ClickHouse Practice and Contributions -- from academy to industry

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快手

About me

- Active ClickHouse Contributor
  - 200 + valid PRs
  - ~40 Stack Overflow Answers
  - Doing some code reviews occasionally

https://github.com/amosbird

- Graduated from ICT CAS with a Ph.D degree in database

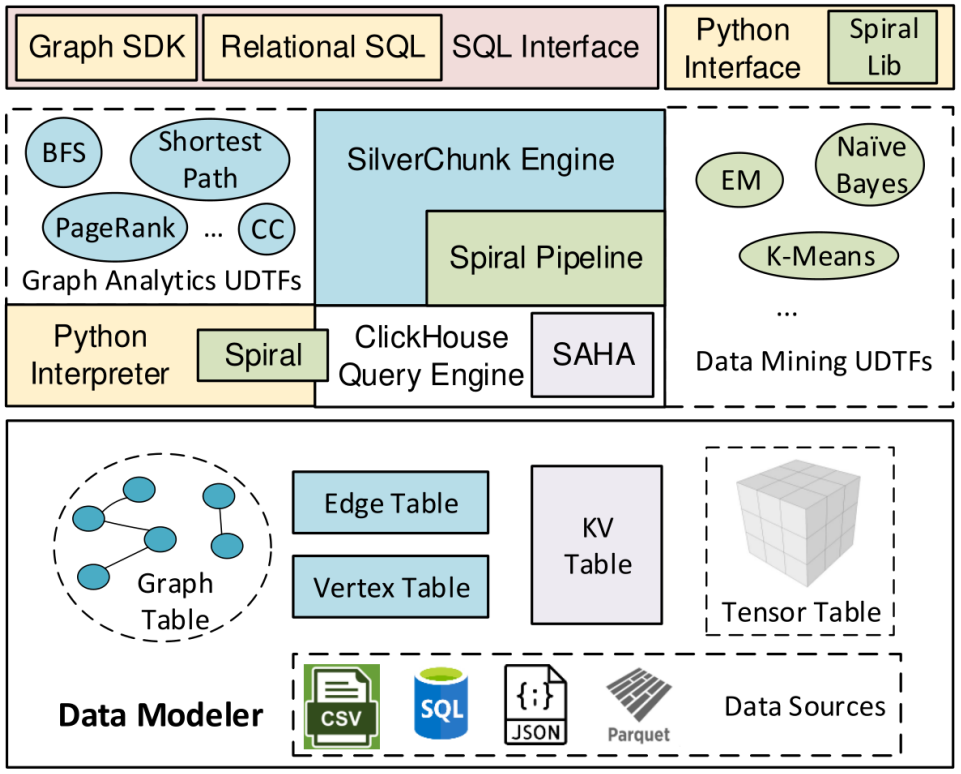
- Currently @kuaishou Data Platform Department

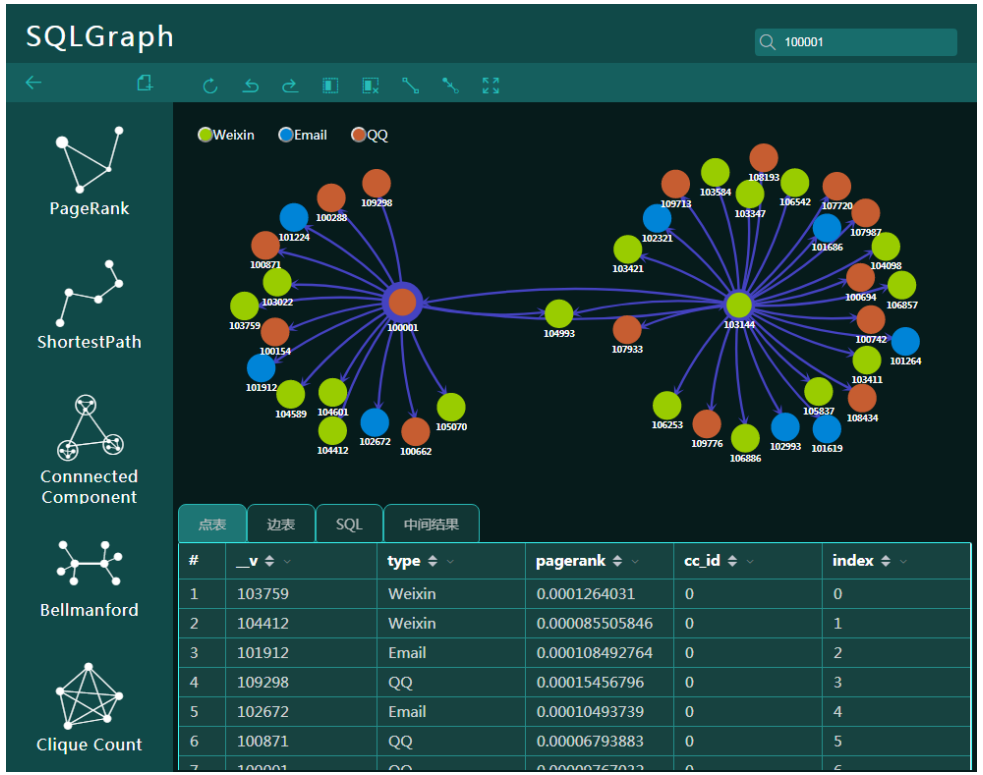
Outline

- Back in the school days – scenario exploration
- First entry into the industry – OLAP practice
- Consistent efforts in the open-source field – novel features
- Looking into the future – current working items

Back in the school days

- Try every possibilities out of ClickHouse





Back in the school days (Lessons learned)

- ClickHouse is very extensible and portable
  - A barebone computational framework (/programs)
  - A self-contained portable binary (even on Android)
  - A rich set of input/output interfaces and formats (omnipotent)

- ClickHouse is friendly to use, and easy to hack
  - There are 4 contributors in my lab, some are green hands
  - The system is understandable from top to bottom

- ClickHouse can solve real problems

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- ClickHouse is [illegible]
  - There are 4 [illegible]s
  - The system is understandable from top to bottom
- ClickHouse can solve real problems

"If some system works a little faster than ClickHouse on some degenerate query, this means that I have not yet optimized the code, and I will do it tomorrow." – Alexey Milovidov

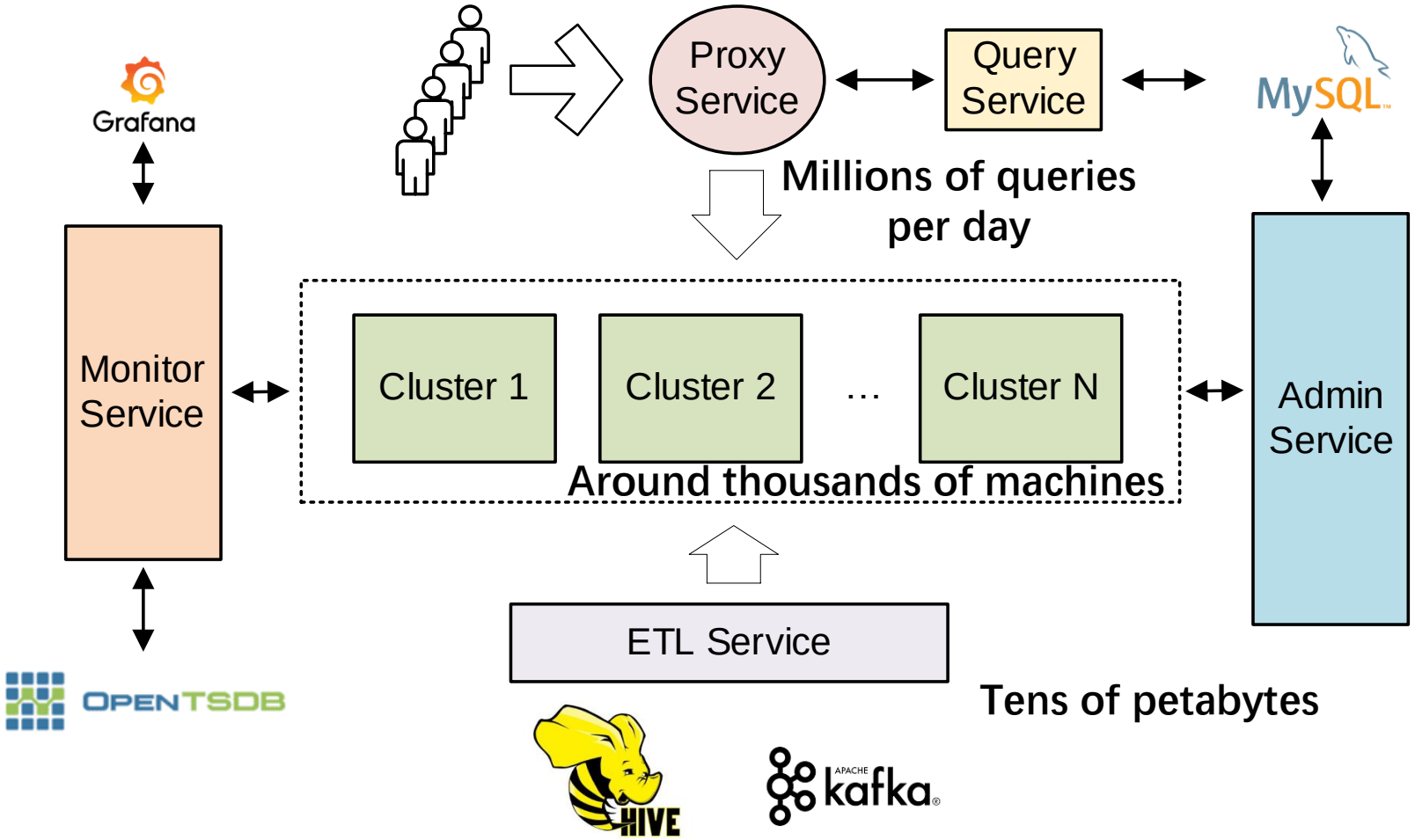
First entry into the industry

- @kuaishou for ~100 days now

- Interesting setups
  - Multiple clusters with a proxy service portal
  - Frontend of ClickHouse management
  - ETL pipelines from Hive and Kafka
  - Two kinds of ClickHouse clusters

