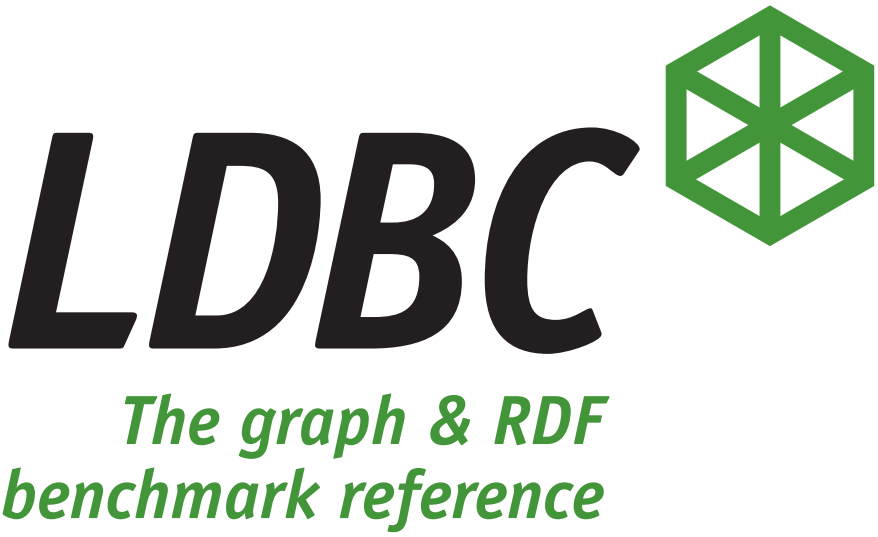

Full Disclosure Report of the LDBC Social Network Benchmark

An Implementation of the LDBC Social Network Benchmark's Interactive Workload over Graphscope Flex

April 21, 2025

General Terms

Executive Summary

This document describes an implementation of the LDBC Social Network Benchmark's Interactive workload on a graph database-like build of GraphScope Flex, a modular graph computing stack developed by Alibaba Cloud.

GraphScope Flex[1] is designed to accommodate the diverse and complex needs of real-world graph applications. These applications can involve a variety of graph workloads and can be deployed in different modes. In the audited benchmark runs, GraphScope Flex 0.31.3 was used to execute scale factors SF30, SF100, and SF300 in a single-instance setting (plus another instance to run the driver). The instances were deployed on the Alibaba Cloud infrastructure.

The queries were implemented declaratively using GraphScope's Cypher implementation and compiled at runtime using their in-house compiler. The data schema follows the property graph model with indices only over vertex identifiers and neighbor sets. No additional indices or precomputed properties were used. The system under test and the driver communicate using remote HTTP.

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 (serializable), and verified the overall system's configuration conformance to the description of the benchmark and its strict requirements.

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[1] https://github.com/alibaba/GraphScope/tree/main/flex

Table of Contents

1 System Description and Pricing Summary

1.1 Details of machines driving and running the workload

1.1.1 Machine overview

The details below were obtained from Amazon Web Services dashboard (Instance Details page). The operating system was obtained from running `uname -a` command.

Table 1.1: Machine Type and Location

Cloud provider	Alibaba Cloud
Machine region	China (Ulanqab)
Common name of the item	ecs.g8a.48xlarge
Operating system	Ubuntu 20.04.6 LTS 5.4.0-204-generic

Note that the system is configured with the following additional command, to allow for the required amount of asynchronous requests:

```
echo "fs.aio-max-nr = 2116992" » etcsysctl.conf && sysctl -p etcsysctl.conf
```

Also, for SF30, SF100 and SF300 hugepages[1] are enabled with: `echo "vm.nr_hugepages=229376" » etcsysctl.conf && sysctl -p etcsysctl.conf`

This benchmark used two `ecs.g8a.48xlarge` instances, one for the driver and one for the system under test (SUT). Both machines were assigned to the same VPC with the same subnetwork. This is shown in Figure 1.1.

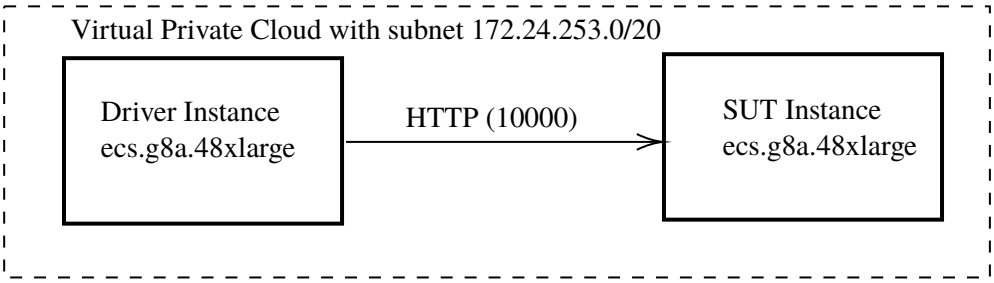

Figure 1.1: Overview of benchmark setup

1.1.2 CPU details

The details below were obtained using the command `lscpu` (Listing A.1) issued from the machine SUT and the data-sheet of the used CPU type.

Table 1.2: CPU details summary

Type	AMD EPYC 9T24 96-Core Processor
Total number	1
Cores per CPU	96
Threads per CPU core	2
CPU clock frequency	3.70 GHz
Total cache size per CPU	L1 cache: 3MiB Data + 3MiB Instruction L2 cache: 96MiB L3 cache: 384MiB

[1] https://www.kernel.org/doc/html/latest/admin-guide/mm/hugetlbpage.html

1.1.3 Memory details

The total size of the memory installed is 768GB and the type of memory is DDR5 (according to CPU specs). We could not obtain the memory type nor the frequencies using the `sudo lshw -c memory` (Listing A.2) and other similar commands (e.g. `dmidecode`), as they were reported as 'Unknown'.

We measured the memory read and write bandwidth with the sysbench tool, obtaining a read bandwidth of `1379946.65 MiB/sec` Listing A.3 and write bandwidth of `312619.18 MiB/sec` Listing A.4.

1.1.4 Disk and storage details

Instances have two disks installed: One 40GB NVMe ESSD device `/dev/nvme0n1` with three partitions

- `/dev/nvme0n1p1` bios boot, not mounted (1M)
- `/dev/nvme0n1p2` mounted at /boot/efi (fat32 - 191MB)
- `/dev/nvme0n1p3` mounted at `/` (ext4 39.8GB)

and another 4TB NVMe ESSD device `/dev/nvme1n1` mounted at `/data`. The filesystem used for this disk is xfs. During all the audit, only the 4TB disk was used in both instances Listing A.5.

We tested the performance of `/dev/nvme1n1` of the SUT, both for Driver Listing A.8 and Server Listing A.9 instances with the fio command, using 4KB blocks and a queue depth of 1 obtaining an average of 5558 and 4495 IOPS respectively.

1.1.5 Network details

The benchmark was run using two `ecs.g8a.48xlarge` instances, both deployed in the same availability zone behind a Virtual Private Cloud (VPC) configured with subnetwork `172.24.253.0/20`. Only SUT had the following ports open:

- `10000`: HTTP port used by SUT

The `ecs.g8a.48xlarge` instances use a common Ethernet adapter. This information was obtained using the `lshw -class network` command (Listing A.6). Network throughput between the two instances was measured using the `iperf` tool on port 10000 using 64 threads and the output (Listing A.7) showed an average of 64 Gbit/sec between the client and the server.

1.1.6 Machine pricing

The system pricing summary is included in the table below. The pricing of the Alibaba Cloud machine instance is the price for a 3 x 1-year reserved dedicated instance machine without upfront payment. The Graphscope Flex database software is freely available under the Apache Software License v2.0, hence its permanent license cost is 0.00 $. The maintenance service fee guarantees 24-hour availability, 7 days a week with a 4-hour response time. The service is provided by the open-source project's major contributors and maintainers.

Table 1.3: Pricing summary

Item	**Price**
ecs.g8a.48xlarge reserved instance machine in Alibaba Cloud (standard 3-year term)	408 444.48 RMB
Permanent Graphscope Flex license	0.00 RMB
Maintenance service fee (3 years)	400 000.00 RMB
Total cost of ownership	808 444.48 RMB

1.1.7 System availability

The latest software version of Graphscope Flex (version 0.31.3) was made available on March 17th, 2025. This version was deployed to the machine described in this section. Graphscope Flex is an open-source software released under the Apache Software License 2.0, the used release is available online on GitHub[2].

[2] https://github.com/alibaba/GraphScope/releases/download/v0.31.0/graphscope_flex_0.31.3_amd64.deb

2 Dataset Generation

2.1 General information

The data generation settings of the LDBC Datagen are described below. Datagen configuration for SF30 to SF300 are shown in Listing A.10–Listing A.12

Table 2.1: Datagen settings summary

Datagen version	v1.0.0
Output format	CsvComposite serializer
Scale factors	30, 100, and 300
Number of partitions	48

For validation, we used all validation sets from SF0.1 to SF10. Validation parameters where downloaded from LDBC GitHub[1], which are generated using the Neo4j Implementation.

Table 2.2: Datagen settings summary for Validation Datasets

Datagen version	v1.0.0
Output format	CsvComposite serializer
Scale factors	0.1, 0.3, 1, 3 and 10
Number of partitions	1

Listing 2.1: Contents of `params-sf10.ini` used for generating scale factor 10 validation set. Similar files can be used to generate the other validation datasets

```
1 ldbc.snb.datagen.generator.scaleFactor:snb.interactive.10
2 ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.
      activity.CsvCompositeDynamicActivitySerializer
3 ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.
      CsvCompositeDynamicPersonSerializer
4 ldbc.snb.datagen.serializer.staticSerializer:ldbc.snb.datagen.serializer.snb.csv.staticserializer.
      CsvCompositeStaticSerializer
```

2.2 Data loading and data schema

Some preprocessing is performed on the output produced by Datagen. One the one hand, `post_0_0.csv` and `comment_0_0.csv` are sorted by their creator ids. This is performed by two scripts, `reorder_post.py` and `reorder_comment.py`. `reorder_post.py` loads the `post_0_0.csv` and `post_hasCreator_person_0_0.csv` files into two tables of a Duckdb instance. Then, the two tables are joined with a left-join using `Post` and `Creator` ids. Finally, the join result is sorted by the `Creator` id and the `Post` columns are projected into a new Post file. An identical process is used for processing `Comments` in `reorder_comment.py`

On the other hand, two new files `post_hasCreator_person_0_0.csv.creation_date` and `comment_hasCreator_person_0_0.csv.creation_date` are created. These are obtained by joining the creationDate column extracted from `post_0_0.csv` and `comment_0_0.csv` with the `post_hasCreator_person_0_0.csv` and `comment_hasCreator_person_0_0.csv`, respectively. These are generated with `add_column`, a tool provided (including source code in C++).

We utilize two configuration files to define the data loading process and the schema: `bulk_load.yaml` Listing A.13 and `graph.yaml` Listing A.14. The former is used to configure how data should be loaded while the later contains the schema definition.

[1] `https://datasets.ldbcouncil.org/interactive-v1/validation_params-interactive-v1.0.0-sf0.1-to-sf10.tar.zst`

Data loading times are shown for each scale factor in the table below (second column). Loading times are reported by the SUT, and source code was inspected to audit its correctness. After loading, the database was shut down and started again. The third column shows the times to startup from an already loaded database.

Table 2.3: Data preprocessing, loading and startup times

Scale factor	**Preprocessing time (s)**	**Loading time (s)**	**Startup time (s)**
30	220	44	25
100	702	338	208
300	2 314	1 429	827

3 Test Driver Details

The driver and implementations version 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	v2.2.4	`https://arxiv.org/pdf/2001.02299`
Driver read threads	192	
Driver write threads	96	

3.1 Driver implementation

A test driver adaptation for the SUT was provided by the test sponsor and is available as part of the supplementary package. The SUT-specific test driver class `org.ldbcoucil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb` extends the class `com.ldbc.driver.Db` provided in the LDBC SNB Interactive driver package. Internally, the `GraphScopeInteractiveDb` relies on an HTTP connection to communicate with the SUT.

3.2 Benchmark configuration of driver

The following table shows, the Warmup Operation Count, Operation Count and Time Compression Ratio (TCR) for the different scale factors:

Table 3.2: Driver configuration parameters per Scale Factor

Scale factor	**Warmup Operation Count**	**Operation Count**	**TCR**
30	64 000 000	272 000 000	0.001
100	152 000 000	579 000 000	0.0016
300	155 400 000	591 800 000	0.0054

The complete driver configuration files for the different scale factors are shown in Listings A.15–A.17, and are also included in the attached supplementary materials.

4 Performance Metrics

The performance metrics reported here show benchmark runs with scale factors 30, 100 and 300. In each case, the query on-time compliance is higher than the minimum required 95% [1]. The performance summary tables below highlight key performance characteristics.

Table 4.1: Summary of results for scale factor 30

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
2:00:23.894	271 979 638	37 650.00 $\frac{\text{operations}}{\text{second}}$	100.00%

Table 4.2: Summary of results for scale factor 100

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
2:01:46.167	578 971 217	79 244.18 $\frac{\text{operations}}{\text{second}}$	95.25%

Table 4.3: Summary of results for scale factor 300

Benchmark duration	Benchmark operations	Throughput	Query on-time compliance
2:02:30.422	591 788 249	80 510.79 $\frac{\text{operations}}{\text{second}}$	95.71%

During the benchmark run, the query execution times shown in the tables below were observed using the different scale factors. Columns (except for Query and Total count) are showing duration values in microseconds (μs) precision. The notation $\mathbf{P_i}$ is used for the i^{th} percentile among all observed execution run times of a given query type.

[1] The total number of late operations for each run in the results in the attachment is referred to as `excessive_delay_count`.

