ORACLE®

TPC Benchmark   H
Full Disclosure Report

SPARC T5-4 Server
Using
Oracle Database 11g Release 2 Enterprise Edition
with Partitioning

Submitted for Review
November 25, 2013

	SPARC T5-4 Server	TPC-H Rev. 2.16.0 TPC-Pricing 1.7.0
ORACLE		**Report Date:** November 25, 2013

Total System Cost	Composite Query per Hour Metric	Price / Performance
$1,755,709 USD	**377,594.3 QphH@10,000GB**	**$4.65/QphH@10,000GB**

Database Size	Database Manager	Operating System	Other Software	Availability Date
10,000GB	Oracle Database 11g Release 2 Enterprise Edition with Partitioning	Oracle Solaris 11.1	None	November 25, 2013

Throughput ▮
Power ▯
Geometric Mean of Power ——
Arithmetic Mean of Throughput ----

105.0   9326.2

Query Time in seconds
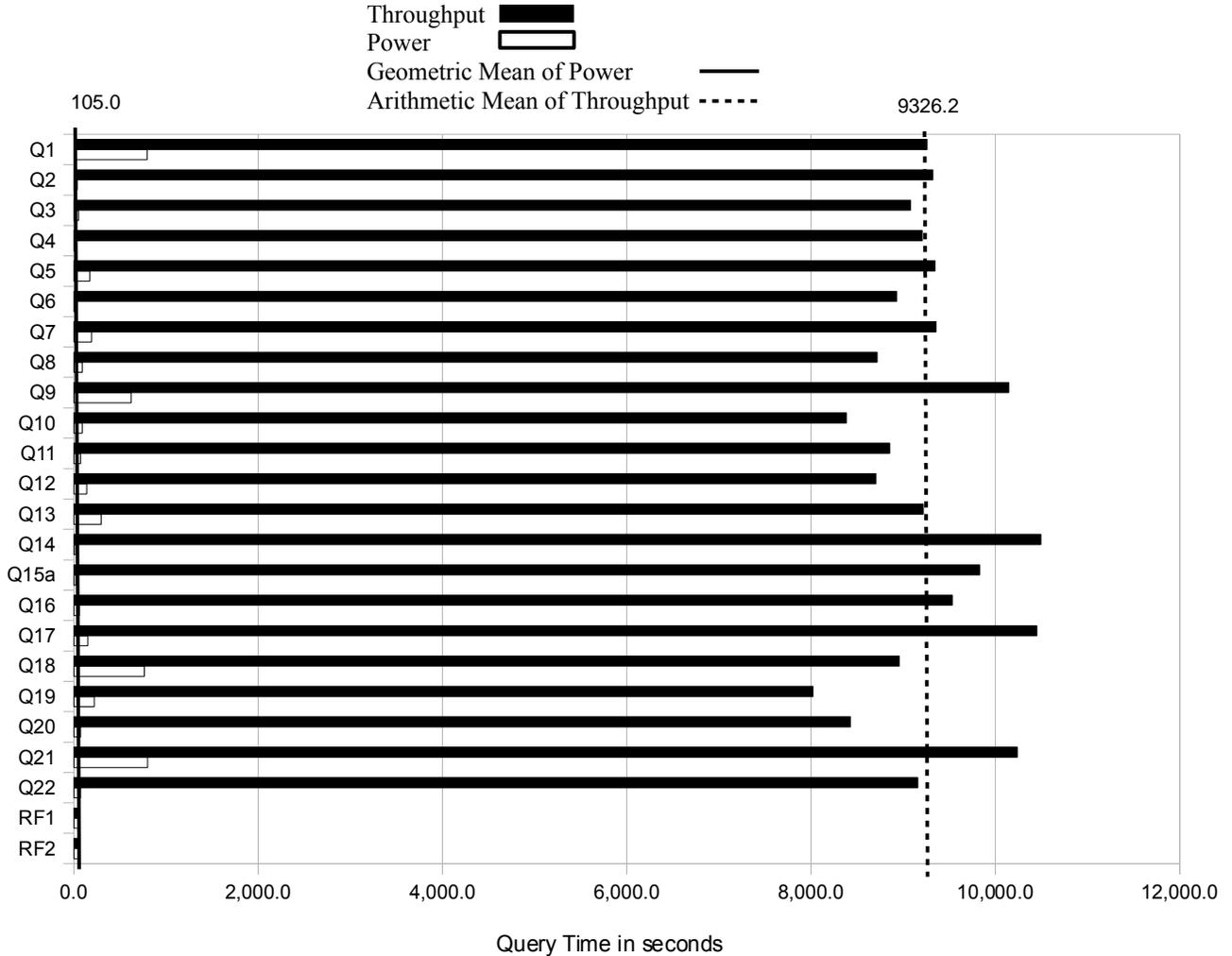
Database Load Time = 9:37:54
Load Includes Backup: N
Total Data Storage / Database Size = 60.8
Memory to Database Size Percentage = 20%

Storage Redundancy Levels:
  Base Tables: Level Three
  Auxiliary Data Structures: Level Three
  DBMS Temporary Space: Level Zero
  OS and DBMS Software: Level One

System Configuration:
  Processors:
  Memory:
  Disks:

  Total Storage:

SPARC T5-4 Server
4 SPARC T5 3.6GHz Processors, 64 cores, 512 threads
2TB
24 Sun Server X4-2L w/
    6 4TB 3.5" 7.2K RPM SAS disks
    4 800GB F80 Flash Accelerator PCIe
    2 600GB 10K SAS Internal (not included in Total Storage Calculations)
2 300GB 10K SAS Internal for the T5-4 (not included in Total Storage Calculation)
607,963.2GB (GB = 1024*1024*1024 bytes)

Description	Part Number	Source	Unit Price	Qty	Ext. Price	3 Yr. Maint.
Server Hardware						
SPARC T5-4 Server, base chassis	7104191	1	35,300	1	35,300	
2 SPARC T5 3.6GHz 16-core processors	7104194	1	33,856	2	67,712	
One 32GB DDR3-1066 registered DIMM	7104200	1	2,000	64	128,000	
300GB 2.5" 10K RPM SAS-2 HDD (factory install)	7105211	1	345	2	690	
Sun Storage 16Gb/s FC PCIe HBA, dual port, Qlogic	7101673	1	1,696	12	20,352	
2 Sun Storage 16Gb/s FC optics, SR, Qlogic	7101675	1	960	12	11,520	
Power Cord, 2.5M, C20 plug	SELY9P31Z	1	29	2	58	
Sun Server X4-2; base chassis	7106599	1	2,620	1	2,620	
Oracle Solaris 11.1 Pre-Install (factory install)	7100734	1	0	1	0	
8GB DDR3-1600 DIMM (factory install)	7100730	1	152	2	304	
Sun Storage 6 Gb/s SAS PCIe HBA, Internal; 8 Port	SG-SAS6-INT-Z	1	270	1	270	
Four 2.5" drive slots and 1 DVD-RW disk cage	7102740	1	508	1	508	
Heatsink (factory install)	7102758	1	20	1	20	
PCIe filler panel (factory install)	7102748	1	2	3	6	
Single processor I/O cover kit (factory install)	7104900	1	10	1	10	
Power Cord North America, 2.5M, 5-15P plug	333A-25-15-NEMA	1	13	2	26	
600GB 10K RPM 2.5" SAS-2 HDD w/ bracket	RA-SS2CF-600G10K2	1	615	1	615	
Intel® Xeon® E5-2609 v2 4-core 2.5GHz (factory install)	7106545	1	536	1	536	
Logitec MK120 – Keyboard & Mouse Combo (+2 spares)	2124292	2	17	3	51	
Acer V196HQLAb - LED 18.5" (+ 2 spares)	2973003	2	85	3	255	
Server Hardware Subtotal					**268,853**	**0**
Storage						
Sun Server X4-2L; base chassis	7106601	1s	3,306	24	79,344	
Oracle Solaris 11.1 preinstall	7100734	1	0	24	0	
600GB 10K RPM 2.5" SAS-2 HDD w/ bracket	RA-SS2CF-600G10K2	1	615	48	29,520	
4TB 7.2K RPM 2.5" SAS-2 HDD w/ bracket	7106637	1s	858	144	123,552	
Intel® Xeon® E5-2609 v2 4-core 2.5GHz (factory install)	7106545	1s	536	48	25,728	
8GB DDR3-1600 DIMM	7100730	1	152	48	7,296	
StorageTek 8Gb/s FC PCIe HBA dual port Qlogic	SG-PCIE2FC-QF8-Z	1	2,399	24	57,576	
Sun Storage 6Gb/s SAS PCIe HBA, Internal; 8 Port	SG-SAS6-INT-Z	1	270	24	6,480	
Flash Accelerator F80 PCIe Card: 800GB eMLC	7107091	1s	4,500	96	432,000	
Heat Sink (factory install)	7102745	1	28	48	1,344	
12 LFF slot disk cage and 2 SFF rear slot disk cage	7102743	1	1,108	24	26,592	
Power cord North America, 2.5M, 5-15P plug	333A-25-15-NEMA	1	13	48	624	
5M LC to LC FC cable (+10% spare)	X9733A-Z-N	1	80	80	6,400	
Brocade 6510 Fibre Channel Swith w/ 24 16Gb/s activated	7103553	1	26,046	2	52,092	
Brocade 6510 Activation Permit for 12 8Gb/s SFPs	7103555	1	12,741	2	25,482	
Brocade 8Gb/s SFP short wave optic module	SGXSWBROSFP8GSWS-N	1	399	24	9,576	
Power cord; Sun Rack jumper, 2M, C14 plug, C13 connector	X333V-20-15-C14-N	1	25	4	100	
Rack rail kit	7103770	1	282	2	564	
Sun Rack II 42U	SR-1242E	1	2,849	2	5,698	
PDU 15kVA, Single Phase, LV	SR-15K-L630-N	1	1,200	4	4,800	
Jumper Cable Kit SunRack II – 20 C13 cables	SR-JUMPKIT-N	1	198	2	396	
Storage Subtotal					**895,164**	**0**
Server Software						
Oracle Solaris 11.1, Oracle Solaris Studio 12	7104202	1	0	1	0	
Oracle Solaris Development Tools Support	B59320	1	1,200	3		3,600
Oracle Database 11g Release 2 Enterprise Edition, Per Processor for 3 years (for 32 processors)		1	23,750	32	760,000	
Oracle Partitioning, Per Processor for 3 years (for 32 processors)		1	5,750	32	184,000	
Oracle Incident Server Support Package (for 3 years)		1	2,300	3		6,900,
Server Software Subtotal					**944,000**	**10,500**
Oracle Premier Hardware Support	Q-PREM-SPRT-SYS	1	139,645	3		418,936
			Totals		**2,108,017**	**429,436**
Total Oracle Software, Hardware and Maintenance Discount		1			(781,744)	
			3 Yr. Cost		**$1,755,709**	
			QphH @10,000GB		**377,594.3**	
			$/QphH @10,000GB		**$4.65**	

Audited by Francois Raab of InfoSizing, Inc.

Pricing Sources
1. Oracle America
2. CDW

1s – One or more components of the measured configuration have been substituted in the priced configuration. See the FDR for details

Oracle's discounts are based upon US list prices and for similar quantities and configurations. A total discount of 30.9% has been applied to all Oracle hardware, software and services based on the total value and quantities of the components of the configuration, including full payment of all components and maintenance.

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 section 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

Measurement Results:

Database Scale Factor	= 10,000GB
Total Data Storage / Database Size	= 60.8
Start of database load time	= 11/03/13 01:25:08
End of database load time	= 11/03/13 11:03:02
Database Load Time	= 9:37:54
Query Streams for Throughput Test	= 128
TPC-H Power	= 342,714.1
TPC-H Throughput	= 416,024.4
TPC-H Composite Query-per-Hour Rating (QphH@10,000GB)	= 377,594.3
Total System Price Over 3 Years	= $1,755,709
TPC-H Price/Performance Metric ($/QphH@10,000GB)	= $4.65

Measurement Intervals:

Measurement Interval in Throughput Test (Ts)	= 243,678 seconds

Duration of Stream Execution:

Power Run	Seed	RF1 Start RF1 End	Query Start Query End	RF2 Start RF2 End	Duration
	1103110302	11/3/13 11:03:02	11/3/13 11:04:04	11/3/13 12:23:48	1:21:45
		11/3/13 11:04:04	11/3/13 12:23:48	11/3/13 12:24:48	

Throughput Stream	Seed	Query Start Query End	Duration	RF1 Start RF1 End	RF2 Start RF2 End
1	1103110303	11/3/13 12:25:14 11/5/13 19:33:49	55:08:35	11/6/13 3:48:30 11/6/13 3:49:25	11/6/13 3:49:25 11/6/13 3:50:25
2	1103110304	11/3/13 12:25:14 11/5/13 19:19:09	54:53:55	11/6/13 3:50:25 11/6/13 3:51:17	11/6/13 3:51:17 11/6/13 3:52:19
3	1103110305	11/3/13 12:25:14 11/5/13 19:33:45	55:08:31	11/6/13 3:52:19 11/6/13 3:53:11	11/6/13 3:53:11 11/6/13 3:54:13
4	1103110306	11/3/13 12:25:14 11/5/13 19:37:51	55:12:37	11/6/13 3:54:13 11/6/13 3:55:05	11/6/13 3:55:05 11/6/13 3:56:07
5	1103110307	11/3/13 12:25:14 11/5/13 19:33:44	55:08:30	11/6/13 3:56:07 11/6/13 3:57:02	11/6/13 3:57:02 11/6/13 3:58:04
6	1103110308	11/3/13 12:25:14 11/5/13 19:42:09	55:16:55	11/6/13 3:58:04 11/6/13 3:58:59	11/6/13 3:58:59 11/6/13 4:00:00
7	1103110309	11/3/13 12:25:14 11/5/13 19:52:00	55:26:46	11/6/13 4:00:00 11/6/13 4:00:56	11/6/13 4:00:56 11/6/13 4:01:57
8	1103110310	11/3/13 12:25:14 11/5/13 19:36:18	55:11:04	11/6/13 4:01:57 11/6/13 4:02:55	11/6/13 4:02:55 11/6/13 4:03:56
9	1103110311	11/3/13 12:25:14 11/5/13 19:39:03	55:13:49	11/6/13 4:03:56 11/6/13 4:04:52	11/6/13 4:04:52 11/6/13 4:05:53
10	1103110312	11/3/13 12:25:14	55:16:51	11/6/13 4:05:53	11/6/13 4:06:47