- Demanding issues
  - HW RAID crash and IO inefficiency
  - Query optimization (mostly indices)
  - Resource management

Full picture of our ClickHouse service



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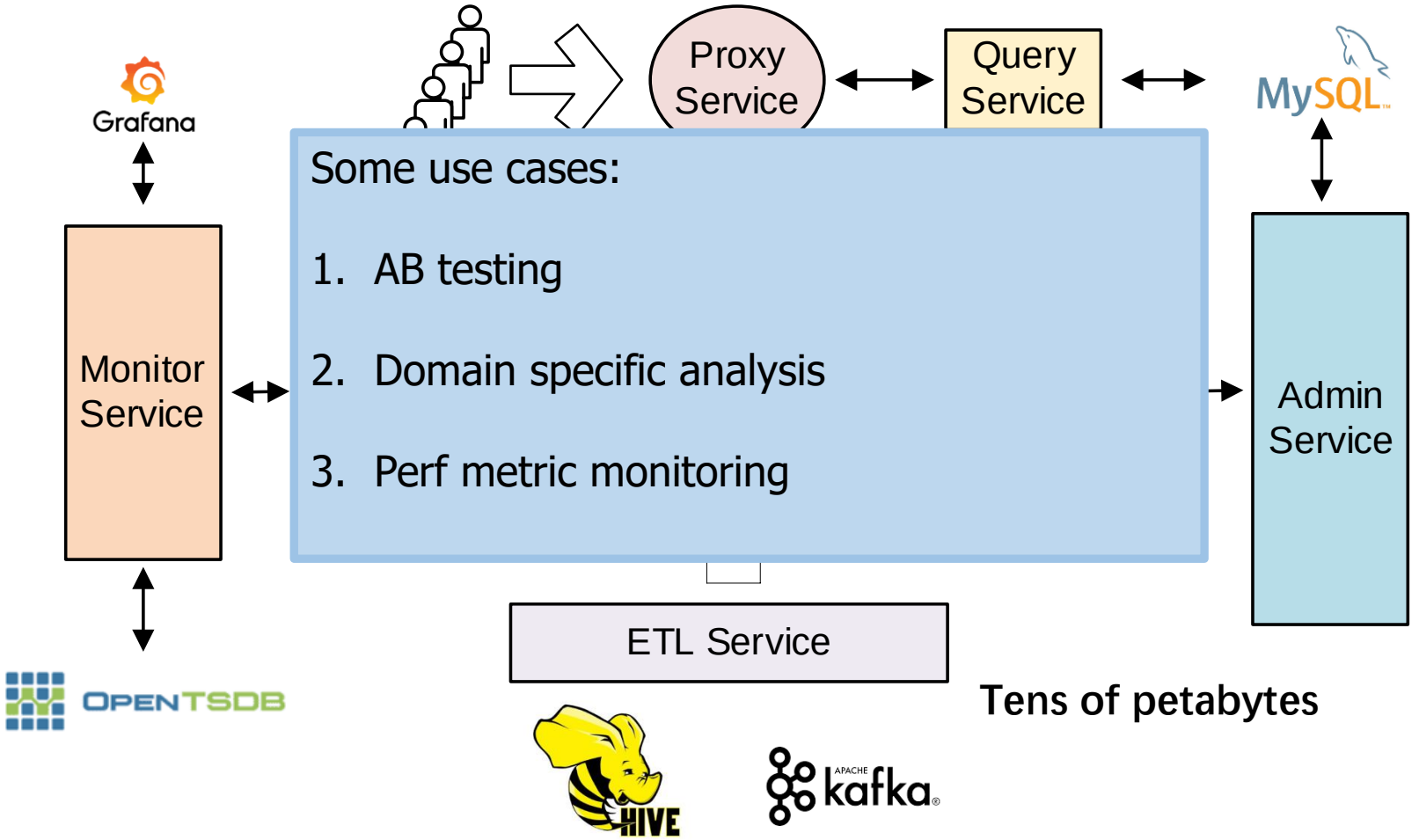

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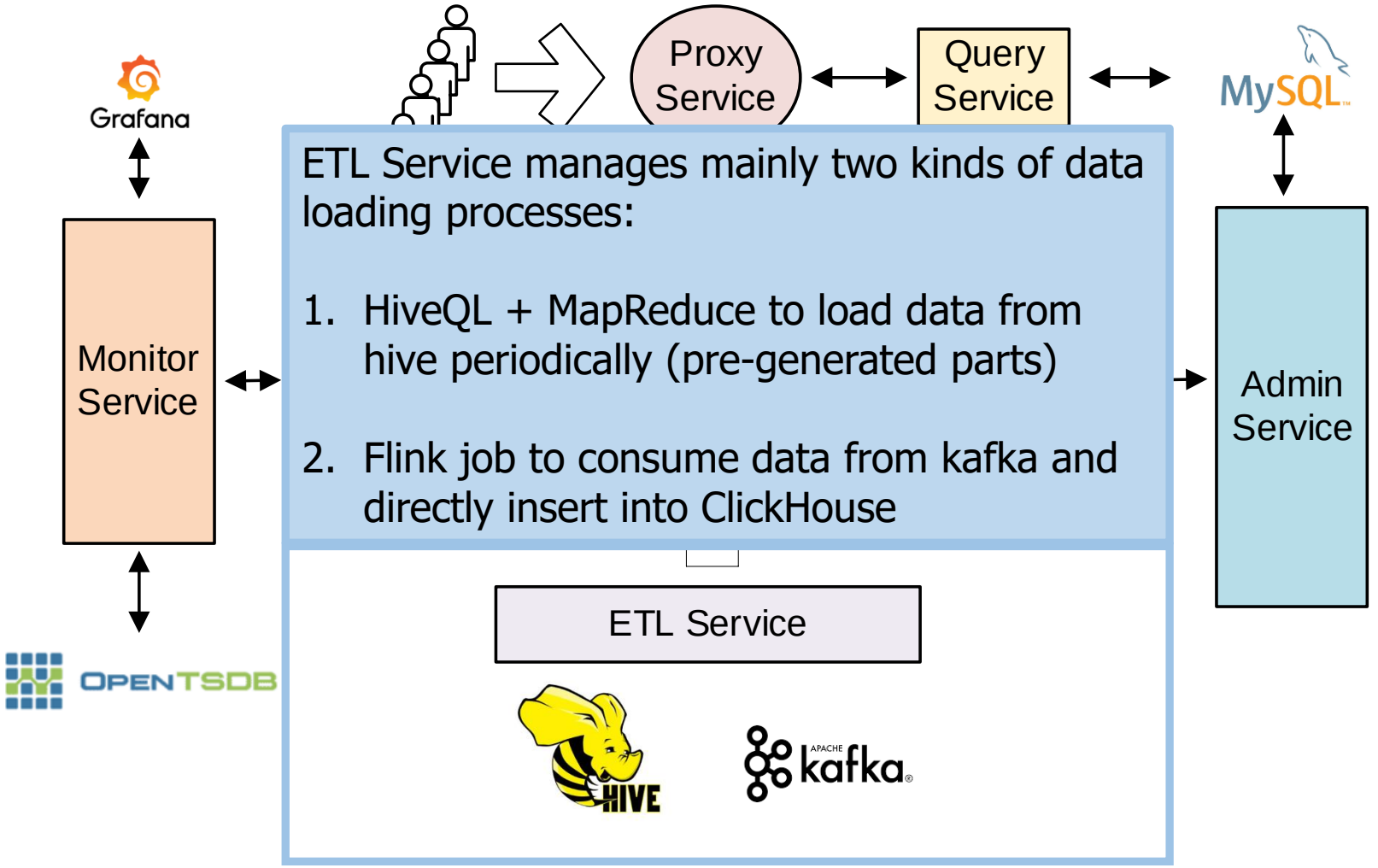

