Change Data Streaming Patterns With Debezium & Apache Flink

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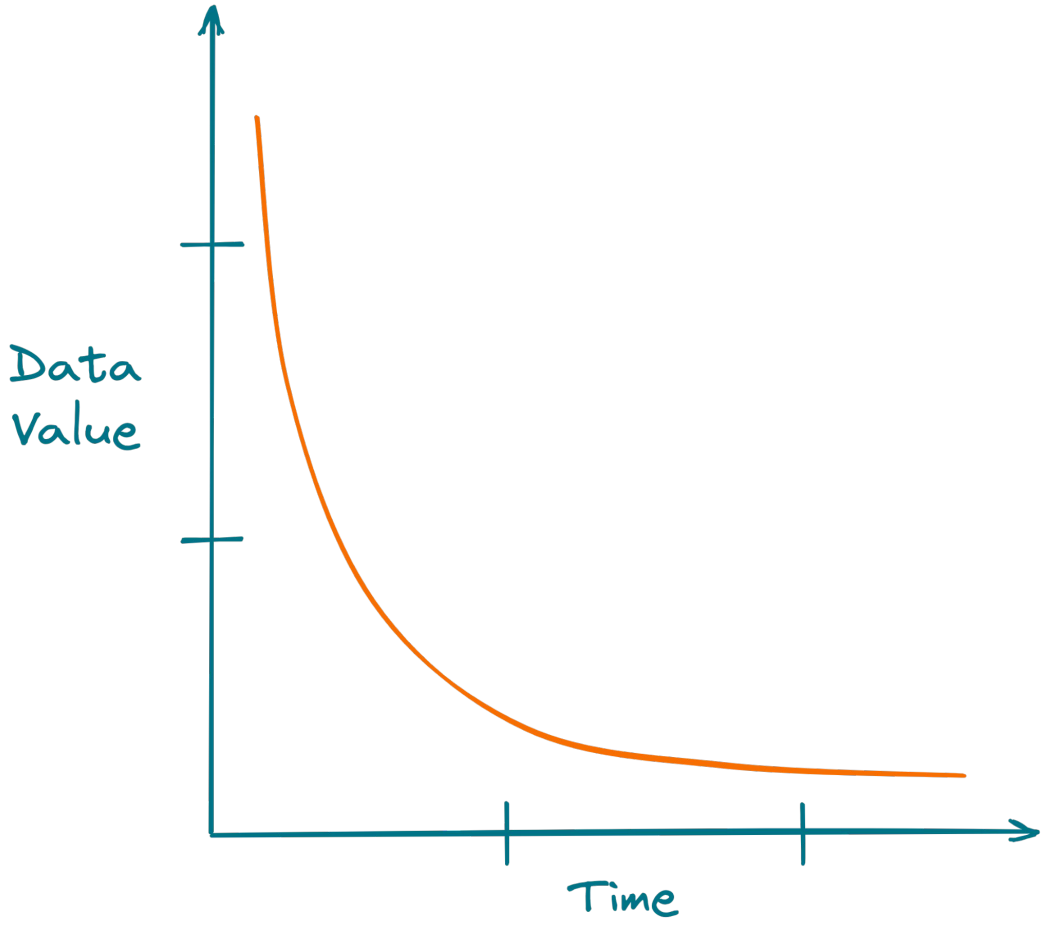
decodable

The world is ***real-time.***
So should be your ***data.***


Data
Value
Time

Today's Mission

Learn About...

...implemented with change data capture.

Gunnar Morling

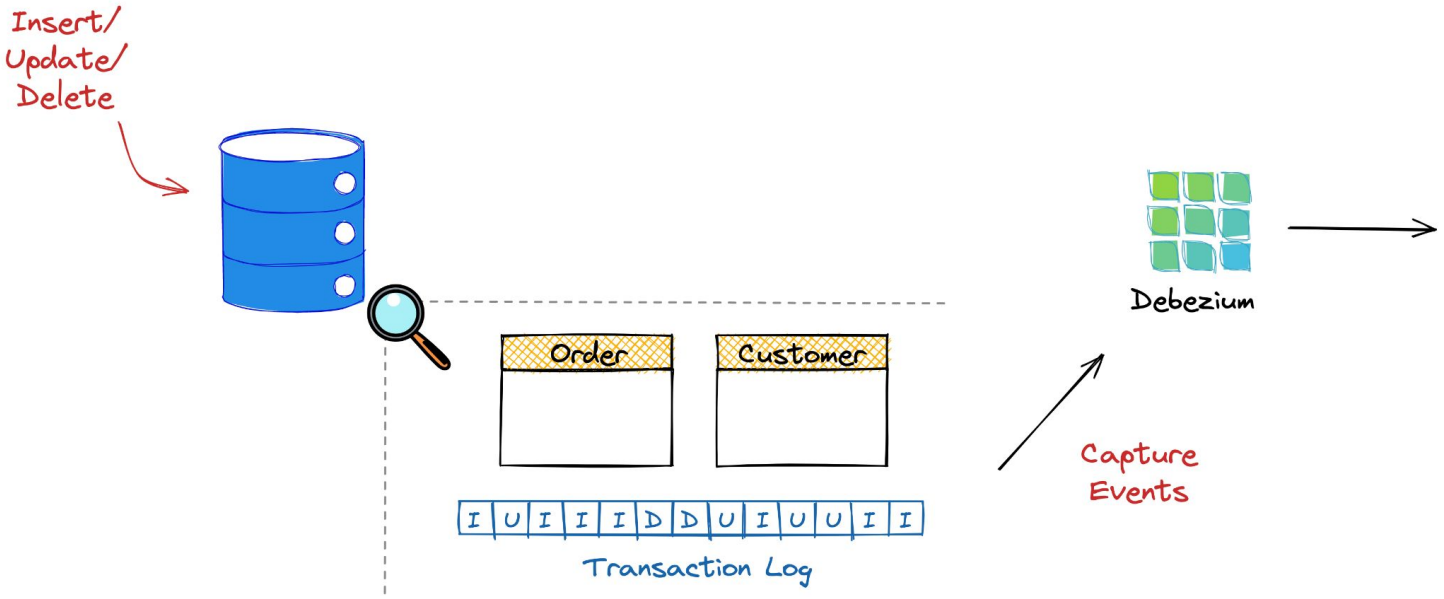
- Software engineer at **Decodable**
- Former project lead of **Debezium**
- **kcctl** 🧸, JfrUnit, ModiTect, MapStruct
- Spec Lead for Bean Validation 2.0
- Java Champion

The Tools

https://flic.kr/p/RE3vkY Public Domain, Angelo Brathot

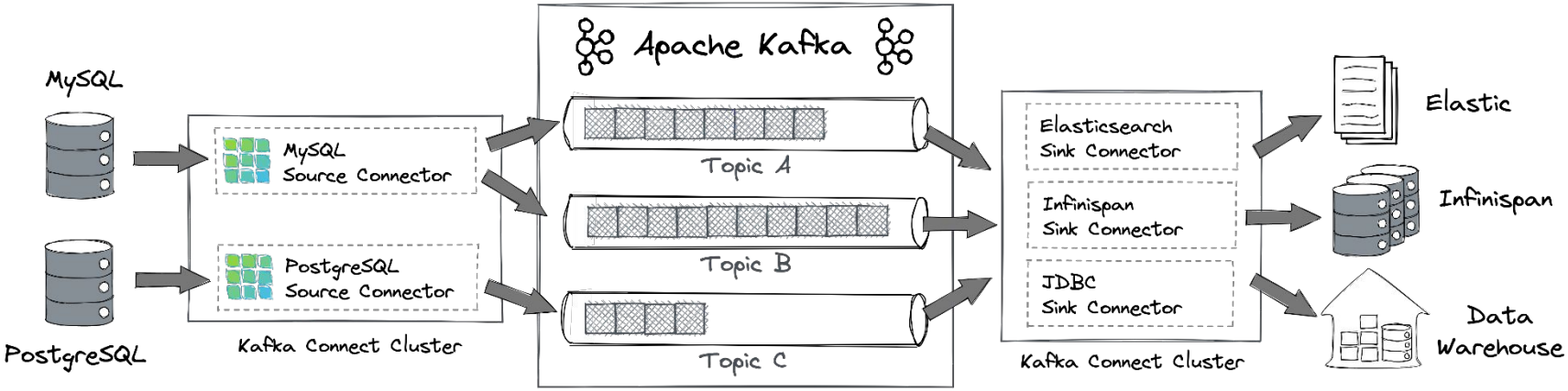
Debezium

Log-Based Change Data Capture



Debezium

Log-Based Change Data Capture



- **Taps into TX log** to capture INSERT/UPDATE/DELETE events
- Typically propagated to consumers via **Apache Kafka**

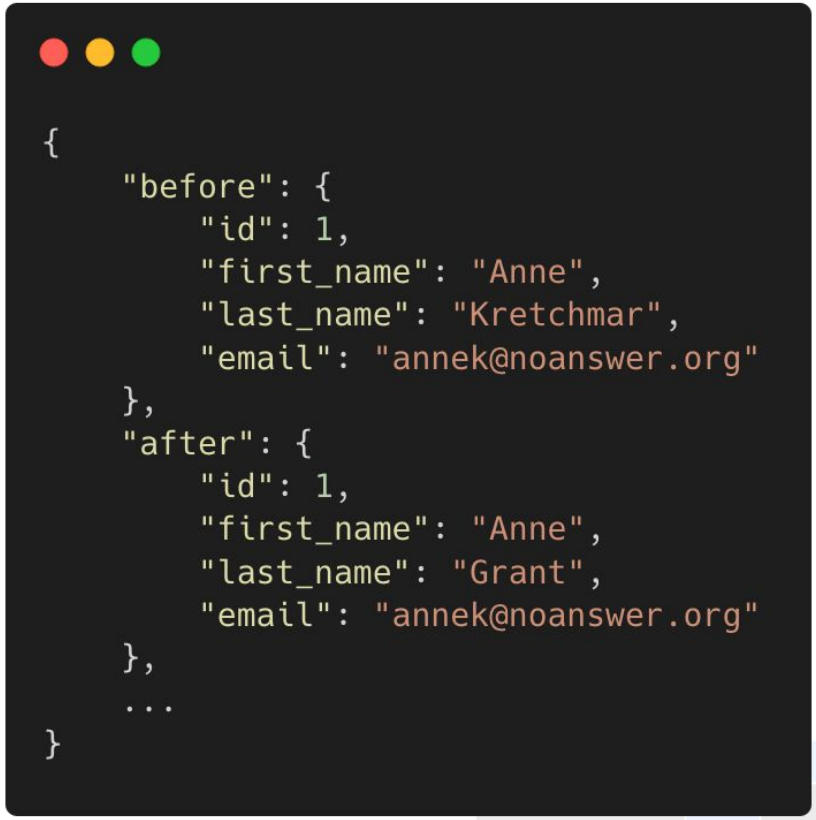
Debezium

Open-Source Change Data Capture

- A CDC Platform
  - Based on **transaction logs**
  - Snapshotting, filtering, etc.
  - Outbox support
  - Web-based **UI**
- Fully **open-source**, very active community
- Large production deployments

Debezium: Data Change Events

- **Old** and **new row state**
- **Metadata** on table, TX id, etc.
- **Operation type**, timestamp



