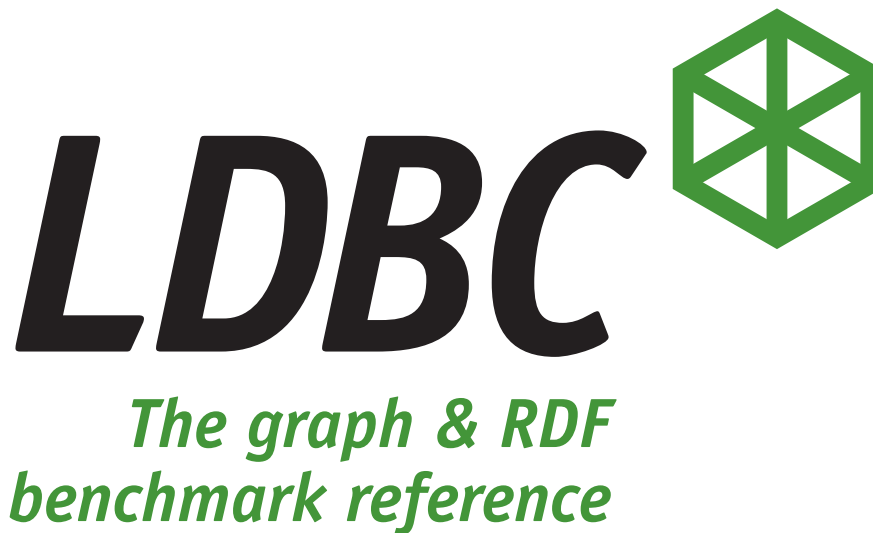




Full Disclosure Report of the LDBC Social Network Benchmark

An Implementation of the LDBC Social Network Benchmark's
Interactive Workload over the Graph Engine Service (GES)

December 1, 2025

GENERAL TERMS

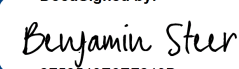
Executive Summary

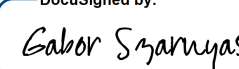
This audit was conducted using the LDBC Social Network Benchmark’s Interactive workload, to assess the performance of Huawei’s Graph Engine Service (GES) utilizing the industry-standard LDBC Social Network Benchmark’s Interactive workload. Deployed as a single-node instance on Huawei Cloud’s Kunpeng CPU architecture, and implemented in C++, GES achieved throughputs ranging from 125 872 to 139 411 operations per second across scale factors SF100, SF300, and SF1000.

Communication between the benchmark driver and GES was facilitated via HTTP REST calls. Key performance enhancements included the implementation of a materialized view for the post in forums data. This audit builds upon prior testing in 2024, utilizing a property graph model and Cypher language, demonstrating continued optimization and scalability of the GES platform for interactive graph workloads.

Declaration of Audit Success

This report contains an audited LDBC benchmark run. The results have been gathered by an independent and impartial auditor who has validated the implementation of the queries, successfully run the ACID tests associated with the claimed isolation level, read-committed, and verified the overall system’s configuration conformance to the description of the benchmark and its strict requirements.

DocuSigned by:

2F59540E6EF240D.....
Dr. Benjamin Steer
(Auditor) 12/4/2025
Date

DocuSigned by:

FA33C2C8CB944A5.....
Dr. Gábor Szárnyas
(Head of LDBC SNB Task Force) 12/4/2025
Date

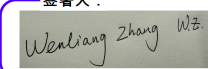
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Date

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System Description and Pricing Summary

1 SYSTEM DESCRIPTION AND PRICING SUMMARY

1.1 Details of machines driving and running the workload

1.1.1 Machine overview

The machine details were provided by Huawei Cloud.

Table 1.1: Machine Type and Location

Cloud provider	Huawei Cloud Services
Machine region	Beijing 4, availability zone 1
Common name of the item	km2.40xlarge.8
Operating system	24.04.1-Ubuntu

This benchmark used a single km2.40xlarge.8 instance. Both the driver and SUT ran on the same machine.

1.1.2 CPU details

The details below were obtained using the command `cat /proc/cpuinfo` (Listing A.1) issued from the machine instance and the datasheet of the used CPU type.

Table 1.2: CPU details summary

Type	Kunpeng 920 processor ®
Total number	4
Cores per CPU	40
Threads per core	1
CPU clock frequency	2.0GHz
Total cache size per CPU	L1d cache: 10 MiB L1i cache: 10 MiB L2 cache: 80 MiB L3 cache: 128 MiB

1.1.3 Memory details

The total size of the memory installed is 1280GiB and the type of memory is DDR4. This information was obtained using the `sudo lshw -c memory` command (Listing A.2) issued from the virtual machine instance.

1.1.4 Disk and storage details

The disk controller and motherboard types were not obtainable from the virtual machine instance. The storage consists of 1 x 6000GB Extreme SSD (configured as data disk), formatted with ext4 filesystem and 1 x 345GB General Purpose SSD (configured as system disk). The storage size and type is from the Huawei Cloud Services website.¹

The 4KB QD1 write performance was measured with the `fio` command on the data disk and the output showed an average of 1 269 IOPS (Listing A.3).

¹https://support.huaweicloud.com/intl/en-us/productdesc-evs/en-us_topic_0014580744.html (accessed: August 31, 2025).

1.1.5 Machine pricing

The system pricing summary is included in the table below. The pricing of the Huawei Cloud machine instance is the price for a 3×1 -year reserved dedicated instance machine without upfront payment.² The license fee for the GES database includes 24/7 enterprise support.

Table 1.3: Pricing summary

Item	Price
km2.40xlarge.8 reserved instance machine in Huawei Cloud (standard 3-year term)	539 112 RMB
License fee including 24/7 enterprise support fee (3-year term)	2 400 000 RMB
Total cost of ownership	2 939 112 RMB

1.1.6 System availability

The latest software version of the Graph Engine Service (GES), version 3.1.0, which was published on 28 October, 2025. This version was deployed to the machine described in this section.

²<https://www.huaweicloud.com/intl/en-us/pricing/calculator.html#/ges> (accessed: October 28, 2025).

2 DATASET GENERATION

2.1 General information

The implementation uses the CsvComposite StringDateFormatter output format generated by datagen, with 48 partitions. SF0.1 through SF10 are used for validation, SF100, SF300 and SF1000 are used for the benchmarks.

For validation, we used SF10 from the validation parameters package, generated using Neo4j, available at https://datasets.ldbcouncil.org/interactive-v1/validation_params-sf0.1-sf10.tar.zst.

For the social network datasets, we downloaded the data from the LDBC SURF repository. Note: to download these datasets, follow the instructions at <https://ldbcouncil.org/data-sets-surf-repository/>.

Scale Factor	URL
0.1	https://repository.surfsara.nl/datasets/cwi/ldbc-snb-interactive-v1-datagen-v100/files/social_network-sf0.1-CsvComposite-StringDateFormatter.tar.zst
0.3	https://repository.surfsara.nl/datasets/cwi/ldbc-snb-interactive-v1-datagen-v100/files/social_network-sf0.3-CsvComposite-StringDateFormatter.tar.zst
1	https://repository.surfsara.nl/datasets/cwi/ldbc-snb-interactive-v1-datagen-v100/files/social_network-sf1-CsvComposite-StringDateFormatter.tar.zst
3	https://repository.surfsara.nl/datasets/cwi/ldbc-snb-interactive-v1-datagen-v100/files/social_network-sf3-CsvComposite-StringDateFormatter.tar.zst
10	https://repository.surfsara.nl/datasets/cwi/ldbc-snb-interactive-v1-datagen-v100/files/social_network-sf10-CsvComposite-StringDateFormatter.tar.zst
100	https://repository.surfsara.nl/datasets/cwi/ldbc-snb-interactive-v1-datagen-v100/files/social_network-sf100-CsvComposite-StringDateFormatter.tar.zst
300	https://repository.surfsara.nl/datasets/cwi/ldbc-snb-interactive-v1-datagen-v100/files/social_network-sf300-CsvComposite-StringDateFormatter.tar.zst
1000	https://repository.surfsara.nl/datasets/cwi/ldbc-snb-interactive-v1-datagen-v100/files/social_network-sf1000-CsvComposite-StringDateFormatter.tar.zst

2.2 Data loading and data schema

The output produced by the Datagen is pre-processed by a Python script to add the Person-knows-Person edges with swapped person ids as the edges are bi-directional. Then, the data is loaded into the database by bulk-loading the CSV files (see Listing A.4) using the schema defined in the `schema.json` (see Listing A.5).

