arm
TREASURE DATA

PlazmaDB

ペタバイトオーダのデータ分析基盤を支える分散ストレージのアーキテクチャとその運用

Keisuke Suzuki
Software engineer

Who am I?

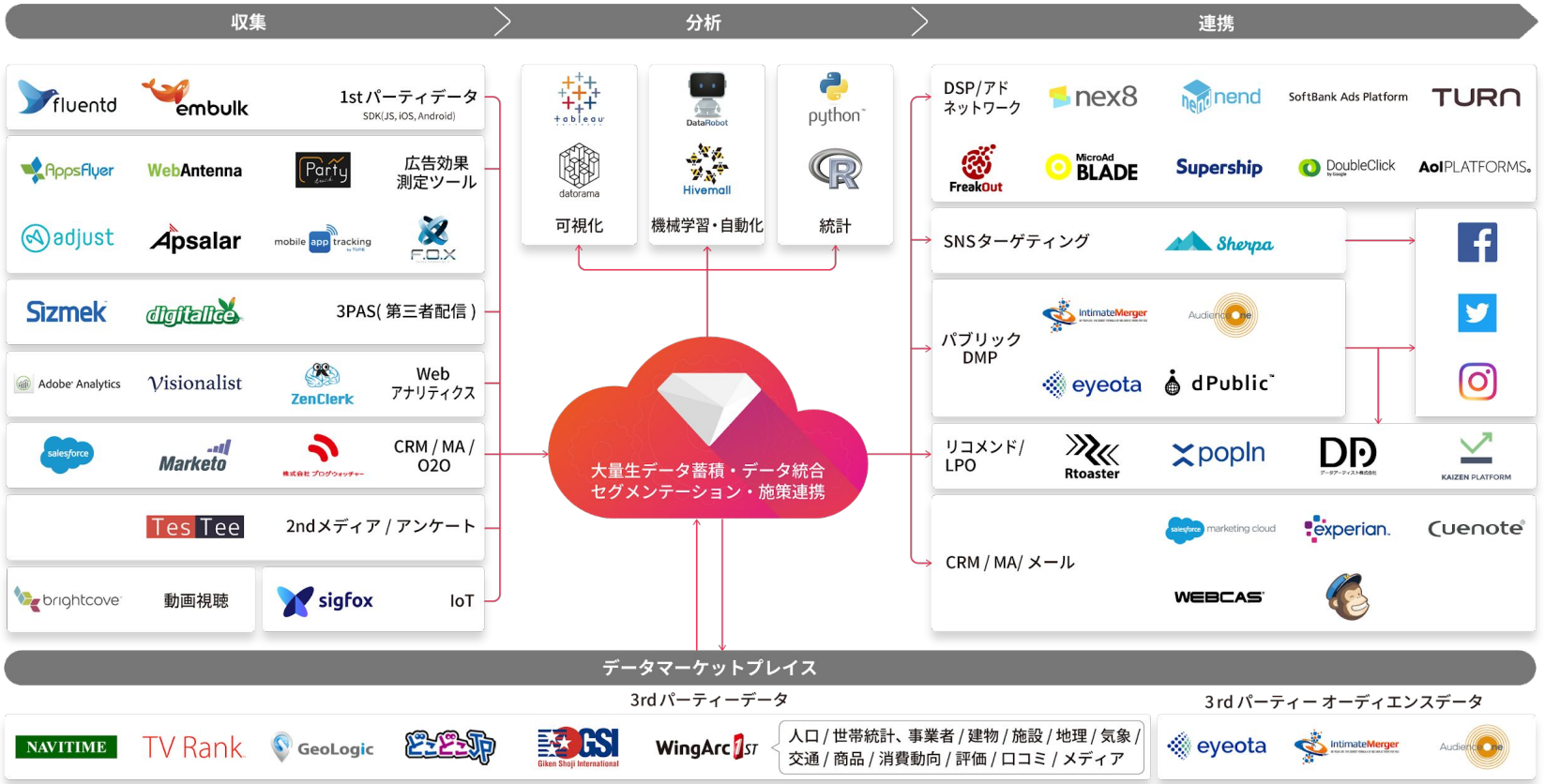
Keisuke Suzuki

- Backend Engineer @ Treasure Data KK
  - Ex. Fujitsu
- DB / Distributed system / Performance optimization
- Twitter: @yajilobee

Treasure Data & PlazmaDB

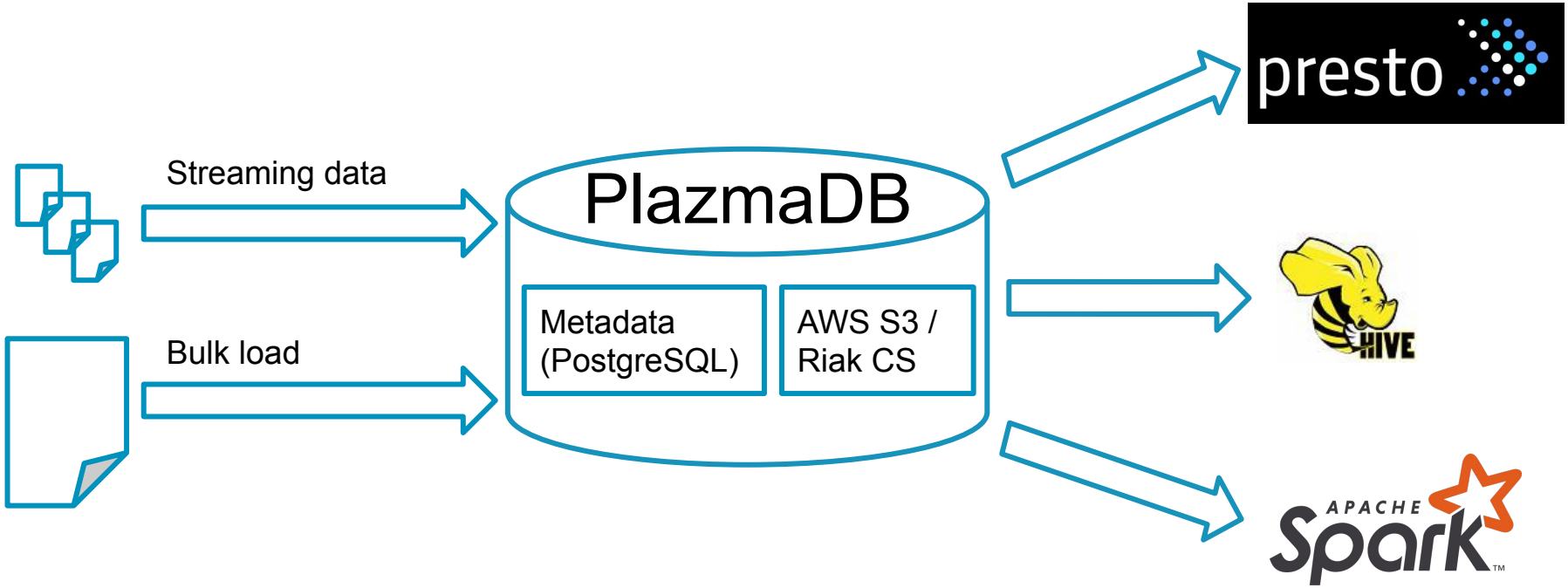
arm

Arm Treasure Data eCDP



arm TREASURE DATA

PlazmaDB



Daily Workload & Storage Size

Import

500 Billion Records / day
~ 5.8 Million Records / sec

Query

600,000 Queries / day
15 Trillion Records / day

Storage size

5 PB (+5~10 TB / day)
55 Trillion Records

PlazmaDB Features

- Columnar format
  - Partitioned by time and optionally user defined column
- Schema less
- Partition index
- Partition optimization
  - Merge partitions
  - Realtime Storage & Archive Storage
- Transaction
  - Read committed isolation

PlazmaDB Features

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Log data

time	orderid	user	region	price	...
2018-01-01 10:00:00	1	1	‘A’	10000	
2018-01-01 10:03:03	2	7	‘C’	40000	
2018-01-01 10:23:03	3	6	‘B’	3000	
2018-01-01 10:23:12	4	3	‘A’	5500	
2018-01-01 11:04:44	5	1	‘A’	20000	
2018-01-01 11:30:00	6	8	‘C’	3000	
...					

Accumulate over time

Many columns (attributes)

Analytical Query

time	orderid	user	region	price	...
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...					

```
SELECT
  region,
  SUM(price)
FROM
  orders
WHERE time >= ‘2018-01-01 10:00’
    AND time <= ‘2018-01-01 11:00’
GROUP BY
  region
```

Few part of columns

Filter by time window

Inefficiency of Row Based Format

time	orderid	user	region	price	...
2018-01-01 10:00:00	1	1	‘A’	10000	
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Columnar Format

time	orderid	user	region	price	...
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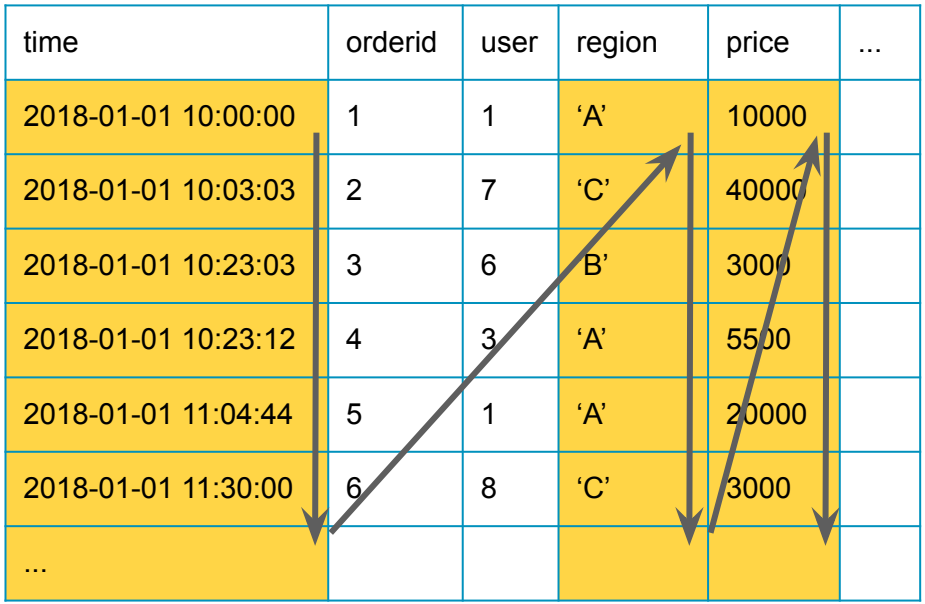