Table 4.4: Detailed performance benchmark results for scale factor 30 in microseconds

Query	Total count	Min.	Max.	Mean	P_{50}	P_{90}	P_{95}	P_{99}
Query1	1 780 974	4 357	471 744	8 334.64	7 896	9 743	10 755	19 772
Query10	1 251 496	6 147	407 152	15 028.21	14 410	19 115	21 277	28 875
Query11	2 315 267	242	426 432	717.48	442	623	782	10 658
Query12	1 052 394	1 409	515 968	4 598.28	4 214	6 090	6 993	15 552
Query13	2 437 123	139	401 280	635.38	325	740	856	10 330
Query14	945 007	433	617 408	23 460.38	7 986	19 746	205 216	319 632
Query2	1 251 496	615	459 120	1 910.16	1 577	2 181	2 467	13 325
Query3	436 843	3 559	364 912	7 818.53	7 465	8 729	9 719	19 046
Query4	1 286 259	1 099	406 608	2 452.76	2 024	2 584	2 976	13 773
Query5	643 130	49 352	671 200	167 623.78	163 144	233 168	246 888	270 048
Query6	146 535	300	314 992	1 878.99	1 840	3 125	3 578	12 099
Query7	964 695	150	401 856	599.72	268	447	641	10 599
Query8	5 145 038	500	413 456	1 675.91	1 178	2 462	3 004	12 080
Query9	120 587	50 808	473 984	112 087.96	109 936	135 864	142 400	155 320
ShortQuery1PersonProfile	24 825 117	88	483 952	351.76	125	176	240	6 280
ShortQuery2PersonPosts	24 825 117	99	465 232	507.31	219	418	678	12 019
ShortQuery3PersonFriends	24 825 117	95	447 792	585.35	241	778	1 435	11 894
ShortQuery4MessageContent	24 821 748	80	449 248	371.71	114	159	232	10 183
ShortQuery5MessageCreator	24 821 748	79	464 624	356.05	110	150	205	11 548
ShortQuery6MessageForum	24 821 748	85	526 528	330.40	120	163	207	10 259
ShortQuery7MessageReplies	24 821 748	98	481 616	343.96	155	236	284	6 561
Update1AddPerson	14 143	243	250 984	848.27	394	873	1 193	10 704
Update2AddPostLike	11 307 701	157	448 576	500.63	216	339	665	8 596
Update3AddCommentLike	12 121 088	158	461 232	490.87	215	328	636	8 384
Update4AddForum	253 334	178	289 408	541.23	237	428	748	9 335
Update5AddForumMembership	40 999 247	157	500 576	503.17	216	344	677	8 558
Update6AddPost	3 278 856	177	446 592	502.79	250	500	732	5 512
Update7AddComment	9 457 383	180	504 832	556.15	253	513	791	8 875
Update8AddFriendship	1 008 699	159	313 648	491.36	217	333	651	8 657

Table 4.5: 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	3 472 159	774	1 301 696	24 541.80	23 998	31 446	34 912	43 268
Query10	2 256 903	372	1 194 048	30 987.98	30 444	39 566	42 718	50 280
Query11	4 103 461	192	1 154 304	1 420.09	855	1 296	2 378	11 525
Query12	2 051 731	181	1 067 456	9 176.34	8 594	12 346	14 001	19 934
Query13	4 751 376	180	1 084 736	1 674.27	960	2 315	3 274	11 807
Query14	1 842 371	463	1 147 840	102 182.09	14 383	368 096	423 584	520 320
Query2	2 439 896	160	715 392	3 609.48	3 038	4 362	5 339	13 672
Query3	733 952	14 539	727 840	32 803.06	32 759	38 244	40 824	49 214
Query4	2 507 671	590	1 052 096	4 348.18	3 731	5 146	6 304	14 626
Query5	1 157 387	25 530	1 160 256	401 099.04	405 504	560 064	597 664	667 040
Query6	208 010	366	644 576	4 984.70	4 567	9 639	10 857	16 556
Query7	2 375 688	170	1 047 840	933.45	387	862	1 968	10 636
Query8	18 055 229	112	1 145 792	779.45	274	473	1 323	10 531
Query9	171 302	43 636	991 104	254 343.33	256 760	318 944	338 480	381 600
ShortQuery1PersonProfile	57 897 426	95	1 100 096	570.73	178	282	611	9 847
ShortQuery2PersonPosts	57 897 426	108	802 656	863.00	380	848	1 409	10 826
ShortQuery3PersonFriends	57 897 426	104	770 848	1 107.75	452	1 916	3 300	11 267
ShortQuery4MessageContent	57 897 623	86	1 058 048	609.08	153	280	865	10 428
ShortQuery5MessageCreator	57 897 623	84	1 065 088	533.11	151	239	502	10 124
ShortQuery6MessageForum	57 897 623	91	1 188 224	554.13	172	263	501	10 228
ShortQuery7MessageReplies	57 897 623	102	1 052 096	643.44	241	459	690	10 125
Update1AddPerson	23 128	265	639 808	1 976.43	586	1 768	4 075	12 904
Update2AddPostLike	17 926 496	163	1 137 728	1 019.89	265	815	2 396	12 115
Update3AddCommentLike	24 309 064	168	1 076 288	1 017.40	265	819	2 459	12 154
Update4AddForum	405 346	194	645 312	1 066.64	299	930	2 602	12 326
Update5AddForumMembership	60 452 627	166	1 165 568	1 019.56	264	807	2 323	12 077
Update6AddPost	5 453 465	190	734 048	1 078.77	331	949	2 430	11 893
Update7AddComment	17 096 609	193	1 140 032	1 127.11	332	997	2 808	12 394
Update8AddFriendship	1 894 576	175	708 736	1 022.39	266	820	2 426	12 207

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	3 018 969	267	1 273 536	29 015.48	28 855	36 844	39 022	46 410
Query10	1 783 937	292	1 062 784	34 648.49	34 100	45 030	48 654	57 042
Query11	3 270 551	228	1 259 904	1 575.46	1 002	1 432	2 123	11 958
Query12	1 783 937	158	1 027 648	9 345.11	8 776	13 252	15 064	20 966
Query13	4 131 222	335	1 124 096	3 226.11	2 602	4 912	5 842	13 543
Query14	1 601 902	548	1 120 384	140 099.50	20 423	364 256	408 496	508 752
Query2	2 121 438	142	723 648	3 288.32	2 822	3 962	4 576	13 465
Query3	552 769	41 706	791 776	89 971.67	90 748	103 348	109 300	122 332
Query4	2 180 366	177	742 784	4 799.78	4 225	5 506	6 315	15 120
Query5	934 443	221	1 161 152	439 602.19	449 984	596 608	628 224	679 264
Query6	135 333	371	693 728	8 357.76	7 812	17 818	19 420	23 823
Query7	2 452 912	165	713 216	865.44	364	764	1 572	10 715
Query8	26 164 402	110	1 086 208	703.77	246	419	990	10 544
Query9	111 337	143	936 672	284 193.00	288 160	354 608	370 400	403 680
ShortQuery1PersonProfile	63 062 669	95	1 094 464	546.52	172	270	561	9 990
ShortQuery2PersonPosts	63 062 669	103	1 108 800	861.78	383	848	1 381	10 825
ShortQuery3PersonFriends	63 062 669	102	1 099 008	1 146.02	494	1 892	3 375	11 363
ShortQuery4MessageContent	63 067 784	85	1 196 032	575.49	150	274	787	10 670
ShortQuery5MessageCreator	63 067 784	84	1 227 520	504.81	148	231	460	9 927
ShortQuery6MessageForum	63 067 784	88	794 112	533.94	168	254	475	10 185
ShortQuery7MessageReplies	63 067 784	104	897 088	635.23	242	461	675	10 182
Update1AddPerson	17 915	273	679 296	1 636.54	581	1 413	2 945	11 938
Update2AddPostLike	14 085 435	166	1 054 784	971.35	266	766	2 020	13 190
Update3AddCommentLike	23 529 914	170	1 429 568	967.61	266	776	2 114	13 155
Update4AddForum	306 828	192	696 096	1 028.65	301	876	2 144	13 445
Update5AddForumMembership	43 530 106	167	1 035 552	968.87	266	756	1 933	13 184
Update6AddPost	4 067 600	196	778 240	1 078.54	333	927	2 099	13 175
Update7AddComment	12 980 359	188	1 038 336	1 088.07	333	938	2 279	13 401
Update8AddFriendship	1 567 431	173	698 336	964.24	267	763	1 982	13 231

5 Validation of the Results

All scale factors from 0.1 to 10 were used for validating the correctness of the implementation over the SUT. The validation data sets were created using the SNB Interactive reference implementation over Neo4j, which can be download from the LDBC GitHub repository[1]. All validation runs completed with all queries executed successfully with the expected results. A sample of the driver configuration file used for validation runs is shown in Listing A.18. Additionally, the auditor audited all query implementations, driver and configuration files.

[1] https://datasets.ldbcouncil.org/interactive-v1/validation_params-interactive-v1.0.0-sf0.1-to-sf10.tar.zst

6 ACID Compliance

6.1 Transaction isolation level

The SUT supports the *serializable* isolation level, which is stricter than the *read committed* isolation level minimally required by the SNB Interactive specification.

6.2 SNB Interactive ACID test results

The ACID test implementation was reviewed to conform to the ACID test specifications, with all specified test cases implemented. The test was executed 100 times with a 100% rate of success: no atomicity or isolation tests failed. In particular, the following anomaly tests tested successfully:

- Dirty Writes (G0)
- Aborted Reads (G1A)
- Intermediate Reads (G1B)
- Circular Information Flow (G1C)
- Item-Many-Preceders (IMP)
- Predicate-Many-Preceders (PMP)
- Observed Transaction Vanishes (OTV)
- Fractured Reads (FR)
- Lost Updates (LU)
- Write Skews (WS)

6.3 Recovery and durability

Durability tests were conducted on all three audited scale factors: SF30, SF100 and SF300. After around two hours of execution time, the database process was killed with the `sudo pkill -9 rt_server` command. The following table shows the database restart times after the database server was killed.

Scale factor	Recovery startup time (s)
30	113.02
100	229.18
300	780.19

After killing and recovering from the crash, the driver log was inspected and, for each scale factor, the last 10 update operations were matched with their corresponding update queries from the dataset. Then, using the provided `rt_admin` tool, the presence of the contents on each update query was checked.

Additionally, we used the provided script `test_recovery.sh` which automatically searches for the last query instance of each type, and checks, using `rt_admin` tool, that the contents of the query are materialized in the database.

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. See the different README files for further instructions.

Table 7.1: Supplementary materials

File	Purpose
`graphscope_audit_2025_1`	Scripts used during the audit to streamline the benchmark runs
`flex_ldbc_snb`	Package provided by the SUT vendor. Contains instructions to install the system, tools, scripts, and driver implementation
`graphscope_flex_0.31.3_amd64.deb`	Binary package with the SUT database
`server.tgz`	Package with all the logs obtained from the server machine
`driver.tgz`	Package with all the logs obtained from the driver machine

A Appendix

A.1 CPU details

Listing A.1: Output of the `lscpu` command for one core

```
Architecture:                       x86_64
CPU op-mode(s):                     32-bit, 64-bit
Byte Order:                         Little Endian
Address sizes:                      52 bits physical, 57 bits virtual
CPU(s):                             192
On-line CPU(s) list:                0-191
Thread(s) per core:                 2
Core(s) per socket:                 96
Socket(s):                          1
NUMA node(s):                       1
Vendor ID:                          AuthenticAMD
CPU family:                         25
Model:                              17
Model name:                         AMD EPYC 9T24 96-Core Processor
Stepping:                           1
CPU MHz:                            3664.462
BogoMIPS:                           5399.99
Hypervisor vendor:                  KVM
Virtualization type:                full
L1d cache:                          3 MiB
L1i cache:                          3 MiB
L2 cache:                           96 MiB
L3 cache:                           384 MiB
NUMA node0 CPU(s):                  0-191
Vulnerability Gather data sampling: Not affected
Vulnerability Itlb multihit:        Not affected
Vulnerability L1tf:                 Not affected
Vulnerability Mds:                  Not affected
Vulnerability Meltdown:             Not affected
Vulnerability Mmio stale data:      Not affected
Vulnerability Retbleed:             Not affected
Vulnerability Spec store bypass:    Vulnerable
Vulnerability Spectre v1:           Mitigation; usercopy/swapgs barriers and __user pointer sanitization
Vulnerability Spectre v2:           Mitigation; Enhanced / Automatic IBRS; STIBP disabled; RSB filling; PBRSB-
    eIBRS Not affected; BHI Not
                                    affected
Vulnerability Srbds:                Not affected
Vulnerability Tsx async abort:      Not affected
Flags:                              fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36
    clflush mmx fxsr sse sse2 ht s
                                    yscall nx mmxext fxsr_opt pdpe1gb rdtscp lm constant_tsc rep_good nopl
    nonstop_tsc cpuid extd_apicid a
                                    perfmperf tsc_known_freq pni pclmulqdq monitor ssse3 fma cx16 pcid sse4_1
    sse4_2 x2apic movbe popcnt a
                                    es xsave avx f16c rdrand hypervisor lahf_lm cmp_legacy cr8_legacy abm sse4a
    misalignsse 3dnowprefetch
                                    osvw topoext perfctr_core perfctr_nb perfctr_llc mwaitx invpcid_single
    ibrs_enhanced vmmcall fsgsbase
                                    tsc_adjust bmi1 avx2 smep bmi2 erms invpcid avx512f avx512dq rdseed adx smap
    avx512ifma clflushopt clw
```

```
44                                  b avx512cd sha_ni avx512bw avx512vl xsaveopt xsavec xgetbv1 xsaves
    avx512_bf16 clzero irperf xsaveerpt
45                                  r wbnoinvd arat avx512vbmi umip pku ospke avx512_vbmi2 gfni vaes vpclmulqdq
    avx512_vnni avx512_bitalg
46                                  avx512_vpopcntdq rdpid arch_capabilities
```

