YDB

YDB: How To Implement Streaming RAG In A Distributed Database

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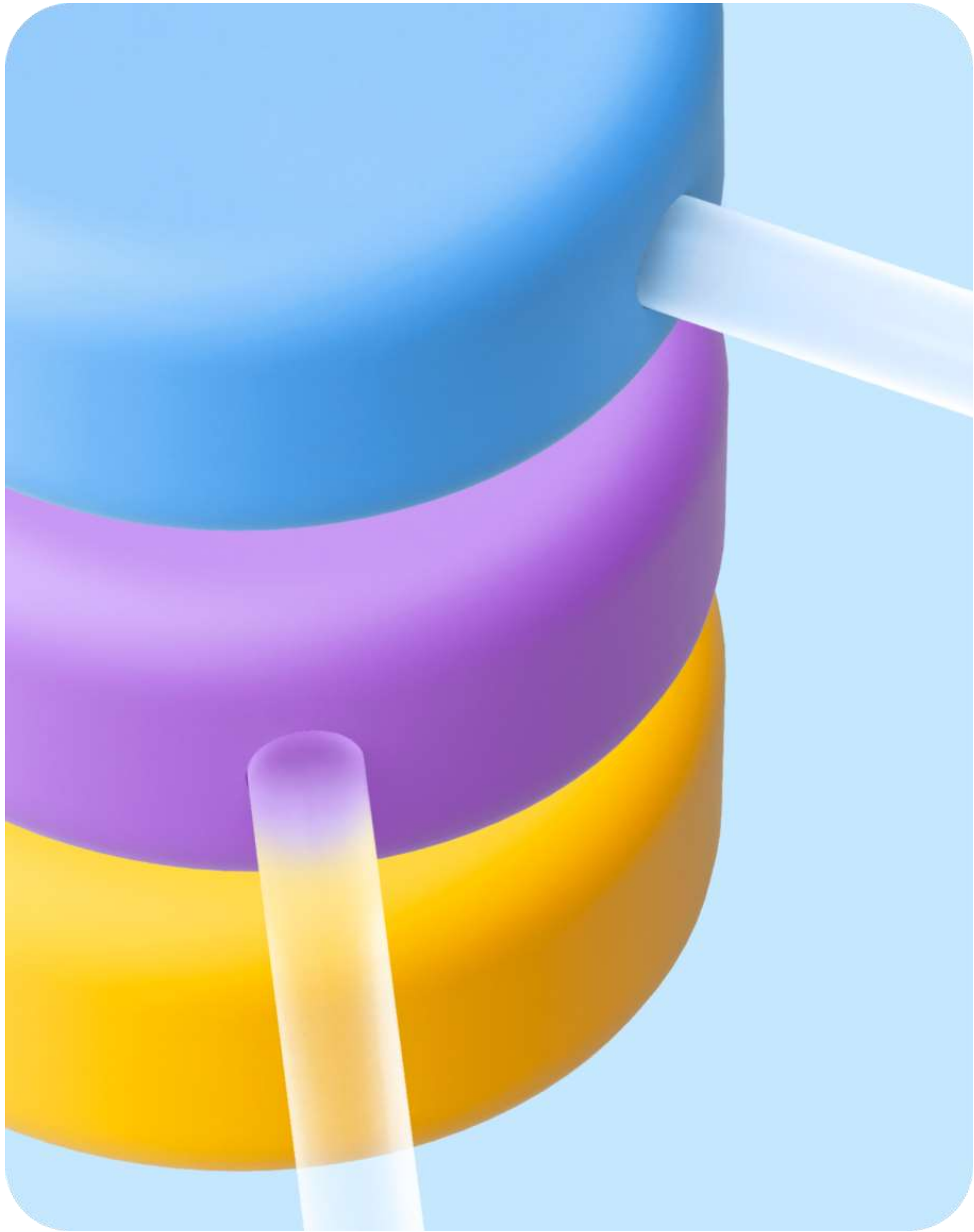
Streaming RAG

Retrieval Augmented Generation



Enterprises Are Not Developing Their Own Generative AI Models

Too complex and too costly

Millions of dollars

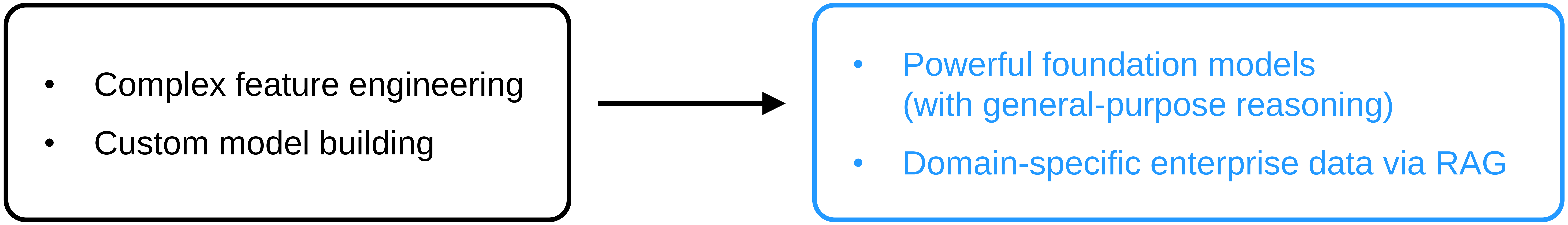
A lot of data acquisition

Compute infrastructure

Scarce GPU

Expertise

Data privacy



- Complex feature engineering
- Custom model building

- Powerful foundation models (with general-purpose reasoning)
- Domain-specific enterprise data via RAG

Retrieval Augmented Generation

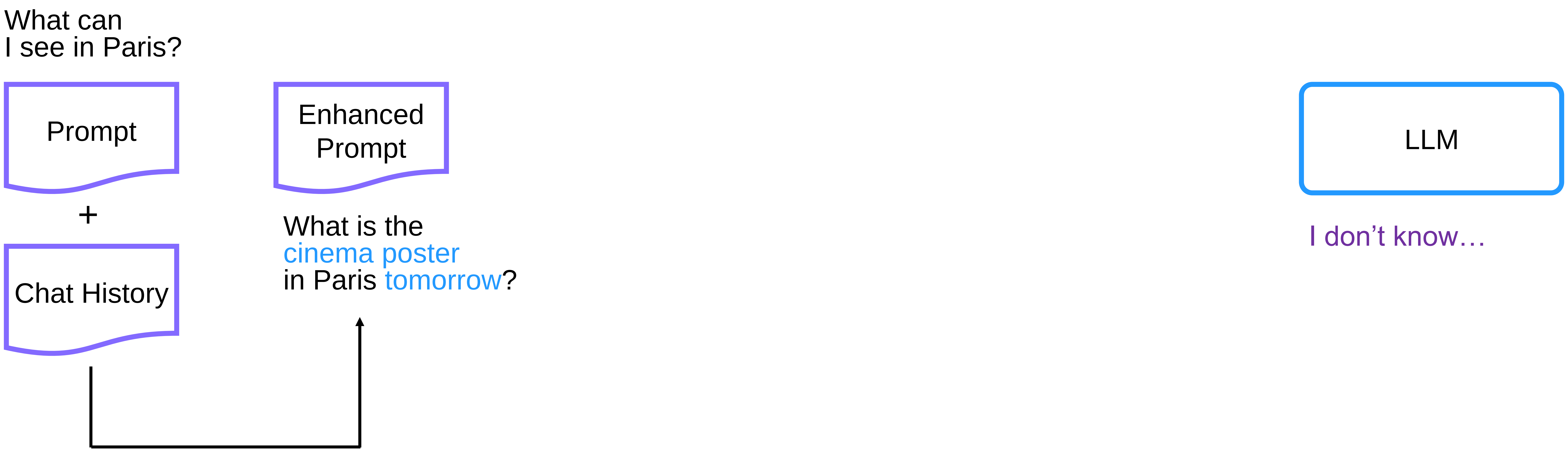
What can
I see in Paris?

