Set your own ClickHouse Warehouse

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Agenda

0. Why do you need a Data Warehouse?

1. What is ClickHouse?

2. Installation and Configuration

3. Advanced Configuration for HA

4. Data Ingestion

5. Querying Data

6. Q&A

A Note about **my Experience**

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- I want to be upfront about my experience with ClickHouse.
- I've managed a few ClickHouse instances on VPS, but I've never personally set up a large-scale data warehouse in a live, production environment.
- My goal for this presentation is to provide you with a roadmap to navigate the world of ClickHouse and know where to find the information you need.
- Think of me as your guide, not the ultimate expert. I'm here to help you get started and learn where to look for further resources.

0. Why do you need a Data Warehouse?

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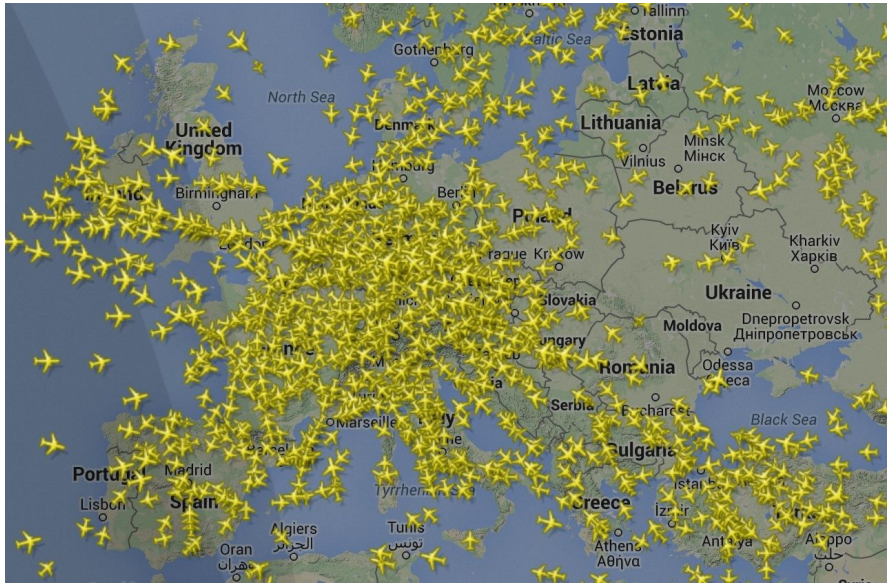
A data warehouse is a centralized repository that stores and manages data from various sources for analytical purposes. It is designed to support complex queries and analysis.

Benefits of Data Warehouses

- **Improved Decision-Making:** Data warehouses provide a comprehensive view of data, enabling better-informed decisions based on historical trends, patterns, and correlations.
- **Enhanced Data Analysis:** Data warehouses support complex queries and aggregations, allowing for in-depth analysis of large datasets.
- **Data Integration:** Data warehouses consolidate data from disparate sources, ensuring consistency and accuracy for analysis.
- **Performance Optimization:** Data warehouses are optimized for analytical workloads, providing faster query response times.
- **Data Governance:** Data warehouses enforce data quality standards and access control policies, ensuring data integrity and security.

0.1 Real Scenario

Let’s consider a real application:



Database?

0.2 Database Choices

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Row Store

Flight #	Date	Origin	Destiny	Airline #
3620	2020-11-02	OPO	LIS	23
3626	2020-11-03	LIS	OPO	25
3631	2021-01-21	OPO	DUB	35
3650	2021-02-11	DUB	BCN	12

Column Store

Flight #	Date	Origin	Destiny	Airline #
3620	2020-11-02	OPO	LIS	23
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3650	2021-02-11	DUB	BCN	12