Listing 2.1: Excerpt from graph-sf10.yaml1, describing the data schema

```

1 name: ldbc_snb
2 ...
3 store_type: mutable_csr
4 schema:
5   vertex_types:
6     - type_id: 2
7       type_name: COMMENT
8       x_csr_params:
9         max_vertex_num: 26540464
10      properties:
11        - property_id: 0
12          property_name: id
13          property_type:
14            primitive_type: DT_SIGNED_INT64
15        - property_id: 1
16          property_name: creationDate
17          property_type:
18            date: "date"
19        - property_id: 2
20          property_name: locationIP
21          property_type:
22            varchar:
23              max_length: 40
24        - property_id: 3
25          property_name: browserUsed
26          property_type:
27            varchar:
28              max_length: 40
29        - property_id: 4
30          property_name: content
31          property_type:
32            varchar:
33              max_length: 2000
34        - property_id: 5
35          property_name: length
36          property_type:
37            primitive_type: DT_SIGNED_INT32
38      primary_keys:
39        - id
40    ...
41   edge_types:
42     - type_id: 0
43       type_name: HASCREATOR
44       vertex_type_pair_relations:
45         - source_vertex: COMMENT
46           destination_vertex: PERSON
47           relation: MANY_TO_ONE
48         x_csr_params:
49           oe_mutability: IMMUTABLE
50           sort_on_compaction: TRUE
51         - source_vertex: POST
52           destination_vertex: PERSON
53           relation: MANY_TO_ONE
54         x_csr_params:
55           oe_mutability: IMMUTABLE
56           sort_on_compaction: TRUE

```



Data loading times are shown for each scale factor in the table below. Values were observed by executing the provided `load_dataset.sh` script for the preprocessing and checking the output of the bulk loader script. The bulk load configuration is the same for all scale factors. The schema is defined per scale factor. The difference between scale factors is the pre-allocated memory per table.

Table 2.1: Data loading times

Scale factor	Preprocessing time (s)	Loading time (s)
100	950	103.451
300	2 952	265.238
1000	11 738	1 431.720

Test Driver Details

3 TEST DRIVER DETAILS

The software versions used are described below as well as the amount of read and write threads used by the driver.

Table 3.1: Summary of test artifacts and main configuration parameters

Driver version	v1.2.0	https://github.com/ldbc/ldbc_snb_interactive_driver/releases/tag/v1.2.0
Implementations version	v1.0.0	https://github.com/ldbc/ldbc_snb_interactive_impls/releases/tag/1.0.0
LDBC SNB specification version	v0.3.6	https://arxiv.org/pdf/2001.02299v3.pdf
Driver read threads	64	
Driver write threads	48	

3.1 Driver implementation

A test driver adaptation for the SUT was provided by the test sponsor and is available as part of the attachment package. The archive created from the version of the driver used for the audited run is included in the attachments of this report.

The SUT-specific test driver class `org.ldbcouncil.snb.impls.workloads.ges.interactive.GesInteractiveDb` extends the class `org.ldbcouncil.driver.Db` provided in the LDBC SNB Interactive driver package. Internally, the `GesInteractiveDb` relies on REST calls (HTTP) to communicate with the SUT.

3.2 Benchmark configuration

The driver applied time compression ratio (TCR) values of

- TCR = 0.00100 for scale factor 100,
- TCR = 0.00315 for scale factor 300,
- TCR = 0.02300 for scale factor 1000.

The complete configuration files are shown in Listings A.6–A.8 and are also included in the attached supplementary materials.

4 PERFORMANCE METRICS

The performance metrics reported here show benchmark runs with scale factors 100, 300, and 1000. In each case, the query on-time compliance is higher than the minimum required 95%. The performance summary tables below highlight key performance characteristics.

Table 4.1: Summary of results for scale factor 100

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
02h 10m 36s	1 011 574 388	129 089.68 operations second	98.92%

Table 4.2: Summary of results for scale factor 300

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
02h 0m 55s	1 011 528 900	139 411.14 operations second	98.96%

Table 4.3: Summary of results for scale factor 1000

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
02h 02m 28s	924 962 052	125 872.54 operations second	95.50%

During the benchmark run, the query executions shown in the tables below were observed using the different scale factors. Columns (except for Query and Total count) are showing duration values with microsecond (μs) precision. The notation P_i is used for the i^{th} percentile among all observed execution run times of a given query type. After each benchmark result table a table with the percentage of late operations per query type is shown.

Performance Metrics

Table 4.4: Detailed performance benchmark results for scale factor 100 in microseconds

Query	Total count	Min.	Max.	Mean	P ₅₀	P ₉₀	P ₉₅	P ₉₉
Query1	5 813 865	204	43 732	1 437.10	528	673	13 810	18 123
Query2	4 085 419	92	39 072	171.58	158	196	211	278
Query3	1 228 947	11 333	45 046	15 250.81	15 161	17 073	17 630	18 652
Query4	4 198 902	90	35 358	326.85	292	474	541	751
Query5	1 937 955	1 283	54 972	17 873.74	17 675	23 309	24 621	26 899
Query6	348 296	103	31 930	968.09	239	2 037	2 169	2 437
Query7	3 977 908	62	28 946	114.40	98	140	160	269
Query8	30 232 100	57	37 280	122.08	108	144	160	247
Query9	286 832	3 408	45 490	14 673.72	13 922	22 764	25 039	29 366
Query10	3 779 012	548	31 262	3 427.10	3 371	4 204	4 484	5 146
Query11	6 870 932	77	32 340	133.00	122	142	152	229
Query12	3 435 466	1 472	34 694	6 796.47	6 630	8 982	9 797	11 790
Query13	7 955 816	67	29 261	176.97	160	242	256	313
Query14	3 084 908	147	52 738	6 114.32	2 153	17 540	20 075	24 975
ShortQuery1PersonProfile	96 944 734	51	35 966	85.55	76	93	103	165
ShortQuery2PersonPosts	96 944 734	56	37 940	107.30	98	117	128	187
ShortQuery3PersonFriends	96 944 734	54	36 184	124.75	98	180	254	508
ShortQuery4MessageContent	96 944 489	52	43 604	86.20	77	93	103	163
ShortQuery5MessageCreator	96 944 489	50	33 268	83.75	75	91	101	158
ShortQuery6MessageForum	96 944 489	52	38 804	85.12	76	93	103	159
ShortQuery7MessageReplies	96 944 489	53	35 000	89.18	81	99	109	163
Update1AddPerson	38 623	91	21 583	183.23	144	208	240	1 036
Update2AddPostLike	36 179 233	54	35 394	105.23	82	104	124	831
Update3AddCommentLike	41 397 855	52	39 244	104.20	82	104	123	792
Update4AddForum	694 091	63	29 171	108.99	86	110	129	821
Update5AddForumMembership	135 365 353	52	42 548	105.45	82	104	125	844
Update6AddPost	9 319 106	59	33 124	115.76	93	124	143	763
Update7AddComment	29 422 553	60	36 346	113.63	90	119	138	804
Update8AddFriendship	3 309 058	58	27 312	105.95	83	105	125	811

