QINGCLOUD

Continue to use ClickHouse as TSDB

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Why we choose it

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不断收集CPU、
Memory等系统指标预
测系统未来趋势

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Why we choose it

不断的汇总日成交量从而制定商业规划

商务分析

不断收集市场变化信息预测股价涨跌

股票交易

不断收集CPU、Memory等系统指标预测系统未来趋势

系统监控

不断收集温度，坐标，方向，速度等指标，优化路线和驾驶方式

自动驾驶

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Why we choose it

- 上述业务数据特点:
  - (1) 数据多
  - (2) 旧数据趋于不变
  - (3) 新数据更有价值
  - (4) 数据总是随时间变化而不断变化

Why we choose it

- 解决方案
  - (1) Row-Orient Database
  - (2) Column-Orient Database
  - (3) Time-Series-Orient Database

INSERT INTO ...

Time	Name	Age	Humidity	HeartRate	Localtion	...	Temperature
2019/10/10/ 10:00:00	Tracy	22	45%	95	116.29860 40.13091	...	11
2019/10/10/ 10:00:00	Tom	26	45%	92	121.55687 31.31908	...	20
...	...	...	...	...	...	...	...
2019/10/11/ 11:00:01	Tracy	22	45%	90	116.30101 31.31673	...	11
2019/10/11/ 11:00:01	Tom	26	45%	96	121.54794 31.32318	...	21

Why we choose it

- Row-Orient Database

Time	Name	Age	Humidity	HeartRate	…	Temperature
2019/10/10/ 10:00:00	Tracy	22	45%	95	…	11
2019/10/10/ 10:00:00	Tom	26	45%	92	…	20
…	…	…	…	…	…	…
2019/10/11/ 11:00:01	Tracy	22	45%	90	…	11
2019/10/11/ 11:00:01	Tom	26	45%	96	…	21

Why we choose it

SELECT HeartRate FROM …
WHERE Time BETWEEN … AND … AND Name = “Tom”

Time	Name	Age	Humidity	HeartRate	…	Temperature
2019/10/10/ 10:00:00	Tracy	22	45%	95	…	11
2019/10/10/ 10:00:00	**Tom**	**26**	**45%**	**92**	**…**	**20**
…	…	…	…	…	…	…
2019/10/11/ 11:00:01	Tracy	22	45%	90	…	11
2019/10/11/ 11:00:01	**Tom**	**26**	**45%**	**96**	**…**	**21**

Red : Data needed **Green** : Data Scaned

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Why we choose it

- Column-Orient Database

Time	Name	Age	Humidity	HeartRate	Localtion	Temperature	…
2019/10/10/ 10:00:00	Tracy	22	45%	95	116.29860 40.13091	11	…
2019/10/10/ 10:00:00	Tom	26	45%	92	121.55687 31.31908	20	…
…	…	…	…	…	…	…	…
2019/10/11/ 11:00:01	Tracy	22	45%	90	116.30101 31.31673	11	…
2019/10/11/ 11:00:01	Tom	26	45%	96	121.54794 31.32318	21	…

Why we choose it

SELECT HeartRate FROM …
WHERE Time BETWEEN … AND … AND Name = “Tom”

Time	Name	Age	Humidity	HeartRate	Localtion	Temperature	…
2019/10/10/ 10:00:00	**Tracy**	22	45%	**95**	116.29860 40.13091	11	…
2019/10/10/ 10:00:00	**Tom**	26	45%	**92**	121.55687 31.31908	20	…
…	**…**	…	…	**…**	…	…	…
2019/10/11/ 11:00:01	**Tracy**	22	45%	**90**	116.30101 31.31673	11	…
2019/10/11/ 11:00:01	**Tom**	26	45%	**96**	121.54794 31.32318	21	…

Red : Data needed **Green** : Data Scaned

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Why we choose it

- Time-Series Database

Name	Age	Metric	Time Interval	00:00	00:01	…	59:59
Tracy	22	Humidity	2019/10/10/ 10	45%	…	…	…
Tracy	22	HeartRate	2019/10/10/ 10	95	…	…	…
…	…	…	…	…	…	…	…
Tom	26	Humidity	2019/10/10/ 10	45%	…	…	…
Tom	26	HeartRate	2019/10/10/ 10	92	…	…	…
…	…	…	…	…	…	…	…
Tracy	22	Humidity	2019/10/10/ 11	…	45%	…	…
Tracy	22	HeartRate	2019/10/10/ 11	…	90	…	…
…	…	…	…	…	…	…	…
Tom	26	Humidity	2019/10/10/ 11	…	45%	…	…
Tom	26	HeartRate	2019/10/10/ 11	…	96	…	…
…	…	…	…	…	…	…	…

Why we choose it

SELECT HeartRate FROM …
WHERE Time BETWEEN … AND … AND Name = “Tom”

Name	Age	Metric	Time Interval	00:00	00:01	…	59:59
Tracy	22	Humidity	2019/10/10/ 10	45%	…	…	…
Tracy	22	HeartRate	2019/10/10/ 10	95	…	…	…
…	…	…	…	…	…	…	…
Tom	26	Humidity	2019/10/10/ 10	45%	…	…	…
Tom	**26**	**HeartRate**	**2019/10/10/ 10**	**92**	**…**	**…**	**…**
…	…	…	…	…	…	…	…
Tracy	22	Humidity	2019/10/11/ 11	…	45%	…	…
Tracy	22	HeartRate	2019/10/10/ 11	…	90	…	…
…	…	…	…	…	…	…	…
Tom	26	Humidity	2019/10/10/ 11	…	45%	…	…
Tom	26	HeartRate	2019/10/10/ 11	…	96	…	…
…	…	…	…	…	…	…	…