Prompt

LLM

I don’t know…

Retrieval Augmented Generation

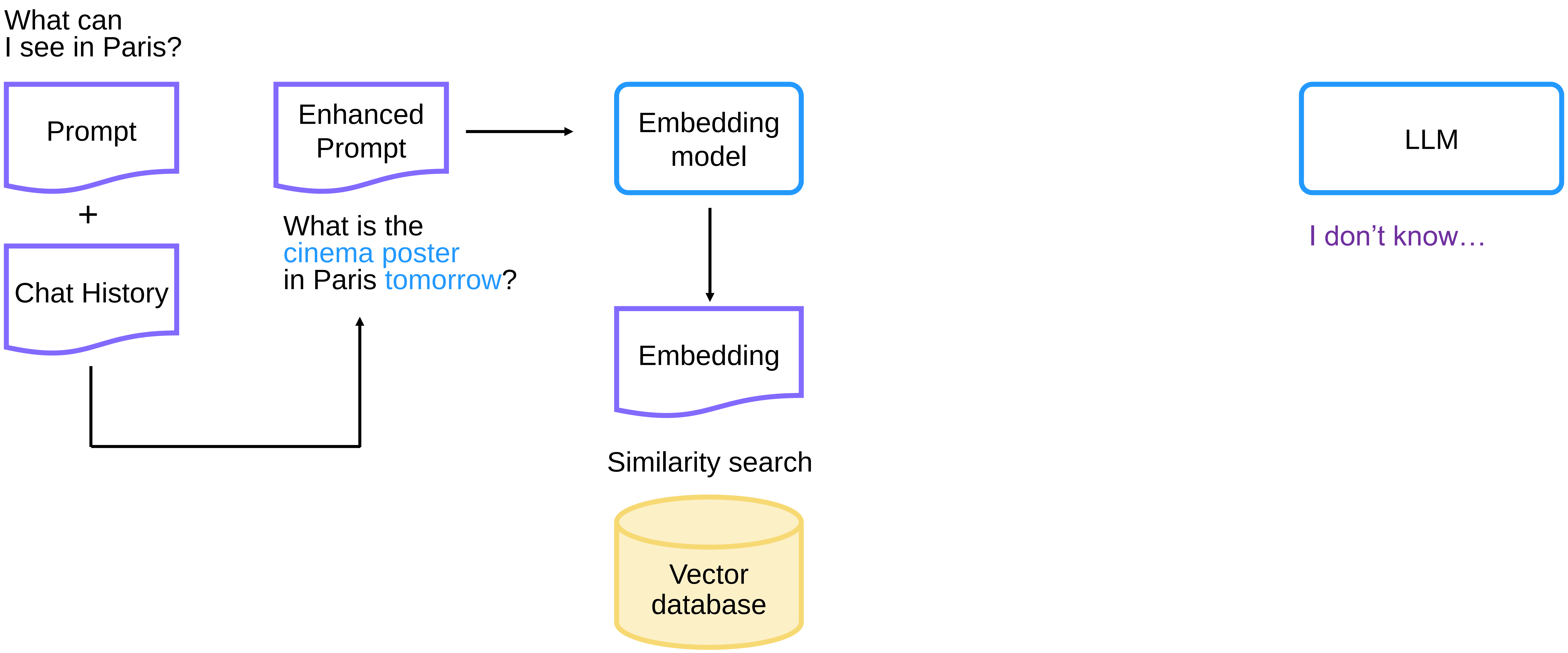


What can
I see in Paris?

What is the
cinema poster
in Paris tomorrow?

I don’t know…

Retrieval Augmented Generation



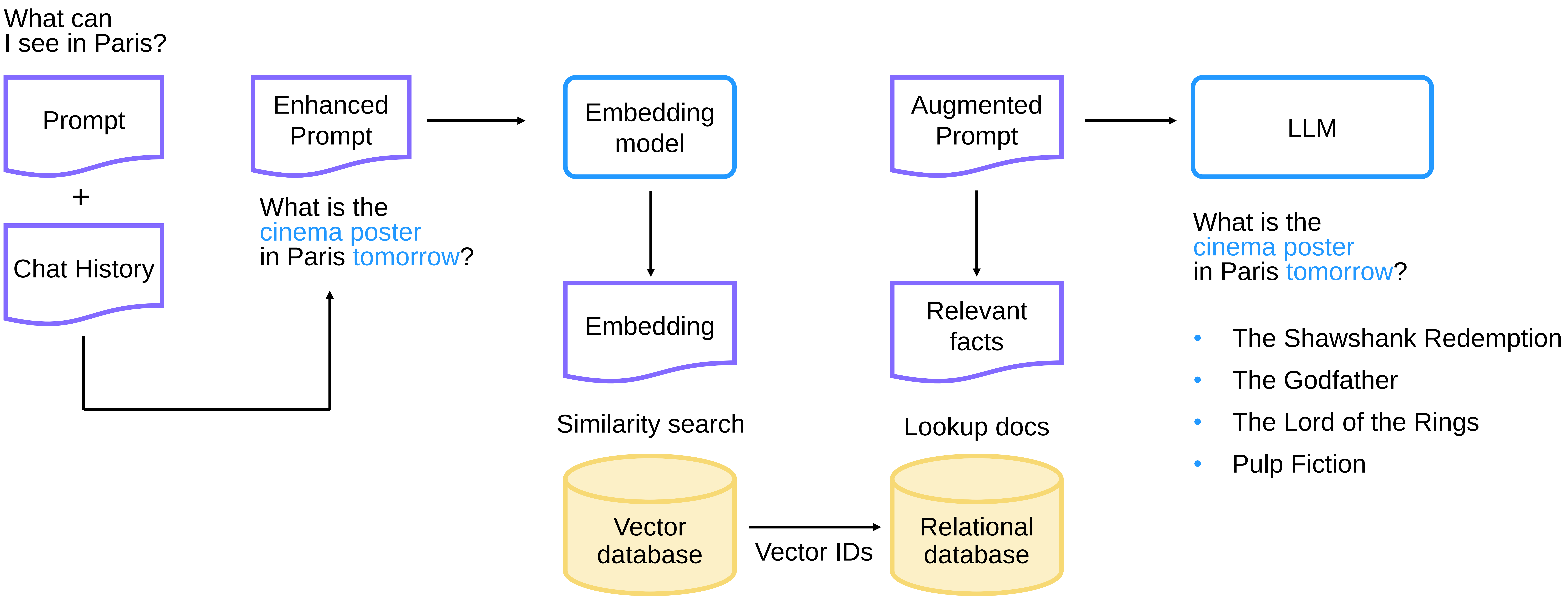
What can
I see in Paris?

What is the
cinema poster
in Paris tomorrow?

Similarity search

I don’t know…

Retrieval Augmented Generation



Trend #2: Moving Toward Streaming RAG

AI without up-to-date data is frustrating and its value is limited

Generative AI in the enterprise is more about streaming, not batch

2018 GPT-1

2019 GPT-2

2020 GPT-3

2022 GPT-3.5

2023 GPT-4

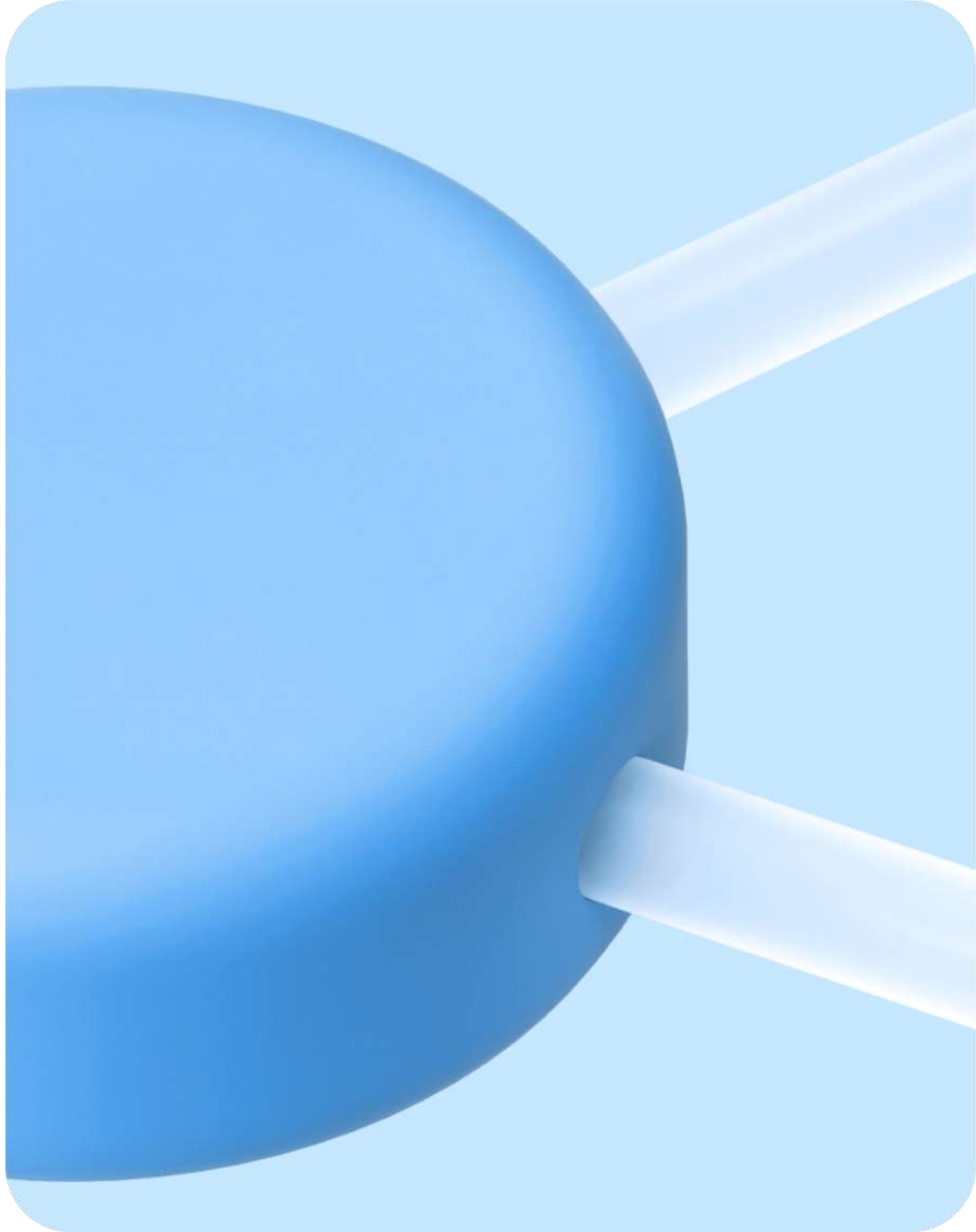
Use Cases Of Streaming RAG

Real-Time Financial Advisory Platform

Dynamic Healthcare Monitoring and Assistance

Live News Analysis

YDB



What Is YDB?

