OSA CON 24

UNIFIED DATA MANAGEMENT WITH CLICKHOUSE® AND POSTGRES

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November 19-21, 2024 I Free, online.

About The Speakers

Shivji Kumar Jha
Data Platform Engineer

- Software Engineer & Regular Speaker / Meetups
- Excited about:
  - Distributed Databases & Streaming
  - Open-Source Software & Communities
  - MySQL/Postgres, Pulsar/NATS, Druid/Clickhouse

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Software Engineer
OLAP Ninja

- Regular Platform Engineer
- Excited about:
  - Distributed OLAP Databases
  - Open-Source Enthusiast

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CONTENTS

- Background
  - The explosion of data
  - Variety of data & query patterns
- Running an open-source data stack YOURSELF
  - Operational challenges and cost
  - Distributed system is hard in the real world!
- More pieces in data stack => more complexity
- Thought Experiment: (Postgres, Clickhouse)
  - Is that enough?
  - Does it work well together?

So much data & So many databases. How do I map?

Volume, Variety, and Use Cases

- Complexity from data diversity
  - Volume: Data size grows exponentially
    - Compared to 2010 we are generating 76x data per year in 2024 . (details in upcoming slides)
  - Variety: Different types of data (structured, semi-structured, unstructured)
    - Row oriented
    - Column oriented
    - Documents(JSON, Protobuf) – text, audio, video
    - Graph data
    - Vector Embeddings?
  - Use-Cases: Expanding range of query patterns and applications across business functions
    - Transactions
    - Join Queries
    - Filters and Window Functions
    - Realtime or Batch or both (Lambda, Kappa?)
    - Slice and dice queries: group by, Sorting and Limiting, Aggregations etc
    - Lossy, Lossless, performance, dollars, availability etc etc