Performance Metrics

Table 4.5: Detailed query on-time results for scale factor 100

Query	Total count	Total late count	Late count Percentage
Query1	5 813 865	551	0.01
Query2	4 085 419	376	0.01
Query3	1 228 947	103	0.01
Query4	4 198 902	348	0.01
Query5	1 937 955	165	0.01
Query6	348 296	29	0.01
Query7	3 977 908	339	0.01
Query8	30 232 100	2 594	0.01
Query9	286 832	33	0.01
Query10	3 779 012	329	0.01
Query11	6 870 932	557	0.01
Query12	3 435 466	298	0.01
Query13	7 955 816	660	0.01
Query14	3 084 908	297	0.01
ShortQuery1PersonProfile	96 944 734	1 106	0.00
ShortQuery2PersonPosts	96 944 734	75	0.00
ShortQuery3PersonFriends	96 944 734	101	0.00
ShortQuery4MessageContent	96 944 489	1 130	0.00
ShortQuery5MessageCreator	96 944 489	113	0.00
ShortQuery6MessageForum	96 944 489	68	0.00
ShortQuery7MessageReplies	96 944 489	78	0.00
Update1AddPerson	38 623	1 321	3.42
Update2AddPostLike	36 179 233	1 541 865	4.26
Update3AddCommentLike	41 397 855	1 698 273	4.10
Update4AddForum	694 091	29 463	4.24
Update5AddForumMembership	135 365 353	5 879 453	4.34
Update6AddPost	9 319 106	391 328	4.20
Update7AddComment	29 422 553	1 210 957	4.12
Update8AddFriendship	3 309 058	139 590	4.22
Total	1 011 574 388	10 901 600	1.08

Performance Metrics

Table 4.6: Detailed performance benchmark results for scale factor 300 in microseconds

Query	Total count	Min.	Max.	Mean	P ₅₀	P ₉₀	P ₉₅	P ₉₉
Query1	5 813 865	213	40 044	1 442.96	532	685	13 758	18 194
Query2	4 085 419	94	26 836	174.41	160	198	214	307
Query3	1 228 947	11 727	43 156	14 745.49	14 658	16 013	16 461	17 367
Query4	4 198 902	90	28 546	321.27	286	464	534	753
Query5	1 937 955	1 295	50 172	17 632.62	17 322	23 426	24 805	27 121
Query6	348 296	102	20 869	1 204.62	254	2 597	2 766	3 093
Query7	3 977 908	61	27 250	118.05	100	145	168	289
Query8	30 232 100	60	37 042	125.38	110	148	166	273
Query9	286 832	3 553	43 288	14 292.61	13 678	21 708	23 714	27 461
Query10	3 779 012	564	33 088	3 192.69	3 143	3 891	4 134	4 735
Query11	6 870 932	78	29 920	134.88	122	144	156	260
Query12	3 435 466	1 517	35 396	6 325.56	6 172	8 338	9 093	10 937
Query13	7 955 816	67	34 826	181.04	163	246	260	337
Query14	3 084 908	155	52 194	6 070.22	2 110	17 521	20 017	24 856
ShortQuery1PersonProfile	96 940 746	51	36 044	87.30	76	96	108	183
ShortQuery2PersonPosts	96 940 746	55	34 380	109.51	99	120	133	206
ShortQuery3PersonFriends	96 940 746	54	33 906	127.90	99	186	259	571
ShortQuery4MessageContent	96 936 108	48	34 506	88.33	78	96	108	183
ShortQuery5MessageCreator	96 936 108	50	36 320	85.60	75	94	107	177
ShortQuery6MessageForum	96 936 108	51	34 802	86.91	76	96	108	178
ShortQuery7MessageReplies	96 936 108	51	37 616	91.12	81	102	114	182
Update1AddPerson	38 623	94	22 695	187.52	145	208	243	1 234
Update2AddPostLike	36 179 233	53	36 464	108.16	82	108	131	910
Update3AddCommentLike	41 397 855	53	36 014	107.29	82	107	130	884
Update4AddForum	694 091	61	26 276	111.63	86	113	135	894
Update5AddForumMembership	135 365 353	53	39 064	108.25	82	108	131	919
Update6AddPost	9 319 106	61	31 352	118.60	94	126	147	840
Update7AddComment	29 422 553	60	36 166	116.83	91	121	143	896
Update8AddFriendship	3 309 058	56	30 124	109.21	84	109	132	893

Performance Metrics

Table 4.7: Detailed query on-time results for scale factor 300

Query	Total count	Total late count	Late count Percentage
Query1	5 813 865	5 064	0.09
Query2	4 085 419	3 561	0.09
Query3	1 228 947	1 083	0.09
Query4	4 198 902	3 676	0.09
Query5	1 937 955	1 697	0.09
Query6	348 296	292	0.08
Query7	3 977 908	3 466	0.09
Query8	30 232 100	26 432	0.09
Query9	286 832	260	0.09
Query10	3 779 012	3 297	0.09
Query11	6 870 932	6 007	0.09
Query12	3 435 466	2 992	0.09
Query13	7 955 816	6 944	0.09
Query14	3 084 908	2 700	0.09
ShortQuery1PersonProfile	96 940 746	838	0.00
ShortQuery2PersonPosts	96 940 746	71	0.00
ShortQuery3PersonFriends	96 940 746	77	0.00
ShortQuery4MessageContent	96 936 108	889	0.00
ShortQuery5MessageCreator	96 936 108	98	0.00
ShortQuery6MessageForum	96 936 108	46	0.00
ShortQuery7MessageReplies	96 936 108	46	0.00
Update1AddPerson	38 623	1 232	3.19
Update2AddPostLike	36 179 233	1 484 482	4.10
Update3AddCommentLike	41 397 855	1 674 288	4.04
Update4AddForum	694 091	28 272	4.07
Update5AddForumMembership	135 365 353	5 584 539	4.13
Update6AddPost	9 319 106	378 618	4.06
Update7AddComment	29 422 553	1 202 216	4.09
Update8AddFriendship	3 309 058	133 781	4.04
Total	1 011 528 900	10 556 964	1.04

Performance Metrics

Table 4.8: Detailed performance benchmark results for scale factor 1000 in microseconds

Query	Total count	Min.	Max.	Mean	P ₅₀	P ₉₀	P ₉₅	P ₉₉
Query1	2 445 827	51	191 624	2 686.25	1 295	1 782	1 927	69 796
Query10	1 353 011	65	164 888	9 916.21	9 316	15 521	17 156	21 033
Query11	2 445 827	66	202 680	305.29	278	452	492	572
Query12	1 445 262	52	129 484	15 287.46	14 442	23 444	26 252	32 018
Query13	3 346 921	89	182 056	349.28	327	511	622	1 043
Query14	1 297 785	169	492 560	23 691.34	14 671	56 628	67 916	91 884
Query2	1 718 689	54	212 968	234.12	208	307	336	401
Query3	385 403	75	264 688	19 965.98	15 681	28 078	34 324	198 040
Query4	1 766 431	59	188 392	128.82	111	158	183	284
Query5	698 808	60	238 816	5 500.27	4 754	10 607	15 285	20 992
Query6	79 889	138	80 788	11 028.10	781	27 812	30 058	33 684
Query7	2 543 659	58	190 856	136.53	121	170	194	284
Query8	63 591 493	50	241 136	117.71	104	134	148	211
Query9	65 762	72	209 432	27 989.98	17 501	66 520	75 528	87 440
ShortQuery1PersonProfile	104 410 193	42	263 808	90.71	78	98	110	173
ShortQuery2PersonPosts	104 410 193	46	306 720	129.72	116	143	157	227
ShortQuery3PersonFriends	104 410 193	45	315 488	143.91	111	193	283	478
ShortQuery4MessageContent	104 408 056	43	357 136	92.25	79	99	111	180
ShortQuery5MessageCreator	104 408 056	39	314 592	88.50	76	97	109	170
ShortQuery6MessageForum	104 408 056	44	315 264	92.11	79	100	113	174
ShortQuery7MessageReplies	104 408 056	51	247 664	108.20	93	125	139	201
Update1AddPerson	11 978	91	63 772	279.15	178	289	363	1 537
Update2AddPostLike	14 459 991	47	236 936	146.49	90	134	226	1 399
Update3AddCommentLike	28 149 709	47	238 944	153.11	88	138	382	1 421
Update4AddForum	207 259	54	78 384	143.98	92	134	199	1 378
Update5AddForumMembership	31 953 226	46	247 624	140.65	88	127	196	1 372
Update6AddPost	4 964 732	57	280 336	204.09	112	195	429	1 516
Update7AddComment	29 999 946	52	239 512	153.55	97	147	216	1 410
Update8AddFriendship	1 167 641	53	196 296	151.59	93	139	260	1 406

