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## **Full Disclosure Report of the LDBC Social Network Benchmark**

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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<sup>1</sup> 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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<sup>1</sup><https://github.com/alibaba/GraphScope/tree/main/flex>



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## System Description and Pricing Summary

# 1 SYSTEM DESCRIPTION AND PRICING SUMMARY

## 1.1 Details of machines driving and running the workload

### 1.1.1 Machine overview

The 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" » /etc/sysctl.conf && sysctl -p /etc/sysctl.conf
```

Also, for SF30, SF100 and SF300 hugepages<sup>1</sup> are enabled with: `echo "vm.nr_hugepages=229376" » /etc/sysctl.conf && sysctl -p /etc/sysctl.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.

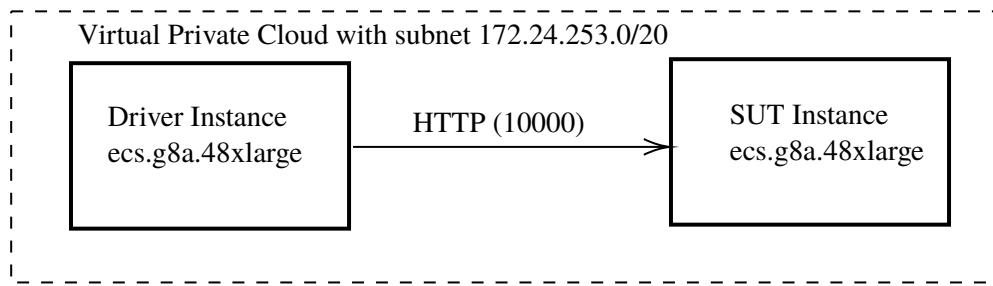


Figure 1.1: Overview of benchmark setup

### 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

<sup>1</sup><https://www.kernel.org/doc/html/latest/admin-guide/mm/hugetlbpage.html>

## System Description and Pricing Summary

### 1.1. Details of machines driving and running the workload

#### 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
<b>Total cost of ownership</b>	<b>808 444.48 RMB</b>

### 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<sup>2</sup>.

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<sup>2</sup>[https://github.com/alibaba/GraphScope/releases/download/v0.31.0/graphscope\\_flex\\_0.31.3\\_amd64.deb](https://github.com/alibaba/GraphScope/releases/download/v0.31.0/graphscope_flex_0.31.3_amd64.deb)



## Dataset Generation

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## 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 were downloaded from LDBC GitHub<sup>1</sup>, 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 latter contains the schema definition.

<sup>1</sup>[https://datasets.ldbcouncil.org/interactive-v1/validation\\_params-interactive-v1.0.0-sf0.1-to-sf10.tar.zst](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

## Test Driver Details

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### 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	<a href="https://github.com/ldbc/ldbc_snb_interactive_driver/releases/tag/v1.2.0">https://github.com/ldbc/ldbc_snb_interactive_driver/releases/tag/v1.2.0</a>
Implementations version	v1.0.0	<a href="https://github.com/ldbc/ldbc_snb_interactive_implementations/releases/tag/v1.0.0">https://github.com/ldbc/ldbc_snb_interactive_implementations/releases/tag/v1.0.0</a>
LDBC SNB specification version	v2.2.4	<a href="https://arxiv.org/pdf/2001.02299.pdf">https://arxiv.org/pdf/2001.02299.pdf</a>
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.ldbcouncil.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.

## Performance Metrics

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### 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%<sup>1</sup>. 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 operations 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 operations 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 operations 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 ( $\mu\text{s}$ ) precision. The notation  $P_i$  is used for the  $i^{\text{th}}$  percentile among all observed execution run times of a given query type.

<sup>1</sup>The total number of late operations for each run in the results in the attachment is referred to as excessive\_delay\_count.

## Performance Metrics

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

Query	Total count	Min.	Max.	Mean	P <sub>50</sub>	P <sub>90</sub>	P <sub>95</sub>	P <sub>99</sub>
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

## Performance Metrics

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Table 4.5: Detailed performance benchmark results for scale factor 100 in microseconds

Query	Total count	Min.	Max.	Mean	P <sub>50</sub>	P <sub>90</sub>	P <sub>95</sub>	P <sub>99</sub>
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

## Performance Metrics

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

Query	Total count	Min.	Max.	Mean	P <sub>50</sub>	P <sub>90</sub>	P <sub>95</sub>	P <sub>99</sub>
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

## Validation of the Results

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### 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<sup>1</sup>. 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.

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<sup>1</sup>[https://datasets.ldbcouncil.org/interactive-v1/validation\\_params-interactive-v1.0.0-sf0.1-to-sf10.tar.zst](https://datasets.ldbcouncil.org/interactive-v1/validation_params-interactive-v1.0.0-sf0.1-to-sf10.tar.zst)

## ACID Compliance

---

### 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.

## Supplementary Materials

---

### 7 SUPPLEMENTARY MATERIALS

The table below shows the list of supplementary materials. These materials are made available with this full disclosure report to allow reproducibility of results. 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_1dbc_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

## Appendix

---

### A APPENDIX

#### A.1 CPU details

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

```

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

```



## Appendix

### A.1. CPU details

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

## Appendix

### A.2. Memory details

#### A.2 Memory details

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

```

1  *--memory
2      description: System Memory
3          physical id: 1000
4          size: 768GiB
5          capabilities: ecc
6          configuration: errordetection=multi-bit-ecc
7  *--bank:0
8      description: DIMM RAM
9          vendor: Alibaba Cloud
10         physical id: 0
11         slot: DIMM 0
12         size: 16GiB
13  *--bank:1
14      description: DIMM RAM
15          vendor: Alibaba Cloud
16         physical id: 1
17         slot: DIMM 1
18         size: 16GiB
19  *--bank:2
20      description: DIMM RAM
21          vendor: Alibaba Cloud
22         physical id: 2
23         slot: DIMM 2
24         size: 16GiB
25  *--bank:3
26      description: DIMM RAM
27          vendor: Alibaba Cloud
28         physical id: 3
29         slot: DIMM 3
30         size: 16GiB
31  *--bank:4
32      description: DIMM RAM
33          vendor: Alibaba Cloud
34         physical id: 4
35         slot: DIMM 4
36         size: 16GiB
37  *--bank:5
38      description: DIMM RAM
39          vendor: Alibaba Cloud
40         physical id: 5
41         slot: DIMM 5
42         size: 16GiB
43  *--bank:6
44      description: DIMM RAM
45          vendor: Alibaba Cloud
46         physical id: 6
47         slot: DIMM 6
48         size: 16GiB
49  *--bank:7
50      description: DIMM RAM
51          vendor: Alibaba Cloud
52         physical id: 7
53         slot: DIMM 7
54         size: 16GiB

```

## Appendix

### A.2. Memory details

```

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

```

## Appendix

### A.2. Memory details

```
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
```

## Appendix

### A.2. Memory details

```
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
```

## Appendix

### A.2. Memory details

```

229    *--bank:37
230        description: DIMM RAM
231        vendor: Alibaba Cloud
232        physical id: 25
233        slot: DIMM 37
234        size: 16GiB
235    *--bank:38
236        description: DIMM RAM
237        vendor: Alibaba Cloud
238        physical id: 26
239        slot: DIMM 38
240        size: 16GiB
241    *--bank:39
242        description: DIMM RAM
243        vendor: Alibaba Cloud
244        physical id: 27
245        slot: DIMM 39
246        size: 16GiB
247    *--bank:40
248        description: DIMM RAM
249        vendor: Alibaba Cloud
250        physical id: 28
251        slot: DIMM 40
252        size: 16GiB
253    *--bank:41
254        description: DIMM RAM
255        vendor: Alibaba Cloud
256        physical id: 29
257        slot: DIMM 41
258        size: 16GiB
259    *--bank:42
260        description: DIMM RAM
261        vendor: Alibaba Cloud
262        physical id: 2a
263        slot: DIMM 42
264        size: 16GiB
265    *--bank:43
266        description: DIMM RAM
267        vendor: Alibaba Cloud
268        physical id: 2b
269        slot: DIMM 43
270        size: 16GiB
271    *--bank:44
272        description: DIMM RAM
273        vendor: Alibaba Cloud
274        physical id: 2c
275        slot: DIMM 44
276        size: 16GiB
277    *--bank:45
278        description: DIMM RAM
279        vendor: Alibaba Cloud
280        physical id: 2d
281        slot: DIMM 45
282        size: 16GiB
283    *--bank:46
284        description: DIMM RAM
285        vendor: Alibaba Cloud
286        physical id: 2e

```



## Appendix

### A.2. Memory details

```
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
```

## Appendix

### A.2. Memory details

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

```

1 sysbench memory --memory-lock-size=1G --memory-total-size=16384G --memory-oper=read --threads=92 run
2 sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)
3
4 Running the test with following options:
5 Number of threads: 92
6 Initializing random number generator from current time
7
8
9 Running memory speed test with the following options:
10 block size: 1048576KiB
11 total size: 16777216MiB
12 operation: read
13 scope: global
14
15 Initializing worker threads...
16
17 Threads started!
18
19 Total operations: 13547 ( 1347.60 per second)
20
21 13872128.00 MiB transferred (1379946.65 MiB/sec)
22
23
24 General statistics:
25     total time:          10.0521s
26     total number of events: 13547
27
28 Latency (ms):
29         min:            49.14
30         avg:            68.08
31         max:            264.88
32         95th percentile: 102.97
33         sum:           922303.55
34
35 Threads fairness:
36     events (avg/stddev): 147.2500/18.42
37     execution time (avg/stddev): 10.0250/0.02b

```

## Appendix

### A.2. Memory details

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

```

1 sysbench memory --memory-lock-size=1G --memory-total-size=16384G --memory-oper=write --threads=92 run
2 sysbench 1.0.18 (using system LuaJIT 2.1.0-beta3)
3
4 Running the test with following options:
5 Number of threads: 92
6 Initializing random number generator from current time
7
8
9 Running memory speed test with the following options:
10 block size: 1048576KiB
11 total size: 16777216MiB
12 operation: write
13 scope: global
14
15 Initializing worker threads...
16
17 Threads started!
18
19 Total operations: 3100 ( 305.29 per second)
20
21 3174400.00 MiB transferred (312619.18 MiB/sec)
22
23
24 General statistics:
25     total time:          10.1536s
26     total number of events: 3100
27
28 Latency (ms):
29         min:           101.88
30         avg:            299.87
31         max:            506.44
32         95th percentile: 369.77
33         sum:           929601.52
34
35 Threads fairness:
36     events (avg/stddev): 33.6957/1.21
37     execution time (avg/stddev): 10.1044/0.04b

```

## Appendix

### A.3. Disk details

#### A.3 Disk details

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

```

1 lsblk
2 NAME      MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
3 nvme0n1    259:0   0   40G  0 disk
4   -nvme0n1p1 259:1   0   1M  0 part
5     -nvme0n1p2 259:2   0  191M  0 part /boot/efi
6     -nvme0n1p3 259:3   0 39.8G  0 part /
7 nvme1n1    259:4   0   4T  0 disk /data
8
9 -----
10 sudo parted -l
11 Model: Alibaba Cloud Elastic Block Storage (nvme)
12 Disk /dev/nvme0n1: 42.9GB
13 Sector size (logical/physical): 512B/512B
14 Partition Table: gpt
15 Disk Flags:
16
17 Number  Start   End     Size   File system  Name  Flags
18   1      1049kB 2097kB  1049kB          bios_grub
19   2      2097kB  202MB   200MB    fat32        boot, esp
20   3      202MB   42.9GB  42.7GB   ext4
21
22
23 Model: Alibaba Cloud Elastic Block Storage (nvme)
24 Disk /dev/nvme1n1: 4398GB
25 Sector size (logical/physical): 512B/512B
26 Partition Table: loop
27 Disk Flags:
28
29 Number  Start   End     Size   File system  Flags
30   1      0.00B  4398GB  4398GB  xfs

```

## Appendix

### A.4. Network details

#### A.4 Network details

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

```

1 lshw -class network
2 *--network
3     description: Ethernet controller
4     product: Virtio network device
5     vendor: Red Hat, Inc.
6     physical id: 5
7     bus info: pci@0000:00:05.0
8     version: 00
9     width: 64 bits
10    clock: 33MHz
11    capabilities: msix bus_master cap_list
12    configuration: driver=virtio-pci latency=0
13    resources: irq:0 memory:cc402000-cc402fff memory:cc408000-cc40bfff
14 *--virtio1
15     description: Ethernet interface
16     physical id: 0
17     bus info: virtio@1
18     logical name: eth0
19     serial: 00:16:3e:07:ae:29
20     capabilities: ethernet physical
21     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 brevity. First sum is from client to server, second sum from server to client.