Other top of mind concerns…

ACTIVITY

TRANSACTIONS

ANALYTICS

METRICS

LOGGING

DATA

ACTIVITY

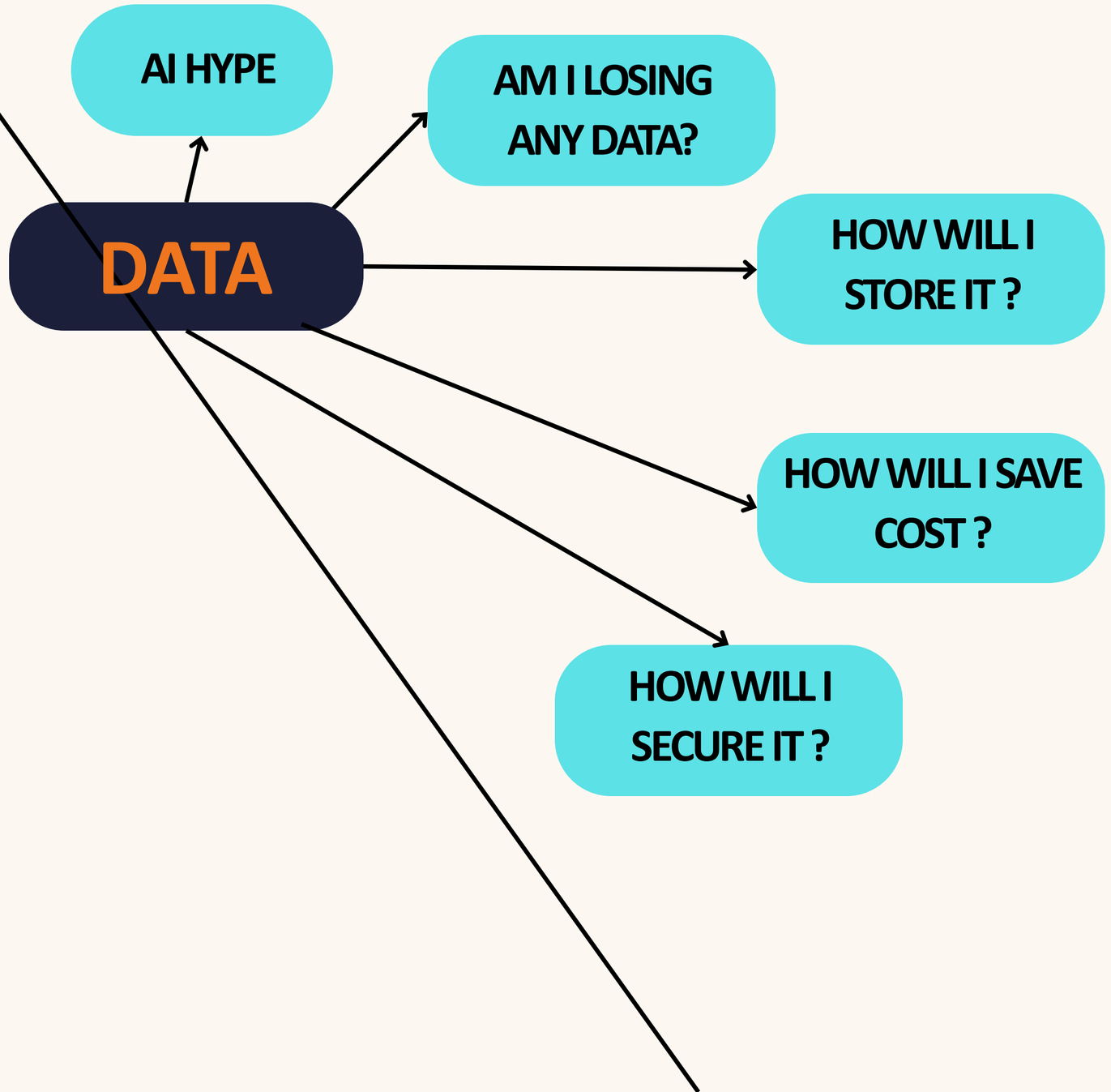
TRANSACTIONS

ANALYTICS

METRICS

LOGGING

Other top of mind concerns…



The Data Explosion

TRANSACTIONS

DATA

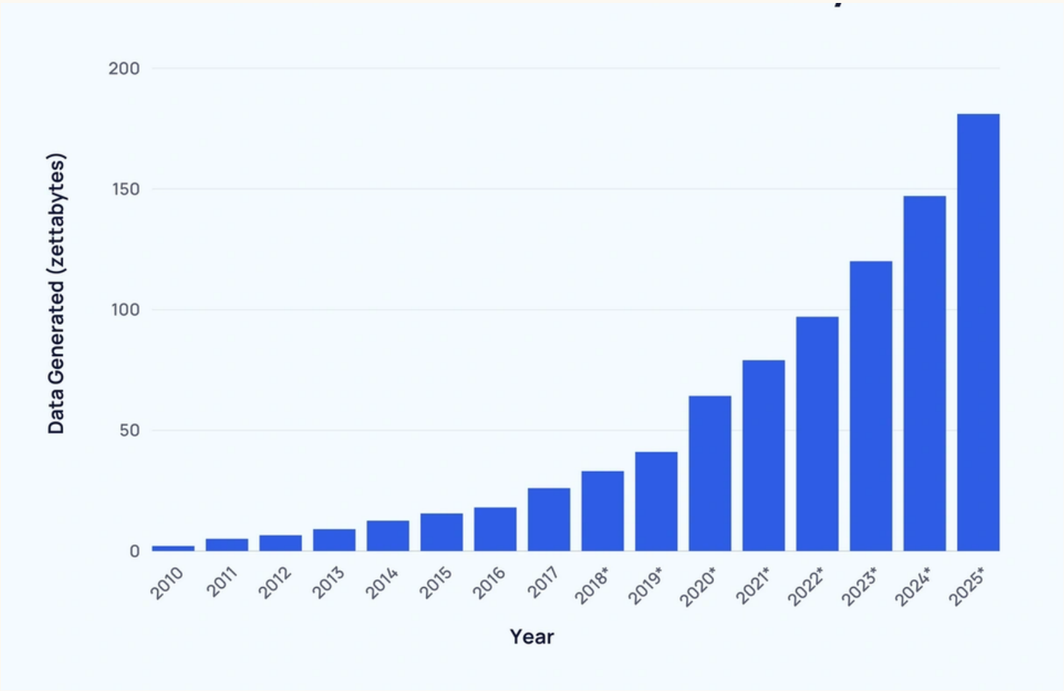
VECTOR DB

ANALYTICS

METRICS

LOGGING

Year	Data generated
2010	2 zb (x)
2015	15.5 zb (8x)
2020	64 zb (32x)
2024*	147 zb (74x)



