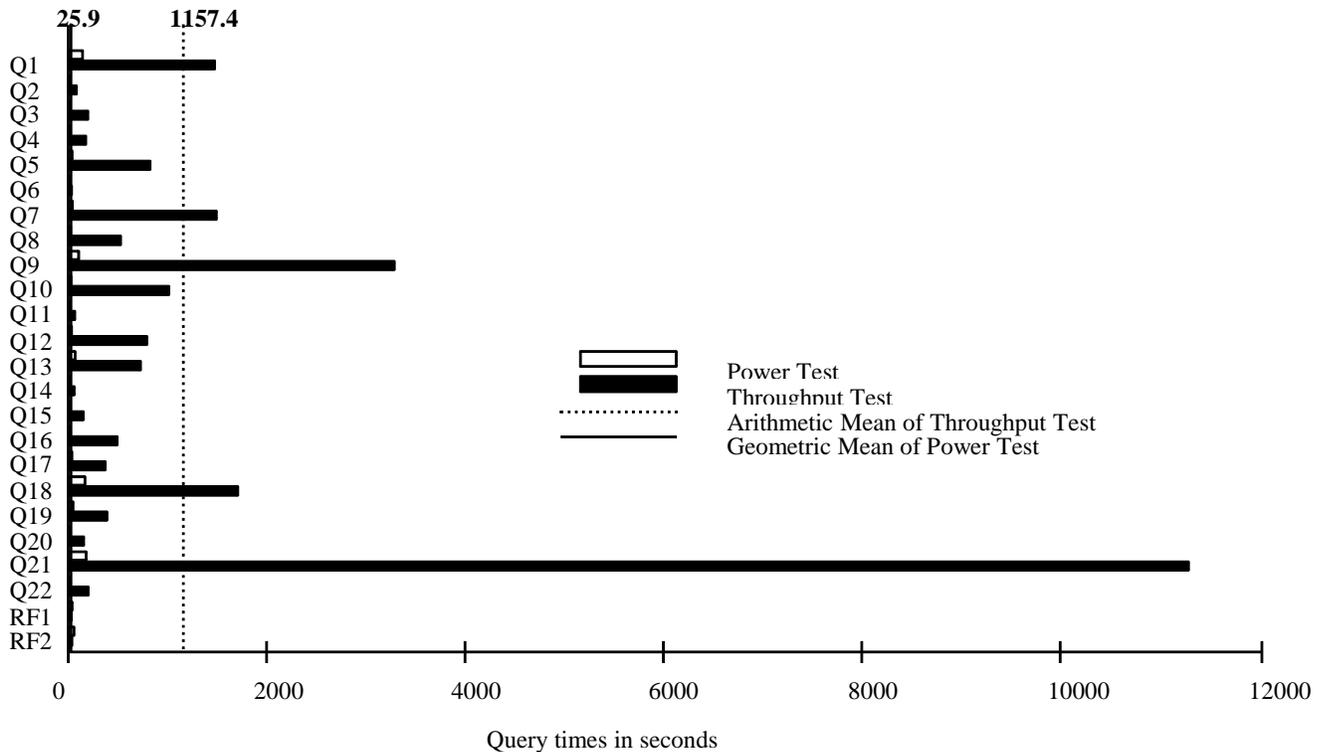
Are generally available to users;

Are relevant to the market segment that the individual TPC benchmark models or represents (e.g. TPC-H models and represents complex, high data volume, decision support environments);

Would plausibly be implemented by a significant number of users in the market segment the benchmark models or represents.

Hewlett-Packard Company does not warrant or represent that a user can or will achieve performance similar to the benchmark results contained in this report. No warranty of system performance or price/performance is expressed or implied by this report

	<h1>HP Integrity Superdome 2</h1>		TPC-H Rev 2.10.0 TPC Pricing Rev 1.5.0	
			Report Date: April 26, 2010	
Total System Cost	Composite Query per Hour Metric		Price/Performance	
\$1,703,613 USD	140,181.1 QphH@1000GB		\$12.15 USD Price/QphH@1000GB	
Database Size	Database Manager	Operating System	Other Software	Availability Date
1000 GB	Oracle Database 11g R2 Enterprise Edition with Partitioning and Oracle Automatic Storage Management	HP-UX 11i v3 September 2010 Update	None	10/20/2010



Database Load Time = 01:04:41	Load Includes Backup: N
Total Data Storage/Database Size = 42.06	Memory/Database Size Percentage = 51.2%
Storage Redundancy Level 1 for Base Tables, Auxiliary Data Structures, DBMS temporary space, and OS and DBMS Software	

System Configuration

Number of Nodes: 1
 Processors/Cores/Threads/Type: 16/64/64/Intel Itanium 9350 1.73 Ghz, 24MB iL3 cache
 Memory: 512 GB
 Disk Drives: 24 HP MSA 2324 with a total of 576, 72GB disks
 1 HP MSA 2324 with a total of 4, 146GB disks
 Total Disk Storage: 42056GB (In this number one GB is defined as 1024*1024*1024 bytes)
 Lan Controllers: 16 Embedded LAN Cards



HP Integrity Superdome 2

TPC-H Rev 2.10.0
TPC Pricing Rev 1.5.0

Report Date:
April 26, 2010

Description	Part Number	Source	Reference Price	Qty	Extended Price	3 yr Maint Price
Server Hardware						
HP Superdome 2 -16s Server**	AH337A	1	56,500	1	56,500	
HP CB900s i2 1.86GHz/24MB Cell Blade**	AM253A	1	44,000	8	352,000	
HP DDR3 512GB (32x16GB) Memory Bundle**	AH407A	1	112,000	1	112,000	
HP 3y Support Plus 24 SVC - SD2-16s hw/sw**	HA110A3	1	321,742	1		321,742
HP Superdome 2 IOX Enclosure**	AH338A	1	11,850	4	47,400	
HP ProCurve 6120XG Blade Switch	AT064A	1	9,000	1	9,000	
HP Universal Rack 10642 G2 Shock Rack	AF002A	1	1,489	1	1,489	
HP 16A High Voltage Modular PDU	252663-B24	1	299	2	598	
HP 17" FlatPanel Monitor	GV537A8	1	130	1	130	
HP USB Keyboard	GM321AA#ABA	1	14	1	14	
HP Optical 4 Button USB Mouse	EW208AA#ABA	1	7	1	7	
Subtotal					579,138	321,742
Server Software						
Oracle Database 11g Release 2 Enterprise Edition, Named User Plus for 3 years		2	11,875	32	380,000	
Partitioning, Named User Plus for 3 years		2	2,875	32	92,000	
Oracle Incident Server Support Packag for 3 years		2	6,900	1		6,900
PSL HP-UX 11i Integrity 16Skt/4Core BOE LTU	BA927AC#464	1	5,450	16	87,200	
DVD media	BA927AA#AJR	1	565	1	565	
Subtotal					559,765	6,900
Storage						
5m Fibre Channel Cables	221692-B22	1	95	104	9,880	
HP 2324fc DC Modular Smart Array	AJ797A	1	8,900	25	222,500	37,825
HP PCIe 2-port 8Gb FC SR (Qlogic) HBA	AH401A	1	4,631	48	222,288	
HP 146GB 3G SAS 10K 2.5in DP ENT HDD	418367-B21	1	269	4	1,076	
HP 72GB 3G SAS 15K 2.5in DP ENT HDD	418371-B21	1	349	576	201,024	
HP Universal Rack 10642 G2 Shock Rack	AF002A	1	1,489	2	2,978	
HP 16A High Voltage Modular PDU	252663-B24	1	299	4	1,196	
HP 8/24 Base 16-ports Enabled SAN Switch	AM868A	1	6,899	1	6,899	963
HP 8Gb Shortwave B-series FC SFP+ 1 Pack	AJ716A	1	249	12	2,988	
Subtotal					670,829	38,788
Total					1,809,732	367,430
Oracle Mandatory E-Business Discount on (Licenses and Support)					(95,780)	
23 % Large Configuration Discount and Support Prepayment*					(275,194)	(102,575)
Grand Total					1,438,758	264,855

*All discounts are based on US list prices and for similar quantities and configurations

** These components are not immediately orderable. See FDR for more information

Source 1=HP, 2=Oracle

Audited By: Francois Raab for InfoSizing (www.sizing.com) (www.sizing.com)

3-yr Cost of Ownership: 1,703,613

QpH@1000GB: 140,181

\$/QpH@1000GB: 12.15

Prices used in TPC benchmarks reflect 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 the stated prices are not available according to these terms, please inform the TPC at pricing@tpc.org. Thank you.