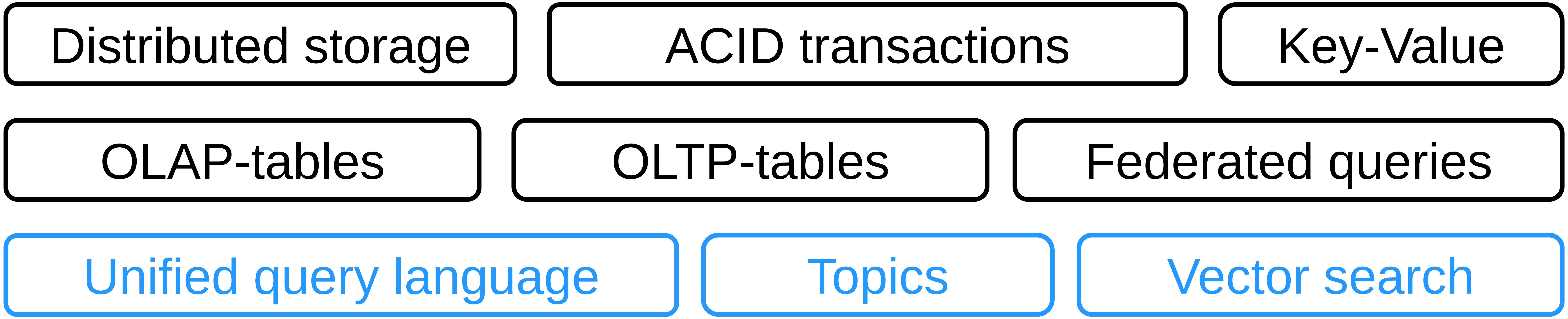
Distributed SQL RDMS for operational, analytical and streaming workloads

github.com/ydb-platform/ydb

ydb.tech

- Horizontal scaling
- ACID transactions in multiple AZ
- Operability and automatic recovery in case of failures
- Scaling by millions of transactions per second and **petabytes** of data
- Production installations of **tens of thousands** of servers
- Open-Source under Apache 2.0 license