0.2 Database Choices - Real Example

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```
1  select toYear(Date) year,
2         count(1)     count,
3         AirlineId    airline
4  from ontime
5  group by year, airline
6  order by count desc, year desc
```

0.2 Database Choices

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Row Store

Flight #	Date	Origin	Destiny	Airline #
3620	2020-11-02	OPO	LIS	23
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0.2 Database Choices - Then what?

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Row Store

Flight #	Date	Origin	Destiny	Airline #
3620	2020-11-02	OPO	LIS	23
3626	2020-11-03	LIS	OPO	25
3631	2021-01-21	OPO	DUB	35
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Entire dataset

Column Store

Flight #	Date	Origin	Destiny	Airline #
3620	2020-11-02	OPO	LIS	23
3626	2020-11-03	LIS	OPO	25
3631	2021-01-21	OPO	DUB	35
3650	2021-02-11	DUB	BCN	12

Small fraction of the data

0.3 Column store Data Warehouse

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- **Compressed data**
  - ratios of 10:1 or higher for certain types of data
  - more significant compression ratios, such as 20:1 or even greater when dealing with large datasets that have repeated patterns or low cardinality columns
  - this vastly reduces the amount of I/O we have to do
- Reads compressed columns **in parallel**
  - ClickHouse breaks the columns in pieces and farm them out to different CPU cores

0.3 Column store Data Warehouse

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```
SELECT
    toYear(FlightDate) AS year,
    count(1) AS count,
    Reporting_Airline AS airline
FROM ontime
GROUP BY
    year,
    airline
ORDER BY
    count DESC,
    year DESC
```

```
Query id: e0668f19-3cf7-4d6c-925a-264d981222bd
```

year	count	airline
2022	97436	WN
2022	69400	AA
2022	68963	DL
2022	63146	OO
2022	45741	UA
2022	27261	YX
2022	22205	MQ
2022	21644	9E
2022	21332	B6
2022	20541	OH
2022	17554	NK
2022	16549	AS
2022	12039	F9
2022	11404	YV
2022	8714	G4
2022	8105	QX
2022	5868	HA

```
17 rows in set. Elapsed: 0.301 sec. Processed 537.90 thousand rows, 1.61 MB (1.79 million rows/s., 5.37 MB/s.)
```

1. What is ClickHouse?

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- ClickHouse is an open-source, columnar, analytical database management system.
- Was initially developed by ***Yandex***, a Russian tech company, to power their web analytics platform (Metrica)
    - It was then open sourced in **2016**, and the code can be found on GitHub.
- It's designed for high-performance data warehousing and real-time analytics.

1. What is ClickHouse?

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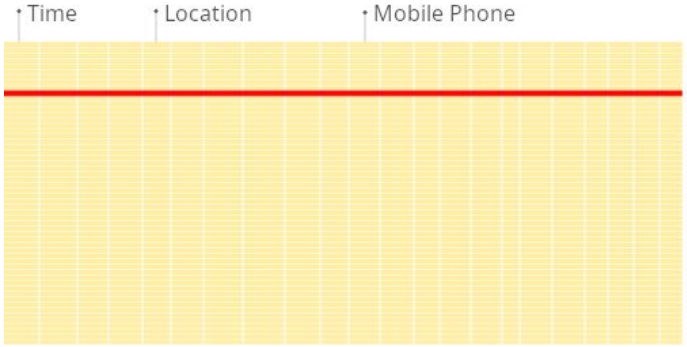
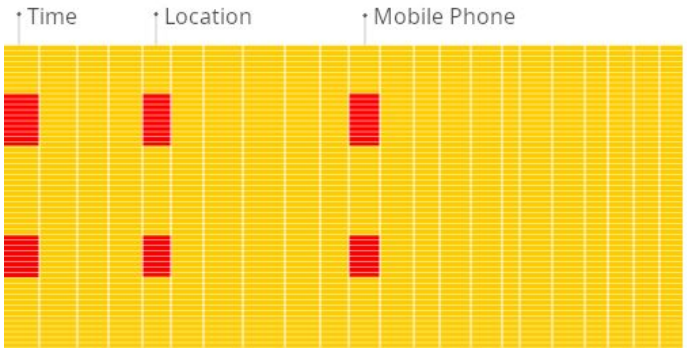
Traditional row-oriented:



Colunar:



1.1. Why Choose ClickHouse?

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- **Speed:** ClickHouse is *blazingly fast*, capable of processing terabytes of data per second.
- **Scalability:** It scales horizontally to handle growing datasets.
- **Cost-Effective:** Open-source nature means no licensing costs.
- **Flexibility:** Supports various data formats and query languages.
- **Ideal for Analytical Workloads:** Suited for complex analytical queries.