Red : Data needed **Green** : Data Scaned

Why we choose it

没有最好的解决方案

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Why we choose it

没有最好的解决方案

小孩子才做选择

“好的”我们都想要！

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How we do

How we do

- ClickHouse 实现方式
  - (1) Column-Orient Model
  - (2) Time-Series-Orient Model

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How we do

Column-Orient Model

```
CREATE TABLE demonstration.insert_view
(
  `Time` DateTime,
  `Name` String,  `Age` UInt8, ...,
  `HeartRate` UInt8, `Humidity` Float32, ...
) ENGINE = MergeTree()
PARTITION BY toYYYYMM(Time)
ORDER BY (Name, Time, Age, ...);
```

Time	Name	Age	Humidity	HeartRate	Localtion	Temperature	...
2019/10/10/ 10:00:00	Tracy	22	45%	95	116.29860 40.13091	11	...
2019/10/10/ 10:00:00	Tom	26	45%	92	121.55687 31.31908	20	...
...	...	...	...	...	...	...	...
2019/10/11/ 11:00:01	Tracy	22	45%	90	116.30101 31.31673	11	...
2019/10/11/ 11:00:01	Tom	26	45%	96	121.54794 31.32318	21	...

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How we do

► Column-Orient Model

```
CREATE TABLE demonstration.insert_view
(
    `Time` DateTime,
    `Name` LowCardinality(String), `Age` UInt8, ...,
    `HeartRate` UInt8, `Humidity` Float32, ...
) ENGINE = MergeTree()
PARTITION BY toYYYYMM(Time)
ORDER BY (Name, Time, Age, ...);
```

Time	Name Dict	Name index	Age	Humidity	HeartRate	Localtion	Temperature	...
2019/10/10/ 10:00:00	Tracy,1	1	22	45%	95	116.29860 40.13091	11	...
2019/10/10/ 10:00:00	Tom,2	2	26	45%	92	121.55687 31.31908	20	...
...		...	...	...	...	...	...	...
2019/10/11/ 11:00:01		1	22	45%	90	116.30101 31.31673	11	...
2019/10/11/ 11:00:01		2	26	45%	96	121.54794 31.32318	21	...

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How we do

- Column-Orient Model

CPU : **Intel Skylake** 8 **core**

Memory : 64 **GB**

Disk : 500**GB SSD**

Data Set : **TSBS**, 12 **Hours**, 40000 **Drivers**, 10 **Metrics** ≈ 16.9 **billion Rows**

How we do

- Column-Orient Model

```
:) SELECT value
FROM benchmark.tags
WHERE (metric_name = 'cpu-usage_user')
AND
((created_at >= '2016-01-01 08:00:00')
AND
(created_at <= '2016-01-01 09:00:00'))
ORDER BY toStartOfMinute(created_at) DESC
LIMIT 5
```

```
┌─value─┐
│     4 │
│     4 │
│     4 │
│     4 │
│     4 │
└───────┘
```

```
5 rows in set. Elapsed: 0.854 sec.
Processed 144.06 million rows,
5.19 GB (168.64 million rows/s.,
6.07 GB/s.)
```

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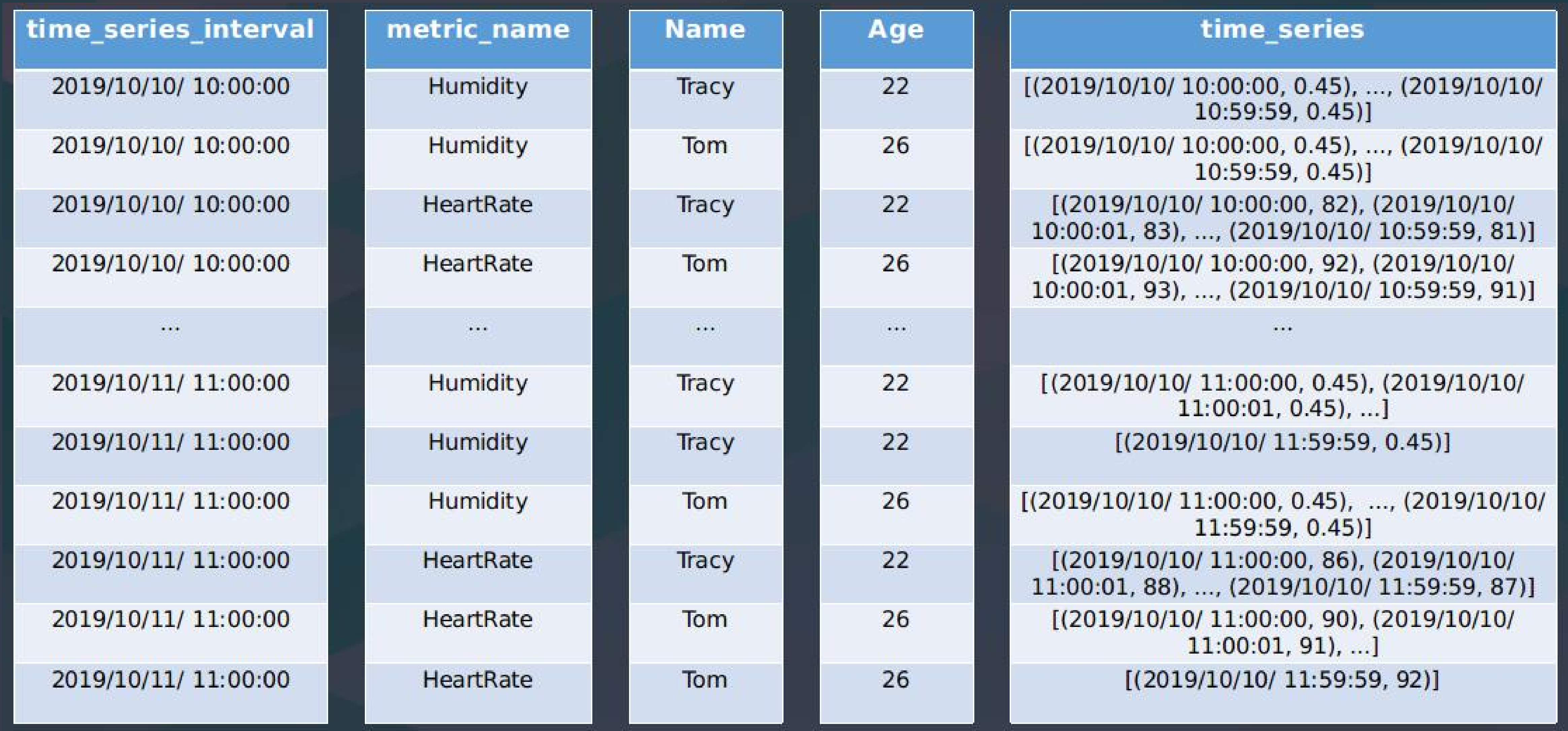
How we do