Scan direction Scanned data

```
SELECT
  region,
  SUM(price)
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  orders
WHERE time >= ‘2018-01-01 10:00’
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GROUP BY
  region
```
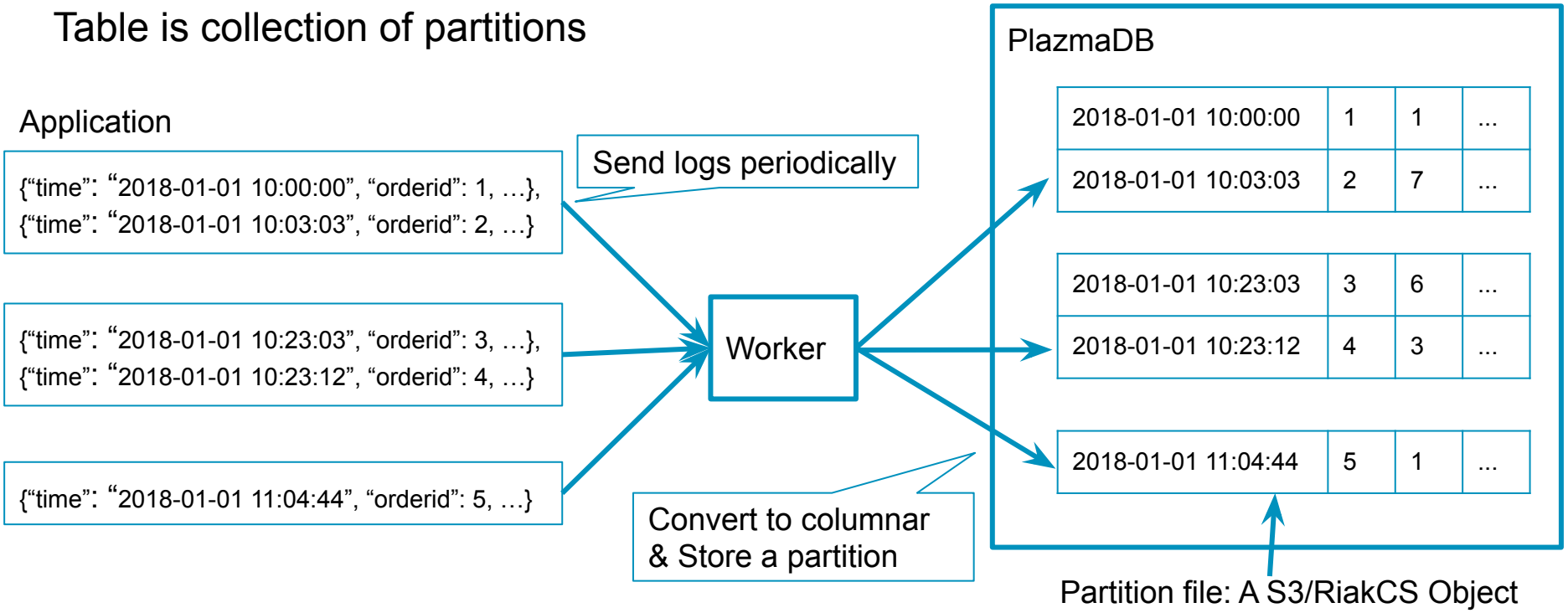