YDB As A Platform



Distributed storage

ACID transactions

Key-Value

OLAP-tables

OLTP-tables

Federated queries

Unified query language

Topics

Vector search

YDB Intrinsic Advantages

Scale

Sharding

Replication

Spiky workload

Cross Datacenter

Production readiness

Fault-tolerance

Rolling update

Persistence

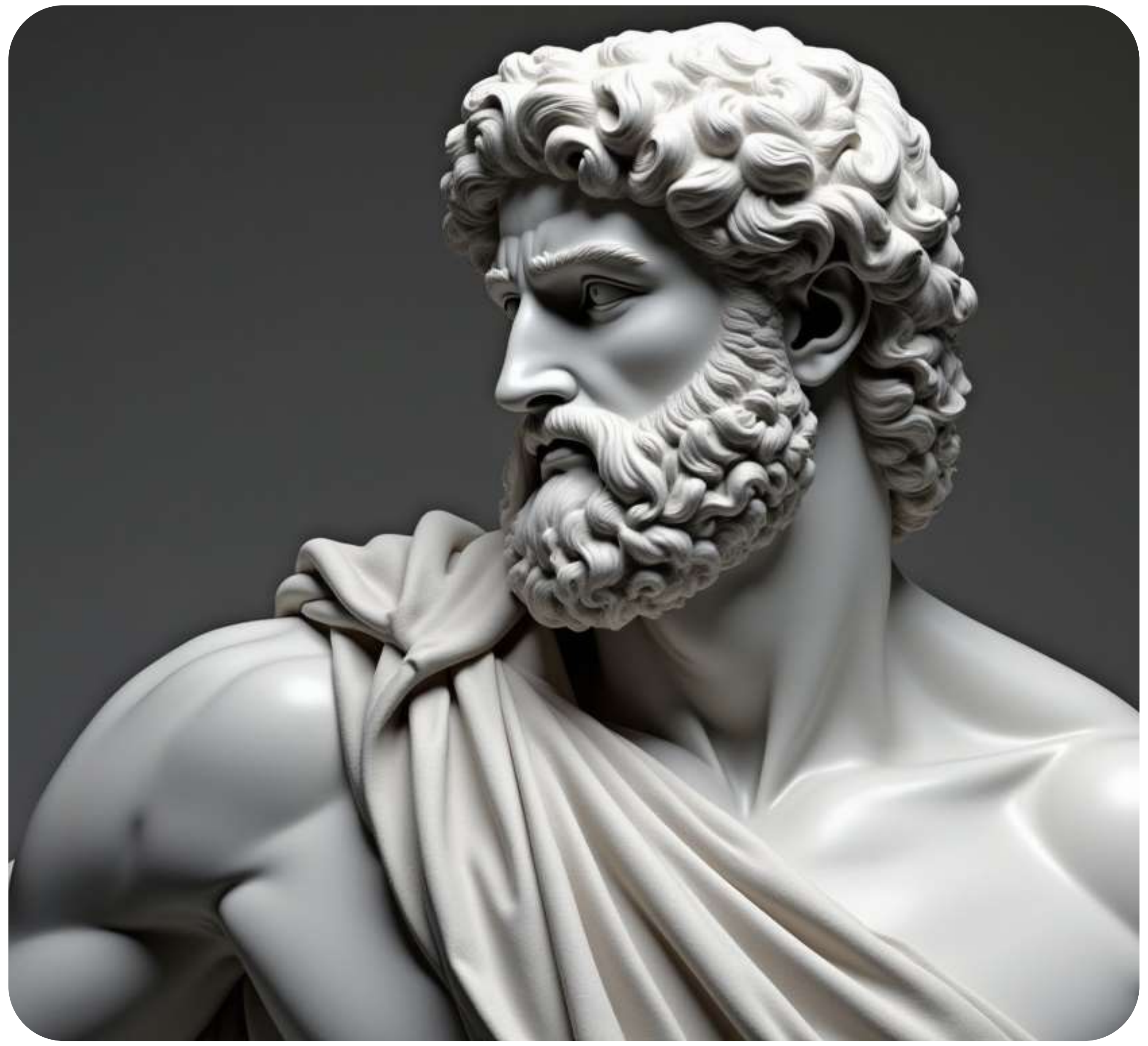
Consistency

Alerting

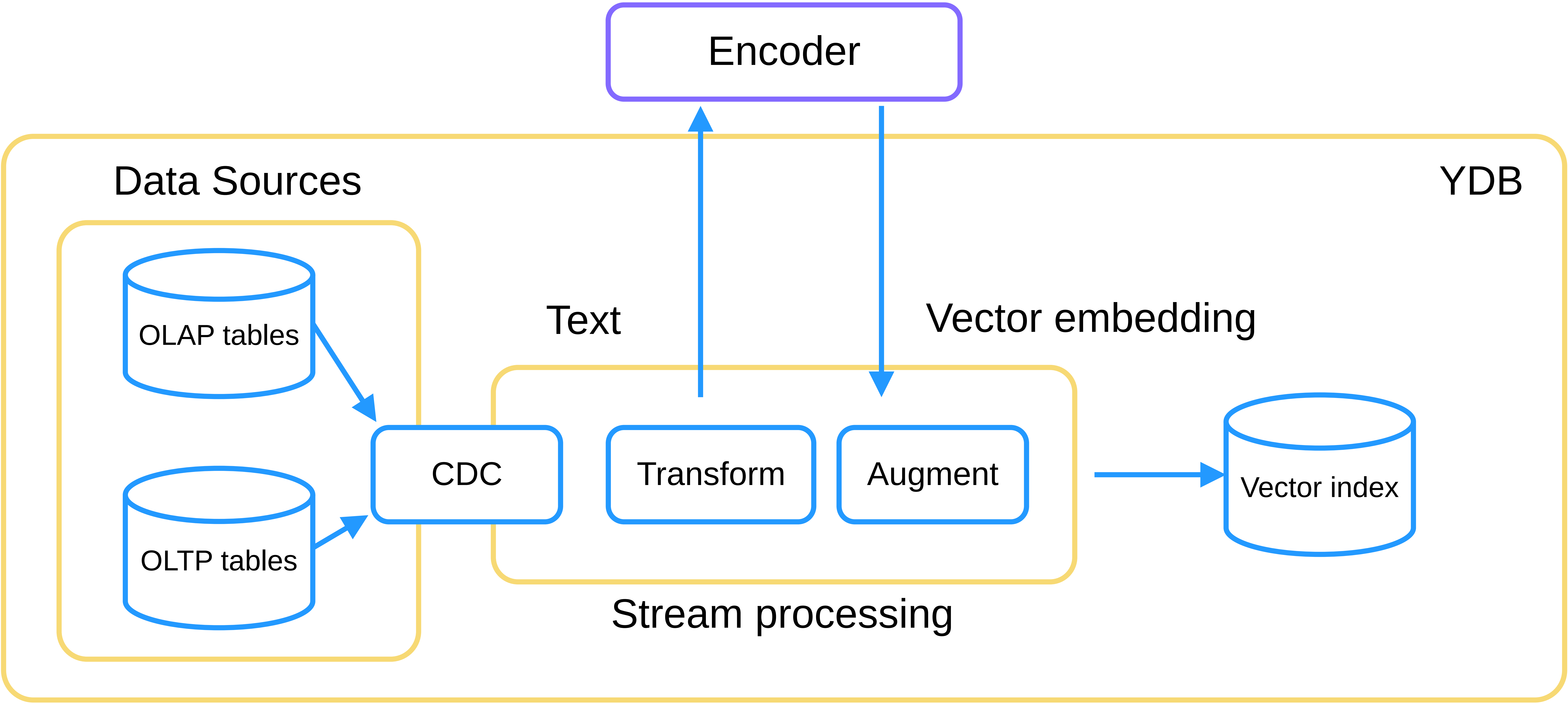
Support

Monitoring

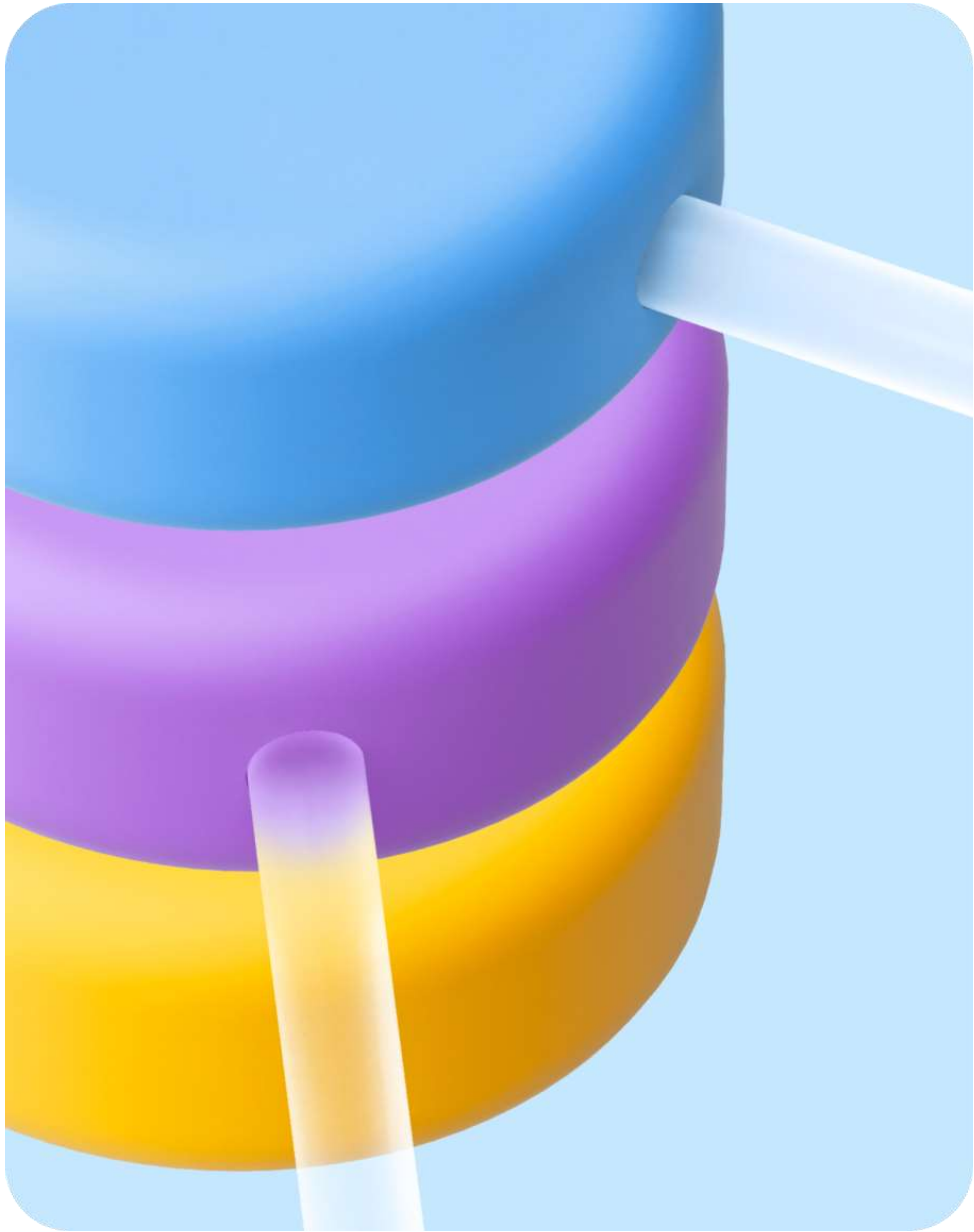
Herculean tasks



YDB: Real-time Streaming RAG



Streaming Processing



Elena Kalinina,

Technical Project Manager, YDB

YDB Topics — What’s This?

YDB Topics is an implementation of persistent queues within YDB

Main features

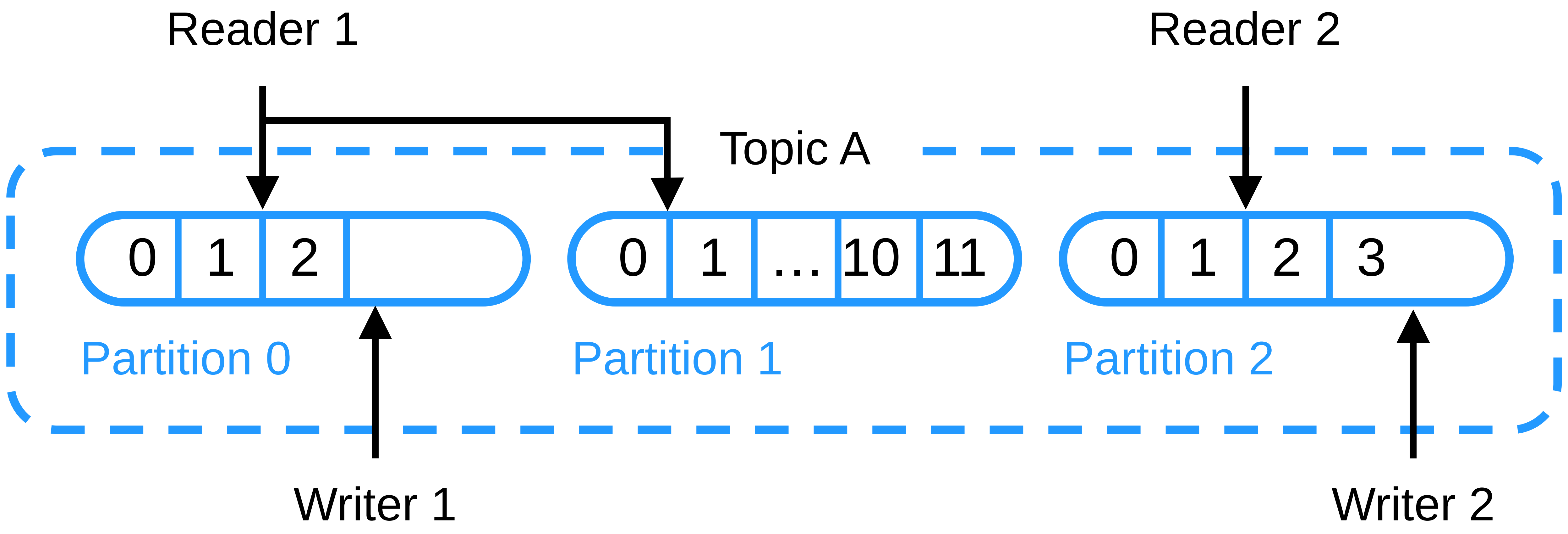
- Reliability
- High throughput

Based on YDB platform

- Change Data Capture (CDC)
- Transactions with topics and tables

API

- YDB Topic API
  C++ SDK, Java SDK, Python SDK, Go SDK
  All YDB Topics features are supported
- Apache Kafka API