- Time-Series-Orient Model

```
CREATE TABLE demonstration.test
(
    `time_series_interval` DateTime,
    `metric_name` String,
    `Name` String, `Age` UInt8, ...,
    `time_series` AggregateFunction(
        groupArray, Tuple(DateTime, Float64))
) ENGINE = AggregatingMergeTree()
PARTITION BY toYYYYMM(time_series_interval)
ORDER BY (metric_name, time_series_interval)
```



time_series_interval	metric_name	Name	Age	time_series
2019/10/10/ 10:00:00	Humidity	Tracy	22	[(2019/10/10/ 10:00:00, 0.45), ..., (2019/10/10/ 10:59:59, 0.45)]
2019/10/10/ 10:00:00	Humidity	Tom	26	[(2019/10/10/ 10:00:00, 0.45), ..., (2019/10/10/ 10:59:59, 0.45)]
2019/10/10/ 10:00:00	HeartRate	Tracy	22	[(2019/10/10/ 10:00:00, 82), (2019/10/10/ 10:00:01, 83), ..., (2019/10/10/ 10:59:59, 81)]
2019/10/10/ 10:00:00	HeartRate	Tom	26	[(2019/10/10/ 10:00:00, 92), (2019/10/10/ 10:00:01, 93), ..., (2019/10/10/ 10:59:59, 91)]
...	...	...	...	...
2019/10/11/ 11:00:00	Humidity	Tracy	22	[(2019/10/10/ 11:00:00, 0.45), (2019/10/10/ 11:00:01, 0.45), ...]
2019/10/11/ 11:00:00	Humidity	Tracy	22	[(2019/10/10/ 11:59:59, 0.45)]
2019/10/11/ 11:00:00	Humidity	Tom	26	[(2019/10/10/ 11:00:00, 0.45), ..., (2019/10/10/ 11:59:59, 0.45)]
2019/10/11/ 11:00:00	HeartRate	Tracy	22	[(2019/10/10/ 11:00:00, 86), (2019/10/10/ 11:00:01, 88), ..., (2019/10/10/ 11:59:59, 87)]
2019/10/11/ 11:00:00	HeartRate	Tom	26	[(2019/10/10/ 11:00:00, 90), (2019/10/10/ 11:00:01, 91), ...]
2019/10/11/ 11:00:00	HeartRate	Tom	26	[(2019/10/10/ 11:59:59, 92)]

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How we do

► Time-Series-Orient Model

```
CREATE TABLE demonstration.test
(
    `time_series_interval` DateTime,
    `metric_name` LowCardinality(String),
    `Name` LowCardinality(String), `Age` UInt8, ...,
    `time_series` AggregateFunction(
        groupArray, Tuple(DateTime, Float64))
) ENGINE = AggregatingMergeTree()
PARTITION BY toYYYYMM(time_series_interval)
ORDER BY (metric_name, time_series_interval)
```

time_series_interval	dict	metric_name	dict	Name	Age	time_series
2019/10/10/ 10:00:00	Humidity	1	Tracy	1	22	[(2019/10/10/ 10:00:00, 0.45), ..., (2019/10/10/ 10:59:59, 0.45)]
2019/10/10/ 10:00:00	HeartRate	2	Tom	2	26	[(2019/10/10/ 10:00:00, 0.45), ..., (2019/10/10/ 10:59:59, 0.45)]
2019/10/10/ 10:00:00	...	1	...	1	22	[(2019/10/10/ 10:00:00, 82), (2019/10/10/ 10:00:01, 83), ..., (2019/10/10/ 10:59:59, 81)]
2019/10/10/ 10:00:00		2		2	26	[(2019/10/10/ 10:00:00, 92), (2019/10/10/ 10:00:01, 93), ..., (2019/10/10/ 10:59:59, 91)]
...		...		...	...	...
2019/10/11/ 11:00:00		1		1	22	[(2019/10/10/ 11:00:00, 0.45), (2019/10/10/ 11:00:01, 0.45), ...]
2019/10/11/ 11:00:00		1		1	22	[(2019/10/10/ 11:59:59, 0.45)]
2019/10/11/ 11:00:00		1		2	26	[(2019/10/10/ 11:00:00, 0.45), ..., (2019/10/10/ 11:59:59, 0.45)]
2019/10/11/ 11:00:00		2		1	22	[(2019/10/10/ 11:00:00, 86), (2019/10/10/ 11:00:01, 88), ..., (2019/10/10/ 11:59:59, 87)]
2019/10/11/ 11:00:00		2		1	26	[(2019/10/10/ 11:00:00, 90), (2019/10/10/ 11:00:01, 91), ...]
2019/10/11/ 11:00:00		2		2	26	[(2019/10/10/ 11:59:59, 92)]