Debezium: Data Change Events

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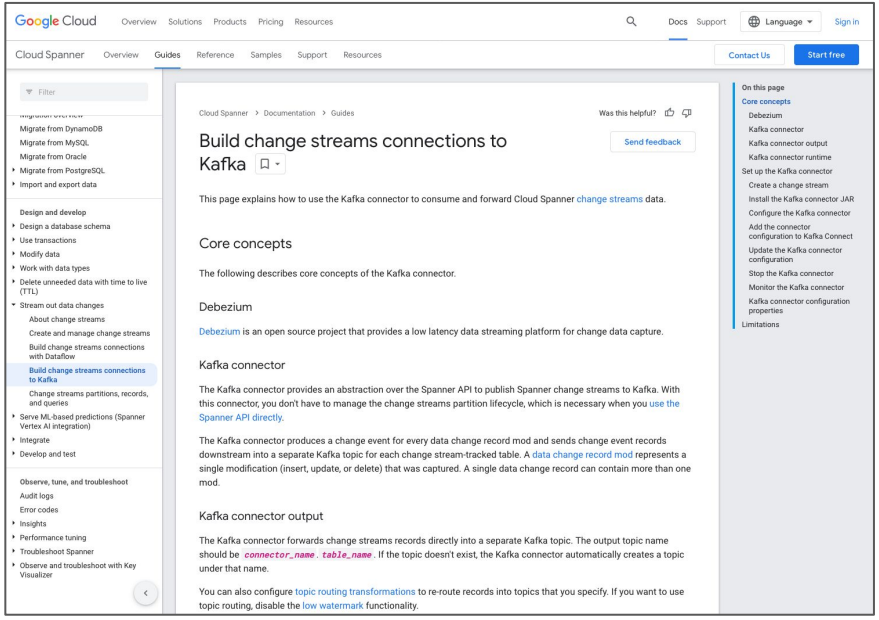
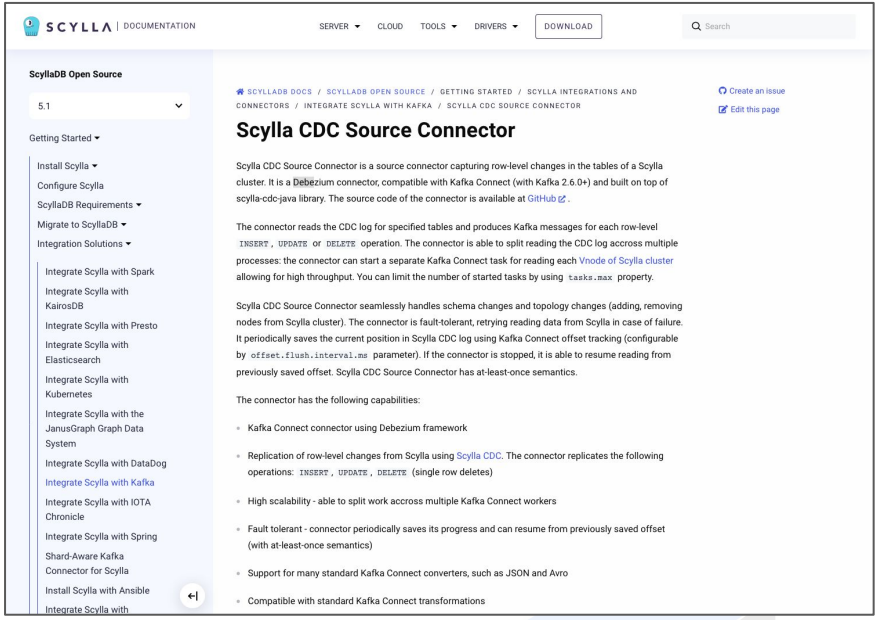
Debezium

Becoming the De-Facto CDC Standard

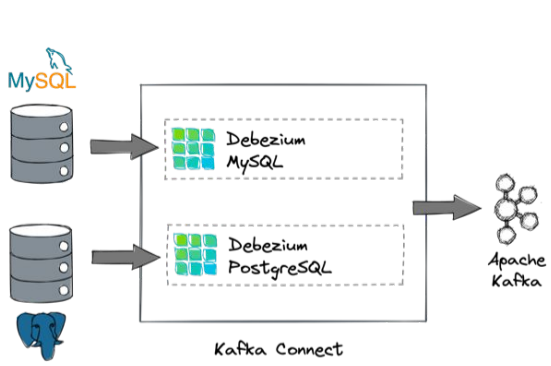


Google Cloud Spanner

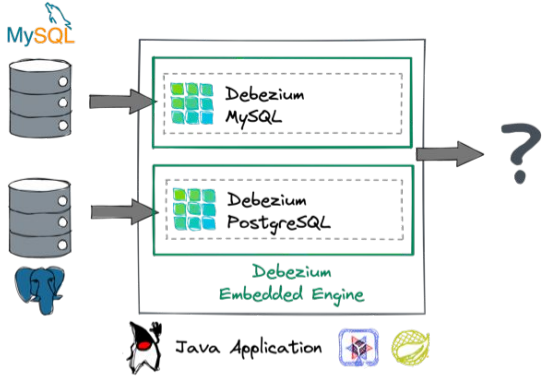


ScyllaDB

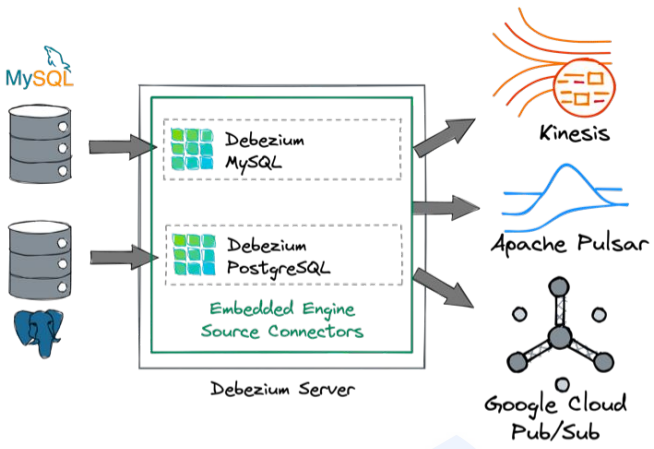
Debezium
Deployment Options



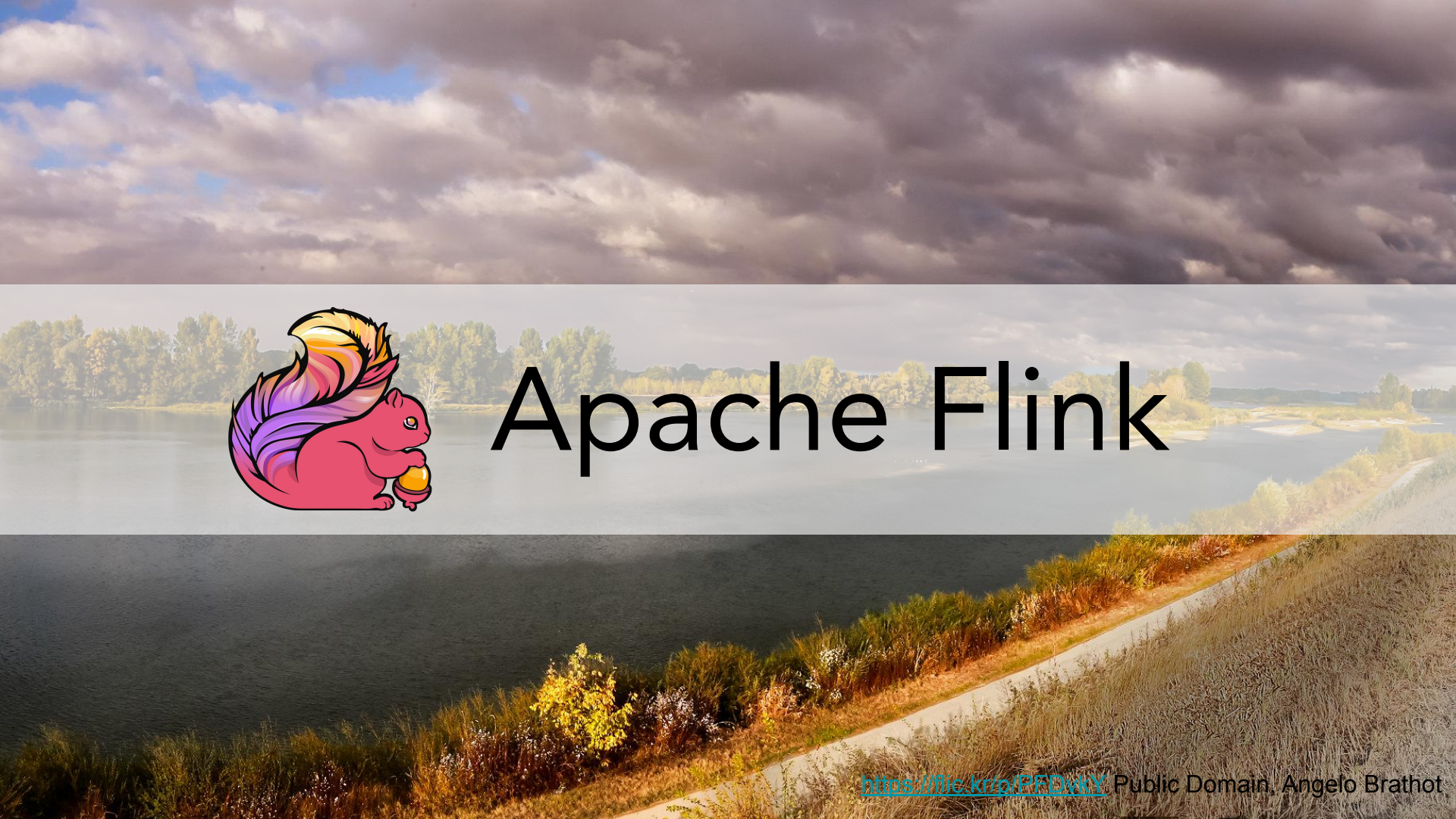
Kafka Connect



Debezium Embedded Engine



Debezium Server



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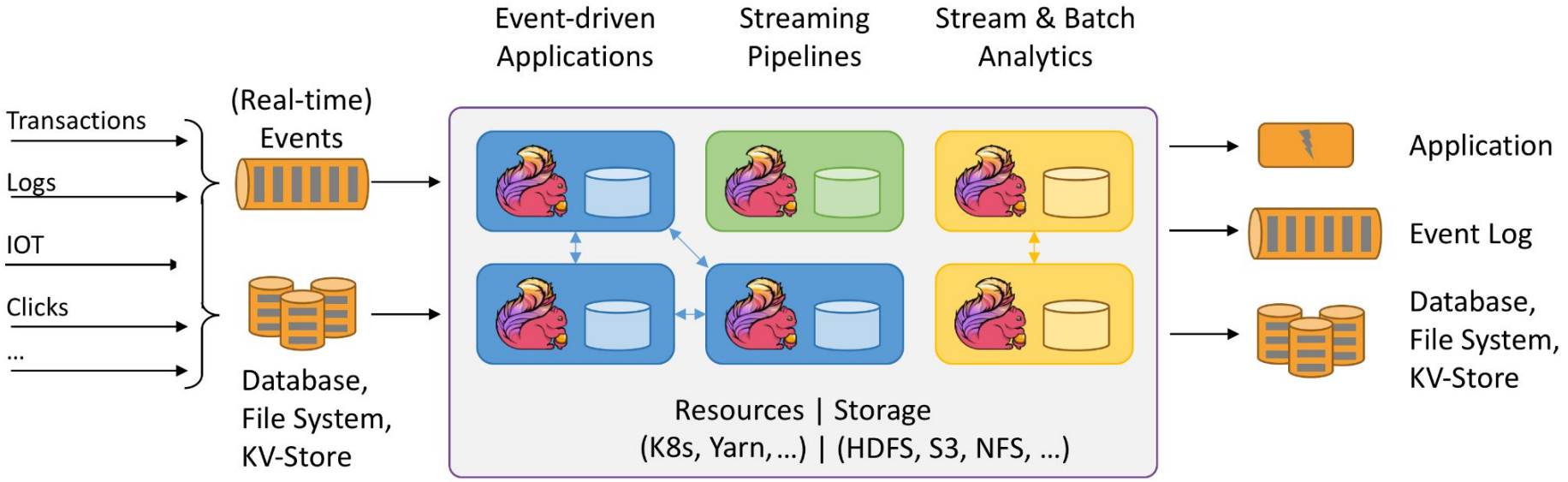
Apache Flink