Change Data Capture

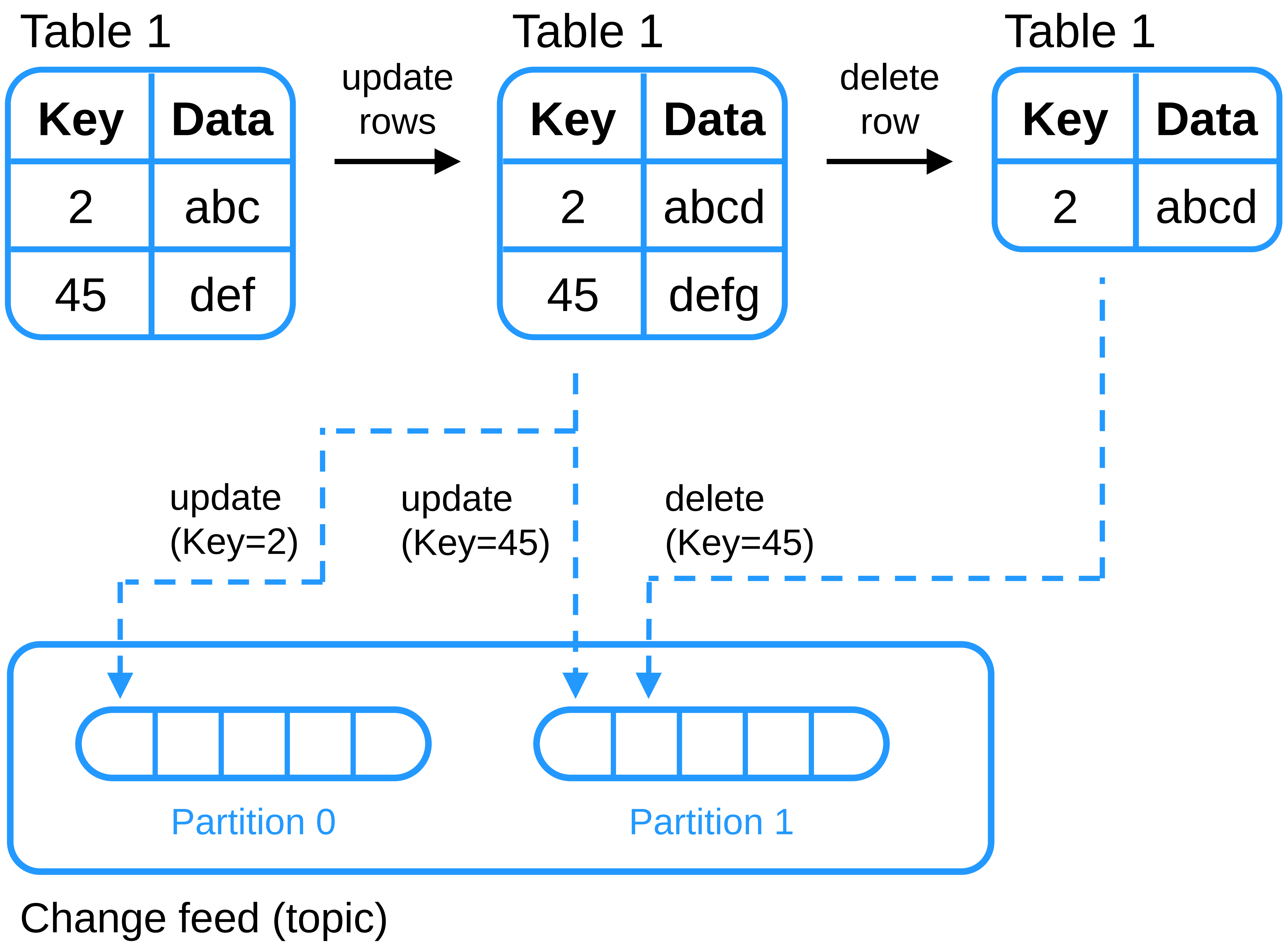


Table 1

Key	Data
2	abc
45	def

Table 1

Key	Data
2	abcd
45	defg

Table 1

Key	Data
2	abcd

- Changefeeds

  for capture any table changes

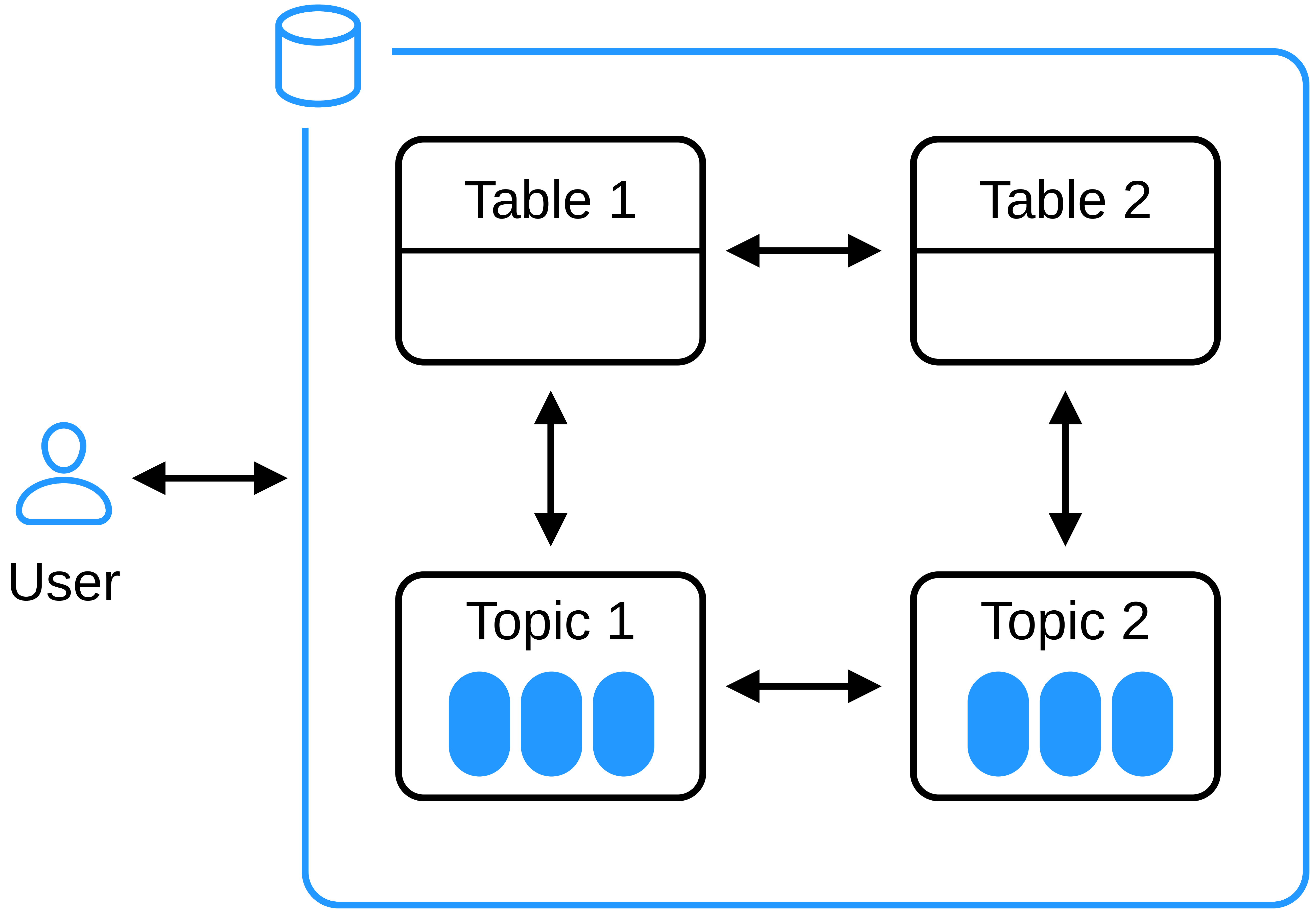
- Exactly once delivery
- Change records are sharded
- Order of changes

Transfer Data From Topic To Table

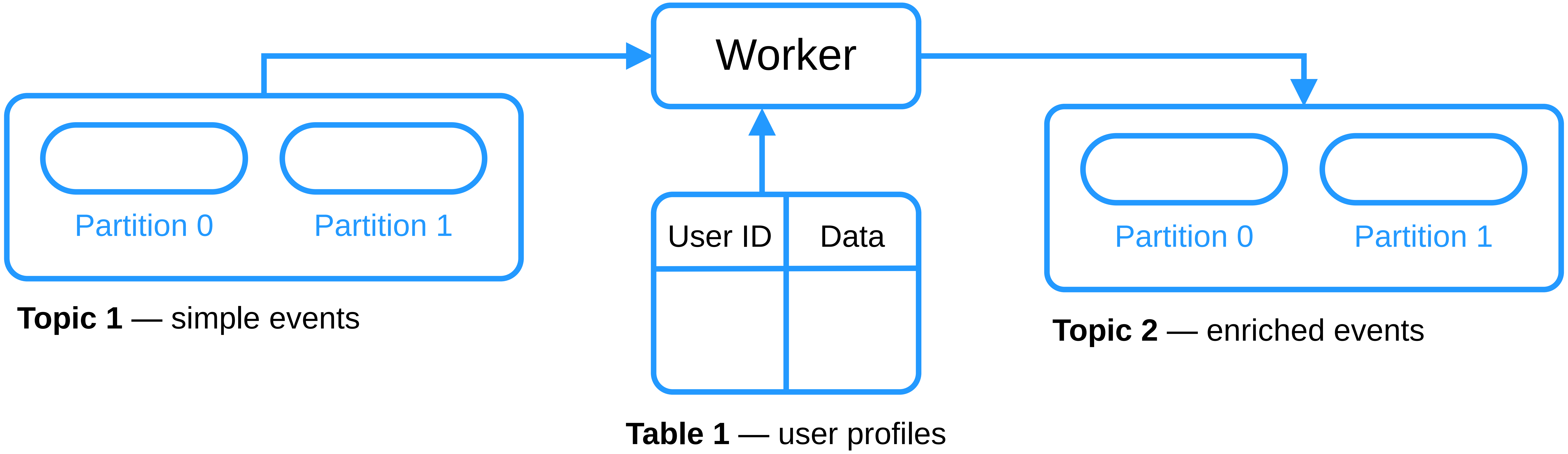
```
CREATE TABLE TargetTable (<Some Columns>);

CREATE TOPIC SourceTopic;

$transform = {
      < Some Complex Transformation Logic >
};

CREATE TRANSFER ExampleTransfer
FROM SourceTopic TO TargetTable USING $transform;
```

Transactions With Tables And Topics

- ACID transactions involving tables and topics
- Within one database



Distributed Transaction Example: Enrich Events


Worker
Partition 0
Partition 1
Topic 1 — simple events
User ID
Data
Table 1 — user profiles
Partition 0
Partition 1
Topic 2 — enriched events

```
BEGIN TRANSACTION Tx1;
A = READ 1 EVENT FROM Topic1;
B = READ Data FROM Table1 WHERE UserID = GetUserID(A);
C = EnrichEvent (A,B);
WRITE INTO Topic2: EVENT C;
COMMIT Tx1;
```