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Measurement Results

Database Scaling (SF/size)	1000
Total Data Storage/Database Size	42.06
Memory/Database Size Percentage	51.20%
Start of Database Load Time	04/13/10 09:51:16
End of Database Load Time	04/13/10 10:55:57
Database Load Time	1:04:41
Query Streams for Throughput Test (S)	64
TPC-H Power	139,181.0
TPC-H Throughput	141,188.3
TPC-H Composite Query-per-Hour Metric (QphH@1000GB)	140,181.1
Total System Price Over 3 Years	1,703,613
TPC-H Price/Performance Metric (\$/QphH@1000GB)	12.15

Measurement Intervals

Measurement Interval in Throughput Test (Ts)	35,901
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Duration of Stream Execution:

Power Run	Seed	Query Start Time	Duration (sec)	RF1 Start Time	RF2 Start Time
		Query End Time		RF1 End Time	RF2 End Time
	0413105557	04/13/10 11:01:10	999	04/13/10 11:00:30	04/13/10 11:17:50
		04/13/10 11:17:49		04/13/10 11:01:10	04/13/10 11:18:46

Throuput Stream	Seed	Query Start Time	Query End Time	Duration (sec)	RF1 Start Time	RF1 End Time	RF2 Start Time	RF2 End Time
1	0413105558	04/13/10 11:18:47	04/13/10 19:31:51	29,584	04/13/10 20:10:03	04/13/10 20:10:39	04/13/10 20:10:39	04/13/10 20:11:14
2	0413105559	04/13/10 11:18:47	04/13/10 18:37:33	26,326	04/13/10 20:11:14	04/13/10 20:11:46	04/13/10 20:11:46	04/13/10 20:12:21
3	0413105560	04/13/10 11:18:47	04/13/10 19:46:27	30,460	04/13/10 20:12:21	04/13/10 20:12:59	04/13/10 20:12:59	04/13/10 20:13:34
4	0413105561	04/13/10 11:18:47	04/13/10 18:10:03	24,676	04/13/10 20:13:34	04/13/10 20:13:57	04/13/10 20:13:57	04/13/10 20:14:32
5	0413105562	04/13/10 11:18:47	04/13/10 20:03:03	31,456	04/13/10 20:14:32	04/13/10 20:14:55	04/13/10 20:14:55	04/13/10 20:15:30
6	0413105563	04/13/10 11:18:47	04/13/10 15:57:48	16,741	04/13/10 20:15:30	04/13/10 20:15:53	04/13/10 20:15:53	04/13/10 20:16:28
7	0413105564	04/13/10 11:18:47	04/13/10 17:59:52	24,065	04/13/10 20:16:28	04/13/10 20:16:51	04/13/10 20:16:51	04/13/10 20:17:26
8	0413105565	04/13/10 11:18:47	04/13/10 16:49:36	19,849	04/13/10 20:17:26	04/13/10 20:17:50	04/13/10 20:17:50	04/13/10 20:18:25
9	0413105566	04/13/10 11:18:47	04/13/10 17:06:01	20,834	04/13/10 20:18:25	04/13/10 20:18:48	04/13/10 20:18:48	04/13/10 20:19:23
10	0413105567	04/13/10 11:18:48	04/13/10 17:21:11	21,743	04/13/10 20:19:23	04/13/10 20:19:46	04/13/10 20:19:46	04/13/10 20:20:21



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Duration of Stream Execution (Continued):

Throughput Stream	Seed	Query Start Time Query End Time	Duration (sec)	RF1 Start Time RF1 End Time	RF2 Start Time RF2 End Time
11	0413105568	04/13/10 11:18:48 04/13/10 16:27:34	18,526	04/13/10 20:20:21 04/13/10 20:20:46	04/13/10 20:20:46 04/13/10 20:21:21
12	0413105569	04/13/10 11:18:48 04/13/10 16:30:56	18,728	04/13/10 20:21:21 04/13/10 20:21:48	04/13/10 20:21:48 04/13/10 20:22:23
13	0413105570	04/13/10 11:18:48 04/13/10 19:25:03	29,175	04/13/10 20:22:23 04/13/10 20:22:47	04/13/10 20:22:47 04/13/10 20:23:22
14	0413105571	04/13/10 11:18:48 04/13/10 18:48:08	26,960	04/13/10 20:23:22 04/13/10 20:23:54	04/13/10 20:23:54 04/13/10 20:24:29
15	0413105572	04/13/10 11:18:48 04/13/10 17:28:19	22,171	04/13/10 20:24:29 04/13/10 20:24:56	04/13/10 20:24:56 04/13/10 20:25:30
16	0413105573	04/13/10 11:18:48 04/13/10 18:41:15	26,547	04/13/10 20:25:30 04/13/10 20:26:03	04/13/10 20:26:03 04/13/10 20:26:37
17	0413105574	04/13/10 11:18:48 04/13/10 19:29:44	29,456	04/13/10 20:26:37 04/13/10 20:27:07	04/13/10 20:27:07 04/13/10 20:27:41
18	0413105575	04/13/10 11:18:48 04/13/10 18:18:48	25,200	04/13/10 20:27:41 04/13/10 20:28:06	04/13/10 20:28:06 04/13/10 20:28:41
19	0413105576	04/13/10 11:18:48 04/13/10 19:45:56	30,428	04/13/10 20:28:41 04/13/10 20:29:10	04/13/10 20:29:10 04/13/10 20:29:44
20	0413105577	04/13/10 11:18:49 04/13/10 16:56:38	20,269	04/13/10 20:29:44 04/13/10 20:30:15	04/13/10 20:30:15 04/13/10 20:30:51
21	0413105578	04/13/10 11:18:48 04/13/10 20:02:15	31,407	04/13/10 20:30:51 04/13/10 20:31:16	04/13/10 20:31:16 04/13/10 20:31:50
22	0413105579	04/13/10 11:18:48 04/13/10 18:19:51	25,263	04/13/10 20:31:50 04/13/10 20:32:22	04/13/10 20:32:22 04/13/10 20:32:56
23	0413105580	04/13/10 11:18:49 04/13/10 18:24:04	25,515	04/13/10 20:32:56 04/13/10 20:33:27	04/13/10 20:33:27 04/13/10 20:34:02
24	0413105581	04/13/10 11:18:48 04/13/10 18:14:02	24,914	04/13/10 20:34:02 04/13/10 20:34:33	04/13/10 20:34:33 04/13/10 20:35:07
25	0413105582	04/13/10 11:18:49 04/13/10 17:49:44	23,455	04/13/10 20:35:07 04/13/10 20:35:38	04/13/10 20:35:38 04/13/10 20:36:12
26	0413105583	04/13/10 11:18:49 04/13/10 18:40:42	26,513	04/13/10 20:36:12 04/13/10 20:36:42	04/13/10 20:36:42 04/13/10 20:37:17
27	0413105584	04/13/10 11:18:49 04/13/10 18:21:52	25,383	04/13/10 20:37:17 04/13/10 20:37:48	04/13/10 20:37:48 04/13/10 20:38:23
28	0413105585	04/13/10 11:18:49 04/13/10 18:28:53	25,804	04/13/10 20:38:23 04/13/10 20:38:54	04/13/10 20:38:54 04/13/10 20:39:29
29	0413105586	04/13/10 11:18:49 04/13/10 16:57:06	20,297	04/13/10 20:39:29 04/13/10 20:39:58	04/13/10 20:39:58 04/13/10 20:40:33
30	0413105587	04/13/10 11:18:49 04/13/10 20:10:03	31,874	04/13/10 20:40:33 04/13/10 20:40:58	04/13/10 20:40:58 04/13/10 20:41:33



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Duration of Stream Execution (Continued):