A.2 Memory details

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

```
*-memory
     description: System Memory
     physical id: 1000
     size: 768GiB
     capabilities: ecc
     configuration: errordetection=multi-bit-ecc
   *-bank:0
        description: DIMM RAM
        vendor: Alibaba Cloud
        physical id: 0
        slot: DIMM 0
        size: 16GiB
   *-bank:1
        description: DIMM RAM
        vendor: Alibaba Cloud
        physical id: 1
        slot: DIMM 1
        size: 16GiB
   *-bank:2
        description: DIMM RAM
        vendor: Alibaba Cloud
        physical id: 2
        slot: DIMM 2
        size: 16GiB
   *-bank:3
        description: DIMM RAM
        vendor: Alibaba Cloud
        physical id: 3
        slot: DIMM 3
        size: 16GiB
   *-bank:4
        description: DIMM RAM
        vendor: Alibaba Cloud
        physical id: 4
        slot: DIMM 4
        size: 16GiB
   *-bank:5
        description: DIMM RAM
        vendor: Alibaba Cloud
        physical id: 5
        slot: DIMM 5
        size: 16GiB
   *-bank:6
        description: DIMM RAM
        vendor: Alibaba Cloud
        physical id: 6
        slot: DIMM 6
        size: 16GiB
   *-bank:7
        description: DIMM RAM
        vendor: Alibaba Cloud
        physical id: 7
        slot: DIMM 7
        size: 16GiB
```

```
55      *-bank:8
56           description: DIMM RAM
57           vendor: Alibaba Cloud
58           physical id: 8
59           slot: DIMM 8
60           size: 16GiB
61      *-bank:9
62           description: DIMM RAM
63           vendor: Alibaba Cloud
64           physical id: 9
65           slot: DIMM 9
66           size: 16GiB
67      *-bank:10
68           description: DIMM RAM
69           vendor: Alibaba Cloud
70           physical id: a
71           slot: DIMM 10
72           size: 16GiB
73      *-bank:11
74           description: DIMM RAM
75           vendor: Alibaba Cloud
76           physical id: b
77           slot: DIMM 11
78           size: 16GiB
79      *-bank:12
80           description: DIMM RAM
81           vendor: Alibaba Cloud
82           physical id: c
83           slot: DIMM 12
84           size: 16GiB
85      *-bank:13
86           description: DIMM RAM
87           vendor: Alibaba Cloud
88           physical id: d
89           slot: DIMM 13
90           size: 16GiB
91      *-bank:14
92           description: DIMM RAM
93           vendor: Alibaba Cloud
94           physical id: e
95           slot: DIMM 14
96           size: 16GiB
97      *-bank:15
98           description: DIMM RAM
99           vendor: Alibaba Cloud
100          physical id: f
101          slot: DIMM 15
102          size: 16GiB
103     *-bank:16
104          description: DIMM RAM
105          vendor: Alibaba Cloud
106          physical id: 10
107          slot: DIMM 16
108          size: 16GiB
109     *-bank:17
110          description: DIMM RAM
111          vendor: Alibaba Cloud
112          physical id: 11
```

```
113          slot: DIMM 17
114          size: 16GiB
115     *-bank:18
116          description: DIMM RAM
117          vendor: Alibaba Cloud
118          physical id: 12
119          slot: DIMM 18
120          size: 16GiB
121     *-bank:19
122          description: DIMM RAM
123          vendor: Alibaba Cloud
124          physical id: 13
125          slot: DIMM 19
126          size: 16GiB
127     *-bank:20
128          description: DIMM RAM
129          vendor: Alibaba Cloud
130          physical id: 14
131          slot: DIMM 20
132          size: 16GiB
133     *-bank:21
134          description: DIMM RAM
135          vendor: Alibaba Cloud
136          physical id: 15
137          slot: DIMM 21
138          size: 16GiB
139     *-bank:22
140          description: DIMM RAM
141          vendor: Alibaba Cloud
142          physical id: 16
143          slot: DIMM 22
144          size: 16GiB
145     *-bank:23
146          description: DIMM RAM
147          vendor: Alibaba Cloud
148          physical id: 17
149          slot: DIMM 23
150          size: 16GiB
151     *-bank:24
152          description: DIMM RAM
153          vendor: Alibaba Cloud
154          physical id: 18
155          slot: DIMM 24
156          size: 16GiB
157     *-bank:25
158          description: DIMM RAM
159          vendor: Alibaba Cloud
160          physical id: 19
161          slot: DIMM 25
162          size: 16GiB
163     *-bank:26
164          description: DIMM RAM
165          vendor: Alibaba Cloud
166          physical id: 1a
167          slot: DIMM 26
168          size: 16GiB
169     *-bank:27
170          description: DIMM RAM
```

```
171          vendor: Alibaba Cloud
172          physical id: 1b
173          slot: DIMM 27
174          size: 16GiB
175       *-bank:28
176          description: DIMM RAM
177          vendor: Alibaba Cloud
178          physical id: 1c
179          slot: DIMM 28
180          size: 16GiB
181       *-bank:29
182          description: DIMM RAM
183          vendor: Alibaba Cloud
184          physical id: 1d
185          slot: DIMM 29
186          size: 16GiB
187       *-bank:30
188          description: DIMM RAM
189          vendor: Alibaba Cloud
190          physical id: 1e
191          slot: DIMM 30
192          size: 16GiB
193       *-bank:31
194          description: DIMM RAM
195          vendor: Alibaba Cloud
196          physical id: 1f
197          slot: DIMM 31
198          size: 16GiB
199       *-bank:32
200          description: DIMM RAM
201          vendor: Alibaba Cloud
202          physical id: 20
203          slot: DIMM 32
204          size: 16GiB
205       *-bank:33
206          description: DIMM RAM
207          vendor: Alibaba Cloud
208          physical id: 21
209          slot: DIMM 33
210          size: 16GiB
211       *-bank:34
212          description: DIMM RAM
213          vendor: Alibaba Cloud
214          physical id: 22
215          slot: DIMM 34
216          size: 16GiB
217       *-bank:35
218          description: DIMM RAM
219          vendor: Alibaba Cloud
220          physical id: 23
221          slot: DIMM 35
222          size: 16GiB
223       *-bank:36
224          description: DIMM RAM
225          vendor: Alibaba Cloud
226          physical id: 24
227          slot: DIMM 36
228          size: 16GiB
```

```
    *-bank:37
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 25
         slot: DIMM 37
         size: 16GiB
    *-bank:38
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 26
         slot: DIMM 38
         size: 16GiB
    *-bank:39
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 27
         slot: DIMM 39
         size: 16GiB
    *-bank:40
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 28
         slot: DIMM 40
         size: 16GiB
    *-bank:41
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 29
         slot: DIMM 41
         size: 16GiB
    *-bank:42
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 2a
         slot: DIMM 42
         size: 16GiB
    *-bank:43
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 2b
         slot: DIMM 43
         size: 16GiB
    *-bank:44
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 2c
         slot: DIMM 44
         size: 16GiB
    *-bank:45
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 2d
         slot: DIMM 45
         size: 16GiB
    *-bank:46
         description: DIMM RAM
         vendor: Alibaba Cloud
         physical id: 2e
```

```
287          slot: DIMM 46
288          size: 16GiB
289       *-bank:47
290          description: DIMM RAM
291          vendor: Alibaba Cloud
292          physical id: 2f
293          slot: DIMM 47
294          size: 16GiB
295    *-firmware
296         description: BIOS
297         vendor: Alibaba Cloud ECS
298         physical id: 0
299         version: 1.0.0
300         date: 01/01/2017
301         size: 96KiB
302         capabilities: uefi virtualmachine
```

Listing A.3: Output of the `sysbench memory` read command

```
sysbench memory --memory-lock-size=1G --memory-total-size=16384G --memory-oper=read --threads=92 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 92
Initializing random number generator from current time


Running memory speed test with the following options:
  block size: 1048576KiB
  total size: 16777216MiB
  operation: read
  scope: global

Initializing worker threads...

Threads started!

Total operations: 13547 ( 1347.60 per second)

13872128.00 MiB transferred (1379946.65 MiB/sec)


General statistics:
    total time:                          10.0521s
    total number of events:              13547

Latency (ms):
         min:                                    49.14
         avg:                                    68.08
         max:                                   264.88
         95th percentile:                       102.97
         sum:                                922303.55

Threads fairness:
    events (avg/stddev):           147.2500/18.42
    execution time (avg/stddev):   10.0250/0.02b
```

Listing A.4: Output of the `sysbench memory` write command

```
sysbench memory --memory-lock-size=1G --memory-total-size=16384G --memory-oper=write --threads=92 run
sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)

Running the test with following options:
Number of threads: 92
Initializing random number generator from current time


Running memory speed test with the following options:
  block size: 1048576KiB
  total size: 16777216MiB
  operation: write
  scope: global

Initializing worker threads...

Threads started!

Total operations: 3100 (  305.29 per second)

3174400.00 MiB transferred (312619.18 MiB/sec)


General statistics:
    total time:                          10.1536s
    total number of events:              3100

Latency (ms):
         min:                                  101.88
         avg:                                  299.87
         max:                                  506.44
         95th percentile:                      369.77
         sum:                                929601.52

Threads fairness:
    events (avg/stddev):           33.6957/1.21
    execution time (avg/stddev):   10.1044/0.04b
```

A.3 Disk details

Listing A.5: Output of the `lsblk` and `parted -l` command

```
lsblk
NAME        MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
nvme0n1     259:0    0   40G  0 disk
  -nvme0n1p1 259:1    0    1M  0 part
  -nvme0n1p2 259:2    0  191M  0 part /boot/efi
  -nvme0n1p3 259:3    0 39.8G  0 part /
nvme1n1     259:4    0    4T  0 disk /data

--------------------------------------------------------------------------------
sudo parted -l
Model: Alibaba Cloud Elastic Block Storage (nvme)
Disk /dev/nvme0n1: 42.9GB
Sector size (logical/physical): 512B/512B
Partition Table: gpt
Disk Flags:

Number  Start   End     Size    File system  Name  Flags
 1      1049kB  2097kB  1049kB                     bios_grub
 2      2097kB  202MB   200MB   fat32              boot, esp
 3      202MB   42.9GB  42.7GB  ext4


Model: Alibaba Cloud Elastic Block Storage (nvme)
Disk /dev/nvme1n1: 4398GB
Sector size (logical/physical): 512B/512B
Partition Table: loop
Disk Flags:

Number  Start  End     Size    File system  Flags
 1      0.00B  4398GB  4398GB  xfs
```

A.4 Network details

Listing A.6: Output of the `lshw -class network` command

```
lshw -class network
*-network
       description: Ethernet controller
       product: Virtio network device
       vendor: Red Hat, Inc.
       physical id: 5
       bus info: pci@0000:00:05.0
       version: 00
       width: 64 bits
       clock: 33MHz
       capabilities: msix bus_master cap_list
       configuration: driver=virtio-pci latency=0
       resources: irq:0 memory:cc402000-cc402fff memory:cc408000-cc40bfff
     *-virtio1
          description: Ethernet interface
          physical id: 0
          bus info: virtio@1
          logical name: eth0
          serial: 00:16:3e:07:ae:29
          capabilities: ethernet physical
          configuration: autonegotiation=off broadcast=yes driver=virtio_net driverversion=1.0.0 ip=172.24.253.93
      link=yes multicast=yes
```

A.5 Network performance

Some of the output has been omitted for briefness. First sum is from client to server, second sum from server to client.