https://explodingtopics.com/blog/data-generated-per-day#how-much

DATA

Financial

TRANSACTIONS

ANALYTICS

User interaction

User Activity

METRICS

Time Series

AI ML

VECTOR DB

LOGGING

Historical logs

DATA

Oracle
SQL Server
MySQL

Financial

TRANSACTIONS

ANALYTICS

User interaction

User Activity

Snowflake
Druid / Pinot
DuckDB

METRICS

Time Series

Prometheus
TimeScaleDB

Pinecone
Milvus/QuestDB

AI ML

VECTOR DB

LOGGING

Historical logs

ElasticSearch
Splunk

DATA

https://dbdb.io

Discover and learn about 1,014 database management systems

Oracle

SQL Server

MySQL

Financial

TRANSACTIONS

ANALYTICS

User interaction

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Splunk

Challenges of Running A Database in Enterprise Environments

- If the DBaaS mode works for you, that's a fine option
  - Cost affordable at scale?
  - Vendor lock-in?
  - Flexibility?
- Running yourself has complex challenges that go beyond just adding resources. Managing these systems requires
  - specialized expertise
  - often necessitating a dedicated platform team for configurations,
  - resilience testing, and legal compliance approvals.
  - For example, large enterprises must consider factors like system performance, high availability, and load balancing across nodes to ensure uptime and meet demands, especially in mission-critical applications.

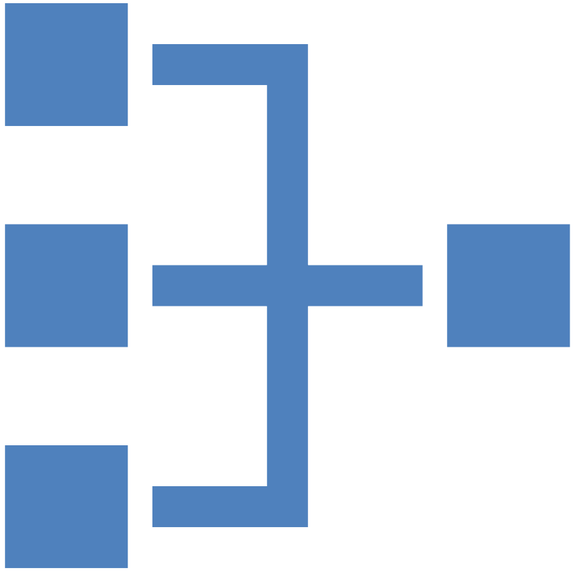
Deeper Technical Challenges

1. **Compliance and Security:** GDPR, HIPAA, region-specific storage, encryption etc
2. **Reliability and Uptime:**
    1. High availability with replication, backup, and disaster recovery
3. **Performance Optimization:**
    1. Data and access patterns evolve
    2. Load balancing, caching, and efficient query handling requires ongoing monitoring and configuration updates
4. **Resource and Cost Management:**
    1. Scaling resources dynamically in cloud environments costly.
    2. Running on-prem opens up need for more specialization.

This operational complexity demonstrates the importance of a skilled platform team and highlights why many enterprises consider managed database services or carefully select database technologies with robust enterprise support.