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

```

1 -----
2 Client connecting to 172.24.253.92, TCP port 10000
3 TCP window size: 289 KByte (default)
4 -----
5 [ 66] local 172.24.253.93 port 47566 connected with 172.24.253.92 port 10000
6 [ 61] local 172.24.253.93 port 47512 connected with 172.24.253.92 port 10000
7 [ 64] local 172.24.253.93 port 47556 connected with 172.24.253.92 port 10000
8 [ 56] local 172.24.253.93 port 47476 connected with 172.24.253.92 port 10000
9 [ 6] local 172.24.253.93 port 47034 connected with 172.24.253.92 port 10000
10 [ 65] local 172.24.253.93 port 47544 connected with 172.24.253.92 port 10000
11 [ 62] local 172.24.253.93 port 47536 connected with 172.24.253.92 port 10000
12 [ 58] local 172.24.253.93 port 47488 connected with 172.24.253.92 port 10000
13 [ 3] local 172.24.253.93 port 47002 connected with 172.24.253.92 port 10000
14 [ 9] local 172.24.253.93 port 47046 connected with 172.24.253.92 port 10000
15 [ 7] local 172.24.253.93 port 47054 connected with 172.24.253.92 port 10000
16 [ 5] local 172.24.253.93 port 47028 connected with 172.24.253.92 port 10000
17 [ 12] local 172.24.253.93 port 47074 connected with 172.24.253.92 port 10000
18 [ 10] local 172.24.253.93 port 47086 connected with 172.24.253.92 port 10000
19 [ 4] local 172.24.253.93 port 47016 connected with 172.24.253.92 port 10000
20 [ 16] local 172.24.253.93 port 47082 connected with 172.24.253.92 port 10000
21 [ 11] local 172.24.253.93 port 47064 connected with 172.24.253.92 port 10000
22 [ 8] local 172.24.253.93 port 47042 connected with 172.24.253.92 port 10000
23 [ 14] local 172.24.253.93 port 47102 connected with 172.24.253.92 port 10000

```

## Appendix

### A.5. Network performance

```

24 [ 15] local 172.24.253.93 port 47122 connected with 172.24.253.92 port 10000
25 [ 17] local 172.24.253.93 port 47134 connected with 172.24.253.92 port 10000
26 [ 19] local 172.24.253.93 port 47142 connected with 172.24.253.92 port 10000
27 [ 22] local 172.24.253.93 port 47176 connected with 172.24.253.92 port 10000
28 [ 18] local 172.24.253.93 port 47148 connected with 172.24.253.92 port 10000
29 [ 20] local 172.24.253.93 port 47154 connected with 172.24.253.92 port 10000
30 [ 21] local 172.24.253.93 port 47166 connected with 172.24.253.92 port 10000
31 [ 24] local 172.24.253.93 port 47198 connected with 172.24.253.92 port 10000
32 [ 26] local 172.24.253.93 port 47216 connected with 172.24.253.92 port 10000
33 [ 23] local 172.24.253.93 port 47202 connected with 172.24.253.92 port 10000
34 [ 27] local 172.24.253.93 port 47222 connected with 172.24.253.92 port 10000
35 [ 29] local 172.24.253.93 port 47228 connected with 172.24.253.92 port 10000
36 [ 28] local 172.24.253.93 port 47236 connected with 172.24.253.92 port 10000
37 [ 30] local 172.24.253.93 port 47242 connected with 172.24.253.92 port 10000
38 [ 31] local 172.24.253.93 port 47244 connected with 172.24.253.92 port 10000
39 [ 32] local 172.24.253.93 port 47258 connected with 172.24.253.92 port 10000
40 [ 33] local 172.24.253.93 port 47262 connected with 172.24.253.92 port 10000
41 [ 34] local 172.24.253.93 port 47278 connected with 172.24.253.92 port 10000
42 [ 35] local 172.24.253.93 port 47292 connected with 172.24.253.92 port 10000
43 [ 37] local 172.24.253.93 port 47302 connected with 172.24.253.92 port 10000
44 [ 38] local 172.24.253.93 port 47330 connected with 172.24.253.92 port 10000
45 [ 40] local 172.24.253.93 port 47332 connected with 172.24.253.92 port 10000
46 [ 36] local 172.24.253.93 port 47314 connected with 172.24.253.92 port 10000
47 [ 39] local 172.24.253.93 port 47334 connected with 172.24.253.92 port 10000
48 [ 42] local 172.24.253.93 port 47346 connected with 172.24.253.92 port 10000
49 [ 43] local 172.24.253.93 port 47348 connected with 172.24.253.92 port 10000
50 [ 45] local 172.24.253.93 port 47364 connected with 172.24.253.92 port 10000
51 [ 41] local 172.24.253.93 port 47366 connected with 172.24.253.92 port 10000
52 [ 44] local 172.24.253.93 port 47374 connected with 172.24.253.92 port 10000
53 [ 48] local 172.24.253.93 port 47388 connected with 172.24.253.92 port 10000
54 [ 46] local 172.24.253.93 port 47386 connected with 172.24.253.92 port 10000
55 [ 49] local 172.24.253.93 port 47396 connected with 172.24.253.92 port 10000
56 [ 47] local 172.24.253.93 port 47412 connected with 172.24.253.92 port 10000
57 [ 50] local 172.24.253.93 port 47420 connected with 172.24.253.92 port 10000
58 [ 51] local 172.24.253.93 port 47428 connected with 172.24.253.92 port 10000
59 [ 52] local 172.24.253.93 port 47424 connected with 172.24.253.92 port 10000
60 [ 53] local 172.24.253.93 port 47438 connected with 172.24.253.92 port 10000
61 [ 57] local 172.24.253.93 port 47452 connected with 172.24.253.92 port 10000
62 [ 60] local 172.24.253.93 port 47504 connected with 172.24.253.92 port 10000
63 [ 55] local 172.24.253.93 port 47462 connected with 172.24.253.92 port 10000
64 [ 63] local 172.24.253.93 port 47528 connected with 172.24.253.92 port 10000
65 [ 59] local 172.24.253.93 port 47498 connected with 172.24.253.92 port 10000
66 [ 54] local 172.24.253.93 port 47448 connected with 172.24.253.92 port 10000
67 [ 13] local 172.24.253.93 port 47116 connected with 172.24.253.92 port 10000
68 [ 25] local 172.24.253.93 port 47188 connected with 172.24.253.92 port 10000
69 [ ID] Interval Transfer Bandwidth
70 [ 61] 0.0- 5.0 sec 500 MBytes 840 Mbits/sec
71 [ 56] 0.0- 5.0 sec 701 MBytes 1.18 Gbits/sec
72 [ 6] 0.0- 5.0 sec 568 MBytes 954 Mbits/sec
73 [ 62] 0.0- 5.0 sec 566 MBytes 949 Mbits/sec
74 [ 3] 0.0- 5.0 sec 709 MBytes 1.19 Gbits/sec
75 [ 10] 0.0- 5.0 sec 807 MBytes 1.35 Gbits/sec
76 [ 14] 0.0- 5.0 sec 621 MBytes 1.04 Gbits/sec
77 [ 15] 0.0- 5.0 sec 540 MBytes 906 Mbits/sec
78 [ 19] 0.0- 5.0 sec 587 MBytes 984 Mbits/sec
79 [ 21] 0.0- 5.0 sec 687 MBytes 1.15 Gbits/sec
80 [ 26] 0.0- 5.0 sec 561 MBytes 941 Mbits/sec
81 [ 29] 0.0- 5.0 sec 574 MBytes 963 Mbits/sec

```

## Appendix

## A.5. Network performance

82	[ 28]	0.0- 5.0 sec	817 MBytes	1.37 Gbits/sec
83	[ 30]	0.0- 5.0 sec	490 MBytes	823 Mbits/sec
84	[ 31]	0.0- 5.0 sec	574 MBytes	962 Mbits/sec
85	[ 33]	0.0- 5.0 sec	402 MBytes	674 Mbits/sec
86	[ 35]	0.0- 5.0 sec	820 MBytes	1.38 Gbits/sec
87	[ 38]	0.0- 5.0 sec	661 MBytes	1.11 Gbits/sec
88	[ 40]	0.0- 5.0 sec	430 MBytes	722 Mbits/sec
89	[ 36]	0.0- 5.0 sec	557 MBytes	935 Mbits/sec
90	[ 39]	0.0- 5.0 sec	709 MBytes	1.19 Gbits/sec
91	[ 42]	0.0- 5.0 sec	460 MBytes	772 Mbits/sec
92	[ 43]	0.0- 5.0 sec	754 MBytes	1.27 Gbits/sec
93	[ 45]	0.0- 5.0 sec	570 MBytes	956 Mbits/sec
94	[ 51]	0.0- 5.0 sec	433 MBytes	727 Mbits/sec
95	[ 53]	0.0- 5.0 sec	560 MBytes	940 Mbits/sec
96	[ 57]	0.0- 5.0 sec	830 MBytes	1.39 Gbits/sec
97	[ 13]	0.0- 5.0 sec	594 MBytes	996 Mbits/sec
98	[ 25]	0.0- 5.0 sec	577 MBytes	968 Mbits/sec
99	[ 58]	0.0- 5.0 sec	802 MBytes	1.35 Gbits/sec
100	[ 12]	0.0- 5.0 sec	581 MBytes	975 Mbits/sec
101	[ 41]	0.0- 5.0 sec	382 MBytes	641 Mbits/sec
102	[ 52]	0.0- 5.0 sec	625 MBytes	1.05 Gbits/sec
103	[ 54]	0.0- 5.0 sec	785 MBytes	1.32 Gbits/sec
104	[ 65]	0.0- 5.0 sec	843 MBytes	1.41 Gbits/sec
105	[ 32]	0.0- 5.0 sec	312 MBytes	524 Mbits/sec
106	[ 37]	0.0- 5.0 sec	613 MBytes	1.03 Gbits/sec
107	[ 24]	0.0- 5.0 sec	470 MBytes	789 Mbits/sec
108	[ 34]	0.0- 5.0 sec	562 MBytes	943 Mbits/sec
109	[ 46]	0.0- 5.0 sec	428 MBytes	717 Mbits/sec
110	[ 50]	0.0- 5.0 sec	609 MBytes	1.02 Gbits/sec
111	[ 55]	0.0- 5.0 sec	471 MBytes	790 Mbits/sec
112	[ 66]	0.0- 5.0 sec	660 MBytes	1.11 Gbits/sec
113	[ 63]	0.0- 5.0 sec	566 MBytes	949 Mbits/sec
114	[ 7]	0.0- 5.0 sec	688 MBytes	1.15 Gbits/sec
115	[ 16]	0.0- 5.0 sec	471 MBytes	790 Mbits/sec
116	[ 44]	0.0- 5.0 sec	414 MBytes	695 Mbits/sec
117	[ 49]	0.0- 5.0 sec	697 MBytes	1.17 Gbits/sec
118	[ 59]	0.0- 5.0 sec	452 MBytes	759 Mbits/sec
119	[ 64]	0.0- 5.0 sec	730 MBytes	1.22 Gbits/sec
120	[ 9]	0.0- 5.0 sec	715 MBytes	1.20 Gbits/sec
121	[ 8]	0.0- 5.0 sec	588 MBytes	986 Mbits/sec
122	[ 48]	0.0- 5.0 sec	492 MBytes	825 Mbits/sec
123	[ 20]	0.0- 5.0 sec	496 MBytes	833 Mbits/sec
124	[ 23]	0.0- 5.0 sec	583 MBytes	978 Mbits/sec
125	[ 11]	0.0- 5.0 sec	583 MBytes	979 Mbits/sec
126	[ 27]	0.0- 5.0 sec	732 MBytes	1.23 Gbits/sec
127	[ 47]	0.0- 5.0 sec	657 MBytes	1.10 Gbits/sec
128	[ 5]	0.0- 5.0 sec	707 MBytes	1.19 Gbits/sec
129	[ 4]	0.0- 5.0 sec	679 MBytes	1.14 Gbits/sec
130	[ 22]	0.0- 5.0 sec	642 MBytes	1.08 Gbits/sec
131	[ 60]	0.0- 5.0 sec	635 MBytes	1.07 Gbits/sec
132	[ 17]	0.0- 5.0 sec	1.01 GBytes	1.73 Gbits/sec
133	[ 18]	0.0- 5.0 sec	730 MBytes	1.22 Gbits/sec
134	[SUM]	0.0- 5.0 sec	38.2 GBytes	65.6 Gbits/sec
135	[ 56]	5.0-10.0 sec	405 MBytes	680 Mbits/sec
136	[ 6]	5.0-10.0 sec	624 MBytes	1.05 Gbits/sec
137	[ 65]	5.0-10.0 sec	820 MBytes	1.38 Gbits/sec
138	[ 58]	5.0-10.0 sec	840 MBytes	1.41 Gbits/sec
139	[ 3]	5.0-10.0 sec	698 MBytes	1.17 Gbits/sec