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How we do

Now :

```
INSERT INTO demonstration.test SELECT ..., 'HeartRate',
groupArrayState(Tuple('2019-10-11 11:11:00', 87));
```

AND :

```
SELECT ..., metric_name, groupArrayMerge(time_series)
FROM demonstration.test ...;
```

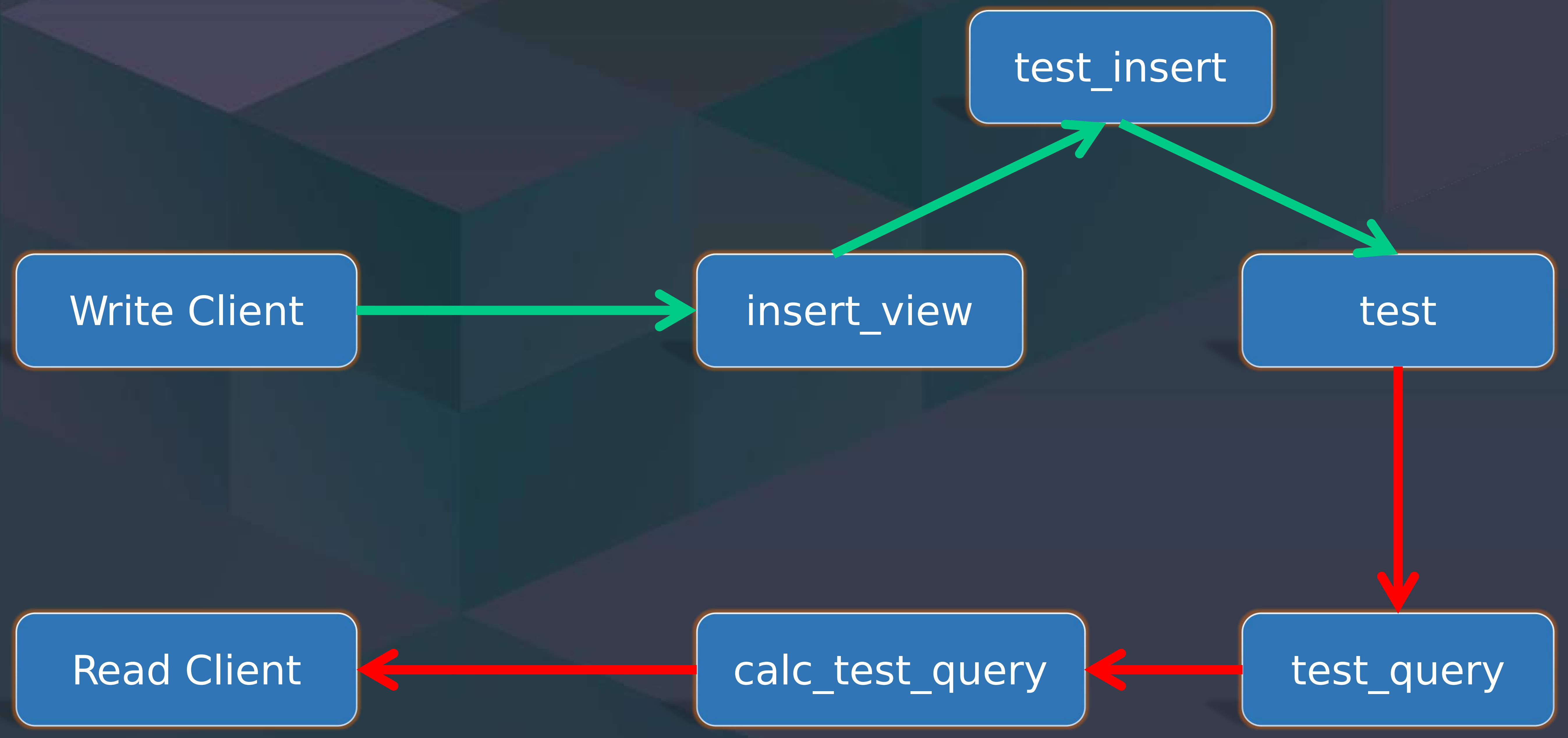
How we do

It's veeeeeery complicated!!!

So...