Stateful Computations over Data Streams



https://flink.apache.org/

Apache Flink

APIs for Application Development

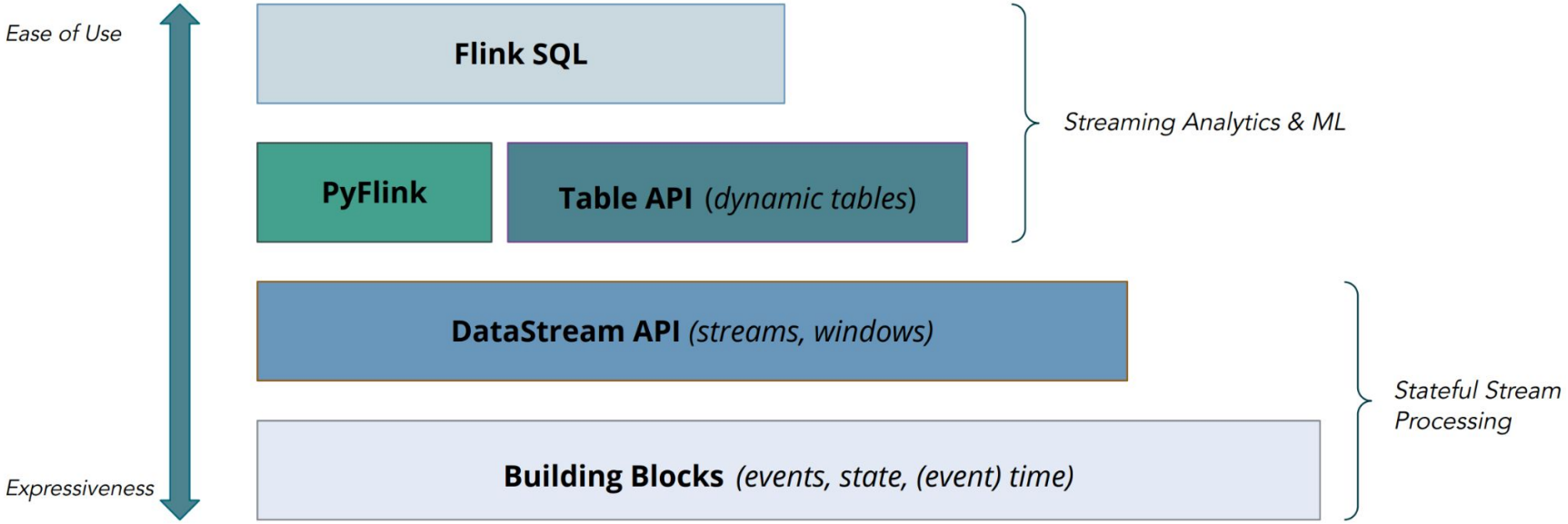
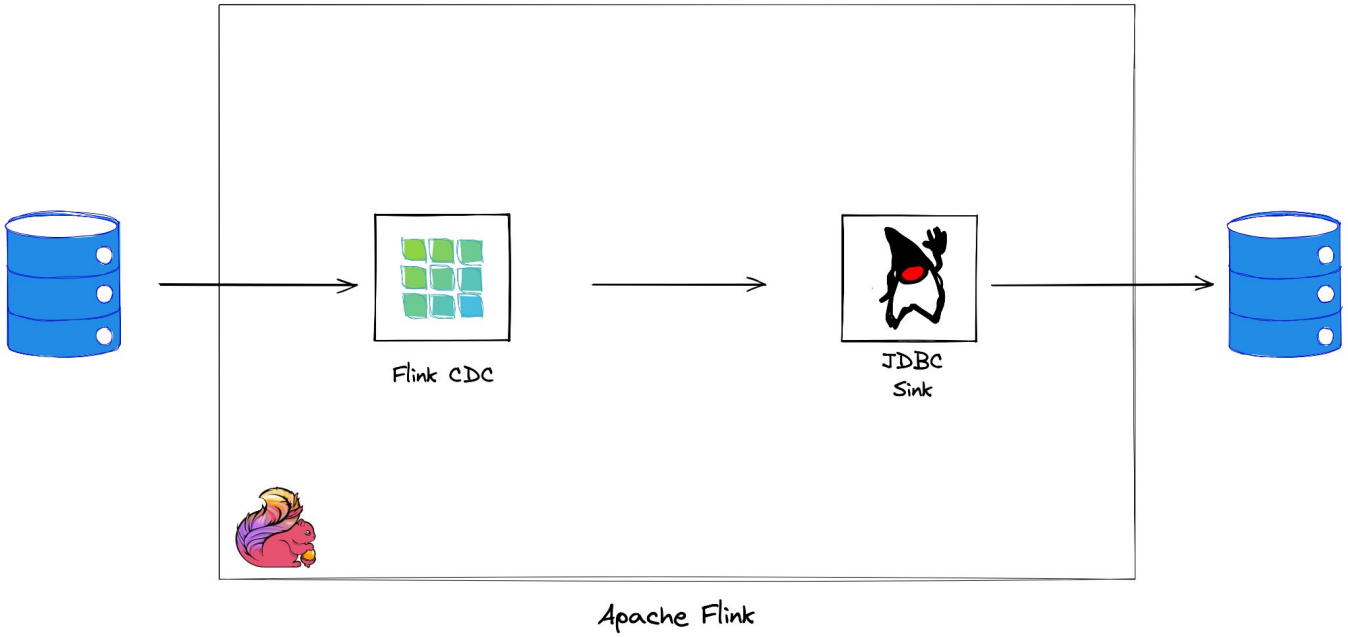


Image source: “Change Data Capture with Flink SQL and Debezium, by Marta Paes at DataEngBytes (https://noti.st/morsapaes/liQzgs/change-data-capture-with-flink-sql-and-debezium)

Apache Flink

Stream Processing of Change Data Events



Apache Flink

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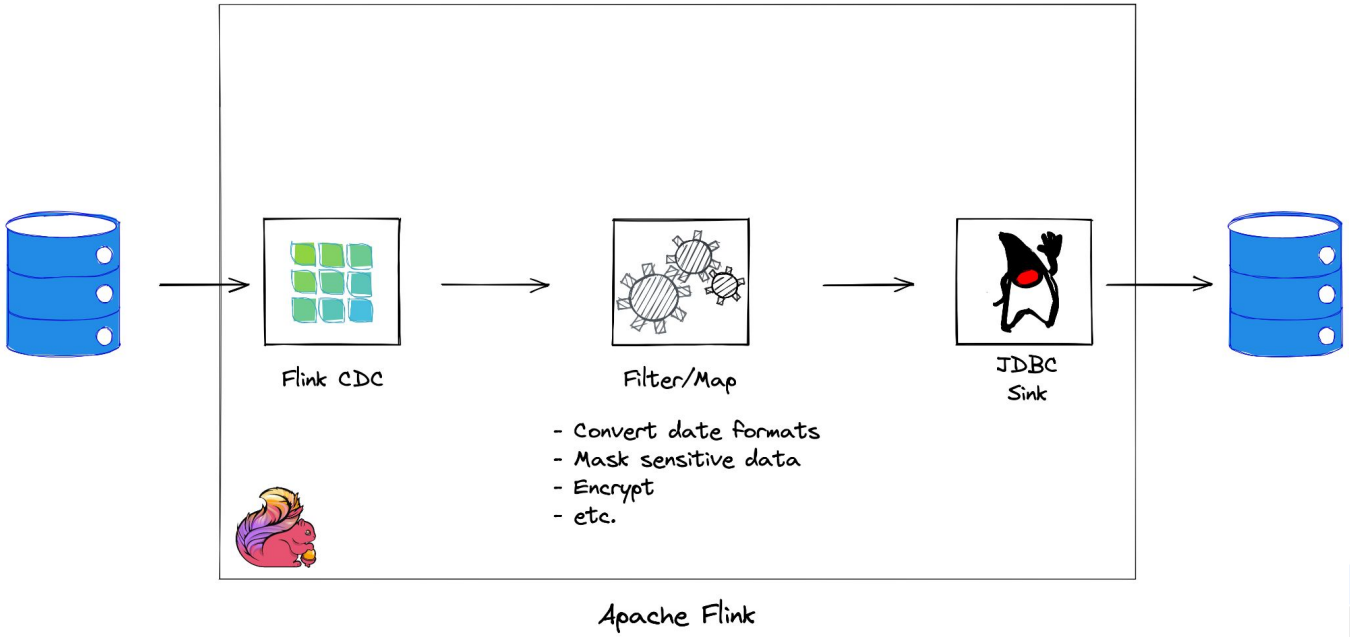

Apache Flink

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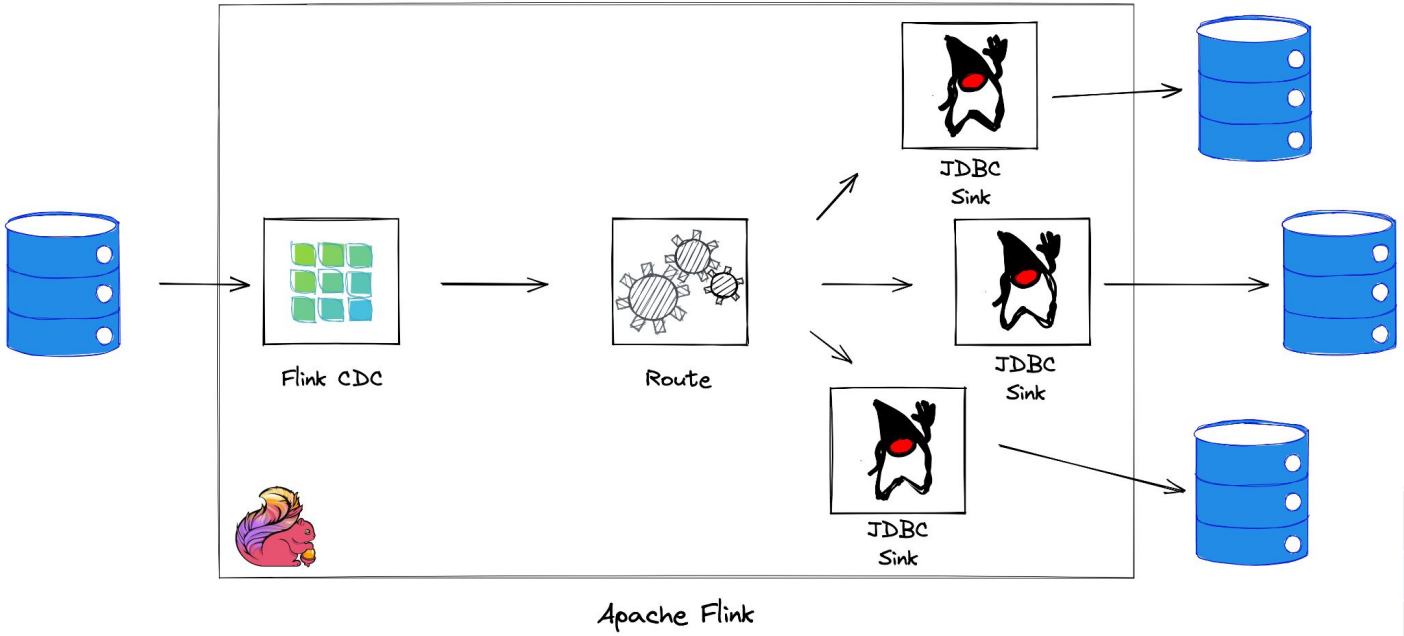