## Appendix

## A.5. Network performance

140	[ 9]	5.0-10.0 sec	790 MBytes	1.33 Gbits/sec
141	[ 7]	5.0-10.0 sec	440 MBytes	738 Mbits/sec
142	[ 12]	5.0-10.0 sec	594 MBytes	996 Mbits/sec
143	[ 10]	5.0-10.0 sec	769 MBytes	1.29 Gbits/sec
144	[ 16]	5.0-10.0 sec	811 MBytes	1.36 Gbits/sec
145	[ 11]	5.0-10.0 sec	515 MBytes	864 Mbits/sec
146	[ 19]	5.0-10.0 sec	498 MBytes	835 Mbits/sec
147	[ 21]	5.0-10.0 sec	680 MBytes	1.14 Gbits/sec
148	[ 23]	5.0-10.0 sec	472 MBytes	791 Mbits/sec
149	[ 27]	5.0-10.0 sec	656 MBytes	1.10 Gbits/sec
150	[ 31]	5.0-10.0 sec	743 MBytes	1.25 Gbits/sec
151	[ 32]	5.0-10.0 sec	330 MBytes	554 Mbits/sec
152	[ 33]	5.0-10.0 sec	908 MBytes	1.52 Gbits/sec
153	[ 34]	5.0-10.0 sec	500 MBytes	839 Mbits/sec
154	[ 35]	5.0-10.0 sec	630 MBytes	1.06 Gbits/sec
155	[ 38]	5.0-10.0 sec	958 MBytes	1.61 Gbits/sec
156	[ 36]	5.0-10.0 sec	600 MBytes	1.01 Gbits/sec
157	[ 41]	5.0-10.0 sec	516 MBytes	865 Mbits/sec
158	[ 48]	5.0-10.0 sec	455 MBytes	763 Mbits/sec
159	[ 49]	5.0-10.0 sec	640 MBytes	1.07 Gbits/sec
160	[ 50]	5.0-10.0 sec	439 MBytes	736 Mbits/sec
161	[ 52]	5.0-10.0 sec	728 MBytes	1.22 Gbits/sec
162	[ 57]	5.0-10.0 sec	577 MBytes	968 Mbits/sec
163	[ 55]	5.0-10.0 sec	494 MBytes	829 Mbits/sec
164	[ 63]	5.0-10.0 sec	489 MBytes	821 Mbits/sec
165	[ 54]	5.0-10.0 sec	719 MBytes	1.21 Gbits/sec
166	[ 13]	5.0-10.0 sec	524 MBytes	879 Mbits/sec
167	[ 24]	5.0-10.0 sec	485 MBytes	813 Mbits/sec
168	[ 45]	5.0-10.0 sec	669 MBytes	1.12 Gbits/sec
169	[ 44]	5.0-10.0 sec	434 MBytes	727 Mbits/sec
170	[ 8]	5.0-10.0 sec	492 MBytes	826 Mbits/sec
171	[ 28]	5.0-10.0 sec	705 MBytes	1.18 Gbits/sec
172	[ 53]	5.0-10.0 sec	338 MBytes	568 Mbits/sec
173	[ 66]	5.0-10.0 sec	472 MBytes	793 Mbits/sec
174	[ 64]	5.0-10.0 sec	910 MBytes	1.53 Gbits/sec
175	[ 22]	5.0-10.0 sec	475 MBytes	796 Mbits/sec
176	[ 29]	5.0-10.0 sec	588 MBytes	986 Mbits/sec
177	[ 40]	5.0-10.0 sec	595 MBytes	998 Mbits/sec
178	[ 42]	5.0-10.0 sec	506 MBytes	848 Mbits/sec
179	[ 60]	5.0-10.0 sec	433 MBytes	727 Mbits/sec
180	[ 61]	5.0-10.0 sec	675 MBytes	1.13 Gbits/sec
181	[ 25]	5.0-10.0 sec	823 MBytes	1.38 Gbits/sec
182	[ 4]	5.0-10.0 sec	630 MBytes	1.06 Gbits/sec
183	[ 18]	5.0-10.0 sec	679 MBytes	1.14 Gbits/sec
184	[ 26]	5.0-10.0 sec	801 MBytes	1.34 Gbits/sec
185	[ 43]	5.0-10.0 sec	601 MBytes	1.01 Gbits/sec
186	[ 17]	5.0-10.0 sec	713 MBytes	1.20 Gbits/sec
187	[ 14]	5.0-10.0 sec	540 MBytes	905 Mbits/sec
188	[ 15]	5.0-10.0 sec	554 MBytes	929 Mbits/sec
189	[ 37]	5.0-10.0 sec	660 MBytes	1.11 Gbits/sec
190	[ 47]	5.0-10.0 sec	579 MBytes	971 Mbits/sec
191	[ 51]	5.0-10.0 sec	477 MBytes	800 Mbits/sec
192	[ 30]	5.0-10.0 sec	408 MBytes	685 Mbits/sec
193	[ 39]	5.0-10.0 sec	586 MBytes	983 Mbits/sec
194	[ 5]	5.0-10.0 sec	753 MBytes	1.26 Gbits/sec
195	[ 20]	5.0-10.0 sec	547 MBytes	918 Mbits/sec
196	[ 62]	5.0-10.0 sec	453 MBytes	759 Mbits/sec
197	[ 46]	5.0-10.0 sec	321 MBytes	539 Mbits/sec