Throughput Stream	Seed	Query Start Time Query End Time	Duration (sec)	RF1 Start Time RF1 End Time	RF2 Start Time RF2 End Time
31	0413105588	04/13/10 11:18:49 04/13/10 17:57:35	23,926	04/13/10 20:41:33 04/13/10 20:42:01	04/13/10 20:42:01 04/13/10 20:42:35
32	0413105589	04/13/10 11:18:49 04/13/10 18:43:05	26,656	04/13/10 20:42:35 04/13/10 20:43:05	04/13/10 20:43:05 04/13/10 20:43:44
33	0413105590	04/13/10 11:18:49 04/13/10 19:36:37	29,868	04/13/10 20:43:44 04/13/10 20:44:14	04/13/10 20:44:14 04/13/10 20:44:48
34	0413105591	04/13/10 11:18:49 04/13/10 17:41:45	22,976	04/13/10 20:44:48 04/13/10 20:45:18	04/13/10 20:45:18 04/13/10 20:45:52
35	0413105592	04/13/10 11:18:50 04/13/10 18:12:13	24,803	04/13/10 20:45:52 04/13/10 20:46:17	04/13/10 20:46:17 04/13/10 20:46:51
36	0413105593	04/13/10 11:18:50 04/13/10 18:45:23	26,793	04/13/10 20:46:51 04/13/10 20:47:19	04/13/10 20:47:19 04/13/10 20:47:53
37	0413105594	04/13/10 11:18:50 04/13/10 19:51:24	30,754	04/13/10 20:47:53 04/13/10 20:48:23	04/13/10 20:48:23 04/13/10 20:48:57
38	0413105595	04/13/10 11:18:50 04/13/10 17:49:35	23,445	04/13/10 20:48:57 04/13/10 20:49:24	04/13/10 20:49:24 04/13/10 20:49:59
39	0413105596	04/13/10 11:18:50 04/13/10 18:19:11	25,221	04/13/10 20:49:59 04/13/10 20:50:31	04/13/10 20:50:31 04/13/10 20:51:05
40	0413105597	04/13/10 11:18:51 04/13/10 18:16:45	25,074	04/13/10 20:51:05 04/13/10 20:51:36	04/13/10 20:51:36 04/13/10 20:52:10
41	0413105598	04/13/10 11:18:51 04/13/10 17:56:35	23,864	04/13/10 20:52:10 04/13/10 20:52:36	04/13/10 20:52:36 04/13/10 20:53:10
42	0413105599	04/13/10 11:18:50 04/13/10 19:15:46	28,616	04/13/10 20:53:11 04/13/10 20:53:38	04/13/10 20:53:38 04/13/10 20:54:12
43	0413105600	04/13/10 11:18:50 04/13/10 17:29:11	22,221	04/13/10 20:54:12 04/13/10 20:54:43	04/13/10 20:54:43 04/13/10 20:55:17
44	0413105601	04/13/10 11:18:53 04/13/10 17:26:31	22,058	04/13/10 20:55:17 04/13/10 20:55:49	04/13/10 20:55:49 04/13/10 20:56:23
45	0413105602	04/13/10 11:18:53 04/13/10 18:15:28	24,995	04/13/10 20:56:23 04/13/10 20:56:53	04/13/10 20:56:53 04/13/10 20:57:28
46	0413105603	04/13/10 11:18:53 04/13/10 20:05:40	31,607	04/13/10 20:57:28 04/13/10 20:57:54	04/13/10 20:57:54 04/13/10 20:58:28
47	0413105604	04/13/10 11:18:51 04/13/10 17:13:03	21,252	04/13/10 20:58:28 04/13/10 20:58:55	04/13/10 20:58:55 04/13/10 20:59:30
48	0413105605	04/13/10 11:18:51 04/13/10 19:21:10	28,939	04/13/10 20:59:30 04/13/10 21:00:02	04/13/10 21:00:02 04/13/10 21:00:36
49	0413105606	04/13/10 11:18:51 04/13/10 19:24:40	29,149	04/13/10 21:00:36 04/13/10 21:01:02	04/13/10 21:01:02 04/13/10 21:01:37
50	0413105607	04/13/10 11:18:51 04/13/10 17:37:28	22,717	04/13/10 21:01:37 04/13/10 21:02:02	04/13/10 21:02:02 04/13/10 21:02:37



HP Integrity Superdome 2

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Duration of Stream Execution (Continued):

Thruput Stream	Seed	Query Start Time Query End Time	Duration (sec)	RF1 Start Time RF1 End Time	RF2 Start Time RF2 End Time
51	0413105608	04/13/10 11:18:51 04/13/10 18:34:28	26,137	04/13/10 21:02:37 04/13/10 21:03:05	04/13/10 21:03:05 04/13/10 21:03:39
52	0413105609	04/13/10 11:18:51 04/13/10 18:50:22	27,091	04/13/10 21:03:39 04/13/10 21:04:04	04/13/10 21:04:04 04/13/10 21:04:38
53	0413105610	04/13/10 11:18:51 04/13/10 18:39:35	26,444	04/13/10 21:04:38 04/13/10 21:05:02	04/13/10 21:05:02 04/13/10 21:05:36
54	0413105611	04/13/10 11:18:51 04/13/10 19:48:49	30,598	04/13/10 21:05:36 04/13/10 21:06:04	04/13/10 21:06:04 04/13/10 21:06:38
55	0413105612	04/13/10 11:18:51 04/13/10 17:42:00	22,989	04/13/10 21:06:38 04/13/10 21:07:02	04/13/10 21:07:02 04/13/10 21:07:36
56	0413105613	04/13/10 11:18:51 04/13/10 17:02:36	20,625	04/13/10 21:07:36 04/13/10 21:08:05	04/13/10 21:08:05 04/13/10 21:08:40
57	0413105614	04/13/10 11:18:51 04/13/10 16:34:50	18,959	04/13/10 21:08:40 04/13/10 21:09:11	04/13/10 21:09:11 04/13/10 21:09:45
58	0413105615	04/13/10 11:18:52 04/13/10 19:13:13	28,461	04/13/10 21:09:45 04/13/10 21:10:13	04/13/10 21:10:13 04/13/10 21:10:48
59	0413105616	04/13/10 11:18:52 04/13/10 18:36:55	26,283	04/13/10 21:10:48 04/13/10 21:11:16	04/13/10 21:11:16 04/13/10 21:11:51
60	0413105617	04/13/10 11:18:53 04/13/10 17:51:56	23,583	04/13/10 21:11:51 04/13/10 21:12:22	04/13/10 21:12:22 04/13/10 21:12:57
61	0413105618	04/13/10 11:18:52 04/13/10 17:41:23	22,951	04/13/10 21:12:57 04/13/10 21:13:20	04/13/10 21:13:20 04/13/10 21:13:55
62	0413105619	04/13/10 11:18:52 04/13/10 20:08:27	31,775	04/13/10 21:13:55 04/13/10 21:14:24	04/13/10 21:14:24 04/13/10 21:14:59
63	0413105620	04/13/10 11:18:52 04/13/10 18:34:46	26,154	04/13/10 21:14:59 04/13/10 21:15:32	04/13/10 21:15:32 04/13/10 21:16:06
64	0413105621	04/13/10 11:18:52 04/13/10 19:22:43	29,031	04/13/10 21:16:06 04/13/10 21:16:33	04/13/10 21:16:33 04/13/10 21:17:07



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Duration of stream execution:

Stream ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Stream 00	142.0	9.4	8.6	7.8	39.4	5.3	41.8	22.4	104.3	27.6	12.0	32.2
Stream 01	0.1	10.7	33.0	0.1	0.1	0.1	0.1	33.7	0.1	0.1	3.9	155.8
Stream 02	0.1	62.6	0.1	256.7	0.1	6.0	480.7	576.7	5587.2	3758.7	204.6	1323.0
Stream 03	1467.9	77.8	0.1	0.1	1570.8	80.9	3711.9	2002.7	1704.7	1942.6	135.8	108.4
Stream 04	1229.7	57.4	98.7	0.1	807.2	87.2	0.1	514.0	4788.9	0.1	9.3	1647.7
Stream 05	0.1	30.8	29.5	0.1	0.1	15.3	0.1	89.4	0.1	0.1	4.1	216.8
Stream 06	0.1	84.7	537.2	193.7	0.1	74.6	2315.5	852.3	5728.0	360.5	4.5	1419.1
Stream 07	2462.9	82.3	197.0	243.3	0.1	0.1	0.1	718.9	0.1	0.1	8.8	609.7
Stream 08	3628.0	82.9	271.1	245.4	944.6	86.0	2189.6	590.1	4431.6	2796.0	169.6	1420.8
Stream 09	0.1	95.1	268.1	337.8	1514.8	35.4	0.3	1178.9	0.1	0.3	253.5	642.5
Stream 10	2179.9	76.0	236.5	255.5	0.1	99.7	0.1	646.0	0.1	0.1	14.0	466.2
Stream 11	0.1	105.9	394.1	233.9	1552.2	97.9	0.1	574.6	0.1	2456.2	9.2	1038.6
Stream 12	4106.5	0.1	300.6	203.5	1336.1	28.5	3367.8	254.7	3071.6	0.2	93.4	753.9
Stream 13	0.1	7.4	0.1	0.1	0.1	0.1	0.1	22.6	0.1	0.1	2.9	146.6
Stream 14	2233.7	216.4	12.0	319.5	0.1	0.1	3381.7	27.5	11036.8	0.1	3.1	30.6
Stream 15	0.1	74.9	269.7	214.7	0.1	33.6	0.1	596.7	5778.2	0.1	211.5	776.5
Stream 16	3757.5	82.4	364.4	348.2	2397.2	62.4	0.1	653.1	4543.9	1103.0	139.6	1734.3
Stream 17	0.1	32.9	896.6	0.1	2150.3	8.5	0.1	49.1	0.1	0.1	289.9	44.3
Stream 18	2456.1	101.7	279.2	871.4	2244.7	73.8	1194.3	749.1	0.1	2669.5	130.5	463.8
Stream 19	0.1	56.6	22.6	896.4	1701.0	16.6	0.1	741.0	3911.9	3200.1	61.9	1874.9
Stream 20	1461.4	72.9	237.7	605.1	0.1	58.4	3585.3	689.2	4643.5	2110.4	4.2	818.3
Stream 21	0.1	22.4	0.1	0.1	0.1	0.1	0.1	108.9	194.4	0.1	4.3	0.1
Stream 22	2591.6	72.5	220.5	0.1	0.1	0.1	0.1	545.4	2308.3	2.1	236.7	1398.8
Stream 23	2336.2	85.0	34.3	0.1	731.7	0.1	0.1	628.0	4018.6	1384.3	10.2	1581.0
Stream 24	1952.7	75.1	337.4	286.1	0.1	0.1	4223.3	630.3	3754.3	2756.4	72.0	494.9
Stream 25	2042.9	70.0	308.7	0.1	925.8	0.1	0.1	772.9	3097.8	2709.8	7.2	1829.6
Stream 26	206.9	70.4	0.1	0.1	2164.7	0.1	3461.6	104.7	1612.3	1305.4	112.8	268.8
Stream 27	898.6	94.2	81.9	0.1	1709.0	0.1	2333.5	708.4	3732.6	0.1	3.2	278.1
Stream 28	2027.4	104.2	260.5	178.9	861.4	0.1	3532.0	233.8	1630.3	2259.4	3.2	659.2
Stream 29	1982.9	90.8	295.4	0.1	1211.1	42.5	3557.6	993.7	4765.8	2072.1	5.6	519.4
Stream 30	2822.2	7.2	287.8	0.1	1615.6	0.1	5155.2	22.0	3758.6	3695.4	2.9	791.0
Stream 31	2577.8	292.8	0.1	217.6	0.1	0.1	0.1	403.0	12457.5	0.1	18.7	275.0
Stream 32	2096.9	24.2	233.8	344.5	0.1	67.1	2304.4	752.9	4754.5	0.1	4.1	1412.0