Transactions With Tables And Topics

We add ACID guarantees to topic-table operations

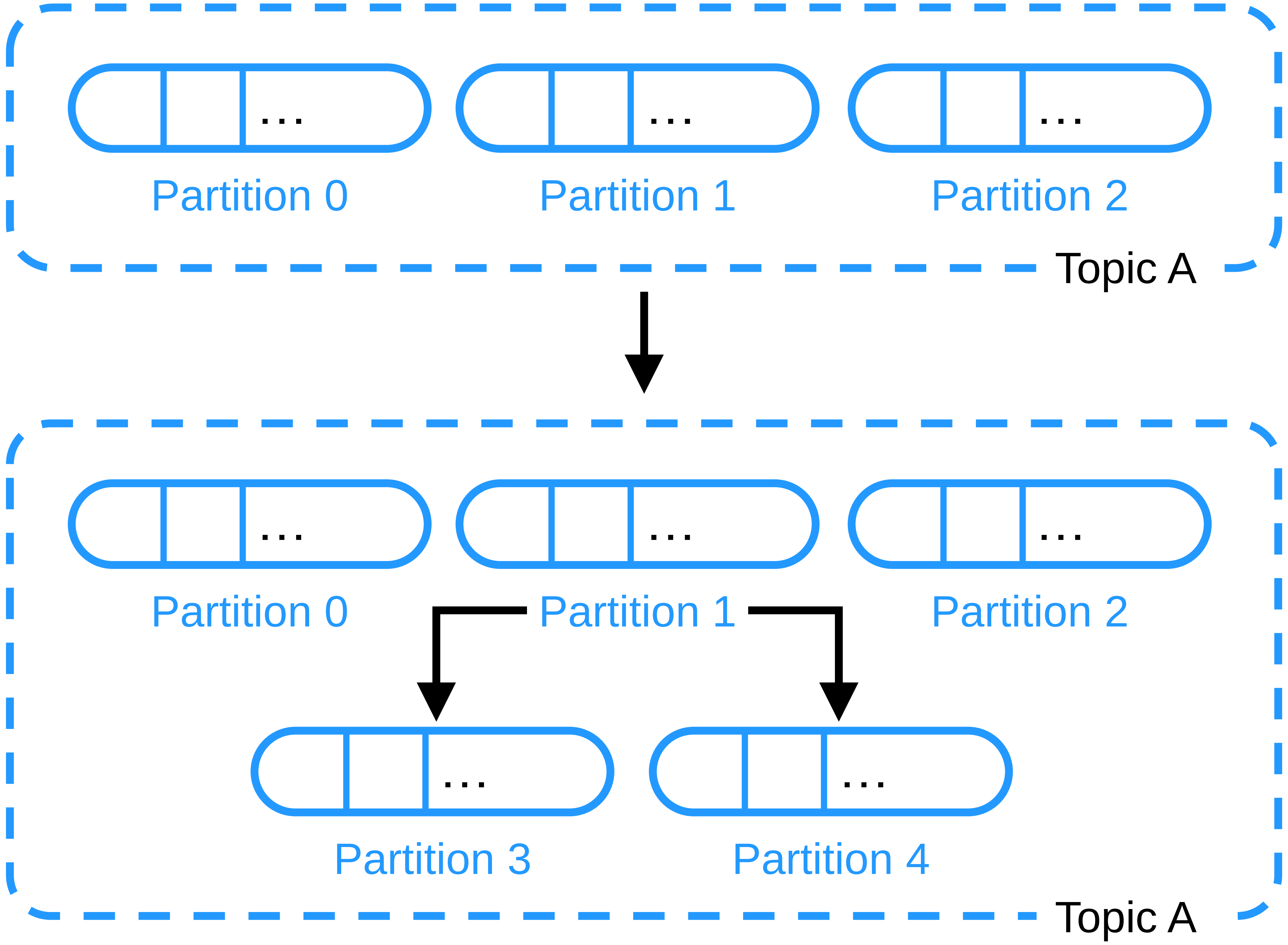
It simplifies user code

CPU usage and system throughput are the same

Minimal impact on latency

Topics Autopartitioning

- Topic is divided into the partitions for scalability
- Partitions count can be increased automatically
- Guarantees:
  - Exactly once for writing
  - Reading order

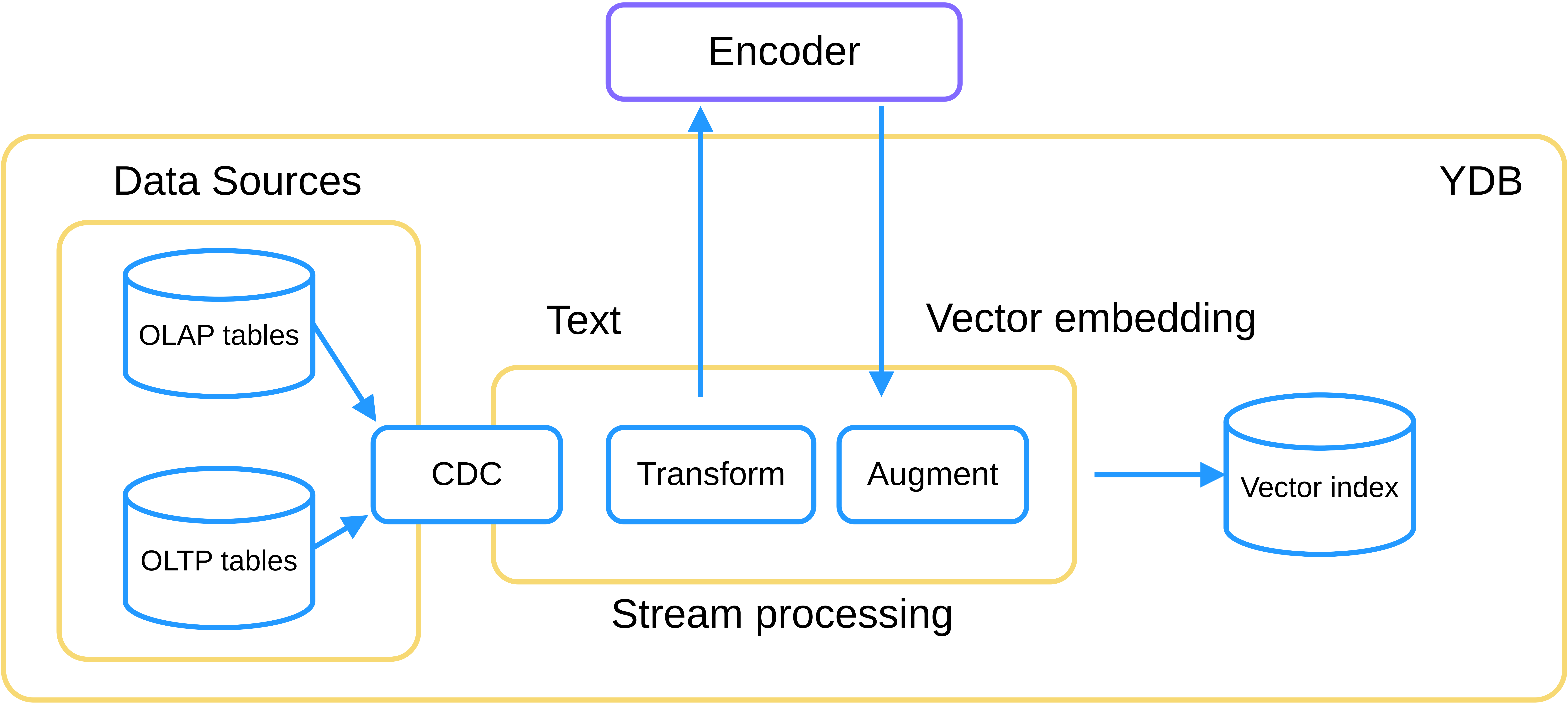


Streaming For RAG in YDB

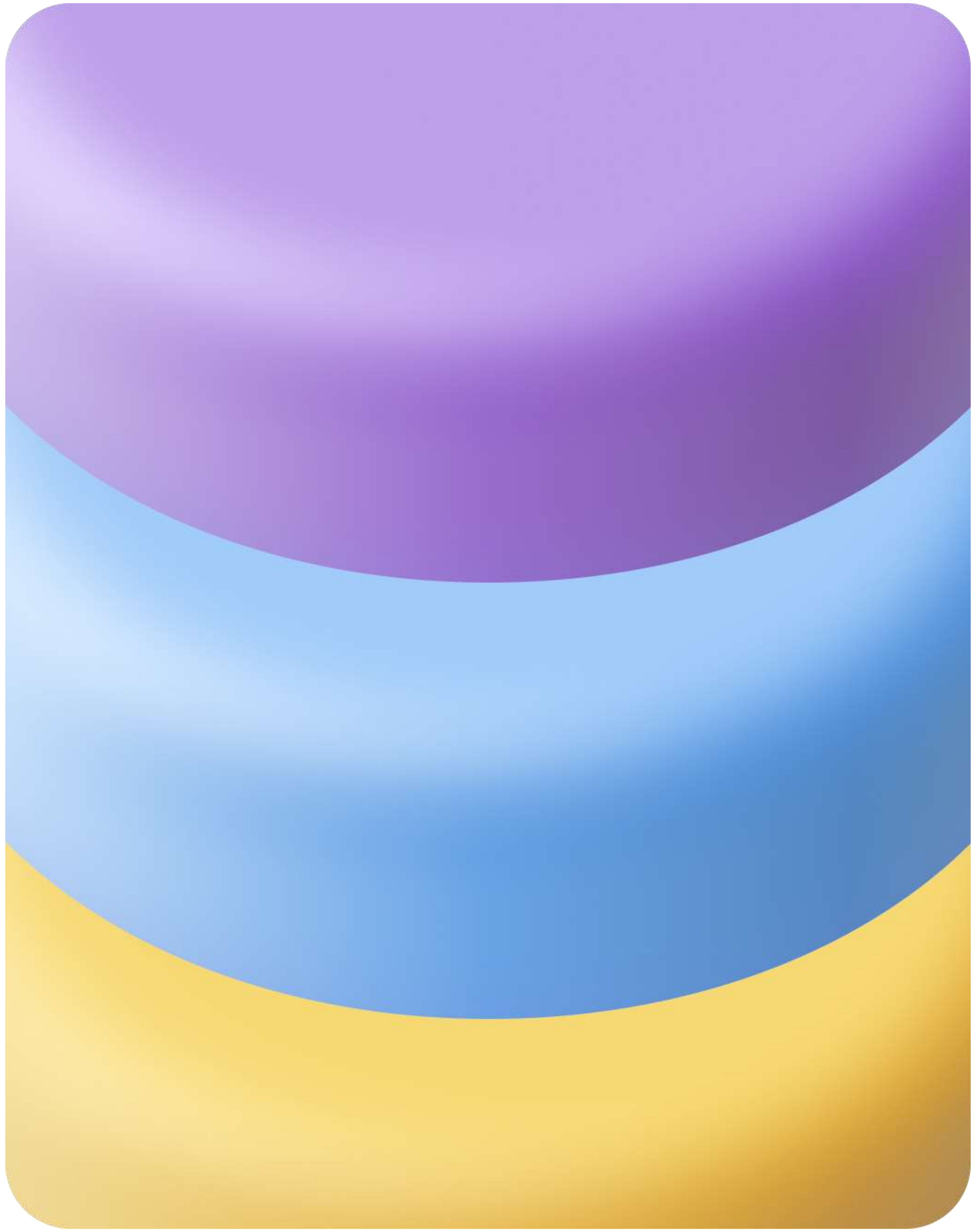
- Deliver table changes with changefeeds
- Transfer data from topic to table
- Any topic-table data transformations within classic ACID transactions
- Topics autopartitioning

- High throughput
- Reliable
- Kafka API compatible

YDB: Real-time Streaming RAG



Vector Index



Vector Index Requirements

- The index is global
- The index is synchronous and consistent

- Table size = billions
- Search latency = tens of ms

- Creation time = O (table size)
- Occupied space = O (table size)

= scale in a linear way

Why Don't Existing Algorithms Suit Us?