Performance Metrics

Table 4.9: Detailed query on-time results for scale factor 1000

Query	Total count	Total late count	Late count Percentage
Query1	2 445 827	1 034 329	42.29
Query2	1 718 689	726 825	42.29
Query3	385 403	162 984	42.29
Query4	1 766 431	747 004	42.29
Query5	698 808	295 522	42.29
Query6	79 889	33 782	42.29
Query7	2 543 659	1 075 683	42.29
Query8	63 591 493	26 892 395	42.29
Query9	65 762	27 810	42.29
Query10	1 353 011	572 190	42.29
Query11	2 445 827	1 034 313	42.29
Query12	1 445 262	611 170	42.29
Query13	3 346 921	1 415 394	42.29
Query14	1 297 785	548 826	42.29
ShortQuery1PersonProfile	104 410 193	2 247	0.00
ShortQuery2PersonPosts	104 410 193	652	0.00
ShortQuery3PersonFriends	104 410 193	577	0.00
ShortQuery4MessageContent	104 408 056	2 488	0.00
ShortQuery5MessageCreator	104 408 056	1 601	0.00
ShortQuery6MessageForum	104 408 056	245	0.00
ShortQuery7MessageReplies	104 408 056	474	0.00
Update1AddPerson	11 978	490	4.09
Update2AddPostLike	14 459 991	844 817	5.84
Update3AddCommentLike	28 149 709	1 698 172	6.03
Update4AddForum	207 259	11 589	5.59
Update5AddForumMembership	31 953 226	1 799 533	5.63
Update6AddPost	4 964 732	273 723	5.51
Update7AddComment	29 999 946	1 775 221	5.92
Update8AddFriendship	1 167 641	66 007	5.65
Total	924 962 052	41 656 063	4.50

5 VALIDATION OF THE RESULTS

The scale factor 10 data set was used for validating the correctness of the implementation over the SUT. The validation data set with 150 038 entries was created with the SNB Interactive reference implementation over Neo4j, which can be download from https://datasets.ldbcouncil.org/interactive-v1/validation_params-sf0.1-sf10.tar.zst.

Additionally, validation runs using scale factors 0.1, 0.3, 1 and 3 were conducted to test the SUT across different dataset sizes. The system with the driver configuration shown in Listing A.9 successfully returned the expected result sets for the queries of the benchmark.

6 ACID COMPLIANCE

6.1 Transaction isolation level

The benchmark was executed using the *Read committed* isolation level setting of the SUT, which conforms to the minimum isolation level required by the SNB Interactive specification.

6.2 SNB Interactive ACID test results

The ACID test implementations were reviewed to conform to the ACID test specifications, with all specified test cases implemented. Furthermore, test execution was successful, passing the tests required for the *read committed* isolation level.

6.3 Recovery and durability

6.3.1 Recovery

Durability tests were run using the regular benchmark workload with scale factor 100, starting at 17:35 GMT+0. The machine was shutdown using the command `sudo shutdown -rf 19:35`. This command force-rebooted the machine, without a graceful shutdown period, 2 hours after start of the benchmark, with 583 663 080 completed operations. The database server process was manually started again after the crash and it was ready in 11 minutes and 4 seconds.

6.3.2 Durability

From the driver log, the last update operations before the crash were obtained using the commands below.

```

1 $ grep LdbcUpdate1 LDBC-SNB-results_log.csv | tail -n 1
2 LdbcUpdate1AddPerson|1756323299866|1756323299866|142|0|1353052406511
3 $ grep LdbcUpdate2 LDBC-SNB-results_log.csv | tail -n 1
4 LdbcUpdate2AddPostLike|1756323300214|1756323300214|97|0|1353052729000
5 $ grep LdbcUpdate3 LDBC-SNB-results_log.csv | tail -n 1
6 LdbcUpdate3AddCommentLike|1756323300213|1756323300214|71|0|1353052727966
7 $ grep LdbcUpdate4 LDBC-SNB-results_log.csv | tail -n 1
8 LdbcUpdate4AddForum|1756323300209|1756323300209|87|0|1353052724526
9 $ grep LdbcUpdate5 LDBC-SNB-results_log.csv | tail -n 1
10 LdbcUpdate5AddForumMembership|1756323300214|1756323300214|102|0|1353052728827
11 $ grep LdbcUpdate6 LDBC-SNB-results_log.csv | tail -n 1
12 LdbcUpdate6AddPost|1756323300213|1756323300213|141|0|1353052727836
13 $ grep LdbcUpdate7 LDBC-SNB-results_log.csv | tail -n 1
14 LdbcUpdate7AddComment|1756323300214|1756323300214|104|0|1353052728890
15 $ grep LdbcUpdate8 LDBC-SNB-results_log.csv | tail -n 1
16 LdbcUpdate8AddFriendship|1756323300209|1756323300210|84|0|1353052724444

```

The log entries include the operation name, actual and scheduled start time, the execution time, the delay between scheduled and actual start times, and the initial query start time without the total compression ratio multiplier (which is shown in the last column). From the logs, the last completed updates were retrieved for each update. For the fifth update, the entry was incomplete due to the driver stopping while writing the log. The corresponding update was retrieved by taking the last complete update entry from the driver logs and using the CSV update streams to fetch the update. The query parameters were obtained from the initial CSV files generated by the Datagen using the initial query start time and the type number of the operation using the commands below.

```

1 $ grep -rnw 'social_network-sf100-numpart-1/' -e '1353052406511|.|*|1|.|.*'
2 social_network-sf100-numpart-1/updateStream_0_0_person.csv:29425:1353052406511|0|1|37383395377866|Victor|Ilie|
   female|517104000000|1353052406511|78.95.16.173|Safari|1310|ro;hu;en|Victor37383395377866@gmail.com
   |1885;2119;6991;9150|5961,2005|1013,2005;1021,2005
3 $ grep -rnw 'social_network-sf100-numpart-1/' -e '1353052729000|.|*|2|.|.*'
4 social_network-sf100-numpart-1/updateStream_0_0_forum.csv
   :161558195:1353052729000|1262363584334|2|470277|52776576674120|1353052729000
5 $ grep -rnw 'social_network-sf100-numpart-1/' -e '1353052727966|.|*|3|.|.*'
6 social_network-sf100-numpart-1/updateStream_0_0_forum.csv
   :161558159:1353052727966|1291293294511|3|10995116760329|74767035936169|1353052727966
7 $ grep -rnw 'social_network-sf100-numpart-1/' -e '1353052724526|.|*|4|.|.*'
8 social_network-sf100-numpart-1/updateStream_0_0_forum.csv
   :161558036:1353052724526|1265018213957|4|74766836917582|Album 4 of Kalu LuaLua|1353052724526|486589|2802
9 $ grep -rnw 'social_network-sf100-numpart-1/' -e '1353052728827|.|*|5|.|.*'
10 social_network-sf100-numpart-1/updateStream_0_0_forum.csv
   :161558183:1353052728827|1292155512946|5|52776565486614|10995116415253|1353052728827
11 $ grep -rnw 'social_network-sf100-numpart-1/' -e '1353052727836|.|*|6|.|.*'
12 social_network-sf100-numpart-1/updateStream_0_0_forum.csv
   :161558149:1353052727836|1297053534056|6|74766861701480||1353052727836|27.54.156.70|Internet Explorer|uz|
   About Augustine of Hippo, re-eminent Doctor ofAbout Plato, d science. In the woAbout Plutarch, eotia, a town
   about|114|13194139864405|26388282238546|1|6;973;974;2048;2077;11379
13 $ grep -rnw 'social_network-sf100-numpart-1/' -e '1353052728890|.|*|7|.|.*'
14 social_network-sf100-numpart-1/updateStream_0_0_forum.csv
   :161558185:1353052728890|1290701539361|7|74766879526807|1353052728890|202.163.95.234|Chrome|About Bitches
   Brew, nd a progenitor of the jazz rock genre, as well as a major infl
   |83|10995116689961|54|74766879526802|-1|5817
15 $ grep -rnw 'social_network-sf100-numpart-1/' -e '1353052724444|.|*|8|.|.*'
16 social_network-sf100-numpart-1/updateStream_0_0_forum.csv
   :161558034:1353052724444|1351124253346|8|6597070199750|35184372143677|1353052724444

```

To check whether the graph entities in the driver log entries were persisted in the database, custom read queries were executed after database restart using a provided script. The queries returned the data that was committed according to the logs, so the system passed this check. These additional test queries are included in the supplementary materials.