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Stream ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Stream 33	143.1	134.4	35.0	338.3	1683.5	0.1	3221.8	25.0	437.9	0.1	208.1	25.4
Stream 34	3454.9	60.1	286.1	333.5	0.1	0.1	0.1	477.2	4402.0	0.1	209.7	1019.2
Stream 35	1500.1	42.4	0.1	0.1	58.8	0.1	0.1	1012.6	3257.1	3442.4	3.6	2004.8
Stream 36	540.9	13.1	0.1	250.4	0.1	12.3	0.1	29.2	15144.9	0.1	44.6	37.7
Stream 37	2879.6	84.8	317.7	176.9	2148.9	0.1	2790.8	542.6	4322.6	0.1	139.2	1200.2
Stream 38	1848.6	74.2	177.5	327.8	3098.3	0.1	2801.1	696.4	2930.7	2526.5	206.4	930.3
Stream 39	2086.6	27.5	1042.1	0.1	1814.7	33.1	3748.3	279.6	2072.8	0.1	3.7	280.1
Stream 40	1866.4	75.8	258.2	257.0	897.8	0.3	1461.5	628.0	3931.0	1894.6	192.0	546.5
Stream 41	0.1	292.6	385.8	201.7	0.1	35.4	2789.4	349.7	8191.0	0.1	163.6	534.1
Stream 42	0.1	10.4	21.2	0.1	0.1	0.1	0.1	26.5	185.0	0.1	3.6	82.4
Stream 43	2271.6	67.2	0.1	204.5	1151.1	154.0	3731.6	541.9	4562.4	3247.3	5.8	1396.0
Stream 44	1555.7	98.8	0.1	0.1	1799.3	76.2	3455.5	1769.1	3967.1	0.1	22.4	1863.1
Stream 45	0.1	71.9	0.1	0.1	801.2	90.5	1374.8	467.5	4375.2	0.1	7.2	1114.3
Stream 46	0.1	20.0	17.9	0.1	0.2	0.1	0.1	82.6	138.0	0.1	4.2	256.6
Stream 47	2517.7	0.2	132.6	0.1	1283.8	58.6	2634.3	583.7	5605.4	5063.9	176.7	679.1
Stream 48	0.1	22.2	10.0	0.1	0.1	0.1	0.1	507.5	0.1	0.1	20.0	36.5
Stream 49	3280.4	108.0	309.7	0.1	803.6	99.6	2654.1	756.3	5730.6	0.1	10.2	455.4
Stream 50	0.1	68.3	196.2	242.7	0.1	42.2	3315.2	1217.7	600.6	0.1	146.9	1964.2
Stream 51	1703.3	40.8	35.8	101.2	0.1	152.4	2649.9	222.3	2707.0	3500.7	5.4	1007.7
Stream 52	0.1	0.1	0.1	315.1	0.1	0.1	0.1	844.3	0.1	2358.6	25.1	779.4
Stream 53	3878.8	86.7	15.0	301.1	0.1	59.9	3663.3	568.4	3889.7	0.1	48.1	714.9
Stream 54	0.1	9.3	20.2	7.2	0.1	0.1	0.1	22.1	0.1	0.1	2.8	117.0
Stream 55	1696.7	812.5	0.1	204.1	1639.0	52.4	2949.4	600.8	5262.7	0.1	4.6	759.5
Stream 56	2461.0	80.5	328.9	0.3	0.1	32.9	0.1	693.1	5578.1	0.1	147.7	741.2
Stream 57	4178.5	83.4	226.5	251.8	2114.5	58.0	0.1	658.9	3624.9	1897.2	132.0	1212.3
Stream 58	0.1	11.6	1312.3	0.1	1678.5	12.0	0.1	46.4	0.1	0.1	4.4	54.2
Stream 59	1991.8	97.1	201.0	666.8	2554.1	0.1	0.1	627.7	1969.7	1214.0	4.2	378.7
Stream 60	2065.0	43.9	351.1	342.3	2095.8	74.6	3840.0	653.7	8424.0	0.1	7.9	1855.5
Stream 61	2849.4	67.4	205.7	263.0	1670.0	0.2	1092.5	454.4	0.1	2935.4	4.8	0.1
Stream 62	477.7	7.4	0.1	20.9	0.1	5.4	45.8	22.5	0.1	0.1	3.3	252.0
Stream 63	2417.3	98.5	109.2	210.3	0.1	0.1	2287.4	260.2	1648.7	0.1	5.8	1872.9
Stream 64	0.1	83.8	11.7	14.7	0.1	0.1	53.6	560.5	5704.0	0.1	4.7	1221.0
Minimum	0.1	0.1	0.1	0.1	0.1	0.1	0.1	22.0	0.1	0.1	2.8	0.1
Maximum	4178.5	812.5	1312.3	896.4	3098.3	154.0	5155.2	2002.7	15144.9	5063.9	289.9	2004.8
Average	1471.7	81.5	195.6	176.3	824.0	31.7	1490.0	526.4	3280.9	1010.4	65.7	790.5



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Duration of stream execution:

Stream ID	Q13	Q14	Q15a	Q16	Q17	Q18	Q19	Q20	Q21	Q22	RF1	RF2
Stream 00	69.6	4.0	6.3	12.1	35.0	167.6	47.1	14.7	178.1	12.1	39.7	56.0
Stream 01	0.1	0.1	0.1	31.9	73.7	0.1	47.7	32.5	29143.1	18.2	35.3	35.0
Stream 02	0.1	101.2	0.1	1024.6	1734.8	0.1	774.1	214.6	9975.1	245.8	32.2	34.8
Stream 03	0.1	0.1	187.9	18.8	401.4	845.4	81.5	175.8	15761.6	184.4	38.5	35.1
Stream 04	0.1	54.5	209.7	327.8	507.3	0.1	584.7	64.7	13557.9	129.9	22.8	35.0
Stream 05	0.1	0.1	0.1	27.3	62.7	0.1	53.3	55.6	30720.6	150.9	22.9	34.7
Stream 06	1977.7	0.1	287.1	520.6	501.4	0.1	557.4	160.9	949.5	216.8	22.9	35.1
Stream 07	0.1	0.1	124.8	387.5	391.8	5616.2	489.7	96.5	12391.0	245.0	23.1	35.0
Stream 08	967.3	0.1	174.0	594.9	265.2	0.1	471.4	208.9	0.1	311.7	23.3	35.1
Stream 09	2566.3	61.1	0.1	643.6	328.0	0.1	670.9	125.4	11770.8	341.3	23.0	34.9
Stream 10	0.1	59.5	707.6	604.6	356.9	12375.6	599.3	218.8	2560.0	287.2	23.2	35.1
Stream 11	0.1	133.4	782.4	470.0	308.4	9165.0	748.5	164.5	0.1	291.5	25.2	34.8
Stream 12	0.1	68.9	0.1	408.6	257.6	0.1	850.9	211.9	3225.0	188.9	27.3	35.0
Stream 13	0.1	4.0	0.1	12.9	176.9	0.1	61.3	13.9	28685.6	41.0	23.2	35.0
Stream 14	0.1	5.2	216.3	577.7	415.6	970.9	52.7	189.9	7255.4	15.6	32.4	34.7
Stream 15	1912.2	65.0	0.1	993.3	414.6	0.1	509.6	166.5	9870.2	284.1	26.9	34.8
Stream 16	0.1	44.7	0.1	521.2	374.4	1.0	812.1	114.6	9296.1	197.0	32.1	34.2
Stream 17	0.1	5.8	0.1	836.6	67.5	0.1	58.5	21.9	24968.5	25.1	29.7	34.1
Stream 18	2728.4	83.5	85.0	153.5	560.3	0.1	787.5	236.0	9253.4	77.9	25.3	34.6
Stream 19	0.1	54.6	116.7	523.2	188.7	0.1	56.5	20.2	16710.6	274.5	28.8	34.2
Stream 20	2449.3	91.5	272.5	1047.1	282.2	1000.4	507.8	184.3	0.1	148.5	31.6	35.3
Stream 21	0.1	169.6	0.1	57.8	121.6	0.1	102.0	766.5	29783.1	76.3	24.9	34.5
Stream 22	2733.3	81.4	150.0	1046.4	49.9	0.1	599.6	137.1	12807.3	282.0	31.6	34.5
Stream 23	0.1	101.3	0.1	751.2	254.9	13182.5	60.0	27.3	0.1	328.8	30.3	34.7
Stream 24	0.1	107.3	0.1	231.0	200.3	0.1	267.2	244.8	8984.5	295.5	31.5	34.3
Stream 25	0.1	49.8	0.1	753.4	552.0	5614.3	453.7	193.7	3746.3	327.8	30.6	34.3
Stream 26	3042.9	63.9	0.1	20.8	101.1	0.1	98.0	160.9	13513.8	204.2	30.1	34.6
Stream 27	0.1	81.8	0.1	185.4	1284.6	0.1	75.0	40.7	13608.4	267.4	31.0	34.3
Stream 28	1745.8	76.0	0.1	590.4	349.3	0.1	257.2	219.8	10511.6	303.8	31.6	34.6
Stream 29	0.1	87.3	230.2	626.2	428.8	2247.1	715.9	156.0	0.1	268.6	29.4	34.4
Stream 30	0.1	67.3	0.1	40.9	259.7	1305.3	186.8	13.5	11619.4	223.3	25.2	34.6
Stream 31	0.1	20.2	92.7	552.4	274.8	0.1	501.1	137.0	5987.3	117.6	28.2	34.3
Stream 32	2234.2	0.1	1100.8	500.5	399.1	3035.8	64.0	22.1	7006.5	298.8	29.7	39.3



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Duration of stream execution:

Stream ID	Q13	Q14	Q15a	Q16	Q17	Q18	Q19	Q20	Q21	Q22	RF1	RF2
Stream 33	0.1	46.9	1111.2	848.8	542.9	0.1	45.8	97.0	20907.9	15.0	29.8	34.3
Stream 34	2155.7	60.4	0.1	548.5	339.3	0.1	423.8	205.9	8740.1	259.1	29.0	34.3
Stream 35	0.1	83.0	0.1	722.2	1407.8	0.1	231.0	243.9	10440.2	353.0	25.0	34.3
Stream 36	0.1	5.3	0.1	26.2	429.1	0.5	49.0	21.2	10044.8	144.5	27.7	34.4
Stream 37	2881.0	88.9	0.1	537.4	361.4	0.1	485.5	36.3	11614.5	145.7	29.9	34.1
Stream 38	0.1	123.1	0.1	764.2	535.9	0.1	713.3	407.3	5043.4	239.8	26.6	34.5
Stream 39	0.1	58.0	124.9	527.8	129.5	0.2	721.6	198.4	11999.3	73.2	32.2	34.1
Stream 40	2879.2	49.8	0.1	510.1	384.3	0.1	184.3	173.1	8712.5	171.7	30.7	34.1
Stream 41	1.5	110.5	241.0	557.6	243.0	0.1	663.6	107.3	8682.2	314.0	26.2	34.3
Stream 42	0.1	5.6	0.1	15.3	54.2	0.1	54.9	29.5	28114.4	13.4	27.2	34.1
Stream 43	1569.2	83.5	142.0	756.8	1342.5	0.1	569.7	144.3	0.1	278.9	30.7	34.5
Stream 44	1221.4	54.2	0.1	603.6	399.0	4123.0	601.0	227.9	0.1	220.5	31.3	34.4
Stream 45	1140.1	77.6	176.7	358.2	504.8	0.1	575.0	55.8	13716.8	87.8	30.5	34.3
Stream 46	0.1	9.4	0.1	25.0	62.4	0.1	98.7	53.0	30806.4	33.2	26.1	34.0
Stream 47	0.1	76.1	119.5	545.2	569.4	0.1	752.1	179.9	0.1	274.0	27.4	34.6
Stream 48	0.1	10.3	0.1	26.6	51.6	12541.2	54.6	190.9	15443.1	25.2	31.7	34.4
Stream 49	0.1	51.7	167.5	645.9	269.1	0.1	959.2	228.2	12211.6	408.0	25.9	34.5
Stream 50	2668.5	48.6	0.1	428.3	341.2	0.1	548.1	126.0	10519.4	242.9	25.7	34.3
Stream 51	0.1	49.8	635.7	76.3	369.0	4823.7	97.6	36.1	7744.3	178.0	28.3	34.2
Stream 52	0.1	109.1	1331.6	589.2	406.1	11738.8	49.3	193.8	8060.4	290.1	25.2	33.9
Stream 53	0.1	8.3	35.9	714.5	274.8	4009.0	61.9	200.6	7674.3	238.4	23.1	34.0
Stream 54	0.1	4.0	0.1	12.1	81.3	0.1	47.7	12.9	30247.2	14.4	28.1	34.4
Stream 55	1849.9	64.8	123.4	422.8	290.7	2158.2	638.9	111.5	3146.9	199.7	24.0	34.2
Stream 56	0.1	87.9	0.1	1239.2	411.1	0.1	778.3	239.0	7474.2	331.2	28.7	34.6
Stream 57	2121.9	58.2	183.3	670.6	403.7	0.1	778.0	85.5	0.1	219.7	31.3	34.2
Stream 58	0.1	0.1	0.1	888.5	53.0	0.1	56.2	45.5	24229.1	69.3	27.2	35.3
Stream 59	2175.6	132.1	40.4	51.6	427.1	0.1	443.1	181.5	13100.8	26.5	27.8	34.6
Stream 60	0.1	90.9	100.3	505.0	284.9	0.1	692.6	190.0	1552.6	413.0	31.2	35.4
Stream 61	1648.7	82.3	0.2	1425.6	490.2	8867.4	478.1	163.5	0.1	252.4	23.2	34.1
Stream 62	0.1	96.4	0.1	12.6	53.6	0.1	51.3	890.5	29820.2	15.2	29.6	34.4
Stream 63	1793.9	87.9	101.7	1274.8	56.6	0.3	674.0	76.7	12895.8	282.4	33.4	34.2
Stream 64	0.1	47.1	199.1	23.1	164.1	5610.8	65.7	17.2	15006.1	244.3	26.4	34.4
Minimum	0.1	0.1	0.1	12.1	49.9	0.1	45.8	12.9	0.1	13.4	22.8	33.9
Average	3042.9	169.6	1331.6	1425.6	1734.8	13182.5	959.2	890.5	30806.4	413.0	38.5	39.3
Maximum	726.1	57.8	149.6	491.2	370.0	1706.8	387.5	155.7	11275.2	199.1	28.2	34.6

Benchmark Sponsor: Sharada Bose
 Performance Manager BCS
 Hewlett-Packard
 Pruneridge Avenue, MS4105
 Cupertino, CA 95014

April 23, 2010

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

Platform: **HP Integrity Superdome 2**
 Database Manager: **Oracle Database 11g R2 Enterprise Edition with Partitioning and Oracle Automatic Storage**
 Operating System: **HP-UX 11i v3**

The results were:

CPU (Speed)	Memory	Disks	QphH@1000GB
HP Integrity Superdome 2			
16 x Intel Itanium 9350 (1.73GHz, quad-core)	24MB iL3 512GB Main	576 x 72GB 15Krpm 4 x 146GB 10Krpm	140,181.1

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
- 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 one 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 64 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,

A handwritten signature in black ink, appearing to read "François Raab", with a long horizontal flourish extending to the right.