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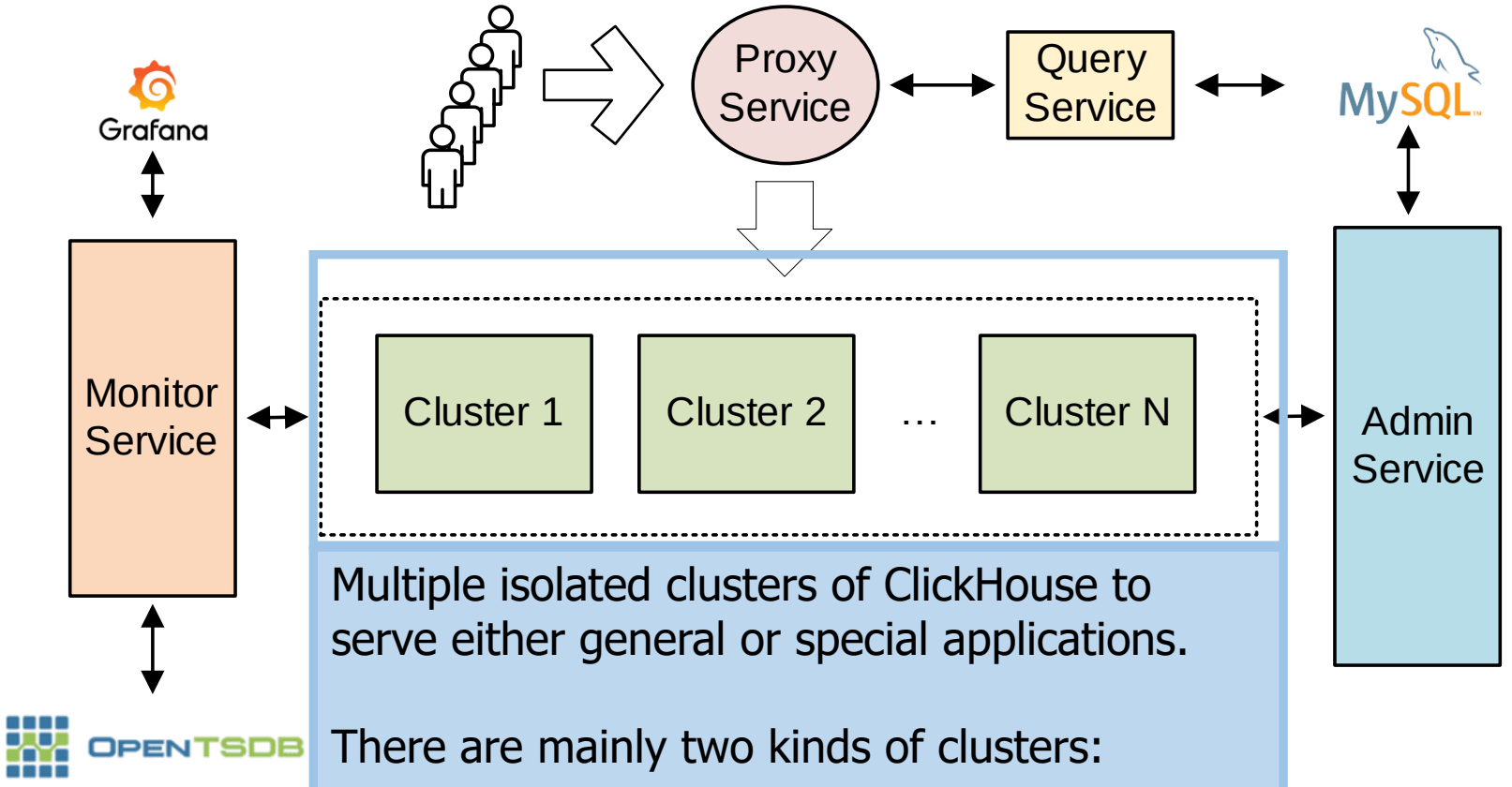

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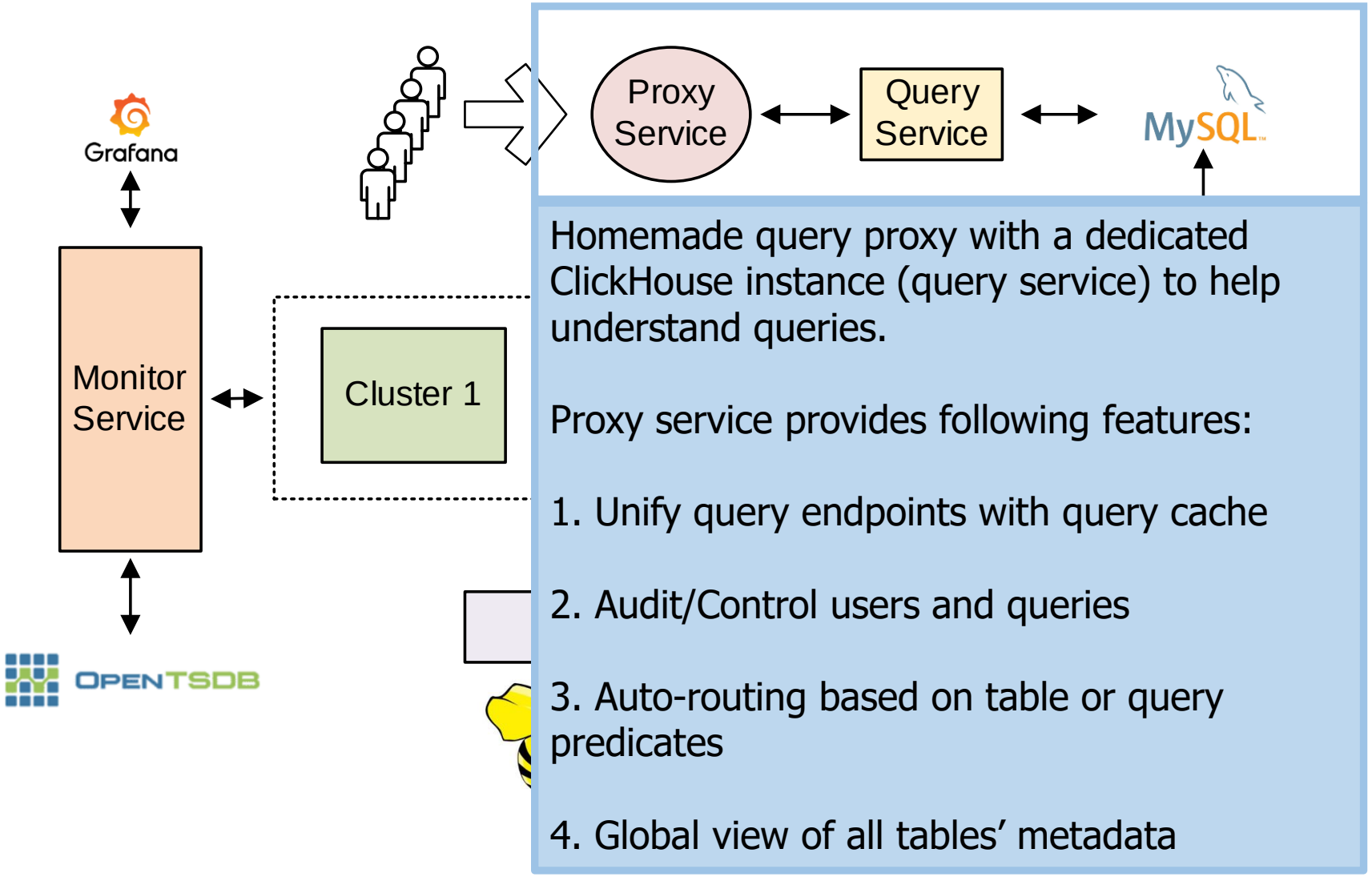

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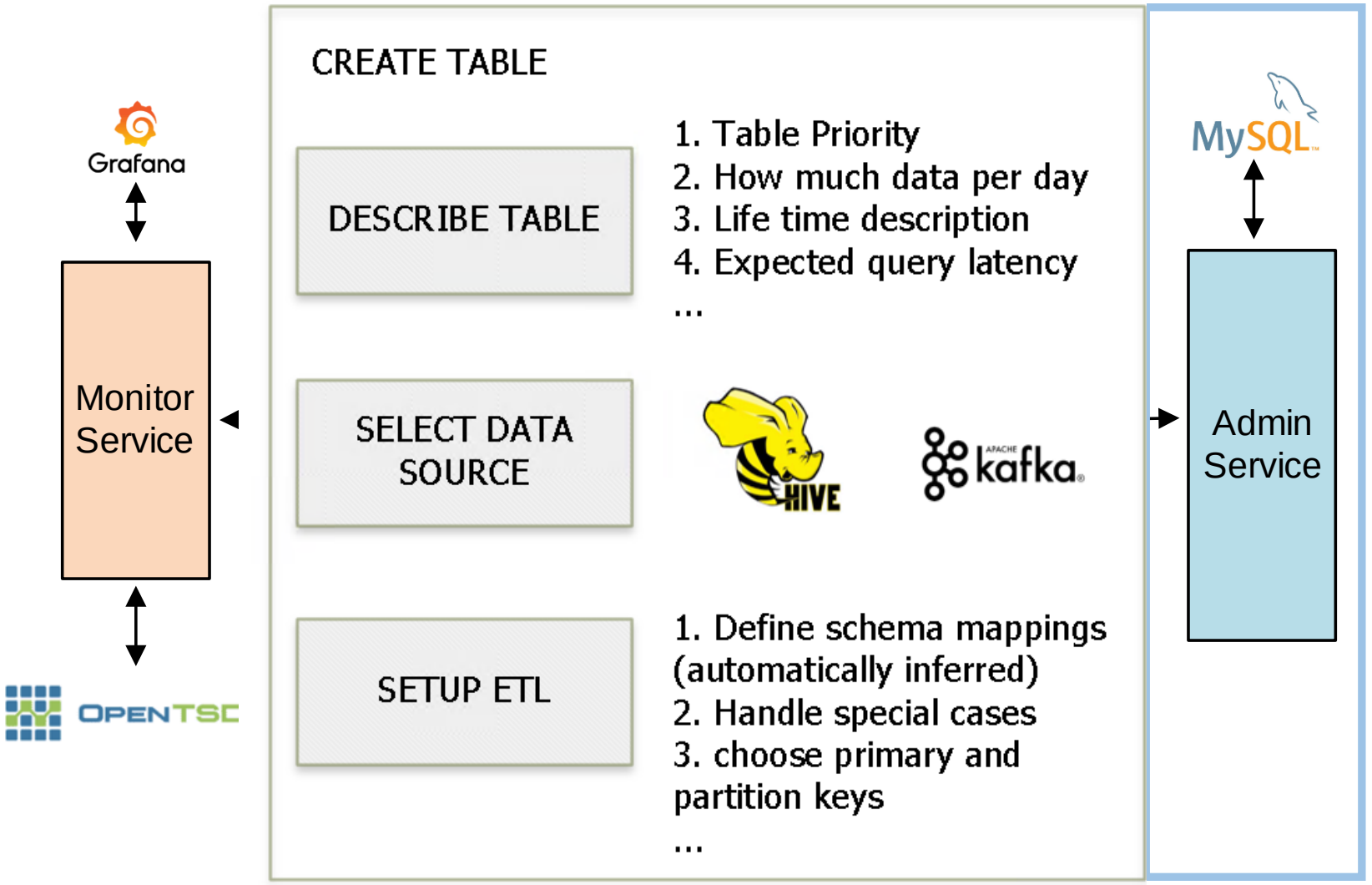