## Appendix

## A.5. Network performance

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198 [ 59] 5.0-10.0 sec 493 MBytes 827 Mbits/sec
199 [SUM] 5.0-10.0 sec 37.4 GBytes 64.2 Gbits/sec
200 [ 61] 10.0-15.0 sec 513 MBytes 860 Mbits/sec
201 [ 64] 10.0-15.0 sec 825 MBytes 1.38 Gbits/sec
202 [ 56] 10.0-15.0 sec 545 MBytes 915 Mbits/sec
203 [ 6] 10.0-15.0 sec 812 MBytes 1.36 Gbits/sec
204 [ 65] 10.0-15.0 sec 782 MBytes 1.31 Gbits/sec
205 [ 62] 10.0-15.0 sec 667 MBytes 1.12 Gbits/sec
206 [ 9] 10.0-15.0 sec 809 MBytes 1.36 Gbits/sec
207 [ 7] 10.0-15.0 sec 566 MBytes 950 Mbits/sec
208 [ 16] 10.0-15.0 sec 704 MBytes 1.18 Gbits/sec
209 [ 11] 10.0-15.0 sec 770 MBytes 1.29 Gbits/sec
210 [ 8] 10.0-15.0 sec 401 MBytes 672 Mbits/sec
211 [ 18] 10.0-15.0 sec 452 MBytes 759 Mbits/sec
212 [ 20] 10.0-15.0 sec 462 MBytes 774 Mbits/sec
213 [ 21] 10.0-15.0 sec 713 MBytes 1.20 Gbits/sec
214 [ 23] 10.0-15.0 sec 410 MBytes 687 Mbits/sec
215 [ 27] 10.0-15.0 sec 767 MBytes 1.29 Gbits/sec
216 [ 29] 10.0-15.0 sec 640 MBytes 1.07 Gbits/sec
217 [ 28] 10.0-15.0 sec 840 MBytes 1.41 Gbits/sec
218 [ 33] 10.0-15.0 sec 566 MBytes 950 Mbits/sec
219 [ 34] 10.0-15.0 sec 439 MBytes 736 Mbits/sec
220 [ 42] 10.0-15.0 sec 522 MBytes 876 Mbits/sec
221 [ 45] 10.0-15.0 sec 613 MBytes 1.03 Gbits/sec
222 [ 41] 10.0-15.0 sec 649 MBytes 1.09 Gbits/sec
223 [ 49] 10.0-15.0 sec 699 MBytes 1.17 Gbits/sec
224 [ 47] 10.0-15.0 sec 498 MBytes 835 Mbits/sec
225 [ 52] 10.0-15.0 sec 678 MBytes 1.14 Gbits/sec
226 [ 55] 10.0-15.0 sec 371 MBytes 622 Mbits/sec
227 [ 54] 10.0-15.0 sec 661 MBytes 1.11 Gbits/sec
228 [ 13] 10.0-15.0 sec 572 MBytes 960 Mbits/sec
229 [ 25] 10.0-15.0 sec 638 MBytes 1.07 Gbits/sec
230 [ 24] 10.0-15.0 sec 431 MBytes 724 Mbits/sec
231 [ 30] 10.0-15.0 sec 263 MBytes 442 Mbits/sec
232 [ 35] 10.0-15.0 sec 736 MBytes 1.23 Gbits/sec
233 [ 40] 10.0-15.0 sec 652 MBytes 1.09 Gbits/sec
234 [ 51] 10.0-15.0 sec 385 MBytes 645 Mbits/sec
235 [ 66] 10.0-15.0 sec 590 MBytes 990 Mbits/sec
236 [ 58] 10.0-15.0 sec 736 MBytes 1.24 Gbits/sec
237 [ 22] 10.0-15.0 sec 540 MBytes 906 Mbits/sec
238 [ 38] 10.0-15.0 sec 566 MBytes 950 Mbits/sec
239 [ 44] 10.0-15.0 sec 488 MBytes 818 Mbits/sec
240 [ 4] 10.0-15.0 sec 624 MBytes 1.05 Gbits/sec
241 [ 10] 10.0-15.0 sec 655 MBytes 1.10 Gbits/sec
242 [ 39] 10.0-15.0 sec 608 MBytes 1.02 Gbits/sec
243 [ 48] 10.0-15.0 sec 631 MBytes 1.06 Gbits/sec
244 [ 50] 10.0-15.0 sec 429 MBytes 720 Mbits/sec
245 [ 5] 10.0-15.0 sec 459 MBytes 770 Mbits/sec
246 [ 59] 10.0-15.0 sec 572 MBytes 960 Mbits/sec
247 [ 12] 10.0-15.0 sec 691 MBytes 1.16 Gbits/sec
248 [ 37] 10.0-15.0 sec 589 MBytes 988 Mbits/sec
249 [ 46] 10.0-15.0 sec 607 MBytes 1.02 Gbits/sec
250 [ 53] 10.0-15.0 sec 410 MBytes 688 Mbits/sec
251 [ 3] 10.0-15.0 sec 545 MBytes 914 Mbits/sec
252 [ 14] 10.0-15.0 sec 559 MBytes 938 Mbits/sec
253 [ 19] 10.0-15.0 sec 534 MBytes 895 Mbits/sec
254 [ 31] 10.0-15.0 sec 636 MBytes 1.07 Gbits/sec
255 [ 57] 10.0-15.0 sec 751 MBytes 1.26 Gbits/sec

```

## Appendix

## A.5. Network performance

256	[ 17]	10.0-15.0 sec	906 MBytes	1.52 Gbits/sec
257	[ 26]	10.0-15.0 sec	703 MBytes	1.18 Gbits/sec
258	[ 32]	10.0-15.0 sec	596 MBytes	1.00 Gbits/sec
259	[ 36]	10.0-15.0 sec	524 MBytes	878 Mbites/sec
260	[ 15]	10.0-15.0 sec	372 MBytes	625 Mbites/sec
261	[ 43]	10.0-15.0 sec	584 MBytes	980 Mbites/sec
262	[ 60]	10.0-15.0 sec	614 MBytes	1.03 Gbits/sec
263	[ 63]	10.0-15.0 sec	677 MBytes	1.14 Gbits/sec
264	[SUM]	10.0-15.0 sec	37.3 GBytes	64.2 Gbits/sec
265	[ 66]	15.0-20.0 sec	503 MBytes	844 Mbites/sec
266	[ 61]	15.0-20.0 sec	579 MBytes	972 Mbites/sec
267	[ 64]	15.0-20.0 sec	692 MBytes	1.16 Gbits/sec
268	[ 62]	15.0-20.0 sec	769 MBytes	1.29 Gbits/sec
269	[ 58]	15.0-20.0 sec	822 MBytes	1.38 Gbits/sec
270	[ 7]	15.0-20.0 sec	685 MBytes	1.15 Gbits/sec
271	[ 12]	15.0-20.0 sec	659 MBytes	1.10 Gbits/sec
272	[ 10]	15.0-20.0 sec	693 MBytes	1.16 Gbits/sec
273	[ 16]	15.0-20.0 sec	710 MBytes	1.19 Gbits/sec
274	[ 11]	15.0-20.0 sec	710 MBytes	1.19 Gbits/sec
275	[ 14]	15.0-20.0 sec	559 MBytes	938 Mbites/sec
276	[ 15]	15.0-20.0 sec	608 MBytes	1.02 Gbits/sec
277	[ 22]	15.0-20.0 sec	534 MBytes	896 Mbites/sec
278	[ 20]	15.0-20.0 sec	676 MBytes	1.13 Gbits/sec
279	[ 26]	15.0-20.0 sec	449 MBytes	754 Mbites/sec
280	[ 29]	15.0-20.0 sec	598 MBytes	1.00 Gbits/sec
281	[ 33]	15.0-20.0 sec	532 MBytes	892 Mbites/sec
282	[ 40]	15.0-20.0 sec	726 MBytes	1.22 Gbits/sec
283	[ 39]	15.0-20.0 sec	608 MBytes	1.02 Gbits/sec
284	[ 43]	15.0-20.0 sec	653 MBytes	1.10 Gbits/sec
285	[ 45]	15.0-20.0 sec	784 MBytes	1.32 Gbits/sec
286	[ 41]	15.0-20.0 sec	470 MBytes	788 Mbites/sec
287	[ 44]	15.0-20.0 sec	487 MBytes	817 Mbites/sec
288	[ 49]	15.0-20.0 sec	747 MBytes	1.25 Gbits/sec
289	[ 47]	15.0-20.0 sec	633 MBytes	1.06 Gbits/sec
290	[ 52]	15.0-20.0 sec	777 MBytes	1.30 Gbits/sec
291	[ 54]	15.0-20.0 sec	471 MBytes	790 Mbites/sec
292	[ 13]	15.0-20.0 sec	800 MBytes	1.34 Gbits/sec
293	[ 25]	15.0-20.0 sec	596 MBytes	1000 Mbites/sec
294	[ 46]	15.0-20.0 sec	542 MBytes	910 Mbites/sec
295	[ 50]	15.0-20.0 sec	451 MBytes	756 Mbites/sec
296	[ 65]	15.0-20.0 sec	836 MBytes	1.40 Gbits/sec
297	[ 8]	15.0-20.0 sec	516 MBytes	866 Mbites/sec
298	[ 18]	15.0-20.0 sec	566 MBytes	950 Mbites/sec
299	[ 24]	15.0-20.0 sec	354 MBytes	595 Mbites/sec
300	[ 42]	15.0-20.0 sec	303 MBytes	509 Mbites/sec
301	[ 32]	15.0-20.0 sec	322 MBytes	541 Mbites/sec
302	[ 37]	15.0-20.0 sec	611 MBytes	1.02 Gbits/sec
303	[ 63]	15.0-20.0 sec	645 MBytes	1.08 Gbits/sec
304	[ 35]	15.0-20.0 sec	675 MBytes	1.13 Gbits/sec
305	[ 36]	15.0-20.0 sec	445 MBytes	747 Mbites/sec
306	[ 51]	15.0-20.0 sec	501 MBytes	840 Mbites/sec
307	[ 53]	15.0-20.0 sec	431 MBytes	723 Mbites/sec
308	[ 17]	15.0-20.0 sec	773 MBytes	1.30 Gbits/sec
309	[ 34]	15.0-20.0 sec	532 MBytes	893 Mbites/sec
310	[ 4]	15.0-20.0 sec	631 MBytes	1.06 Gbits/sec
311	[ 19]	15.0-20.0 sec	371 MBytes	622 Mbites/sec
312	[ 21]	15.0-20.0 sec	686 MBytes	1.15 Gbits/sec
313	[ 38]	15.0-20.0 sec	652 MBytes	1.09 Gbits/sec

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## A.5. Network performance

314	[ 59]	15.0-20.0 sec	624 MBytes	1.05 Gbits/sec
315	[ 60]	15.0-20.0 sec	477 MBytes	800 Mbits/sec
316	[ 56]	15.0-20.0 sec	494 MBytes	828 Mbits/sec
317	[ 55]	15.0-20.0 sec	516 MBytes	866 Mbits/sec
318	[ 6]	15.0-20.0 sec	667 MBytes	1.12 Gbits/sec
319	[ 5]	15.0-20.0 sec	478 MBytes	801 Mbits/sec
320	[ 23]	15.0-20.0 sec	522 MBytes	876 Mbits/sec
321	[ 48]	15.0-20.0 sec	602 MBytes	1.01 Gbits/sec
322	[ 30]	15.0-20.0 sec	640 MBytes	1.07 Gbits/sec
323	[ 9]	15.0-20.0 sec	729 MBytes	1.22 Gbits/sec
324	[ 57]	15.0-20.0 sec	676 MBytes	1.13 Gbits/sec
325	[ 3]	15.0-20.0 sec	659 MBytes	1.11 Gbits/sec
326	[ 27]	15.0-20.0 sec	617 MBytes	1.04 Gbits/sec
327	[ 28]	15.0-20.0 sec	766 MBytes	1.28 Gbits/sec
328	[ 31]	15.0-20.0 sec	409 MBytes	686 Mbits/sec
329	[SUM]	15.0-20.0 sec	37.4 GBytes	64.2 Gbits/sec
330	[ 61]	20.0-25.0 sec	485 MBytes	813 Mbits/sec
331	[ 64]	20.0-25.0 sec	996 MBytes	1.67 Gbits/sec
332	[ 58]	20.0-25.0 sec	732 MBytes	1.23 Gbits/sec
333	[ 3]	20.0-25.0 sec	722 MBytes	1.21 Gbits/sec
334	[ 5]	20.0-25.0 sec	628 MBytes	1.05 Gbits/sec
335	[ 4]	20.0-25.0 sec	708 MBytes	1.19 Gbits/sec
336	[ 15]	20.0-25.0 sec	642 MBytes	1.08 Gbits/sec
337	[ 17]	20.0-25.0 sec	902 MBytes	1.51 Gbits/sec
338	[ 19]	20.0-25.0 sec	442 MBytes	741 Mbits/sec
339	[ 22]	20.0-25.0 sec	530 MBytes	890 Mbits/sec
340	[ 20]	20.0-25.0 sec	534 MBytes	896 Mbits/sec
341	[ 26]	20.0-25.0 sec	342 MBytes	575 Mbits/sec
342	[ 29]	20.0-25.0 sec	637 MBytes	1.07 Gbits/sec
343	[ 30]	20.0-25.0 sec	524 MBytes	880 Mbits/sec
344	[ 32]	20.0-25.0 sec	586 MBytes	984 Mbits/sec
345	[ 35]	20.0-25.0 sec	676 MBytes	1.13 Gbits/sec
346	[ 39]	20.0-25.0 sec	714 MBytes	1.20 Gbits/sec
347	[ 45]	20.0-25.0 sec	645 MBytes	1.08 Gbits/sec
348	[ 41]	20.0-25.0 sec	559 MBytes	938 Mbits/sec
349	[ 44]	20.0-25.0 sec	554 MBytes	929 Mbits/sec
350	[ 46]	20.0-25.0 sec	464 MBytes	778 Mbits/sec
351	[ 57]	20.0-25.0 sec	578 MBytes	970 Mbits/sec
352	[ 59]	20.0-25.0 sec	567 MBytes	951 Mbits/sec
353	[ 54]	20.0-25.0 sec	606 MBytes	1.02 Gbits/sec
354	[ 65]	20.0-25.0 sec	739 MBytes	1.24 Gbits/sec
355	[ 7]	20.0-25.0 sec	570 MBytes	957 Mbits/sec
356	[ 10]	20.0-25.0 sec	524 MBytes	880 Mbits/sec
357	[ 40]	20.0-25.0 sec	531 MBytes	890 Mbits/sec
358	[ 55]	20.0-25.0 sec	335 MBytes	563 Mbits/sec
359	[ 63]	20.0-25.0 sec	451 MBytes	756 Mbits/sec
360	[ 24]	20.0-25.0 sec	532 MBytes	892 Mbits/sec
361	[ 37]	20.0-25.0 sec	744 MBytes	1.25 Gbits/sec
362	[ 8]	20.0-25.0 sec	624 MBytes	1.05 Gbits/sec
363	[ 31]	20.0-25.0 sec	660 MBytes	1.11 Gbits/sec
364	[ 43]	20.0-25.0 sec	792 MBytes	1.33 Gbits/sec
365	[ 13]	20.0-25.0 sec	495 MBytes	830 Mbits/sec
366	[ 25]	20.0-25.0 sec	670 MBytes	1.12 Gbits/sec
367	[ 66]	20.0-25.0 sec	544 MBytes	913 Mbits/sec
368	[ 6]	20.0-25.0 sec	777 MBytes	1.30 Gbits/sec
369	[ 28]	20.0-25.0 sec	740 MBytes	1.24 Gbits/sec
370	[ 33]	20.0-25.0 sec	681 MBytes	1.14 Gbits/sec
371	[ 34]	20.0-25.0 sec	486 MBytes	815 Mbits/sec

## Appendix

## A.5. Network performance

372	[ 38]	20.0-25.0 sec	532 MBytes	893 Mbits/sec
373	[ 52]	20.0-25.0 sec	517 MBytes	867 Mbits/sec
374	[ 62]	20.0-25.0 sec	505 MBytes	848 Mbits/sec
375	[ 11]	20.0-25.0 sec	560 MBytes	940 Mbits/sec
376	[ 23]	20.0-25.0 sec	625 MBytes	1.05 Gbits/sec
377	[ 36]	20.0-25.0 sec	588 MBytes	987 Mbits/sec
378	[ 48]	20.0-25.0 sec	628 MBytes	1.05 Gbits/sec
379	[ 47]	20.0-25.0 sec	388 MBytes	651 Mbits/sec
380	[ 27]	20.0-25.0 sec	574 MBytes	963 Mbits/sec
381	[ 60]	20.0-25.0 sec	663 MBytes	1.11 Gbits/sec
382	[ 12]	20.0-25.0 sec	692 MBytes	1.16 Gbits/sec
383	[ 56]	20.0-25.0 sec	402 MBytes	674 Mbits/sec
384	[ 9]	20.0-25.0 sec	522 MBytes	876 Mbits/sec
385	[ 18]	20.0-25.0 sec	392 MBytes	657 Mbits/sec
386	[ 42]	20.0-25.0 sec	679 MBytes	1.14 Gbits/sec
387	[ 50]	20.0-25.0 sec	368 MBytes	618 Mbits/sec
388	[ 51]	20.0-25.0 sec	373 MBytes	626 Mbits/sec
389	[ 53]	20.0-25.0 sec	508 MBytes	853 Mbits/sec
390	[ 16]	20.0-25.0 sec	817 MBytes	1.37 Gbits/sec
391	[ 49]	20.0-25.0 sec	801 MBytes	1.34 Gbits/sec
392	[ 21]	20.0-25.0 sec	751 MBytes	1.26 Gbits/sec
393	[ 14]	20.0-25.0 sec	688 MBytes	1.16 Gbits/sec
394	[SUM]	20.0-25.0 sec	37.3 GBytes	64.2 Gbits/sec
395	[ 61]	25.0-30.0 sec	711 MBytes	1.19 Gbits/sec
396	[ 61]	0.0-30.0 sec	3.38 GBytes	968 Mbits/sec
397	[ 64]	25.0-30.0 sec	753 MBytes	1.26 Gbits/sec
398	[ 64]	0.0-30.0 sec	4.79 GBytes	1.37 Gbits/sec
399	[ 65]	25.0-30.0 sec	843 MBytes	1.41 Gbits/sec
400	[ 65]	0.0-30.0 sec	4.75 GBytes	1.36 Gbits/sec
401	[ 62]	25.0-30.0 sec	434 MBytes	727 Mbits/sec
402	[ 62]	0.0-30.0 sec	3.31 GBytes	948 Mbits/sec
403	[ 9]	25.0-30.0 sec	489 MBytes	820 Mbits/sec
404	[ 9]	0.0-30.0 sec	3.96 GBytes	1.13 Gbits/sec
405	[ 12]	25.0-30.0 sec	652 MBytes	1.09 Gbits/sec
406	[ 12]	0.0-30.0 sec	3.78 GBytes	1.08 Gbits/sec
407	[ 10]	25.0-30.0 sec	753 MBytes	1.26 Gbits/sec
408	[ 10]	0.0-30.0 sec	4.10 GBytes	1.17 Gbits/sec
409	[ 4]	25.0-30.0 sec	816 MBytes	1.37 Gbits/sec
410	[ 4]	0.0-30.0 sec	3.99 GBytes	1.14 Gbits/sec
411	[ 17]	25.0-30.0 sec	822 MBytes	1.38 Gbits/sec
412	[ 17]	0.0-30.0 sec	5.03 GBytes	1.44 Gbits/sec
413	[ 19]	25.0-30.0 sec	829 MBytes	1.39 Gbits/sec
414	[ 19]	0.0-30.0 sec	3.18 GBytes	911 Mbits/sec
415	[ 22]	25.0-30.0 sec	549 MBytes	920 Mbits/sec
416	[ 22]	0.0-30.0 sec	3.19 GBytes	914 Mbits/sec
417	[ 21]	25.0-30.0 sec	748 MBytes	1.26 Gbits/sec
418	[ 21]	0.0-30.0 sec	4.16 GBytes	1.19 Gbits/sec
419	[ 26]	25.0-30.0 sec	644 MBytes	1.08 Gbits/sec
420	[ 26]	0.0-30.0 sec	3.42 GBytes	979 Mbits/sec
421	[ 27]	25.0-30.0 sec	527 MBytes	885 Mbits/sec
422	[ 27]	0.0-30.0 sec	3.78 GBytes	1.08 Gbits/sec
423	[ 29]	25.0-30.0 sec	681 MBytes	1.14 Gbits/sec
424	[ 29]	0.0-30.0 sec	3.63 GBytes	1.04 Gbits/sec
425	[ 31]	25.0-30.0 sec	610 MBytes	1.02 Gbits/sec
426	[ 31]	0.0-30.0 sec	3.55 GBytes	1.01 Gbits/sec
427	[ 32]	25.0-30.0 sec	404 MBytes	678 Mbits/sec
428	[ 32]	0.0-30.0 sec	2.49 GBytes	713 Mbits/sec
429	[ 34]	25.0-30.0 sec	442 MBytes	742 Mbits/sec

## Appendix

### A.5. Network performance