Throughput Stream	Seed	Query Start Query End	Duration	RF1 Start RF1 End	RF2 Start RF2 End
		11/5/13 19:42:05		11/6/13 4:06:47	11/6/13 4:07:47
11	1103110313	11/3/13 12:25:14	55:43:05	11/6/13 4:07:47	11/6/13 4:08:42
		11/5/13 20:08:19		11/6/13 4:08:42	11/6/13 4:09:42
12	1103110314	11/3/13 12:25:14	55:36:04	11/6/13 4:09:42	11/6/13 4:10:37
		11/5/13 20:01:18		11/6/13 4:10:37	11/6/13 4:11:38
13	1103110315	11/3/13 12:25:14	55:01:15	11/6/13 4:11:38	11/6/13 4:12:33
		11/5/13 19:26:29		11/6/13 4:12:33	11/6/13 4:13:35
14	1103110316	11/3/13 12:25:14	55:26:47	11/6/13 4:13:35	11/6/13 4:14:31
		11/5/13 19:52:01		11/6/13 4:14:30	11/6/13 4:15:32
15	1103110317	11/3/13 12:25:14	55:36:01	11/6/13 4:15:32	11/6/13 4:16:31
		11/5/13 20:01:15		11/6/13 4:16:31	11/6/13 4:17:34
16	1103110318	11/3/13 12:25:14	55:43:12	11/6/13 4:17:34	11/6/13 4:18:33
		11/5/13 20:08:26		11/6/13 4:18:33	11/6/13 4:19:35
17	1103110319	11/3/13 12:25:14	55:16:48	11/6/13 4:19:35	11/6/13 4:20:33
		11/5/13 19:42:02		11/6/13 4:20:33	11/6/13 4:21:35
18	1103110320	11/3/13 12:25:15	55:34:43	11/6/13 4:21:35	11/6/13 4:22:34
		11/5/13 19:59:58		11/6/13 4:22:34	11/6/13 4:23:37
19	1103110321	11/3/13 12:25:15	54:54:42	11/6/13 4:23:37	11/6/13 4:24:34
		11/5/13 19:19:57		11/6/13 4:24:34	11/6/13 4:25:37
20	1103110322	11/3/13 12:25:15	55:03:53	11/6/13 4:25:37	11/6/13 4:26:36
		11/5/13 19:29:08		11/6/13 4:26:36	11/6/13 4:27:38
21	1103110323	11/3/13 12:25:15	55:48:38	11/6/13 4:27:38	11/6/13 4:28:38
		11/5/13 20:13:53		11/6/13 4:28:38	11/6/13 4:29:40
22	1103110324	11/3/13 12:25:15	55:17:52	11/6/13 4:29:40	11/6/13 4:30:41
		11/5/13 19:43:07		11/6/13 4:30:41	11/6/13 4:31:43
23	1103110325	11/3/13 12:25:15	55:16:58	11/6/13 4:31:43	11/6/13 4:32:44
		11/5/13 19:42:13		11/6/13 4:32:44	11/6/13 4:33:46
24	1103110326	11/3/13 12:25:15	55:37:54	11/6/13 4:33:46	11/6/13 4:34:47
		11/5/13 20:03:09		11/6/13 4:34:47	11/6/13 4:35:49
25	1103110327	11/3/13 12:25:15	55:44:59	11/6/13 4:35:49	11/6/13 4:36:43
		11/5/13 20:10:14		11/6/13 4:36:43	11/6/13 4:37:45
26	1103110328	11/3/13 12:25:15	55:54:15	11/6/13 4:37:45	11/6/13 4:38:39
		11/5/13 20:19:30		11/6/13 4:38:39	11/6/13 4:39:42
27	1103110329	11/3/13 12:25:15	55:43:08	11/6/13 4:39:42	11/6/13 4:40:36
		11/5/13 20:08:23		11/6/13 4:40:36	11/6/13 4:41:38
28	1103110330	11/3/13 12:25:15	55:36:05	11/6/13 4:41:38	11/6/13 4:42:33
		11/5/13 20:01:20		11/6/13 4:42:33	11/6/13 4:43:35
29	1103110331	11/3/13 12:25:15	55:52:23	11/6/13 4:43:35	11/6/13 4:44:28
		11/5/13 20:17:38		11/6/13 4:44:28	11/6/13 4:45:29
30	1103110332	11/3/13 12:25:15	56:10:52	11/6/13 4:45:29	11/6/13 4:46:30
		11/5/13 20:36:07		11/6/13 4:46:30	11/6/13 4:47:32
31	1103110333	11/3/13 12:25:15	55:44:59	11/6/13 4:47:32	11/6/13 4:48:35
		11/5/13 20:10:14		11/6/13 4:48:35	11/6/13 4:49:38
32	1103110334	11/3/13 12:25:15	55:45:45	11/6/13 4:49:38	11/6/13 4:50:41
		11/5/13 20:11:00		11/6/13 4:50:41	11/6/13 4:51:44
33	1103110335	11/3/13 12:25:15	55:45:47	11/6/13 4:51:44	11/6/13 4:52:47
		11/5/13 20:11:02		11/6/13 4:52:47	11/6/13 4:53:52

Throughput Stream	Seed	Query Start Query End	Duration	RF1 Start RF1 End	RF2 Start RF2 End
34	1103110336	11/3/13 12:25:15	55:50:22	11/6/13 4:53:52	11/6/13 4:54:55
		11/5/13 20:15:37		11/6/13 4:54:55	11/6/13 4:55:58
35	1103110337	11/3/13 12:25:16	55:43:45	11/6/13 4:55:58	11/6/13 4:56:57
		11/5/13 20:09:01		11/6/13 4:56:57	11/6/13 4:57:59
36	1103110338	11/3/13 12:25:16	55:32:42	11/6/13 4:57:59	11/6/13 4:58:58
		11/5/13 19:57:58		11/6/13 4:58:58	11/6/13 5:00:01
37	1103110339	11/3/13 12:25:16	55:47:50	11/6/13 5:00:01	11/6/13 5:01:01
		11/5/13 20:13:06		11/6/13 5:01:01	11/6/13 5:02:02
38	1103110340	11/3/13 12:25:16	56:10:15	11/6/13 5:02:02	11/6/13 5:03:03
		11/5/13 20:35:31		11/6/13 5:03:03	11/6/13 5:04:03
39	1103110341	11/3/13 12:25:16	55:49:16	11/6/13 5:04:04	11/6/13 5:05:04
		11/5/13 20:14:32		11/6/13 5:05:04	11/6/13 5:06:06
40	1103110342	11/3/13 12:25:16	55:49:18	11/6/13 5:06:06	11/6/13 5:07:05
		11/5/13 20:14:34		11/6/13 5:07:05	11/6/13 5:08:08
41	1103110343	11/3/13 12:25:16	55:55:44	11/6/13 5:08:08	11/6/13 5:09:05
		11/5/13 20:21:00		11/6/13 5:09:05	11/6/13 5:10:07
42	1103110344	11/3/13 12:25:16	55:50:22	11/6/13 5:10:08	11/6/13 5:11:06
		11/5/13 20:15:38		11/6/13 5:11:06	11/6/13 5:12:08
43	1103110345	11/3/13 12:25:16	55:51:50	11/6/13 5:12:08	11/6/13 5:13:04
		11/5/13 20:17:06		11/6/13 5:13:04	11/6/13 5:14:07
44	1103110346	11/3/13 12:25:16	55:55:44	11/6/13 5:14:07	11/6/13 5:15:05
		11/5/13 20:21:00		11/6/13 5:15:05	11/6/13 5:16:08
45	1103110347	11/3/13 12:25:16	55:51:48	11/6/13 5:16:08	11/6/13 5:17:14
		11/5/13 20:17:04		11/6/13 5:17:14	11/6/13 5:18:18
46	1103110348	11/3/13 12:25:16	55:50:26	11/6/13 5:18:18	11/6/13 5:19:23
		11/5/13 20:15:42		11/6/13 5:19:23	11/6/13 5:20:26
47	1103110349	11/3/13 12:25:16	63:23:15	11/6/13 5:20:26	11/6/13 5:21:27
		11/6/13 3:48:31		11/6/13 5:21:27	11/6/13 5:22:29
48	1103110350	11/3/13 12:25:16	56:04:46	11/6/13 5:22:29	11/6/13 5:23:34
		11/5/13 20:30:02		11/6/13 5:23:34	11/6/13 5:24:37
49	1103110351	11/3/13 12:25:16	55:56:18	11/6/13 5:24:37	11/6/13 5:25:40
		11/5/13 20:21:34		11/6/13 5:25:40	11/6/13 5:26:44
50	1103110352	11/3/13 12:25:16	56:05:57	11/6/13 5:26:44	11/6/13 5:27:39
		11/5/13 20:31:13		11/6/13 5:27:39	11/6/13 5:28:42
51	1103110353	11/3/13 12:25:17	56:08:56	11/6/13 5:28:42	11/6/13 5:29:38
		11/5/13 20:34:13		11/6/13 5:29:38	11/6/13 5:30:42
52	1103110354	11/3/13 12:25:17	56:03:43	11/6/13 5:30:42	11/6/13 5:31:40
		11/5/13 20:29:00		11/6/13 5:31:40	11/6/13 5:32:42
53	1103110355	11/3/13 12:25:17	55:50:29	11/6/13 5:32:42	11/6/13 5:33:39
		11/5/13 20:15:46		11/6/13 5:33:39	11/6/13 5:34:41
54	1103110356	11/3/13 12:25:17	56:14:31	11/6/13 5:34:41	11/6/13 5:35:39
		11/5/13 20:39:48		11/6/13 5:35:39	11/6/13 5:36:41
55	1103110357	11/3/13 12:25:17	56:34:49	11/6/13 5:36:41	11/6/13 5:37:44
		11/5/13 21:00:06		11/6/13 5:37:44	11/6/13 5:38:47
56	1103110358	11/3/13 12:25:17	56:34:24	11/6/13 5:38:47	11/6/13 5:39:48
		11/5/13 20:59:41		11/6/13 5:39:48	11/6/13 5:40:53
57	1103110359	11/3/13 12:25:17	56:34:26	11/6/13 5:40:53	11/6/13 5:41:56