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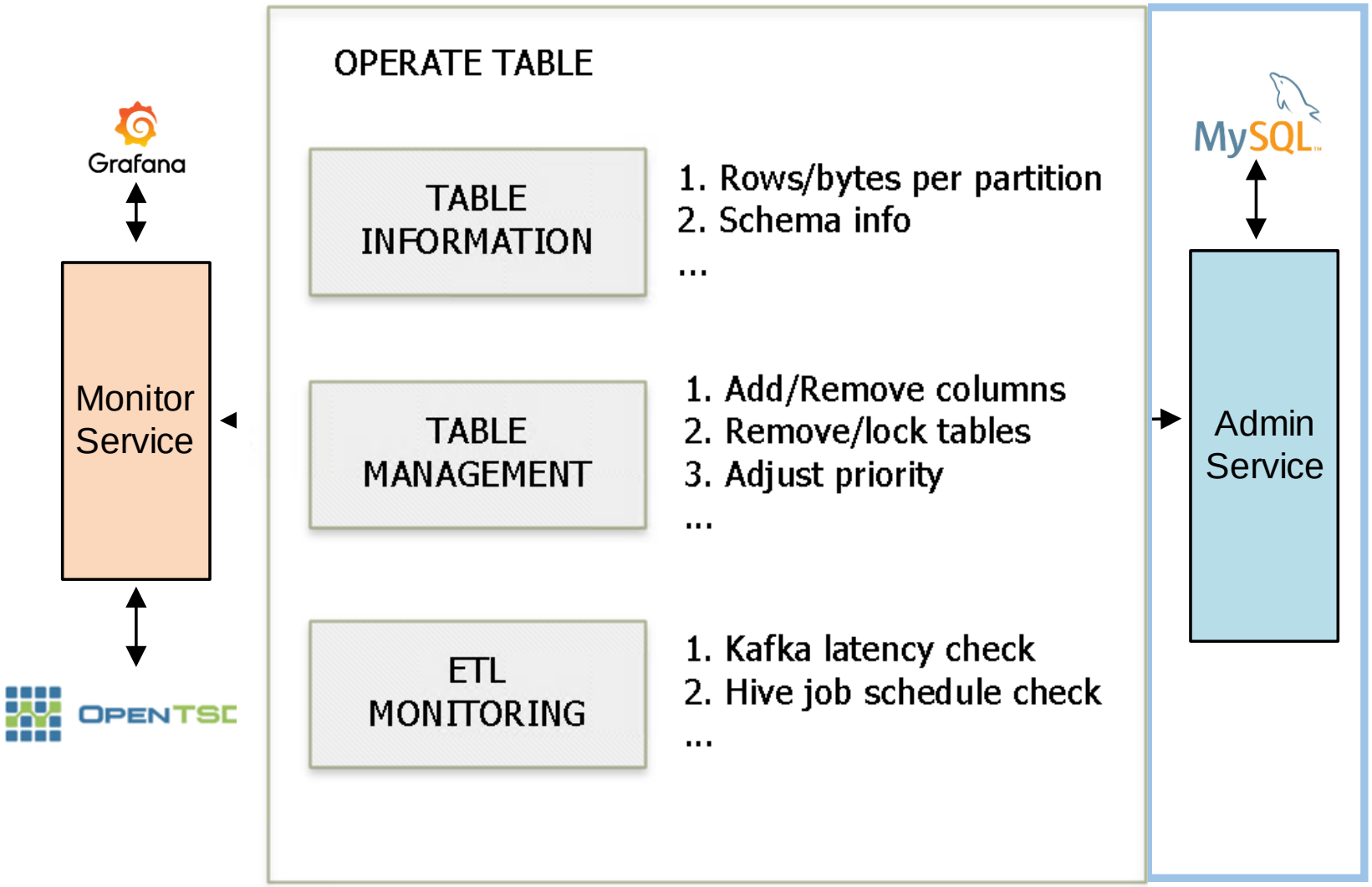