Few part of columns

Filter by time window

PlazmaDB Partitions

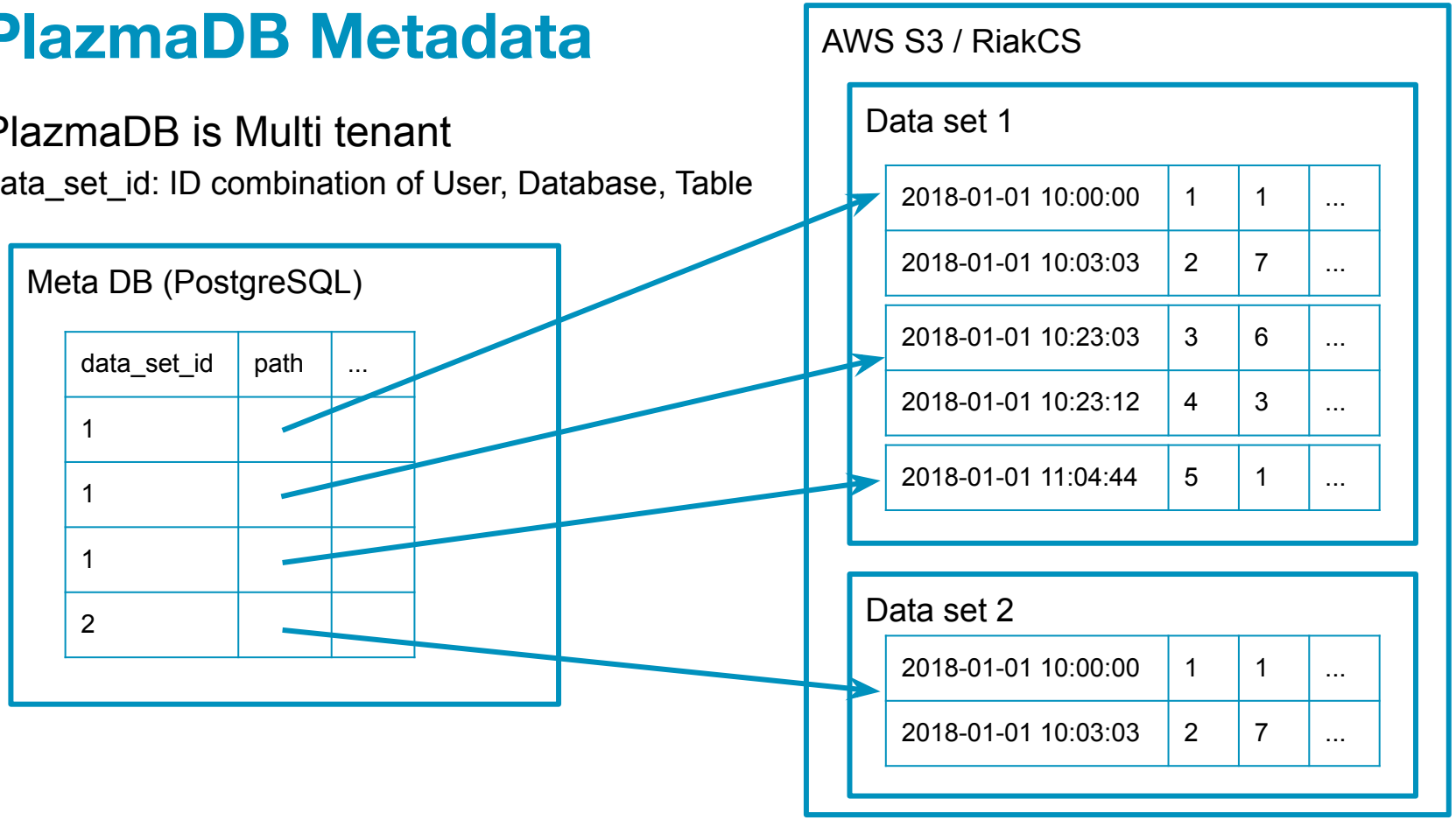
Table is collection of partitions



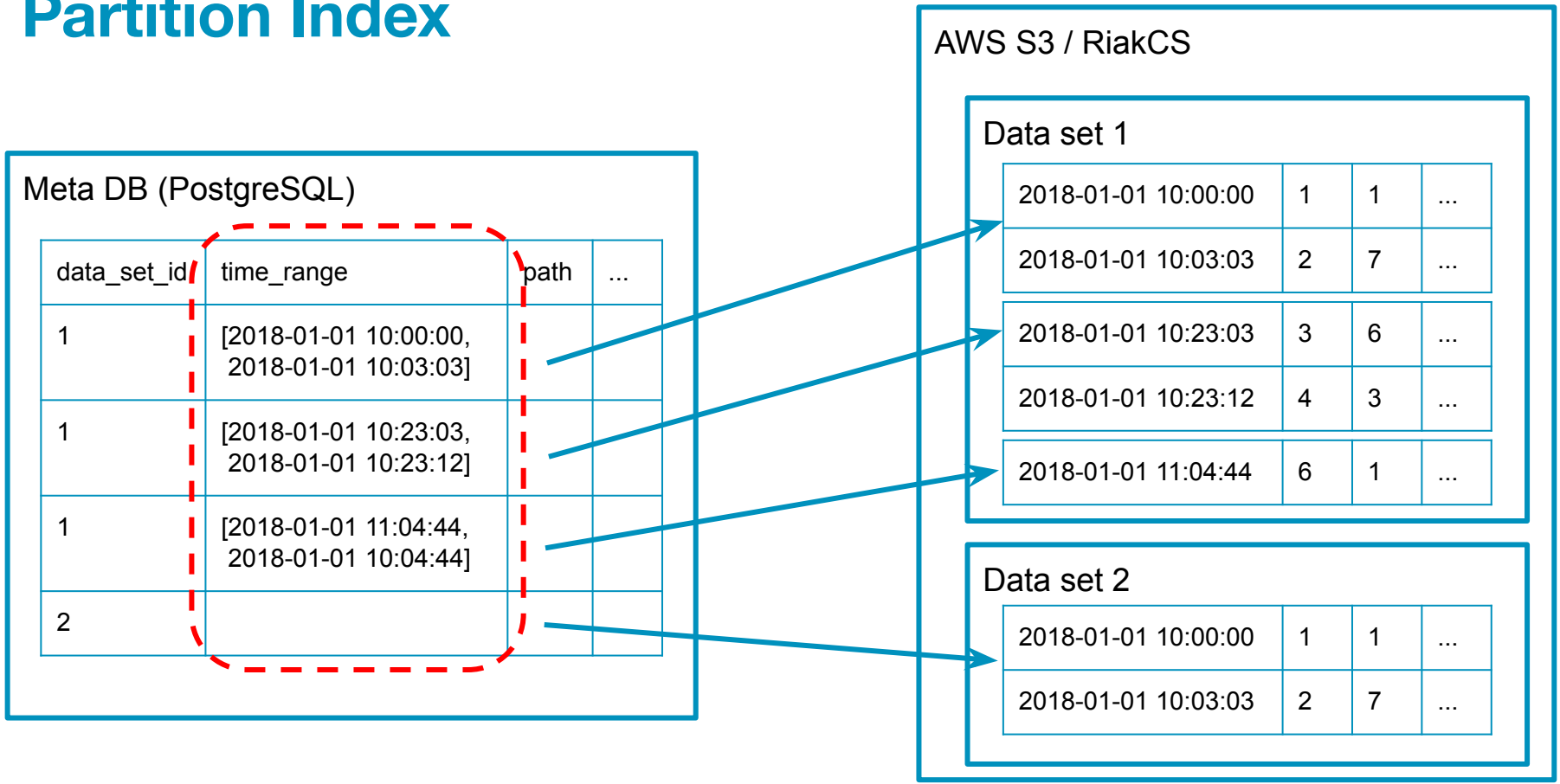
PlazmaDB Metadata

PlazmaDB is Multi tenant

data_set_id: ID combination of User, Database, Table



Partition Index



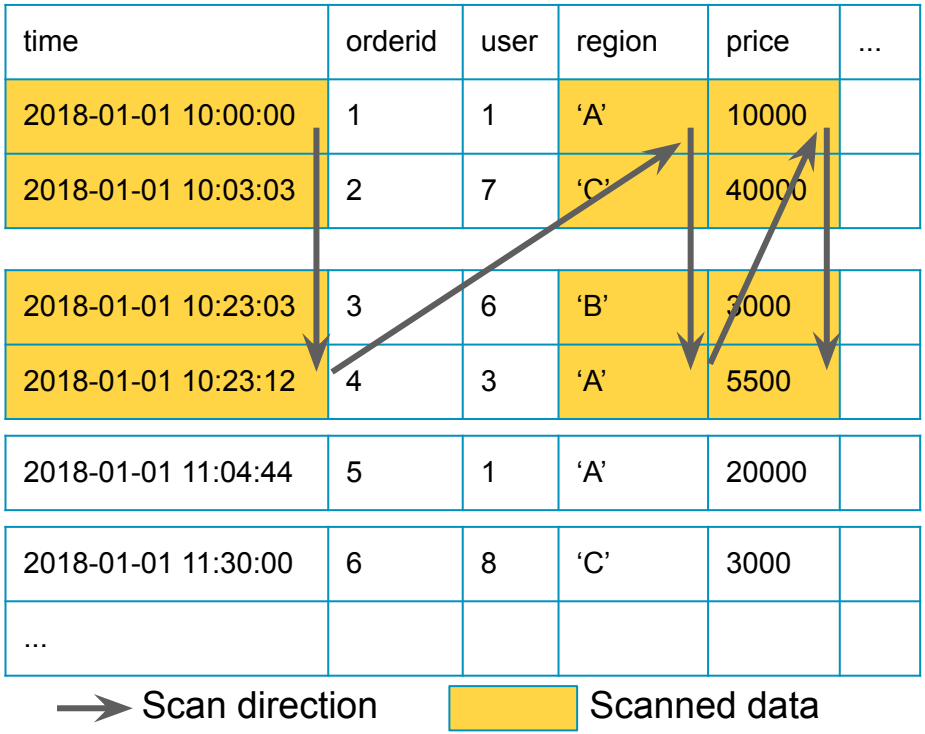
Partition Lookup

Meta DB (PostgreSQL)

data_set_id	time_range	path	...
1	[2018-01-01 10:00:00, 2018-01-01 10:03:03]		
1	[2018-01-01 10:23:03, 2018-01-01 10:23:12]		
1	[2018-01-01 11:04:44, 2018-01-01 10:04:44]		
2			

```
SELECT
  region,
  SUM(price)
FROM
  orders  -- assume this is data set 1
WHERE time >= '2018-01-01 10:00'
    AND time <= '2018-01-01 11:00'
GROUP BY
  region
```

Skip Partition Scan

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```

How to find Partitions?

Meta DB (PostgreSQL)

data_set_id	time_range	path	...
1	[2018-01-01 10:00:00, 2018-01-01 10:03:03]		
1	[2018-01-01 10:23:03, 2018-01-01 10:23:12]		
1	[2018-01-01 11:04:44, 2018-01-01 10:04:44]		
2			

Number of partitions in a data set can be large (1M+) for large tables.

?

```
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FROM
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WHERE time >= '2018-01-01 10:00'
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GROUP BY
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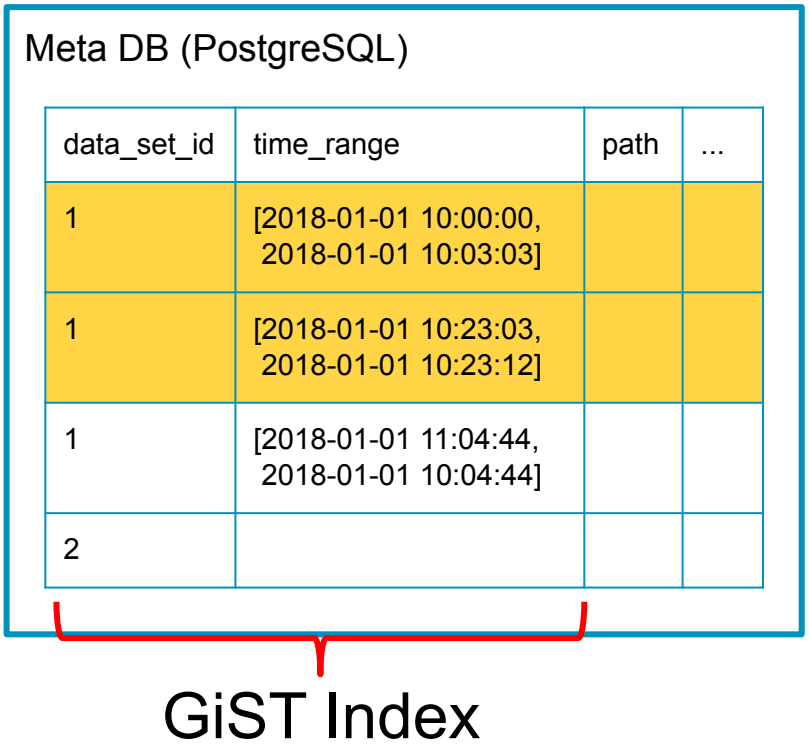
```

Range Type and GiST Index of PostgreSQL



Range type

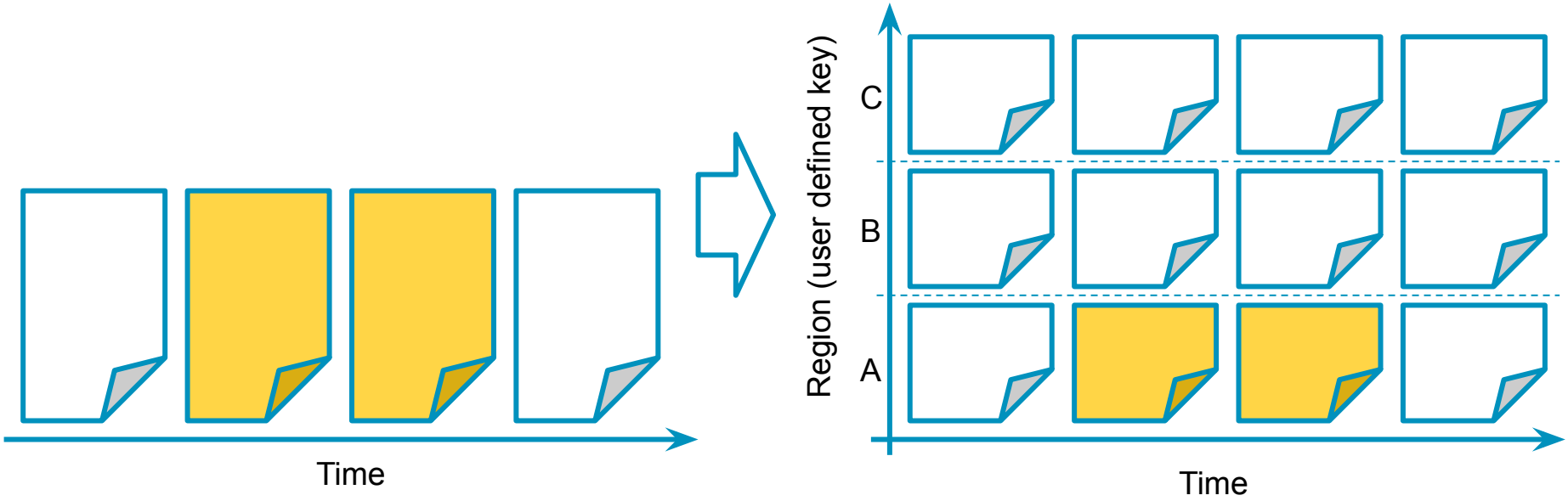
- Overlap operator

  time_range && [2018-01-01 10:00, 2018-01-01 11:00]