1.2. Key Features

- **Columnar Storage:** Stores data in columns for efficient compression and query performance.
- **SQL Support:** Familiar SQL querying for data analysis.
- **Distributed Architecture:** Enables high availability and scalability.
- **Real-Time Data Ingestion:** Supports continuous data ingestion for up-to-the-minute insights.

1.3. Use Cases

- **Data Warehousing:** Store and analyze large volumes of historical data.
- **Log Analytics:** Ideal for analyzing logs and event data.
- **Time-Series Data:** Great for handling time-series data and metrics.
- **Clickstream Analysis:** Track user behavior in real time.
- **Ad-Hoc Analytics:** Supports on-the-fly analysis of diverse datasets.
- **EXADS Analytics:** Yeah, you saw it right…

1.4. Who Uses ClickHouse?

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- Companies like:
  - Yandex
  - Cloudflare
  - Cisco
  - Disney+
  - eBay
  - GitLab
  - IBM
  - …
- It's gaining popularity across various industries, including e-commerce, finance, and telecommunications.

2. Simple Installation

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Community builds for four architectures:

- **Linux x86_64** (main and the mostly supported one)
- Linux AArch64*
- MacOs*
- FreeBSD*

* less stable.

```
sudo apt-get install -y clickhouse-server clickhouse-client
sudo systemctl enable clickhouse-server
sudo systemctl start clickhouse-server
```

2.1 Configuration

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ClickHouse utilizes configuration files to define various settings and parameters for the server and user configurations. These files can be written in either XML or YAML files.

- /etc/clickhouse-server/**config.xml**

  Defines global server settings, including network configurations, logging options, and performance tuning parameters.

- /etc/clickhouse-server/**users.xml**

  Manages user accounts, roles, access rights, and resource quotas.

- Additional Configuration Files:

  Enables separation of configuration settings into distinct files for better organization and maintainability.