Throughput Stream	Seed	Query Start Query End	Duration	RF1 Start RF1 End	RF2 Start RF2 End
		11/5/13 20:59:43		11/6/13 5:41:56	11/6/13 5:43:00
58	1103110360	11/3/13 12:25:17	55:59:18	11/6/13 5:43:00	11/6/13 5:44:02
		11/5/13 20:24:35		11/6/13 5:44:02	11/6/13 5:45:05
59	1103110361	11/3/13 12:25:17	56:48:58	11/6/13 5:45:05	11/6/13 5:46:07
		11/5/13 21:14:15		11/6/13 5:46:07	11/6/13 5:47:10
60	1103110362	11/3/13 12:25:17	55:55:45	11/6/13 5:47:10	11/6/13 5:48:13
		11/5/13 20:21:02		11/6/13 5:48:13	11/6/13 5:49:12
61	1103110363	11/3/13 12:25:17	56:41:54	11/6/13 5:49:12	11/6/13 5:50:13
		11/5/13 21:07:11		11/6/13 5:50:13	11/6/13 5:51:15
62	1103110364	11/3/13 12:25:17	56:15:05	11/6/13 5:51:15	11/6/13 5:52:15
		11/5/13 20:40:22		11/6/13 5:52:15	11/6/13 5:53:17
63	1103110365	11/3/13 12:25:17	56:17:29	11/6/13 5:53:17	11/6/13 5:54:18
		11/5/13 20:42:46		11/6/13 5:54:18	11/6/13 5:55:20
64	1103110366	11/3/13 12:25:17	56:38:04	11/6/13 5:55:20	11/6/13 5:56:21
		11/5/13 21:03:21		11/6/13 5:56:21	11/6/13 5:57:22
65	1103110367	11/3/13 12:25:17	56:40:18	11/6/13 5:57:23	11/6/13 5:58:19
		11/5/13 21:05:35		11/6/13 5:58:19	11/6/13 5:59:21
66	1103110368	11/3/13 12:25:17	56:40:18	11/6/13 5:59:21	11/6/13 6:00:17
		11/5/13 21:05:35		11/6/13 6:00:17	11/6/13 6:01:18
67	1103110369	11/3/13 12:25:17	56:47:26	11/6/13 6:01:18	11/6/13 6:02:14
		11/5/13 21:12:43		11/6/13 6:02:14	11/6/13 6:03:16
68	1103110370	11/3/13 12:25:18	56:21:09	11/6/13 6:03:16	11/6/13 6:04:12
		11/5/13 20:46:27		11/6/13 6:04:12	11/6/13 6:05:14
69	1103110371	11/3/13 12:25:18	57:28:01	11/6/13 6:05:14	11/6/13 6:06:10
		11/5/13 21:53:19		11/6/13 6:06:10	11/6/13 6:07:11
70	1103110372	11/3/13 12:25:18	56:38:34	11/6/13 6:07:11	11/6/13 6:08:11
		11/5/13 21:03:52		11/6/13 6:08:11	11/6/13 6:09:13
71	1103110373	11/3/13 12:25:18	57:00:13	11/6/13 6:09:13	11/6/13 6:10:12
		11/5/13 21:25:31		11/6/13 6:10:12	11/6/13 6:11:14
72	1103110374	11/3/13 12:25:18	56:10:11	11/6/13 6:11:14	11/6/13 6:12:13
		11/5/13 20:35:29		11/6/13 6:12:13	11/6/13 6:13:16
73	1103110375	11/3/13 12:25:18	56:21:45	11/6/13 6:13:16	11/6/13 6:14:14
		11/5/13 20:47:03		11/6/13 6:14:14	11/6/13 6:15:16
74	1103110376	11/3/13 12:25:18	57:28:02	11/6/13 6:15:16	11/6/13 6:16:17
		11/5/13 21:53:20		11/6/13 6:16:17	11/6/13 6:17:18
75	1103110377	11/3/13 12:25:18	57:02:05	11/6/13 6:17:19	11/6/13 6:18:14
		11/5/13 21:27:23		11/6/13 6:18:14	11/6/13 6:19:16
76	1103110378	11/3/13 12:25:18	56:47:48	11/6/13 6:19:16	11/6/13 6:20:13
		11/5/13 21:13:06		11/6/13 6:20:13	11/6/13 6:21:14
77	1103110379	11/3/13 12:25:18	57:55:44	11/6/13 6:21:14	11/6/13 6:22:10
		11/5/13 22:21:02		11/6/13 6:22:10	11/6/13 6:23:11
78	1103110380	11/3/13 12:25:18	57:29:39	11/6/13 6:23:11	11/6/13 6:24:07
		11/5/13 21:54:57		11/6/13 6:24:07	11/6/13 6:25:10
79	1103110381	11/3/13 12:25:18	57:28:06	11/6/13 6:25:10	11/6/13 6:26:06
		11/5/13 21:53:24		11/6/13 6:26:06	11/6/13 6:27:09
80	1103110382	11/3/13 12:25:18	56:39:09	11/6/13 6:27:09	11/6/13 6:28:11
		11/5/13 21:04:27		11/6/13 6:28:11	11/6/13 6:29:12

Throughput Stream	Seed	Query Start / Query End	Duration	RF1 Start / RF1 End	RF2 Start / RF2 End
81	1103110383	11/3/13 12:25:18	57:59:27	11/6/13 6:29:12	11/6/13 6:30:10
		11/5/13 22:24:45		11/6/13 6:30:10	11/6/13 6:31:14
82	1103110384	11/3/13 12:25:18	56:46:13	11/6/13 6:31:14	11/6/13 6:32:13
		11/5/13 21:11:31		11/6/13 6:32:13	11/6/13 6:33:15
83	1103110385	11/3/13 12:25:18	56:47:25	11/6/13 6:33:15	11/6/13 6:34:15
		11/5/13 21:12:43		11/6/13 6:34:15	11/6/13 6:35:16
84	1103110386	11/3/13 12:25:19	57:49:32	11/6/13 6:35:16	11/6/13 6:36:17
		11/5/13 22:14:51		11/6/13 6:36:17	11/6/13 6:37:18
85	1103110387	11/3/13 12:25:19	57:30:29	11/6/13 6:37:18	11/6/13 6:38:21
		11/5/13 21:55:48		11/6/13 6:38:21	11/6/13 6:39:24
86	1103110388	11/3/13 12:25:19	57:01:30	11/6/13 6:39:24	11/6/13 6:40:27
		11/5/13 21:26:49		11/6/13 6:40:27	11/6/13 6:41:29
87	1103110389	11/3/13 12:25:19	56:59:38	11/6/13 6:41:29	11/6/13 6:42:33
		11/5/13 21:24:57		11/6/13 6:42:33	11/6/13 6:43:35
88	1103110390	11/3/13 12:25:19	57:16:20	11/6/13 6:43:35	11/6/13 6:44:37
		11/5/13 21:41:39		11/6/13 6:44:36	11/6/13 6:45:40
89	1103110391	11/3/13 12:25:19	57:35:14	11/6/13 6:45:40	11/6/13 6:46:44
		11/5/13 22:00:33		11/6/13 6:46:44	11/6/13 6:47:47
90	1103110392	11/3/13 12:25:19	57:23:05	11/6/13 6:47:47	11/6/13 6:48:41
		11/5/13 21:48:24		11/6/13 6:48:41	11/6/13 6:49:41
91	1103110393	11/3/13 12:25:19	57:21:52	11/6/13 6:49:41	11/6/13 6:50:36
		11/5/13 21:47:11		11/6/13 6:50:36	11/6/13 6:51:37
92	1103110394	11/3/13 12:25:19	57:33:32	11/6/13 6:51:37	11/6/13 6:52:33
		11/5/13 21:58:51		11/6/13 6:52:33	11/6/13 6:53:34
93	1103110395	11/3/13 12:25:19	57:28:09	11/6/13 6:53:34	11/6/13 6:54:31
		11/5/13 21:53:28		11/6/13 6:54:31	11/6/13 6:55:31
94	1103110396	11/3/13 12:25:19	57:30:07	11/6/13 6:55:31	11/6/13 6:56:26
		11/5/13 21:55:26		11/6/13 6:56:26	11/6/13 6:57:28
95	1103110397	11/3/13 12:25:19	57:26:48	11/6/13 6:57:28	11/6/13 6:58:27
		11/5/13 21:52:07		11/6/13 6:58:27	11/6/13 6:59:28
96	1103110398	11/3/13 12:25:19	57:30:28	11/6/13 6:59:28	11/6/13 7:00:27
		11/5/13 21:55:47		11/6/13 7:00:27	11/6/13 7:01:29
97	1103110399	11/3/13 12:25:19	57:29:41	11/6/13 7:01:29	11/6/13 7:02:28
		11/5/13 21:55:00		11/6/13 7:02:28	11/6/13 7:03:31
98	1103110400	11/3/13 12:25:20	58:43:45	11/6/13 7:03:31	11/6/13 7:04:33
		11/5/13 23:09:05		11/6/13 7:04:33	11/6/13 7:05:35
99	1103110401	11/3/13 12:25:20	57:20:41	11/6/13 7:05:35	11/6/13 7:06:35
		11/5/13 21:46:01		11/6/13 7:06:35	11/6/13 7:07:37
100	1103110402	11/3/13 12:25:20	58:00:37	11/6/13 7:07:37	11/6/13 7:08:35
		11/5/13 22:25:57		11/6/13 7:08:35	11/6/13 7:09:38
101	1103110403	11/3/13 12:25:20	58:24:44	11/6/13 7:09:38	11/6/13 7:10:37
		11/5/13 22:50:04		11/6/13 7:10:37	11/6/13 7:11:39
102	1103110404	11/3/13 12:25:21	59:24:51	11/6/13 7:11:39	11/6/13 7:12:39
		11/5/13 23:50:12		11/6/13 7:12:39	11/6/13 7:13:42
103	1103110405	11/3/13 12:25:21	59:31:37	11/6/13 7:13:42	11/6/13 7:14:41
		11/5/13 23:56:58		11/6/13 7:14:41	11/6/13 7:15:44
104	1103110406	11/3/13 12:25:21	57:51:56	11/6/13 7:15:44	11/6/13 7:16:44

Throughput Stream	Seed	Query Start / Query End	Duration	RF1 Start / RF1 End	RF2 Start / RF2 End
		11/5/13 22:17:17		11/6/13 7:16:44	11/6/13 7:17:47
105	1103110407	11/3/13 12:25:22	59:22:04	11/6/13 7:17:47	11/6/13 7:18:44
		11/5/13 23:47:26		11/6/13 7:18:44	11/6/13 7:19:46
106	1103110408	11/3/13 12:25:23	60:02:18	11/6/13 7:19:46	11/6/13 7:20:44
		11/6/13 0:27:41		11/6/13 7:20:44	11/6/13 7:21:47
107	1103110409	11/3/13 12:25:22	58:11:20	11/6/13 7:21:47	11/6/13 7:22:45
		11/5/13 22:36:42		11/6/13 7:22:45	11/6/13 7:23:48
108	1103110410	11/3/13 12:25:22	58:44:52	11/6/13 7:23:48	11/6/13 7:24:45
		11/5/13 23:10:14		11/6/13 7:24:45	11/6/13 7:25:47
109	1103110411	11/3/13 12:25:23	58:29:34	11/6/13 7:25:47	11/6/13 7:26:47
		11/5/13 22:54:57		11/6/13 7:26:47	11/6/13 7:27:49
110	1103110412	11/3/13 12:25:23	58:25:50	11/6/13 7:27:49	11/6/13 7:28:52
		11/5/13 22:51:13		11/6/13 7:28:52	11/6/13 7:29:54
111	1103110413	11/3/13 12:25:23	59:31:01	11/6/13 7:29:54	11/6/13 7:30:59
		11/5/13 23:56:24		11/6/13 7:30:59	11/6/13 7:31:59
112	1103110414	11/3/13 12:25:24	59:32:06	11/6/13 7:31:59	11/6/13 7:33:03
		11/5/13 23:57:30		11/6/13 7:33:03	11/6/13 7:34:06
113	1103110415	11/3/13 12:25:24	58:51:12	11/6/13 7:34:06	11/6/13 7:35:12
		11/5/13 23:16:36		11/6/13 7:35:11	11/6/13 7:36:13
114	1103110416	11/3/13 12:25:24	59:32:38	11/6/13 7:36:13	11/6/13 7:37:16
		11/5/13 23:58:02		11/6/13 7:37:16	11/6/13 7:38:19
115	1103110417	11/3/13 12:25:24	59:08:16	11/6/13 7:38:19	11/6/13 7:39:17
		11/5/13 23:33:40		11/6/13 7:39:17	11/6/13 7:40:19
116	1103110418	11/3/13 12:25:25	58:45:24	11/6/13 7:40:19	11/6/13 7:41:17
		11/5/13 23:10:49		11/6/13 7:41:17	11/6/13 7:42:19
117	1103110419	11/3/13 12:25:25	59:23:16	11/6/13 7:42:19	11/6/13 7:43:16
		11/5/13 23:48:41		11/6/13 7:43:16	11/6/13 7:44:18
118	1103110420	11/3/13 12:25:25	58:54:52	11/6/13 7:44:18	11/6/13 7:45:14
		11/5/13 23:20:17		11/6/13 7:45:14	11/6/13 7:46:16
119	1103110421	11/3/13 12:25:26	59:29:49	11/6/13 7:46:16	11/6/13 7:47:13
		11/5/13 23:55:15		11/6/13 7:47:13	11/6/13 7:48:14
120	1103110422	11/3/13 12:25:26	59:58:13	11/6/13 7:48:14	11/6/13 7:49:12
		11/6/13 0:23:39		11/6/13 7:49:12	11/6/13 7:50:16
121	1103110423	11/3/13 12:25:26	59:30:24	11/6/13 7:50:16	11/6/13 7:51:16
		11/5/13 23:55:50		11/6/13 7:51:16	11/6/13 7:52:19
122	1103110424	11/3/13 12:25:27	59:28:29	11/6/13 7:52:19	11/6/13 7:53:19
		11/5/13 23:53:56		11/6/13 7:53:19	11/6/13 7:54:21
123	1103110425	11/3/13 12:25:27	58:49:51	11/6/13 7:54:21	11/6/13 7:55:20
		11/5/13 23:15:18		11/6/13 7:55:20	11/6/13 7:56:23
124	1103110426	11/3/13 12:25:27	59:47:24	11/6/13 7:56:23	11/6/13 7:57:23
		11/6/13 0:12:51		11/6/13 7:57:23	11/6/13 7:58:26
125	1103110427	11/3/13 12:25:27	59:46:54	11/6/13 7:58:26	11/6/13 7:59:26
		11/6/13 0:12:21		11/6/13 7:59:26	11/6/13 8:00:28
126	1103110428	11/3/13 12:25:28	60:01:02	11/6/13 8:00:28	11/6/13 8:01:27
		11/6/13 0:26:30		11/6/13 8:01:27	11/6/13 8:02:30
127	1103110429	11/3/13 12:25:28	60:00:13	11/6/13 8:02:30	11/6/13 8:03:30
		11/6/13 0:25:41		11/6/13 8:03:30	11/6/13 8:04:32

Throughput Stream	Seed	Query Start Query End	Duration	RF1 Start RF1 End	RF2 Start RF2 End
128	1103110430	11/3/13 12:25:28	59:18:42	11/6/13 8:04:32	11/6/13 8:05:32
		11/5/13 23:44:10		11/6/13 8:05:32	11/6/13 8:06:32

TPC-H Timing Intervals (in seconds):