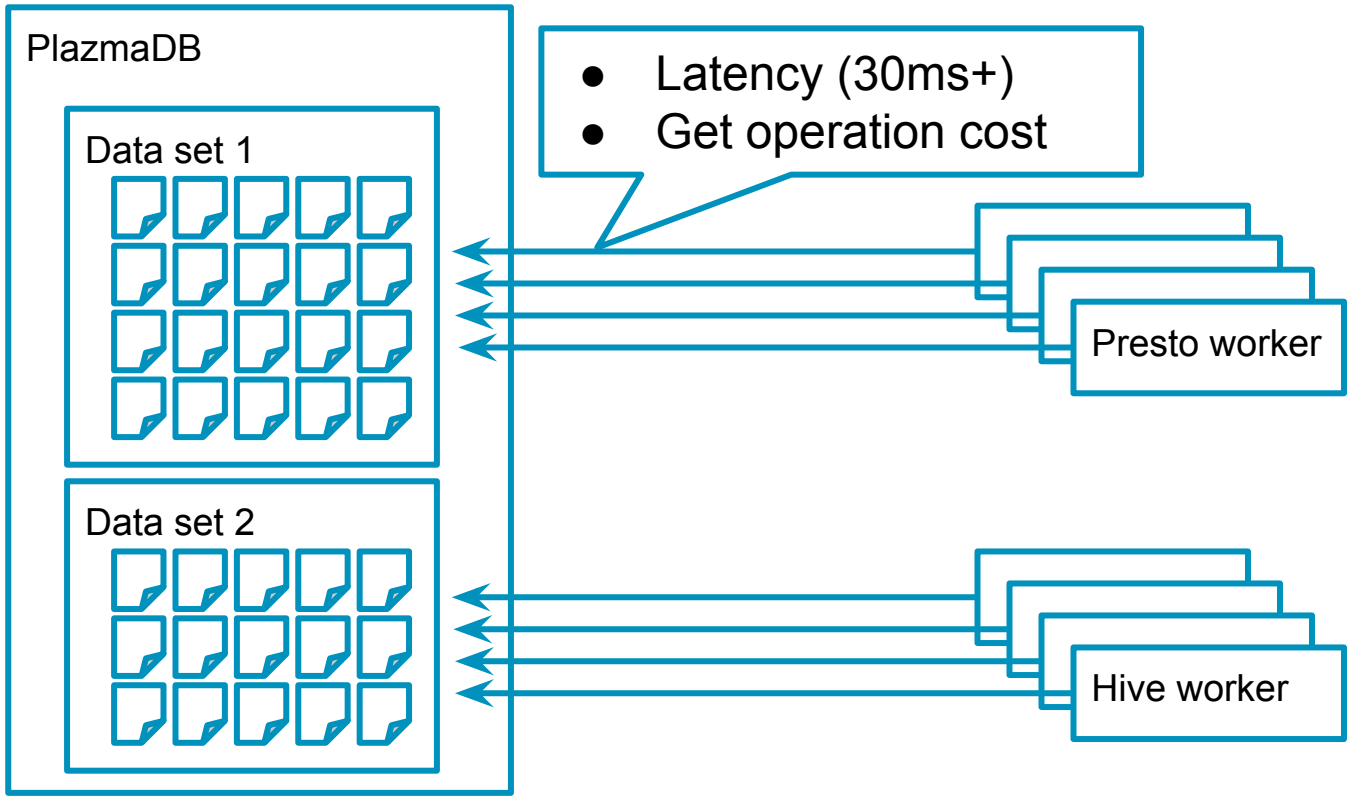
Overlap is checked by index scan

User Defined Partition (Beta)

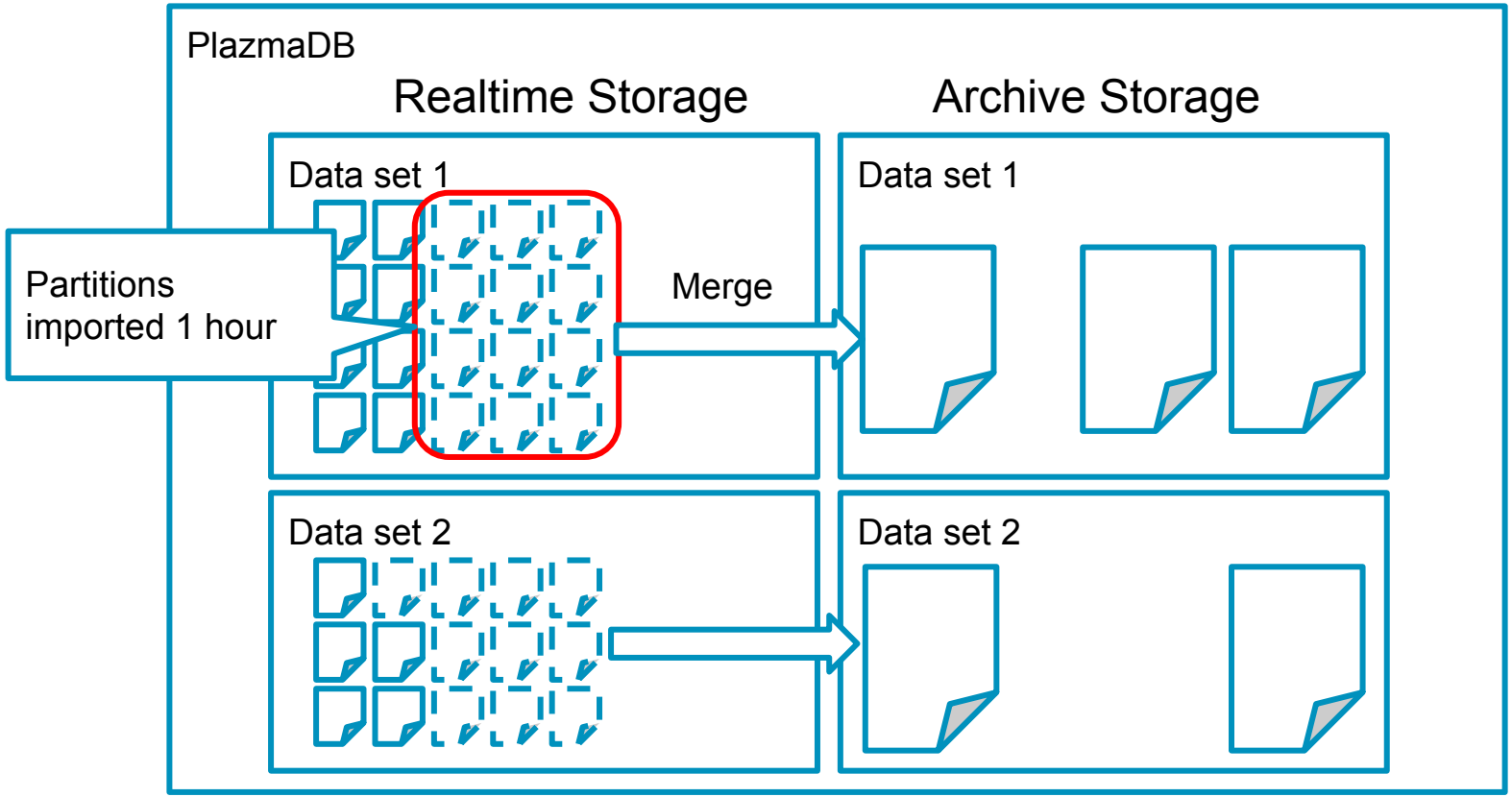
SELECT … FROM … WHERE time > … AND time <... AND region = ‘A’