Listing A.7: Output of the `iperf` command

```
------------------------------------------------------------
Client connecting to 172.24.253.92, TCP port 10000
TCP window size:  289 KByte (default)
------------------------------------------------------------
[ 66] local 172.24.253.93 port 47566 connected with 172.24.253.92 port 10000
[ 61] local 172.24.253.93 port 47512 connected with 172.24.253.92 port 10000
[ 64] local 172.24.253.93 port 47556 connected with 172.24.253.92 port 10000
[ 56] local 172.24.253.93 port 47476 connected with 172.24.253.92 port 10000
[  6] local 172.24.253.93 port 47034 connected with 172.24.253.92 port 10000
[ 65] local 172.24.253.93 port 47544 connected with 172.24.253.92 port 10000
[ 62] local 172.24.253.93 port 47536 connected with 172.24.253.92 port 10000
[ 58] local 172.24.253.93 port 47488 connected with 172.24.253.92 port 10000
[  3] local 172.24.253.93 port 47002 connected with 172.24.253.92 port 10000
[  9] local 172.24.253.93 port 47046 connected with 172.24.253.92 port 10000
[  7] local 172.24.253.93 port 47054 connected with 172.24.253.92 port 10000
[  5] local 172.24.253.93 port 47028 connected with 172.24.253.92 port 10000
[ 12] local 172.24.253.93 port 47074 connected with 172.24.253.92 port 10000
[ 10] local 172.24.253.93 port 47086 connected with 172.24.253.92 port 10000
[  4] local 172.24.253.93 port 47016 connected with 172.24.253.92 port 10000
[ 16] local 172.24.253.93 port 47082 connected with 172.24.253.92 port 10000
[ 11] local 172.24.253.93 port 47064 connected with 172.24.253.92 port 10000
[  8] local 172.24.253.93 port 47042 connected with 172.24.253.92 port 10000
[ 14] local 172.24.253.93 port 47102 connected with 172.24.253.92 port 10000
```

```
[ 15] local 172.24.253.93 port 47122 connected with 172.24.253.92 port 10000
[ 17] local 172.24.253.93 port 47134 connected with 172.24.253.92 port 10000
[ 19] local 172.24.253.93 port 47142 connected with 172.24.253.92 port 10000
[ 22] local 172.24.253.93 port 47176 connected with 172.24.253.92 port 10000
[ 18] local 172.24.253.93 port 47148 connected with 172.24.253.92 port 10000
[ 20] local 172.24.253.93 port 47154 connected with 172.24.253.92 port 10000
[ 21] local 172.24.253.93 port 47166 connected with 172.24.253.92 port 10000
[ 24] local 172.24.253.93 port 47198 connected with 172.24.253.92 port 10000
[ 26] local 172.24.253.93 port 47216 connected with 172.24.253.92 port 10000
[ 23] local 172.24.253.93 port 47202 connected with 172.24.253.92 port 10000
[ 27] local 172.24.253.93 port 47222 connected with 172.24.253.92 port 10000
[ 29] local 172.24.253.93 port 47228 connected with 172.24.253.92 port 10000
[ 28] local 172.24.253.93 port 47236 connected with 172.24.253.92 port 10000
[ 30] local 172.24.253.93 port 47242 connected with 172.24.253.92 port 10000
[ 31] local 172.24.253.93 port 47244 connected with 172.24.253.92 port 10000
[ 32] local 172.24.253.93 port 47258 connected with 172.24.253.92 port 10000
[ 33] local 172.24.253.93 port 47262 connected with 172.24.253.92 port 10000
[ 34] local 172.24.253.93 port 47278 connected with 172.24.253.92 port 10000
[ 35] local 172.24.253.93 port 47292 connected with 172.24.253.92 port 10000
[ 37] local 172.24.253.93 port 47302 connected with 172.24.253.92 port 10000
[ 38] local 172.24.253.93 port 47330 connected with 172.24.253.92 port 10000
[ 40] local 172.24.253.93 port 47332 connected with 172.24.253.92 port 10000
[ 36] local 172.24.253.93 port 47314 connected with 172.24.253.92 port 10000
[ 39] local 172.24.253.93 port 47334 connected with 172.24.253.92 port 10000
[ 42] local 172.24.253.93 port 47346 connected with 172.24.253.92 port 10000
[ 43] local 172.24.253.93 port 47348 connected with 172.24.253.92 port 10000
[ 45] local 172.24.253.93 port 47364 connected with 172.24.253.92 port 10000
[ 41] local 172.24.253.93 port 47366 connected with 172.24.253.92 port 10000
[ 44] local 172.24.253.93 port 47374 connected with 172.24.253.92 port 10000
[ 48] local 172.24.253.93 port 47388 connected with 172.24.253.92 port 10000
[ 46] local 172.24.253.93 port 47386 connected with 172.24.253.92 port 10000
[ 49] local 172.24.253.93 port 47396 connected with 172.24.253.92 port 10000
[ 47] local 172.24.253.93 port 47412 connected with 172.24.253.92 port 10000
[ 50] local 172.24.253.93 port 47420 connected with 172.24.253.92 port 10000
[ 51] local 172.24.253.93 port 47428 connected with 172.24.253.92 port 10000
[ 52] local 172.24.253.93 port 47424 connected with 172.24.253.92 port 10000
[ 53] local 172.24.253.93 port 47438 connected with 172.24.253.92 port 10000
[ 57] local 172.24.253.93 port 47452 connected with 172.24.253.92 port 10000
[ 60] local 172.24.253.93 port 47504 connected with 172.24.253.92 port 10000
[ 55] local 172.24.253.93 port 47462 connected with 172.24.253.92 port 10000
[ 63] local 172.24.253.93 port 47528 connected with 172.24.253.92 port 10000
[ 59] local 172.24.253.93 port 47498 connected with 172.24.253.92 port 10000
[ 54] local 172.24.253.93 port 47448 connected with 172.24.253.92 port 10000
[ 13] local 172.24.253.93 port 47116 connected with 172.24.253.92 port 10000
[ 25] local 172.24.253.93 port 47188 connected with 172.24.253.92 port 10000
[ ID] Interval       Transfer     Bandwidth
[ 61]  0.0- 5.0 sec   500 MBytes   840 Mbits/sec
[ 56]  0.0- 5.0 sec   701 MBytes  1.18 Gbits/sec
[  6]  0.0- 5.0 sec   568 MBytes   954 Mbits/sec
[ 62]  0.0- 5.0 sec   566 MBytes   949 Mbits/sec
[  3]  0.0- 5.0 sec   709 MBytes  1.19 Gbits/sec
[ 10]  0.0- 5.0 sec   807 MBytes  1.35 Gbits/sec
[ 14]  0.0- 5.0 sec   621 MBytes  1.04 Gbits/sec
[ 15]  0.0- 5.0 sec   540 MBytes   906 Mbits/sec
[ 19]  0.0- 5.0 sec   587 MBytes   984 Mbits/sec
[ 21]  0.0- 5.0 sec   687 MBytes  1.15 Gbits/sec
[ 26]  0.0- 5.0 sec   561 MBytes   941 Mbits/sec
[ 29]  0.0- 5.0 sec   574 MBytes   963 Mbits/sec
```

```
[ 28]  0.0- 5.0 sec   817 MBytes  1.37 Gbits/sec
[ 30]  0.0- 5.0 sec   490 MBytes   823 Mbits/sec
[ 31]  0.0- 5.0 sec   574 MBytes   962 Mbits/sec
[ 33]  0.0- 5.0 sec   402 MBytes   674 Mbits/sec
[ 35]  0.0- 5.0 sec   820 MBytes  1.38 Gbits/sec
[ 38]  0.0- 5.0 sec   661 MBytes  1.11 Gbits/sec
[ 40]  0.0- 5.0 sec   430 MBytes   722 Mbits/sec
[ 36]  0.0- 5.0 sec   557 MBytes   935 Mbits/sec
[ 39]  0.0- 5.0 sec   709 MBytes  1.19 Gbits/sec
[ 42]  0.0- 5.0 sec   460 MBytes   772 Mbits/sec
[ 43]  0.0- 5.0 sec   754 MBytes  1.27 Gbits/sec
[ 45]  0.0- 5.0 sec   570 MBytes   956 Mbits/sec
[ 51]  0.0- 5.0 sec   433 MBytes   727 Mbits/sec
[ 53]  0.0- 5.0 sec   560 MBytes   940 Mbits/sec
[ 57]  0.0- 5.0 sec   830 MBytes  1.39 Gbits/sec
[ 13]  0.0- 5.0 sec   594 MBytes   996 Mbits/sec
[ 25]  0.0- 5.0 sec   577 MBytes   968 Mbits/sec
[ 58]  0.0- 5.0 sec   802 MBytes  1.35 Gbits/sec
[ 12]  0.0- 5.0 sec   581 MBytes   975 Mbits/sec
[ 41]  0.0- 5.0 sec   382 MBytes   641 Mbits/sec
[ 52]  0.0- 5.0 sec   625 MBytes  1.05 Gbits/sec
[ 54]  0.0- 5.0 sec   785 MBytes  1.32 Gbits/sec
[ 65]  0.0- 5.0 sec   843 MBytes  1.41 Gbits/sec
[ 32]  0.0- 5.0 sec   312 MBytes   524 Mbits/sec
[ 37]  0.0- 5.0 sec   613 MBytes  1.03 Gbits/sec
[ 24]  0.0- 5.0 sec   470 MBytes   789 Mbits/sec
[ 34]  0.0- 5.0 sec   562 MBytes   943 Mbits/sec
[ 46]  0.0- 5.0 sec   428 MBytes   717 Mbits/sec
[ 50]  0.0- 5.0 sec   609 MBytes  1.02 Gbits/sec
[ 55]  0.0- 5.0 sec   471 MBytes   790 Mbits/sec
[ 66]  0.0- 5.0 sec   660 MBytes  1.11 Gbits/sec
[ 63]  0.0- 5.0 sec   566 MBytes   949 Mbits/sec
[  7]  0.0- 5.0 sec   688 MBytes  1.15 Gbits/sec
[ 16]  0.0- 5.0 sec   471 MBytes   790 Mbits/sec
[ 44]  0.0- 5.0 sec   414 MBytes   695 Mbits/sec
[ 49]  0.0- 5.0 sec   697 MBytes  1.17 Gbits/sec
[ 59]  0.0- 5.0 sec   452 MBytes   759 Mbits/sec
[ 64]  0.0- 5.0 sec   730 MBytes  1.22 Gbits/sec
[  9]  0.0- 5.0 sec   715 MBytes  1.20 Gbits/sec
[  8]  0.0- 5.0 sec   588 MBytes   986 Mbits/sec
[ 48]  0.0- 5.0 sec   492 MBytes   825 Mbits/sec
[ 20]  0.0- 5.0 sec   496 MBytes   833 Mbits/sec
[ 23]  0.0- 5.0 sec   583 MBytes   978 Mbits/sec
[ 11]  0.0- 5.0 sec   583 MBytes   979 Mbits/sec
[ 27]  0.0- 5.0 sec   732 MBytes  1.23 Gbits/sec
[ 47]  0.0- 5.0 sec   657 MBytes  1.10 Gbits/sec
[  5]  0.0- 5.0 sec   707 MBytes  1.19 Gbits/sec
[  4]  0.0- 5.0 sec   679 MBytes  1.14 Gbits/sec
[ 22]  0.0- 5.0 sec   642 MBytes  1.08 Gbits/sec
[ 60]  0.0- 5.0 sec   635 MBytes  1.07 Gbits/sec
[ 17]  0.0- 5.0 sec  1.01 GBytes  1.73 Gbits/sec
[ 18]  0.0- 5.0 sec   730 MBytes  1.22 Gbits/sec
[SUM]  0.0- 5.0 sec  38.2 GBytes  65.6 Gbits/sec
[ 56]  5.0-10.0 sec   405 MBytes   680 Mbits/sec
[  6]  5.0-10.0 sec   624 MBytes  1.05 Gbits/sec
[ 65]  5.0-10.0 sec   820 MBytes  1.38 Gbits/sec
[ 58]  5.0-10.0 sec   840 MBytes  1.41 Gbits/sec
[  3]  5.0-10.0 sec   698 MBytes  1.17 Gbits/sec
```

```
[  9]  5.0-10.0 sec   790 MBytes  1.33 Gbits/sec
[  7]  5.0-10.0 sec   440 MBytes   738 Mbits/sec
[ 12]  5.0-10.0 sec   594 MBytes   996 Mbits/sec
[ 10]  5.0-10.0 sec   769 MBytes  1.29 Gbits/sec
[ 16]  5.0-10.0 sec   811 MBytes  1.36 Gbits/sec
[ 11]  5.0-10.0 sec   515 MBytes   864 Mbits/sec
[ 19]  5.0-10.0 sec   498 MBytes   835 Mbits/sec
[ 21]  5.0-10.0 sec   680 MBytes  1.14 Gbits/sec
[ 23]  5.0-10.0 sec   472 MBytes   791 Mbits/sec
[ 27]  5.0-10.0 sec   656 MBytes  1.10 Gbits/sec
[ 31]  5.0-10.0 sec   743 MBytes  1.25 Gbits/sec
[ 32]  5.0-10.0 sec   330 MBytes   554 Mbits/sec
[ 33]  5.0-10.0 sec   908 MBytes  1.52 Gbits/sec
[ 34]  5.0-10.0 sec   500 MBytes   839 Mbits/sec
[ 35]  5.0-10.0 sec   630 MBytes  1.06 Gbits/sec
[ 38]  5.0-10.0 sec   958 MBytes  1.61 Gbits/sec
[ 36]  5.0-10.0 sec   600 MBytes  1.01 Gbits/sec
[ 41]  5.0-10.0 sec   516 MBytes   865 Mbits/sec
[ 48]  5.0-10.0 sec   455 MBytes   763 Mbits/sec
[ 49]  5.0-10.0 sec   640 MBytes  1.07 Gbits/sec
[ 50]  5.0-10.0 sec   439 MBytes   736 Mbits/sec
[ 52]  5.0-10.0 sec   728 MBytes  1.22 Gbits/sec
[ 57]  5.0-10.0 sec   577 MBytes   968 Mbits/sec
[ 55]  5.0-10.0 sec   494 MBytes   829 Mbits/sec
[ 63]  5.0-10.0 sec   489 MBytes   821 Mbits/sec
[ 54]  5.0-10.0 sec   719 MBytes  1.21 Gbits/sec
[ 13]  5.0-10.0 sec   524 MBytes   879 Mbits/sec
[ 24]  5.0-10.0 sec   485 MBytes   813 Mbits/sec
[ 45]  5.0-10.0 sec   669 MBytes  1.12 Gbits/sec
[ 44]  5.0-10.0 sec   434 MBytes   727 Mbits/sec
[  8]  5.0-10.0 sec   492 MBytes   826 Mbits/sec
[ 28]  5.0-10.0 sec   705 MBytes  1.18 Gbits/sec
[ 53]  5.0-10.0 sec   338 MBytes   568 Mbits/sec
[ 66]  5.0-10.0 sec   472 MBytes   793 Mbits/sec
[ 64]  5.0-10.0 sec   910 MBytes  1.53 Gbits/sec
[ 22]  5.0-10.0 sec   475 MBytes   796 Mbits/sec
[ 29]  5.0-10.0 sec   588 MBytes   986 Mbits/sec
[ 40]  5.0-10.0 sec   595 MBytes   998 Mbits/sec
[ 42]  5.0-10.0 sec   506 MBytes   848 Mbits/sec
[ 60]  5.0-10.0 sec   433 MBytes   727 Mbits/sec
[ 61]  5.0-10.0 sec   675 MBytes  1.13 Gbits/sec
[ 25]  5.0-10.0 sec   823 MBytes  1.38 Gbits/sec
[  4]  5.0-10.0 sec   630 MBytes  1.06 Gbits/sec
[ 18]  5.0-10.0 sec   679 MBytes  1.14 Gbits/sec
[ 26]  5.0-10.0 sec   801 MBytes  1.34 Gbits/sec
[ 43]  5.0-10.0 sec   601 MBytes  1.01 Gbits/sec
[ 17]  5.0-10.0 sec   713 MBytes  1.20 Gbits/sec
[ 14]  5.0-10.0 sec   540 MBytes   905 Mbits/sec
[ 15]  5.0-10.0 sec   554 MBytes   929 Mbits/sec
[ 37]  5.0-10.0 sec   660 MBytes  1.11 Gbits/sec
[ 47]  5.0-10.0 sec   579 MBytes   971 Mbits/sec
[ 51]  5.0-10.0 sec   477 MBytes   800 Mbits/sec
[ 30]  5.0-10.0 sec   408 MBytes   685 Mbits/sec
[ 39]  5.0-10.0 sec   586 MBytes   983 Mbits/sec
[  5]  5.0-10.0 sec   753 MBytes  1.26 Gbits/sec
[ 20]  5.0-10.0 sec   547 MBytes   918 Mbits/sec
[ 62]  5.0-10.0 sec   453 MBytes   759 Mbits/sec
[ 46]  5.0-10.0 sec   321 MBytes   539 Mbits/sec
```