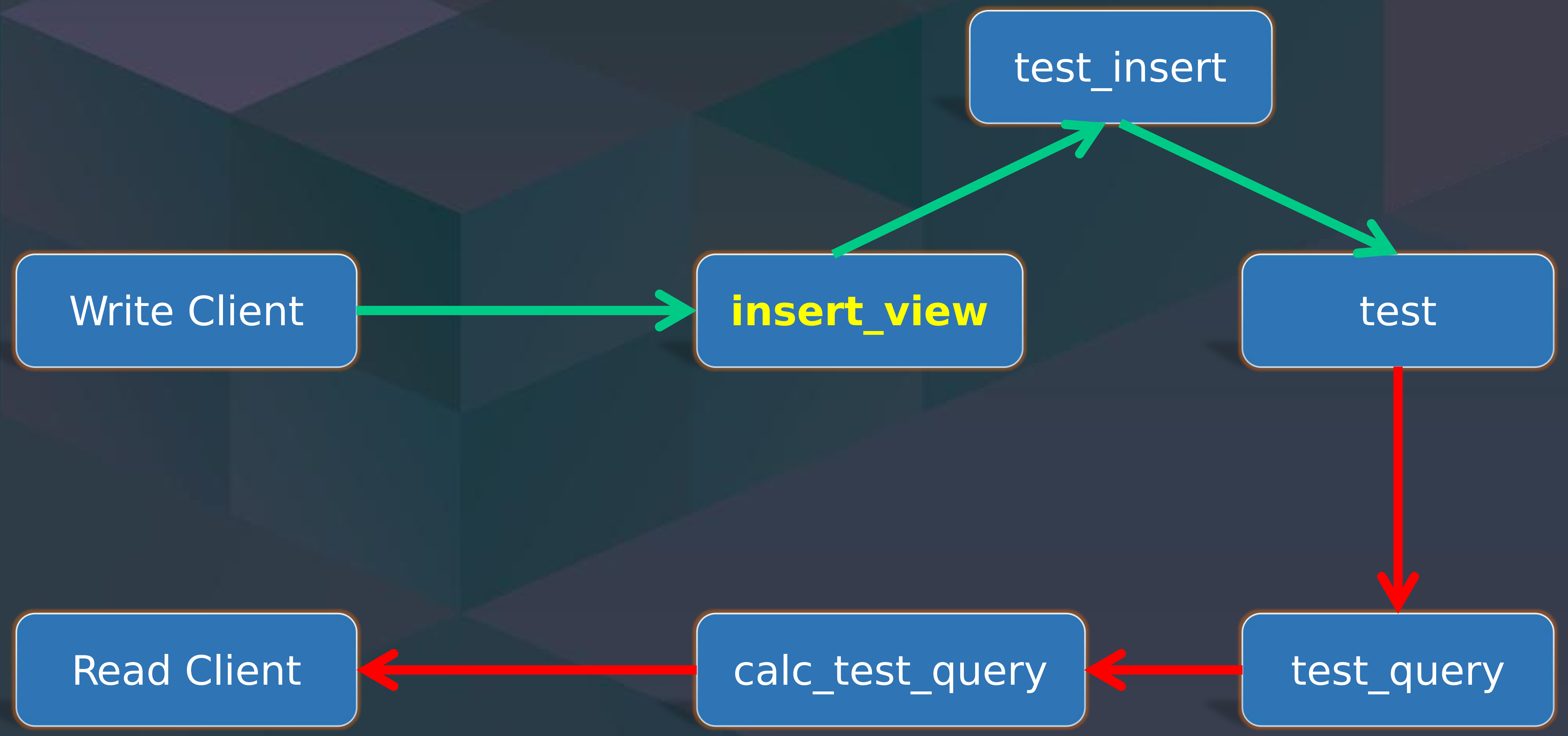
How we do

- Time-Series-Orient Model



How we do

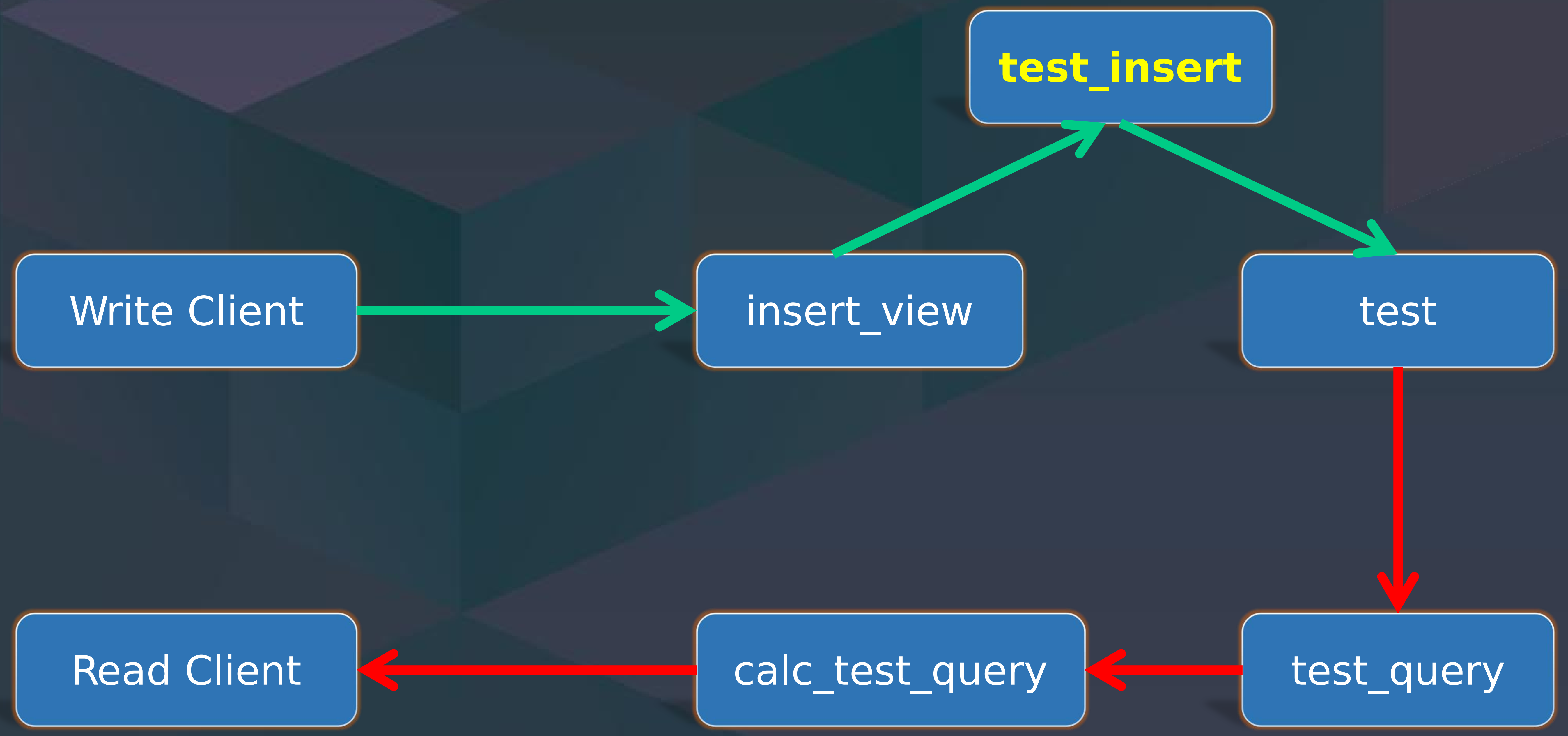
- Time-Series-Orient Model



```
CREATE TABLE demonstration.insert_view
(
    `Time` DateTime,
    `metric_name` String,
    `Name` String, `Age` UInt8, ...,
    `value` Float64
)
ENGINE = Null
```