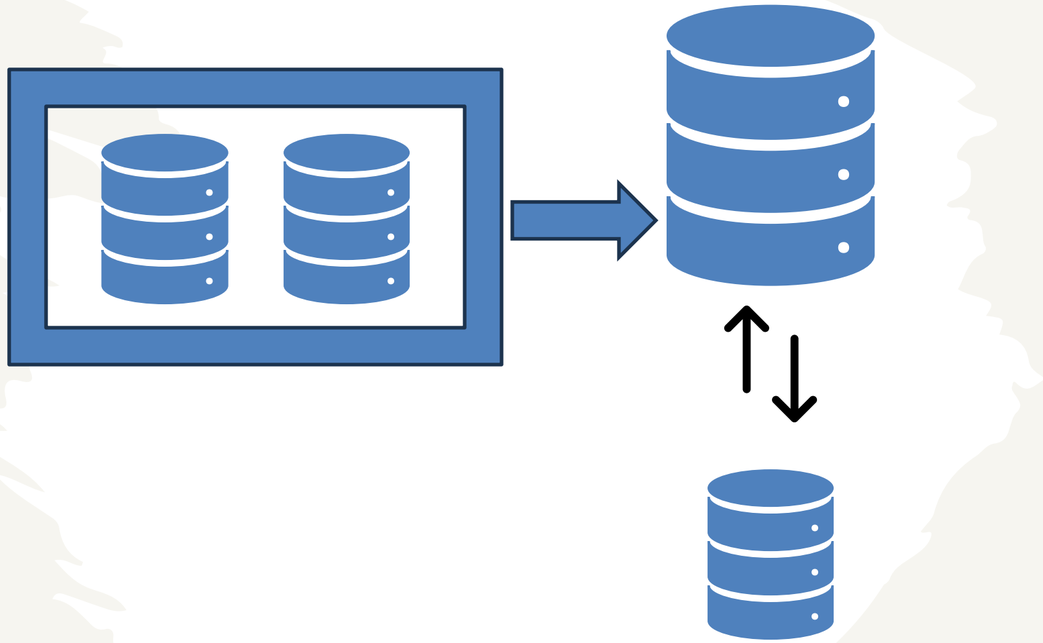
Challenges in Distributed Systems (~~Auto~~-scale)

- Operating distributed systems is complex
  - Coordination, consistency, and fault tolerance are difficult to achieve
    - Leader election
    - Ensure linearizability
  - Complexities in scaling maintaining these systems
    - Patch update
    - Zero downtime upgrade
    - Seamless migration
  - Impact on performance and reliability when not handled well
    - Prod down time = loss of business and trust
    - Cost
    - Data loss



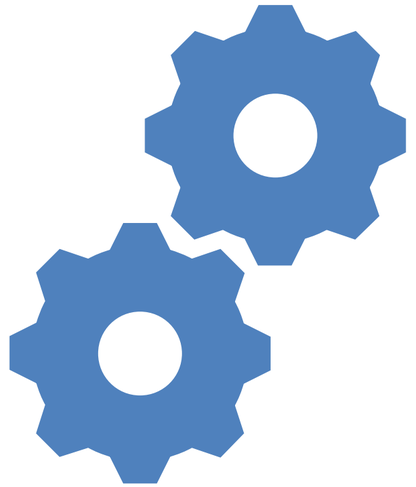
Many Distributed Databases = Exponentially More Complexity

- More databases, more problems
  - Managing multiple databases in a distributed environment increases the complexity exponentially
    - Cost
    - Duplicate data
    - More Experts required
    - Cloud and onPrem
  - Challenges with data consistency, replication, and cross-database querying
    - Data spread across database
    - Different queries
  - Increased operational overhead for managing and monitoring
    - Patch
    - Upgrade
      - Infra
      - new release



Simplifying Complexity - Reducing Moving Parts

- Consolidate where possible
  - Reduce number of systems to reduce complexity
    - Save cost, disk, expertise, support
    - Less duplicate data
  - Aim for solutions that balance flexibility with simplicity
    - Monitor at one place
    - Less Experts needed
  - Leverage multipurpose databases like Postgres and Clickhouse for versatility
  - Keep options open
    - A good architecture is one that commits least (OSS)



We Love PostgreSQL

Why Postgres?

- Advantages of using PostgreSQL
  - As open as you get them!
  - Mature, robust, and highly extensible
  - Supports a wide variety of data types and use cases
  - Strong community and ecosystem support
  - Proven reliability for both transactional and analytical workloads

"PostgreSQL is our DBMS of the Year for the fourth time, after winning already three titles between 2017 and 2020."

https://db-engines.com/en/blog_post/106

Postgres supercharged with Extensions

- Postgres is the most popular database
- **And there is so much innovation happening with its extensibility**
  - **Hydra**, pg_**duckdb**, **citus** etc for analytics
  - **Parade_db :** Postgres for Search and Analytics
  - **Postgres for logs:** parseable
  - **Postgres for timeseries:** timescale
  - **Postgres on S3 :** NeonDB
  - Postgres for Vector embeddings : pg_vector

A piece of opinion..