Supplementary Materials

7 SUPPLEMENTARY MATERIALS

The table below shows the list of supplementary materials. These materials are made available with this full disclosure report to allow reproducibility of results.

Table 7.1: Supplementary materials

File	Purpose
results/results-benchmark-sf{100,300,1000}.tar.gz	Driver output files for the selected scale factors
ges_imperative_1.0_kunpeng.deb	Linux installer package of database
process_dataset.sh	script to process the dataset before load
README.md	Readme for the benchmark package
README_api.md	Readme for the query api
set_up.sh	Set up script to prepare the instance
tools/stored_procedures	Folder containing all stored procedures (queries, utils and api)
tools/tests	ACID test files
tools/tools	Helper functions

Supplementary Materials

The attachment folder directory structure is as follows:

```
attachments
├── audit_folder
│   ├── benchmark-sf*.properties
│   ├── validate-sf*.properties
│   ├── graph_sf*.yaml
│   ├── bulk_load.yaml
│   ├── load_dataset.sh
│   ├── run_driver.sh
│   ├── run_driver_validate.sh
│   ├── run_server.sh
│   └── run_server_recovery.sh
├── driver
├── ges_imperative_1.0_kunpeng.deb
├── process_dataset.sh
├── queryGraph.sh
├── set_up.sh
├── README.md
├── README_api.md
├── tools
│   ├── build_api.sh
│   ├── build_tools.sh
│   ├── stored_procedures
│   ├── tests
│   └── tools
├── results
│   ├── results-benchmark-sf100.tar.gz
│   ├── results-benchmark-sf300.tar.gz
│   └── results-benchmark-sf1000.tar.gz
```

Acknowledgements

8 ACKNOWLEDGEMENTS

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Appendix

A APPENDIX

A.1 CPU details

Listing A.1: Output of the `cat /proc/cpuinfo` command for one core

```
1 Architecture: aarch64
2 CPU op-mode(s): 64-bit
3 Byte Order: Little Endian
4 CPU(s): 160
5 On-line CPU(s) list: 0-159
6 Vendor ID: HiSilicon
7 BIOS Vendor ID: QEMU
8 Model name: -
9 BIOS Model name: virt-6.2 CPU @ 2.0GHz
10 BIOS CPU family: 1
11 Model: 0
12 Thread(s) per core: 1
13 Core(s) per socket: 40
14 Socket(s): 4
15 Stepping: 0x0
16 BogoMIPS: 200.00
17 Flags: fp asimd evtstrm aes pmull sha1 sha2 crc32 atomics fphp asimdhp cpuid
    asimdrdm jscvt fcma lrcpc dcpop sha3 sm4 asimddp sha512 sve asimdghm dit uscat ilrcpc flagm ssbs sb
    dcpodp flagm2 frint svei8mm svef32mm svef64mm svebf16 i8mm bf16 dgh rng bti ecv
18 L1d cache: 10 MiB (160 instances)
19 L1i cache: 10 MiB (160 instances)
20 L2 cache: 80 MiB (160 instances)
21 L3 cache: 128 MiB (4 instances)
22 NUMA node(s): 4
23 NUMA node0 CPU(s): 0-39
24 NUMA node1 CPU(s): 40-79
25 NUMA node2 CPU(s): 80-119
26 NUMA node3 CPU(s): 120-159
27 Vulnerability Gather data sampling: Not affected
28 Vulnerability Itlb multihit: Not affected
29 Vulnerability L1tf: Not affected
30 Vulnerability Mds: Not affected
31 Vulnerability Meltdown: Not affected
32 Vulnerability Mmio stale data: Not affected
33 Vulnerability Reg file data sampling: Not affected
34 Vulnerability Retbleed: Not affected
35 Vulnerability Spec rstack overflow: Not affected
36 Vulnerability Spec store bypass: Mitigation; Speculative Store Bypass disabled via prctl
37 Vulnerability Spectre v1: Mitigation; __user pointer sanitization
38 Vulnerability Spectre v2: Not affected
39 Vulnerability Srbds: Not affected
40 Vulnerability Tsx async abort: Not affected
```

A.2 Memory details

Listing A.2: Output of the `lshw -c memory` command

```
1 *-memory
2   description: System Memory
```



```

3      physical id: 1000
4      size: 1280GiB
5      capabilities: ecc
6      configuration: errordetection=multi-bit-ecc
7      *-bank:0
8          description: DIMM RAM
9          vendor: QEMU
10         physical id: 0
11         slot: DIMM 0
12         size: 16GiB

```

Listing A.3: Output of the `fio` command

```

1 bs=4k --name=iotest
2 iotest: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=sync, iodepth=1
3 fio-3.36
4 Starting 1 process
5 iotest: Laying out IO file (1 file / 2048MiB)
6 Jobs: 1 (f=1): [W(1)][100.0%][w=5041KiB/s][w=1260 IOPS][eta 00m:00s]2s]
7 iotest: (groupid=0, jobs=1): err= 0: pid=158054: Fri Aug 29 02:31:05 2025
8   write: IOPS=1269, BW=5080KiB/s (5201kB/s)(2048MiB/412863msec); 0 zone resets
9     clat (usec): min=267, max=14256, avg=355.39, stdev=180.52
10    lat (usec): min=267, max=14256, avg=355.53, stdev=180.52
11    clat percentiles (usec):
12      | 1.00th=[ 285], 5.00th=[ 289], 10.00th=[ 293], 20.00th=[ 302],
13      | 30.00th=[ 306], 40.00th=[ 314], 50.00th=[ 318], 60.00th=[ 326],
14      | 70.00th=[ 343], 80.00th=[ 367], 90.00th=[ 416], 95.00th=[ 506],
15      | 99.00th=[ 889], 99.50th=[ 1369], 99.90th=[ 2835], 99.95th=[ 3195],
16      | 99.99th=[ 4883]
17   bw ( KiB/s): min= 4328, max= 5552, per=100.00%, avg=5080.79, stdev=153.65, samples=825
18   iops        : min= 1082, max= 1388, avg=1270.20, stdev=38.41, samples=825
19   lat (usec)   : 500=94.77%, 750=3.72%, 1000=0.74%
20   lat (msec)   : 2=0.49%, 4=0.27%, 10=0.02%, 20=0.01%
21   fsync/ldatasync/sync_file_range:
22     sync (usec): min=320, max=13592, avg=430.74, stdev=200.02
23     sync percentiles (usec):
24       | 1.00th=[ 347], 5.00th=[ 359], 10.00th=[ 367], 20.00th=[ 371],
25       | 30.00th=[ 379], 40.00th=[ 388], 50.00th=[ 396], 60.00th=[ 404],
26       | 70.00th=[ 420], 80.00th=[ 441], 90.00th=[ 490], 95.00th=[ 578],
27       | 99.00th=[ 979], 99.50th=[ 1663], 99.90th=[ 3163], 99.95th=[ 3490],
28       | 99.99th=[ 5604]
29   cpu          : usr=0.27%, sys=4.96%, ctx=1050236, majf=0, minf=20
30   IO depths    : 1=200.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
31   submit      : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
32   complete    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
33   issued rwts: total=0,524288,0,0 short=524287,0,0,0 dropped=0,0,0,0
34   latency     : target=0, window=0, percentile=100.00%, depth=1
35
36 Run status group 0 (all jobs):
37   WRITE: bw=5080KiB/s (5201kB/s), 5080KiB/s-5080KiB/s (5201kB/s-5201kB/s), io=2048MiB (2147MB), run=412863-412863
38   msec
39
40 Disk stats (read/write):
41   vdc: ios=2/1048004, sectors=40/5818108, merge=0/4, ticks=1/391305, in_queue=427720, util=94.45%