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[ 59]  5.0-10.0 sec   493 MBytes   827 Mbits/sec
[SUM]  5.0-10.0 sec  37.4 GBytes  64.2 Gbits/sec
[ 61] 10.0-15.0 sec   513 MBytes   860 Mbits/sec
[ 64] 10.0-15.0 sec   825 MBytes  1.38 Gbits/sec
[ 56] 10.0-15.0 sec   545 MBytes   915 Mbits/sec
[  6] 10.0-15.0 sec   812 MBytes  1.36 Gbits/sec
[ 65] 10.0-15.0 sec   782 MBytes  1.31 Gbits/sec
[ 62] 10.0-15.0 sec   667 MBytes  1.12 Gbits/sec
[  9] 10.0-15.0 sec   809 MBytes  1.36 Gbits/sec
[  7] 10.0-15.0 sec   566 MBytes   950 Mbits/sec
[ 16] 10.0-15.0 sec   704 MBytes  1.18 Gbits/sec
[ 11] 10.0-15.0 sec   770 MBytes  1.29 Gbits/sec
[  8] 10.0-15.0 sec   401 MBytes   672 Mbits/sec
[ 18] 10.0-15.0 sec   452 MBytes   759 Mbits/sec
[ 20] 10.0-15.0 sec   462 MBytes   774 Mbits/sec
[ 21] 10.0-15.0 sec   713 MBytes  1.20 Gbits/sec
[ 23] 10.0-15.0 sec   410 MBytes   687 Mbits/sec
[ 27] 10.0-15.0 sec   767 MBytes  1.29 Gbits/sec
[ 29] 10.0-15.0 sec   640 MBytes  1.07 Gbits/sec
[ 28] 10.0-15.0 sec   840 MBytes  1.41 Gbits/sec
[ 33] 10.0-15.0 sec   566 MBytes   950 Mbits/sec
[ 34] 10.0-15.0 sec   439 MBytes   736 Mbits/sec
[ 42] 10.0-15.0 sec   522 MBytes   876 Mbits/sec
[ 45] 10.0-15.0 sec   613 MBytes  1.03 Gbits/sec
[ 41] 10.0-15.0 sec   649 MBytes  1.09 Gbits/sec
[ 49] 10.0-15.0 sec   699 MBytes  1.17 Gbits/sec
[ 47] 10.0-15.0 sec   498 MBytes   835 Mbits/sec
[ 52] 10.0-15.0 sec   678 MBytes  1.14 Gbits/sec
[ 55] 10.0-15.0 sec   371 MBytes   622 Mbits/sec
[ 54] 10.0-15.0 sec   661 MBytes  1.11 Gbits/sec
[ 13] 10.0-15.0 sec   572 MBytes   960 Mbits/sec
[ 25] 10.0-15.0 sec   638 MBytes  1.07 Gbits/sec
[ 24] 10.0-15.0 sec   431 MBytes   724 Mbits/sec
[ 30] 10.0-15.0 sec   263 MBytes   442 Mbits/sec
[ 35] 10.0-15.0 sec   736 MBytes  1.23 Gbits/sec
[ 40] 10.0-15.0 sec   652 MBytes  1.09 Gbits/sec
[ 51] 10.0-15.0 sec   385 MBytes   645 Mbits/sec
[ 66] 10.0-15.0 sec   590 MBytes   990 Mbits/sec
[ 58] 10.0-15.0 sec   736 MBytes  1.24 Gbits/sec
[ 22] 10.0-15.0 sec   540 MBytes   906 Mbits/sec
[ 38] 10.0-15.0 sec   566 MBytes   950 Mbits/sec
[ 44] 10.0-15.0 sec   488 MBytes   818 Mbits/sec
[  4] 10.0-15.0 sec   624 MBytes  1.05 Gbits/sec
[ 10] 10.0-15.0 sec   655 MBytes  1.10 Gbits/sec
[ 39] 10.0-15.0 sec   608 MBytes  1.02 Gbits/sec
[ 48] 10.0-15.0 sec   631 MBytes  1.06 Gbits/sec
[ 50] 10.0-15.0 sec   429 MBytes   720 Mbits/sec
[  5] 10.0-15.0 sec   459 MBytes   770 Mbits/sec
[ 59] 10.0-15.0 sec   572 MBytes   960 Mbits/sec
[ 12] 10.0-15.0 sec   691 MBytes  1.16 Gbits/sec
[ 37] 10.0-15.0 sec   589 MBytes   988 Mbits/sec
[ 46] 10.0-15.0 sec   607 MBytes  1.02 Gbits/sec
[ 53] 10.0-15.0 sec   410 MBytes   688 Mbits/sec
[  3] 10.0-15.0 sec   545 MBytes   914 Mbits/sec
[ 14] 10.0-15.0 sec   559 MBytes   938 Mbits/sec
[ 19] 10.0-15.0 sec   534 MBytes   895 Mbits/sec
[ 31] 10.0-15.0 sec   636 MBytes  1.07 Gbits/sec
[ 57] 10.0-15.0 sec   751 MBytes  1.26 Gbits/sec
```

```
[ 17] 10.0-15.0 sec   906 MBytes  1.52 Gbits/sec
[ 26] 10.0-15.0 sec   703 MBytes  1.18 Gbits/sec
[ 32] 10.0-15.0 sec   596 MBytes  1.00 Gbits/sec
[ 36] 10.0-15.0 sec   524 MBytes   878 Mbits/sec
[ 15] 10.0-15.0 sec   372 MBytes   625 Mbits/sec
[ 43] 10.0-15.0 sec   584 MBytes   980 Mbits/sec
[ 60] 10.0-15.0 sec   614 MBytes  1.03 Gbits/sec
[ 63] 10.0-15.0 sec   677 MBytes  1.14 Gbits/sec
[SUM] 10.0-15.0 sec  37.3 GBytes  64.2 Gbits/sec
[ 66] 15.0-20.0 sec   503 MBytes   844 Mbits/sec
[ 61] 15.0-20.0 sec   579 MBytes   972 Mbits/sec
[ 64] 15.0-20.0 sec   692 MBytes  1.16 Gbits/sec
[ 62] 15.0-20.0 sec   769 MBytes  1.29 Gbits/sec
[ 58] 15.0-20.0 sec   822 MBytes  1.38 Gbits/sec
[  7] 15.0-20.0 sec   685 MBytes  1.15 Gbits/sec
[ 12] 15.0-20.0 sec   659 MBytes  1.10 Gbits/sec
[ 10] 15.0-20.0 sec   693 MBytes  1.16 Gbits/sec
[ 16] 15.0-20.0 sec   710 MBytes  1.19 Gbits/sec
[ 11] 15.0-20.0 sec   710 MBytes  1.19 Gbits/sec
[ 14] 15.0-20.0 sec   559 MBytes   938 Mbits/sec
[ 15] 15.0-20.0 sec   608 MBytes  1.02 Gbits/sec
[ 22] 15.0-20.0 sec   534 MBytes   896 Mbits/sec
[ 20] 15.0-20.0 sec   676 MBytes  1.13 Gbits/sec
[ 26] 15.0-20.0 sec   449 MBytes   754 Mbits/sec
[ 29] 15.0-20.0 sec   598 MBytes  1.00 Gbits/sec
[ 33] 15.0-20.0 sec   532 MBytes   892 Mbits/sec
[ 40] 15.0-20.0 sec   726 MBytes  1.22 Gbits/sec
[ 39] 15.0-20.0 sec   608 MBytes  1.02 Gbits/sec
[ 43] 15.0-20.0 sec   653 MBytes  1.10 Gbits/sec
[ 45] 15.0-20.0 sec   784 MBytes  1.32 Gbits/sec
[ 41] 15.0-20.0 sec   470 MBytes   788 Mbits/sec
[ 44] 15.0-20.0 sec   487 MBytes   817 Mbits/sec
[ 49] 15.0-20.0 sec   747 MBytes  1.25 Gbits/sec
[ 47] 15.0-20.0 sec   633 MBytes  1.06 Gbits/sec
[ 52] 15.0-20.0 sec   777 MBytes  1.30 Gbits/sec
[ 54] 15.0-20.0 sec   471 MBytes   790 Mbits/sec
[ 13] 15.0-20.0 sec   800 MBytes  1.34 Gbits/sec
[ 25] 15.0-20.0 sec   596 MBytes  1000 Mbits/sec
[ 46] 15.0-20.0 sec   542 MBytes   910 Mbits/sec
[ 50] 15.0-20.0 sec   451 MBytes   756 Mbits/sec
[ 65] 15.0-20.0 sec   836 MBytes  1.40 Gbits/sec
[  8] 15.0-20.0 sec   516 MBytes   866 Mbits/sec
[ 18] 15.0-20.0 sec   566 MBytes   950 Mbits/sec
[ 24] 15.0-20.0 sec   354 MBytes   595 Mbits/sec
[ 42] 15.0-20.0 sec   303 MBytes   509 Mbits/sec
[ 32] 15.0-20.0 sec   322 MBytes   541 Mbits/sec
[ 37] 15.0-20.0 sec   611 MBytes  1.02 Gbits/sec
[ 63] 15.0-20.0 sec   645 MBytes  1.08 Gbits/sec
[ 35] 15.0-20.0 sec   675 MBytes  1.13 Gbits/sec
[ 36] 15.0-20.0 sec   445 MBytes   747 Mbits/sec
[ 51] 15.0-20.0 sec   501 MBytes   840 Mbits/sec
[ 53] 15.0-20.0 sec   431 MBytes   723 Mbits/sec
[ 17] 15.0-20.0 sec   773 MBytes  1.30 Gbits/sec
[ 34] 15.0-20.0 sec   532 MBytes   893 Mbits/sec
[  4] 15.0-20.0 sec   631 MBytes  1.06 Gbits/sec
[ 19] 15.0-20.0 sec   371 MBytes   622 Mbits/sec
[ 21] 15.0-20.0 sec   686 MBytes  1.15 Gbits/sec
[ 38] 15.0-20.0 sec   652 MBytes  1.09 Gbits/sec
```