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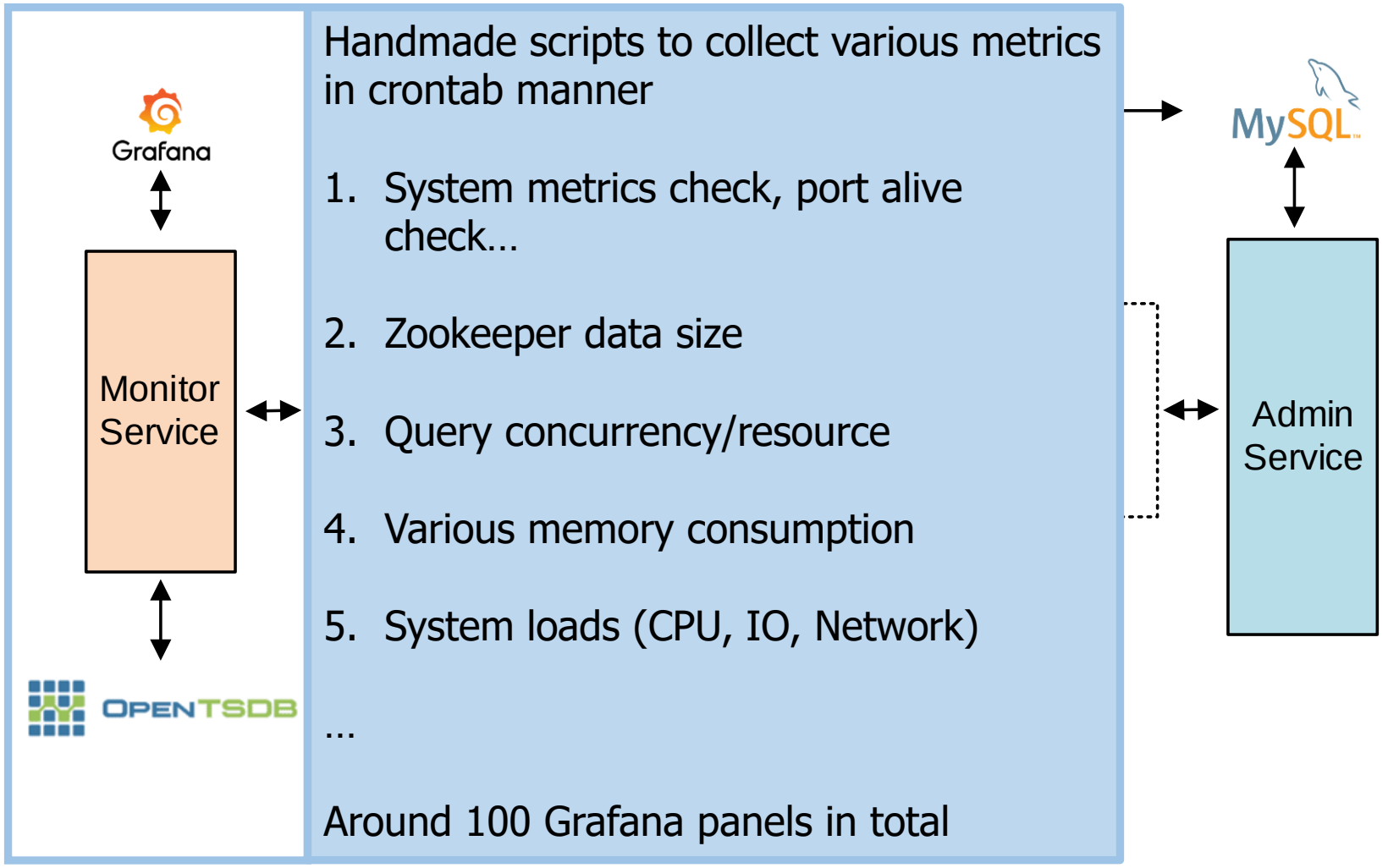
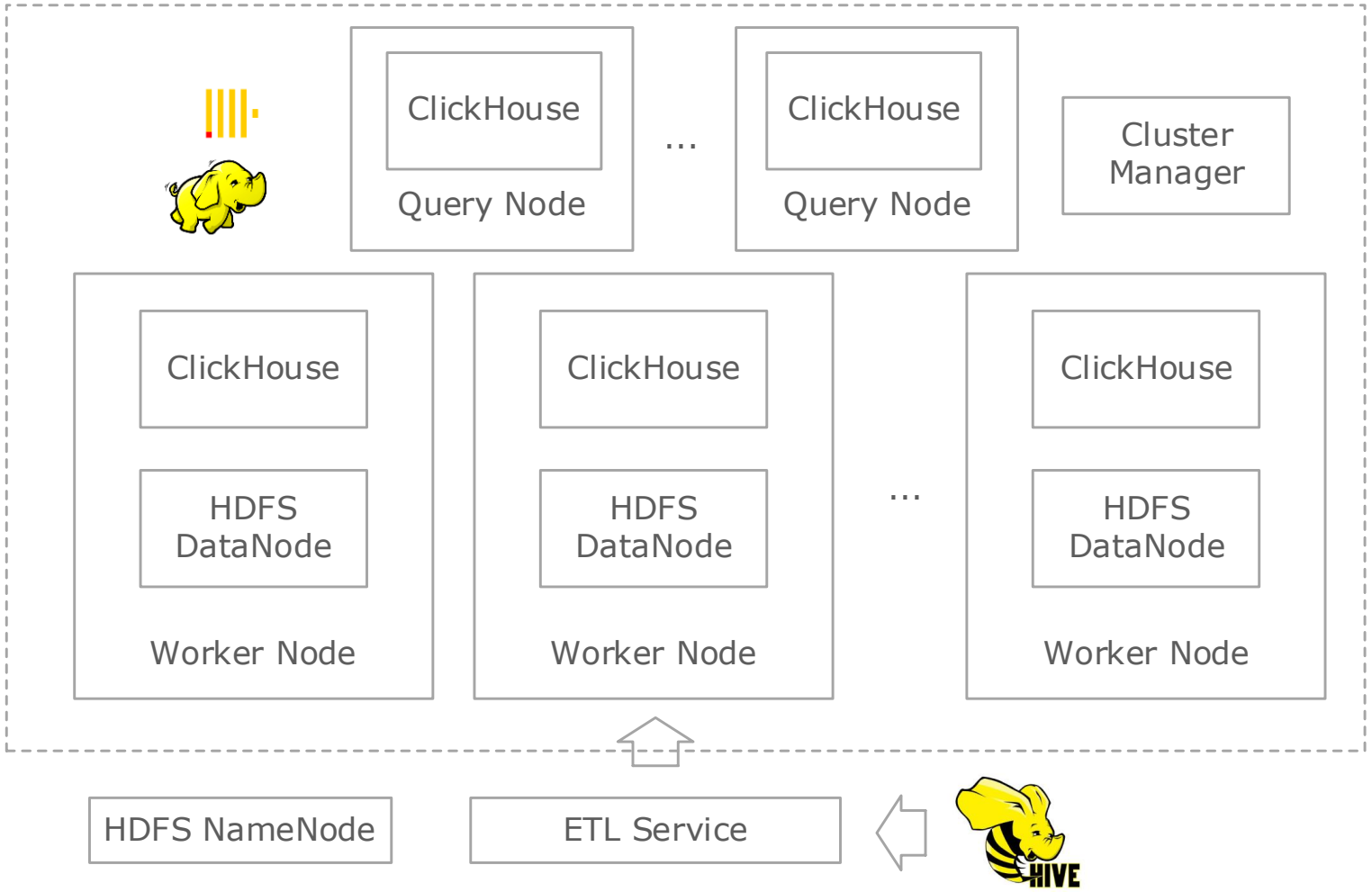


ClickHouse on HDFS



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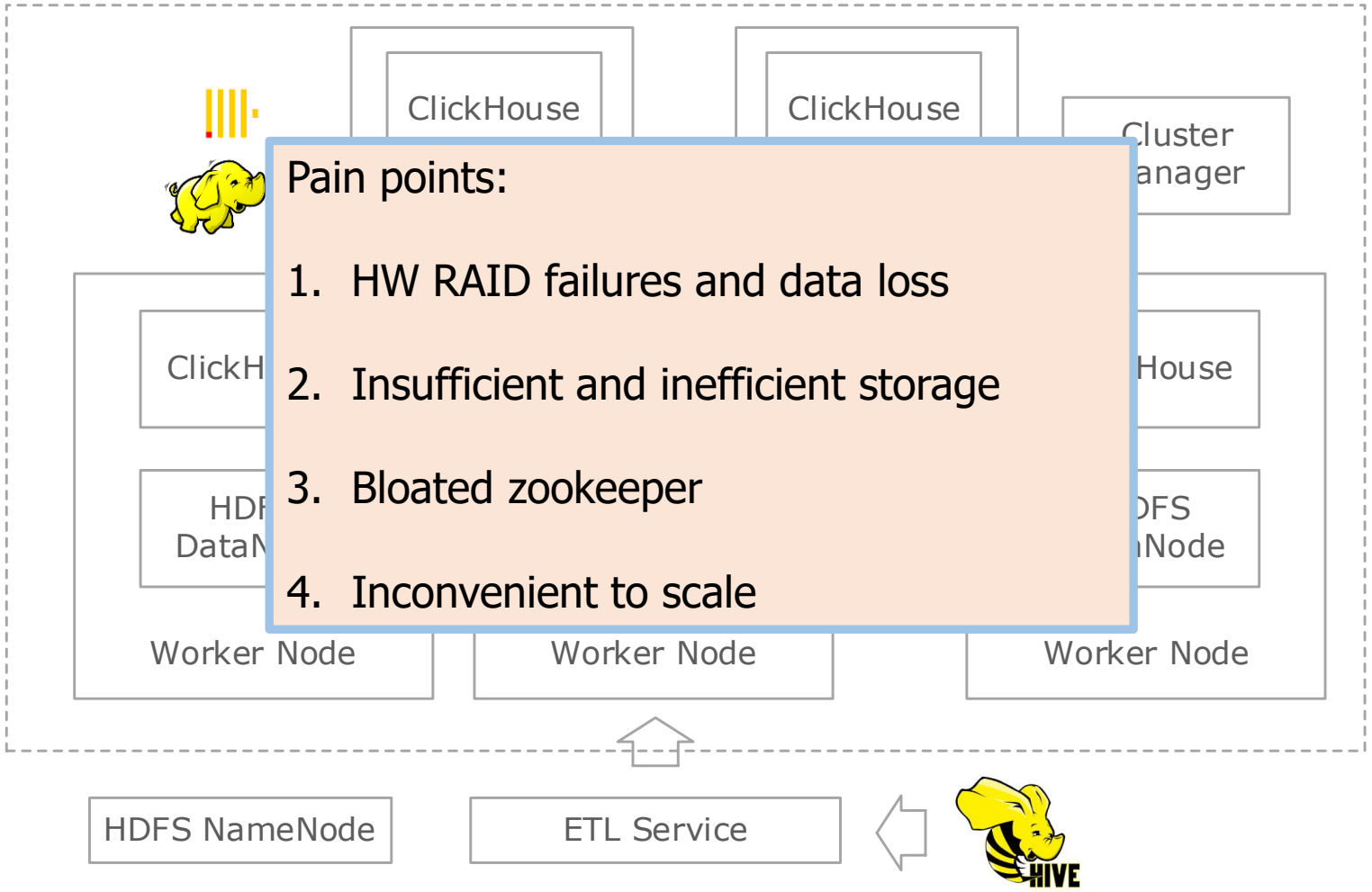