Apache Flink

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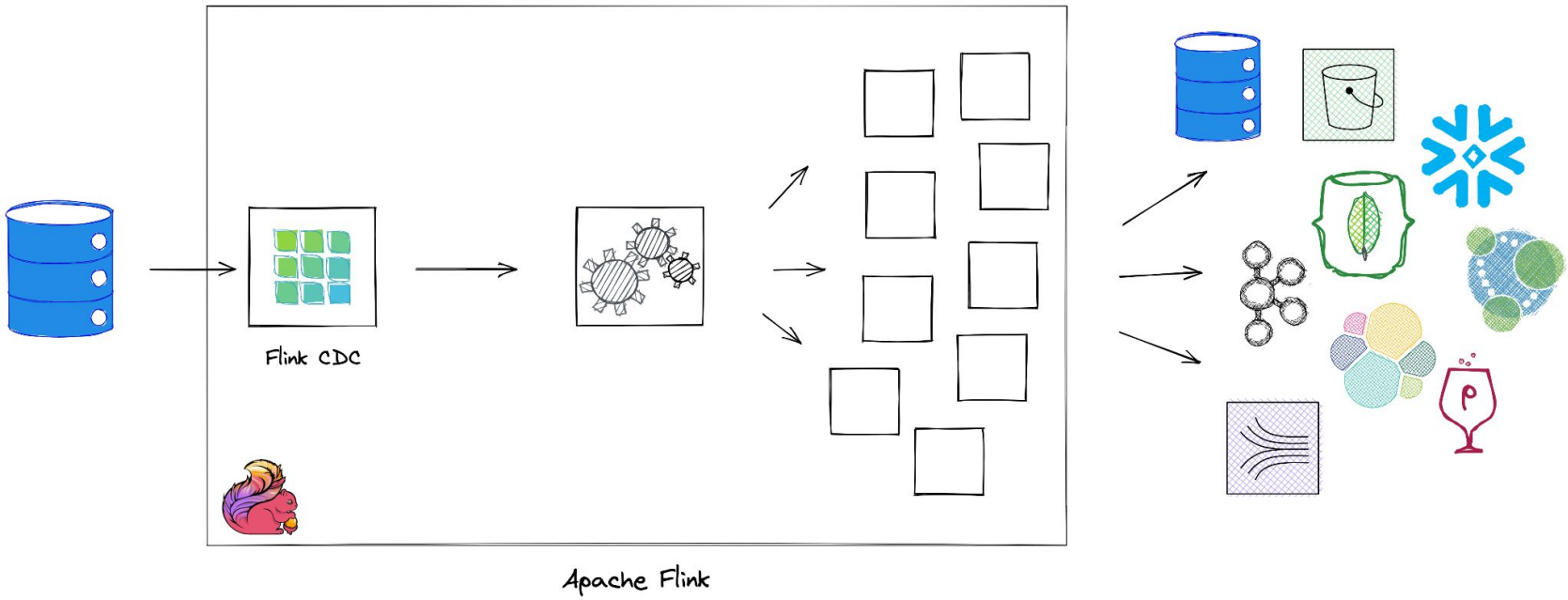

Apache Flink

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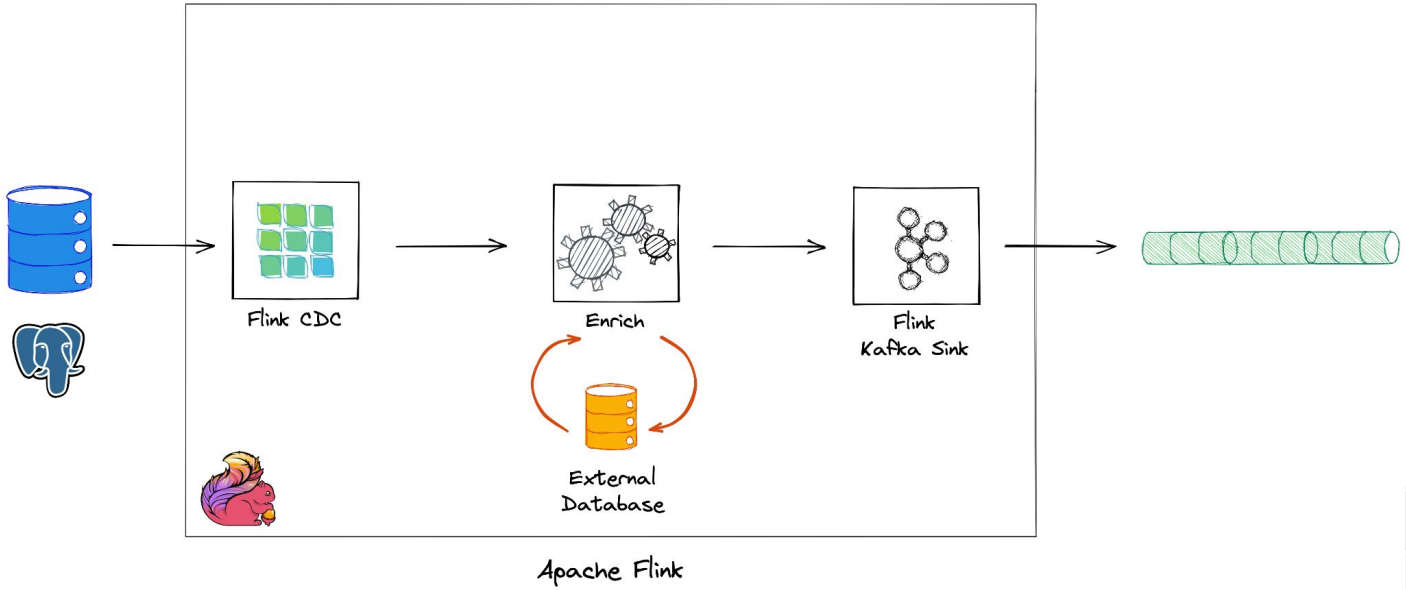
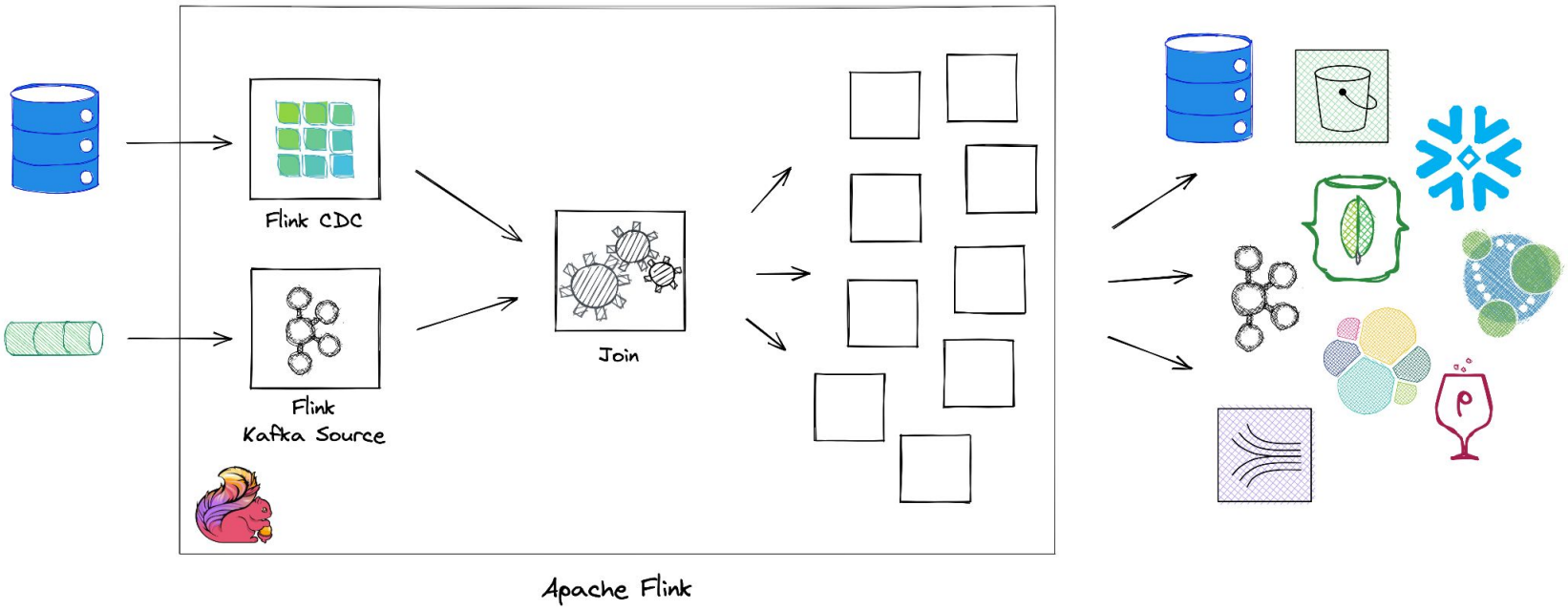