```
[ 59] 15.0-20.0 sec   624 MBytes  1.05 Gbits/sec
[ 60] 15.0-20.0 sec   477 MBytes   800 Mbits/sec
[ 56] 15.0-20.0 sec   494 MBytes   828 Mbits/sec
[ 55] 15.0-20.0 sec   516 MBytes   866 Mbits/sec
[  6] 15.0-20.0 sec   667 MBytes  1.12 Gbits/sec
[  5] 15.0-20.0 sec   478 MBytes   801 Mbits/sec
[ 23] 15.0-20.0 sec   522 MBytes   876 Mbits/sec
[ 48] 15.0-20.0 sec   602 MBytes  1.01 Gbits/sec
[ 30] 15.0-20.0 sec   640 MBytes  1.07 Gbits/sec
[  9] 15.0-20.0 sec   729 MBytes  1.22 Gbits/sec
[ 57] 15.0-20.0 sec   676 MBytes  1.13 Gbits/sec
[  3] 15.0-20.0 sec   659 MBytes  1.11 Gbits/sec
[ 27] 15.0-20.0 sec   617 MBytes  1.04 Gbits/sec
[ 28] 15.0-20.0 sec   766 MBytes  1.28 Gbits/sec
[ 31] 15.0-20.0 sec   409 MBytes   686 Mbits/sec
[SUM] 15.0-20.0 sec  37.4 GBytes  64.2 Gbits/sec
[ 61] 20.0-25.0 sec   485 MBytes   813 Mbits/sec
[ 64] 20.0-25.0 sec   996 MBytes  1.67 Gbits/sec
[ 58] 20.0-25.0 sec   732 MBytes  1.23 Gbits/sec
[  3] 20.0-25.0 sec   722 MBytes  1.21 Gbits/sec
[  5] 20.0-25.0 sec   628 MBytes  1.05 Gbits/sec
[  4] 20.0-25.0 sec   708 MBytes  1.19 Gbits/sec
[ 15] 20.0-25.0 sec   642 MBytes  1.08 Gbits/sec
[ 17] 20.0-25.0 sec   902 MBytes  1.51 Gbits/sec
[ 19] 20.0-25.0 sec   442 MBytes   741 Mbits/sec
[ 22] 20.0-25.0 sec   530 MBytes   890 Mbits/sec
[ 20] 20.0-25.0 sec   534 MBytes   896 Mbits/sec
[ 26] 20.0-25.0 sec   342 MBytes   575 Mbits/sec
[ 29] 20.0-25.0 sec   637 MBytes  1.07 Gbits/sec
[ 30] 20.0-25.0 sec   524 MBytes   880 Mbits/sec
[ 32] 20.0-25.0 sec   586 MBytes   984 Mbits/sec
[ 35] 20.0-25.0 sec   676 MBytes  1.13 Gbits/sec
[ 39] 20.0-25.0 sec   714 MBytes  1.20 Gbits/sec
[ 45] 20.0-25.0 sec   645 MBytes  1.08 Gbits/sec
[ 41] 20.0-25.0 sec   559 MBytes   938 Mbits/sec
[ 44] 20.0-25.0 sec   554 MBytes   929 Mbits/sec
[ 46] 20.0-25.0 sec   464 MBytes   778 Mbits/sec
[ 57] 20.0-25.0 sec   578 MBytes   970 Mbits/sec
[ 59] 20.0-25.0 sec   567 MBytes   951 Mbits/sec
[ 54] 20.0-25.0 sec   606 MBytes  1.02 Gbits/sec
[ 65] 20.0-25.0 sec   739 MBytes  1.24 Gbits/sec
[  7] 20.0-25.0 sec   570 MBytes   957 Mbits/sec
[ 10] 20.0-25.0 sec   524 MBytes   880 Mbits/sec
[ 40] 20.0-25.0 sec   531 MBytes   890 Mbits/sec
[ 55] 20.0-25.0 sec   335 MBytes   563 Mbits/sec
[ 63] 20.0-25.0 sec   451 MBytes   756 Mbits/sec
[ 24] 20.0-25.0 sec   532 MBytes   892 Mbits/sec
[ 37] 20.0-25.0 sec   744 MBytes  1.25 Gbits/sec
[  8] 20.0-25.0 sec   624 MBytes  1.05 Gbits/sec
[ 31] 20.0-25.0 sec   660 MBytes  1.11 Gbits/sec
[ 43] 20.0-25.0 sec   792 MBytes  1.33 Gbits/sec
[ 13] 20.0-25.0 sec   495 MBytes   830 Mbits/sec
[ 25] 20.0-25.0 sec   670 MBytes  1.12 Gbits/sec
[ 66] 20.0-25.0 sec   544 MBytes   913 Mbits/sec
[  6] 20.0-25.0 sec   777 MBytes  1.30 Gbits/sec
[ 28] 20.0-25.0 sec   740 MBytes  1.24 Gbits/sec
[ 33] 20.0-25.0 sec   681 MBytes  1.14 Gbits/sec
[ 34] 20.0-25.0 sec   486 MBytes   815 Mbits/sec
```

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[ 38] 20.0-25.0 sec   532 MBytes   893 Mbits/sec
[ 52] 20.0-25.0 sec   517 MBytes   867 Mbits/sec
[ 62] 20.0-25.0 sec   505 MBytes   848 Mbits/sec
[ 11] 20.0-25.0 sec   560 MBytes   940 Mbits/sec
[ 23] 20.0-25.0 sec   625 MBytes  1.05 Gbits/sec
[ 36] 20.0-25.0 sec   588 MBytes   987 Mbits/sec
[ 48] 20.0-25.0 sec   628 MBytes  1.05 Gbits/sec
[ 47] 20.0-25.0 sec   388 MBytes   651 Mbits/sec
[ 27] 20.0-25.0 sec   574 MBytes   963 Mbits/sec
[ 60] 20.0-25.0 sec   663 MBytes  1.11 Gbits/sec
[ 12] 20.0-25.0 sec   692 MBytes  1.16 Gbits/sec
[ 56] 20.0-25.0 sec   402 MBytes   674 Mbits/sec
[  9] 20.0-25.0 sec   522 MBytes   876 Mbits/sec
[ 18] 20.0-25.0 sec   392 MBytes   657 Mbits/sec
[ 42] 20.0-25.0 sec   679 MBytes  1.14 Gbits/sec
[ 50] 20.0-25.0 sec   368 MBytes   618 Mbits/sec
[ 51] 20.0-25.0 sec   373 MBytes   626 Mbits/sec
[ 53] 20.0-25.0 sec   508 MBytes   853 Mbits/sec
[ 16] 20.0-25.0 sec   817 MBytes  1.37 Gbits/sec
[ 49] 20.0-25.0 sec   801 MBytes  1.34 Gbits/sec
[ 21] 20.0-25.0 sec   751 MBytes  1.26 Gbits/sec
[ 14] 20.0-25.0 sec   688 MBytes  1.16 Gbits/sec
[SUM] 20.0-25.0 sec  37.3 GBytes  64.2 Gbits/sec
[ 61] 25.0-30.0 sec   711 MBytes  1.19 Gbits/sec
[ 61]  0.0-30.0 sec  3.38 GBytes   968 Mbits/sec
[ 64] 25.0-30.0 sec   753 MBytes  1.26 Gbits/sec
[ 64]  0.0-30.0 sec  4.79 GBytes  1.37 Gbits/sec
[ 65] 25.0-30.0 sec   843 MBytes  1.41 Gbits/sec
[ 65]  0.0-30.0 sec  4.75 GBytes  1.36 Gbits/sec
[ 62] 25.0-30.0 sec   434 MBytes   727 Mbits/sec
[ 62]  0.0-30.0 sec  3.31 GBytes   948 Mbits/sec
[  9] 25.0-30.0 sec   489 MBytes   820 Mbits/sec
[  9]  0.0-30.0 sec  3.96 GBytes  1.13 Gbits/sec
[ 12] 25.0-30.0 sec   652 MBytes  1.09 Gbits/sec
[ 12]  0.0-30.0 sec  3.78 GBytes  1.08 Gbits/sec
[ 10] 25.0-30.0 sec   753 MBytes  1.26 Gbits/sec
[ 10]  0.0-30.0 sec  4.10 GBytes  1.17 Gbits/sec
[  4] 25.0-30.0 sec   816 MBytes  1.37 Gbits/sec
[  4]  0.0-30.0 sec  3.99 GBytes  1.14 Gbits/sec
[ 17] 25.0-30.0 sec   822 MBytes  1.38 Gbits/sec
[ 17]  0.0-30.0 sec  5.03 GBytes  1.44 Gbits/sec
[ 19] 25.0-30.0 sec   829 MBytes  1.39 Gbits/sec
[ 19]  0.0-30.0 sec  3.18 GBytes   911 Mbits/sec
[ 22] 25.0-30.0 sec   549 MBytes   920 Mbits/sec
[ 22]  0.0-30.0 sec  3.19 GBytes   914 Mbits/sec
[ 21] 25.0-30.0 sec   748 MBytes  1.26 Gbits/sec
[ 21]  0.0-30.0 sec  4.16 GBytes  1.19 Gbits/sec
[ 26] 25.0-30.0 sec   644 MBytes  1.08 Gbits/sec
[ 26]  0.0-30.0 sec  3.42 GBytes   979 Mbits/sec
[ 27] 25.0-30.0 sec   527 MBytes   885 Mbits/sec
[ 27]  0.0-30.0 sec  3.78 GBytes  1.08 Gbits/sec
[ 29] 25.0-30.0 sec   681 MBytes  1.14 Gbits/sec
[ 29]  0.0-30.0 sec  3.63 GBytes  1.04 Gbits/sec
[ 31] 25.0-30.0 sec   610 MBytes  1.02 Gbits/sec
[ 31]  0.0-30.0 sec  3.55 GBytes  1.01 Gbits/sec
[ 32] 25.0-30.0 sec   404 MBytes   678 Mbits/sec
[ 32]  0.0-30.0 sec  2.49 GBytes   713 Mbits/sec
[ 34] 25.0-30.0 sec   442 MBytes   742 Mbits/sec
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[ 34]  0.0-30.0 sec  2.89 GBytes   828 Mbits/sec
[ 35] 25.0-30.0 sec   660 MBytes  1.11 Gbits/sec
[ 35]  0.0-30.0 sec  4.10 GBytes  1.17 Gbits/sec
[ 38] 25.0-30.0 sec   730 MBytes  1.23 Gbits/sec
[ 38]  0.0-30.0 sec  4.00 GBytes  1.15 Gbits/sec
[ 42] 25.0-30.0 sec   476 MBytes   798 Mbits/sec
[ 42]  0.0-30.0 sec  2.88 GBytes   823 Mbits/sec
[ 41] 25.0-30.0 sec   481 MBytes   807 Mbits/sec
[ 41]  0.0-30.0 sec  2.98 GBytes   855 Mbits/sec
[ 44] 25.0-30.0 sec   516 MBytes   866 Mbits/sec
[ 44]  0.0-30.0 sec  2.82 GBytes   808 Mbits/sec
[ 46] 25.0-30.0 sec   473 MBytes   794 Mbits/sec
[ 46]  0.0-30.0 sec  2.77 GBytes   793 Mbits/sec
[ 49] 25.0-30.0 sec   642 MBytes  1.08 Gbits/sec
[ 49]  0.0-30.0 sec  4.13 GBytes  1.18 Gbits/sec
[ 47] 25.0-30.0 sec   594 MBytes   997 Mbits/sec
[ 47]  0.0-30.0 sec  3.27 GBytes   936 Mbits/sec
[ 60] 25.0-30.0 sec   570 MBytes   957 Mbits/sec
[ 60]  0.0-30.0 sec  3.31 GBytes   949 Mbits/sec
[ 59] 25.0-30.0 sec   677 MBytes  1.14 Gbits/sec
[ 59]  0.0-30.0 sec  3.31 GBytes   947 Mbits/sec
[ 54] 25.0-30.0 sec   713 MBytes  1.20 Gbits/sec
[ 54]  0.0-30.0 sec  3.86 GBytes  1.11 Gbits/sec
[ 13] 25.0-30.0 sec   616 MBytes  1.03 Gbits/sec
[ 13]  0.0-30.0 sec  3.52 GBytes  1.01 Gbits/sec
[  3] 25.0-30.0 sec   579 MBytes   971 Mbits/sec
[  3]  0.0-30.0 sec  3.82 GBytes  1.09 Gbits/sec
[  7] 25.0-30.0 sec   647 MBytes  1.08 Gbits/sec
[  7]  0.0-30.0 sec  3.51 GBytes  1.00 Gbits/sec
[ 16] 25.0-30.0 sec   493 MBytes   826 Mbits/sec
[ 16]  0.0-30.0 sec  3.91 GBytes  1.12 Gbits/sec
[ 11] 25.0-30.0 sec   578 MBytes   970 Mbits/sec
[ 11]  0.0-30.0 sec  3.63 GBytes  1.04 Gbits/sec
[ 23] 25.0-30.0 sec   682 MBytes  1.14 Gbits/sec
[ 23]  0.0-30.0 sec  3.22 GBytes   920 Mbits/sec
[ 28] 25.0-30.0 sec   531 MBytes   891 Mbits/sec
[ 28]  0.0-30.0 sec  4.30 GBytes  1.23 Gbits/sec
[ 37] 25.0-30.0 sec   726 MBytes  1.22 Gbits/sec
[ 37]  0.0-30.0 sec  3.85 GBytes  1.10 Gbits/sec
[ 40] 25.0-30.0 sec   528 MBytes   887 Mbits/sec
[ 40]  0.0-30.0 sec  3.38 GBytes   967 Mbits/sec
[ 36] 25.0-30.0 sec   634 MBytes  1.06 Gbits/sec
[ 36]  0.0-30.0 sec  3.27 GBytes   935 Mbits/sec
[ 43] 25.0-30.0 sec   665 MBytes  1.12 Gbits/sec
[ 43]  0.0-30.0 sec  3.95 GBytes  1.13 Gbits/sec
[ 57] 25.0-30.0 sec   754 MBytes  1.26 Gbits/sec
[ 57]  0.0-30.1 sec  4.07 GBytes  1.16 Gbits/sec
[ 25] 25.0-30.0 sec   490 MBytes   823 Mbits/sec
[ 25]  0.0-30.0 sec  3.71 GBytes  1.06 Gbits/sec
[ 58] 25.0-30.0 sec   645 MBytes  1.08 Gbits/sec
[ 58]  0.0-30.1 sec  4.47 GBytes  1.28 Gbits/sec
[ 45] 25.0-30.0 sec   563 MBytes   945 Mbits/sec
[ 45]  0.0-30.1 sec  3.75 GBytes  1.07 Gbits/sec
[  6] 25.0-30.0 sec   614 MBytes  1.03 Gbits/sec
[  6]  0.0-30.1 sec  3.97 GBytes  1.13 Gbits/sec
[ 39] 25.0-30.0 sec   491 MBytes   823 Mbits/sec
[ 39]  0.0-30.1 sec  3.63 GBytes  1.04 Gbits/sec
[ 52] 25.0-30.0 sec   769 MBytes  1.29 Gbits/sec
```

```
[ 52]  0.0-30.1 sec  4.00 GBytes  1.14 Gbits/sec
[ 55] 25.0-30.0 sec   425 MBytes   713 Mbits/sec
[ 55]  0.0-30.1 sec  2.55 GBytes   728 Mbits/sec
[  8] 25.0-30.0 sec   534 MBytes   897 Mbits/sec
[  8]  0.0-30.1 sec  3.08 GBytes   879 Mbits/sec
[ 14] 25.0-30.0 sec   385 MBytes   646 Mbits/sec
[ 14]  0.0-30.1 sec  3.27 GBytes   934 Mbits/sec
[ 20] 25.0-30.0 sec   516 MBytes   865 Mbits/sec
[ 20]  0.0-30.1 sec  3.16 GBytes   900 Mbits/sec
[ 24] 25.0-30.0 sec   488 MBytes   818 Mbits/sec
[ 24]  0.0-30.1 sec  2.70 GBytes   768 Mbits/sec
[ 51] 25.0-30.0 sec   423 MBytes   710 Mbits/sec
[ 51]  0.0-30.1 sec  2.53 GBytes   722 Mbits/sec
[ 63] 25.0-30.0 sec   539 MBytes   905 Mbits/sec
[ 63]  0.0-30.1 sec  3.29 GBytes   938 Mbits/sec
[ 66] 25.0-30.0 sec   774 MBytes  1.30 Gbits/sec
[ 66]  0.0-30.2 sec  3.46 GBytes   986 Mbits/sec
[ 18] 25.0-30.0 sec   543 MBytes   912 Mbits/sec
[ 18]  0.0-30.1 sec  3.28 GBytes   936 Mbits/sec
[ 30] 25.0-30.0 sec   320 MBytes   538 Mbits/sec
[ 30]  0.0-30.1 sec  2.58 GBytes   737 Mbits/sec
[ 56] 25.0-30.0 sec   470 MBytes   788 Mbits/sec
[ 56]  0.0-30.2 sec  2.95 GBytes   839 Mbits/sec
[ 33] 25.0-30.0 sec   727 MBytes  1.22 Gbits/sec
[ 33]  0.0-30.2 sec  3.73 GBytes  1.06 Gbits/sec
[ 48] 25.0-30.0 sec   649 MBytes  1.09 Gbits/sec
[ 48]  0.0-30.2 sec  3.38 GBytes   961 Mbits/sec
[ 50] 25.0-30.0 sec   406 MBytes   681 Mbits/sec
[ 50]  0.0-30.2 sec  2.64 GBytes   751 Mbits/sec
[  5] 25.0-30.0 sec   670 MBytes  1.12 Gbits/sec
[  5]  0.0-30.2 sec  3.61 GBytes  1.03 Gbits/sec
[ 15] 25.0-30.0 sec   636 MBytes  1.07 Gbits/sec
[ 15]  0.0-30.2 sec  3.27 GBytes   932 Mbits/sec
[ 53] 25.0-30.0 sec   492 MBytes   826 Mbits/sec
[SUM] 25.0-30.0 sec  37.3 GBytes  64.2 Gbits/sec
[ 53]  0.0-30.2 sec  2.68 GBytes   762 Mbits/sec
[SUM]  0.0-30.2 sec   225 GBytes  64.0 Gbits/sec
```

A.6 IO performance

Listing A.8: Output of the `fio` command in the Driver instance

```
fio --rw=write --ioenginesync --fdatasync=1 --direct=1 --directory=io-test-data --size=2g --bs=4k --name=iotest
iotest: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=sync, iodepth=1
fio-3.16
Starting 1 process
iotest: Laying out IO file (1 file / 2048MiB)
Jobs: 1 (f=1): [W(1)][100.0%][w=21.7MiB/s][w=5558 IOPS][eta 00m:00s]
iotest: (groupid=0, jobs=1): err= 0: pid=294592: Sat Mar 29 19:16:59 2025
  write: IOPS=5142, BW=20.1MiB/s (21.1MB/s)(2048MiB/101953msec); 0 zone resets
    clat (usec): min=70, max=11253, avg=90.78, stdev=77.15
     lat (usec): min=70, max=11253, avg=90.82, stdev=77.15
    clat percentiles (usec):
     |  1.00th=[   76],  5.00th=[   78], 10.00th=[   78], 20.00th=[   80],
     | 30.00th=[   81], 40.00th=[   82], 50.00th=[   83], 60.00th=[   84],
     | 70.00th=[   85], 80.00th=[   87], 90.00th=[   94], 95.00th=[  111],
     | 99.00th=[  269], 99.50th=[  412], 99.90th=[ 1012], 99.95th=[ 1483],
     | 99.99th=[ 3425]
   bw (  KiB/s): min= 6008, max=23232, per=99.97%, avg=20562.84, stdev=1860.11, samples=203
   iops        : min= 1502, max= 5808, avg=5140.71, stdev=465.03, samples=203
  lat (usec)   : 100=93.15%, 250=5.72%, 500=0.77%, 750=0.19%, 1000=0.06%
  lat (msec)   : 2=0.07%, 4=0.02%, 10=0.01%, 20=0.01%
  fsync/fdatasync/sync_file_range:
    sync (usec): min=74, max=11488, avg=103.27, stdev=92.68
    sync percentiles (usec):
     |  1.00th=[   81],  5.00th=[   84], 10.00th=[   86], 20.00th=[   88],
     | 30.00th=[   89], 40.00th=[   91], 50.00th=[   92], 60.00th=[   95],
     | 70.00th=[   98], 80.00th=[  101], 90.00th=[  108], 95.00th=[  124],
     | 99.00th=[  338], 99.50th=[  515], 99.90th=[ 1254], 99.95th=[ 1942],
     | 99.99th=[ 3621]
  cpu          : usr=0.60%, sys=4.26%, ctx=1572864, majf=0, minf=14
  IO depths    : 1=200.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued rwts: total=0,524288,0,0 short=524287,0,0,0 dropped=0,0,0,0
     latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
  WRITE: bw=20.1MiB/s (21.1MB/s), 20.1MiB/s-20.1MiB/s (21.1MB/s-21.1MB/s), io=2048MiB (2147MB), run=101953-101953
     msec

Disk stats (read/write):
  nvme1n1: ios=0/1047980, merge=0/4, ticks=0/94529, in_queue=240, util=99.94%=
```