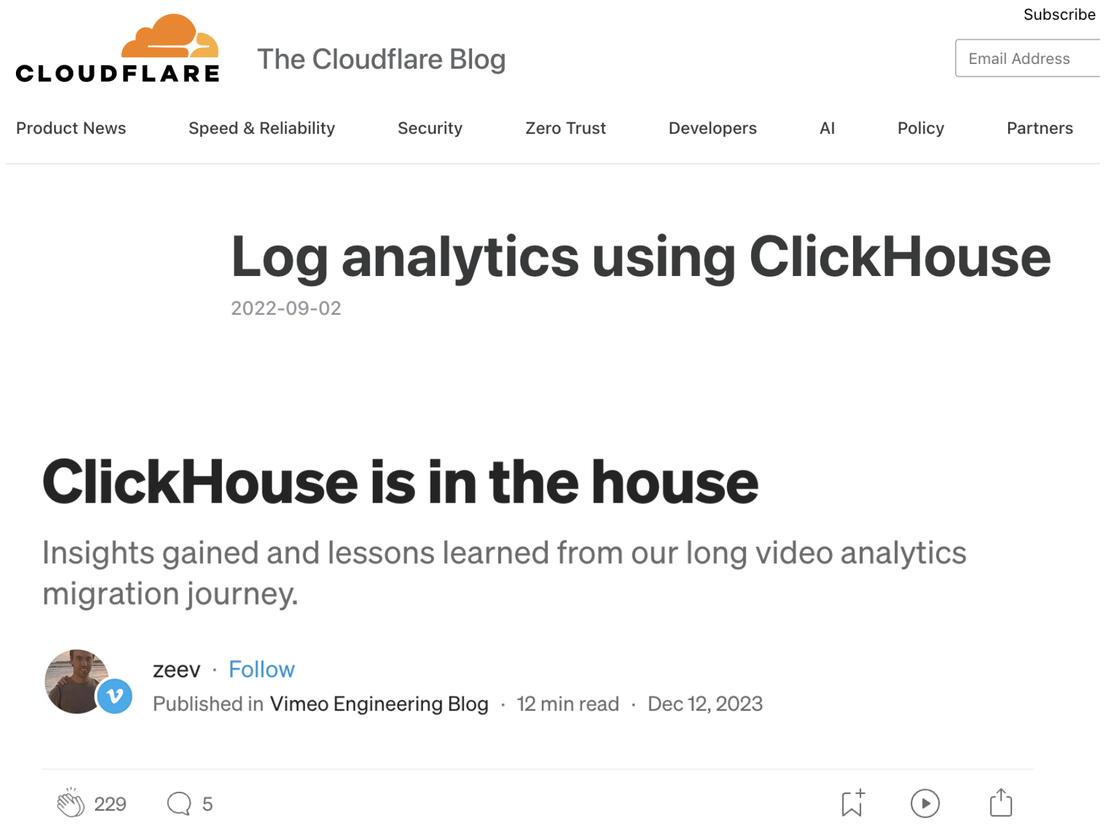
- If I start a company today and have little data, this works like a charm!!!
- But these extensions are not mature enough for enterprise use-cases YET!
- Neither are they mature enough to handle huge scales.

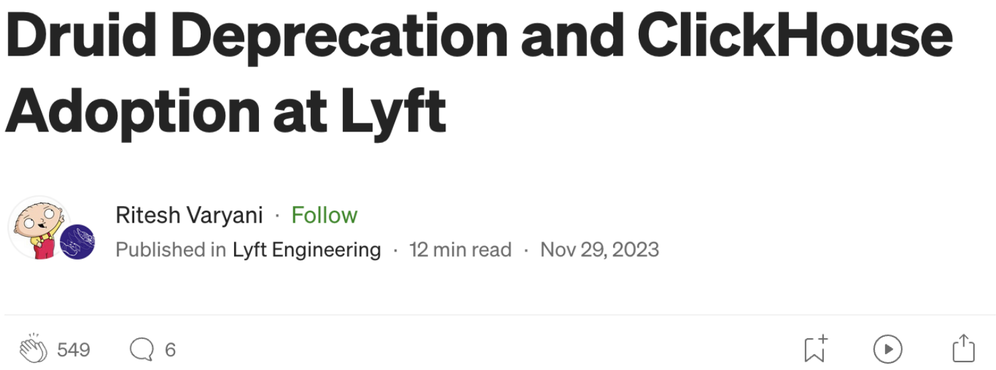
We Love Clickhouse

Clickhouse: A Rising Star in Analytics

- High-performance analytics with Clickhouse
  - Columnar storage optimized for analytical queries
  - Exceptional performance for large-scale data analysis
  - Increasingly popular for real-time analytics and time-series data
  - Complements PostgreSQL for high-speed data querying
- But not for “transactions”!
- Hates updates/deletes, well (almost)!