Apache Flink

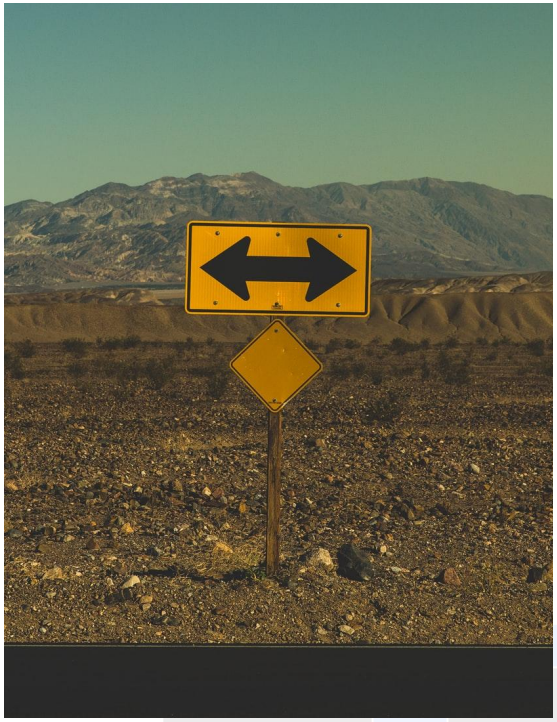
Stream Processing of Change Data Events



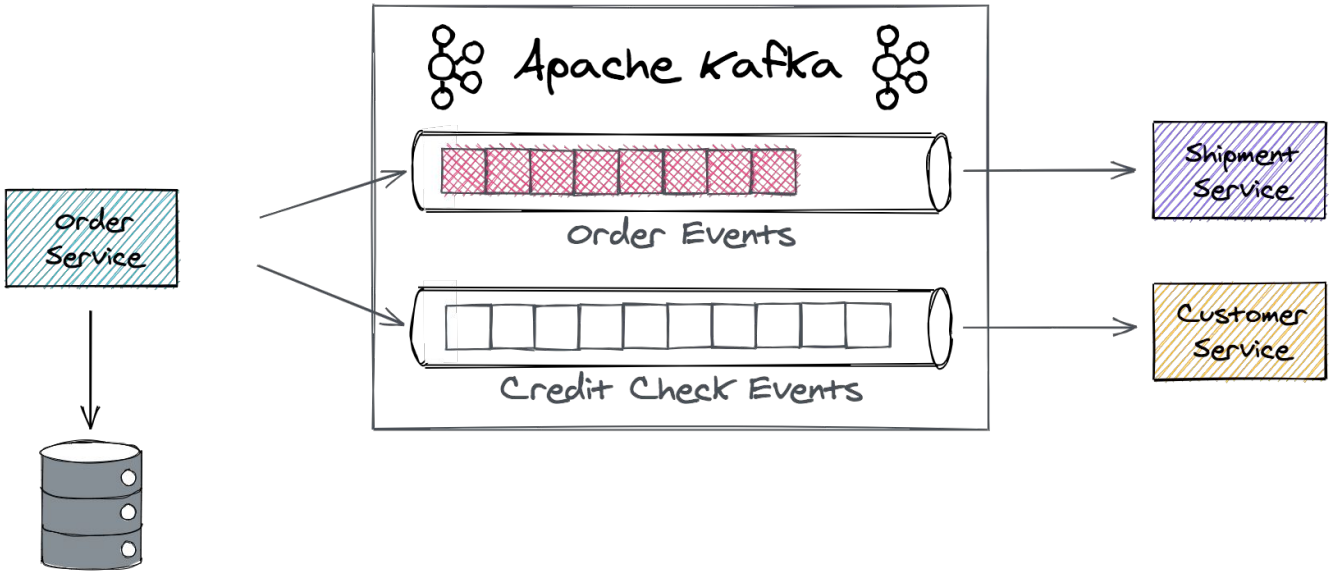
Outbox Pattern

Challenge: Microservices Data Exchange

- Services need to update their **database,**
- send messages to **other services,**
- and that **consistently**!

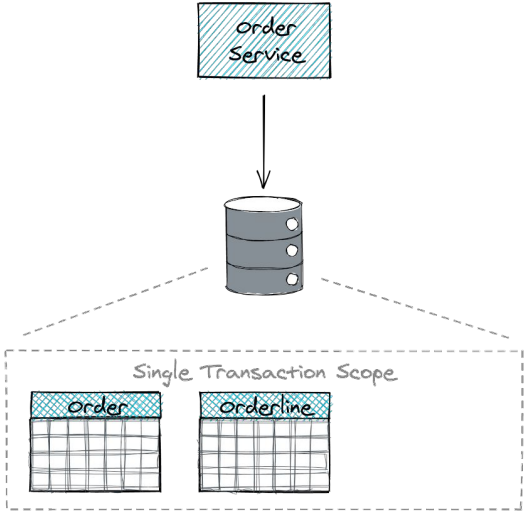


Outbox Pattern

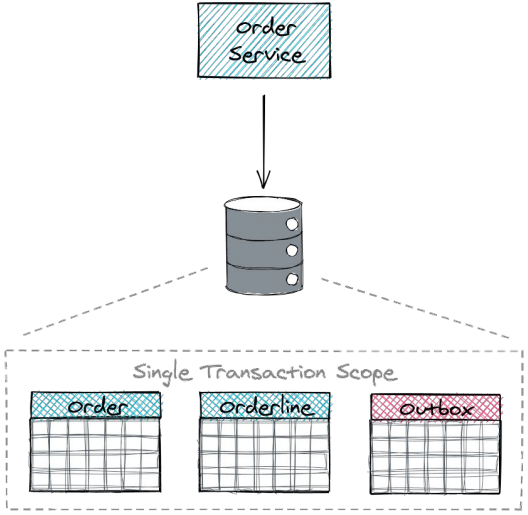


"Dual writes" are **prone to inconsistencies**!

Outbox Pattern



Outbox Pattern



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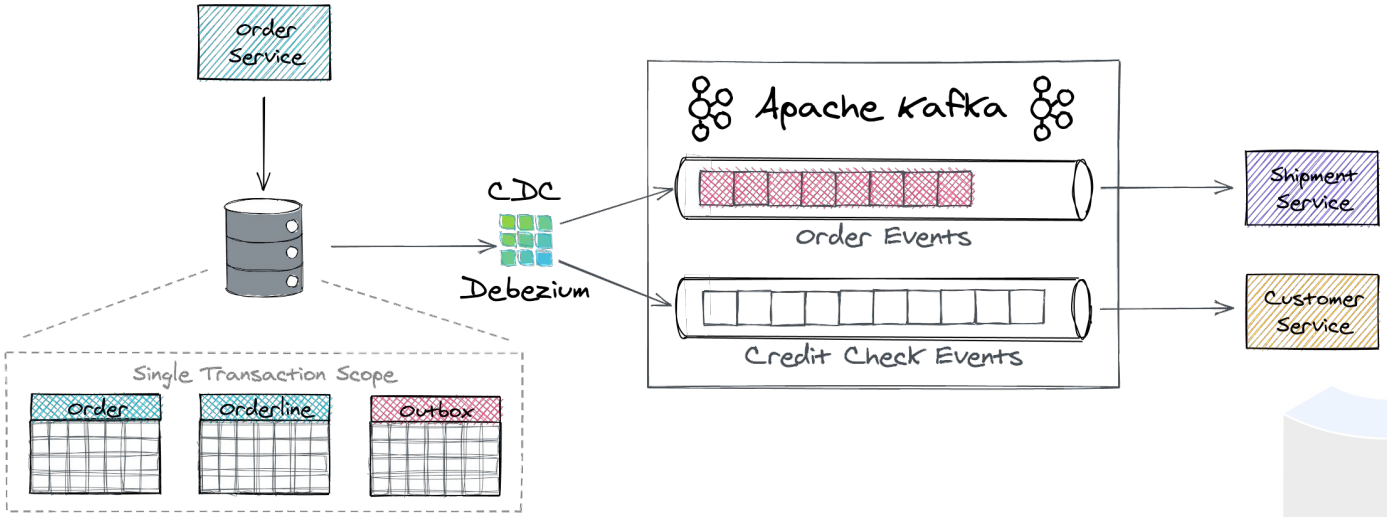

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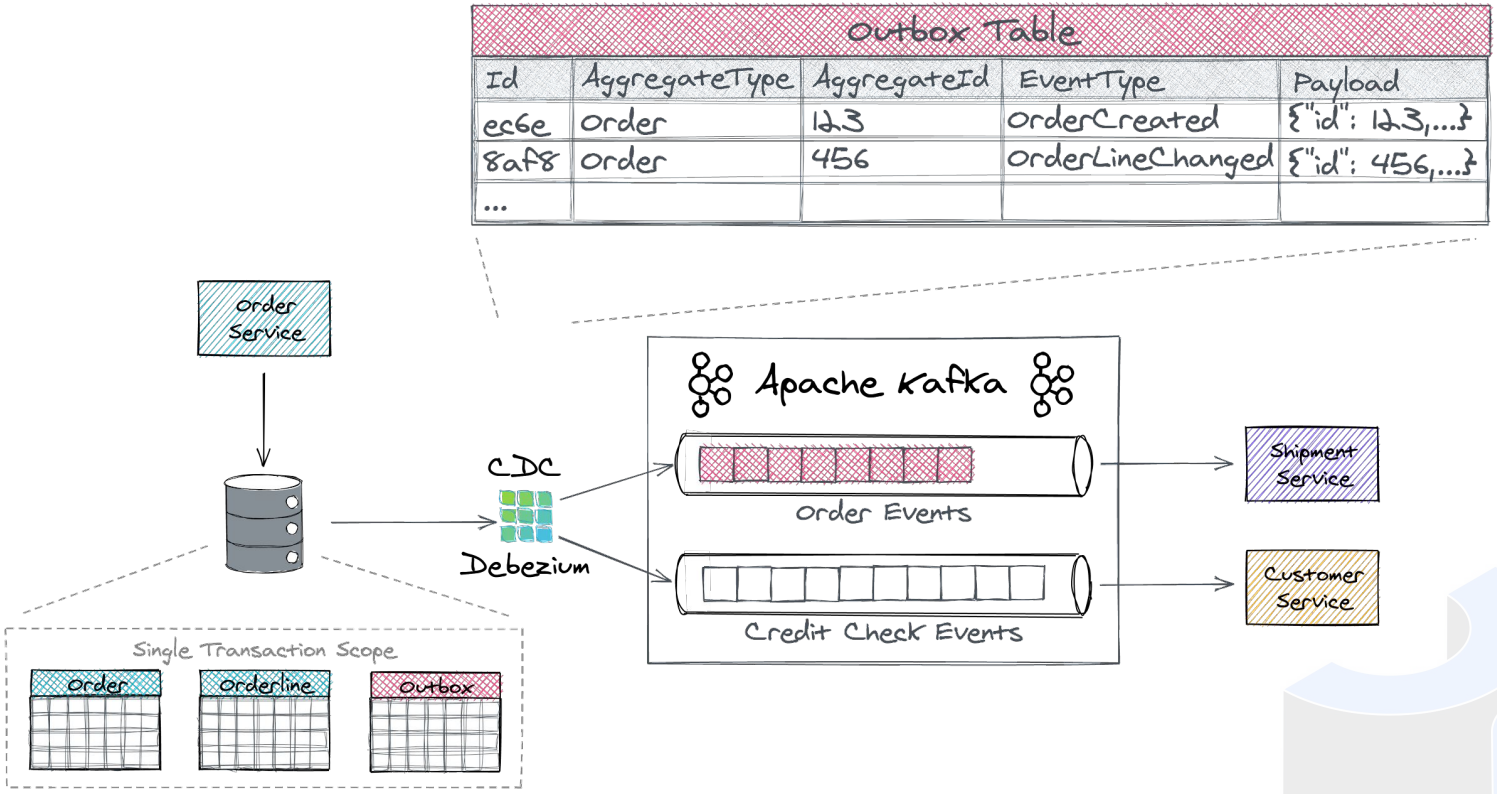
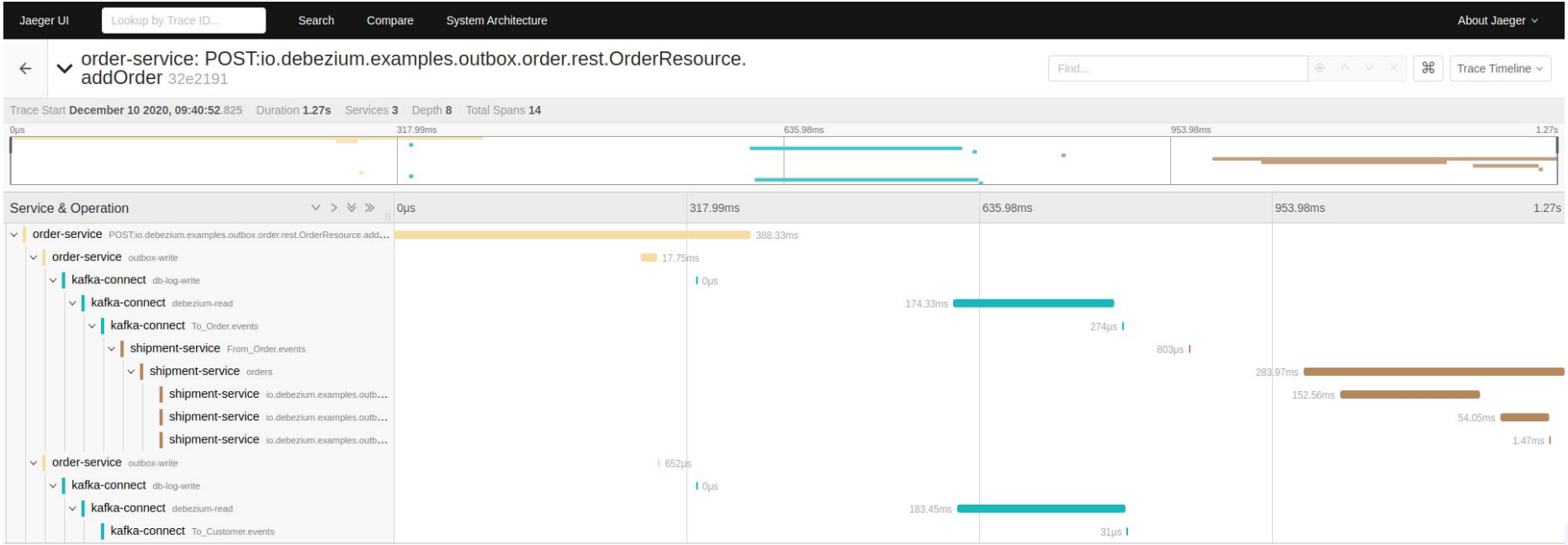