Listing A.9: Output of the `fio` command in the Server instance

```
fio --rw=write --ioengine=sync --fdatasync=1 --direct=1 --directory=io-test-data --size=2g --bs=4k --name=iotest
iotest: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=sync, iodepth=1
fio-3.16
Starting 1 process
iotest: Laying out IO file (1 file / 2048MiB)
Jobs: 1 (f=1): [W(1)][100.0%][w=17.6MiB/s][w=4495 IOPS][eta 00m:00s]
iotest: (groupid=0, jobs=1): err= 0: pid=1898071: Sat Mar 29 19:17:33 2025
  write: IOPS=4636, BW=18.1MiB/s (18.0MB/s)(2048MiB/113081msec); 0 zone resets
    clat (usec): min=69, max=5534, avg=91.36, stdev=85.61
     lat (usec): min=69, max=5535, avg=91.40, stdev=85.61
    clat percentiles (usec):
     |  1.00th=[   75],  5.00th=[   76], 10.00th=[   77], 20.00th=[   79],
     | 30.00th=[   80], 40.00th=[   80], 50.00th=[   82], 60.00th=[   83],
     | 70.00th=[   84], 80.00th=[   87], 90.00th=[   93], 95.00th=[  110],
     | 99.00th=[  322], 99.50th=[  506], 99.90th=[ 1237], 99.95th=[ 1762],
     | 99.99th=[ 3294]
   bw (  KiB/s): min= 9632, max=20208, per=100.00%, avg=18545.28, stdev=1135.63, samples=226
   iops        : min= 2408, max= 5052, avg=4636.32, stdev=283.91, samples=226
  lat (usec)   : 100=93.20%, 250=5.39%, 500=0.90%, 750=0.27%, 1000=0.10%
  lat (msec)   : 2=0.11%, 4=0.03%, 10=0.01%
  fsync/fdatasync/sync_file_range:
    sync (usec): min=79, max=5652, avg=123.92, stdev=86.94
    sync percentiles (usec):
     |  1.00th=[   84],  5.00th=[   86], 10.00th=[   87], 20.00th=[   88],
     | 30.00th=[   89], 40.00th=[   91], 50.00th=[   92], 60.00th=[   95],
     | 70.00th=[  105], 80.00th=[  147], 90.00th=[  217], 95.00th=[  265],
     | 99.00th=[  383], 99.50th=[  490], 99.90th=[  947], 99.95th=[ 1385],
     | 99.99th=[ 2835]
  cpu          : usr=0.49%, sys=3.94%, ctx=1572864, majf=0, minf=14
  IO depths    : 1=200.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
     submit    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     complete  : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
     issued rwts: total=0,524288,0,0 short=524287,0,0,0 dropped=0,0,0,0
     latency   : target=0, window=0, percentile=100.00%, depth=1

Run status group 0 (all jobs):
  WRITE: bw=18.1MiB/s (18.0MB/s), 18.1MiB/s-18.1MiB/s (18.0MB/s-18.0MB/s), io=2048MiB (2147MB), run=113081-113081
     msec

Disk stats (read/write):
  nvme1n1: ios=0/1047075, merge=0/4, ticks=0/105112, in_queue=144, util=99.95%
```

A.7 Datagen configuration

Listing A.10: Contents of `params-sf30.ini` used for scale factor 30

```
ldbc.snb.datagen.generator.scaleFactor:snb.interactive.30
ldbc.snb.datagen.serializer.numUpdatePartitions:48

ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.activity.CsvCompositeDynamicActivitySerializer
ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.CsvCompositeDynamicPersonSerializer
ldbc.snb.datagen.serializer.staticSerializer:ldbc.snb.datagen.serializer.snb.csv.staticserializer.CsvCompositeStaticSerializer
```

Listing A.11: Contents of `params-sf100.ini` used for scale factor 100

```
ldbc.snb.datagen.generator.scaleFactor:snb.interactive.100
ldbc.snb.datagen.serializer.numUpdatePartitions:48

ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.activity.CsvCompositeDynamicActivitySerializer
ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.CsvCompositeDynamicPersonSerializer
ldbc.snb.datagen.serializer.staticSerializer:ldbc.snb.datagen.serializer.snb.csv.staticserializer.CsvCompositeStaticSerializer
```

Listing A.12: Contents of `params-sf300.ini` used for scale factor 300

```
ldbc.snb.datagen.generator.scaleFactor:snb.interactive.300
ldbc.snb.datagen.serializer.numUpdatePartitions:48

ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.activity.CsvCompositeDynamicActivitySerializer
ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.CsvCompositeDynamicPersonSerializer
ldbc.snb.datagen.serializer.staticSerializer:ldbc.snb.datagen.serializer.snb.csv.staticserializer.CsvCompositeStaticSerializer
```

A.8 Load configuration

Listing A.13: Contents of `bulkload.yaml` describing how to import the dataset

```
graph: ldbc_snb
loading_config:
  data_source:
    scheme: file
    location: {PATH_TO_DATASET}
  import_option: init # append, overwrite, only init is supported now
  format:
    type: csv
    metadata:
      delimiter: "|"  # other loading configuration places here
vertex_mappings:
  - type_name: PLACE
    inputs:
      - static/place_0_0.csv
```

```
  - type_name: PERSON
    inputs:
      - dynamic/person_0_0.csv
  - type_name: COMMENT
    inputs:
      - dynamic/comment_0_0.csv.rod
  - type_name: POST
    inputs:
      - dynamic/post_0_0.csv.rod
  - type_name: FORUM
    inputs:
      - dynamic/forum_0_0.csv
  - type_name: ORGANISATION
    inputs:
      - static/organisation_0_0.csv
  - type_name: TAGCLASS
    inputs:
      - static/tagclass_0_0.csv
  - type_name: TAG
    inputs:
      - static/tag_0_0.csv
edge_mappings:
  - type_triplet:
      edge: HASCREATOR
      source_vertex: COMMENT
      destination_vertex: PERSON
    inputs:
      - dynamic/comment_hasCreator_person_0_0.csv.creation_date
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
    column_mappings:
      - column:
          index: 2
          name: creationDate
        property: creationDate
  - type_triplet:
      edge: HASCREATOR
      source_vertex: POST
      destination_vertex: PERSON
    inputs:
      - dynamic/post_hasCreator_person_0_0.csv.creation_date
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
    column_mappings:
      - column:
          index: 2
```

```
        name: creationDate
      property: creationDate
- type_triplet:
    edge: HASTAG
    source_vertex: POST
    destination_vertex: TAG
  inputs:
    - dynamic/post_hasTag_tag_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: REPLYOF
    source_vertex: COMMENT
    destination_vertex: COMMENT
  inputs:
    - dynamic/comment_replyOf_comment_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: REPLYOF
    source_vertex: COMMENT
    destination_vertex: POST
  inputs:
    - dynamic/comment_replyOf_post_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: CONTAINEROF
    source_vertex: FORUM
    destination_vertex: POST
  inputs:
    - dynamic/forum_containerOf_post_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
```

```
- type_triplet:
    edge: HASMEMBER
    source_vertex: FORUM
    destination_vertex: PERSON
  inputs:
    - dynamic/forum_hasMember_person_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: HASMODERATOR
    source_vertex: FORUM
    destination_vertex: PERSON
  inputs:
    - dynamic/forum_hasModerator_person_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: HASINTEREST
    source_vertex: PERSON
    destination_vertex: TAG
  inputs:
    - dynamic/person_hasInterest_tag_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: ISLOCATEDIN
    source_vertex: COMMENT
    destination_vertex: PLACE
  inputs:
    - dynamic/comment_isLocatedIn_place_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: ISLOCATEDIN
```

```
    source_vertex: PERSON
    destination_vertex: PLACE
  inputs:
    - dynamic/person_isLocatedIn_place_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: ISLOCATEDIN
    source_vertex: POST
    destination_vertex: PLACE
  inputs:
    - dynamic/post_isLocatedIn_place_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: ISLOCATEDIN
    source_vertex: ORGANISATION
    destination_vertex: PLACE
  inputs:
    - static/organisation_isLocatedIn_place_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: KNOWS
    source_vertex: PERSON
    destination_vertex: PERSON
  inputs:
    - dynamic/person_knows_person_0_0.csv
  source_vertex_mappings:
    - column:
        index: 0
        name: id
  destination_vertex_mappings:
    - column:
        index: 1
        name: id
- type_triplet:
    edge: LIKES
    source_vertex: PERSON
    destination_vertex: COMMENT
```

```
    inputs:
      - dynamic/person_likes_comment_0_0.csv
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
    column_mappings:
      - column:
          index: 2
          name: creationDate
        property: creationDate
  - type_triplet:
      edge: LIKES
      source_vertex: PERSON
      destination_vertex: POST
    inputs:
      - dynamic/person_likes_post_0_0.csv
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
    column_mappings:
      - column:
          index: 2
          name: creationDate
        property: creationDate
  - type_triplet:
      edge: WORKAT
      source_vertex: PERSON
      destination_vertex: ORGANISATION
    inputs:
      - dynamic/person_workAt_organisation_0_0.csv
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
    column_mappings:
      - column:
          index: 2
          name: workFrom
        property: workFrom
  - type_triplet:
      edge: ISPARTOF
      source_vertex: PLACE
      destination_vertex: PLACE
    inputs:
```

```
      - static/place_isPartOf_place_0_0.csv
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
  - type_triplet:
      edge: HASTYPE
      source_vertex: TAG
      destination_vertex: TAGCLASS
    inputs:
      - static/tag_hasType_tagclass_0_0.csv
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
  - type_triplet:
      edge: ISSUBCLASSOF
      source_vertex: TAGCLASS
      destination_vertex: TAGCLASS
    inputs:
      - static/tagclass_isSubclassOf_tagclass_0_0.csv
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
  - type_triplet:
      edge: STUDYAT
      source_vertex: PERSON
      destination_vertex: ORGANISATION
    inputs:
      - dynamic/person_studyAt_organisation_0_0.csv
    source_vertex_mappings:
      - column:
          index: 0
          name: id
    destination_vertex_mappings:
      - column:
          index: 1
          name: id
    column_mappings:
      - column:
          index: 2
          name: classYear
        property: classYear
```