Partition Fragmentation



Realtime Storage & Archive Storage



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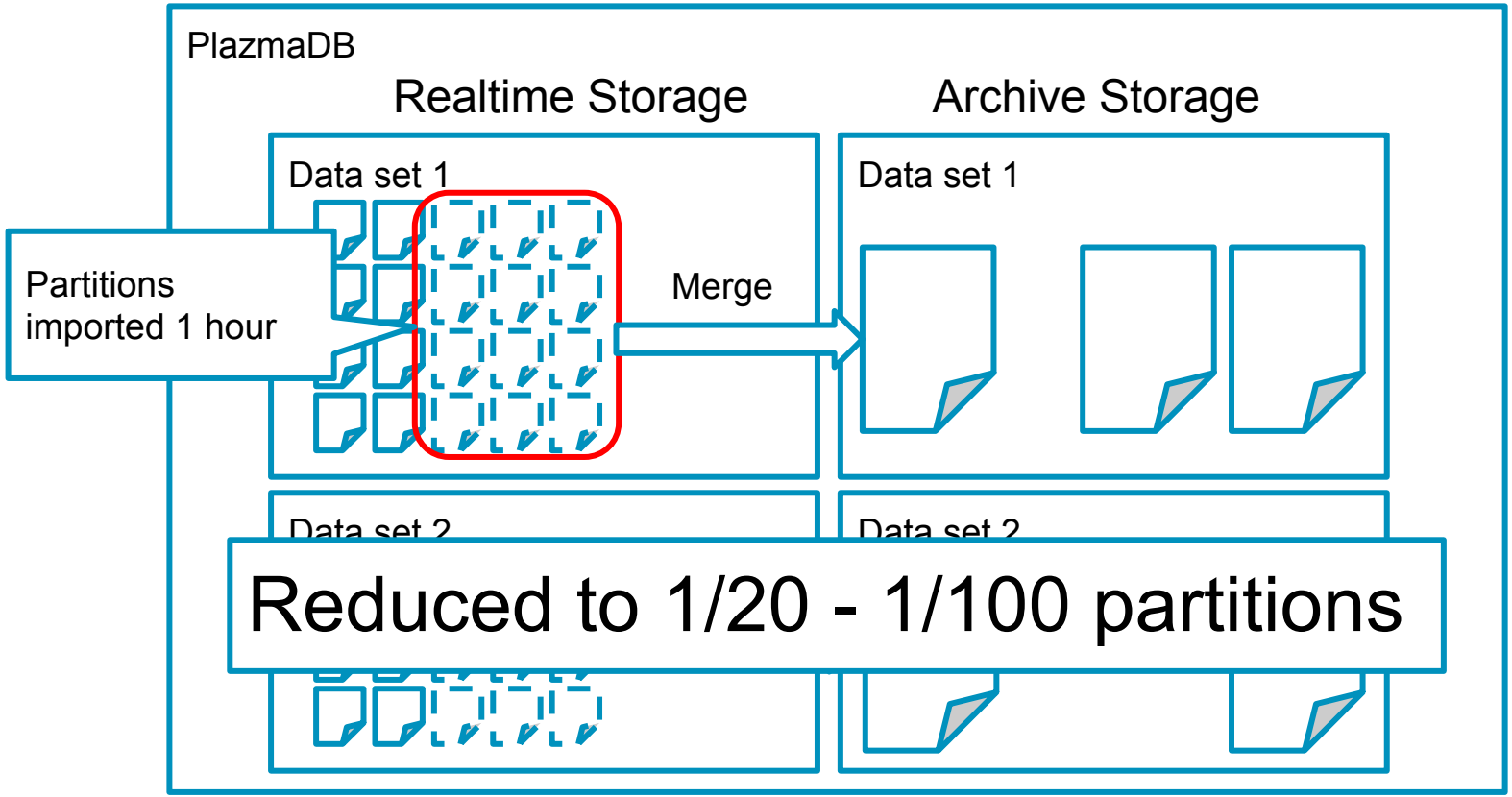
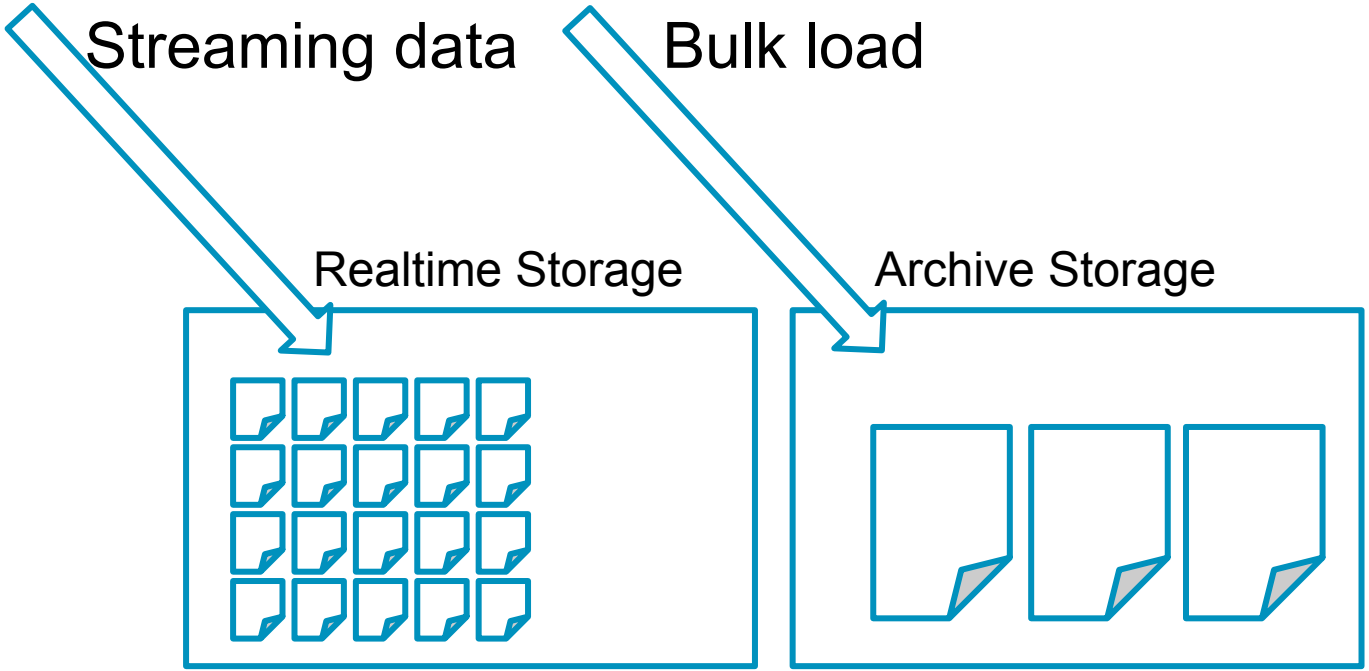
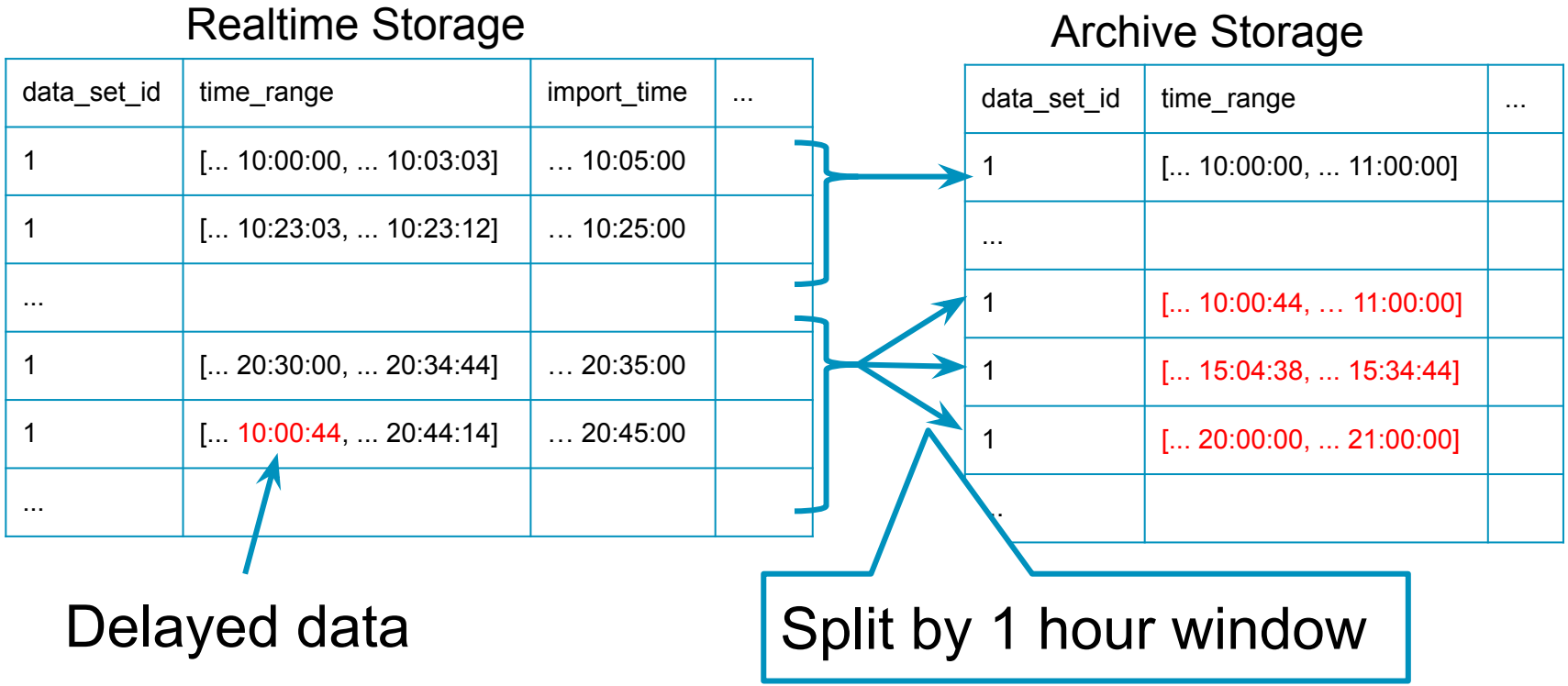