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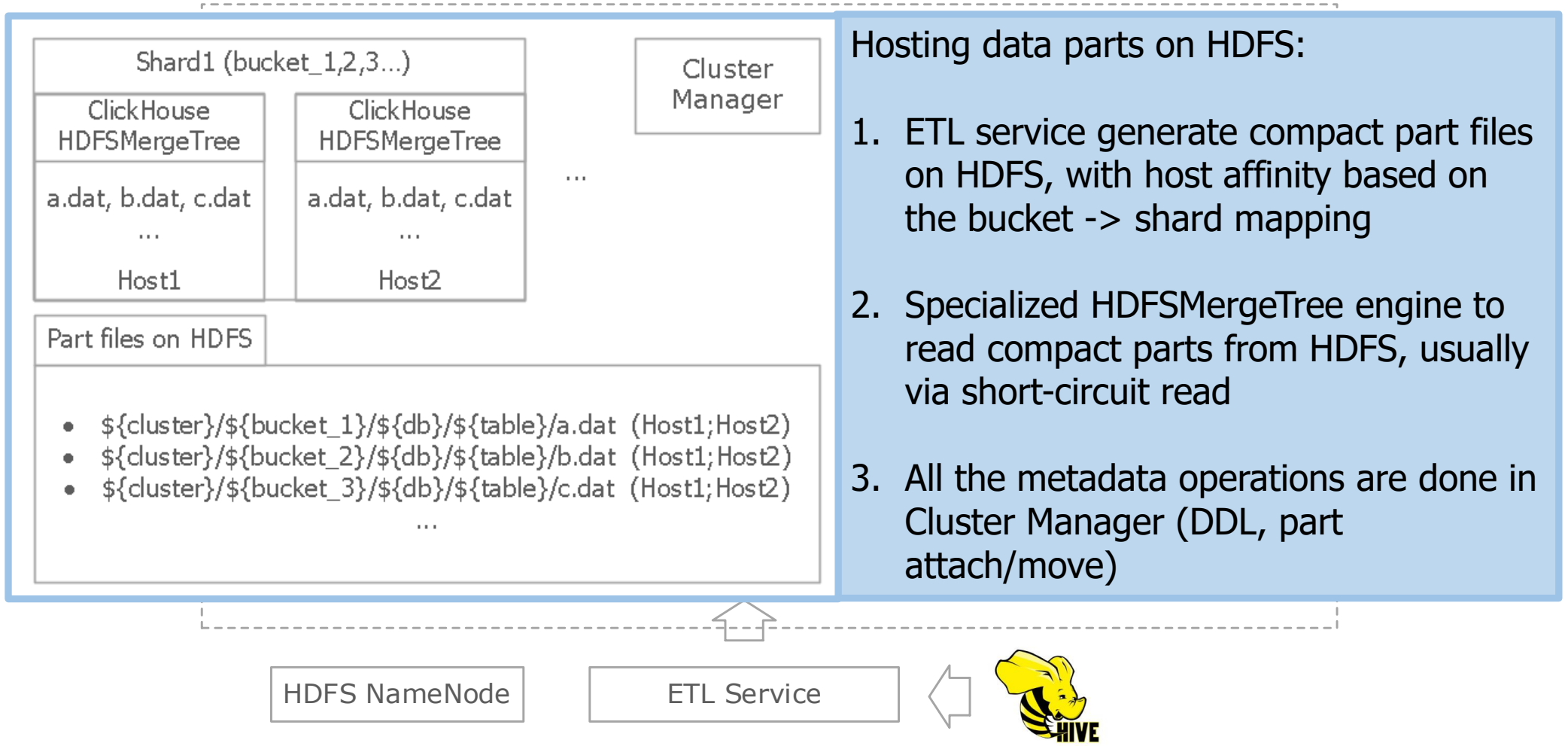
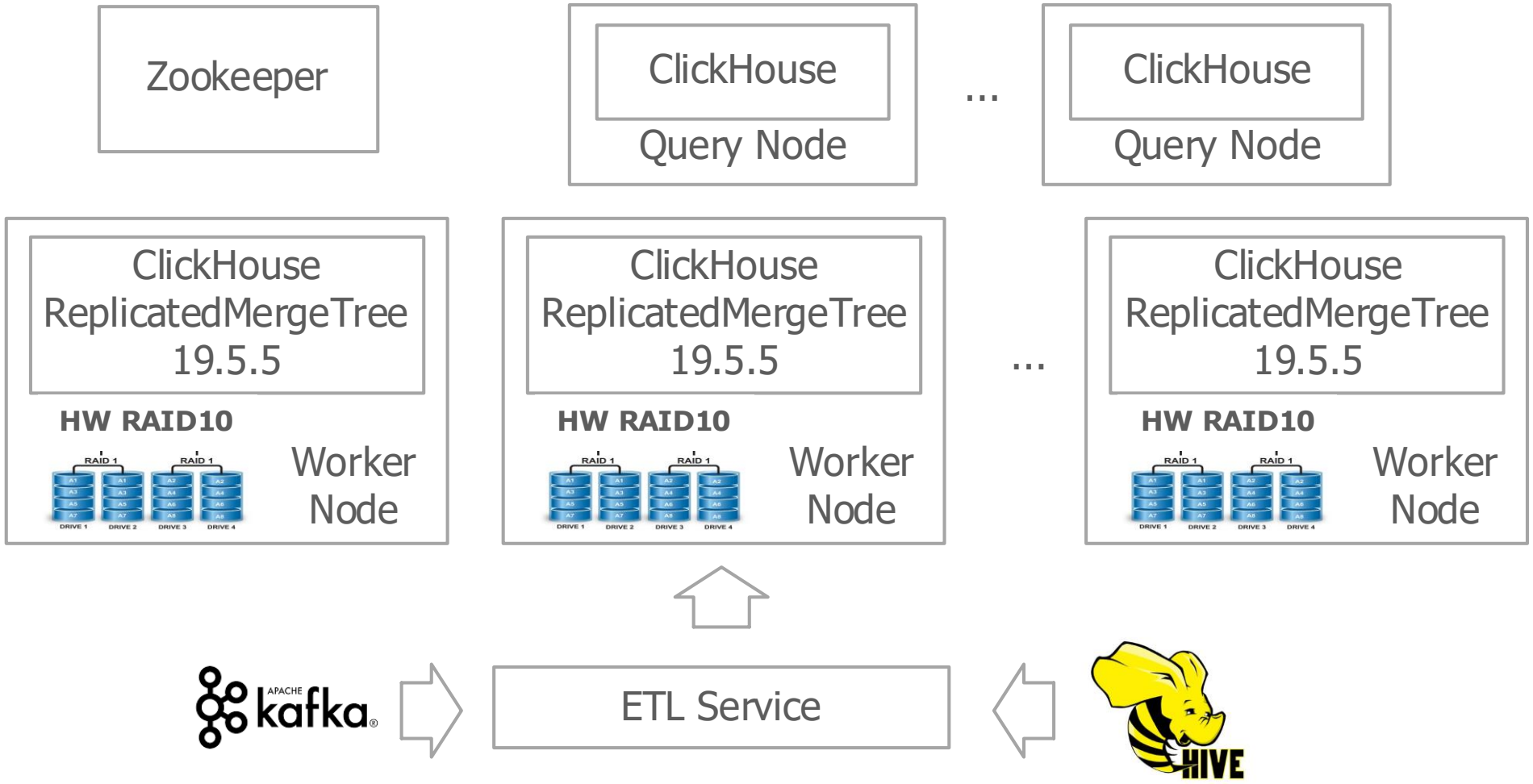


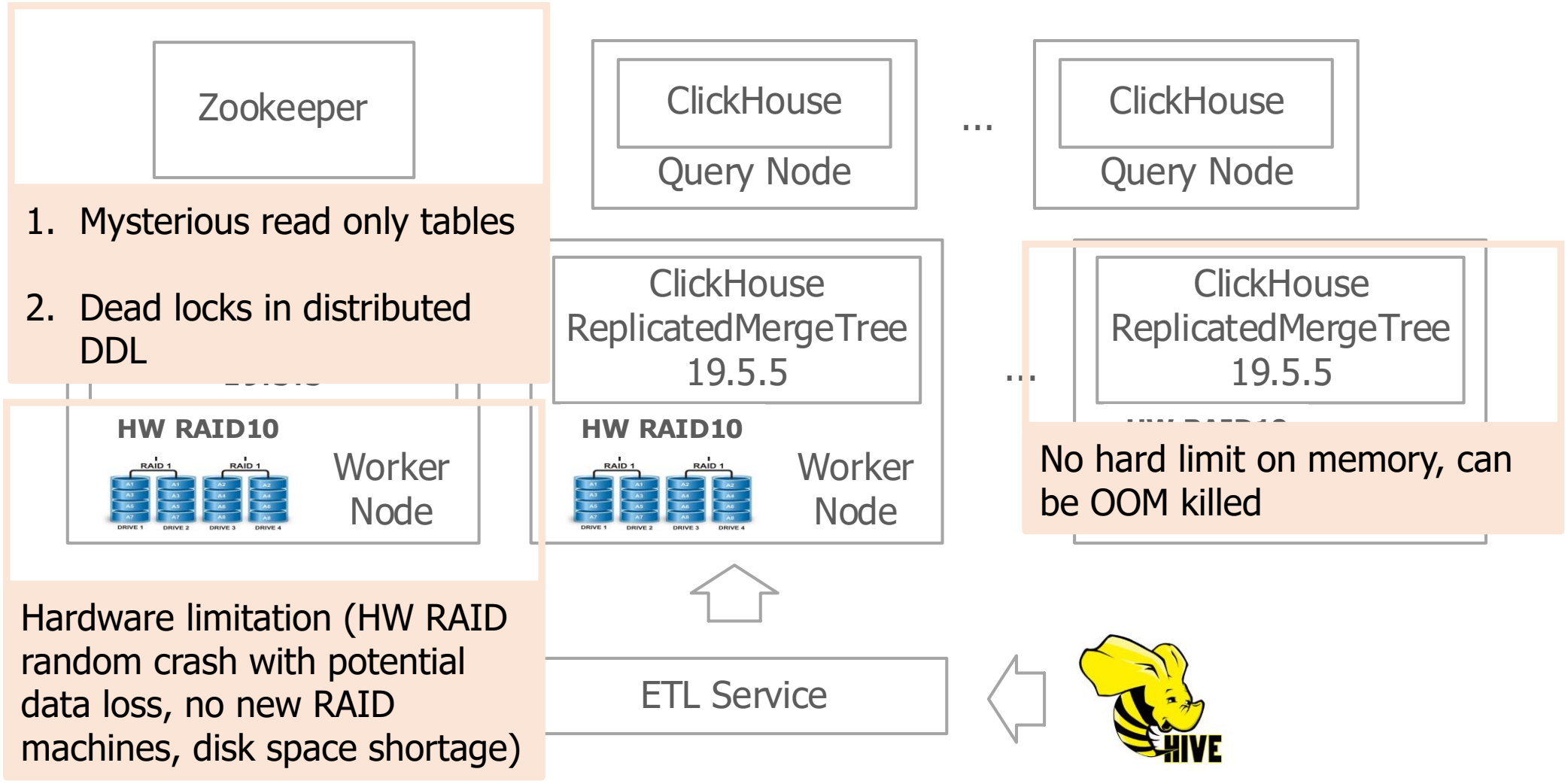
Hosting data parts on HDFS:

1. ETL service generate compact part files on HDFS, with host affinity based on the bucket -> shard mapping
2. Specialized HDFSMergeTree engine to read compact parts from HDFS, usually via short-circuit read
3. All the metadata operations are done in Cluster Manager (DDL, part attach/move)

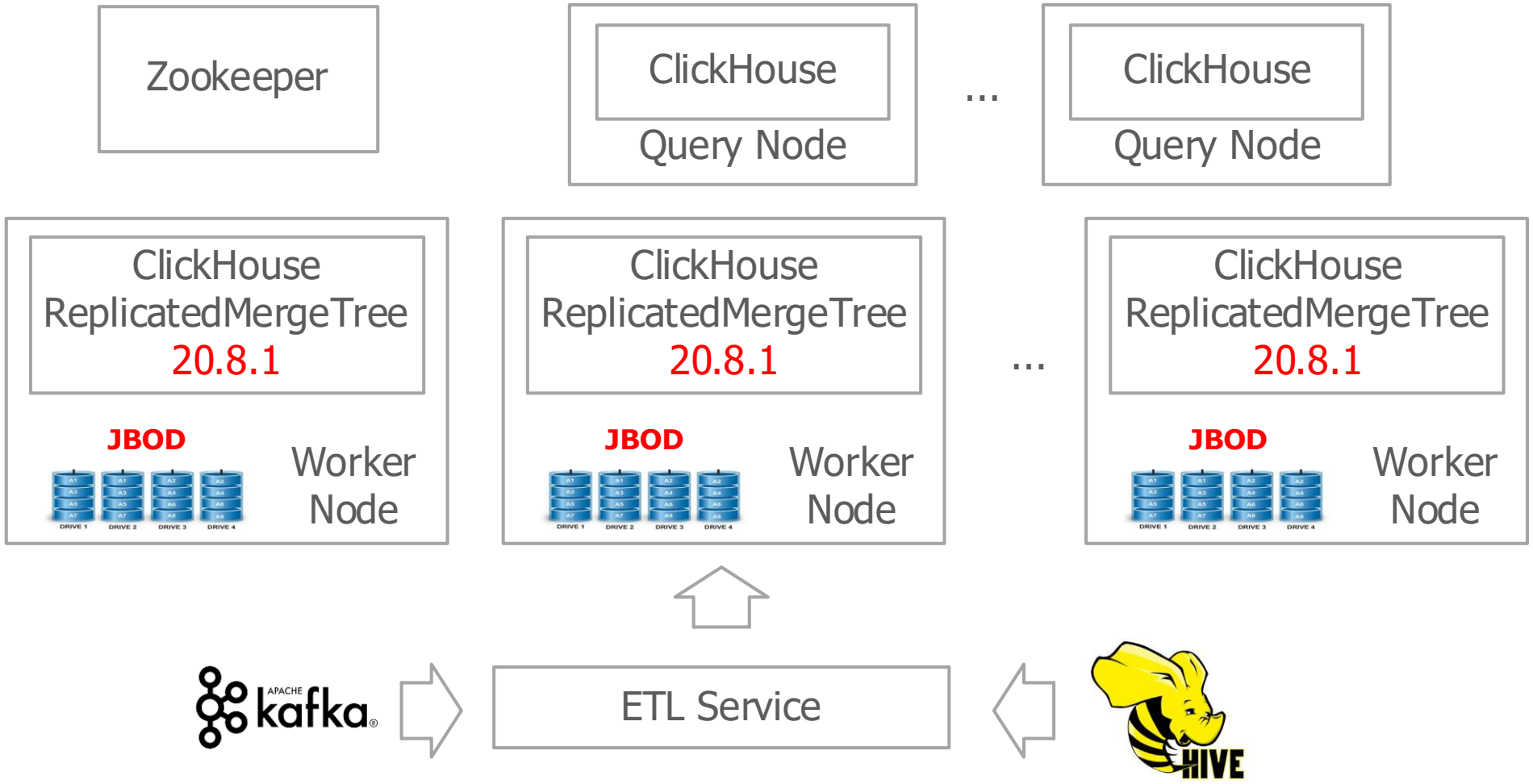
Vanilla ClickHouse (Before)



Vanilla ClickHouse (Pain points recap)



Vanilla ClickHouse (After)



Things we learned in rolling upgrade

- Disable DDL operations or else ReplicatedMergeTree would be stuck at some unrecognizable entry and data insertion will eventually stop

- Do not allow new instances to be leader, or else the new instances assign merges aggressively and the old instances might OOM. Also need to disable *index_granularity_bytes* and *write_final_mark*
  - Bonus point: Prepare to recovery data files from broken marks (kudos to Alexey)

- Distributed queries should be sent to new instances to get correct results

Things we did after using JBOD

- Automatically recover parts when some disk is broken
- Diagnose bad IO utilization and tune disk settings
- Observe read clustering and tail latency issue, solved by balanced JBOD read
- Balance query related data files over JBOD array (WIP)

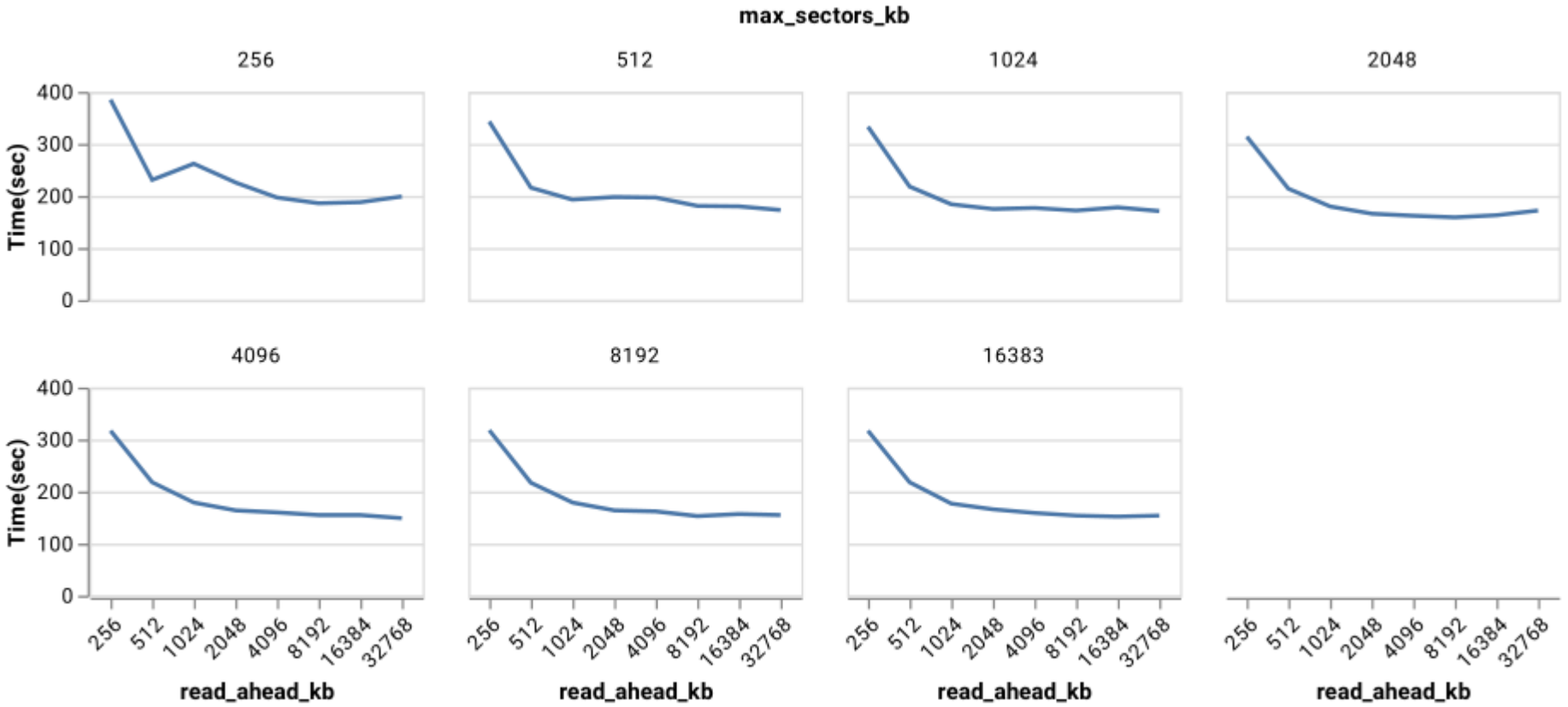
JBOD disk auto-recovery

- Each local disk spawns a disk checker thread, which gives three states: broken, healthy, recovered.
- Disk checker will automatically transit disks from healthy to broken or broken to recovered. One need to create a .recover file in the disk path to bring recovered into healthy (avoid flaky disks)
- Each ReplicatedMergeTree table constantly checks if a part is on an unhealthy disk and starts to recover all related parts.
- Whenever a query scans a broken part, it starts to recover instantly.