How we do

- Time-Series-Orient Model



```
CREATE MATERIALIZED VIEW demonstration.test_insert
TO demonstration.test AS SELECT
    toStartOfInterval(Time, toIntervalMinute(30))
        AS time_series_interval,
    metric_name, Name, Age, ...,
    groupArrayState((Time, value)) AS timeseries
FROM demonstration.insert_view
GROUP BY time_series_interval, metric_name, Name, Age
```

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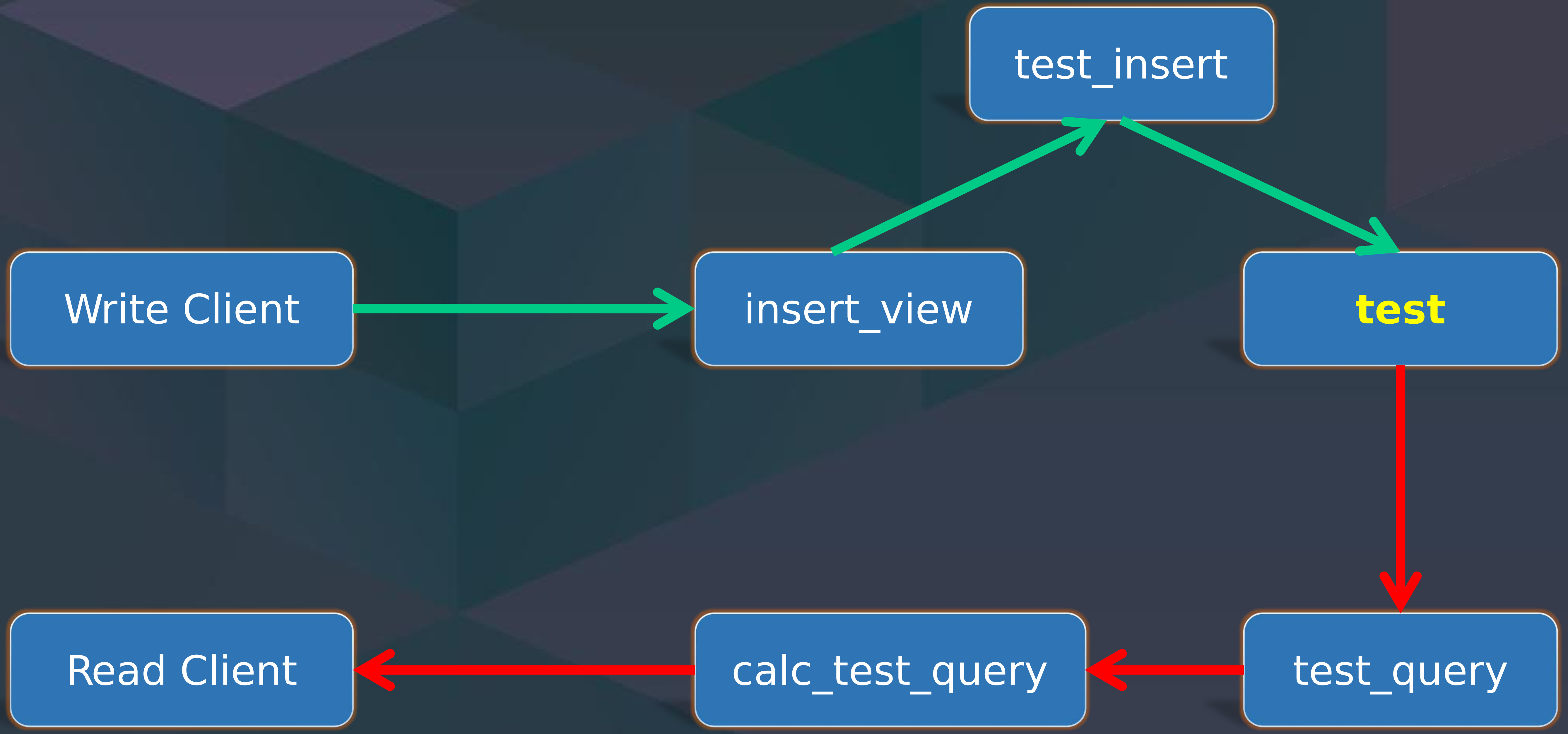
How we do