```

A.3 Import configuration

Listing A.4: Content of `bulk_load.yaml` bulk load configuration

```

1 graph: ldbc_snb
2 loading_config:
3   data_source:
4     scheme: file
5     location: {PATH_TO_DATASET}
6   import_option: init
7   format:
8     type: csv
9     metadata:
10      delimiter: "|"
11
12 vertex_files:
13   - static/place_0_0.csv
14   - dynamic/person_0_0.csv
15   - dynamic/comment_0_0.csv
16   - dynamic/post_0_0.csv
17   - dynamic/forum_0_0.csv
18   - static/organisation_0_0.csv
19   - static/tagclass_0_0.csv
20   - static/tag_0_0.csv
21
22 edge_files:
23   - file: dynamic/comment_hasCreator_person_0_0.csv.creation_date
24     column_mappings:
25       - creationDate
26   - file: dynamic/post_hasCreator_person_0_0.csv.creation_date
27     column_mappings:
28       - creationDate
29   - file: dynamic/post_hasTag_tag_0_0.csv
30   - file: dynamic/comment_replyOf_comment_0_0.csv
31   - file: dynamic/comment_replyOf_post_0_0.csv
32   - file: dynamic/forum_containerOf_post_0_0.csv
33   - file: dynamic/forum_hasMember_person_0_0.csv
34   - file: dynamic/forum_hasModerator_person_0_0.csv
35   - file: dynamic/person_hasInterest_tag_0_0.csv
36   - file: dynamic/comment_isLocatedIn_place_0_0.csv
37   - file: dynamic/person_isLocatedIn_place_0_0.csv
38   - file: dynamic/post_isLocatedIn_place_0_0.csv
39   - file: static/organisation_isLocatedIn_place_0_0.csv
40   - file: dynamic/person_knows_person_0_0.csv
41   - file: dynamic/person_likes_comment_0_0.csv
42     column_mappings:
43       - creationDate
44   - file: dynamic/person_likes_post_0_0.csv
45     column_mappings:
46       - creationDate
47   - file: dynamic/person_workAt_organisation_0_0.csv
48     column_mappings:
49       - workFrom
50   - file: static/place_isPartOf_place_0_0.csv
51   - file: static/tag_hasType_tagclass_0_0.csv
52   - file: static/tagclass_isSubclassOf_tagclass_0_0.csv
53   - file: dynamic/person_studyAt_organisation_0_0.csv
54     column_mappings:

```



55 | - classYear

Listing A.5: Content of `schema.json` describing the data schema. SF100 is shown, only `max_vertex_num` is different across schema definition files.

```

1 name: ldbc_snb
2 store_type: mutable_csr
3 stored_procedures:
4   directory: {PATH_TO_STORED_PROCEDURES}
5   enable_lists:
6     - libic1.so
7     - libic2.so
8     - libic3.so
9     - libic4.so
10    - libic5.so
11    - libic6.so
12    - libic7.so
13    - libic8.so
14    - libic9.so
15    - libic10.so
16    - libic11.so
17    - libic12.so
18    - libic13.so
19    - libic14.so
20    - libis1.so
21    - libis2.so
22    - libis3.so
23    - libis4.so
24    - libis5.so
25    - libis6.so
26    - libis7.so
27    - libins1.so
28    - libins2.so
29    - libins3.so
30    - libins4.so
31    - libins5.so
32    - libins6.so
33    - libins7.so
34    - libins8.so
35 schema:
36   vertex_types:
37     - type_id: 0
38       type_name: PLACE
39       x_csr_params:
40         max_vertex_num: 1460
41       properties:
42         - property_id: 0
43           property_name: id
44           property_type:
45             primitive_type: DT_SIGNED_INT64
46         - property_id: 1
47           property_name: name
48           property_type:
49             varchar:
50               max_length: 256
51         - property_id: 2
52           property_name: url
53           property_type:

```

Appendix

A.3. Import configuration

```

54         varchar:
55             max_length: 256
56     - property_id: 3
57       property_name: type
58       property_type:
59         varchar:
60             max_length: 64
61     primary_keys:
62     - id
63 - type_id: 1
64   type_name: PERSON
65   x_csr_params:
66     max_vertex_num: 499000
67   properties:
68     - property_id: 0
69       property_name: id
70       property_type:
71         primitive_type: DT_SIGNED_INT64
72     - property_id: 1
73       property_name: firstName
74       property_type:
75         varchar:
76             max_length: 40
77     - property_id: 2
78       property_name: lastName
79       property_type:
80         varchar:
81             max_length: 40
82     - property_id: 3
83       property_name: gender
84       property_type:
85         varchar:
86             max_length: 40
87     - property_id: 4
88       property_name: birthday
89       property_type:
90         day: "day"
91     - property_id: 5
92       property_name: creationDate
93       property_type:
94         date: "date"
95     - property_id: 6
96       property_name: locationIP
97       property_type:
98         varchar:
99             max_length: 40
100    - property_id: 7
101      property_name: browserUsed
102      property_type:
103        varchar:
104            max_length: 40
105    - property_id: 8
106      property_name: language
107      property_type:
108        varchar:
109            max_length: 2048
110    - property_id: 9
111      property_name: email

```

Appendix

A.3. Import configuration

```

112         property_type:
113         varchar:
114             max_length: 2048
115     primary_keys:
116     - id
117 - type_id: 2
118   type_name: COMMENT
119   x_csr_params:
120       max_vertex_num: 261475982
121   properties:
122       - property_id: 0
123         property_name: id
124         property_type:
125             primitive_type: DT_SIGNED_INT64
126       - property_id: 1
127         property_name: creationDate
128         property_type:
129             date: "date"
130       - property_id: 2
131         property_name: locationIP
132         property_type:
133             varchar:
134                 max_length: 40
135       - property_id: 3
136         property_name: browserUsed
137         property_type:
138             varchar:
139                 max_length: 40
140       - property_id: 4
141         property_name: content
142         property_type:
143             varchar:
144                 max_length: 2000
145       - property_id: 5
146         property_name: length
147         property_type:
148             primitive_type: DT_SIGNED_INT32
149   primary_keys:
150   - id
151 - type_id: 3
152   type_name: POST
153   x_csr_params:
154       max_vertex_num: 70420477
155   properties:
156       - property_id: 0
157         property_name: id
158         property_type:
159             primitive_type: DT_SIGNED_INT64
160       - property_id: 1
161         property_name: imageFile
162         property_type:
163             varchar:
164                 max_length: 40
165       - property_id: 2
166         property_name: creationDate
167         property_type:
168             date: "date"
169       - property_id: 3

```

Appendix

A.3. Import configuration

```

170         property_name: locationIP
171         property_type:
172             varchar:
173                 max_length: 40
174     - property_id: 4
175       property_name: browserUsed
176       property_type:
177           varchar:
178               max_length: 40
179   - property_id: 5
180     property_name: language
181     property_type:
182         varchar:
183             max_length: 40
184   - property_id: 6
185     property_name: content
186     property_type:
187         varchar:
188             max_length: 2000
189   - property_id: 7
190     property_name: length
191     property_type:
192         primitive_type: DT_SIGNED_INT32
193 primary_keys:
194     - id
195 - type_id: 4
196   type_name: FORUM
197   x_csr_params:
198       max_vertex_num: 4982966
199   properties:
200       - property_id: 0
201         property_name: id
202         property_type:
203             primitive_type: DT_SIGNED_INT64
204       - property_id: 1
205         property_name: title
206         property_type:
207             varchar:
208                 max_length: 256
209       - property_id: 2
210         property_name: creationDate
211         property_type:
212             date: "date"
213 primary_keys:
214     - id
215 - type_id: 5
216   type_name: ORGANISATION
217   x_csr_params:
218       max_vertex_num: 7955
219   properties:
220       - property_id: 0
221         property_name: id
222         property_type:
223             primitive_type: DT_SIGNED_INT64
224       - property_id: 1
225         property_name: type
226         property_type:
227             varchar:

```



Appendix

A.3. Import configuration

```

228         max_length: 64
229     - property_id: 2
230       property_name: name
231       property_type:
232         varchar:
233           max_length: 256
234     - property_id: 3
235       property_name: url
236       property_type:
237         varchar:
238           max_length: 256
239     primary_keys:
240       - id
241   - type_id: 6
242     type_name: TAGCLASS
243     x_csr_params:
244       max_vertex_num: 71
245     properties:
246       - property_id: 0
247         property_name: id
248         property_type:
249           primitive_type: DT_SIGNED_INT64
250       - property_id: 1
251         property_name: name
252         property_type:
253           varchar:
254             max_length: 256
255       - property_id: 2
256         property_name: url
257         property_type:
258           varchar:
259             max_length: 256
260     primary_keys:
261       - id
262   - type_id: 7
263     type_name: TAG
264     x_csr_params:
265       max_vertex_num: 16080
266     properties:
267       - property_id: 0
268         property_name: id
269         property_type:
270           primitive_type: DT_SIGNED_INT64
271       - property_id: 1
272         property_name: name
273         property_type:
274           varchar:
275             max_length: 256
276       - property_id: 2
277         property_name: url
278         property_type:
279           varchar:
280             max_length: 256
281     primary_keys:
282       - id
283   edge_types:
284     - type_id: 0
285       type_name: HASCREATOR

```



Appendix

A.3. Import configuration

```

286     vertex_type_pair_relations:
287     - source_vertex: COMMENT
288       destination_vertex: PERSON
289       relation: MANY_TO_ONE
290       x_csr_params:
291         oe_mutability: IMMUTABLE
292         sort_on_compaction: TRUE
293     - source_vertex: POST
294       destination_vertex: PERSON
295       relation: MANY_TO_ONE
296       x_csr_params:
297         oe_mutability: IMMUTABLE
298         sort_on_compaction: TRUE
299     properties:
300     - property_id: 0
301       property_name: creationDate
302       property_type:
303         date: "date"
304   - type_id: 1
305     type_name: HASTAG
306     vertex_type_pair_relations:
307     - source_vertex: POST
308       destination_vertex: TAG
309       relation: MANY_TO_MANY
310   - type_id: 2
311     type_name: REPLYOF
312     vertex_type_pair_relations:
313     - source_vertex: COMMENT
314       destination_vertex: COMMENT
315       relation: MANY_TO_ONE
316       x_csr_params:
317         oe_mutability: IMMUTABLE
318     - source_vertex: COMMENT
319       destination_vertex: POST
320       relation: MANY_TO_ONE
321       x_csr_params:
322         oe_mutability: IMMUTABLE
323   - type_id: 3
324     type_name: CONTAINEROF
325     vertex_type_pair_relations:
326     - source_vertex: FORUM
327       destination_vertex: POST
328       relation: ONE_TO_MANY
329       x_csr_params:
330         ie_mutability: IMMUTABLE
331         edge_storage_strategy: ONLY_IN
332   - type_id: 4
333     type_name: HASMEMBER
334     vertex_type_pair_relations:
335     - source_vertex: FORUM
336       destination_vertex: PERSON
337       relation: MANY_TO_MANY
338       x_csr_params:
339         edge_storage_strategy: ONLY_IN
340         sort_on_compaction: TRUE
341     properties:
342     - property_id: 0
343       property_name: joinDate

```



Appendix

A.3. Import configuration

```

344     property_type:
345       date: "date"
346   - type_id: 5
347     type_name: HASMODERATOR
348     vertex_type_pair_relations:
349       - source_vertex: FORUM
350         destination_vertex: PERSON
351         relation: MANY_TO_ONE
352         x_csr_params:
353           oe_mutability: IMMUTABLE
354           edge_storage_strategy: ONLY_OUT
355   - type_id: 6
356     type_name: HASINTEREST
357     vertex_type_pair_relations:
358       - source_vertex: PERSON
359         destination_vertex: TAG
360         relation: MANY_TO_MANY
361         x_csr_params:
362           edge_storage_strategy: ONLY_OUT
363   - type_id: 7
364     type_name: ISLOCATEDIN
365     vertex_type_pair_relations:
366       - source_vertex: COMMENT
367         destination_vertex: PLACE
368         relation: MANY_TO_ONE
369         x_csr_params:
370           oe_mutability: IMMUTABLE
371       - source_vertex: PERSON
372         destination_vertex: PLACE
373         relation: MANY_TO_ONE
374         x_csr_params:
375           oe_mutability: IMMUTABLE
376       - source_vertex: POST
377         destination_vertex: PLACE
378         relation: MANY_TO_ONE
379         x_csr_params:
380           oe_mutability: IMMUTABLE
381       - source_vertex: ORGANISATION
382         destination_vertex: PLACE
383         relation: MANY_TO_ONE
384         x_csr_params:
385           oe_mutability: IMMUTABLE
386   - type_id: 8
387     type_name: KNOWS
388     vertex_type_pair_relations:
389       - source_vertex: PERSON
390         destination_vertex: PERSON
391         relation: MANY_TO_MANY
392     properties:
393       - property_id: 0
394         property_name: creationDate
395         property_type:
396           date: "date"
397   - type_id: 9
398     type_name: LIKES
399     vertex_type_pair_relations:
400       - source_vertex: PERSON
401         destination_vertex: COMMENT

```



Appendix

A.3. Import configuration

```

402         relation: MANY_TO_MANY
403         x_csr_params:
404             edge_storage_strategy: ONLY_IN
405     - source_vertex: PERSON
406       destination_vertex: POST
407       relation: MANY_TO_MANY
408       x_csr_params:
409           edge_storage_strategy: ONLY_IN
410     properties:
411     - property_id: 0
412       property_name: creationDate
413       property_type:
414         date: "date"
415   - type_id: 10
416     type_name: WORKAT
417     vertex_type_pair_relations:
418     - source_vertex: PERSON
419       destination_vertex: ORGANISATION
420       relation: MANY_TO_MANY
421     properties:
422     - property_id: 0
423       property_name: workFrom
424       property_type:
425         primitive_type: DT_SIGNED_INT32
426   - type_id: 11
427     type_name: ISPARTOF
428     vertex_type_pair_relations:
429     - source_vertex: PLACE
430       destination_vertex: PLACE
431       relation: MANY_TO_ONE
432       x_csr_params:
433         oe_mutability: IMMUTABLE
434   - type_id: 12
435     type_name: HASTYPE
436     vertex_type_pair_relations:
437     - source_vertex: TAG
438       destination_vertex: TAGCLASS
439       relation: MANY_TO_ONE
440       x_csr_params:
441         oe_mutability: IMMUTABLE
442   - type_id: 13
443     type_name: ISSUBCLASSOF
444     vertex_type_pair_relations:
445     - source_vertex: TAGCLASS
446       destination_vertex: TAGCLASS
447       relation: MANY_TO_ONE
448       x_csr_params:
449         oe_mutability: IMMUTABLE
450   - type_id: 14
451     type_name: STUDYAT
452     vertex_type_pair_relations:
453     - source_vertex: PERSON
454       destination_vertex: ORGANISATION
455       relation: MANY_TO_MANY
456       x_csr_params:
457         edge_storage_strategy: ONLY_OUT
458     properties:
459     - property_id: 0

```



460	property_name: classYear
461	property_type:
462	primitive_type: DT_SIGNED_INT32

A.4 Benchmark configuration

Listing A.6: Contents of `interactive-benchmark-sf100.properties` used for scale factor 30

```

1 url={SERVER}
2
3 printQueryNames=false
4 printQueryStrings=false
5 printQueryResults=false
6
7 status=1
8 thread_count=64
9 name=LDBC-SNB
10 mode=execute_benchmark
11 results_log=true
12 time_unit=MICROSECONDS
13 time_compression_ratio=0.001
14 peer_identifiers=
15 workload_statistics=false
16 spinner_wait_duration=1
17 help=false
18 ignore_scheduled_start_times=false
19
20 workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
21 db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb
22
23
24 ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
25 ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
26 ldbc.snb.interactive.short_read_dissipation=0.2
27 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
28 ldbc.snb.interactive.scale_factor=100
29 operation_count=1011600000
30 warmup=250800000
31
32 ldbc.snb.interactive.LdbcQuery1_enable=true
33 ldbc.snb.interactive.LdbcQuery2_enable=true
34 ldbc.snb.interactive.LdbcQuery3_enable=true
35 ldbc.snb.interactive.LdbcQuery4_enable=true
36 ldbc.snb.interactive.LdbcQuery5_enable=true
37 ldbc.snb.interactive.LdbcQuery6_enable=true
38 ldbc.snb.interactive.LdbcQuery7_enable=true
39 ldbc.snb.interactive.LdbcQuery8_enable=true
40 ldbc.snb.interactive.LdbcQuery9_enable=true
41 ldbc.snb.interactive.LdbcQuery10_enable=true
42 ldbc.snb.interactive.LdbcQuery11_enable=true
43 ldbc.snb.interactive.LdbcQuery12_enable=true
44 ldbc.snb.interactive.LdbcQuery13_enable=true
45 ldbc.snb.interactive.LdbcQuery14_enable=true
46
47 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
48 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
49 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
50 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
51 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
52 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
53 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
54