https://github.com/ClickHouse/ClickHouse/pull/13544

Some test results of JBOD

- Disk read-ahead tuning benchmark using long running queries



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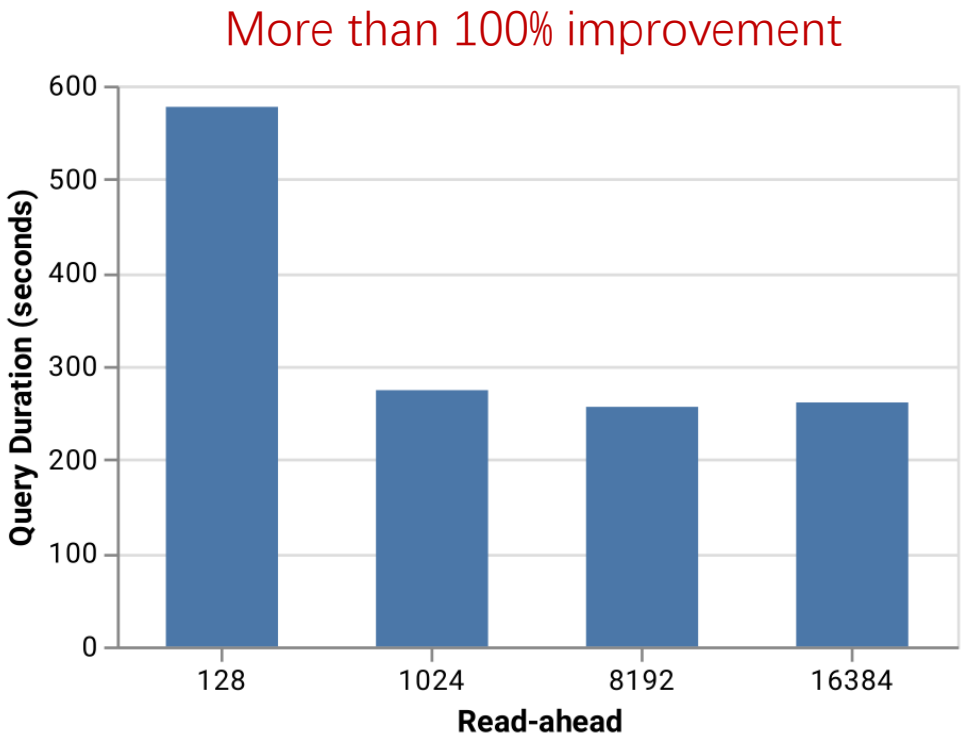
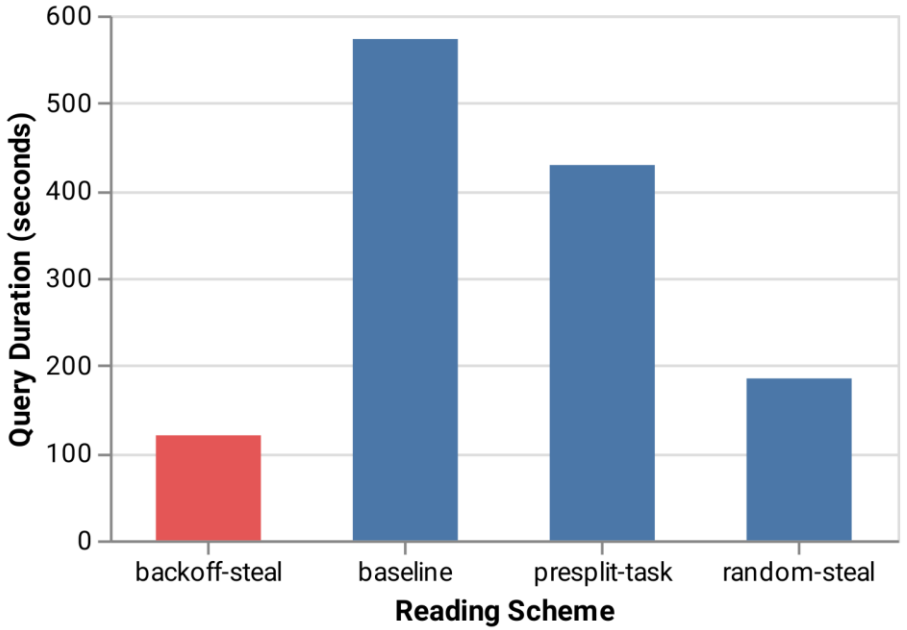


Balanced read among JBOD disks

- Avoid read clustering and tail latency

Significant improvements, more than 400%



https://github.com/ClickHouse/ClickHouse/pull/16423

Balanced data among JBOD disks (WIP)

- Focused on long running queries targeting for given partitions (usually a day)
- Lower *max_bytes_to_merge_at_max_space_in_pool* to have smaller but more parts (hopefully gets better balanced)
- Currently balance via ALTER PART MOVE in crontab manner
- Eventually will have automatic part balancer over JBOD array

https://github.com/ClickHouse/ClickHouse/pull/16481

Nullable primary key

- Almost 99% of columns are Nullable in production
- Nulls are default to be greater than any other values. It's trivial to allow Nullable types appearing in the primary key expression, but a bit tricky to have index condition work correctly.
- We introduce '-inf' and '+inf' as two value sentinels and let Null = +inf. Index processing is extended to handle these sentinels.

https://github.com/ClickHouse/ClickHouse/pull/12455

Index usage optimization (Monotonicity)

- toDate is not satuerated
  - toDate will not work when a part doesn't have a final mark (+Inf)
  - toDate might not work when a part's primary key range outside one monotonic interval

- Binary operator with a constant argument (notably division)

- Now we can have `toDate(timestamp_ms / 1000)` work as index column

https://github.com/ClickHouse/ClickHouse/pull/13497

https://github.com/ClickHouse/ClickHouse/pull/14513

Partition predicates optimization

- Prune partition in verbatim way
  - Partition expressions can be wrapped in non-monotonic functions, such as hashing and modulo.
  - We use the invariant: Partition value is fixed in each part, and filter parts with that value and given predicates.
- Instant count() with partition predicates
  - We use similar technology to select parts that are always true and filter parts that are always false. When there is nothing left, we return the count

https://github.com/ClickHouse/ClickHouse/pull/16253

https://github.com/ClickHouse/ClickHouse/pull/15074

Consistent efforts in the open-source field

- Column transformers
- untuple (feat. Nikolai)
- CTE and global with
- protobuf format schema via HDFS
- View function
- Fetch partitions from another cluster
- clickhouse-client Introspection usability

Column transformers

- Idea is originated from Big Query and suggested by Alexey
- Three kinds of column matchers: “ `*, table.* and COLUMNS(<regexp>)`” are extended to do column transformations

https://github.com/ClickHouse/ClickHouse/pull/14233

Column transformers

- Some examples

```
SELECT * APPLY(sum)
FROM columns_transformers

┌─sum(i)─┬─sum(j)─┬─sum(k)─┐
│    220 │     18 │    347 │
└────────┴────────┴────────┘
```

```
SELECT columns_transformers.* EXCEPT(j) APPLY(avg)
FROM columns_transformers

┌─avg(i)─┬─avg(k)─┐
│    110 │  173.5 │
└────────┴────────┘
```

```
SELECT columns_transformers.* REPLACE(j + 2 AS j, i + 1 AS i) APPLY(avg)
FROM columns_transformers

┌─avg(plus(i, 1))─┬─avg(plus(j, 2))─┬─avg(k)─┐
│             111 │              11 │  173.5 │
└─────────────────┴─────────────────┴────────┘
```

Column transformers

- Useful for INSERT SELECT

```
INSERT INTO insert_select_dst(* EXCEPT (middle_a, middle_b)) SELECT * FROM insert_select_src
```

- Schema transformers?

```
INSERT INTO table SELECT * FROM file('./table/*','CSV', schema(table EXCEPT …))
```

  - Some discussion https://github.com/ClickHouse/ClickHouse/issues/16295

untuple (feat. Nikolai)

- The missing feature of named tuples.

```
SELECT
    key,
    untuple(argMax(tuple(* EXCEPT(key)), v1))
FROM kv
GROUP BY key
```

key	v1	v2	v3	v4	v5
4	10	20	10	20	30
3	70	20	10	20	30
2	11	20	10	20	30
5	10	20	10	20	30
1	20	20	10	20	30
6	10	20	10	20	30
7	18	20	10	20	30
8	30	20	10	20	30

https://github.com/ClickHouse/ClickHouse/pull/16242

CTE (common table expression)

- ClickHouse has exotic support of the WITH statement. It's used to introduce scalar aliases into the query context.
  - WITH 1 AS a, (select * from table) AS b SELECT ⋯
- Sometimes we need to have named subqueries introduced as table objects (not scalars). The syntax is consistent with standard.
  - WITH s AS (select * from table) SELECT * from s

https://github.com/ClickHouse/ClickHouse/pull/14771

Near future in kuaishou

- Projections
  - Consistent materialized views at part level
- External table powered by elastic search
  - Used to serve updates and full text search
- Resource management

Thank You!