Distributed system

Automatic scaling

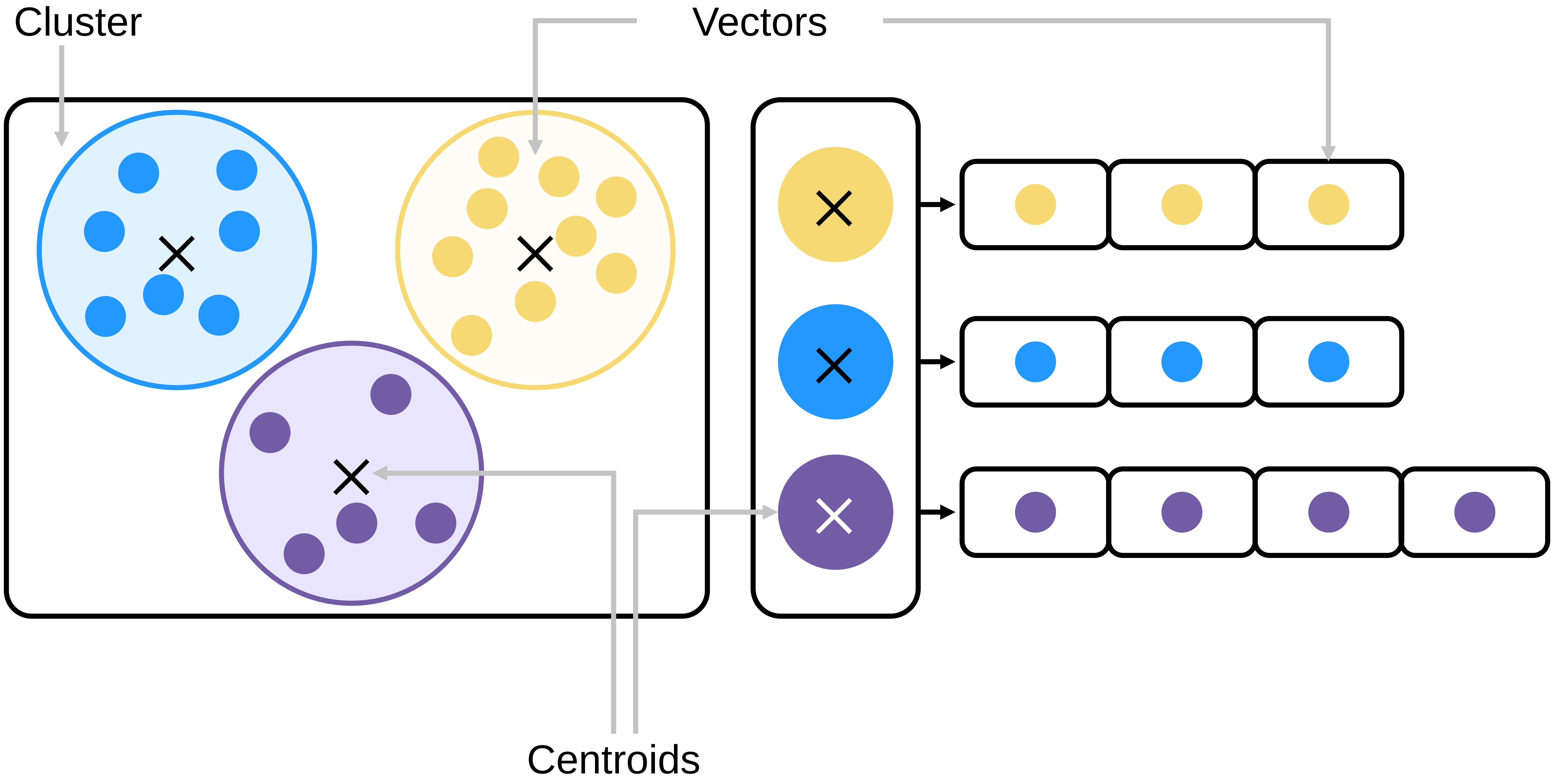
Consistent transactional insertion and searching

SQL Commands

```
CREATE TABLE table (
id Uint32,
embedding String,
INDEX idx_vector
GLOBAL USING vector_kmeans_tree
ON (embedding)
WITH (
    similarity=inner_product,
    vector_type=float,
    vector_dimension=1024),
PRIMARY KEY (id)
)
```

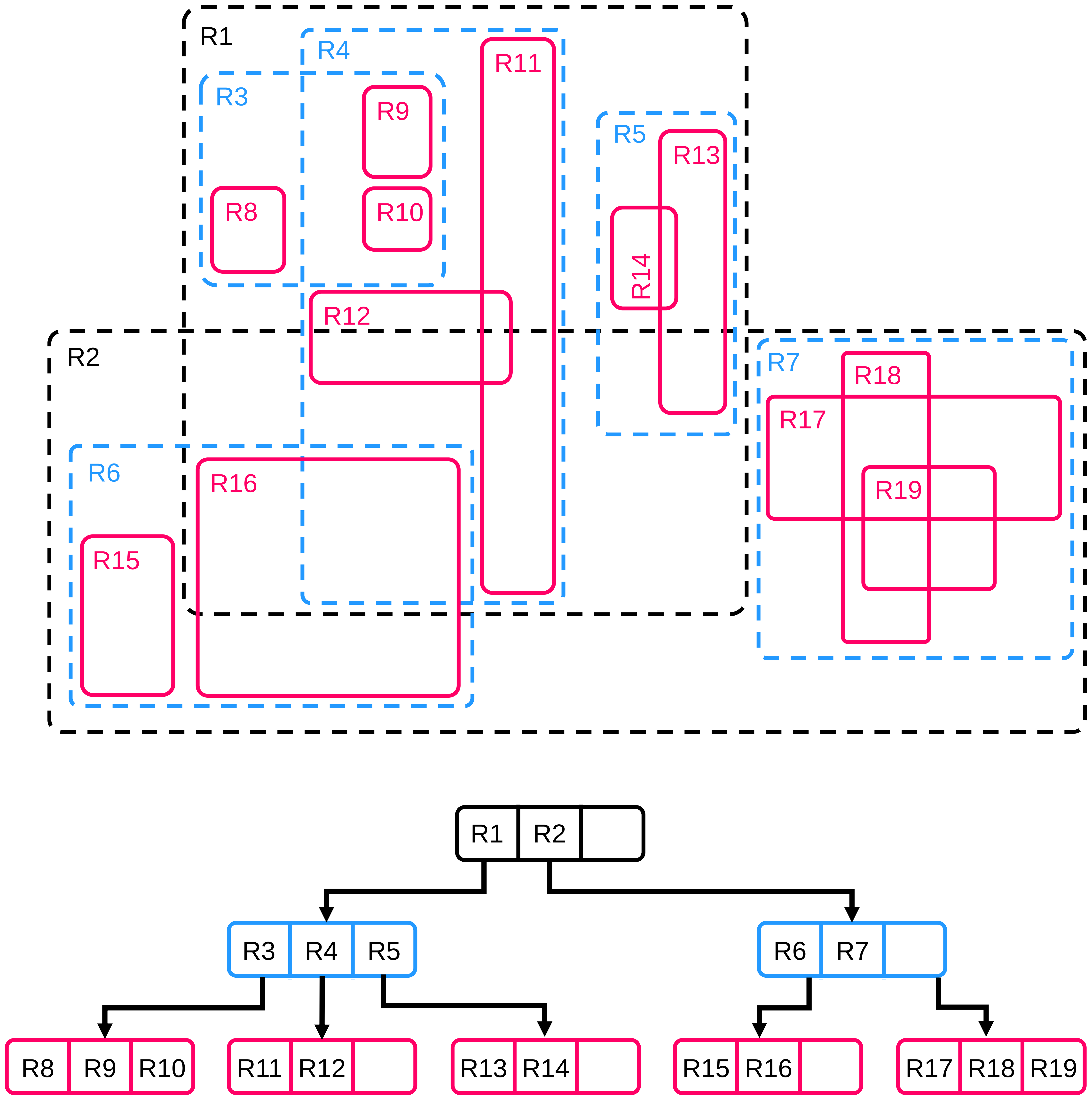
```
SELECT * FROM table
VIEW idx_vector
ORDER BY Knn::CosineDistance(
    embedding,
    $target)
LIMIT $k
```