Outbox Pattern

Observability



Variation on Postgres

pg_logical_emit_message()

- Directly writing arbitrary messages **to the WAL**
- No need for an outbox table

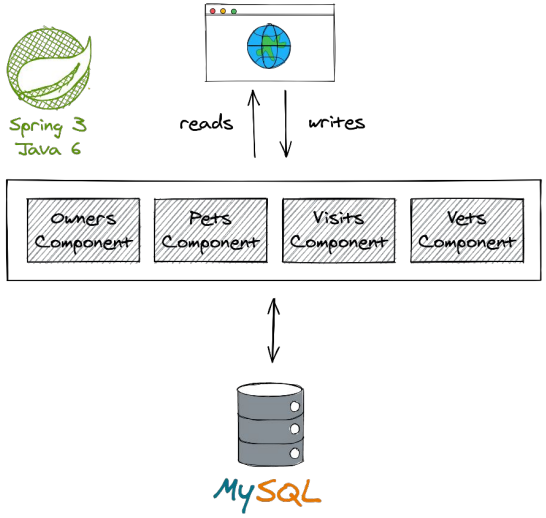
```
SELECT pg_logical_emit_message(
    true,
    'outbox-messages',
    '{ "id" : "ec6e", "aggregateType" : "Order", ...}'
);
```

Strangler Fig Pattern

Challenge: Migrating Systems

- **Gradually evolve** from old into new
- Support temporary **coexistence**
- **Avoid big bang** cut-over

CDC-based Strangler Fig Pattern



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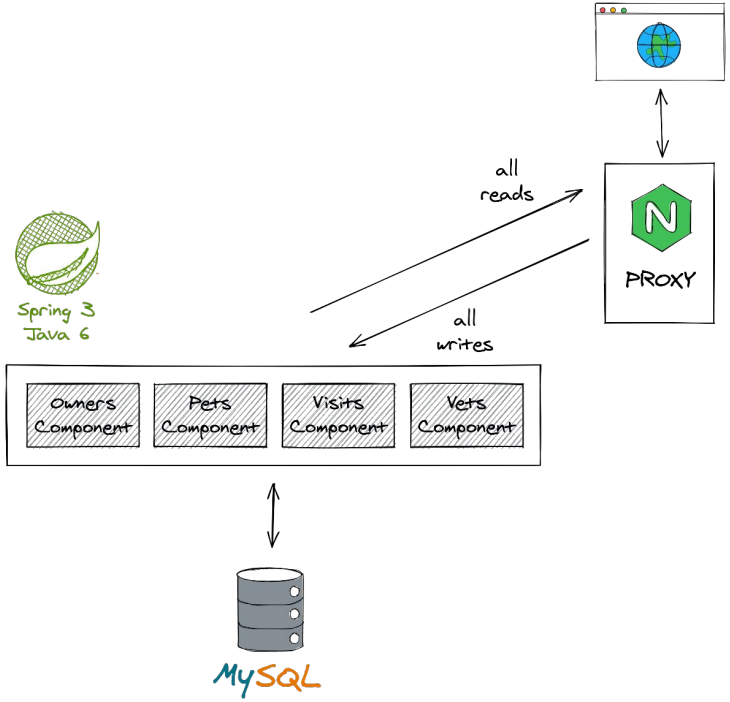

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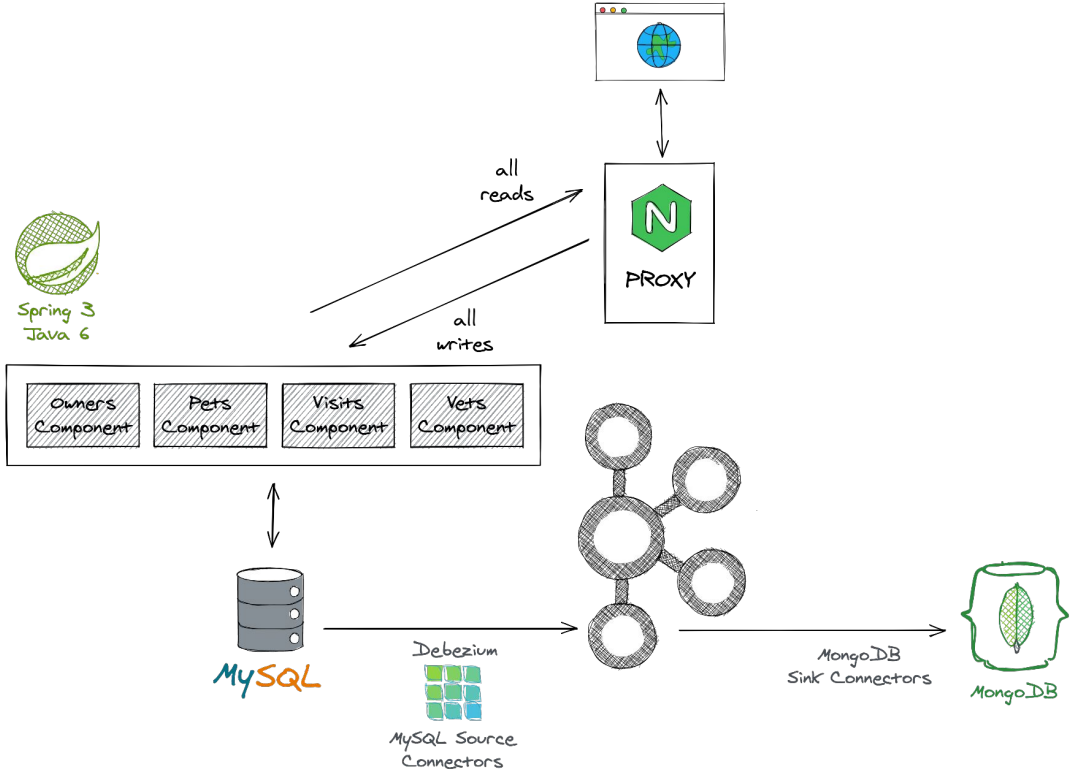

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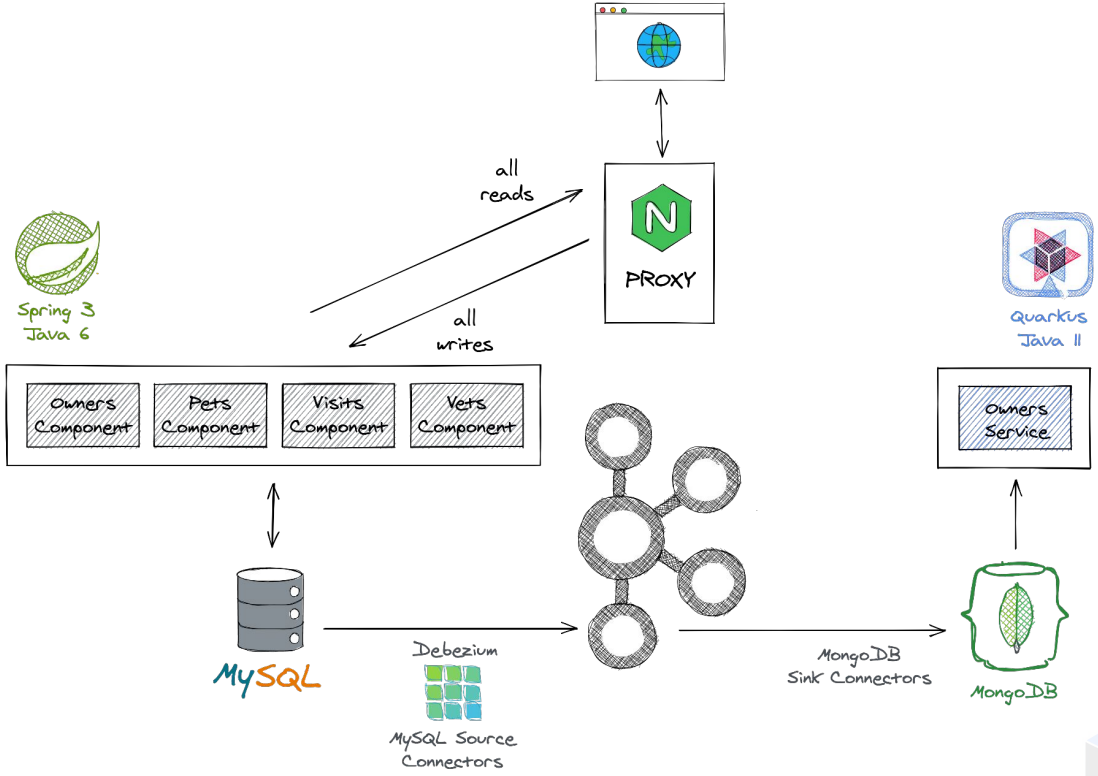

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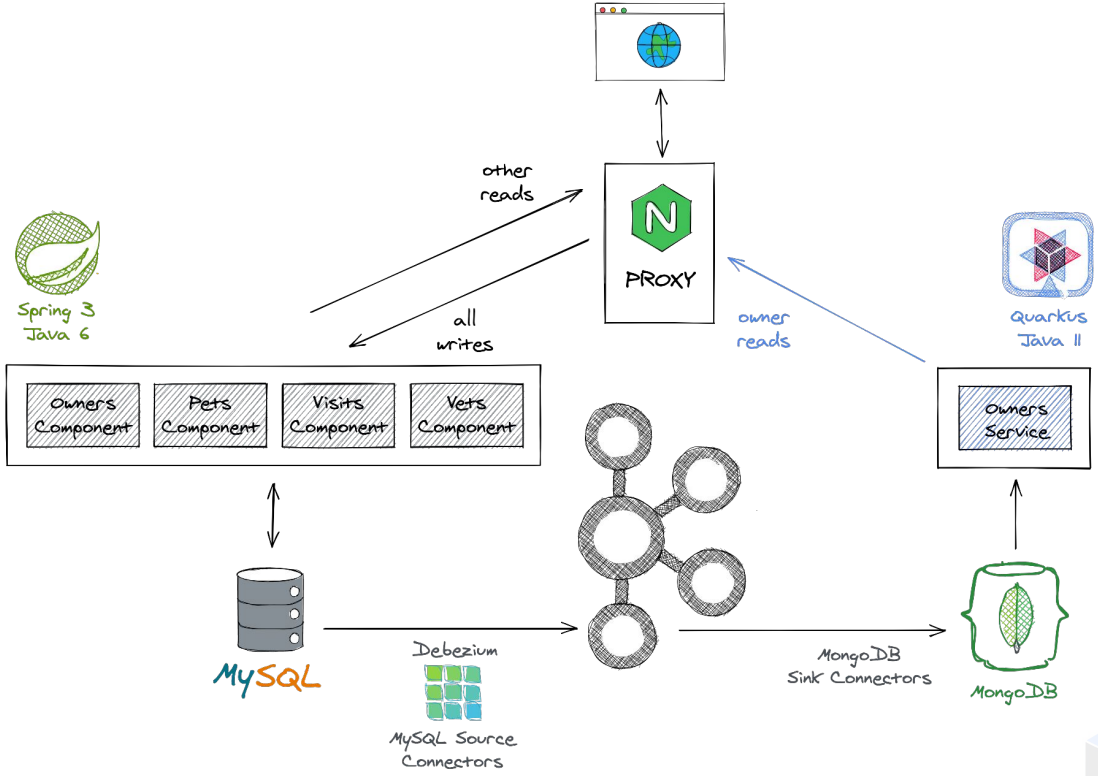