Stream ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
0	794.7	35.5	49.8	28.7	172.9	18.5	190.5	91.1	620.2	90.3	71.1	138.5
1	6839.8	5913.7	23333.5	6149.5	13940.9	13746	9477.9	6157.8	6712.7	5555.8	9293.5	7498.7
2	5567.3	13623.8	6742.5	6280.3	10474.1	25.2	5341.8	7703.2	14046.9	9237.2	6926.5	10795.9
3	13129.8	6049.8	6148.1	15318.8	24308.2	13680.1	9339.6	181.8	10240.1	8377.1	5618.7	7394.3
4	5779.4	5237.9	6966.3	6169.8	462.2	12980.9	6624.1	10200.6	8458.7	6294.5	10931.8	14226.5
5	5615.9	5868.6	10584.5	15160.7	6086.4	13921.1	9260.7	5396.1	6676.7	6628.1	10281.1	6275.1
6	5211.1	5815.4	23256	6161.6	6202.7	9323.2	12667	9517.5	14695.2	1438	7758.3	11113.1
7	7402	9100.9	9919.5	8816.7	5686.9	7022.4	5778.9	22346.6	11363.8	5451.4	7414.4	6759.3
8	23587.3	6668.5	7597.7	10441	9085.7	6182.7	7868.4	8860.1	15307.9	5653.7	6166.2	12461.5
9	5772.7	15260.8	9386.4	5275.7	6850.1	14009.2	5567.3	2687.6	7438.6	7745.3	7554.3	6777
10	10512.5	12367	5750.9	5512.5	6279.7	2719.4	14222.7	6975.7	6183	7596	7212.4	9379
11	6154.2	6261.6	6182.6	10408	10856.1	5231.7	7236.3	7901.4	6774.6	8711.2	12866.1	5600.5
12	4142.4	9962.3	5229.1	7646.5	5789.6	12422.2	22131.9	6207.9	9184.9	6583.6	10912.6	14649.4
13	9890.2	10890.6	14090.1	5242.2	6124.3	10083.9	15305.4	5829	6092.7	8664	7641.8	14702.3
14	8708.5	4081.4	5603.6	13946.3	14582.5	6694.4	10075.2	5749	22191.3	7382.8	6345.5	7125.7
15	5368.7	5533.4	7456.6	7036.3	5302.7	6844.4	10992.5	14168.4	23054.7	13779.5	9943.6	12479.5
16	5561.6	9057	21264.8	10399.2	14413.5	14363.4	6966	5775.3	8310.3	10270.3	5952.7	5637.2
17	5499.5	13831.7	4243.2	6363.5	14759.8	6850.4	7930.9	10342.2	9956.9	6429.7	14302.8	6430
18	10257.5	10767.7	6903.9	22176.6	14324.1	12195.8	5179.9	12785.4	5546.8	5832.6	10571.1	5869.5
19	5499.1	12258.8	6203.4	4321.1	9262.7	5682.6	5243.7	6203.1	7405.6	8181.2	6184.8	22390.8
20	8002	6724.1	5640	9265	10733.3	6808.3	6304.7	6041.3	5777	5211.7	5925.6	10519.2
21	8600	7287.7	6730.2	12639.5	5296.1	5640	5286.7	6121.3	7209	7536.5	11058.3	13544.7
22	6153.1	14245.5	6359.7	12249.3	5079	5501.8	6497.7	5541.7	6824.3	8958.3	14594.4	7742.3
23	7417.1	9607.1	7020.6	6472	5685.4	10287.3	6210.7	13904.1	15455.8	5778.9	12342.1	9402.3
24	5668.3	6181.6	21411.8	7632.4	5655.3	12366.6	5881.7	7740.9	10382.1	14316.4	6977.6	6918.8
25	22644.6	12325.9	6275.2	7316.1	7650	6845.7	10789.3	6029.5	7337.4	10106.1	7923.5	5720.5
26	6777.6	21458.6	5634.8	10693	12022.5	5879	6817.7	6264.4	7756.1	7420.2	9226.5	6371.8
27	7417.4	9367	5079.5	12411	6852.8	12672.4	7803.5	11890.1	10652.5	7261	6220.7	5231.9
28	16487.3	6827.6	5913.1	5681.6	5207.9	7395.6	7292.5	5228.3	6933.6	6289.9	7207.9	11949.4
29	14000	5379.9	5276.1	7264.7	11681.4	10205.7	6361.3	21489.4	17334.5	6417.2	7670.5	9741.7
30	8979.1	7504.5	9705.6	6867.8	10982.4	6265.6	6669.4	5707.1	7676.2	10185.4	7382.6	5829
31	12658.5	6344.3	10772	9305.3	7638	5583.8	10823.4	5958.1	21409.5	5795.5	12415.2	6031.4
32	5595.5	7253.2	7748.6	10817.4	7938.5	9668.3	11118.7	17243.7	6295.1	6259.4	5563.1	21662.4
33	7122.6	17147.8	7995.2	7467.1	12478.2	5970.7	10312.6	5474.5	5655.5	9605.2	10863	6537.1
34	7953.5	7245.5	10683.3	9746.3	5592	12687.3	9807.8	5560.9	7868.1	6295.1	16744.3	5649.2
35	6629.2	10905.8	5483.4	6295.1	12754.1	7216.7	6259.4	9795.9	5376.7	12371	7276.6	9895.1
36	7572.7	5086.4	7748.5	10722.7	9653.3	9960.2	16983.4	7398.3	7689	6495.5	6685.9	7033.8
37	5745.7	5640.2	6165.2	5319.2	16654.8	11436.7	9776.5	11027.1	13273.3	8074.2	9990.4	7326.7
38	11470	9687.9	7824	16847	21075.4	13730.9	10525.3	7357.2	7468.6	7252.8	9725.6	5353.1
39	5315.4	7193	8026.4	10913	10032.4	9681.5	21005.3	5796.9	5378.7	7532.5	7087.2	5891.3
40	10492.3	6479.9	12450.1	12404.4	6966	5960.6	6949.5	5499.6	9776.5	7047.2	10266	5580
41	6059.8	20959.5	10323.8	5129.6	5566.9	9423.6	6582.1	10058.2	17603.6	6243.2	6719.5	7494.5

Stream ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
42	6697.2	6630.8	19686.5	7181.1	10849.6	13378.2	10581.9	5365.4	6814.6	5363.2	9936.1	7754.8
43	6059.8	10643.7	5449.2	6292.9	10739.5	8625	5361.1	7669	14158.3	9990.7	6603.7	10119.4
44	13374.3	5320.5	7131.5	16651	20703.4	10584.1	10600.7	8762.7	10713.1	8076	5368.6	7191
45	6075.8	5318.2	6810.7	6925.4	8625.3	10945.2	6880.8	10248.4	8526.7	6681.5	9731.9	13548
46	5363.2	6541.2	9776.5	16656.8	5248.7	10785.9	9753.2	6050.9	7181.1	6585.2	10768	7391.8
47	5243	6090.5	19559.1	7349.3	6683.2	9795.3	9900.5	10423.4	14691.9	9990.9	7800.2	9676.7
48	6219.6	8822.2	9642.3	11987.8	6299.1	7330.2	5607	18698.6	9641.7	5559.5	8891.8	7395.9
49	20182.5	7419.5	7583.6	9692.7	9160.5	6195.5	8837	10769.1	14564.4	5712.5	6892.5	10637.4
50	5606.9	16675	10469.8	5636.7	6938.1	13641.6	5707.5	10889.6	7250.5	7641.4	8839.4	6453.9
51	10395	10469.9	6719	5606.6	7392.6	10742.7	13687.1	6944.8	5279.2	8068.1	7394.4	9894.9
52	7129.8	6305.3	6293.3	10110.6	9661.3	5655.9	7219.8	8080.1	5488.5	9941.7	9956.7	5695.4
53	12328.5	9652.6	5567.3	8021.4	5283	10195.1	17452.7	7468.5	7749.6	6199.2	10295.4	13768.4
54	8802	8674.8	11440.1	5229.3	6403.3	9582.3	16034.8	5844.5	6981.7	12037.4	8855.3	13333.7
55	12158.2	12368.5	5870.9	11221.5	15986.9	8507.3	9651.7	5475.6	18432	7052.6	6321	7052.1
56	5558.9	5852	7693.1	6953.8	5607.1	6008.2	9580.7	11357.7	19359.1	13107.1	12000.5	10879.1
57	13820.8	8763.9	18378.7	9617.2	11065.9	15433.3	6953.7	5489.4	9191.3	8629	5053.8	5853.2
58	5811.6	12981.4	12539.6	6263.4	15651.3	6706.3	7800.4	9823.2	11815.6	7299.1	11302.6	7073.8
59	8624.9	9787.6	6852.8	18612.6	11621.2	10576.5	6377	12316.4	5603	5908.3	12292.5	6360.2
60	6864.4	9892.7	6519.5	12621.4	8868.9	5538.5	5355	7245.4	7583.1	8787.9	7294.3	18892.3
61	9295.1	6122.8	5630.9	8872.7	8536.3	6407.4	6743	8712	6006.6	5050.6	7109.3	10032.1
62	9033.5	7756.5	6861.8	13106.9	5226.5	5672.7	5318.9	5890.5	7067.6	9180.9	9535.4	11610.6
63	6685.7	11469.8	6459.7	10376.6	5208.1	5815.8	6299.1	5702.9	6698.8	11917.4	13003.3	8340.1
64	8235.5	11754.3	7031	6541.5	6418.4	9263	8669.8	13101	16435.5	5338.9	10785	9222.1
65	5320.2	6449.9	18574.8	8517.1	5707.5	10761	13254.5	8303.1	9580.7	15649.3	6479.9	6911.7
66	19994.6	10691.5	6456.9	6838.7	8104.7	6459.9	9777.1	6520.3	8616.9	12302.7	8892.3	6390.6
67	5707.5	18146.8	5607	9532.6	11070.4	6299.1	6549.9	6457.7	7831.7	8928.1	8743.5	6049.9
68	6403.4	9436.9	5226.9	10624.2	6883.6	11902.2	8818.2	11213.7	12957.6	7078.2	6422.9	5801
69	16738.8	7081.1	5022.7	6267.3	5973.9	6906.6	8852.3	6612	5951	13857.9	10991.5	9898.9
70	14102.7	5604.8	4944.4	8697.9	9750.5	11832.1	6731.4	18521.2	16486.4	13959.7	7916.2	9398.2
71	8909.6	9664.7	9806.6	6006.8	9978.6	6735	14232.1	5939.4	7582.4	12232.8	6772.6	5844.1
72	12641.6	13910.6	10820.6	9137.7	8566.4	5604.5	12090.1	5354.5	18418.6	5707.5	10865	6447.7
73	5192.3	7827.9	8108.3	9778.2	8820.1	8674.9	9656.7	16308.1	6403.4	6459.7	5376.6	18778.7
74	10974.7	16231.7	8948.1	8047.2	11967.5	6768.7	12366.1	5812.7	5834.8	8776.2	9920.1	6036.7
75	15535.7	9522.8	9819.2	9803.9	4950.6	12936.3	8636.5	6240.2	8952.2	6423.4	15799.4	6090.5
76	6985.2	9840.9	6083.5	5899.1	12906.1	6877.3	6711.6	9740.3	5315.5	9754.1	9059.3	8863.9
77	10191.1	6332.8	8035.6	9755.1	9750.9	8133.8	16115.4	7048.7	15237.7	6900.1	7037.5	6377.1
78	6701.3	6594.8	5744.1	5609.6	15599.1	8810.7	8909.9	9971.6	13855.6	8875.7	11961.6	7067.1
79	13560.1	8672.1	8469	15658.2	17965.5	13606.5	9738.1	7371.7	10976.8	6784.5	9900	5756.1
80	4948.2	8601.4	15611.7	9656.7	12290.4	9764.3	18067.7	6007.8	5422.9	8108.3	6902	6136.5
81	11640.8	4737.7	13702.7	6751	6345.9	6660.3	7501.7	6516.5	8568.4	6784.5	13886.5	6973.5
82	6027.7	17957.5	9852.2	5315.8	6107.2	9944.1	6405.9	9615.4	15792.2	6451.5	5898.6	8972.6
83	6218.4	5954.2	16736.7	9040.6	9845.3	13008.3	12796.2	5720.3	6587.3	5242.8	9978.2	8186.6
84	5723.7	7230.6	6162.7	6824.1	9271.3	16169.5	6488.5	9000.5	14665.3	12657.9	6406.9	9024.1
85	13948.8	5799.1	10595.5	15536.9	17663.3	9850.6	12502.7	16316	10895.5	8166.6	5778.3	6404.4
86	5675.7	5791.5	5951.1	7313.1	16594.8	7487.1	6748.3	9420.5	9045.6	5499.3	8598	14148.4
87	5239.3	5957.5	8695.9	15436.3	5576.7	9801	10270.3	6119.2	9633.9	6117.8	9911.4	7155.2
88	5594.9	5902.9	16806.4	7273.9	5615	9981	8148.9	12937.7	13859	17326.2	8840.3	8668.5