Lots of buzz around clickhouse lately





Postgres and Clickhouse “together”

https://www.deviantart.com/lucianovecchio/art/Batman-and-Robin-561000332

Postgres & Clickhouse “together” !

- Powerful combination for diverse data needs
  - Use Postgres for complex transactional data and flexible schema support
  - Use Clickhouse for high-speed analytics and heavy query loads
  - Together, they offer a powerful blend of reliability and speed for modern data requirements

Data Movement Between PostgreSQL and Clickhouse

- **Key Point:** Seamless **bi-directional data movement** between PostgreSQL and Clickhouse enables versatile use cases, allowing teams to combine strengths of both databases.

- **Tools**
  - **PostgreSQL Table Engine**
    - **Query postgres data directly from clickhouse**
  - **Altinity clickhouse connector**
    - **Moves data in real time from transactional database tables in MySQL and PostgreSQL to ClickHouse for analysis.**
  - **Clickhouse fdw**
    - **Use the clickhouse_fdw extension provided by Supabase to start querying data in ClickHouse from within Postgres. Variety use cases**
      - **Consolidating to a single query interface to support both transactional (OLTP) and analytical (OLAP) applications**
      - **Providing a simple way to join transactional data stored in Postgres with analytical data such as logs, telemetry, events, and more.**

PostgreSQL and Clickhouse: Use cases & Success Stories!

Use Cases:

- **Hybrid Analytical Workloads**: Run real-time analytics in Clickhouse, then sync processed results back to PostgreSQL for integration into transactional applications.
- **High-Performance Reporting**: Transfer large datasets to Clickhouse for intensive analytical queries while PostgreSQL handles transactional processing.
- **Data Archiving and Query Offloading**: Archive older data from PostgreSQL to Clickhouse to reduce storage and query load while retaining fast access to historical data.

Success Stories:

- **eCommerce Platforms**: Companies use Clickhouse for detailed customer behavior analysis and then sync relevant results to PostgreSQL for integration with customer management systems.
- **Financial Services**: Banks utilize this setup for real-time trading analytics in Clickhouse, syncing essential results to PostgreSQL for transactional integrity.
- **IoT Data Processing**: IoT providers analyze large volumes of sensor data in Clickhouse and aggregate results in PostgreSQL for reporting and device managemen

This integration gives companies the flexibility to build robust and scalable architectures using PostgreSQL and Clickhouse, supporting diverse, data-intensive applications.