```

430 [ 34] 0.0-30.0 sec 2.89 GBytes 828 Mbits/sec
431 [ 35] 25.0-30.0 sec 660 MBytes 1.11 Gbytes/sec
432 [ 35] 0.0-30.0 sec 4.10 GBytes 1.17 Gbits/sec
433 [ 38] 25.0-30.0 sec 730 MBytes 1.23 Gbits/sec
434 [ 38] 0.0-30.0 sec 4.00 GBytes 1.15 Gbits/sec
435 [ 42] 25.0-30.0 sec 476 MBytes 798 Mbits/sec
436 [ 42] 0.0-30.0 sec 2.88 GBytes 823 Mbits/sec
437 [ 41] 25.0-30.0 sec 481 MBytes 807 Mbits/sec
438 [ 41] 0.0-30.0 sec 2.98 GBytes 855 Mbits/sec
439 [ 44] 25.0-30.0 sec 516 MBytes 866 Mbits/sec
440 [ 44] 0.0-30.0 sec 2.82 GBytes 808 Mbits/sec
441 [ 46] 25.0-30.0 sec 473 MBytes 794 Mbits/sec
442 [ 46] 0.0-30.0 sec 2.77 GBytes 793 Mbits/sec
443 [ 49] 25.0-30.0 sec 642 MBytes 1.08 Gbytes/sec
444 [ 49] 0.0-30.0 sec 4.13 GBytes 1.18 Gbits/sec
445 [ 47] 25.0-30.0 sec 594 MBytes 997 Mbits/sec
446 [ 47] 0.0-30.0 sec 3.27 GBytes 936 Mbits/sec
447 [ 60] 25.0-30.0 sec 570 MBytes 957 Mbits/sec
448 [ 60] 0.0-30.0 sec 3.31 GBytes 949 Mbits/sec
449 [ 59] 25.0-30.0 sec 677 MBytes 1.14 Gbytes/sec
450 [ 59] 0.0-30.0 sec 3.31 GBytes 947 Mbits/sec
451 [ 54] 25.0-30.0 sec 713 MBytes 1.20 Gbytes/sec
452 [ 54] 0.0-30.0 sec 3.86 GBytes 1.11 Gbits/sec
453 [ 13] 25.0-30.0 sec 616 MBytes 1.03 Gbytes/sec
454 [ 13] 0.0-30.0 sec 3.52 GBytes 1.01 Gbits/sec
455 [ 3] 25.0-30.0 sec 579 MBytes 971 Mbits/sec
456 [ 3] 0.0-30.0 sec 3.82 GBytes 1.09 Gbytes/sec
457 [ 7] 25.0-30.0 sec 647 MBytes 1.08 Gbytes/sec
458 [ 7] 0.0-30.0 sec 3.51 GBytes 1.00 Gbytes/sec
459 [ 16] 25.0-30.0 sec 493 MBytes 826 Mbits/sec
460 [ 16] 0.0-30.0 sec 3.91 GBytes 1.12 Gbytes/sec
461 [ 11] 25.0-30.0 sec 578 MBytes 970 Mbits/sec
462 [ 11] 0.0-30.0 sec 3.63 GBytes 1.04 Gbytes/sec
463 [ 23] 25.0-30.0 sec 682 MBytes 1.14 Gbytes/sec
464 [ 23] 0.0-30.0 sec 3.22 GBytes 920 Mbits/sec
465 [ 28] 25.0-30.0 sec 531 MBytes 891 Mbits/sec
466 [ 28] 0.0-30.0 sec 4.30 GBytes 1.23 Gbytes/sec
467 [ 37] 25.0-30.0 sec 726 MBytes 1.22 Gbytes/sec
468 [ 37] 0.0-30.0 sec 3.85 GBytes 1.10 Gbytes/sec
469 [ 40] 25.0-30.0 sec 528 MBytes 887 Mbits/sec
470 [ 40] 0.0-30.0 sec 3.38 GBytes 967 Mbits/sec
471 [ 36] 25.0-30.0 sec 634 MBytes 1.06 Gbytes/sec
472 [ 36] 0.0-30.0 sec 3.27 GBytes 935 Mbits/sec
473 [ 43] 25.0-30.0 sec 665 MBytes 1.12 Gbytes/sec
474 [ 43] 0.0-30.0 sec 3.95 GBytes 1.13 Gbytes/sec
475 [ 57] 25.0-30.0 sec 754 MBytes 1.26 Gbytes/sec
476 [ 57] 0.0-30.1 sec 4.07 GBytes 1.16 Gbytes/sec
477 [ 25] 25.0-30.0 sec 490 MBytes 823 Mbits/sec
478 [ 25] 0.0-30.0 sec 3.71 GBytes 1.06 Gbytes/sec
479 [ 58] 25.0-30.0 sec 645 MBytes 1.08 Gbytes/sec
480 [ 58] 0.0-30.1 sec 4.47 GBytes 1.28 Gbytes/sec
481 [ 45] 25.0-30.0 sec 563 MBytes 945 Mbits/sec
482 [ 45] 0.0-30.1 sec 3.75 GBytes 1.07 Gbytes/sec
483 [ 6] 25.0-30.0 sec 614 MBytes 1.03 Gbytes/sec
484 [ 6] 0.0-30.1 sec 3.97 GBytes 1.13 Gbytes/sec
485 [ 39] 25.0-30.0 sec 491 MBytes 823 Mbits/sec
486 [ 39] 0.0-30.1 sec 3.63 GBytes 1.04 Gbytes/sec
487 [ 52] 25.0-30.0 sec 769 MBytes 1.29 Gbytes/sec

```

## Appendix

### A.5. Network performance

488	[ 52]	0.0-30.1 sec	4.00 GBytes	1.14 Gbits/sec
489	[ 55]	25.0-30.0 sec	425 MBytes	713 Mbits/sec
490	[ 55]	0.0-30.1 sec	2.55 GBytes	728 Mbits/sec
491	[ 8]	25.0-30.0 sec	534 MBytes	897 Mbits/sec
492	[ 8]	0.0-30.1 sec	3.08 GBytes	879 Mbits/sec
493	[ 14]	25.0-30.0 sec	385 MBytes	646 Mbits/sec
494	[ 14]	0.0-30.1 sec	3.27 GBytes	934 Mbits/sec
495	[ 20]	25.0-30.0 sec	516 MBytes	865 Mbits/sec
496	[ 20]	0.0-30.1 sec	3.16 GBytes	900 Mbits/sec
497	[ 24]	25.0-30.0 sec	488 MBytes	818 Mbits/sec
498	[ 24]	0.0-30.1 sec	2.70 GBytes	768 Mbits/sec
499	[ 51]	25.0-30.0 sec	423 MBytes	710 Mbits/sec
500	[ 51]	0.0-30.1 sec	2.53 GBytes	722 Mbits/sec
501	[ 63]	25.0-30.0 sec	539 MBytes	905 Mbits/sec
502	[ 63]	0.0-30.1 sec	3.29 GBytes	938 Mbits/sec
503	[ 66]	25.0-30.0 sec	774 MBytes	1.30 Gbits/sec
504	[ 66]	0.0-30.2 sec	3.46 GBytes	986 Mbits/sec
505	[ 18]	25.0-30.0 sec	543 MBytes	912 Mbits/sec
506	[ 18]	0.0-30.1 sec	3.28 GBytes	936 Mbits/sec
507	[ 30]	25.0-30.0 sec	320 MBytes	538 Mbits/sec
508	[ 30]	0.0-30.1 sec	2.58 GBytes	737 Mbits/sec
509	[ 56]	25.0-30.0 sec	470 MBytes	788 Mbits/sec
510	[ 56]	0.0-30.2 sec	2.95 GBytes	839 Mbits/sec
511	[ 33]	25.0-30.0 sec	727 MBytes	1.22 Gbits/sec
512	[ 33]	0.0-30.2 sec	3.73 GBytes	1.06 Gbits/sec
513	[ 48]	25.0-30.0 sec	649 MBytes	1.09 Gbits/sec
514	[ 48]	0.0-30.2 sec	3.38 GBytes	961 Mbits/sec
515	[ 50]	25.0-30.0 sec	406 MBytes	681 Mbits/sec
516	[ 50]	0.0-30.2 sec	2.64 GBytes	751 Mbits/sec
517	[ 5]	25.0-30.0 sec	670 MBytes	1.12 Gbits/sec
518	[ 5]	0.0-30.2 sec	3.61 GBytes	1.03 Gbits/sec
519	[ 15]	25.0-30.0 sec	636 MBytes	1.07 Gbits/sec
520	[ 15]	0.0-30.2 sec	3.27 GBytes	932 Mbits/sec
521	[ 53]	25.0-30.0 sec	492 MBytes	826 Mbits/sec
522	[SUM]	25.0-30.0 sec	37.3 GBytes	64.2 Gbits/sec
523	[ 53]	0.0-30.2 sec	2.68 GBytes	762 Mbits/sec
524	[SUM]	0.0-30.2 sec	225 GBytes	64.0 Gbits/sec

## Appendix

## A.6. IO performance

## A.6 IO performance

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