3. Advanced Installation for HA

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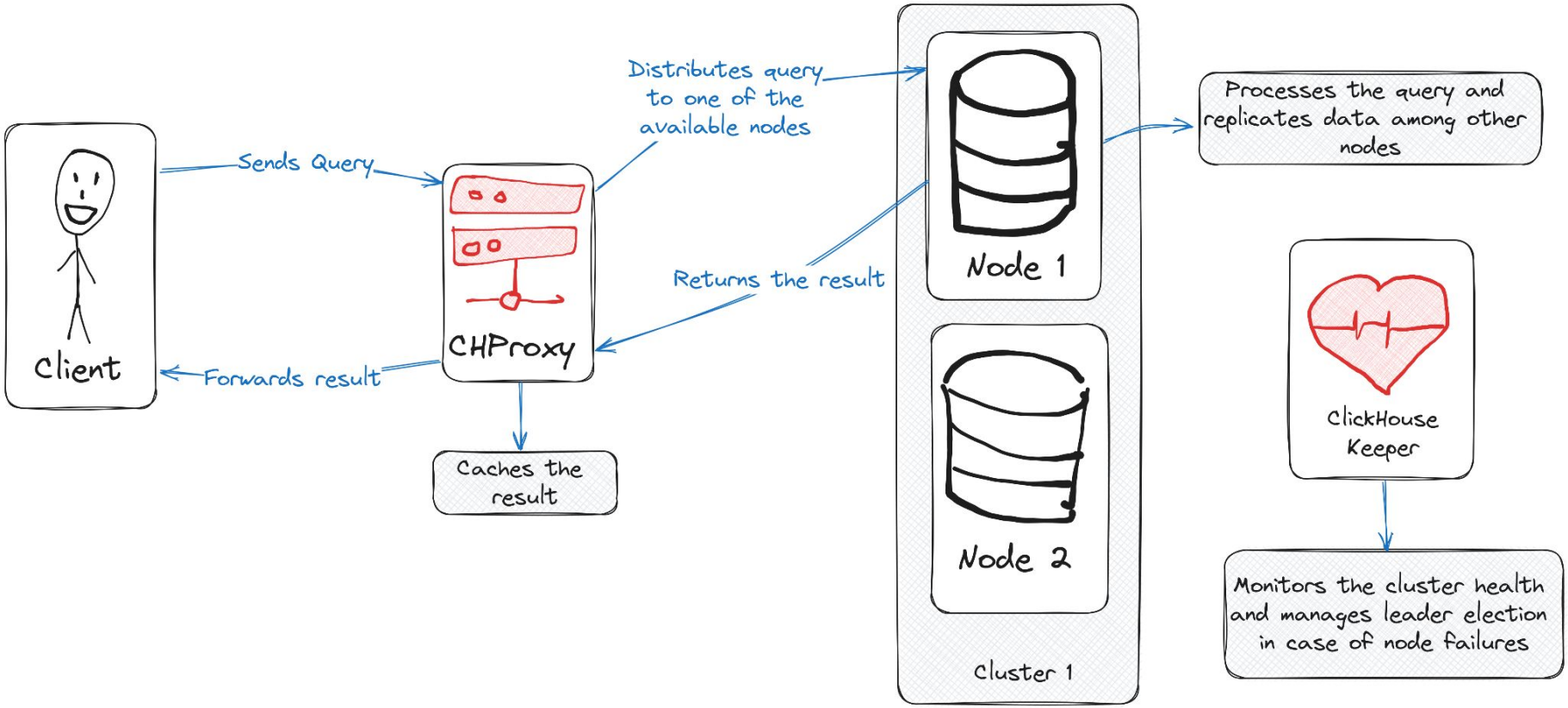
Achieving high availability (HA) in ClickHouse involves deploying a **distributed cluster** with replication and load balancing capabilities.

ClickHouse Keeper and **CHProxy** are essential components for establishing a robust and scalable HA setup.

3.1 Advanced Installation for HA - Why?

- **Resilience:** Ensures continuous operation even if individual nodes fail.
- **Scalability:** Enables horizontal scaling to handle increasing data volumes and query workloads.
- **Performance:** Optimizes query performance through load balancing and caching.

3.2 Advanced Installation for HA - The Flow



3.3 ClickHouse Keeper

A distributed coordination service that manages cluster membership, leader election, and configuration synchronization.

- Developed by the ClickHouse community
- Best candidate to replace ZooKeeper:
  - written in C++, which is generally more performant than Java (ZooKeeper). This can lead to faster cluster operations and reduced latency
  - it has a smaller memory footprint and consumes less disk space compared to ZooKeeper
  - stronger consistency guarantees, including linearizable reads, which ensures that clients always see the latest consistent state of the cluster
  - …

https://clickhouse.com/docs/en/guides/sre/keeper/clickhouse-keeper

3.4 CHProxy

A lightweight proxy server that sits between clients and the ClickHouse cluster, providing load balancing, failover, and caching capabilities.

- **Load Balancing:** CHProxy effectively distributes incoming queries across multiple nodes, preventing any single node from becoming overloaded
- **Failover:** detects failed or unresponsive ClickHouse nodes and automatically redirects queries to healthy nodes
- **Caching:** can cache frequently accessed query results, reducing the load on ClickHouse nodes and improving response times for subsequent requests
- **Security Enhancements:** can enforce access control rules and limit resource usage for specific users or groups
- …

https://www.chproxy.org/install/


Water Break
PUPPY BOWL

4. Data Ingestion

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Data ingestion is the process of loading data into ClickHouse for storage, analysis, and querying. ClickHouse supports various data ingestion methods to accommodate different data sources, formats, and ingestion patterns.