Stream ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
89	6918.8	8341.5	8184.6	14128.7	5306.9	6858.7	5528.4	16354.7	9016.8	5518.1	9604.5	10825.9
90	16989.5	6949.5	8019.6	9512.8	9723.3	4981.1	9036.7	12803.6	14964.5	5610.9	10704.8	6882.5
91	5748.9	14357.6	12843.8	5842.1	5946	14615.7	5727.7	18817.9	6904.6	7930	9031.1	6747.8
92	12696.6	8029	5153.5	6177.3	10726.6	18705.9	13606.7	6407	6453	8383.8	6953.9	10237.6
93	7256.3	6763.8	4975.1	9515.3	8555.8	6557	10714.6	9181.3	5800.2	9972.1	7149.3	6417.8
94	20228.5	8549.8	6222.1	7969	6462.1	6803.9	15501.5	7430.6	9834.9	6824.1	9015.7	14652.3
95	8294.7	8568.4	11703.3	6292.9	4911	9198.5	13175.3	5759.1	7113.1	13886	8108.9	14019.7
96	14140.8	20268.1	6225.1	11502.9	13061.9	10679	8999.1	5479.8	16742	7006.5	6798.2	6274.1
97	5718	6230.7	7978.7	6112.5	6511.4	7246.8	9547.6	11453	16283.7	14602	12855	7091.5
98	21802.8	8526.9	15981.3	8990.6	10406.5	13943.2	5953.8	5429	10305.6	6672.1	6076.9	6073.4
99	5727.7	13668	20495	6748.8	13064.2	5946.3	7884.6	8687.6	13841.6	7233.8	11631	10565.8
100	8557.7	9306.6	7249.2	16517	11630	6774.1	6319.6	13716	5238.7	5379.6	14044.1	6276.5
101	13424	7008.2	5500.5	20579.6	8282.6	5344.4	6431.2	7053.4	9226.5	9406.6	6919.4	16703
102	10761.3	6541	5307.1	8332.6	5568.2	6021.5	7197.3	16483.8	6165.2	5826.6	7153.3	9110.1
103	11488.2	16672.3	5866.8	13851.4	6077.3	6885.5	5567.1	6238.8	6913.1	9260.5	8840.2	10650.1
104	7132.9	11287.6	6986.7	6950.6	6100.5	5384.2	5647.1	5339.6	6216.8	14215.5	13916.6	9224.2
105	9467.4	13757.7	6313.4	6106.4	5794	7424	16322.5	13883.2	14424.6	5326.7	6935.2	8785.6
106	6578.6	5673.1	15919	9296.9	6416.8	6933.5	21863.8	8634.7	9178.3	14058.6	6169.1	5768
107	17625.8	6972	6909.3	6968.7	9407.6	6362.4	9839.1	5649.3	12638.4	13647	9346.1	6440.5
108	6492	15919.6	5378.9	8684.5	10319.7	5671.1	7396.8	6059.6	9344	9408.6	8589.9	6697.3
109	6130.8	8215.9	6368.1	6812.8	7079.6	13716.9	7938.6	10289.7	14122.2	6908	6508.7	6591.1
110	13977.9	7158.7	6566.9	5303.3	5521.3	6867.7	8481	6595.1	6220	21581.5	13493.6	10445.6
111	15263.3	5398.9	5870.1	16715.5	6046	13506.3	5793.5	15997.4	14967.6	21936.4	9285.8	8616.2
112	10772.4	16697.3	8491.3	5812.6	9673.6	5847.7	22176.1	6087.5	8204.1	13627.2	6991.5	5563.9
113	13915	21990.3	9925.2	8468.2	9291.8	6561	13649.9	6041.2	16885	6075.6	7055.6	6394.5
114	6010.9	16716.1	9260.5	9837	10097.5	6608	8799.3	13603.9	5847.3	6247.9	5478.7	16841.9
115	15580.2	13537.3	9259.9	9212.2	13866.8	5955.8	13328.5	5328.1	5887.7	7651.6	9929.9	5985.1
116	23515	14275.2	9590.9	8777.4	5890.8	13892.5	7648.4	6494.2	9259.9	5823.3	13688.2	6327.8
117	7516.9	8769.4	6219.5	5931.3	13862.6	6768.8	6195.8	8505.9	5897.2	6933.7	16397	7950.2
118	10959.5	6629.9	9260.5	9274.8	8832.9	5875.2	13846.6	6908.1	23216.8	6212.1	7766.5	6182.1
119	6120.1	6831.3	6185	6010.7	13858.8	7306.1	5736	8877.1	13552.7	10883.9	13226.8	7165.2
120	14455.7	5602.6	10608.5	13863.8	15735.2	13937.5	7887.1	7686.8	17829.8	6740.4	8916.9	6333.5
121	5781	16682	23589.3	8600.4	13402.4	8809.5	15912.3	6337.1	5359	9348.6	6994.2	6811.2
122	9218.7	5941	13905	6845	5771.2	6029.1	7364.6	6150.6	5739.9	7080.9	13200.4	6864.1
123	6223.7	15768	8668.5	6008.9	6558.9	8785.2	6253.9	7284.3	13808.6	5951.8	5846.1	14541.9
124	5745.7	5763.7	15268.2	17578.2	9032.9	13302	13983	5671.7	6642.1	6154.7	9567.4	10172.6
125	6279.3	6106.7	6772.9	5900.1	8082.8	23749.4	5980.9	10395.4	14546.4	13086.7	5847.1	5733.1
126	13595.5	5864.8	17380.2	13822.5	15594.5	9340.7	13441.5	23908.2	9544.7	10623.3	6098.7	6384.3
127	6403.5	6296.3	6097.6	8056.7	24183.9	6067.3	6160.1	7514.6	11131.9	5598.2	5171.2	12822.3
128	6098.7	5934.2	5739.9	13643.5	5292	9239.9	9099.3	6219.8	16209.7	6229.9	8751.3	6937.6
Min.	794.7	35.5	49.8	28.7	172.9	18.5	190.5	91.1	620.2	90.3	71.1	138.5
Avg.	9257.5	9319.9	9078.8	9207.1	9345.7	8930.6	9357.7	8716	10144	8382.8	8854.6	8703.9
Max.	23587.3	21990.3	23589.3	22176.6	24308.2	23749.4	22176.1	23908.2	23216.8	21936.4	16744.3	22390.8

Stream ID	Q13	Q14	Q15a	Q16	Q17	Q18	Q19	Q20	Q21	Q22	RF1	RF2
0	297.4	17	20.8	61	150.5	764.2	220.3	74.1	801.7	74.8	61	59.9
1	10606.1	5569.6	8007.9	10507.4	6202.9	15254.3	6440.4	13631.6	1261.1	6413.2	53.4	60.5

Stream ID	Q13	Q14	Q15a	Q16	Q17	Q18	Q19	Q20	Q21	Q22	RF1	RF2
2	6094.7	15318.8	6160	13708.8	24462.6	5895.3	9568.4	5900.9	5824.8	7934.7	52.1	61.9
3	5846.4	7535.8	10584.5	7081.7	9444.5	13598.7	6529.3	5882.2	5266.2	6954.7	51.5	61.7
4	6399.5	15351	9216.9	7653.2	9651.4	5639.2	14057.3	6256	24031.8	6167.9	52.6	61.3
5	8231.5	6129.6	22426.6	9384.9	7035.1	13526.5	13834.1	6229.4	2315.2	7641.2	55.4	61.5
6	13938.5	6360.1	15158.7	5782.7	7112.5	7799.5	7034.1	5842.6	6274.8	10551.8	55.7	61
7	5831.2	5384	7055.1	6585.4	12712.6	2539.4	7666.2	15206.1	14967.4	14595.3	55.3	61.4
8	6399.5	6382.1	14611.6	5164.6	14139.3	6966	2692.7	10589.6	6115.8	5720.8	57.9	60.8
9	22202.3	5544.5	10856.4	6251.3	9215.6	6169.8	10946.1	13936.2	13275.6	6105.3	55.8	60.9
10	7737.1	10588.3	22297.2	5573.9	14052.1	15236.1	6479.7	5416.7	10441	6477.4	54.7	59.7
11	7218.5	22324.3	2723.6	14325	14336.3	15208.7	7316.4	9510.1	5516.6	7919.9	54.8	60.6
12	5451.4	6934	7201.7	14715.6	14308.8	8861.7	7411.4	5791.5	5674.3	8949.8	54.8	60.7
13	6101.4	5763.3	6849.7	8333.4	21260.2	6740.4	5889.5	6192.4	4037.8	12348.9	55.3	62
14	10856.4	5295.9	12588.5	6242	8299.7	9310.7	6434.7	14618.7	7748.2	5725.3	55.1	61.2
15	6363.5	9056.3	10369.3	4165.5	14219.6	7311.3	7520.9	5549.1	7400.8	6243.5	59.7	62.1
16	5583.8	13997.7	5758	9672.4	6428.9	7084.4	6625.9	7869.8	7237.5	12360.8	59	62.4
17	5543	6115.3	12309.1	22151.8	10628	7868.4	5339.6	5801.6	9138.8	7170.1	58.3	62
18	14540.8	4275.2	7244.5	7128.3	7574.6	6493.7	5714.1	7535.6	10025.4	7139.7	58.8	62.4
19	5671.3	14186.1	8827.6	14669.1	10319.3	6263.5	6850.7	6741	10888.4	14427.5	57.6	62.1
20	14178.6	14380.2	22327.3	4433	7260.6	14573	12610.1	6328.4	6395.5	8794	59.1	62
21	6629.1	22114.2	9163.3	9782.8	10766.6	6583.2	12663.2	4708.7	15614.4	5941.6	60.6	62.1
22	14342.6	22257.3	7036.2	4540.6	6494.6	10183	10978.8	5966.1	9205.9	8318.5	60.6	62.1
23	5382.2	12851.5	21260.3	10884	5914.3	6067.2	5454.9	7134.1	7565.3	6920.2	60.7	62.2
24	9056.9	13993.1	5089.7	7306.6	5357.4	12686.1	7362.6	6644.6	11073	10569.3	61.2	61.6
25	17148.3	12784.8	5652.4	9699.9	5747.3	5561.2	7078.1	5457.4	10925	9680	53.5	62.2
26	6291.8	12320	6766	7201.2	6393.7	5814.8	10593.4	12796.6	10535	16218.8	54.4	62.3
27	7416.9	6095.6	10220.3	5570	21482.2	5476.9	7498.8	7058.1	16263.1	10645.7	54.4	62.2
28	9685.3	7536.9	10284.3	11008.6	5782.3	10116.8	6848.6	12316	12754	21416.5	54.2	62.3
29	6669.7	7244.8	6076.3	9674.2	10620.9	10753.9	5692.9	7245.4	6261.9	8079.6	53.6	60.8
30	12514.6	9636.1	7791.9	6508.6	21786.4	12403	5402	5741.2	9664.7	17047.3	60.4	62.4
31	5370.5	6966	7084.9	6755.6	6468.9	9523.5	7865.2	11044.7	17542	7341.5	62.7	63.4
32	10002.1	7220.7	6451.7	12893.1	12419.8	6645.3	7362.8	5325.8	5483.1	9775.5	62.4	63.1
33	5970	12435.1	6497	21706	9890.3	7065.5	5845.5	6994.6	10925	6787.3	63.3	65.2
34	21013.9	12406.2	6736.8	6165.2	7287.2	10922.4	7224.4	5616.5	10055.7	7759.2	62.3	63
35	8014.5	6702.1	6963.7	9994.4	21752.1	5562.8	5582.4	10805	7945.5	17043.2	58.9	62.2
36	9988.7	5637.6	5419.8	5866.5	21055.5	12371	7049.8	5877.2	12758	10907.7	58.8	63
37	8135	20939.6	7532.5	5321.4	6636.6	6953.3	10117.8	7245.5	6728.3	10830	59.7	61.7
38	6422	10483.9	5672.7	10313.7	6024.7	6865.8	5615.7	8127.1	6443.1	7927.6	60.3	60.8
39	6455.2	16711.6	10743.2	8049.6	6238.8	6957	9910.9	12491.3	12686	6858.5	60.6	62.2
40	8603.4	10900.2	20534.4	5903.9	16860.4	5309.6	7601.3	7557.3	8048.2	9766.4	58.2	63.4
41	7796.6	8175.4	5334.6	9705	10808.1	13959.8	7178.2	10946	7193.1	8082	56.9	62.5
42	9747.6	6077.5	8041.9	10465.6	7136.2	16632	6265.6	10739.7	9802.9	5873.1	58.9	61.6
43	6443.1	16707.4	6905.3	10559.3	20781	5334.8	10005.3	7246.2	7235.3	8179.3	56.1	62.4
44	6879.7	7690.8	9776.5	5758.3	10186.7	10614.5	6196.5	6638.4	6113.3	7010.9	58.2	63.1
45	6195.2	16876.8	9749.6	7993.9	10208	5274.7	10880	7268.5	20580.2	5762.4	66.4	63.3
46	8026.4	6905.1	19197.1	10315.4	5974.7	10613.6	13828.8	5939.6	10322.6	7799.2	65	63.4
47	10751.4	6268.6	16661.1	5374.7	6942.6	7965.5	7463.4	5754.9	33456.3	10351.6	60.9	61.9
48	5567.7	5700.4	6706.2	6414.1	10591.8	11081.1	7825.4	16594.1	12148.8	13159.1	64.7	63.3