```

```

55 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
56 ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
57 ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
58 ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
59 ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
60 ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
61 ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
62 ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true

```

Listing A.7: Contents of `interactive-benchmark-sf300.properties` used for scale factor 300

```

1 url={SERVER}
2
3 printQueryNames=false
4 printQueryStrings=false
5 printQueryResults=false
6
7 status=1
8 thread_count=64
9 name=LDBC-SNB
10 mode=execute_benchmark
11 results_log=true
12 time_unit=MICROSECONDS
13 time_compression_ratio=0.00315
14
15 peer_identifiers=
16 workload_statistics=false
17 spinner_wait_duration=1
18 help=false
19 ignore_scheduled_start_times=false
20
21
22 workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
23 db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb
24
25 ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
26 ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
27 ldbc.snb.interactive.short_read_dissipation=0.2
28 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
29 ldbc.snb.interactive.scale_factor=300
30 operation_count=1080000000
31 warmup=270000000
32
33 ldbc.snb.interactive.LdbcQuery1_enable=true
34 ldbc.snb.interactive.LdbcQuery2_enable=true
35 ldbc.snb.interactive.LdbcQuery3_enable=true
36 ldbc.snb.interactive.LdbcQuery4_enable=true
37 ldbc.snb.interactive.LdbcQuery5_enable=true
38 ldbc.snb.interactive.LdbcQuery6_enable=true
39 ldbc.snb.interactive.LdbcQuery7_enable=true
40 ldbc.snb.interactive.LdbcQuery8_enable=true
41 ldbc.snb.interactive.LdbcQuery9_enable=true
42 ldbc.snb.interactive.LdbcQuery10_enable=true
43 ldbc.snb.interactive.LdbcQuery11_enable=true
44 ldbc.snb.interactive.LdbcQuery12_enable=true
45 ldbc.snb.interactive.LdbcQuery13_enable=true
46 ldbc.snb.interactive.LdbcQuery14_enable=true
47

```

```

48 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
49 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
50 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
51 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
52 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
53 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
54 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
55
56
57 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
58 ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
59 ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
60 ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
61 ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
62 ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
63 ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
64 ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true

```

Listing A.8: Contents of `interactive-benchmark-sf1000.properties` used for scale factor 1000

```

1 url={SERVER}
2
3 printQueryNames=false
4 printQueryStrings=false
5 printQueryResults=false
6
7 status=1
8 thread_count=64
9 name=LDBC-SNB
10 mode=execute_benchmark
11 results_log=true
12 status=1
13 time_unit=MICROSECONDS
14 time_compression_ratio=0.023
15 peer_identifiers=
16 workload_statistics=false
17 spinner_wait_duration=1
18 help=false
19 ignore_scheduled_start_times=false
20
21 workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
22 db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb
23
24
25 ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
26 ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
27 ldbc.snb.interactive.short_read_dissipation=0.2
28 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
29 ldbc.snb.interactive.scale_factor=1000
30 operation_count=925000000
31 warmup=210000000
32
33 ldbc.snb.interactive.LdbcQuery1_enable=true
34 ldbc.snb.interactive.LdbcQuery2_enable=true
35 ldbc.snb.interactive.LdbcQuery3_enable=true
36 ldbc.snb.interactive.LdbcQuery4_enable=true
37 ldbc.snb.interactive.LdbcQuery5_enable=true
38 ldbc.snb.interactive.LdbcQuery6_enable=true

```



```

39 ldbc.snb.interactive.LdbcQuery7_enable=true
40 ldbc.snb.interactive.LdbcQuery8_enable=true
41 ldbc.snb.interactive.LdbcQuery9_enable=true
42 ldbc.snb.interactive.LdbcQuery10_enable=true
43 ldbc.snb.interactive.LdbcQuery11_enable=true
44 ldbc.snb.interactive.LdbcQuery12_enable=true
45 ldbc.snb.interactive.LdbcQuery13_enable=true
46 ldbc.snb.interactive.LdbcQuery14_enable=true
47
48 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
49 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
50 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
51 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
52 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
53 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
54 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
55
56 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
57 ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
58 ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
59 ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
60 ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
61 ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
62 ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
63 ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true

```

A.5 Validation configuration

Listing A.9: The contents of `validate-sf10.properties`

```

1 url={SERVER}
2 readTimeout=5000000
3 connectTimeout=5000000
4 connectPoolMaxIdle=10
5 keepAliveDuration=5000
6 maxRequestsPerHost=180
7 maxRequests=180
8
9 printQueryNames=false
10 printQueryStrings=false
11 printQueryResults=false
12
13 status=1
14 thread_count=1
15 mode=validate_database
16 name=LDBC-SNB
17 results_log=false
18 time_unit=MILLISECONDS
19 time_compression_ratio=0.001
20 peer_identifiers=
21 workload_statistics=false
22 spinner_wait_duration=0
23 help=false
24 ignore_scheduled_start_times=true
25
26 workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload

```

```

27 db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb
28
29 operation_count=10000
30
31 validate_database={VALIDATION_PARAMS}
32 ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
33 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
34 ldbc.snb.interactive.scale_factor=10
35 ldbc.snb.interactive.short_read_dissipation=0.2
36
37 ldbc.snb.interactive.LdbcQuery1_freq=1
38 ldbc.snb.interactive.LdbcQuery2_freq=1
39 ldbc.snb.interactive.LdbcQuery3_freq=1
40 ldbc.snb.interactive.LdbcQuery4_freq=1
41 ldbc.snb.interactive.LdbcQuery5_freq=1
42 ldbc.snb.interactive.LdbcQuery6_freq=1
43 ldbc.snb.interactive.LdbcQuery7_freq=1
44 ldbc.snb.interactive.LdbcQuery8_freq=1
45 ldbc.snb.interactive.LdbcQuery9_freq=1
46 ldbc.snb.interactive.LdbcQuery10_freq=1
47 ldbc.snb.interactive.LdbcQuery11_freq=1
48 ldbc.snb.interactive.LdbcQuery12_freq=1
49 ldbc.snb.interactive.LdbcQuery13_freq=1
50 ldbc.snb.interactive.LdbcQuery14_freq=1
51
52 ldbc.snb.interactive.LdbcQuery1_enable=true
53 ldbc.snb.interactive.LdbcQuery2_enable=true
54 ldbc.snb.interactive.LdbcQuery3_enable=true
55 ldbc.snb.interactive.LdbcQuery4_enable=true
56 ldbc.snb.interactive.LdbcQuery5_enable=true
57 ldbc.snb.interactive.LdbcQuery6_enable=true
58 ldbc.snb.interactive.LdbcQuery7_enable=true
59 ldbc.snb.interactive.LdbcQuery8_enable=true
60 ldbc.snb.interactive.LdbcQuery9_enable=true
61 ldbc.snb.interactive.LdbcQuery10_enable=true
62 ldbc.snb.interactive.LdbcQuery11_enable=true
63 ldbc.snb.interactive.LdbcQuery12_enable=true
64 ldbc.snb.interactive.LdbcQuery13_enable=true
65 ldbc.snb.interactive.LdbcQuery14_enable=true
66
67 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
68 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
69 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
70 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
71 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
72 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
73 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
74
75 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
76 ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
77 ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
78 ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
79 ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
80 ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
81 ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
82 ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true

```