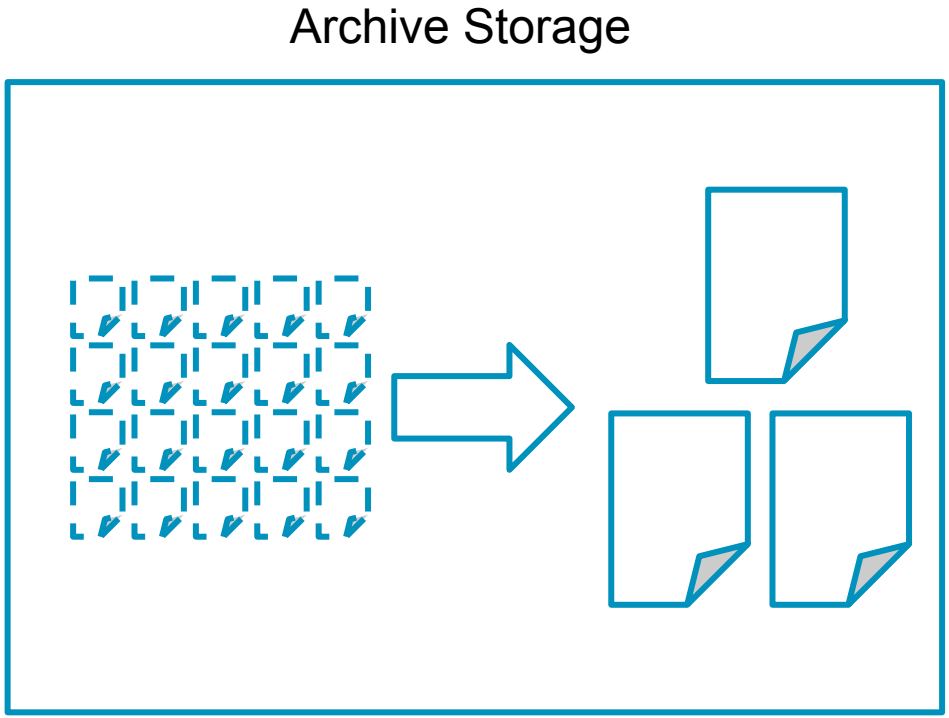
Streaming & Bulk data upload



Fragmentation of Archive Storage



Remerge Partitions



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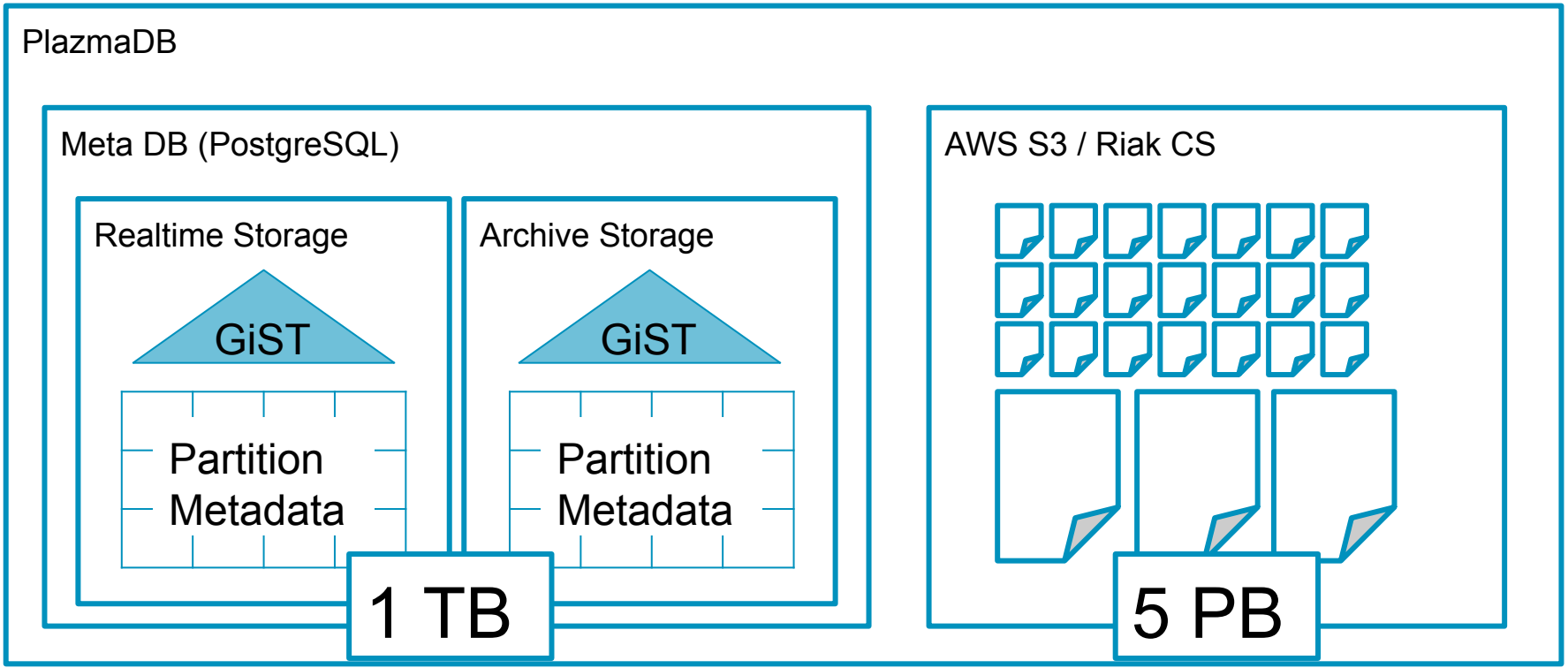
Current PlazmaDB & Future Challenges

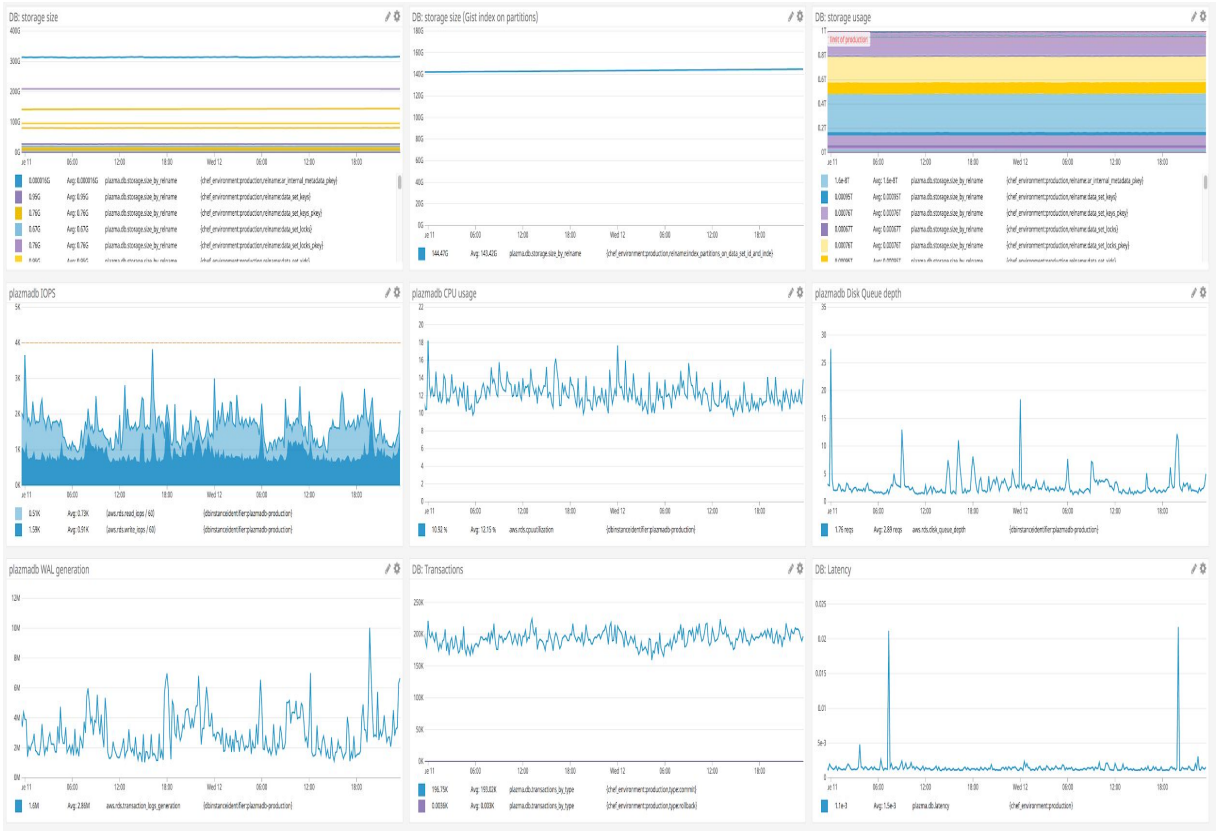
arm

Data Volume



Monitoring

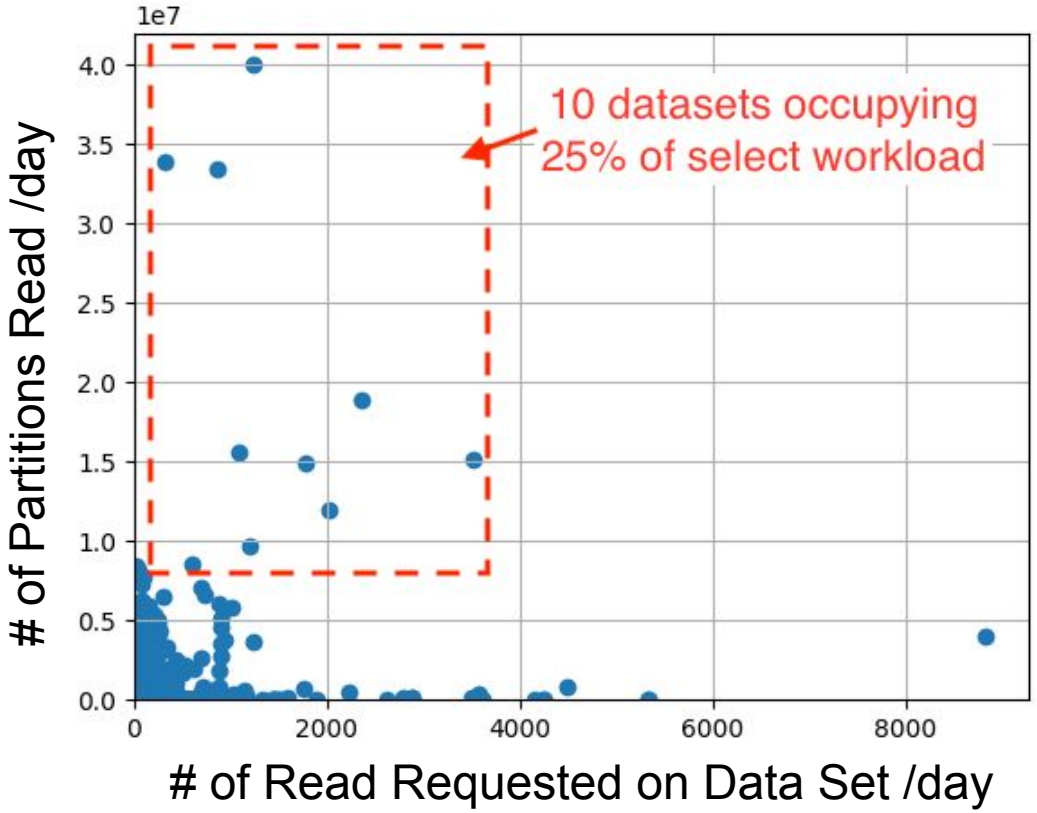
- Arm Treasure Data
  - Detailed log analyze
- DataDog
  - Metrics visualization