```

1 fio --rw=write --ioenginesync --fdatasync=1 --direct=1 --directory=io-test-data --size=2g --bs=4k --name=iotest
2 iotest: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=sync, iodepth=1
3 fio-3.16
4 Starting 1 process
5 iotest: Laying out IO file (1 file / 2048MiB)
6 Jobs: 1 (f=1): [W(1)][100.0%][w=21.7MiB/s][w=5558 IOPS][eta 00m:00s]
7 iotest: (groupid=0, jobs=1): err= 0: pid=294592: Sat Mar 29 19:16:59 2025
8   write: IOPS=5142, BW=20.1MiB/s (21.1MB/s)(2048MiB/101953msec); 0 zone resets
9     clat (usec): min=70, max=11253, avg=90.78, stdev=77.15
10    lat (usec): min=70, max=11253, avg=90.82, stdev=77.15
11    clat percentiles (usec):
12      | 1.00th=[  76], 5.00th=[  78], 10.00th=[  78], 20.00th=[   80],
13      | 30.00th=[  81], 40.00th=[  82], 50.00th=[  83], 60.00th=[  84],
14      | 70.00th=[  85], 80.00th=[  87], 90.00th=[  94], 95.00th=[ 111],
15      | 99.00th=[ 269], 99.50th=[ 412], 99.90th=[ 1012], 99.95th=[ 1483],
16      | 99.99th=[ 3425]
17   bw ( KiB/s): min= 6008, max=23232, per=99.97%, avg=20562.84, stdev=1860.11, samples=203
18   iops          : min= 1502, max= 5808, avg=5140.71, stdev=465.03, samples=203
19   lat (usec)    : 100=93.15%, 250=5.72%, 500=0.77%, 750=0.19%, 1000=0.06%
20   lat (msec)    : 2=0.07%, 4=0.02%, 10=0.01%, 20=0.01%
21 fsync/fdatasync/sync_file_range:
22   sync (usec): min=74, max=11488, avg=103.27, stdev=92.68
23   sync percentiles (usec):
24     | 1.00th=[  81], 5.00th=[  84], 10.00th=[  86], 20.00th=[   88],
25     | 30.00th=[  89], 40.00th=[  91], 50.00th=[  92], 60.00th=[  95],
26     | 70.00th=[  98], 80.00th=[ 101], 90.00th=[ 108], 95.00th=[ 124],
27     | 99.00th=[ 338], 99.50th=[ 515], 99.90th=[ 1254], 99.95th=[ 1942],
28     | 99.99th=[ 3621]
29   cpu          : usr=0.60%, sys=4.26%, ctx=1572864, majf=0, minf=14
30   IO depths    : 1=200.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
31     submit      : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
32     complete    : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
33     issued rwt: total=0,524288,0,0 short=524287,0,0,0 dropped=0,0,0,0
34     latency    : target=0, window=0, percentile=100.00%, depth=1
35
36 Run status group 0 (all jobs):
37   WRITE: bw=20.1MiB/s (21.1MB/s), 20.1MiB/s-20.1MiB/s (21.1MB/s-21.1MB/s), io=2048MiB (2147MB), run=101953-101953
38     msec
39
40 Disk stats (read/write):
41   nvme1n1: ios=0/1047980, merge=0/4, ticks=0/94529, in_queue=240, util=99.94%=

```

## Appendix

## A.6. IO performance

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

```

1 fio --rw=write --ioengine=sync --fdatasync=1 --direct=1 --directory=io-test-data --size=2g --bs=4k --name=iostest
2 iostest: (g=0): rw=write, bs=(R) 4096B-4096B, (W) 4096B-4096B, (T) 4096B-4096B, ioengine=sync,iodepth=1
3 fio-3.16
4 Starting 1 process
5 iostest: Laying out IO file (1 file / 2048MiB)
6 Jobs: 1 (f=1): [W(1)][100.0%][w=17.6MiB/s][w=4495 IOPS][eta 00m:00s]
7 iostest: (groupid=0, jobs=1): err= 0: pid=1898071: Sat Mar 29 19:17:33 2025
8   write: IOPS=4636, BW=18.1MiB/s (18.0MB/s)(2048MiB/113081msec); 0 zone resets
9     clat (usec): min=69, max=5534, avg=91.36, stdev=85.61
10    lat (usec): min=69, max=5535, avg=91.40, stdev=85.61
11    clat percentiles (usec):
12      | 1.00th=[ 75], 5.00th=[ 76], 10.00th=[ 77], 20.00th=[ 79],
13      | 30.00th=[ 80], 40.00th=[ 80], 50.00th=[ 82], 60.00th=[ 83],
14      | 70.00th=[ 84], 80.00th=[ 87], 90.00th=[ 93], 95.00th=[ 110],
15      | 99.00th=[ 322], 99.50th=[ 506], 99.90th=[ 1237], 99.95th=[ 1762],
16      | 99.99th=[ 3294]
17   bw ( KiB/s): min= 9632, max=20208, per=100.00%, avg=18545.28, stdev=1135.63, samples=226
18   iops : min= 2408, max= 5052, avg=4636.32, stdev=283.91, samples=226
19   lat (usec) : 100=93.20%, 250=5.39%, 500=0.90%, 750=0.27%, 1000=0.10%
20   lat (msec) : 2=0.11%, 4=0.03%, 10=0.01%
21 fsync/fdatasync/sync_file_range:
22   sync (usec): min=79, max=5652, avg=123.92, stdev=86.94
23   sync percentiles (usec):
24     | 1.00th=[ 84], 5.00th=[ 86], 10.00th=[ 87], 20.00th=[ 88],
25     | 30.00th=[ 89], 40.00th=[ 91], 50.00th=[ 92], 60.00th=[ 95],
26     | 70.00th=[ 105], 80.00th=[ 147], 90.00th=[ 217], 95.00th=[ 265],
27     | 99.00th=[ 383], 99.50th=[ 490], 99.90th=[ 947], 99.95th=[ 1385],
28     | 99.99th=[ 2835]
29   cpu : usr=0.49%, sys=3.94%, ctx=1572864, majf=0, minf=14
30   IO depths : 1=200.0%, 2=0.0%, 4=0.0%, 8=0.0%, 16=0.0%, 32=0.0%, >=64=0.0%
31     submit : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
32     complete : 0=0.0%, 4=100.0%, 8=0.0%, 16=0.0%, 32=0.0%, 64=0.0%, >=64=0.0%
33     issued rwt: total=0,524288,0,0 short=524287,0,0,0 dropped=0,0,0
34     latency : target=0, window=0, percentile=100.00%, depth=1
35
36 Run status group 0 (all jobs):
37   WRITE: bw=18.1MiB/s (18.0MB/s), 18.1MiB/s-18.1MiB/s (18.0MB/s-18.0MB/s), io=2048MiB (2147MB), run=113081-113081
38     msec
39
40 Disk stats (read/write):
  nvme1n1: ios=0/1047075, merge=0/4, ticks=0/105112, in_queue=144, util=99.95%

```

## Appendix

### A.7 Datalog configuration

#### A.7.1 Datalog configuration

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

```

1 ldbc.snb.datagen.generator.scaleFactor:snb.interactive.30
2 ldbc.snb.datagen.serializer.numUpdatePartitions:48
3
4 ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.
   activity.CsvCompositeDynamicActivitySerializer
5 ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.
   CsvCompositeDynamicPersonSerializer
6 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

```

1 ldbc.snb.datagen.generator.scaleFactor:snb.interactive.100
2 ldbc.snb.datagen.serializer.numUpdatePartitions:48
3
4 ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.
   activity.CsvCompositeDynamicActivitySerializer
5 ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.
   CsvCompositeDynamicPersonSerializer
6 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

```

1 ldbc.snb.datagen.generator.scaleFactor:snb.interactive.300
2 ldbc.snb.datagen.serializer.numUpdatePartitions:48
3
4 ldbc.snb.datagen.serializer.dynamicActivitySerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.
   activity.CsvCompositeDynamicActivitySerializer
5 ldbc.snb.datagen.serializer.dynamicPersonSerializer:ldbc.snb.datagen.serializer.snb.csv.dynamicserializer.person.
   CsvCompositeDynamicPersonSerializer
6 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

```

1 graph: ldbc_snb
2 loading_config:
3   data_source:
4     scheme: file
5     location: {PATH_TO_DATASET}
6   import_option: init # append, overwrite, only init is supported now
7   format:
8     type: csv
9     metadata:
10       delimiter: "|" # other loading configuration places here
11 vertex_mappings:
12 - type_name: PLACE
13   inputs:
14     - static/place_0_0.csv

```

## Appendix

### A.8. Load configuration

```

15   - type_name: PERSON
16     inputs:
17       - dynamic/person_0_0.csv
18   - type_name: COMMENT
19     inputs:
20       - dynamic/comment_0_0.csv.rod
21   - type_name: POST
22     inputs:
23       - dynamic/post_0_0.csv.rod
24   - type_name: FORUM
25     inputs:
26       - dynamic/forum_0_0.csv
27   - type_name: ORGANISATION
28     inputs:
29       - static/organisation_0_0.csv
30   - type_name: TAGCLASS
31     inputs:
32       - static/tagclass_0_0.csv
33   - type_name: TAG
34     inputs:
35       - static/tag_0_0.csv
36 edge_mappings:
37   - type_triplet:
38     edge: HASCREATOR
39     source_vertex: COMMENT
40     destination_vertex: PERSON
41     inputs:
42       - dynamic/comment_hasCreator_person_0_0.csv.creation_date
43     source_vertex_mappings:
44       - column:
45         index: 0
46         name: id
47     destination_vertex_mappings:
48       - column:
49         index: 1
50         name: id
51     column_mappings:
52       - column:
53         index: 2
54         name: creationDate
55         property: creationDate
56   - type_triplet:
57     edge: HASCREATOR
58     source_vertex: POST
59     destination_vertex: PERSON
60     inputs:
61       - dynamic/post_hasCreator_person_0_0.csv.creation_date
62     source_vertex_mappings:
63       - column:
64         index: 0
65         name: id
66     destination_vertex_mappings:
67       - column:
68         index: 1
69         name: id
70     column_mappings:
71       - column:
72         index: 2

```

## Appendix

### A.8. Load configuration

```

73         name: creationDate
74     property: creationDate
75 - type_triplet:
76     edge: HASAG
77     source_vertex: POST
78     destination_vertex: TAG
79     inputs:
80     - dynamic/post_hasTag_tag_0_0.csv
81     source_vertex_mappings:
82     - column:
83         index: 0
84         name: id
85     destination_vertex_mappings:
86     - column:
87         index: 1
88         name: id
89 - type_triplet:
90     edge: REPLYOF
91     source_vertex: COMMENT
92     destination_vertex: COMMENT
93     inputs:
94     - dynamic/comment_replyOf_comment_0_0.csv
95     source_vertex_mappings:
96     - column:
97         index: 0
98         name: id
99     destination_vertex_mappings:
100    - column:
101        index: 1
102        name: id
103 - type_triplet:
104     edge: REPLYOF
105     source_vertex: COMMENT
106     destination_vertex: POST
107     inputs:
108     - dynamic/comment_replyOf_post_0_0.csv
109     source_vertex_mappings:
110     - column:
111         index: 0
112         name: id
113     destination_vertex_mappings:
114     - column:
115         index: 1
116         name: id
117 - type_triplet:
118     edge: CONTAINEROF
119     source_vertex: FORUM
120     destination_vertex: POST
121     inputs:
122     - dynamic/forum_containerOf_post_0_0.csv
123     source_vertex_mappings:
124     - column:
125         index: 0
126         name: id
127     destination_vertex_mappings:
128     - column:
129         index: 1
130         name: id

```



## Appendix

### A.8. Load configuration

```

131 - type_triplet:
132   edge: HASMEMBER
133   source_vertex: FORUM
134   destination_vertex: PERSON
135 inputs:
136   - dynamic/forum_hasMember_person_0_0.csv
137 source_vertex_mappings:
138   - column:
139     index: 0
140     name: id
141 destination_vertex_mappings:
142   - column:
143     index: 1
144     name: id
145 - type_triplet:
146   edge: HASMODERATOR
147   source_vertex: FORUM
148   destination_vertex: PERSON
149 inputs:
150   - dynamic/forum_hasModerator_person_0_0.csv
151 source_vertex_mappings:
152   - column:
153     index: 0
154     name: id
155 destination_vertex_mappings:
156   - column:
157     index: 1
158     name: id
159 - type_triplet:
160   edge: HASINTEREST
161   source_vertex: PERSON
162   destination_vertex: TAG
163 inputs:
164   - dynamic/person_hasInterest_tag_0_0.csv
165 source_vertex_mappings:
166   - column:
167     index: 0
168     name: id
169 destination_vertex_mappings:
170   - column:
171     index: 1
172     name: id
173 - type_triplet:
174   edge: ISLOCATEDIN
175   source_vertex: COMMENT
176   destination_vertex: PLACE
177 inputs:
178   - dynamic/comment_isLocatedIn_place_0_0.csv
179 source_vertex_mappings:
180   - column:
181     index: 0
182     name: id
183 destination_vertex_mappings:
184   - column:
185     index: 1
186     name: id
187 - type_triplet:
188   edge: ISLOCATEDIN

```



## Appendix

### A.8. Load configuration

```

189      source_vertex: PERSON
190      destination_vertex: PLACE
191  inputs:
192    - dynamic/person_isLocatedIn_place_0_0.csv
193  source_vertex_mappings:
194    - column:
195      index: 0
196      name: id
197  destination_vertex_mappings:
198    - column:
199      index: 1
200      name: id
201 - type_triplet:
202   edge: ISLOCATEDIN
203   source_vertex: POST
204   destination_vertex: PLACE
205  inputs:
206    - dynamic/post_isLocatedIn_place_0_0.csv
207  source_vertex_mappings:
208    - column:
209      index: 0
210      name: id
211  destination_vertex_mappings:
212    - column:
213      index: 1
214      name: id
215 - type_triplet:
216   edge: ISLOCATEDIN
217   source_vertex: ORGANISATION
218   destination_vertex: PLACE
219  inputs:
220    - static/organisation_isLocatedIn_place_0_0.csv
221  source_vertex_mappings:
222    - column:
223      index: 0
224      name: id
225  destination_vertex_mappings:
226    - column:
227      index: 1
228      name: id
229 - type_triplet:
230   edge: KNOWS
231   source_vertex: PERSON
232   destination_vertex: PERSON
233  inputs:
234    - dynamic/person_knows_person_0_0.csv
235  source_vertex_mappings:
236    - column:
237      index: 0
238      name: id
239  destination_vertex_mappings:
240    - column:
241      index: 1
242      name: id
243 - type_triplet:
244   edge: LIKES
245   source_vertex: PERSON
246   destination_vertex: COMMENT