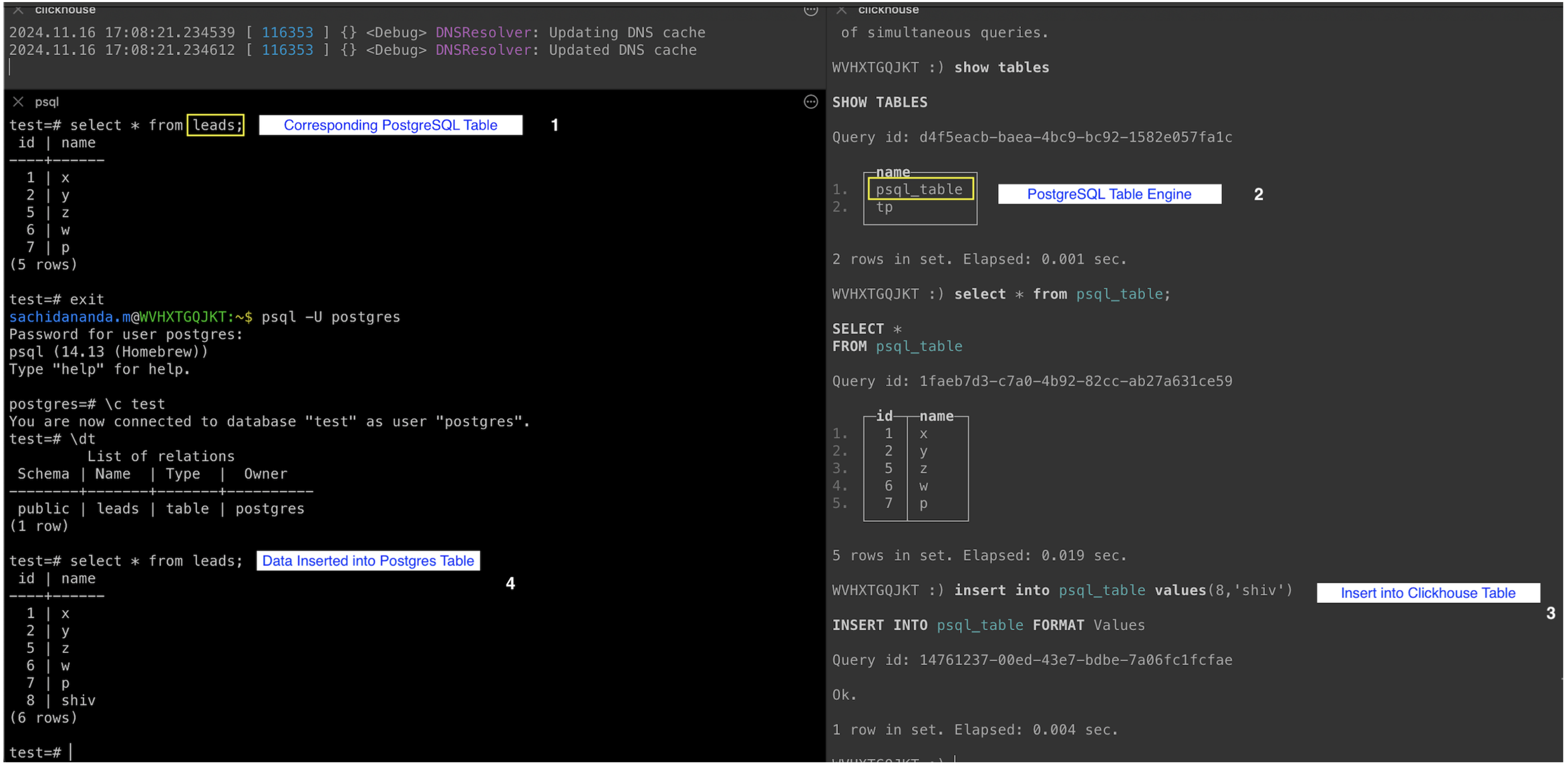
PostgreSQL Table Engine

- In postgres
  - CREATE TABLE leads (id INTEGER PRIMARY KEY, name VARCHAR);
- In Clickhouse
  - CREATE TABLE psql_table

```
(
 `id` Int32,
 `name` String,
)
ENGINE = PostgreSQL('localhost:5432’,'test','leads’,   'postgres','pwd');
```

- The PostgreSQL engine allows SELECT and INSERT queries on data stored on a remote PostgreSQL server.
- Contd.

PostgreSQL Table Engine Demo



The Amazing Duo (Postgres + Clickhouse)

“PeerDB’s technology significantly reduces the time it takes to connect data in transactional databases like Postgres with analytical databases like ClickHouse, boosting developer productivity and time-to-value when building real-time data driven applications. With PeerDB CDC technology integrated into ClickHouse Cloud, users will benefit from seamless, real-time data replication from Postgres databases to ClickHouse.”

Efficient Data Transfer with PeerDB between PostgreSQL and ClickHouse

Overview of PeerDB:

- Real-time replication from PostgreSQL to ClickHouse,
- Change Data Capture (CDC) to track data updates.
- Low-latency sync without impacting source DB performance.