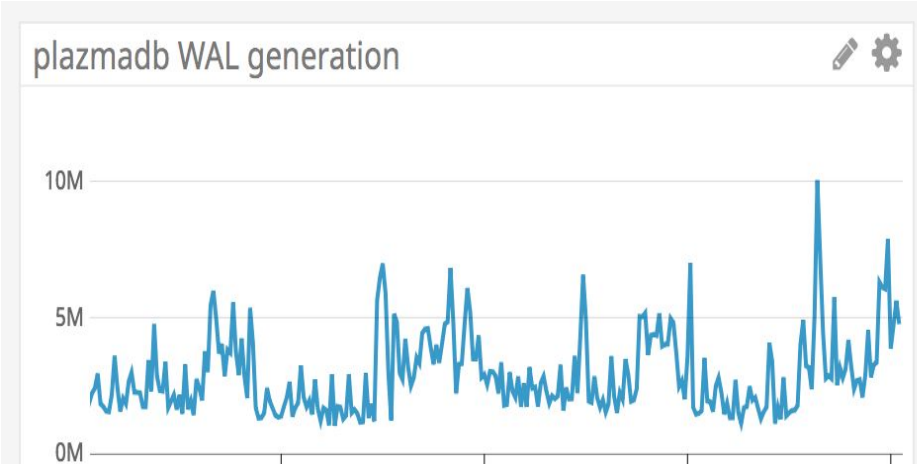
arm TREASURE DATA

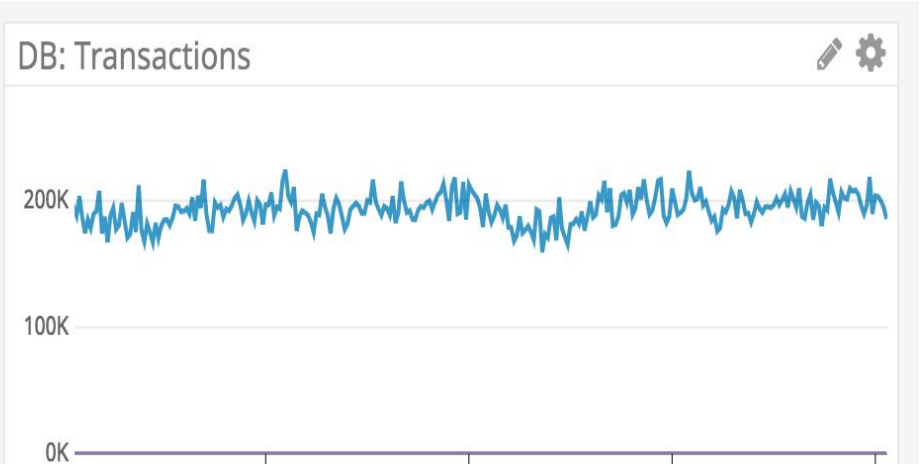
Read Workload on Meta DB

- Metadata size ~ 1TB
- Shared Buffer size ~ 150GB
- But, Hot Data size is much smaller than Shared Buffer



Write Workload on Meta DB





3 MB / sec

200k transaction / min
~ 3k transaction / sec

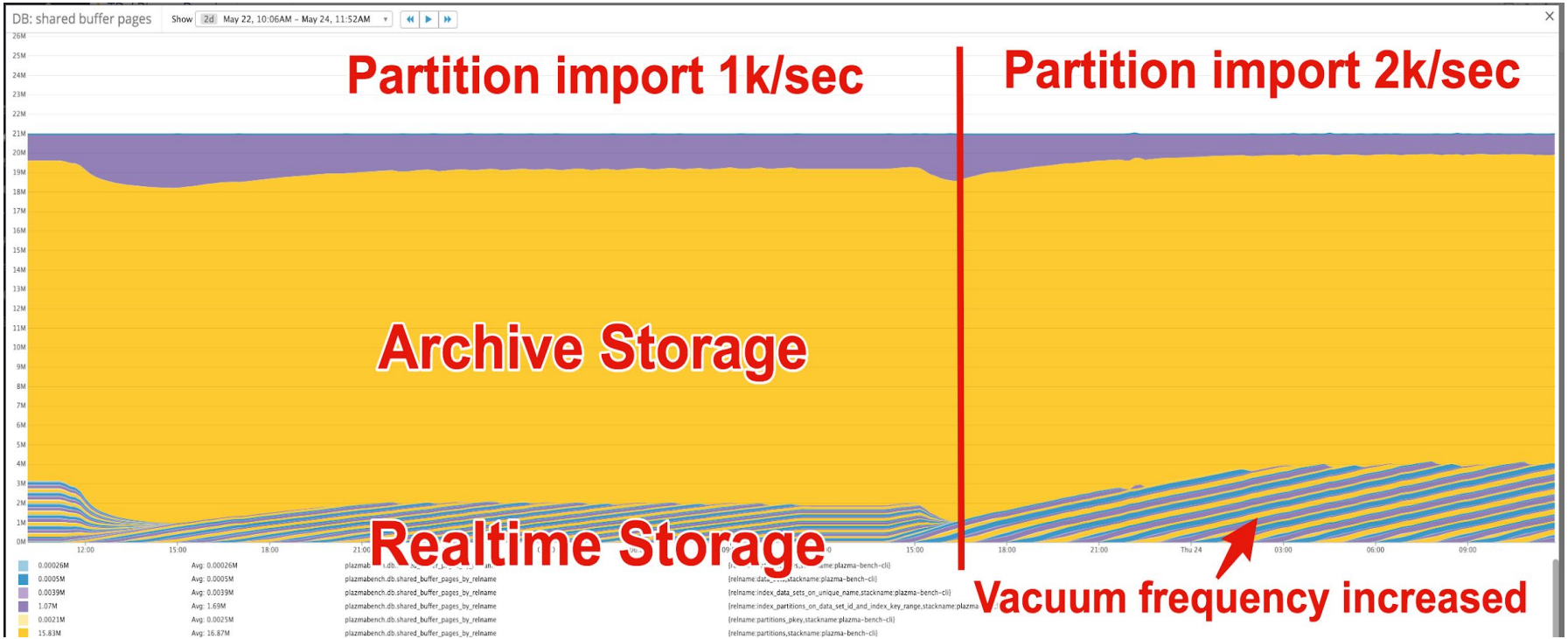
PostgreSQL Auto VACUUM (FREEZE)

VACUUM FREEZE: Vacuum to prevent transaction ID wraparound failures

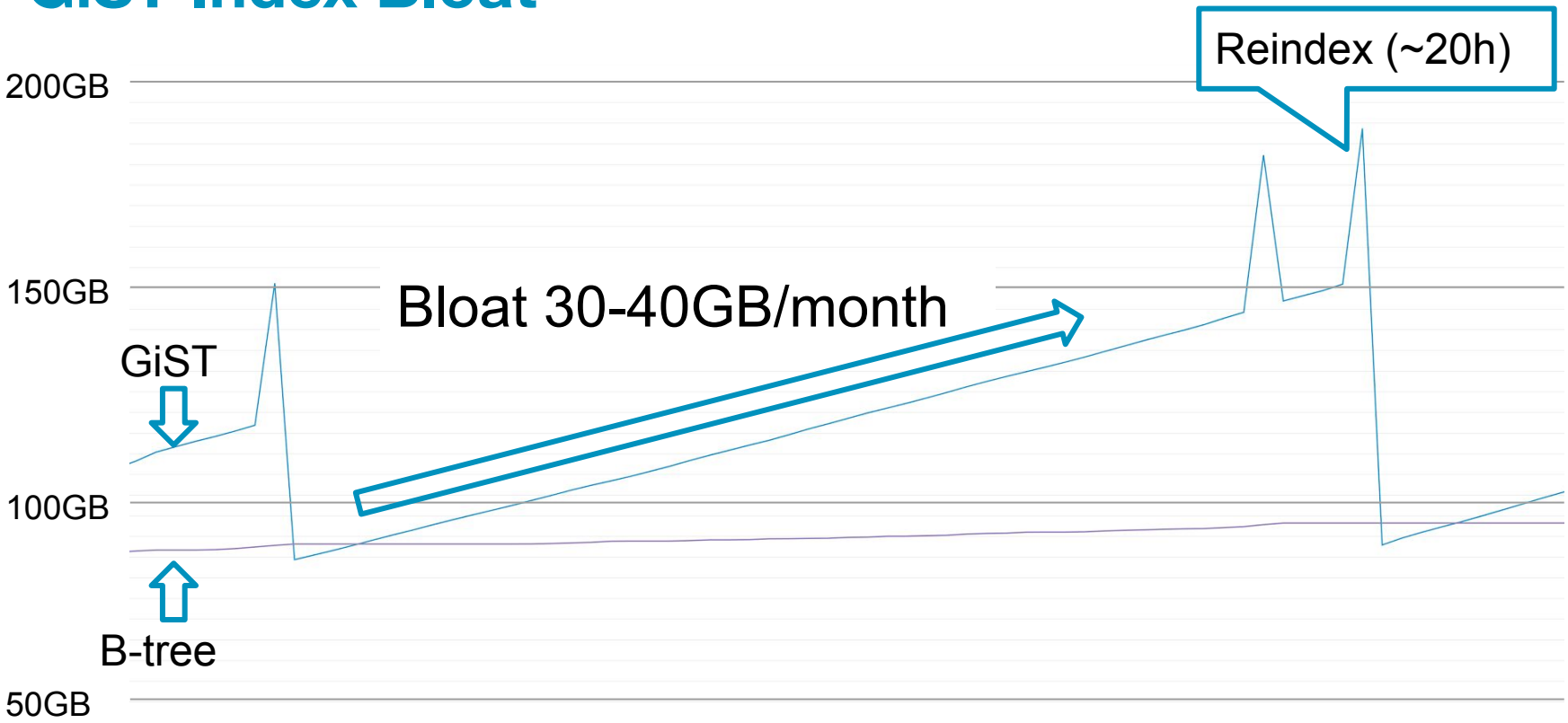
- Force full scan on relation (as of PostgreSQL 9.4)
  - Hot data may be evicted to scan relations for vacuum
    => Read workload can be affected
  - PostgreSQL 9.6 or later mitigate the problem

- The more transaction IDs are consumed, the more vacuum can be happened
  - In our case, it happens every 2-3 day