```



## Appendix

### A.8. Load configuration

```

247 inputs:
248   - dynamic/person_likes_comment_0_0.csv
249 source_vertex_mappings:
250   - column:
251     index: 0
252     name: id
253 destination_vertex_mappings:
254   - column:
255     index: 1
256     name: id
257 column_mappings:
258   - column:
259     index: 2
260     name: creationDate
261     property: creationDate
262 - type_triplet:
263   edge: LIKES
264   source_vertex: PERSON
265   destination_vertex: POST
266 inputs:
267   - dynamic/person_likes_post_0_0.csv
268 source_vertex_mappings:
269   - column:
270     index: 0
271     name: id
272 destination_vertex_mappings:
273   - column:
274     index: 1
275     name: id
276 column_mappings:
277   - column:
278     index: 2
279     name: creationDate
280     property: creationDate
281 - type_triplet:
282   edge: WORKAT
283   source_vertex: PERSON
284   destination_vertex: ORGANISATION
285 inputs:
286   - dynamic/person_workAt_organisation_0_0.csv
287 source_vertex_mappings:
288   - column:
289     index: 0
290     name: id
291 destination_vertex_mappings:
292   - column:
293     index: 1
294     name: id
295 column_mappings:
296   - column:
297     index: 2
298     name: workFrom
299     property: workFrom
300 - type_triplet:
301   edge: ISPARTOF
302   source_vertex: PLACE
303   destination_vertex: PLACE
304 inputs:

```



## Appendix

### A.8. Load configuration

```

305      - static/place_isPartOf_place_0_0.csv
306  source_vertex_mappings:
307    - column:
308      index: 0
309      name: id
310  destination_vertex_mappings:
311    - column:
312      index: 1
313      name: id
314 - type_triplet:
315   edge: HASTYPE
316   source_vertex: TAG
317   destination_vertex: TAGCLASS
318 inputs:
319   - static/tag_hasType_tagclass_0_0.csv
320  source_vertex_mappings:
321    - column:
322      index: 0
323      name: id
324  destination_vertex_mappings:
325    - column:
326      index: 1
327      name: id
328 - type_triplet:
329   edge: ISSUBCLASSOF
330   source_vertex: TAGCLASS
331   destination_vertex: TAGCLASS
332 inputs:
333   - static/tagclass_isSubclassOf_tagclass_0_0.csv
334  source_vertex_mappings:
335    - column:
336      index: 0
337      name: id
338  destination_vertex_mappings:
339    - column:
340      index: 1
341      name: id
342 - type_triplet:
343   edge: STUDYAT
344   source_vertex: PERSON
345   destination_vertex: ORGANISATION
346 inputs:
347   - dynamic/person_studyAt_organisation_0_0.csv
348  source_vertex_mappings:
349    - column:
350      index: 0
351      name: id
352  destination_vertex_mappings:
353    - column:
354      index: 1
355      name: id
356  column_mappings:
357    - column:
358      index: 2
359      name: classYear
360      property: classYear

```

## Appendix

### A.8. Load configuration

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

```

1 name: ldbc_snb
2 store_type: mutable_csr
3 schema:
4   vertex_types:
5     - type_id: 0
6       type_name: PLACE
7       properties:
8         - property_id: 0
9           property_name: id
10          property_type:
11            primitive_type: DT_SIGNED_INT64
12          - property_id: 1
13            property_name: name
14            property_type:
15              string:
16                var_char:
17                  max_length: 256
18          - property_id: 2
19            property_name: url
20            property_type:
21              string:
22                var_char:
23                  max_length: 256
24          - property_id: 3
25            property_name: type
26            property_type:
27              string:
28                var_char:
29                  max_length: 32
30   primary_keys:
31     - id
32   - type_id: 1
33     type_name: PERSON
34     properties:
35       - property_id: 0
36         property_name: id
37         property_type:
38           primitive_type: DT_SIGNED_INT64
39       - property_id: 1
40         property_name: firstName
41         property_type:
42           string:
43             var_char:
44               max_length: 80
45       - property_id: 2
46         property_name: lastName
47         property_type:
48           string:
49             var_char:
50               max_length: 80
51       - property_id: 3
52         property_name: gender
53         property_type:
54           string:
55             var_char:
56               max_length: 80

```



## Appendix

### A.8. Load configuration

```

57     - property_id: 4
58         property_name: birthday
59         property_type:
60             temporal:
61                 date32:
62             - property_id: 5
63                 property_name: creationDate
64                 property_type:
65                     temporal:
66                         timestamp:
67             - property_id: 6
68                 property_name: locationIP
69                 property_type:
70                     string:
71                         var_char:
72                             max_length: 80
73             - property_id: 7
74                 property_name: browserUsed
75                 property_type:
76                     string:
77                         var_char:
78                             max_length: 80
79             - property_id: 8
80                 property_name: language
81                 property_type:
82                     string:
83                         var_char:
84                             max_length: 256
85             - property_id: 9
86                 property_name: email
87                 property_type:
88                     string:
89                         var_char:
90                             max_length: 2144
91             primary_keys:
92                 - id
93             - type_id: 2
94                 type_name: COMMENT
95                 properties:
96                     - property_id: 0
97                         property_name: id
98                         property_type:
99                             primitive_type: DT_SIGNED_INT64
100            - property_id: 1
101                property_name: creationDate
102                property_type:
103                    temporal:
104                        timestamp:
105            - property_id: 2
106                property_name: locationIP
107                property_type:
108                    string:
109                        var_char:
110                            max_length: 80
111            - property_id: 3
112                property_name: browserUsed
113                property_type:
114                    string:

```



## Appendix

### A.8. Load configuration

```

115      var_char:
116          max_length: 80
117      - property_id: 4
118          property_name: content
119          property_type:
120              string:
121                  var_char:
122                      max_length: 2144
123      - property_id: 5
124          property_name: length
125          property_type:
126              primitive_type: DT_SIGNED_INT32
127      primary_keys:
128          - id
129      - type_id: 3
130          type_name: POST
131      properties:
132          - property_id: 0
133              property_name: id
134              property_type:
135                  primitive_type: DT_SIGNED_INT64
136          - property_id: 1
137              property_name: imageFile
138              property_type:
139                  string:
140                      var_char:
141                          max_length: 80
142          - property_id: 2
143              property_name: creationDate
144              property_type:
145                  temporal:
146                      timestamp:
147          - property_id: 3
148              property_name: locationIP
149              property_type:
150                  string:
151                      var_char:
152                          max_length: 80
153          - property_id: 4
154              property_name: browserUsed
155              property_type:
156                  string:
157                      var_char:
158                          max_length: 80
159          - property_id: 5
160              property_name: language
161              property_type:
162                  string:
163                      var_char:
164                          max_length: 80
165          - property_id: 6
166              property_name: content
167              property_type:
168                  string:
169                      var_char:
170                          max_length: 2144
171          - property_id: 7
172              property_name: length

```



## Appendix

### A.8. Load configuration

```

173     property_type:
174         primitive_type: DT_SIGNED_INT32
175     primary_keys:
176         - id
177     - type_id: 4
178     type_name: FORUM
179     properties:
180         - property_id: 0
181             property_name: id
182             property_type:
183                 primitive_type: DT_SIGNED_INT64
184         - property_id: 1
185             property_name: title
186             property_type:
187                 string:
188                     var_char:
189                         max_length: 256
190         - property_id: 2
191             property_name: creationDate
192             property_type:
193                 temporal:
194                     timestamp:
195     primary_keys:
196         - id
197     - type_id: 5
198     type_name: ORGANISATION
199     properties:
200         - property_id: 0
201             property_name: id
202             property_type:
203                 primitive_type: DT_SIGNED_INT64
204         - property_id: 1
205             property_name: type
206             property_type:
207                 string:
208                     var_char:
209                         max_length: 32
210         - property_id: 2
211             property_name: name
212             property_type:
213                 string:
214                     var_char:
215                         max_length: 256
216         - property_id: 3
217             property_name: url
218             property_type:
219                 string:
220                     var_char:
221                         max_length: 256
222     primary_keys:
223         - id
224     - type_id: 6
225     type_name: TAGCLASS
226     properties:
227         - property_id: 0
228             property_name: id
229             property_type:
230                 primitive_type: DT_SIGNED_INT64

```



## Appendix

### A.8. Load configuration

```

231     - property_id: 1
232         property_name: name
233         property_type:
234             string:
235                 var_char:
236                     max_length: 256
237     - property_id: 2
238         property_name: url
239         property_type:
240             string:
241                 var_char:
242                     max_length: 256
243     primary_keys:
244         - id
245 - type_id: 7
246     type_name: TAG
247     properties:
248         - property_id: 0
249             property_name: id
250             property_type:
251                 primitive_type: DT_SIGNED_INT64
252         - property_id: 1
253             property_name: name
254             property_type:
255                 string:
256                 var_char:
257                     max_length: 256
258         - property_id: 2
259             property_name: url
260             property_type:
261                 string:
262                 var_char:
263                     max_length: 256
264     primary_keys:
265         - id
266 edge_types:
267     - type_id: 0
268         type_name: HASCREATOR
269         vertex_type_pair_relations:
270             - source_vertex: COMMENT
271                 destination_vertex: PERSON
272                 relation: MANY_TO_MANY
273                 x_csr_params:
274                     sort_on_compaction: TRUE
275             - source_vertex: POST
276                 destination_vertex: PERSON
277                 relation: MANY_TO_MANY
278                 x_csr_params:
279                     sort_on_compaction: TRUE
280     properties:
281         - property_id: 0
282             property_name: creationDate
283             property_type:
284                 temporal:
285                     timestamp:
286     - type_id: 1
287         type_name: HASTAG
288         vertex_type_pair_relations:

```



## Appendix

### A.8. Load configuration

```

289      - source_vertex: POST
290          destination_vertex: TAG
291          relation: MANY_TO_MANY
292      - source_vertex: FORUM
293          destination_vertex: TAG
294          relation: MANY_TO_MANY
295      - source_vertex: COMMENT
296          destination_vertex: TAG
297          relation: MANY_TO_MANY
298
299      - type_id: 2
300          type_name: REPLYOF
301          vertex_type_pair_relations:
302              - source_vertex: COMMENT
303                  destination_vertex: COMMENT
304                  relation: MANY_TO_MANY
305              - source_vertex: COMMENT
306                  destination_vertex: POST
307                  relation: MANY_TO_MANY
308
309      - type_id: 3
310          type_name: CONTAINEROF
311          vertex_type_pair_relations:
312              - source_vertex: FORUM
313                  destination_vertex: POST
314                  relation: MANY_TO_MANY
315
316      - type_id: 4
317          type_name: HASMEMBER
318          vertex_type_pair_relations:
319              - source_vertex: FORUM
320                  destination_vertex: PERSON
321                  relation: MANY_TO_MANY
322          x_csr_params:
323              sort_on_compaction: TRUE
324
325          properties:
326              - property_id: 0
327                  property_name: joinDate
328                  property_type:
329                      temporal:
330                          timestamp:
331
332      - type_id: 5
333          type_name: HASMODERATOR
334          vertex_type_pair_relations:
335              - source_vertex: FORUM
336                  destination_vertex: PERSON
337                  relation: MANY_TO_MANY
338
339      - type_id: 6
340          type_name: HASINTEREST
341          vertex_type_pair_relations:
342              - source_vertex: PERSON
343                  destination_vertex: TAG
344                  relation: MANY_TO_MANY
345
346      - type_id: 7
347          type_name: ISLOCATEDIN
348          vertex_type_pair_relations:
349              - source_vertex: COMMENT
350                  destination_vertex: PLACE
351                  relation: MANY_TO_MANY
352              - source_vertex: PERSON
353                  destination_vertex: PLACE