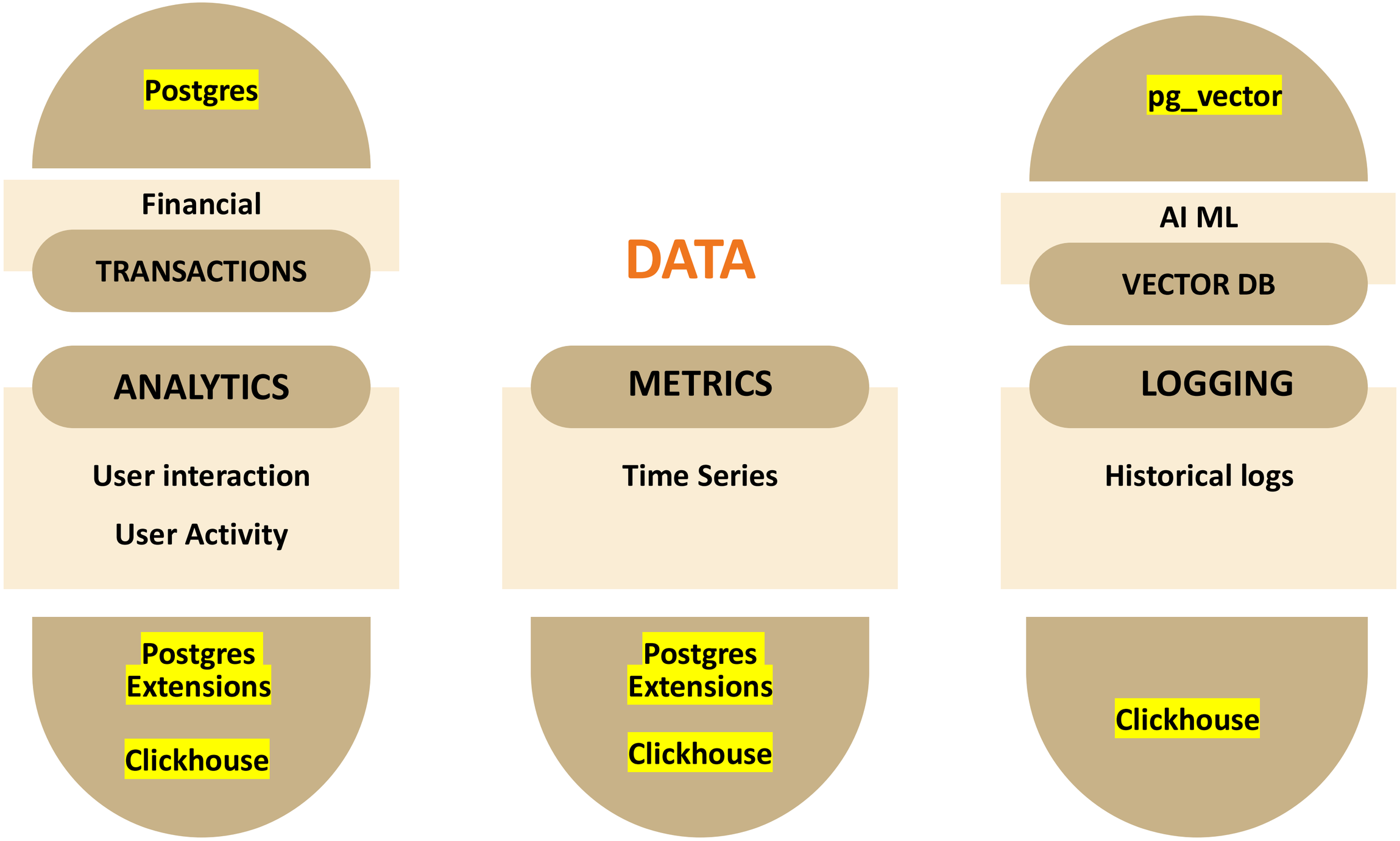
How It Works:

- Uses PostgreSQL Logical Replication to capture changes and transfer them to ClickHouse with minimal lag.
- Data is batched and sent in real time, reducing transfer times (e.g., from hours to minutes for initial loads).
- Supports schema evolution, row-level transformations (e.g., masking PII), and robust data consistency checks, ensuring ClickHouse holds accurate and up-to-date data.

Here is the Picture we wanted to PAINT!

The Amazing Duo (Postgres + Clickhouse)

- Reduce number of databases
- Build a Platform team with concentrated expertise
- Deep in-house experience in leveraging these technologies
  - Skilled in implementing, tuning, and optimizing Postgres and Clickhouse
  - Deep understanding of distributed data challenges and solutions
    - Mitigate crash scenarios
  - Our small and focussed team ensures seamless integrations and performance optimization


Postgres
Financial
TRANSACTIONS
ANALYTICS
User interaction
User Activity
Postgres Extensions
Clickhouse
DATA
METRICS
Time Series
Postgres Extensions
Clickhouse
pg_vector
AI ML
VECTOR DB
LOGGING
Historical logs
Clickhouse

Open for

Q n A

Thank You

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