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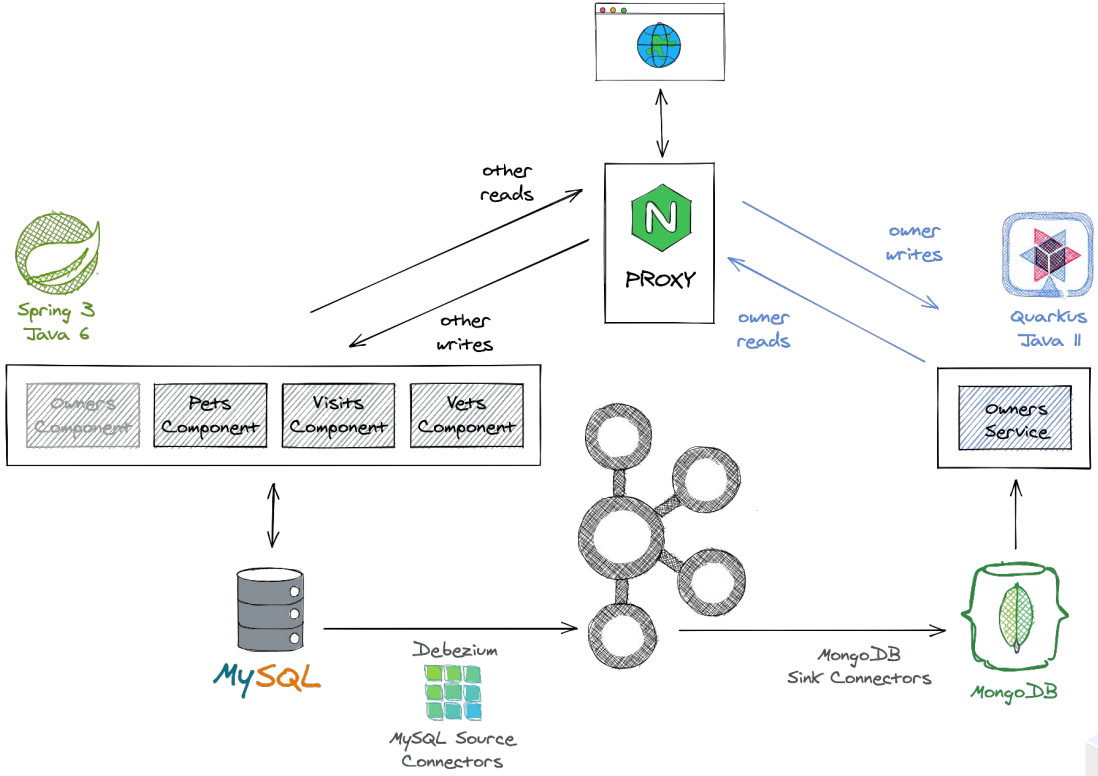

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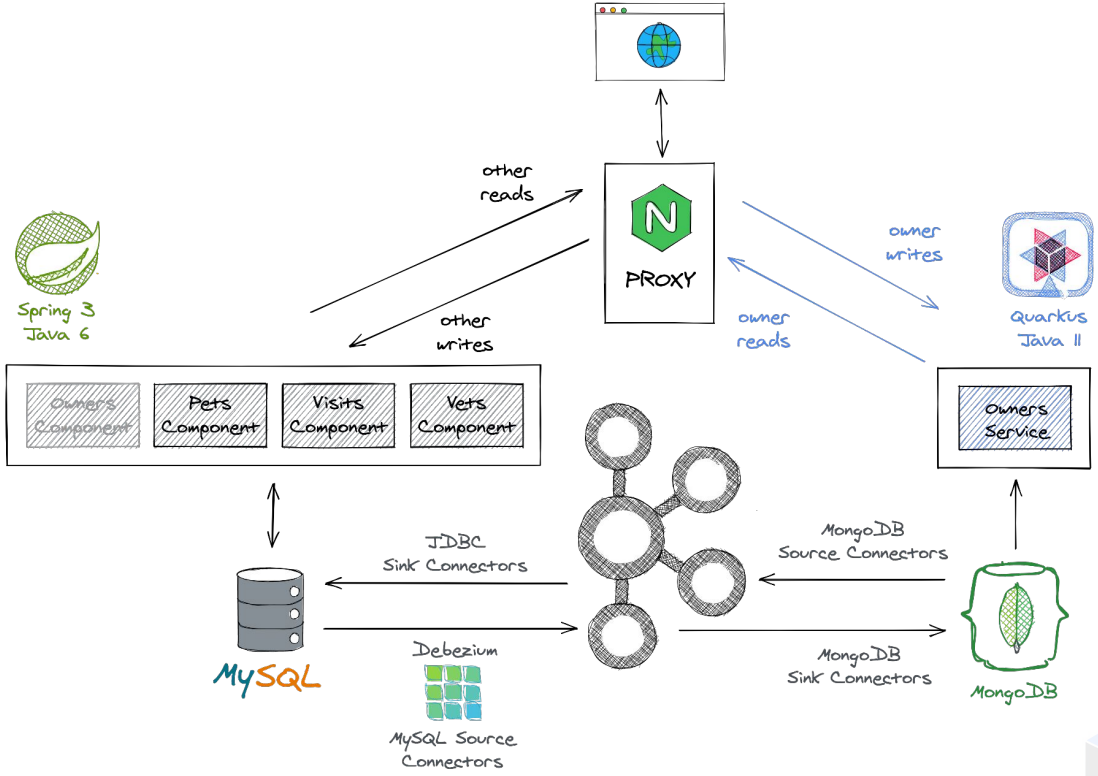

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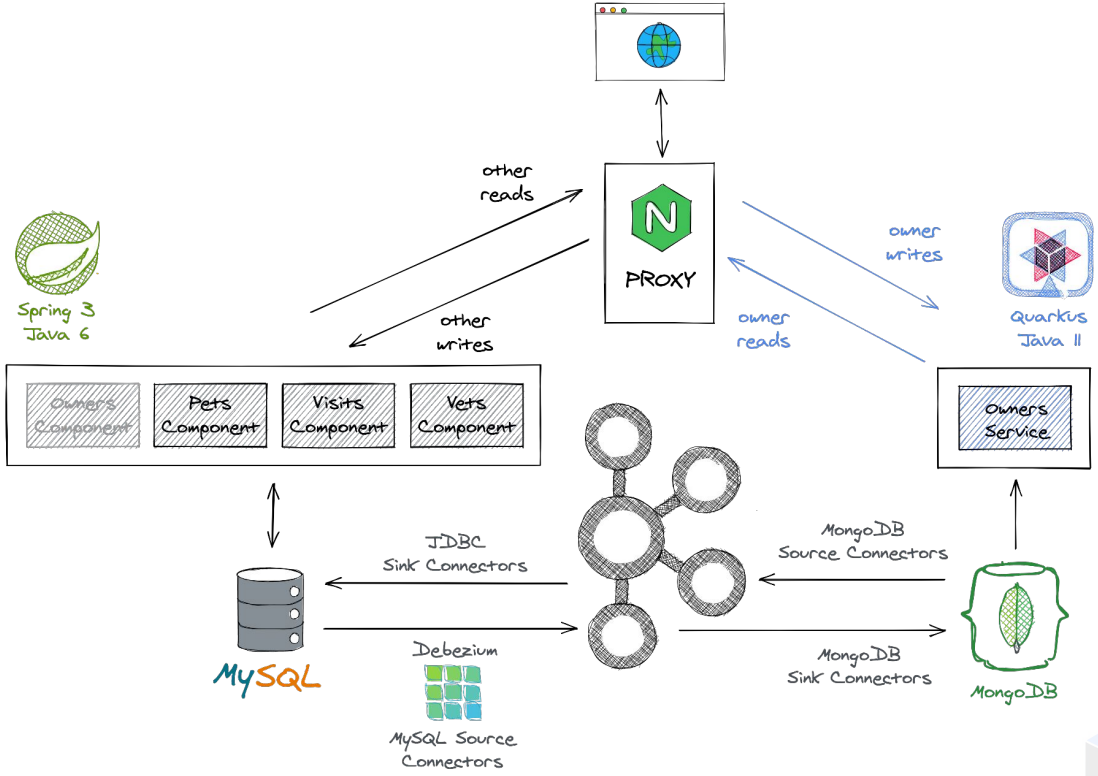


Demo Repo: https://bit.ly/ff21-sfp

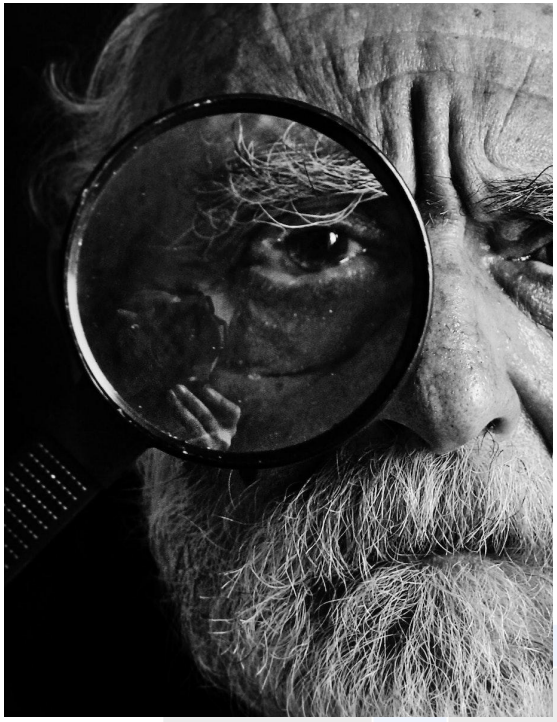
Benefits

- Incremental migration → **“baby steps”**
- **Pause or stop** migration
  without losing spent efforts
- Migration steps ideally **reversible**