ClickHouse can ingest data from various sources, including:

- **Local files:** CSV, TSV, JSON, Parquet, etc.
- **Remote servers:** HTTP, HTTPS, FTP, SFTP
- **Databases:** MySQL, PostgreSQL, ClickHouse replicas
- **Message queues:** Kafka, RabbitMQ, Kinesis
- **Streaming data:** Apache NiFi, ClickHouse-grafana

4.1 Data Ingestion - Methods

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ClickHouse offers multiple ingestion methods:

- **INSERT INTO:** Inserts data directly into ClickHouse tables.
- **COPY FROM:** Loads data from external sources into ClickHouse tables.
- **Materialized Views:** Automatically ingests data from other ClickHouse tables or external sources based on predefined transformations.

4.2 Data Ingestion - Batch vs. Stream

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ClickHouse supports both batch and streaming ingestion:

- **Batch ingestion:** Loads data in bulk at specific intervals or on demand.
- **Streaming ingestion:** Continuously ingests data as it arrives in real-time.

4.3 Data Ingestion - Tools

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Various tools facilitate data ingestion into ClickHouse:

- **ClickHouse-Client:** Command-line tool for loading data and managing ClickHouse instances.
- **Tabix:** High-performance browser tool for loading and transforming data into ClickHouse.
- **ClickHouse-grafana:** Data ingestion and visualization tool for real-time data pipelines.

4.4 Data Ingestion - Best Practices

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- Optimize data formats for ClickHouse's columnar storage.
- Use batch ingestion for large datasets and streaming for real-time data.
- Leverage materialized views to automate data updates.
- Monitor ingestion performance and adjust settings as needed.

Scalable data ingestion abstraction for ClickHouse [GitLab]

5. Querying Data

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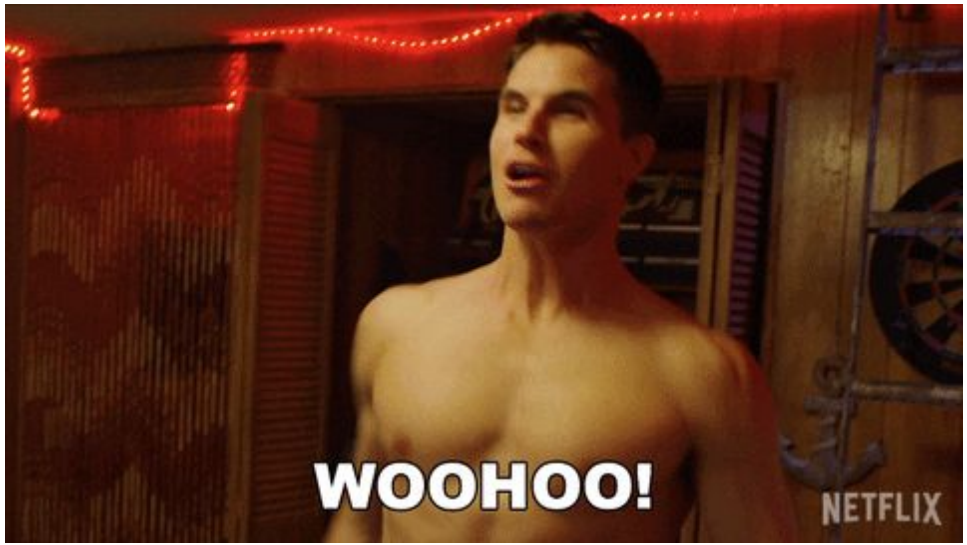
ClickHouse provides a powerful **SQL-based** query language for retrieving, analyzing, and manipulating data stored in its tables. Its query engine is optimized for high-performance analytics on large datasets, enabling users to extract insights quickly and efficiently.

6. [EXTRA] Useful links

- Your First ClickHouse Data Warehouse | ClickHouse Webinar (Video)
- Scalable data ingestion abstraction for ClickHouse (GitLab)
- ClickHouse Keeper: A ZooKeeper alternative written in C++
- Everything you should know about materialized views
- ClickHouse Developer Community

6. [ULTRA] Play time

https://github.com/fiskolini/clickhouse-datawarehouse-sample



Thank you!

Questions?