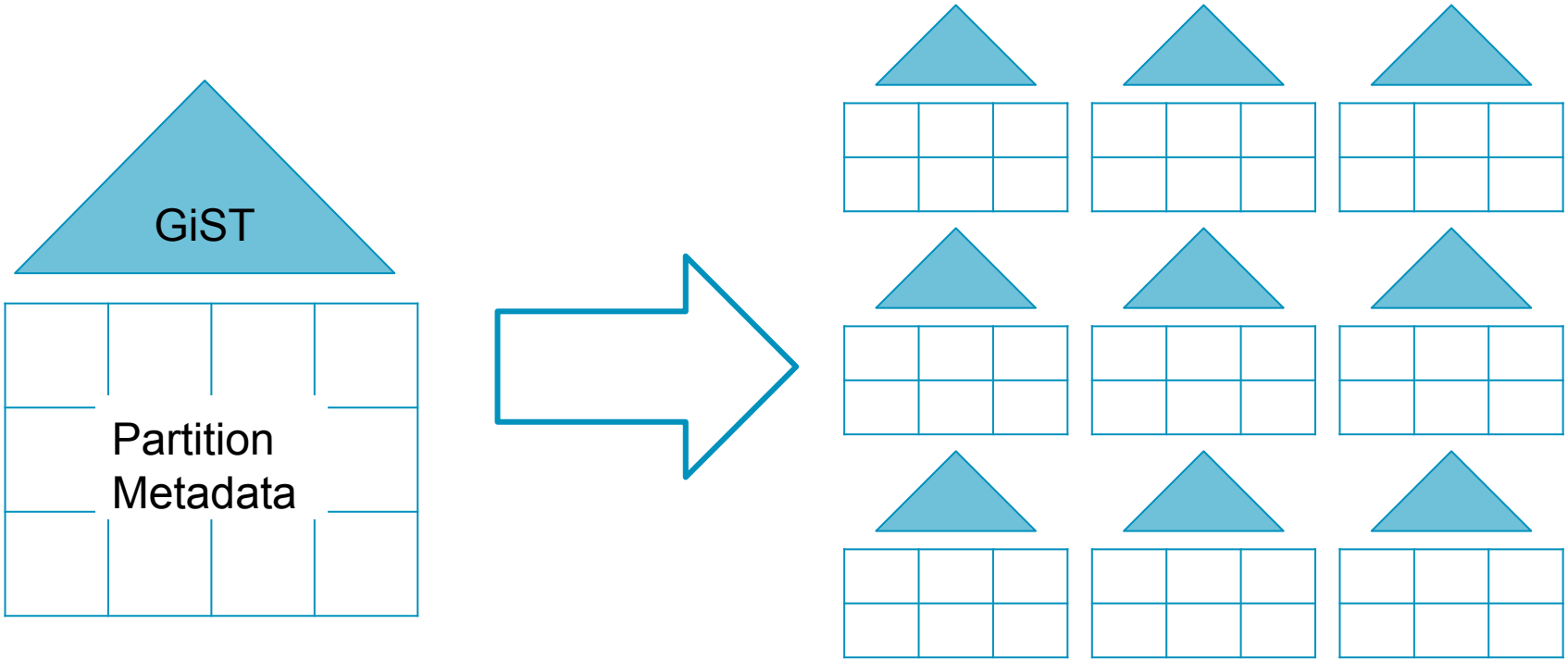
Impact of VACUUM FREEZE



GiST Index Bloat

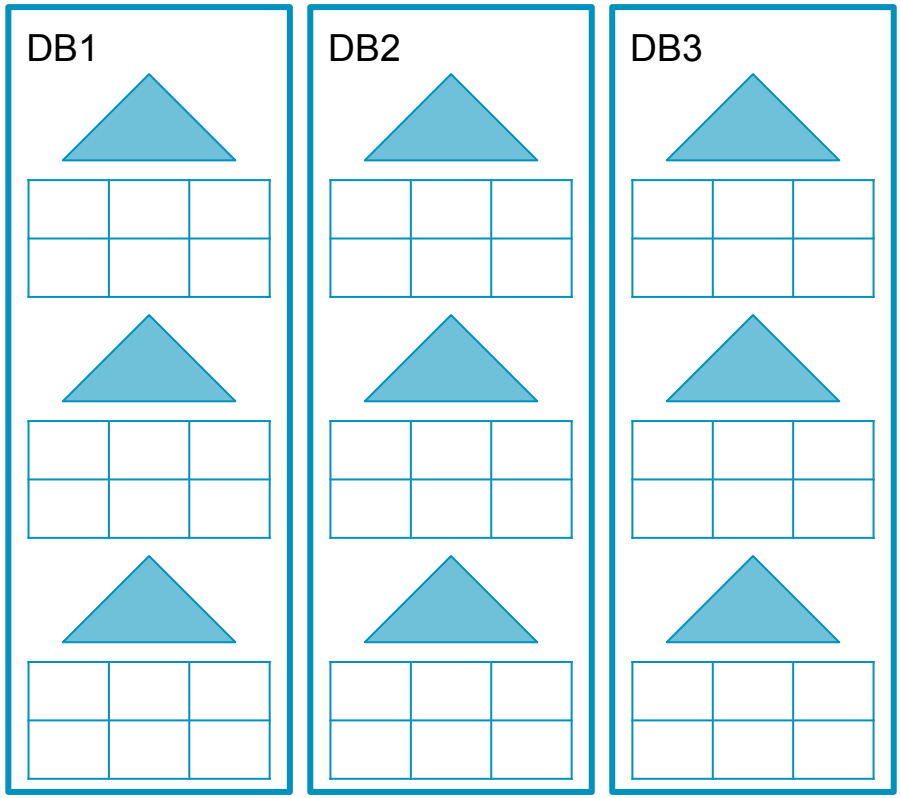


Metadata Table Partitioning

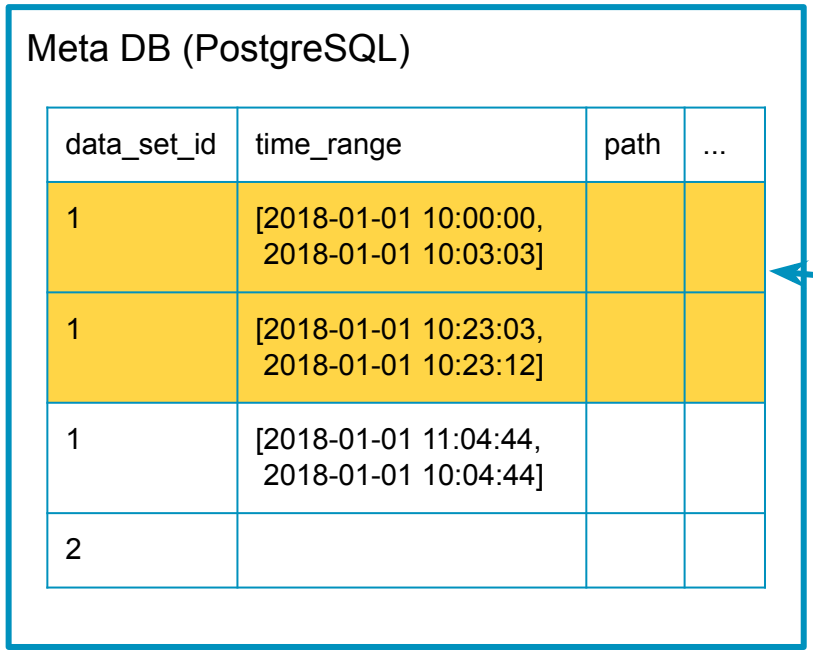


One relation’s reindex becomes shorter and space saving

Meta DB Scale out



More Partition Skip

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FROM
  orders
WHERE time >= '2018-01-01 10:00'
    AND time <= '2018-01-01 11:00'
    AND user_age >= 20
    AND user_age <= 30
GROUP BY
  region
```

Scan partition & Filter

More Partition Skip

Meta DB (PostgreSQL)

data_set_id	time_range	user_age_range
1	[2018-01-01 10:00:00, 2018-01-01 10:03:03]	[35, 40]
1	[2018-01-01 10:23:03, 2018-01-01 10:23:12]	[25, 30]
1	[2018-01-01 11:04:44, 2018-01-01 10:04:44]	
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      AND user_age <= 30
GROUP BY
  region
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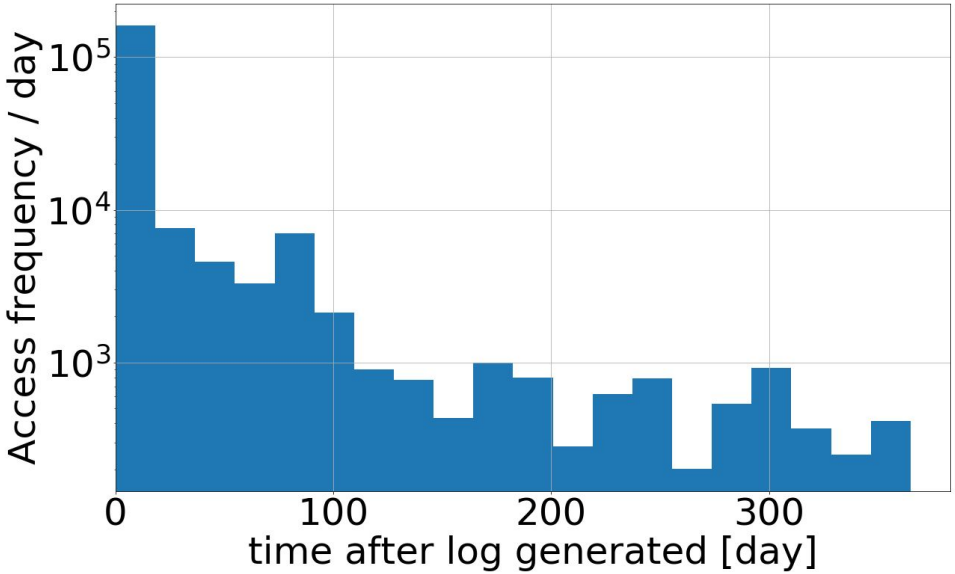
Store metadata on frequently accessed columns

Smart Partition Selection for Remerge

Remerge is resource consuming

- Current
  - Data set size
  - # of Partitions
- Idea
  - Access frequency
  - Data freshness
    Fresh data is likely to be hot



Summary

- PlazmaDB: Storage Layer of Arm Treasure Data Analytics Platform
  - Optimization for Analytical Queries
    - Columnar + Time Partitioning + Partition Index
  - Optimization for Streaming data
    - Realtime & Archive Storage + Merge Partition
- Challenges
  - Reduce impact of PostgreSQL VACUUM FREEZE
  - GiST index management
  - More Partition Optimization
    - Enrich Metadata
    - Smart Remerge

We are Hiring!!

https://www.treasuredata.com/company/careers/

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Thank You!
Danke!
Merci!
谢谢!
Gracias!
Kiitos!