Vector Index As An Inverted List

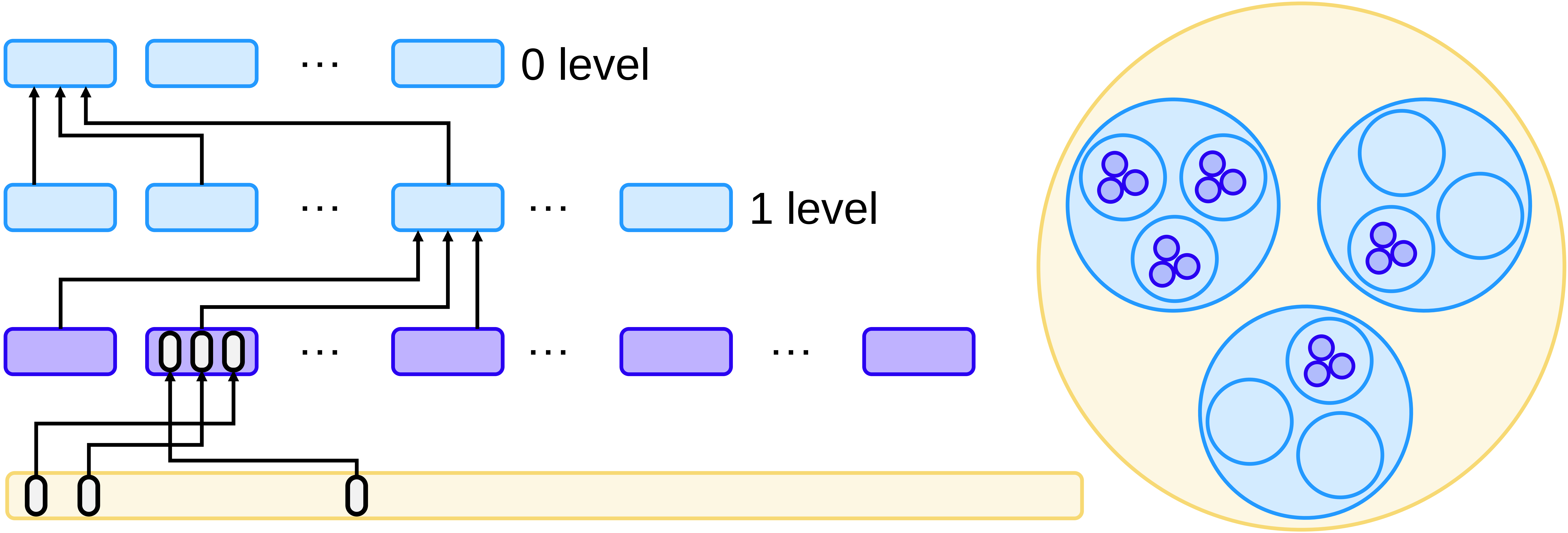


Search Space Pruning Algorithms

R-tree



Hierarchy Of YDB Vector Index Clusters



level table
(parent, id), centroid

posting table
(parent, PK), covered

indexed table
(PK), embedding, covered

Filterable Vector Index

```
SELECT * FROM table VIEW idx_vector
WHERE user_id = $target_user_id
ORDER BY Knn::CosineDistance(
  embedding,$target_embedding)
LIMIT $k;
```

Can’t filter

Before vector index

- can’t use a single index
- need for full scan

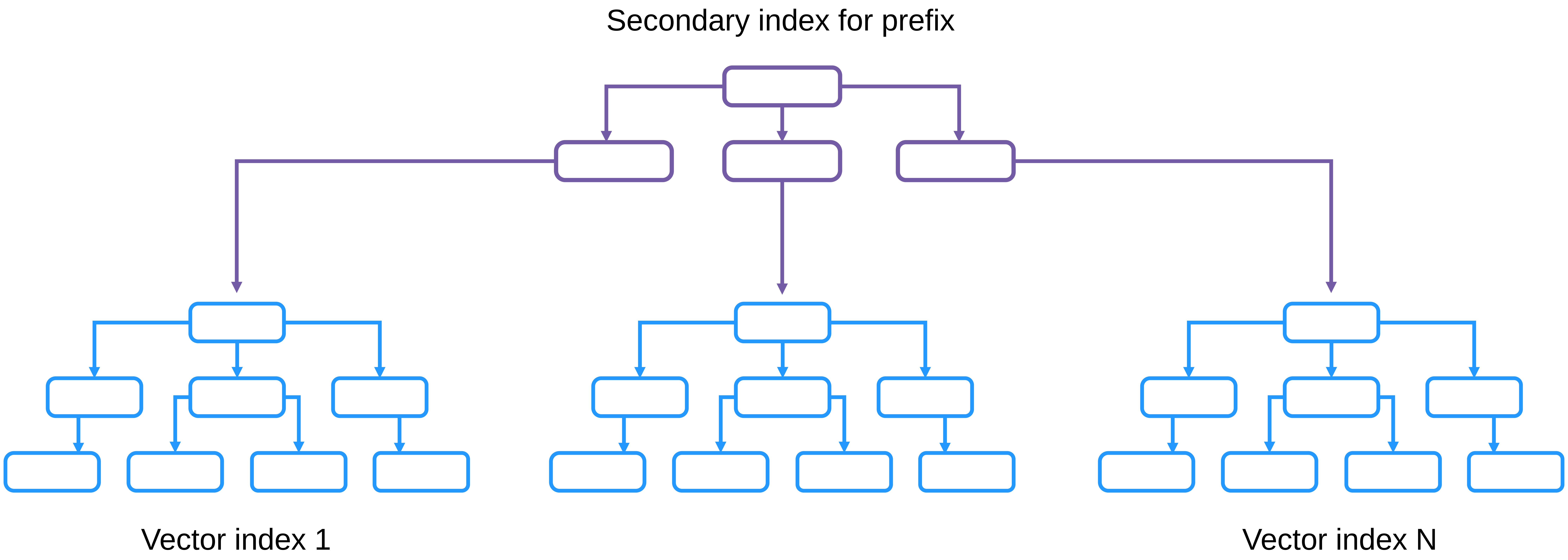
After vector index

- need for a repeat request

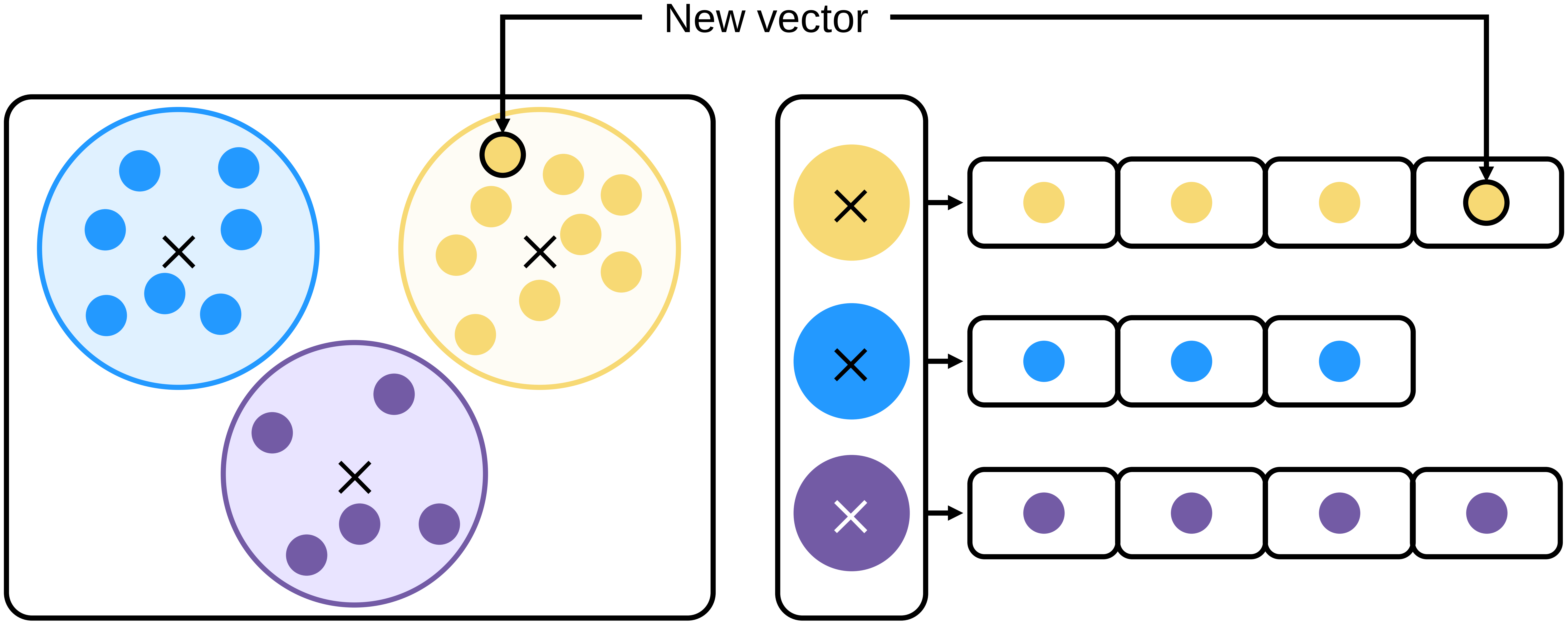
Need to filter

Inside index

Filtrable Vector Index



Insertion To Vector Index



- Just one centroid of one cluster would be changed
- The change needs to be pushed up through the levels

Let’s Stay In Touch

- How to try YDB?
- Why does it scale so well?
- Why is it so robust?
- What client utilities/ languages are supported?

Conclusion

ydb.tech

- YDB is a distributed database
- YDB as a platform offers sophisticated streaming and vector index
- There is a trend for RAG, especially streaming
- We are combining Big Data and AI