Stream ID	Q13	Q14	Q15a	Q16	Q17	Q18	Q19	Q20	Q21	Q22	RF1	RF2
49	6303.4	6224.3	15838.1	5609.3	11206.2	6706.2	10720.5	9816.2	5725.7	5579.8	62.9	64.1
50	18699.8	5608.3	9568.7	7215.2	9998.6	6465.7	9884.5	10837	11621.8	6305.7	54.9	62.5
51	7887.6	9656.3	18846.2	5355.7	10989.7	16623.8	6522	6081	10248.7	7330.3	56.3	63.6
52	7379.2	18701.4	10925	12998.8	11076.1	16638.3	6937	11762.9	5811.6	8054	58.1	62.1
53	6059.8	6585.9	7181.1	16732.3	11062.7	9527	7237.8	6733.1	5340.9	10586.2	57.5	61.6
54	7146.3	5322.7	6865.8	8265.2	18627.6	5672.7	7722.3	6421.2	12391.1	10816.6	58.2	62
55	9520.7	5636.6	10196.8	6788.3	9065.3	9102.6	6660.7	13123	7625.1	5870.8	62.3	63.5
56	6303.4	8707.6	9519.1	12468.2	15491.2	8532.7	7688.3	5607.1	9064.9	6323.5	61.1	64.2
57	5853	13015.9	6360.2	12205.4	6314.8	6700	6740.2	8824.5	8532.8	10868.2	63.5	64.3
58	5502.2	6181.7	10056.8	18597.6	10396.3	7942.8	5594.8	5768.1	9024.1	7424.8	61.6	62.8
59	15607.6	12572.3	6716.5	8994.2	8358.9	6739.4	5381.7	9022	10091.6	6120	62.2	62.9
60	5807.8	11469.6	11799.4	13074.5	9745.2	6263.4	6817.4	5787.9	9684.7	15430.9	62.7	59.7
61	11466	15430.9	18787.6	12729.9	8999.2	12951.5	10368.3	6500.6	6439.5	11920.3	60.8	61.6
62	5911.2	18656.4	8679.9	8720.5	12201.1	6403.4	10812.3	12948.9	15451.3	6457.7	60.3	62.1
63	15388.4	18719.7	7096.7	12840.4	7896.2	9503.3	9743.3	5803.8	8872.7	8806.3	60.8	61.6
64	5686.9	10736.3	18719.6	9649	5345.6	12841.8	6209.8	6866.7	8367.8	6663.9	60.7	61.9
65	8725.7	11218.5	5226.8	8617.3	6366	12061.3	7141.3	6538.1	13326.7	9285.4	56.2	61.8
66	16136.9	12204.6	5109.3	9596	5619.2	12949.7	6973.3	6027.2	9584.6	8769.7	56.3	61.3
67	13726.8	10431	7250.8	9041.6	7152.1	5147.4	9804.3	13269.8	11962.6	15734.1	55.3	62.3
68	8108.3	13757.9	8640.3	5950.7	18367.3	5318.9	7957	6857.6	15483.3	9658.5	56.4	61.9
69	9939.3	7951.1	8720.5	9798.1	5841	12310.6	6981.7	10810.2	11902.1	18471.5	55.5	60.9
70	6345.5	6864.6	5865.8	8719.8	9841.3	9850.7	5987.3	6986.4	6543.5	8963.2	60.2	61.7
71	11902.1	9074.5	8472	5613.6	18868.1	10770.5	5596.4	6435.8	8668.5	16106.6	59	62.3
72	5360.7	6941.9	7252.8	6448.8	6405.8	9311.2	8150.4	9639.5	15667.2	7467	59	62.3
73	12393.5	7099.8	13991.9	12177.5	10843.9	6856.4	7106.4	5721.9	5825.7	9502.2	58.7	62.1
74	5781.1	10578.5	14036.4	18842.7	9750	6747.5	6696.8	7006.4	9656.7	6100.4	60.7	61.5
75	18177	9724.3	6985.2	6500.8	7053.8	9725.9	6749.3	5553.1	12113.4	8031.1	55.3	62.1
76	7916.2	14263.3	5986	12339.6	18929.1	5559	6512.5	9919.5	8952	16053.1	57.1	61.3
77	12233.6	5395	5523.6	6568.5	18135.7	9470.7	11834.9	5429.7	13210.1	9824.9	55.8	60.8
78	15695.8	17985.6	7985.9	5849.1	5711.4	7044.9	10052.4	10802.1	6145.7	10004.5	56	63.1
79	6765.6	9845.9	6553.2	7971.9	5895.5	5969.6	6117.8	15716.1	5462.1	8128.6	56.1	62.9
80	6423.4	15600.3	9885.8	8950.6	6605.3	6740	8888.6	10771.6	11902.1	6662.4	61.4	61.7
81	16148.1	9271.4	17565.3	5863.2	15963.2	5762.8	12057.6	9365.7	7939.6	8759.5	58	63.5
82	7968.3	15762.7	5556.8	8621.9	12211.1	12889	7174.6	9882.2	6959.8	9005	58.9	62.1
83	8692.5	5975.4	8705.9	9552.5	7317.5	15492.1	6889.1	8908.2	17323.6	6272.4	59.9	61.5
84	5294.9	15567.4	7277.6	9903.9	17813.7	5350.7	10320.2	7138.9	11683	8196.8	60.6	61
85	6623.8	7875.7	8680.5	6635.8	9994.3	8244.2	7092.6	5632.2	5711.1	7080.5	63.4	62.2
86	6763.8	14332.5	10038.5	8124.5	12839.6	5847.1	10163.1	9665.1	18680.9	6560.3	62.8	62.5
87	8819.1	7352.1	15778.8	12752.7	6381.9	7868.2	13792.1	6452.8	18389.4	7675.5	63.8	61.9
88	9845.3	6887.5	15423.5	5720	6076.1	8382	6894.4	6575.3	10305.6	9114.6	61.7	63.1
89	6535.5	6165.1	6402	7009.8	6948.6	19110.3	8367.2	14327.7	12001.9	13858.1	64.5	62.4
90	6743.8	7152.5	14000.7	6223.5	10559.2	5949.8	18686	8665.8	6556.2	5867.8	54.1	60.7
91	16495.6	6604.9	8596.5	10636.2	10173.9	7280.7	9620	10222.9	6801.5	5566	54.6	61.3
92	8839.3	8711.5	16606.3	5831.8	10105.8	14295.9	7002.4	5851.8	9116.6	7319	55.5	61.1
93	6784.5	16470.5	18846.9	14359	10310.3	14354.6	6236	12894.5	5755.7	8017.2	56.5	60.7
94	5719.7	6113.6	10822.6	14058.4	10699.9	9474.1	7071.5	5403.7	5238	12909.9	54.3	61.8
95	6781.7	5810.9	5949.8	9315.6	16485	6557.1	10924.3	6763.2	20420.3	6768.6	59	61.5

Stream ID	Q13	Q14	Q15a	Q16	Q17	Q18	Q19	Q20	Q21	Q22	RF1	RF2
96	8568.4	6515.2	6801.7	7199.2	9567.5	8495.6	5166.2	13776.5	7943.4	5815.3	59.3	62
97	6824.1	8545.7	8494.5	20369.9	13418	10800.7	7064	5351.5	9184.5	5295.9	58.7	63.2
98	6693.3	13881.4	5845.3	13780.6	7266.9	6770.8	6253.7	9276	14473	7021.4	61.5	62.4
99	5771.1	5115.9	6799.5	16515.9	9663.8	9028.7	6170.9	6606.5	8367.5	6905.4	59.4	62.4
100	13030.9	20531.1	6966.1	11994.4	9187.8	6563.4	6618.8	8084.9	8368.5	6480.7	58.2	62.5
101	5508.4	10182.1	14165.6	13818	9238.3	7008.2	6694.9	6181.4	7212.1	14394.1	59.1	62.2
102	11702	13011.5	16381.3	20689.3	10585.5	13628.1	7194.2	6113.6	6024	14092.7	59.4	63.5
103	7386.6	16204.3	8408.7	5634.2	13881.5	5915.4	7316.1	20917.2	14548.7	5772	59.1	62.3
104	13453.4	16287.3	6916.6	20802.2	11825	9052.1	7554.5	6290	8306	9425.1	60	63.5
105	6319.7	10237.8	16240.2	9121.7	6316.5	20916.4	6533.2	7082.5	9291.4	7123.5	57	61.9
106	8489.5	10328.3	6458.5	17402.1	7179.6	13883	7225.8	7167	13705.9	7807.8	58	62.1
107	13786.2	13918.5	6300.4	8555.5	5423.1	20920.1	7478.8	5383.8	8681.8	7224.6	58.5	62.5
108	21403.5	6932	6968.6	14281	6214.6	5975.4	7571.9	14044.8	13644.7	14492.4	57.3	62.2
109	9264.3	21436.7	8568.4	5843.4	16134.1	5226.6	13628.7	6312.2	14106.5	9369.8	59.4	62
110	8461.4	9251.4	7824.2	9223.6	5521.1	13720.7	7133	7068.6	13811	16121.5	63	62.2
111	5905	7156.7	6235.6	5814.8	8802.7	9532.9	6905.8	7613.4	6028	10868.2	64.7	60.8
112	13879	7833.8	10608.5	5916.6	16950.1	7021.8	6100.6	6947.9	5599.8	13522	63.1	63
113	5426.8	6253.9	6766.2	7515.8	5889	7252.6	9659.3	8781	13457.2	14615.6	65.9	61.5
114	13591.5	6772.6	22035.1	13977	7171.5	7561.2	6559.3	6777.7	6027.7	8534.4	63.3	62.6
115	6176.6	6959.2	22083.3	16897.8	8779.1	6868.6	6950.8	7615.5	8720.8	6319.8	58.3	61.4
116	15714.2	6931.9	7612.9	6004	7072	8595.5	6460.6	5333.5	13273.6	9341.5	58.1	62.1
117	9292.5	22207.4	6050.9	13614.6	17019.8	5294.9	6904.3	9641.3	9259	13562.1	56.5	61.8
118	13232.8	5347	6067.4	6109.9	16158.9	6929.9	14837.1	5879.9	13890.8	8672.6	56.6	62
119	23684.7	15691.7	9260.5	5385.4	6055.2	7388.6	9071.6	16782.9	5731.6	9382.8	56.5	61.3
120	5865	9219.3	6849.7	6168.3	6395.9	5885.6	5933.9	23689.1	5701.8	10585.2	58.2	63.9
121	5939.3	13822.7	9321.9	10995.2	6155.3	7498.7	5994.9	7396.1	13606.7	5865.2	60	62.4
122	23684.8	8635.6	15735.1	6282.1	14028.6	5357.4	16707.3	9477.5	10880.6	9208.7	59.9	62.4
123	9260.5	23713.3	5275.9	6609.2	13426.3	13606.4	7215.1	9352.1	7410.4	10221.1	58.9	63.2
124	5260.2	6266.5	10894.8	7921.4	8056.5	13838.1	6158.4	6271.2	24967.8	6725.6	59.6	62.8
125	5895.3	13633.4	7579.2	9388.9	15975.2	5567.3	9559.7	6913.2	17550.4	10669	60.1	62.6
126	6319.2	9349.4	5511.6	6924.1	9280.6	6842	6329.1	5979.6	6397.9	7529.1	59	62.8
127	6620.2	13885	8706.1	10550.9	14541	5775.4	9371.1	17434.4	16656.8	6967.4	60	61.7
128	10881.2	7415.4	15574.7	13282	6464.4	6868.5	13877.7	6207.5	24187.4	9366.1	59.8	60.1
Min.	297.4	17	20.8	61	150.5	764.2	220.3	74.1	801.7	74.8	51.5	59.7
Avg.	9218	10494.9	9830.6	9533	10450.5	8955.8	8020.6	8426.9	10237	9157.8	58.8	62.1
Max.	23684.8	23713.3	22426.6	22151.8	24462.6	20920.1	18686	23689.1	33456.3	21416.5	66.4	65.2

InfoSizing
The Right Metric For Sizing IT

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November 20, 2013

I verified the TPC Benchmark™ H v2.16.0 performance of the following configuration:

Platform: SPARC T5-4 Server
Operating System: Oracle Solaris 11.1
Database Manager: Oracle Database 11g Release 2 Enterprise Edition with Partitioning

The results were:

Performance Metric	**377,594.3** QphH@10,000GB
TPC-H Power	342,714.1
TPC-H Throughput	416,024.4
Database Load Time	09:37:54

Server	**SPARC T5-4 Server**		
CPUs	4 x SPARC T5 3.6 GHz (64 cores, 512 threads)		
Memory	2 TB (8MB L3)		
Disks	**Qty**	**Size**	**Type**
	144	4 TB	7.2K rpm SAS HDD
	96	800 GB	F80 Flash Accelerator PCIe SSD

In my opinion, these performance results were produced in compliance with the TPC 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 10,000GB 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 variable were generated by QGen (see note below)

- The query text was produced using minor modifications and one query variant

- The execution of the queries against the SF1 database produced compliant answers

- The implementation used Redundancy Level 3
- A compliant implementation specific layer was used to drive the tests
- The throughput tests involved 128 query streams
- The ratio between the longest and the shortest query was such that no query timings were adjusted
- The execution times for the 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:

Version 2.16.0 of the DBGen package was not available at the time of testing. DGBen v2.15.0 was used instead. The TPC did not make any modification between the two versions. Aside from the release number, the two versions of DBGen are identical. QGen 2.15.0 was used with the modification approved by the TPC for release 2.16.0. These approved modifications are detailed in the FDR.

The measured configuration included:
- (23) Sun Server X3-2L servers with Intel Xeon E5-2609 2.4 GHz CPUs used as COMSTAR storage servers that were substituted by (23) Sun Server X4-2L servers with Intel Xeon E5-2609 v2 2.5 GHz CPUs
- (144) 3TB 7.2K rpm SAS HDDs that were substituted by (144) 4TB 7.2K rpm SAS HDDs
- (92) Flash Accelerator F40 400GB SSDs that were substituted by (92) Flash Accelerator F80 800GB SSDs

Based on the specifications of these items and data collected during testing, it is my opinion that these substitutions have no significant effect on performance.

Respectfully Yours,

François Raab, President

Table of Contents

TPC Benchmark H Overview

The TPC BenchmarkTM H (TPC-H) is a Decision Support benchmark. It is a suite of business-oriented ad-hoc queries and concurrent 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
- 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

0 General Items

0.1 Benchmark Sponsor

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

Oracle Corporation is the sponsor of this TPC-H benchmark.