François Raab
President

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0 General Items

0.1 Benchmark Sponsor

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

Hewlett-Packard Company is the test sponsor of this TPC Benchmark H benchmark.

0.2 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:

Database Tuning Options

Optimizer/Query execution options

Query processing tool/language configuration parameters

Recovery/commit options

Consistency/locking options

Operating system and configuration parameters

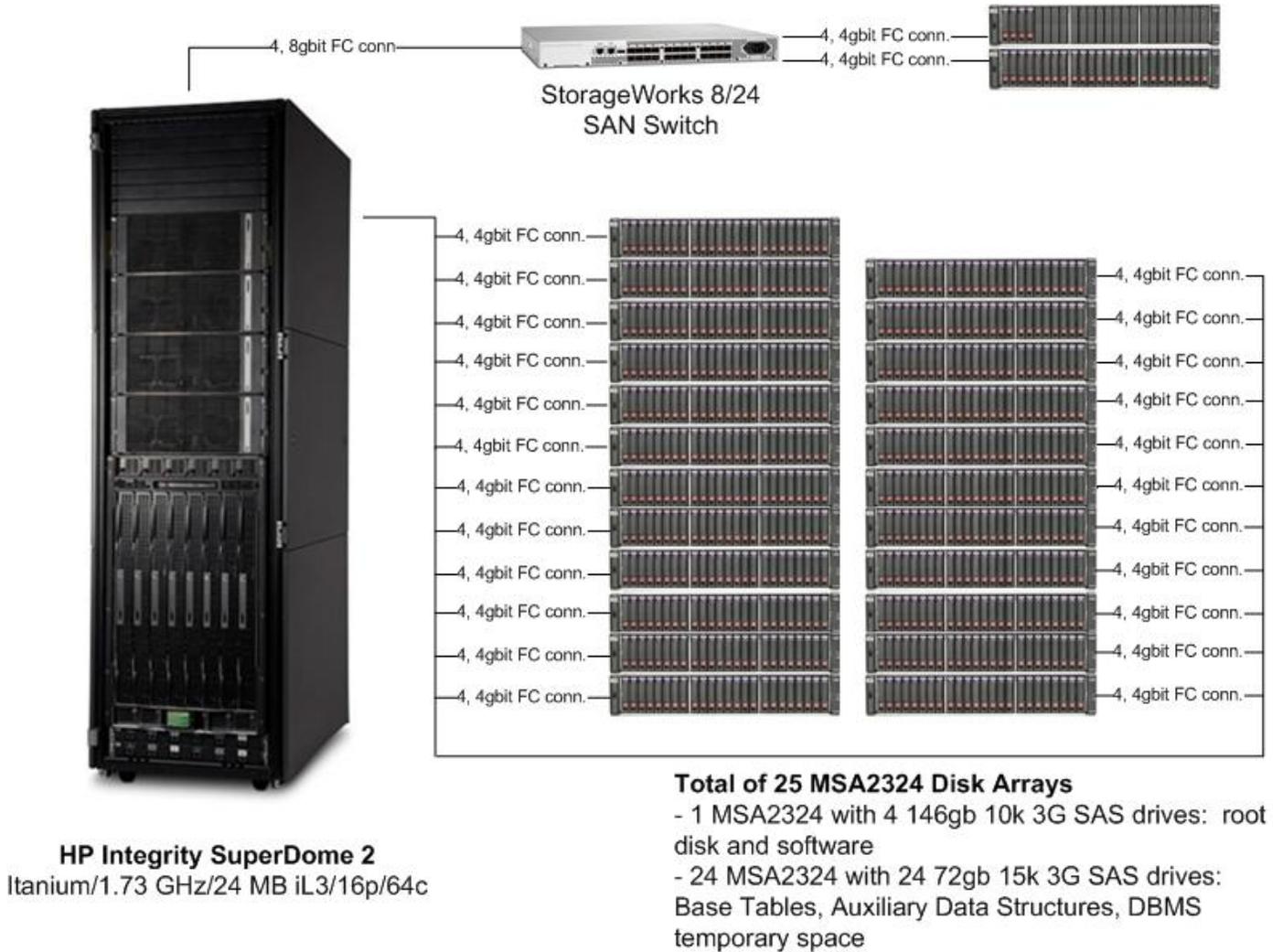
Configuration parameters and options for any other software component incorporated into the pricing structure;

Compiler optimization options.

The Supporting Files Archive contains the HP-UX and Oracle 11g R2 parameters used in this benchmark.

0.3 Configuration Diagrams

Diagrams of both measured and priced configurations must be provided, accompanied by a description of the differences.



Measured Configuration

- 16 1.73 Ghz Intel Itanium 9350 CPUs each with 24MB iL3 cache
- 512 GB Memory
- 4 I/O Expansion Cabinets
- 48 PCIe 2-port 8Gb Fibre Channel Adapter Cards
- 16 Embedded LAN Cards
- 1 HP GbE2c Ethernet Blade Switch
- 1 HP HP MSA 2324 (with a total of 4 146GB disks)
24 HP MSA 2324 (with a total of 576 72GB disks)

Priced Configuration

- 16 1.73 Ghz Intel Itanium 9350 CPUs each with 24MB iL3 cache
- 512 GB Memory
- 4 I/O Expansion Cabinets
- 48 PCIe 2-port 8Gb Fibre Channel Adapter Cards
- 16 Embedded LAN Cards
- 1 HP ProCurve 6120XG Ethernet Blade Switch
- 1 HP HP MSA 2324 (with a total of 4 146GB disks)
24 HP MSA 2324 (with a total of 576 72GB disks)

Differences in Configurations

The following substitutions have no impact on the reported performance. The measured system uses a "HP GbE2c Ethernet Blade Switch" instead of a "HP ProCurve 6120XG Ethernet Blade Switch."

1 Clause 1 Logical Database Design Related Items

1.1 Database Definition Statements

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 scripts that define, create, and analyze the tables and indices for the TPC-H database.

1.2 Physical 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.

No record clustering or index clustering was used. Columns were reordered in the tables – please refer to the table create statements for the ordering.

1.3 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 all base and index tables except NATION and REGION. The details of this partitioning can be understood by examining the syntax of the table and index definition statements in the Supporting Files Archive. Similar partitioning was used in the qualification database size.

Section 5.2 describes the distribution of tables and logs across all media.

1.4 Replication

Any replication of physical objects must be disclosed and must conform to the requirements of Clause 1.5.6.

No replication was used.

2 Clause 2 Queries and Refresh Functions

2.1 Query Language

The query language used to implement the queries must be identified.

SQL was the query language used to implement all queries.

2.2 Verifying Method for Random Number Generation

The method of verification for the random number generation must be described unless the supplied DBGEN and QGEN were used.

TPC supplied versions 2.10.0 of DBGEN and QGEN were used for this TPC-H benchmark.

2.3 Generating Values for Substitution Parameters

The method used to generate values for substitution parameters must be disclosed. If QGEN is not used for this purpose, then the source code of any non-commercial tool used must be disclosed. If QGEN is used, the version number, release number, modification number, and patch level of QGEN must be disclosed.

QGEN version 2.10.0 was used to generate the substitution parameters.

2.4 Query Text and Output Data from Qualification Database

The executable query text used for query validation must be disclosed 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 definition 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 output data for the power and throughput tests must be made available electronically upon request.

The Supporting Files Archive contains the actual query text and query output.

2.5 Query Substitution Parameters and Seeds Used

The query substitution parameters used for all performance tests must be disclosed in tabular format, along with the seeds used to generate these parameters.

The Supporting Files Archive contains the seed and query substitution parameters.

2.6 Query Isolation Level

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

The queries and transactions were run with the isolation level set to "Level 3" (repeatable read).

2.7 Source Code of Refresh Functions

The details of how the refresh functions were implemented must be disclosed (including source code of any non-commercial program used).

The refresh function is part of the implementation-specific layer/driver code included in the Supporting Files Archive.

3 Clause 3 Database System Properties

3.1 ACID Properties

The ACID (Atomicity, Consistency, Isolation, and Durability) properties of transaction processing systems must be supported by the system under test during the timed portion of this benchmark. Since TPC-H is not a transaction processing benchmark, the ACID properties must be evaluated outside the timed portion of the test.

Source code for ACID test is included in the Supporting Files Archive.

3.2 Atomicity

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.

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 ORDERS, LINEITEM, and HISTORY tables.

1. The total price from the ORDERS table and the extended price from the LINEITEM table were retrieved for a randomly selected order key.
2. The ACID Transaction was performed using the order key from step 1.
3. The ACID Transaction committed.
4. The total price from the ORDERS table and the extended price from the LINEITEM table were retrieved for the same order key. It was verified that the appropriate rows had been changed.

Aborted Transaction

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 ORDERS, LINEITEM, and HISTORY tables.