```



## Appendix

### A.8. Load configuration

```

347     relation: MANY_TO_MANY
348   - source_vertex: POST
349     destination_vertex: PLACE
350     relation: MANY_TO_MANY
351   - source_vertex: ORGANISATION
352     destination_vertex: PLACE
353     relation: MANY_TO_MANY
354 - type_id: 8
355   type_name: KNOWS
356   vertex_type_pair_relations:
357     - source_vertex: PERSON
358       destination_vertex: PERSON
359       relation: MANY_TO_MANY
360   properties:
361     - property_id: 0
362       property_name: creationDate
363       property_type:
364         temporal:
365           timestamp:
366 - type_id: 9
367   type_name: LIKES
368   vertex_type_pair_relations:
369     - source_vertex: PERSON
370       destination_vertex: COMMENT
371       relation: MANY_TO_MANY
372     - source_vertex: PERSON
373       destination_vertex: POST
374       relation: MANY_TO_MANY
375   properties:
376     - property_id: 0
377       property_name: creationDate
378       property_type:
379         temporal:
380           timestamp:
381 - type_id: 10
382   type_name: WORKAT
383   vertex_type_pair_relations:
384     - source_vertex: PERSON
385       destination_vertex: ORGANISATION
386       relation: MANY_TO_MANY
387   properties:
388     - property_id: 0
389       property_name: workFrom
390       property_type:
391         primitive_type: DT_SIGNED_INT32
392 - type_id: 11
393   type_name: ISPARTOF
394   vertex_type_pair_relations:
395     - source_vertex: PLACE
396       destination_vertex: PLACE
397       relation: MANY_TO_MANY
398 - type_id: 12
399   type_name: HASTYPE
400   vertex_type_pair_relations:
401     - source_vertex: TAG
402       destination_vertex: TAGCLASS
403       relation: MANY_TO_MANY
404 - type_id: 13

```

## Appendix

### A.8. Load configuration

```
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
```

## Appendix

### A.9. Benchmark configuration

#### A.9 Benchmark configuration

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

```

1 url={SERVER}
2
3 printQueryNames=false
4 printQueryStrings=false
5 printQueryResults=false
6
7 status=1
8 thread_count=192
9 name=LDBC-SNB
10 mode=execute_benchmark
11 results_log=true
12 status=1
13 time_unit=MICROSECONDS
14 time_compression_ratio=0.001
15 peer_identifiers=
16 workload_statistics=false
17 spinner_wait_duration=1
18 help=false
19 ignore_scheduled_start_times=false
20
21 workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
22 db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb
23
24
25 queryDir={FLEX_SN_B_FOLDER}/queries/
26 ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
27 ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
28 ldbc.snb.interactive.short_read_dissipation=0.2
29 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
30 ldbc.snb.interactive.scale_factor=30
31 operation_count=272000000
32 warmup=64000000
33
34 ldbc.snb.interactive.LdbcQuery1_enable=true
35 ldbc.snb.interactive.LdbcQuery2_enable=true
36 ldbc.snb.interactive.LdbcQuery3_enable=true
37 ldbc.snb.interactive.LdbcQuery4_enable=true
38 ldbc.snb.interactive.LdbcQuery5_enable=true
39 ldbc.snb.interactive.LdbcQuery6_enable=true
40 ldbc.snb.interactive.LdbcQuery7_enable=true
41 ldbc.snb.interactive.LdbcQuery8_enable=true
42 ldbc.snb.interactive.LdbcQuery9_enable=true
43 ldbc.snb.interactive.LdbcQuery10_enable=true
44 ldbc.snb.interactive.LdbcQuery11_enable=true
45 ldbc.snb.interactive.LdbcQuery12_enable=true
46 ldbc.snb.interactive.LdbcQuery13_enable=true
47 ldbc.snb.interactive.LdbcQuery14_enable=true
48
49 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
50 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
51 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
52 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
53 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
54 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true

```



## Appendix

### A.9. Benchmark configuration

```
55 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true  
56  
57 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true  
58 ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true  
59 ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true  
60 ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true  
61 ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true  
62 ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true  
63 ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true  
64 ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```

## Appendix

## A.9. Benchmark configuration

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

```

1 url={SERVER}
2
3 printQueryNames=false
4 printQueryStrings=false
5 printQueryResults=false
6
7 status=1
8 thread_count=192
9 name=LDBC-SNB
10 mode=execute_benchmark
11 results_log=true
12 time_unit=MICROSECONDS
13 time_compression_ratio=0.0016
14 peer_identifiers=
15 workload_statistics=false
16 spinner_wait_duration=1
17 help=false
18 ignore_scheduled_start_times=false
19
20 workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
21 db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb
22
23
24 queryDir={FLEX_SN_B_FOLDER}/queries/
25 ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
26 ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
27 ldbc.snb.interactive.short_read_dissipation=0.2
28 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
29 ldbc.snb.interactive.scale_factor=100
30 operation_count=579000000
31 warmup=152000000
32
33 ldbc.snb.interactive.LdbcQuery1_enable=true
34 ldbc.snb.interactive.LdbcQuery2_enable=true
35 ldbc.snb.interactive.LdbcQuery3_enable=true
36 ldbc.snb.interactive.LdbcQuery4_enable=true
37 ldbc.snb.interactive.LdbcQuery5_enable=true
38 ldbc.snb.interactive.LdbcQuery6_enable=true
39 ldbc.snb.interactive.LdbcQuery7_enable=true
40 ldbc.snb.interactive.LdbcQuery8_enable=true
41 ldbc.snb.interactive.LdbcQuery9_enable=true
42 ldbc.snb.interactive.LdbcQuery10_enable=true
43 ldbc.snb.interactive.LdbcQuery11_enable=true
44 ldbc.snb.interactive.LdbcQuery12_enable=true
45 ldbc.snb.interactive.LdbcQuery13_enable=true
46 ldbc.snb.interactive.LdbcQuery14_enable=true
47
48 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
49 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
50 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
51 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
52 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
53 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
54 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
55
56 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true

```

## Appendix

### A.9. Benchmark configuration

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

## Appendix

### A.9. Benchmark configuration

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

```

1 url={SERVER}
2
3 printQueryNames=false
4 printQueryStrings=false
5 printQueryResults=false
6
7 status=1
8 thread_count=192
9 name=LDBC-SNB
10 mode=execute_benchmark
11 results_log=true
12 time_unit=MICROSECONDS
13 time_compression_ratio=0.0054
14
15 peer_identifiers=
16 workload_statistics=false
17 spinner_wait_duration=1
18 help=false
19 ignore_scheduled_start_times=false
20
21
22 workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
23 db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb
24
25 queryDir={FLEX_SN_B_FOLDER}/queries/
26 ldbc.snb.interactive.updates_dir={UPDATE_STREAMS}
27 ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
28 ldbc.snb.interactive.short_read_dissipation=0.2
29 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
30 ldbc.snb.interactive.scale_factor=300
31 operation_count=591800000
32 warmup=155400000
33
34 ldbc.snb.interactive.LdbcQuery1_enable=true
35 ldbc.snb.interactive.LdbcQuery2_enable=true
36 ldbc.snb.interactive.LdbcQuery3_enable=true
37 ldbc.snb.interactive.LdbcQuery4_enable=true
38 ldbc.snb.interactive.LdbcQuery5_enable=true
39 ldbc.snb.interactive.LdbcQuery6_enable=true
40 ldbc.snb.interactive.LdbcQuery7_enable=true
41 ldbc.snb.interactive.LdbcQuery8_enable=true
42 ldbc.snb.interactive.LdbcQuery9_enable=true
43 ldbc.snb.interactive.LdbcQuery10_enable=true
44 ldbc.snb.interactive.LdbcQuery11_enable=true
45 ldbc.snb.interactive.LdbcQuery12_enable=true
46 ldbc.snb.interactive.LdbcQuery13_enable=true
47 ldbc.snb.interactive.LdbcQuery14_enable=true
48
49 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
50 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
51 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
52 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
53 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
54 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
55 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
56

```

## Appendix

### A.9. Benchmark configuration

```
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
```

## Appendix

### A.10. Validation configuration

#### A.10 Validation configuration

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

```

1 url={SERVER}
2 readTimeout=5000000
3 connectTimeout=5000000
4 connectPoolMaxIdle=10
5 keepAliveDuration=5000
6 maxRequestsPerHost=180
7 maxRequests=180
8
9 printQueryNames=false
10 printQueryStrings=false
11 printQueryResults=false
12
13 status=1
14 thread_count=1
15 mode=validate_database
16 name=LDBC-SNB
17 results_log=false
18 time_unit=MILLISECONDS
19 time_compression_ratio=0.001
20 peer_identifiers=
21 workload_statistics=false
22 spinner_wait_duration=0
23 help=false
24 ignore_scheduled_start_times=true
25
26 workload=org.ldbcouncil.snb.driver.workloads.interactive.LdbcSnbInteractiveWorkload
27 db=org.ldbcouncil.snb.impls.workloads.graphscope.interactive.GraphScopeInteractiveDb
28
29 operation_count=10000
30
31 queryDir={FLEX_SN_B_FOLDER}/queries/
32 validate_database={VALIDATION_PARAMS}
33 ldbc.snb.interactive.parameters_dir={SUBSTITUTION_PARAMS}
34 # Supported scale factors are 0.1, 0.3, 1, 3, 10, 30, 100, 300, 1000
35 ldbc.snb.interactive.scale_factor=0.1
36 ldbc.snb.interactive.short_read_dissipation=0.2
37
38 ldbc.snb.interactive.LdbcQuery1_freq=1
39 ldbc.snb.interactive.LdbcQuery2_freq=1
40 ldbc.snb.interactive.LdbcQuery3_freq=1
41 ldbc.snb.interactive.LdbcQuery4_freq=1
42 ldbc.snb.interactive.LdbcQuery5_freq=1
43 ldbc.snb.interactive.LdbcQuery6_freq=1
44 ldbc.snb.interactive.LdbcQuery7_freq=1
45 ldbc.snb.interactive.LdbcQuery8_freq=1
46 ldbc.snb.interactive.LdbcQuery9_freq=1
47 ldbc.snb.interactive.LdbcQuery10_freq=1
48 ldbc.snb.interactive.LdbcQuery11_freq=1
49 ldbc.snb.interactive.LdbcQuery12_freq=1
50 ldbc.snb.interactive.LdbcQuery13_freq=1
51 ldbc.snb.interactive.LdbcQuery14_freq=1
52
53 ldbc.snb.interactive.LdbcQuery1_enable=true
54 ldbc.snb.interactive.LdbcQuery2_enable=true

```



## Appendix

### A.10. Validation configuration

```
55 ldbc.snb.interactive.LdbcQuery3_enable=true
56 ldbc.snb.interactive.LdbcQuery4_enable=true
57 ldbc.snb.interactive.LdbcQuery5_enable=true
58 ldbc.snb.interactive.LdbcQuery6_enable=true
59 ldbc.snb.interactive.LdbcQuery7_enable=true
60 ldbc.snb.interactive.LdbcQuery8_enable=true
61 ldbc.snb.interactive.LdbcQuery9_enable=true
62 ldbc.snb.interactive.LdbcQuery10_enable=true
63 ldbc.snb.interactive.LdbcQuery11_enable=true
64 ldbc.snb.interactive.LdbcQuery12_enable=true
65 ldbc.snb.interactive.LdbcQuery13_enable=true
66 ldbc.snb.interactive.LdbcQuery14_enable=true
67
68 ldbc.snb.interactive.LdbcShortQuery1PersonProfile_enable=true
69 ldbc.snb.interactive.LdbcShortQuery2PersonPosts_enable=true
70 ldbc.snb.interactive.LdbcShortQuery3PersonFriends_enable=true
71 ldbc.snb.interactive.LdbcShortQuery4MessageContent_enable=true
72 ldbc.snb.interactive.LdbcShortQuery5MessageCreator_enable=true
73 ldbc.snb.interactive.LdbcShortQuery6MessageForum_enable=true
74 ldbc.snb.interactive.LdbcShortQuery7MessageReplies_enable=true
75
76 ldbc.snb.interactive.LdbcUpdate1AddPerson_enable=true
77 ldbc.snb.interactive.LdbcUpdate2AddPostLike_enable=true
78 ldbc.snb.interactive.LdbcUpdate3AddCommentLike_enable=true
79 ldbc.snb.interactive.LdbcUpdate4AddForum_enable=true
80 ldbc.snb.interactive.LdbcUpdate5AddForumMembership_enable=true
81 ldbc.snb.interactive.LdbcUpdate6AddPost_enable=true
82 ldbc.snb.interactive.LdbcUpdate7AddComment_enable=true
83 ldbc.snb.interactive.LdbcUpdate8AddFriendship_enable=true
```