0.2 Parameter Settings

Settings must be provided for all customer-tunable parameters and options that 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 system and Oracle parameters used in this benchmark.

0.3 Configuration Diagram

Provide diagrams of both the measured and priced configurations, accompanied by a description of the differences.

The SPARC T5-4 Server is configured as described below. Details of the COMSTAR storage servers are also provided.

	Measured Configuration	Priced Configuration
Processors	4 SPARC T5 3.6GHz	
Sockets / Cores / Threads	4 / 64 / 512	
Memory	2 TB DDR3	
Disks	2 300GB 10K RPM 2.5" SAS – internal	
	23 Sun Server X3-2L COMSTAR 1 Sun Server X4-2L COMSTAR	24 Sun Server X4-2L COMSTAR
Adapters	12 16Gb/s dual port PCI-E FC-AL	
	1 internal PCI-E SAS	
Networks	4 port 1GbE integrated Ethernet	
Service Processor	Integrated	

The measured configuration consists of 23 Sun Server X3-2L and 1 Sun Server X4-2L running Oracle Solaris 11.1 as Common Multi-protocol SCSI Target (COMSTAR) storage servers. The End-of-Material-Life has been announced for the Sun Server X3-2L and will no longer be orderable. The Sun Server X3-2L has been replaced by the Sun Server X4-2L in the Priced Configuration. Each of the COMSTAR storage servers in the measured configuration have the same hardware peripherals (except for the Sun Server X4-2L which has 4 Flash Accelerator F80 PCI-E 800GB cards) and were loaded with the same distribution of database tables and

indexes. The differences of the Sun Server X3-2L and the Sun Server X4-2L are detailed below:

	Sun Server X3-2L (Measured)	Sun Server X4-2L (Priced)
Processor	Intel Xeon E5-2609 2.4GHz	Intel Xeon E5-2609 v2 2.5GHz
Processors / Cores / Threads	2 / 8 / 8	
Memory	16GB DDR3-1600 DIMM	
Disks	6 3TB SAS 3.5" 7.2K RPM 4 Flash Accelerator F40 400GB	6 4TB SAS 3.5" 7.2K RPM 4 Flash Accelerator F80 800GB
	2 600GB 10K rpm 2.5" SAS (not included in Total Storage Calculation)	
Adapters	1 8Gb/s dual port PCI-E FC-AL	
	1 6Gb/s internal SAS PCI-E	
Network	4 port 1GbE integrated Ethernet	
Service Processor	Integrated	

The new Sun Server X4-2L replaces the older Sun Server X3-2L with upgraded CPUs and new storage devices. The rest of the systems are identical, including the mainboard, power, internal storage configuration and memory configurations. A detailed comparison between the CPUs used by each COMSTAR storage server is detailed below:

		Sun Server X3-2L		Sun Server X4-2L
	Qty		Qty	
CPU	1	Intel Xeon E5-2609	1	Intel Xeon E5-2609 v2
GHz		2.4		2.5
# Cores		4		4
# Threads		4		4
L1 cache	4	32KB Inst and 32KB Data	4	32KB Inst and 32KB Data
L2 cache	4	256KB	4	256KB
L3 cache	Shared	10MB	Shared	10MB

The End-of-Material-Life has been announced for the 3TB 3.5" 7.2K rpm SAS disks used in the measurement and will no longer be orderable. The 3TB SAS disks have been replaced by the newer 4TB 3.5" 7.2K rpm SAS disks. A detailed comparison between the two disks are detailed below:

	3TB 3.5" 7.2K RPM	4TB 3.5" 7.2K RPM
	Measured	Priced
Mfg Model	Seagate ST33000650SS	Hitachi HUS724040ALS640
Formatted Capacity	2.73GB	
Interface	SAS	SAS
Interface Speed	6.0 Gb/s	6.0 Gb/s
Avg Seek Time	8.5ms	8.0ms
Buffer Size	64 MB	64 MB
Rotational Speed	7,200 RPM	7,200 RPM
Media Density	N/A	475 Gb/sq. in.
Max Sustained Transfer Rate	155 MB/s	172 MB/s

The End-of-Material-Life has been announced for the Flash Accelerator F40 PCI-E 400GB eMLC cards used in the measurement and will no longer be orderable. The Flash Accelerator F40 PCI-E 400GB eMLC cards

have been replaced by the new Flash Accelerator F80 PCI-E 800GB eMLC cards. A detailed comparison between the two flash accelerators are detailed below.

	Flash Accelerator F40 400GB	*Flash Accelerator F80 800GB*
	Measured	Priced
Capacity	400GB	800GB
NAND Type	eMLC	eMLC
Random Read IOPS	148,958	155,193
Random Write IOPS	121,018	133,390
Read Bandwidth	2.156 GB/sec	2.099 GB/sec
Write Bandwidth	1.059 GB/sec	1.254 GB/sec
Write Latency	95 usec	84 usec
Read Latency	251 usec	230 usec

Substitutions

For this measurement, the substitution of the 3TB SAS disk with the 4TB SAS disk was done according to Clause 2.3.3.2 of the Pricing Specification version 1.7.0 using the data in Disk Substitution table above. The substitutions of the F40 with the F80 and the X3-2L with the X4-2L were done according to Clause 2.3.4.3 and 2.3.4.4 respectively of the Pricing Specification version 1.7.0. The performance data collected was presented to the auditor and approved.

Figure 1 shows the measured configuration and figure 2 the priced configuration.

System Under Test
Measured Configuration

SPARC T5-4 Server
4 SPARC T5 3.6 GHz processors
2 TB Memory
2 300GB SAS Internal disks
12 16Gbs PCI-E dual port HBA
Oracle Solaris 11.1
Oracle 11*g* Release 2 Enterprise Edition

12 FC cables

12 FC cables

Brocade 6510 Switches
12 16Gbs ea
24 8Gbs ea.

24 FC cables

24 FC cables
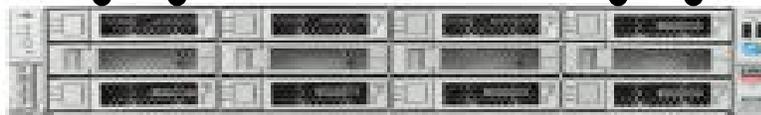
23 Sun Server X3-2L & 1 Sun Server X4-2L
2 600GB 10K RPM 2.5" SAS disks
6 3TB 3.5" 7.2K RPM SAS disks
X3-2L – 4 Flash Accelerator F40 PCI-E 400GB
X4-2L – 4 Flash Accelerator F80 PCI-E 800GB
2 FC connections to Brocade 6510 FC switch

System Under Test
Priced Configuration

SUT Mgmt System – Sun Server X4-2
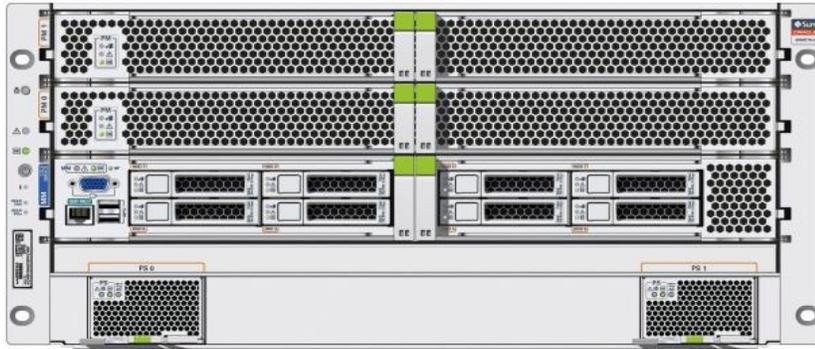
SPARC T5-4 Server
4 SPARC T5 3.6 GHz processors
2 TB Memory
2 300GB SAS Internal disks
12 16Gbs PCI-E dual port HBA
Oracle Solaris 11.1
Oracle 11*g* Release 2 Enterprise Edition

12 FC cables

12 FC cables

Brocade 6510 Switches
12 16Gbs ea
24 8Gbs ea.

24 FC cables

24 FC cables
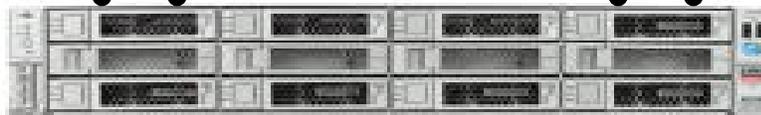
24 Sun Server X4-2L
2 600GB 10K RPM 2.5" SAS disks
6 4TB 3.5" 7.2K RPM SAS disks
4 Flash Accelerator F80 PCI-E 800GB
2 FC connections to Brocade 6510 FC switch

1   Clause 1 - Logical Database Design

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. All listings must be reported in the supporting files archive.

The Supporting Files Archive contains the programs and scripts that create and analyze the tables and indexes 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. The physical organization of tables must be reported in the supporting files archive.

No record clustering or index clustering was used. Column ordering was changed for some tables. Refer to the table create statements in the Supporting Files Archive for further details.

1.3   Horizontal Partitioning

Horizontal partitioning of tables and rows in the test and qualification databases (see Clause 1.5.4) must be disclosed. Scripts to perform horizontal partitioning must be reported in the supporting files archive.

Horizontal partitioning was used for all tables except NATION and REGION. Refer to the table/index create statements in the Supporting Files Archive for more details.

1.4   Replication

Any replication of physical objects must be disclosed and must conform to the requirements of Clause 1.5.7. Scripts to perform any replication must be reported in the supporting files archive.

No replication was used.

1.5   Tunable Parameters

Script or text for all hardware and software tunable parameters must be reported in the supporting files archive.

All hardware and software parameters changed from their defaults are reported in the Supporting Files Archive.

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   QGen Version Verification

*The version number, release number, modification number, and patch level of **QGen** must be disclosed. Any modifications to the **QGen** (see Clause 2.1.4) source code (see Appendix D) must be reported in the supporting files archive.*

QGen from TPC-H Rev 2.15.0 was used for this publication. Modifications were made to QGen to correct bugs in the generation of parameter substitutions for Query 4 and Query 22 per Clause 2.1.4.4 of the Specification.

The bug for Query 4 used an incorrect range of index values for the range of possible dates. The range being generated by QGen was from 1993-02-01 to 1997-11-01. Clause 2.4.4.3 requires the range to be between 1993-01-01 and 1997-10-01. The correction was to modify line 176 of varsub.c to change the indexed range from:

> *tmp_date = UnifInt((DSS_HUGE)1,(DSS_HUGE)58,qnum);*

to:

> *tmp_date = UnifInt((DSS_HUGE)0,(DSS_HUGE)57,qnum);*

Incidentally, these are the exact same changes applied to Query 15 on line 240 of varsub.c. Query 15 has the identical substitution requirements for DATE.

The bug for Query 22 used the wrong indexed values for the generation of country codes for Clause 2.4.22.3. This clause requires the generation of 7 unique country codes per the description in Clause 4.2.2.9, which is an index to the array of N_NAMEs defined in clause 4.2.3. The range of country codes to be generated for Clause 4.2.2.9 is from [10..34] by taking the range of indexes for N_NAME [0..24] and then adding a constant of 10. The problem with Query 22 substitution is created when line 76 of varsub.c defines the ccode array as:

> *long ccode[25] = {10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34};*

To which a constant value of 10 is added to on line 300:

> *sprintf(param[i+1], "%ld", 10 + ccode[i]);*

This generated a range of values for country code to be used by Query 22 in the range of [20..44], not the [10..34] as required by the specification. The corrective action applied for Query 22 was to subtract 10 from each value of the ccode array instantiation on line 76, thus making the array:

> *long ccode[25] = {0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24};*

No changes were made to line 300 of varsub.c and now the values generated for Query 22 are in the range [10..34], matching the defined ranges noted above.

These modifications were verified by the Auditor, and are included in the Supporting Files Archive in Clause2 per the requirements of Clause 2.1.4.5. The subdirectory QGen_Modifications contains a full set of query parameters for each stream for both the original QGen and the corrected QGen, a diff file containing the changes made to varsub.c and a copy of the modified code for varsub.c. Also in this directory is a series of CSV files with counts of the query parameter distributions by query and by query parameter. This information was used to demonstrate to the auditor the necessary corrections were applied without any changes to the other queries, or the required distribution of parameters.

2.3   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 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 output data for the power and throughput tests must be made available electronically upon request.

Clause8 of the Supporting Files Archive contains the executable query text. Approved query variant A was used for Query 15. The zip files containing the run1 and run2 results had to be split into multiple files no larger than 3GB each using the -s option for zip. This generates filenames like run[1|2]result.z01, run[1|2]result.zip.

2.4   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.

2.5   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 isolation Level 3 (repeatable read).

2.6   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 functions are in Clause8/RF_source in the Supporting Files Archive.

3 Clause 3 - Database System Properties Related Items

3.1 ACID Properties

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.

Tests conducted to demonstrate compliance for each of the ACID requirements is detailed in the following section. Source code for the 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.

3.2.1 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.

3.2.2 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.

3.3.1 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 by each of 129 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 the proper order.

3.4.1 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 did not see the uncommitted changes made by the ACID Transaction.
3. The ACID Query completed.
4. The ACID Transaction was resumed and COMMITTED.

3.4.2 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 Query completed.
4. The ACID Transaction was resumed and ROLLED BACK.

3.4.3 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. 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))

3.4.4 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. 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.