1. The total price from the ORDERS table and the extended price from the LINEITEM table were retrieved for a randomly selected order key.
2. The ACID Transaction was performed using the order key from step 1. The transaction was stopped prior to the commit.
3. The ACID Transaction was ROLLED BACK.
4. The total price from the ORDERS table and the extended price from the LINEITEM table were retrieved for the same order key. It was verified that the appropriate rows had not been changed.

3.3 Consistency

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

Consistency Test

Verify that ORDERS and LINEITEM tables are initially consistent, submit the prescribed number of ACID Transactions with randomly selected input parameters, and re-verify the consistency of the ORDERS and LINEITEM.

1. The consistency of the ORDERS and LINEITEM tables was verified based on a sample of order keys.
2. 100 ACID Transactions were submitted from each of 65 execution streams.
3. The consistency of the ORDERS and LINEITEM tables was re-verified.

3.4 Isolation

Operations of concurrent transactions must yield results, which are indistinguishable from the results, which would be obtained by forcing each transaction to be serially executed to completion in some order.

Read-Write Conflict with Commit

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

1. An ACID Transaction was started for a randomly selected O_KEY, L_KEY, and DELTA. The ACID Transaction was suspended prior to COMMIT.
2. An ACID Query was started for the same O_KEY used in step 1. The ACID Query blocked and did not see any uncommitted changes made by the ACID Transaction.
3. The ACID Transaction was resumed, and COMMITTED.
4. The ACID Query completed. It returned the data as committed by the ACID Transaction.

Read-Write Conflict with Rollback

Demonstrate isolation for the read-write conflict of a read-write transaction and a read-only transaction when the read-write transaction is rolled back.

1. An ACID Transaction was started for a randomly selected O_KEY, L_KEY, and DELTA. The ACID Transaction was suspended prior to ROLLBACK.
2. An ACID Query was started for the same O_KEY used in step 1. The ACID Query did not see the uncommitted changes made by the ACID Transaction.
3. The ACID Transaction was ROLLED BACK.
4. The ACID Query completed.

Write-Write Conflict with Commit

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

1. An ACID Transaction, T1, was started for a randomly selected O_KEY, L_KEY, and DELTA. The ACID transaction T1 was suspended prior to COMMIT.
2. Another ACID Transaction, T2, was started using the same O_KEY and L_KEY and a randomly selected DELTA.
3. T2 waited.
4. T1 was allowed to COMMIT and T2 completed.
5. It was verified that $T2.L_EXTENDEDPRICE = T1.L_EXTENDEDPRICE + (DELTA1 * (T1.L_EXTENDEDPRICE / T1.L_QUANTITY))$

Write-Write Conflict with Rollback

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

1. An ACID Transaction, T1, was started for a randomly selected O_KEY, L_KEY, and DELTA. The ACID transaction T1 was suspended prior to ROLLBACK.
2. Another ACID Transaction, T2, was started using the same O_KEY and L_KEY and a randomly selected DELTA.
3. T2 waited.
4. T1 was allowed to ROLLBACK and T2 completed.
5. It was verified that $T2.L_EXTENDEDPRICE = T1.L_EXTENDEDPRICE$.

Concurrent Progress of Read and Write on Different Tables

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

1. An ACID Transaction, T1, was started for a randomly selected O_KEY, L_KEY, and DELTA. T1 was suspended prior to COMMIT.
2. Another ACID transaction, T2 was started using random values for PS_PARTKEY and PS_SUPPKEY, all columns of the PARTSUPP table for which PS_PARTKEY and PS_SUPPKEY are equal are returned.
3. ACID Transaction T2 completed.
4. T1 was allowed to COMMIT.
5. It was verified that the appropriate rows in the ORDER, LINEITEM, and HISTORY tables have been changed.

Read-Only Query Conflict with Update Transactions

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. A Transaction, T1, was started which executed Q21 against the qualification database, was started using a randomly selected DELTA.
2. An ACID Transaction, T2, was started for a randomly selected O_KEY, L_KEY and DELTA.
3. T2 completed and appropriate rows in the ORDERS, LINEITEM and HISTORY tables had been changed.
4. Transaction T1 completed executing Q21.

3.5 Durability

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

Failure of a Durable Medium

Guarantee the database and committed updates are preserved across a permanent irrecoverable failure of any single durable medium containing TPC-H database tables or recovery log tables.

In this test, after each of the 65 streams had completed at least 100 transactions, a disk containing TPC-H tables, indexes and database transaction log data was removed from an array. Since all disks are in RAID-1/0 configuration, the streams continued to submit transactions uninterrupted. After verifying that transactions continued, power to the server was turned off using the “POWEROFF PARTITION 1 FORCE” command on the Onboard Administrator. Because the “FORCE” option was specified, the OS running in the partition did not perform a graceful shutdown before power was removed.. When the power was restored, the system rebooted and the database was restarted. The durability success file and the HISTORY table were compared and the counts were verified, and the consistency of the ORDERS and LINEITEM tables were verified.

System Crash

Guarantee the database and committed updates are preserved across an instantaneous interruption (system crash/system hang) in processing which requires the system to reboot to recover.

The system crash and memory failure tests were combined. In this test, after each of the 65 streams had completed at least 100 transactions, power to the SUT was turned off during the durability test. Power to the server was turned off using the “POWEROFF PARTITION 1 FORCE” command on the Onboard Administrator. Because the “FORCE” option was specified, the OS running in the partition did not perform a graceful shutdown before power was removed. Power to the storage arrays was removed by turning off the power switches. When power was restored to the SUT, the system rebooted and the database was restarted. The durability success file and the HISTORY table were compared and the counts were verified, and the consistency of the ORDERS and LINEITEM tables were verified.

Memory Failure

Guarantee the database and committed updates are preserved across failure of all or part of memory (loss of contents).

See “System Crash”

Array Controller Failure

Durability across controller failure was demonstrated by turning off one of the arrays after each of the 65 streams had completed at least 100 transactions. Power to the storage arrays was removed by turning off the power switches. After the database server was restarted, the durability success files and HISTORY table counts were verified, and the consistency of the ORDERS and LINEITEM tables were verified.

4 Clause 4 Scaling and Database Population

4.1 Ending 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.

Table	Cardinality
ORDER	1,500,000,000
LINEITEM	5,999,989,709
CUSTOMER	150,000,000
PART	200,000,000
SUPPLIER	10,000,000
PARTSUPP	800,000,000
NATION	25
REGION	5

4.2 Distribution of Tables and Logs Across Media

Distribution of tables and logs across media:

Each of the 24 MSA2324 arrays (with 24 disks each) were configured with four MSA2324 vdisks comprising of 6 disks each. The vdisks were configured with RAID10 redundancy. Each MSA2324 vdisk was divided into 3 LUNs equaling a total of 12 LUNs on each MSA2324 array.

LUNs 0-3 (one from each vdisk): Oracle data (eg. tables, indexes, logs)

LUNs 4-7 (one from each vdisk): flate-file data

LUNs 8-11(one from each vdisk): Unused (a few used for Qualification database during the ACID/Qualification database phase of the audit)

OS root and the Oracle home directory were configured on four external disks in a MSA2324 with RAID1/0 redundancy.

96 LUNs, four from each 24 array, were allocated for Oracle ASM use and a single ASM disk group was built across all LUNs. All tables, indexes, temp space and other Oracle files were configured in this ASM disk group.

4.3 Database Partition/Replication Mapping

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

Horizontal partitioning was used for all base and index tables except NATION and REGION. The details of this partitioning can be understood by examining the syntax of the table and index definition statements in the supplemental files. Similar partitioning was used in the qualification database size.

Section 5.2 describes the distribution of tables and logs across all media..

4.4 RAID Feature

Implementation may use some form of RAID to ensure high availability. If used for data, auxiliary storage (e.g. indexes) or temporary space, the level of RAID must be disclosed for each device.

RAID1/0 was used for all data.

4.5 DBGEN Modification

Any modifications to the DBGEN (see clause 4.2.1) source code must be disclosed. In the event that a program other than DBGEN was used to populate the database, it must be disclosed in its entirety.

The supplied DBGEN version 2.10.0 was not modified to generate the database population for this benchmark.

4.6 Database Load Time

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

The database load time was 1:04:41.

4.7 Data Storage Ratio

The data storage ratio must be disclosed. It is computed as the ratio between the total amount of priced disk space, and the chosen test database size as defined in Clause 4.1.3.