- Time-Series-Orient Model



```
CREATE TABLE demonstration.test
(
    `time_series_interval` DateTime,
    `metric_name` LowCardinality(String),
    `Name` LowCardinality(String),  `Age` UInt8, ...
     `time_series` AggregateFunction(
          groupArray, Tuple(DateTime, Float64))
) ENGINE = AggregatingMergeTree()
PARTITION BY toYYYYMM(time_series_interval)
ORDER BY (metric_name, time_series_interval,
Name, ...)
```

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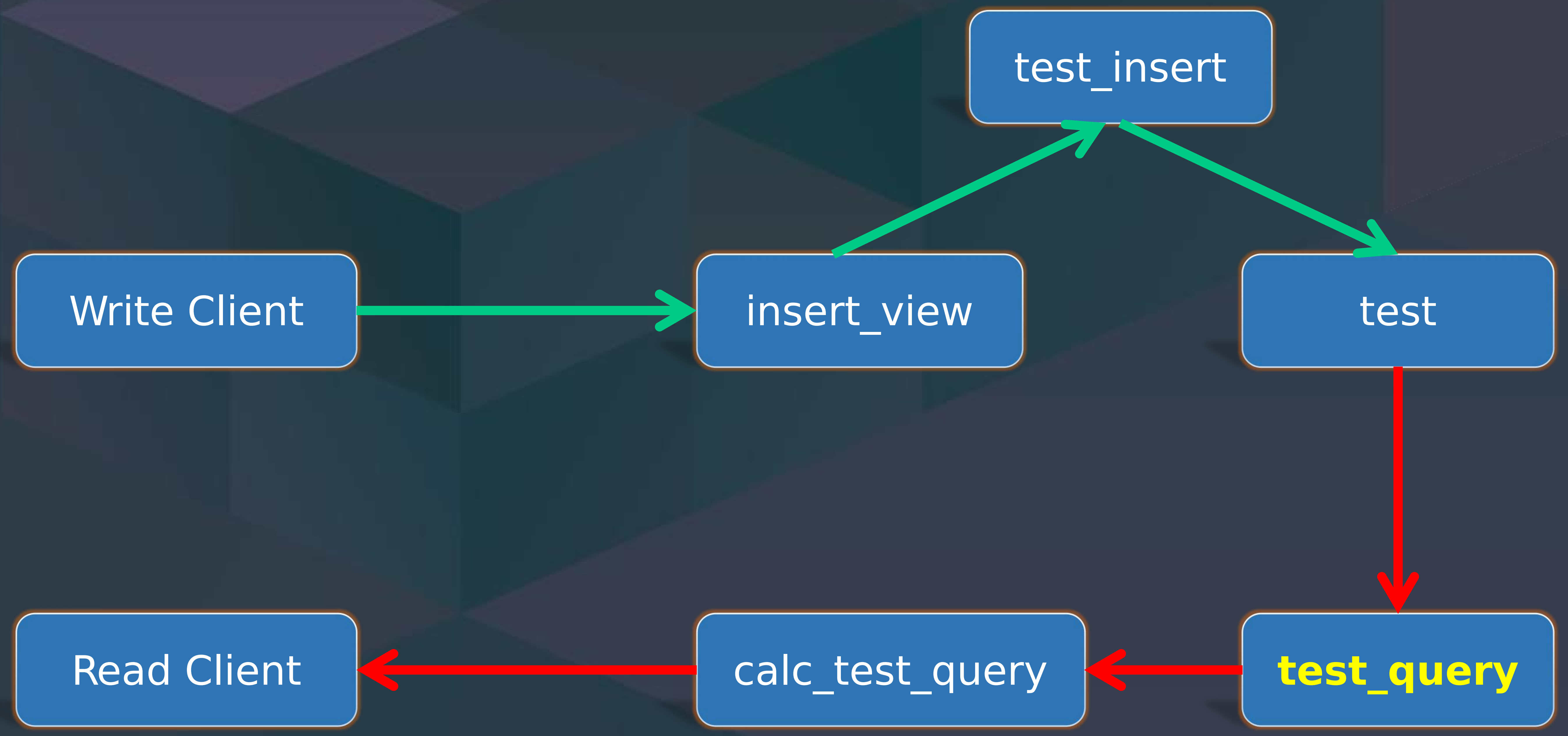
How we do

- Time-Series-Orient Model



```
CREATE VIEW demonstration.test_query AS
SELECT
    metric_name,  Name, Age, ...,
    finalizeAggregation(timeseries) AS timeseries
FROM demonstration.test
```