3.4.5 Concurrent Progress of Read and Write Transactions

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 Transaction, T2, was started which did the following:
   For random values of PS_PARTKEY and PS_SUPPKEY, all columns of the PARTSUPP table for which PS_PARTKEY and PS_SUPPKEY are equal, are returned.
3. T2 completed.
4. T1 was allowed to COMMIT.
5. It was verified that appropriate rows in ORDERS, LINEITEM and HISTORY tables were changed.

3.4.6 Read-Only Query Conflict with Update Transaction

Demonstrate 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, executing Q1 against the qualification database, was started using a randomly selected DELTA.

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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 Q1.

3.5   Durability

The SUT 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.

3.5.1   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.

The disks containing the TPC-H tables, indexes and log files are mirrored across the Sun Server X4-2L COMSTAR arrays using Solaris Volume Manager (SVM). Each disk contains table, index and log files, therefore a failure of one device fails database tables and indexes, and log files.

The following steps were performed to induce a failure of a single disk in an array.

1. The ORDERS and LINEITEM tables were verified to be consistent.
2. 129 streams of the ACID transaction were started.
3. After more than 100 transactions from each stream completed, the cables to the Sun Server X4-2L COMSTAR storage server was removed inducing the failure of the disks on the Sun Server X4-2L, including database tables and redo log devices.
4. Because mirroring was used across the arrays the transactions continued without any interruption.
5. A sample from the durability success file was matched against the contents for the HISTORY table and it was verified that no committed transactions had been lost.
6. The ORDERS and LINEITEM tables were verified to be consistent.

3.5.2   System Crash / Memory Failure / Loss of External Power

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.

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

Loss of External Power: Guarantee the database and committed updates are preserved during the loss of all external power for an indefinite time period

Each of these requirements were satisfied in a single test. The following steps were performed.

1. The ORDERS and LINEITEM tables are verified to be consistent.
2. 129 streams of the ACID transactions are started
3. After more than 100 transactions from each stream has completed, the power breakers to the host is removed thus halting processing immediately and indefinitely.
4. Power was restored to the host, the system was started, along with the database.
5. A sample from the durability success file was matched against the contents for the HISTORY table and it was verified that no committed transactions had been lost.
6. The ORDERS and LINEITEM tables were verified to be consistent.

4 Clause 4 - Scaling and Database Population

4.1 Ending Cardinality of Tables

The cardinality (i.e., 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	Rows
Lineitem	59,999,994,267
Orders	15,000,000,000
Partsupp	8,000,000,000
Part	2,000,000,000
Customer	1,500,000,000
Supplier	100,000,000
Nation	25
Region	5

4.2 Distribution of Tables and Logs Across Media

The distribution of tables and logs across all media must be explicitly described.

The TPC-H tables, indexes, logs and temporary tables are distributed across the COMSTAR storage servers. Each Flash Accelerator card has four separately configurable devices per PCI-E card for a total sixteen flash devices per COMSTAR storage server. These sixteen devices or LUNs are exported to the SPARC T5-4 Server and used by Solaris Volume Manager to create two identically sized stripes, each against one-half of the COMSTAR storage servers. The two stripes are then mirrored using Solaris Volume Manager on the SPARC T5-4 Server. Soft partitions or logical devices are created on the mirrored stripe and made available to Oracle Database 11g Release 2 to distribute the database tables, indexes and logs. Each COMSTAR storage server also has six SAS disks which are individually configured and the LUNs are exported to the SPARC T5-4 Server. One large stripe is created across all the SAS disk LUNs and logical partitions created for use by the database server for the temporary tables. Please see the scripts to generate the devices in the Supporting Files Archive in Clause2/DB_creation_scripts and Clause1/OS_DB_parameters/COMSTAR.

4.3 Database partition/replication mapping

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

The database was not replicated.

Horizontal partitioning was used for base tables LINEITEM, ORDERS, PARTSUPP, PART, SUPPLIER and CUSTOMER. The details for this partitioning can be understood by examining the syntax of the table and index definition statements in Supporting Files Archive.

4.4 Data redundancy mechanisms

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

Items	Storage Redundancy Levels
Base Tables	Level Three
Auxiliary Data Structures	Level Three
DBMS Temporary Space	Level Zero
OS and DBMS Software	Level One
Oracle Redo Logs	Level Three

4.5   Modifications to the DBGEN

*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 supporting files archive.*

DBGen from TPC-H Rev 2.15.0 was used for this result, as the TPC-H Rev. 2.16.0 code was not available from the TPC for the measurement. There were no changes made to the source code between the revisions.

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 9:37:54.

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:

Disk Type	# Of Disks	Space Per Disk*	Sub-Total Disk Space**
Flash Accelerator F80 800GB	96	800GB	71,520 GB
4TB SAS	144	4000GB	536,442.2 GB
		Total Space	**607,963.2**
		Data Storage Ratio	**60.8**

* Disk manufacturer definition of one GB is 10^9 bytes
**In this calculation one GB is defined as 2^30 bytes

4.8   Database Load Mechanism Details and Illustration

The details of the database load must be reported in the supporting files archive . Disclosure of the load procedure includes all steps, scripts, input and configuration files required to completely reproduce the test and qualification databases. A block diagram illustrating the overall process must be disclosed.
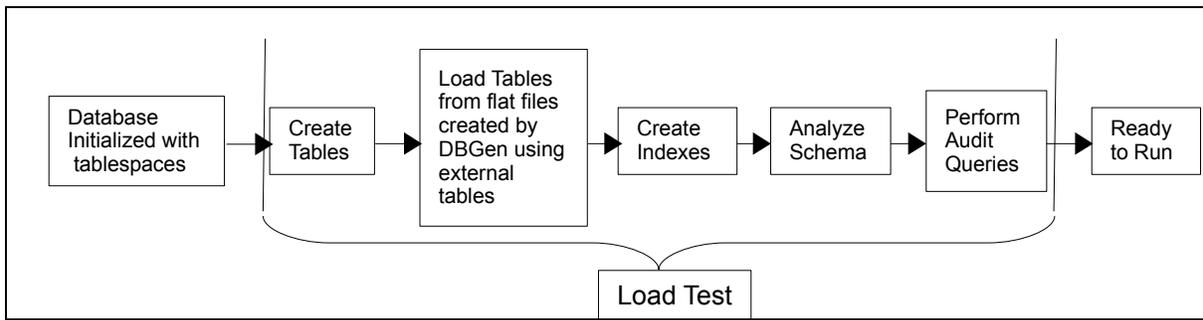
The database was loaded using data stored on flat files that are all on the tested and priced configurations. Oracle created external tables using the files that were created by the DBGEN program.

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 the same scripts to create and load the data with adjustments for the size difference between the test database and the qualification database.

4.10   Memory Ratio

The memory to database size ratio must be disclosed.

The memory to database size ratio is 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 reported in the supporting files archive including listings of scripts, command logs and system activity .

There was no system activity on the SUT between the conclusion of the load and the beginning of the performance test.

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 reported in the supporting files archive.

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 (see Clause 5.3.7) for each query and for both refresh functions must be reported for the power test. The output for each query and for both refresh functions must be reported in the supporting files archive.

The timing intervals for each query and for both refresh functions are contained in the Numerical Quantities section of the Executive Summary, located at the beginning of this document.

5.4 Number of Streams for the Throughput Test

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

128 query streams were used for the throughput test.

5.5 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. The output for each query stream for the throughput test must be reported in the supporting files archive..

The throughput test start time and finish time for each stream are contained in the Numerical Quantities section of the Executive Summary, located at the beginning of this document.

5.6 Total Elapsed Time of the Measurement Interval

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

The total elapsed time of the throughput test is contained in the Numerical Quantities section of Executive Summary, located at the beginning of this document.

5.7 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. The output of each refresh function in the refresh stream for the throughput test must be reported

*in the **supporting files archive**. .*

The start and finish times for each refresh function in the refresh stream are contained in the Numerical Quantities section of the Executive Summary, located at the beginning of this document.

5.8   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, are contained in the Numerical Quantities section of the Executive Summary, located at the beginning of this document.

5.9   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:

Run ID	QppH@10,000GB	QthH@10,000GB	QphH@10,000GB
Run 1	342,714.1	416,024.4	377,594.3
Run 2	336,860.8	436,281.0	383,361.4

5.10   System Activity Between Performance 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.

There was no activity on the SUT between Run1 and Run 2.

5.11   Query Output validation

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

The Supporting Files Archive contains the documentation.

6   Clause 6 - SUT and Driver Implementation

6.1   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 Power Test and Throughput Test are performed by executing a shell script called runTPCHpt. QGEN is first called with a stream id of 0 to generate the queries for the Power Test. Then script runTPCHpus is executed asynchronously to control the refresh functions RF1 and RF2. The script then continues to the query portion of the Power Test (qexecpl.c ISL), which waits until RF1 is completed. After the query portion of the power run has finished the refresh function RF2 is executed by the same refresh stream that previously executed refresh function RF1.

Following the Power Test, QGEN is again executed with the subsequent stream ids and seeds to generate new queries for each stream. Then qexecpl.c is called asynchronously to execute each streams concurrently. Then runTPCHus is executed to control the throughput test refresh function's pairs of RF1 and RF2.

Both wall-clock and high-resolution times are collected for all measurement intervals.

6.2   Implementation-Specific Layer

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

Query execution text generated by QGEN is picked up by the ISL program which submits the query to the SUT.

The ISL program (qexecpl.c) utilizes the Oracle Call Interface (OCI) to communicate with the Oracle database on the SUT. EQTs directly generated by QGEN are read and submitted to the SUT via the ISL program (qexecpl.c) as dynamic SQL statements. The ISL program then fetches the query execution output and reports it to the user. Timings are taken at intervals specified in Section 5.3.7 of the TPC-H benchmark specification.

6.3   Profile-Directed Optimization

If profile-directed optimization as described in Clause 5.2.9 is used, such use must be disclosed. In particular, the procedure and any scripts used to perform the optimization must be reported in the supporting files archive .

Profile-directed optimization was not used.

7 Clause 7 - Pricing

7.1 Hardware and Software Used

A detailed list of hardware and software used in the Priced Configuration must be reported. The listing for each separately Orderable item must have vendor Part Number, description, and applicable release/revision level, price source, unit price, quantity, extended price, applicable Discounted price and 3-year maintenance price. If package-pricing is used, the vendor Part Number of the package and a description uniquely identifying each of the Components of the package must be disclosed to a sufficient level of detail to meet the requirements of 1.4.1.1.

The Executive Summary contains a list of the priced hardware and software, including maintenance for 3-years, and any applicable discounts.

7.2 Total Three-Year Price

The total 3-year price of the Priced Configuration must be reported, including: hardware, software, and maintenance charges. The justification of any Discounts applied must be disclosed in the price sheet. Sufficient detail of what items are being discounted and by how much they are being discounted must be provided so that the Discount amount used in the computation of the total system cost can be independently reproduced.

The Executive Summary contains the details for the total 3-year pricing of the configuration. Oracle's discounts are based upon US list prices and for similar quantities and configurations. A discount of 30.9% has been applied to all Oracle hardware, software and services based on the total value and quantities of the components of the configuration, including full payment of all components and maintenance.

For assistance with any of these prices or their applicability to any customer's requirements please contact:

MaryBeth Pierantoni   mary.beth.pierantoni@oracle.com

7.3 Availability Date

The committed Availability Date of Components used in the price calculations must be reported. The Availability Date must be reported on the first page of the Executive Summary and with a precision of one day. When the priced system includes products with different availability dates, the reported Availability Date for the priced system must be a date at which all Components are committed to be Generally Available. Each Component used in the Priced Configuration is considered to be Available on the Availability Date unless an earlier date is specified.

All components of the Priced Configuration are available now.

7.4 Benchmark Performance Metric

A statement of the benchmark performance metric, as well as the respective calculations for 3-year pricing, price/performance, and the availability date must be included.

Performance Metric	Price/Performance Metric	Total 3-year Cost	Availability Date
377,594.3 QphH@10,000GB	$4.65/QphH@10,000GB	$1,755,709 USD	November 25, 2013

8 Supporting Files Index Table

An index for all files included in the supporting files archive as required by Clause 8.3.2 through 8.3.8 must be provided in the report.

Clause	Description	Archive File	Pathname
Clause 1	OS and DB parameter settings	benchmark_scripts.zip	SupportingFiles/Clause1/OS_DB_parameters
Clause 2	DB creation scripts	benchmark_scripts.zip	SupportingFiles/Clause2/DB_creation_scripts
Clause 3	ACID scripts	benchmark_scripts.zip	SupportingFiles/Clause3/ACID_scripts
	ACID output	benchmark_scripts.zip	SupportingFiles/Clause3/ACID_result
Clause 4	DB Load scripts	benchmark_scripts.zip	SupportingFiles/Clause4/DB_load_scripts
	Qualification output	benchmark_scripts.zip	SupportingFiles/Clause4/QUAL_output
Clause 5	Query output results	run1result.z01 run1result.zip run2result.z01 run2result.zip	
Clause 6	Implementation Specific layer source code	benchmark_scripts.zip	SupportingFiles/Clause6/Implementation_code
Clause 7	3rd Party Price Quotes	benchmark_scripts.zip	SupportingFiles/Clause7
Clause 8	Query substitution parameters	benchmark_scripts.zip	SupportingFiles/Claues8/QueryParms
	RF function source	benchmark_scripts.zip	SupportingFiles/Clause8/RF_source

9 Auditor's Information and Attestation Letter

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.

The auditor's attestation letter is included at the front of this report, just after the Executive Summary.