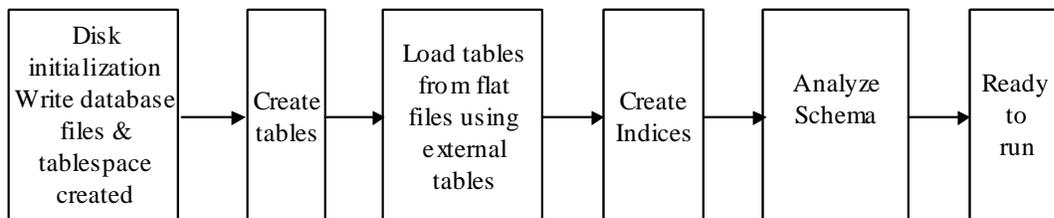
The data storage ratio is computed from the following information:

Type	# Disks	Disk Size (GB)	Total (GB)
24 HP MSA 2324	576	72	41472
1 HP HP MSA 2324	4	146	584.0
TOTAL			42,056.0
Scale Factor			1,000
Storage Ratio			42.06

4.8 Database Load Mechanism Details and Illustration

The details of the database load must be described, including a block diagram illustrating the overall process.

The database was loaded using data generation stored on the flat files all on the tested and priced configuration



4.9 Qualification Database Configuration

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

The qualification database used identical scripts to create and load the data with changes to adjust for the database scale factor.

4.10 Memory to Database Size Percentage

The memory to database size percentage, as defined in clause 8.3.5.10, must be disclosed.

The memory to database size percentage is 51.20%

5 Clause 5 Performance Metrics and Execution-Rules

5.1 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 disclosed.

Auditor requested queries were run against the database to verify the correctness of the database load.

All scripts and queries used are included in the Supporting Files Archive.

5.2 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 Transaction
2. Stream 00 Execution
3. RF2 Refresh Transaction

5.3 Timing Intervals for Each Query and Refresh Functions

The timing intervals for each query for both refresh functions must be reported for the power test.

The timing intervals for each query and both update functions are given in the Executive Summary earlier in this document.

5.4 Number of Streams for the Throughput Test

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

64 streams were used for the throughput test.

5.5 Start and End Date/Time of Each Query Stream

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

The throughput test start time and finish time for each stream are given in the Executive Summary earlier in this document.

5.6 Total Elapsed Time of the Measurement Interval

The total elapsed time of the measurement interval must be reported for the throughput test.

The total elapsed time of the throughput test is given in the Executive Summary earlier in this document.

5.7 Refresh Function Start Date/Time and Finish Date/Time

Start and finish time for each update function in the update stream must be reported for the throughput test.

Start and finish time for each update function in the update stream are given in the Executive Summary earlier in this document.

5.8 Timing Intervals for Each Query and Each Refresh Function for Each Stream

The timing intervals for each query of each stream and for each refresh function must be reported for the throughput test.

The timing intervals for each query and each update function are given in the Executive Summary earlier in this document.

5.9 Performance Metrics

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

The performance metrics, and the numbers, on which they are based, is given in the Executive Summary earlier in this document.

5.10 The Performance Metric and Numerical Quantities from Both Runs

The performance metric and numerical quantities from both runs must be disclosed.

Performance results from the first two executions of the TPC-H benchmark indicated the following percent difference for the metric points:

	QppH@1000GB	QthH@1000GB	QphH@1000GB
Reported Run	139,181.0	141,188.3	140,181.1
Reproducibility Run	196,428.6	153,870.4	173,852.1
% Difference	41.1%	9.0%	24.0%

5.11 System Activity Between Performance Tests

Any activity on the SUT that takes place between the conclusion of the Reported Run and the beginning of Reproducibility Run must be disclosed.

There was no activity on the SUT between the reported run and reproducibility run.

5.12 Dataset Verification

Verify that the rows in the loaded database after the performance test are correct by comparing some small number of rows extracted at random from any two files of the corresponding Base, Insert and Delete reference data set files for each table and the corresponding rows of the database.

Verified according to the specification.

5.13 Referential Integrity

Verify referential integrity in the database after the initial load.

Verified according to the specification.

6 Clause 6 SUT and Driver Implementation Related Items

6.1 Driver

A detailed description of how the driver performs its functions must be supplied, including any related source code or scripts. This description should allow an independent reconstruction of the driver.

All stream executions are performed by a single script. QGEN is used to produce query text.

For each power-test run:

- The SQL for RF1 is submitted to the database from the update stream
- Then the queries as generated by QGEN are submitted from the query stream in the order defined by Clause 5.3.5.4
- The SQL for RF2 is submitted to the database from the update stream

For each throughput-test run:

- The 64 query streams and a single update stream were launched in parallel at the start of the throughput test.
- The Update stream waited until all 64 query streams completed execution.
- The throughput run ended when the update stream completed execution.

6.2 Implementation-Specific Layer (ISL)

If an implementation specific layer is used, then a detailed description of how it performs its functions must be provided. All related source code, scripts and configuration files must be disclosed. The information provided should be sufficient for an independent reconstruction of the implementation specific layer.

The source code for the "qexec" utility can be found in the Supporting Files Archive.

6.3 Profile-Directed Optimization

If profile-directed optimization as described in Clause 5.2. is used, such use must be disclosed..

Profile-directed optimization subject to the requirements of 5.2.9 and 5.2.10 was not used.

7 Clause 7 Pricing

7.1 Hardware and Software Used in the Priced System

A detailed list of hardware and software used in the priced system must be reported. Each item must have vendor part number, description, and release/revision level, and either general availability status or committed delivery date. If package pricing is used, contents of the package must be disclosed. Pricing source(s) and effective date(s) of price(s) must also be reported.

A detailed list of hardware and software used in the priced system is included in the pricing sheet in the executive summary. All prices are currently effective.

7.2 Total Three Year Price

The total 3-year price of the entire configuration must be reported including: hardware, software, and maintenance charges. Separate component pricing is recommended. The basis of all discounts used must be disclosed.

A detailed pricing sheet of all the hardware and software used in this configuration and the 3-year maintenance costs, demonstrating the computation of the total 3-year price of the configuration, is included in the executive summary at the beginning of this document.

7.3 Availability Date

The committed delivery date for general availability of products used in the priced calculations must be reported. When the priced system includes products with different availability dates, the reported availability date for the priced system must be the date at which all components are committed to be available.

Server Hardware	Available 10/20/2010
Server Software	Available 10/20/2010
Storage	Available Now
Oracle Database 11g R2 Enterprise Edition with Partitioning and Oracle Automatic Storage Management	Available Now

*For orderability and pricing, contact: MaryBeth Pierantoni, mary.beth.pierantoni@oracle.com, 916-315-5081

8 Clause 8 Full Disclosure

8.1 Supporting Files Index Table

An index for all files included in the supporting files archive as required by Clauses 8.3.2 must be provided in the report.

Clause	Description	Pathname
Clause 1	OS and database parameter settings	SupportingFilesArchive/ Parameters
	Database creation scripts	SupportingFilesArchive/TestDB
Clause 2	Qualification queries/output	SupportingFilesArchive/QualDB_Out
	Query substitution parameter	SupportingFilesArchive/query_parameters
	Refresh functions	SupportingFilesArchive/TestDB_scripts/runuf1.sh
		SupportingFilesArchive/TestDB_scripts/runuf2.sh
Clause 3	ACID scripts and output	SupportingFilesArchive/ACID_scripts
		SupportingFilesArchive/ACID_Out
Clause 4	Database load scripts	SupportingFilesArchive/TestDB
	Qualification database scripts	SupportingFilesArchive/QualDB_scripts
Clause 5	Benchmark driver scripts	SupportingFilesArchive/TestDB_scripts
	Query and Refresh Output	SupportingFilesArchive/TestDB_Out

9 Clause 9 Audit Related Items

9.1 Auditor's Report

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 who to contact in order to obtain further information regarding the audit process.

This implementation of the TPC Benchmark H was audited by Francois Raab for InfoSizing (www.sizing.com). Further information regarding the audit process may be obtained from:

Francois Raab

InfoSizing (www.sizing.com)

125 West Monroe Street

Colorado Springs, CO_80907

(719) 473-7555

(719) 473-7554

The auditor's attestation letter is included at the front of this report.

Appendix A Price Quotes

From: mary.beth.pierantoni [mailto:mary.beth.pierantoni@oracle.com]
Sent: Thursday, April 22, 2010 10:48 AM
To: Shirley, John David
Subject: Pricing

Product	Price	Qty	Extended Price
Oracle Database 11g Enterprise Edition, Named User Plus for 3 years	\$11,875	32*	\$380,000
Partitioning, Named User Plus for 3 years	\$2,875	32*	\$92,000
Incident Server Support Package for 3 years	\$6,900	1	\$6,900
Oracle Mandatory E-Business Discount			<\$95,780>
Oracle TOTAL			\$383,120

(* 32 = 0.50 * 64). Explanation: For the purposes of counting the number of processors which require licensing, an Intel Itanium multicore chip with "n" cores shall be determined by multiplying "n" cores by a factor of 0.50.

Contact: MaryBeth Pierantoni, mary.beth.pierantoni@oracle.com, 916-315-5081