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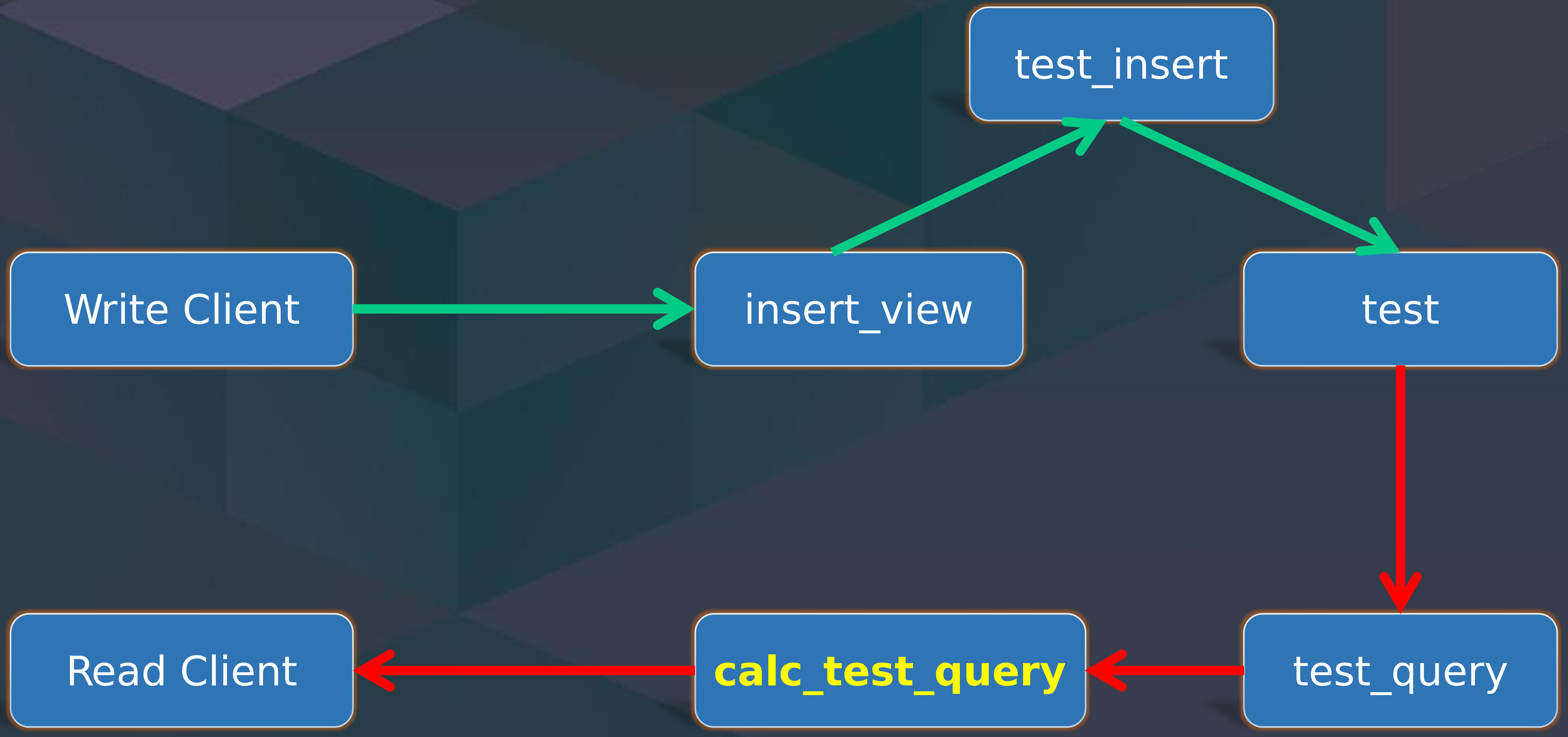
How we do

- Time-Series-Orient Model



```
CREATE VIEW demonstration.calc_test_query AS
SELECT
    metric_name,  Name , Age,
    timeseries.1 AS date_time,  timeseries.2 AS value
FROM demonstration.test_query
ARRAY JOIN timeseries AS timeseries
```

How we do

Now :

```
INSERT INTO demonstration.insert_view(..., metric_name,
date_time, value ) VALUES(...);
```

AND :

```
SELECT ..., metric_name, date_time, value FROM
demonstration.calc_test_query;
```

How we do

- Time-Series-Orient Model

CPU：**Intel Skylake** 8 **core**

Memory：64 **GB**

Disk：500**GB SSD**

Data Set：**TSBS**, 12 **Hours**, 40000 **Drivers**, 10 **Metrics** ≈ 19.6 **billion Rows**

How we do

- Time-Series-Orient Model

```
:) SELECT value
FROM benchmark.calc_tags_query
WHERE (metric_name = 'cpu-usage_user')
AND
((created_at >= '2016-01-01 08:00:00')
AND
(created_at <= '2016-01-01 09:00:00'))
ORDER BY toStartOfMinute(created_at) DESC
LIMIT 5
```

```
┌─value─┐
│     4 │
│     4 │
│     4 │
│     4 │
│     4 │
└───────┘

5 rows in set. Elapsed: 1.565 sec.
Processed 281.69 thousand
rows, 11.06 GB (180.01 thousand
rows/s., 7.07 GB/s.)
```

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What we do

What we do

- Support JSONB DataType for tags & value
  - Support LowCardinality(JSONB)
  - Support BoolFilter skip index with JSONB data type
- Support TimeSeriesMergeTree Table Engine
  - Support Multiple Streams for AggregationFunction
  - Support TimeSeriesAggregateFunction(store sum, min, max, avg)
  - Support convert sum(time_series) to sum(time_series.sum)

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QingCloud ChronusDB

青云 QingCloud 自研的一款高性能、具备强大 分析能力的时序数据库产品

高性能并发读写

- 千万数据点并发实时写入
- 引入辅助索引，加快数据检索速度

低成本存储

- 列式存储结合高效的编码
- Delta、XOR 等适合时序场景的压缩算法
- 通过 Rollup 功能，对历史数据做聚合，减少数据量

稳定可扩展

- 分布式架构
- 数据多副本存储
- 服务高可用

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Thanks For You