Listing A.14: Contents of `graph.yaml` describing the data schema

```yaml
name: ldbc_snb
store_type: mutable_csr
schema:
  vertex_types:
    - type_id: 0
      type_name: PLACE
      properties:
        - property_id: 0
          property_name: id
          property_type:
            primitive_type: DT_SIGNED_INT64
        - property_id: 1
          property_name: name
          property_type:
            string:
              var_char:
                max_length: 256
        - property_id: 2
          property_name: url
          property_type:
            string:
              var_char:
                max_length: 256
        - property_id: 3
          property_name: type
          property_type:
            string:
              var_char:
                max_length: 32
      primary_keys:
        - id
    - type_id: 1
      type_name: PERSON
      properties:
        - property_id: 0
          property_name: id
          property_type:
            primitive_type: DT_SIGNED_INT64
        - property_id: 1
          property_name: firstName
          property_type:
            string:
              var_char:
                max_length: 80
        - property_id: 2
          property_name: lastName
          property_type:
            string:
              var_char:
                max_length: 80
        - property_id: 3
          property_name: gender
          property_type:
            string:
              var_char:
                max_length: 80
```

```
      - property_id: 4
        property_name: birthday
        property_type:
          temporal:
            date32:
      - property_id: 5
        property_name: creationDate
        property_type:
          temporal:
            timestamp:
      - property_id: 6
        property_name: locationIP
        property_type:
          string:
            var_char:
              max_length: 80
      - property_id: 7
        property_name: browserUsed
        property_type:
          string:
            var_char:
              max_length: 80
      - property_id: 8
        property_name: language
        property_type:
          string:
            var_char:
              max_length: 256
      - property_id: 9
        property_name: email
        property_type:
          string:
            var_char:
              max_length: 2144
    primary_keys:
      - id
  - type_id: 2
    type_name: COMMENT
    properties:
      - property_id: 0
        property_name: id
        property_type:
          primitive_type: DT_SIGNED_INT64
      - property_id: 1
        property_name: creationDate
        property_type:
          temporal:
            timestamp:
      - property_id: 2
        property_name: locationIP
        property_type:
          string:
            var_char:
              max_length: 80
      - property_id: 3
        property_name: browserUsed
        property_type:
          string:
```

```
            var_char:
              max_length: 80
      - property_id: 4
        property_name: content
        property_type:
          string:
            var_char:
              max_length: 2144
      - property_id: 5
        property_name: length
        property_type:
          primitive_type: DT_SIGNED_INT32
    primary_keys:
      - id
  - type_id: 3
    type_name: POST
    properties:
      - property_id: 0
        property_name: id
        property_type:
          primitive_type: DT_SIGNED_INT64
      - property_id: 1
        property_name: imageFile
        property_type:
          string:
            var_char:
              max_length: 80
      - property_id: 2
        property_name: creationDate
        property_type:
          temporal:
            timestamp:
      - property_id: 3
        property_name: locationIP
        property_type:
          string:
            var_char:
              max_length: 80
      - property_id: 4
        property_name: browserUsed
        property_type:
         string:
            var_char:
              max_length: 80
      - property_id: 5
        property_name: language
        property_type:
          string:
            var_char:
              max_length: 80
      - property_id: 6
        property_name: content
        property_type:
          string:
            var_char:
              max_length: 2144
      - property_id: 7
        property_name: length
```

```
        property_type:
          primitive_type: DT_SIGNED_INT32
    primary_keys:
      - id
  - type_id: 4
    type_name: FORUM
    properties:
      - property_id: 0
        property_name: id
        property_type:
          primitive_type: DT_SIGNED_INT64
      - property_id: 1
        property_name: title
        property_type:
          string:
            var_char:
              max_length: 256
      - property_id: 2
        property_name: creationDate
        property_type:
          temporal:
            timestamp:
    primary_keys:
      - id
  - type_id: 5
    type_name: ORGANISATION
    properties:
      - property_id: 0
        property_name: id
        property_type:
          primitive_type: DT_SIGNED_INT64
      - property_id: 1
        property_name: type
        property_type:
          string:
            var_char:
              max_length: 32
      - property_id: 2
        property_name: name
        property_type:
          string:
            var_char:
              max_length: 256
      - property_id: 3
        property_name: url
        property_type:
          string:
            var_char:
              max_length: 256
    primary_keys:
      - id
  - type_id: 6
    type_name: TAGCLASS
    properties:
      - property_id: 0
        property_name: id
        property_type:
          primitive_type: DT_SIGNED_INT64
```

```
      - property_id: 1
        property_name: name
        property_type:
          string:
            var_char:
              max_length: 256
      - property_id: 2
        property_name: url
        property_type:
          string:
            var_char:
              max_length: 256
    primary_keys:
      - id
  - type_id: 7
    type_name: TAG
    properties:
      - property_id: 0
        property_name: id
        property_type:
          primitive_type: DT_SIGNED_INT64
      - property_id: 1
        property_name: name
        property_type:
          string:
            var_char:
              max_length: 256
      - property_id: 2
        property_name: url
        property_type:
          string:
            var_char:
              max_length: 256
    primary_keys:
      - id
edge_types:
  - type_id: 0
    type_name: HASCREATOR
    vertex_type_pair_relations:
      - source_vertex: COMMENT
        destination_vertex: PERSON
        relation: MANY_TO_MANY
        x_csr_params:
            sort_on_compaction: TRUE
      - source_vertex: POST
        destination_vertex: PERSON
        relation: MANY_TO_MANY
        x_csr_params:
            sort_on_compaction: TRUE
    properties:
      - property_id: 0
        property_name: creationDate
        property_type:
          temporal:
            timestamp:
  - type_id: 1
    type_name: HASTAG
    vertex_type_pair_relations:
```

```
      - source_vertex: POST
        destination_vertex: TAG
        relation: MANY_TO_MANY
      - source_vertex: FORUM
        destination_vertex: TAG
        relation: MANY_TO_MANY
      - source_vertex: COMMENT
        destination_vertex: TAG
        relation: MANY_TO_MANY
  - type_id: 2
    type_name: REPLYOF
    vertex_type_pair_relations:
      - source_vertex: COMMENT
        destination_vertex: COMMENT
        relation: MANY_TO_MANY
      - source_vertex: COMMENT
        destination_vertex: POST
        relation: MANY_TO_MANY
  - type_id: 3
    type_name: CONTAINEROF
    vertex_type_pair_relations:
      - source_vertex: FORUM
        destination_vertex: POST
        relation: MANY_TO_MANY
  - type_id: 4
    type_name: HASMEMBER
    vertex_type_pair_relations:
      - source_vertex: FORUM
        destination_vertex: PERSON
        relation: MANY_TO_MANY
        x_csr_params:
            sort_on_compaction: TRUE
    properties:
      - property_id: 0
        property_name: joinDate
        property_type:
          temporal:
            timestamp:
  - type_id: 5
    type_name: HASMODERATOR
    vertex_type_pair_relations:
      - source_vertex: FORUM
        destination_vertex: PERSON
        relation: MANY_TO_MANY
  - type_id: 6
    type_name: HASINTEREST
    vertex_type_pair_relations:
      - source_vertex: PERSON
        destination_vertex: TAG
        relation: MANY_TO_MANY
  - type_id: 7
    type_name: ISLOCATEDIN
    vertex_type_pair_relations:
      - source_vertex: COMMENT
        destination_vertex: PLACE
        relation: MANY_TO_MANY
      - source_vertex: PERSON
        destination_vertex: PLACE
```

```
        relation: MANY_TO_MANY
      - source_vertex: POST
        destination_vertex: PLACE
        relation: MANY_TO_MANY
      - source_vertex: ORGANISATION
        destination_vertex: PLACE
        relation: MANY_TO_MANY
  - type_id: 8
    type_name: KNOWS
    vertex_type_pair_relations:
      - source_vertex: PERSON
        destination_vertex: PERSON
        relation: MANY_TO_MANY
    properties:
      - property_id: 0
        property_name: creationDate
        property_type:
          temporal:
            timestamp:
  - type_id: 9
    type_name: LIKES
    vertex_type_pair_relations:
      - source_vertex: PERSON
        destination_vertex: COMMENT
        relation: MANY_TO_MANY
      - source_vertex: PERSON
        destination_vertex: POST
        relation: MANY_TO_MANY
    properties:
      - property_id: 0
        property_name: creationDate
        property_type:
          temporal:
            timestamp:
  - type_id: 10
    type_name: WORKAT
    vertex_type_pair_relations:
      - source_vertex: PERSON
        destination_vertex: ORGANISATION
        relation: MANY_TO_MANY
    properties:
      - property_id: 0
        property_name: workFrom
        property_type:
          primitive_type: DT_SIGNED_INT32
  - type_id: 11
    type_name: ISPARTOF
    vertex_type_pair_relations:
      - source_vertex: PLACE
        destination_vertex: PLACE
        relation: MANY_TO_MANY
  - type_id: 12
    type_name: HASTYPE
    vertex_type_pair_relations:
      - source_vertex: TAG
        destination_vertex: TAGCLASS
        relation: MANY_TO_MANY
  - type_id: 13
```

```
405       type_name: ISSUBCLASSOF
406       vertex_type_pair_relations:
407         - source_vertex: TAGCLASS
408           destination_vertex: TAGCLASS
409           relation: MANY_TO_MANY
410     - type_id: 14
411       type_name: STUDYAT
412       vertex_type_pair_relations:
413         - source_vertex: PERSON
414           destination_vertex: ORGANISATION
415           relation: MANY_TO_MANY
416       properties:
417         - property_id: 0
418           property_name: classYear
419           property_type:
420             primitive_type: DT_SIGNED_INT32
```

A.9 Benchmark configuration

Listing A.15: Contents of `benchmark-sf30.properties` used for scale factor 30

```
url={SERVER}

printQueryNames=false
printQueryStrings=false
printQueryResults=false

status=1
thread_count=192
name=LDBC-SNB
mode=execute_benchmark
results_log=true
status=1
time_unit=MICROSECONDS
time_compression_ratio=0.001
peer_identifiers=
workload_statistics=false
spinner_wait_duration=1
help=false
ignore_scheduled_start_times=false

workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb


queryDir={FLEX_SNB_FOLDER}/queries/
ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
ldbc.snb.interactive.short_read_dissipation=0.2
# Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
ldbc.snb.interactive.scale_factor=30
operation_count=272000000
warmup=64000000

ldbc.snb.interactive.LdbcQuery1_enable=true
ldbc.snb.interactive.LdbcQuery2_enable=true
ldbc.snb.interactive.LdbcQuery3_enable=true
ldbc.snb.interactive.LdbcQuery4_enable=true
ldbc.snb.interactive.LdbcQuery5_enable=true
ldbc.snb.interactive.LdbcQuery6_enable=true
ldbc.snb.interactive.LdbcQuery7_enable=true
ldbc.snb.interactive.LdbcQuery8_enable=true
ldbc.snb.interactive.LdbcQuery9_enable=true
ldbc.snb.interactive.LdbcQuery10_enable=true
ldbc.snb.interactive.LdbcQuery11_enable=true
ldbc.snb.interactive.LdbcQuery12_enable=true
ldbc.snb.interactive.LdbcQuery13_enable=true
ldbc.snb.interactive.LdbcQuery14_enable=true

ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
```

```
ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true

ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```

Listing A.16: Contents of `benchmark-sf100.properties` used for scale factor 100

```
url={SERVER}

printQueryNames=false
printQueryStrings=false
printQueryResults=false

status=1
thread_count=192
name=LDBC-SNB
mode=execute_benchmark
results_log=true
time_unit=MICROSECONDS
time_compression_ratio=0.0016
peer_identifiers=
workload_statistics=false
spinner_wait_duration=1
help=false
ignore_scheduled_start_times=false

workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb


queryDir={FLEX_SNB_FOLDER}/queries/
ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
ldbc.snb.interactive.short_read_dissipation=0.2
# Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
ldbc.snb.interactive.scale_factor=100
operation_count=579000000
warmup=152000000

ldbc.snb.interactive.LdbcQuery1_enable=true
ldbc.snb.interactive.LdbcQuery2_enable=true
ldbc.snb.interactive.LdbcQuery3_enable=true
ldbc.snb.interactive.LdbcQuery4_enable=true
ldbc.snb.interactive.LdbcQuery5_enable=true
ldbc.snb.interactive.LdbcQuery6_enable=true
ldbc.snb.interactive.LdbcQuery7_enable=true
ldbc.snb.interactive.LdbcQuery8_enable=true
ldbc.snb.interactive.LdbcQuery9_enable=true
ldbc.snb.interactive.LdbcQuery10_enable=true
ldbc.snb.interactive.LdbcQuery11_enable=true
ldbc.snb.interactive.LdbcQuery12_enable=true
ldbc.snb.interactive.LdbcQuery13_enable=true
ldbc.snb.interactive.LdbcQuery14_enable=true

ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true

ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
```

```
ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```

Listing A.17: Contents of `benchmark-sf300.properties` used for scale factor 300

```
url={SERVER}

printQueryNames=false
printQueryStrings=false
printQueryResults=false

status=1
thread_count=192
name=LDBC-SNB
mode=execute_benchmark
results_log=true
time_unit=MICROSECONDS
time_compression_ratio=0.0054

peer_identifiers=
workload_statistics=false
spinner_wait_duration=1
help=false
ignore_scheduled_start_times=false


workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb

queryDir={FLEX_SNB_FOLDER}/queries/
ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
ldbc.snb.interactive.short_read_dissipation=0.2
# Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
ldbc.snb.interactive.scale_factor=300
operation_count=591800000
warmup=155400000

ldbc.snb.interactive.LdbcQuery1_enable=true
ldbc.snb.interactive.LdbcQuery2_enable=true
ldbc.snb.interactive.LdbcQuery3_enable=true
ldbc.snb.interactive.LdbcQuery4_enable=true
ldbc.snb.interactive.LdbcQuery5_enable=true
ldbc.snb.interactive.LdbcQuery6_enable=true
ldbc.snb.interactive.LdbcQuery7_enable=true
ldbc.snb.interactive.LdbcQuery8_enable=true
ldbc.snb.interactive.LdbcQuery9_enable=true
ldbc.snb.interactive.LdbcQuery10_enable=true
ldbc.snb.interactive.LdbcQuery11_enable=true
ldbc.snb.interactive.LdbcQuery12_enable=true
ldbc.snb.interactive.LdbcQuery13_enable=true
ldbc.snb.interactive.LdbcQuery14_enable=true

ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true

```

```
57
58 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
59 ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
60 ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
61 ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
62 ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
63 ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
64 ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
65 ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```

A.10 Validation configuration

Listing A.18: The contents of `validate.properties`

```
url={SERVER}
readTimeout=5000000
connectTimeout=5000000
connectPoolMaxIdle=10
keepAliveDuration=5000
maxRequestsPerHost=180
maxRequests=180

printQueryNames=false
printQueryStrings=false
printQueryResults=false

status=1
thread_count=1
mode=validate_database
name=LDBC-SNB
results_log=false
time_unit=MILLISECONDS
time_compression_ratio=0.001
peer_identifiers=
workload_statistics=false
spinner_wait_duration=0
help=false
ignore_scheduled_start_times=true

workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb

operation_count=10000

queryDir={FLEX_SNB_FOLDER}/queries/
validate_database={VALIDATION_PARAMS}
ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
# Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
ldbc.snb.interactive.scale_factor=0.1
ldbc.snb.interactive.short_read_dissipation=0.2

ldbc.snb.interactive.LdbcQuery1_freq=1
ldbc.snb.interactive.LdbcQuery2_freq=1
ldbc.snb.interactive.LdbcQuery3_freq=1
ldbc.snb.interactive.LdbcQuery4_freq=1
ldbc.snb.interactive.LdbcQuery5_freq=1
ldbc.snb.interactive.LdbcQuery6_freq=1
ldbc.snb.interactive.LdbcQuery7_freq=1
ldbc.snb.interactive.LdbcQuery8_freq=1
ldbc.snb.interactive.LdbcQuery9_freq=1
ldbc.snb.interactive.LdbcQuery10_freq=1
ldbc.snb.interactive.LdbcQuery11_freq=1
ldbc.snb.interactive.LdbcQuery12_freq=1
ldbc.snb.interactive.LdbcQuery13_freq=1
ldbc.snb.interactive.LdbcQuery14_freq=1

ldbc.snb.interactive.LdbcQuery1_enable=true
ldbc.snb.interactive.LdbcQuery2_enable=true
```

```
ldbc.snb.interactive.LdbcQuery3_enable=true
ldbc.snb.interactive.LdbcQuery4_enable=true
ldbc.snb.interactive.LdbcQuery5_enable=true
ldbc.snb.interactive.LdbcQuery6_enable=true
ldbc.snb.interactive.LdbcQuery7_enable=true
ldbc.snb.interactive.LdbcQuery8_enable=true
ldbc.snb.interactive.LdbcQuery9_enable=true
ldbc.snb.interactive.LdbcQuery10_enable=true
ldbc.snb.interactive.LdbcQuery11_enable=true
ldbc.snb.interactive.LdbcQuery12_enable=true
ldbc.snb.interactive.LdbcQuery13_enable=true
ldbc.snb.interactive.LdbcQuery14_enable=true

ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true

ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```