Rationale: ⚠️ **minimize risk** ⚠️

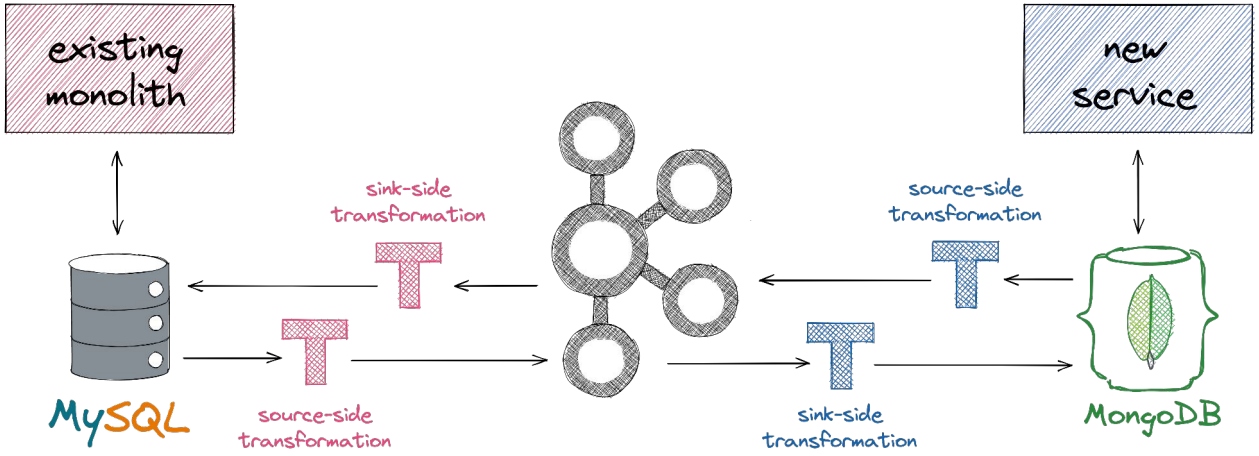
CDC Pipeline Considerations

- **data model leaking** from monolith ?
- ~~"1:1 replication"~~ → **building aggregates ?**



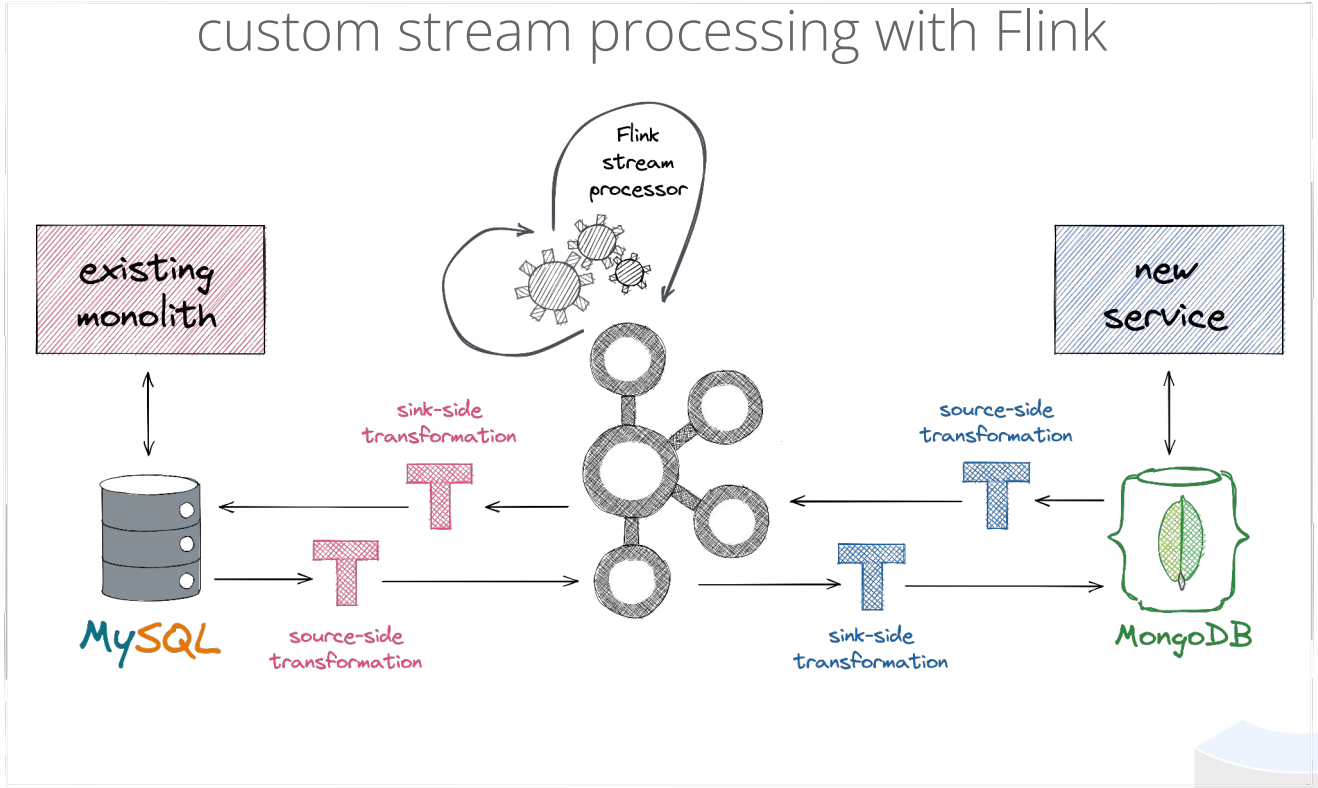
Enhanced CDC Processing

Single Message Transforms

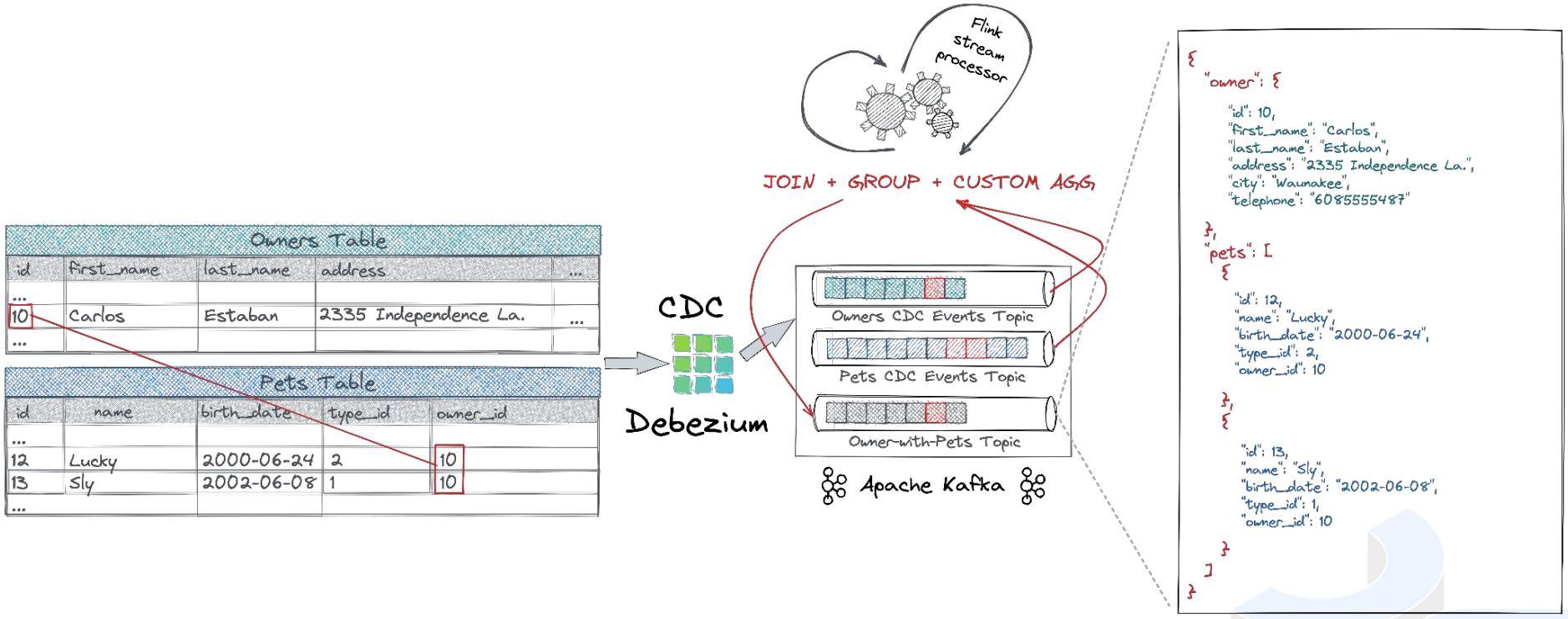


Enhanced CDC Processing

custom stream processing with Flink



Example: Join With Custom Aggregation



Example: Join With Custom Aggregation

Flink SQL

```
INSERT INTO flink_owner_with_pets
SELECT owp.owner.id as key,owp.owner,owp.pets FROM (
    SELECT ff21_agg_owner_pets(owner,pet) as owp FROM (
        SELECT
            ff21_to_owner(o.id, first_name, last_name, address, city, telephone) as owner,
            ff21_to_pet(p.id,name,birth_date,type_id,owner_id) as pet
        FROM dbz_mysql_owners o
        JOIN dbz_mysql_pets p ON p.owner_id = o.id
    ) as t1
    GROUP BY pet.owner_id
) as t2
;
```

Audit Logs

Challenge: Capturing Intent

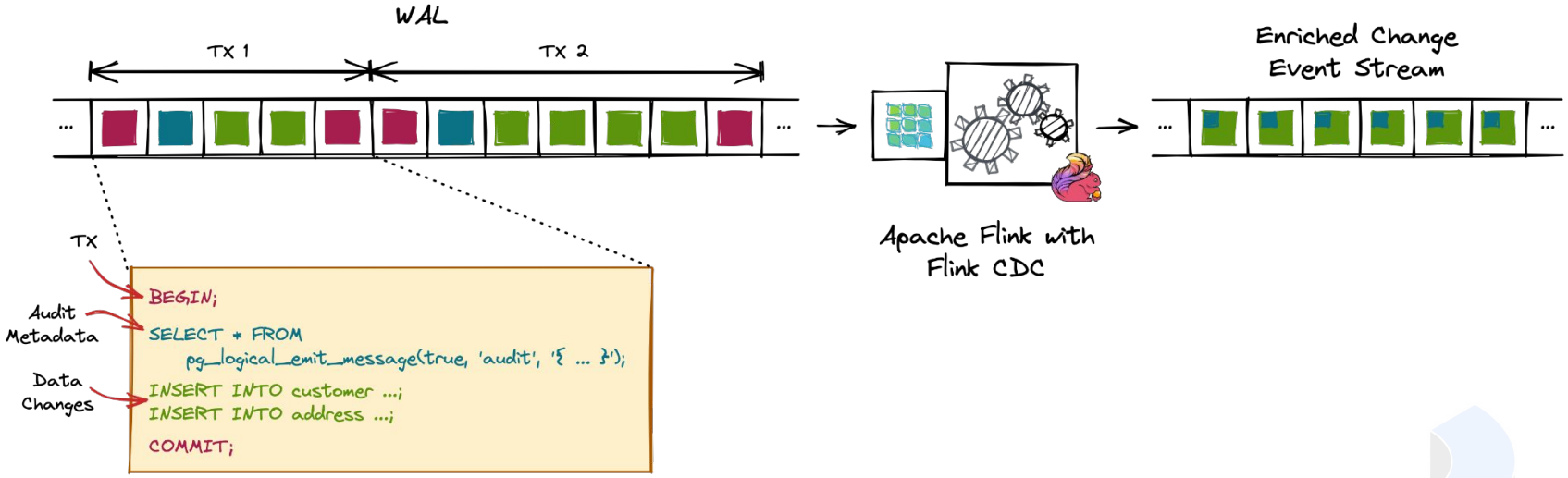
pg_logical_emit_message()

- Pure CDC events **lack metadata** like business user, device id, etc.
- Solution: emit at TX begin, enrich events using Flink

```
SELECT pg_logical_emit_message(
    true,
    'audit-data',
    '{ "client_date" : "2019-08-22 08:12:31", "usecase" : " CREATE VEGETABLE", "user_name" : "farmerbob" }'
);
```

Capturing Intent

Enriching Change Data Events with Metadata



Capturing Intent

Enriching Change Events Via Apache Flink

```
public void flatMap(String value, Collector<String> out) throws Exception {
  ChangeEvent changeEvent = mapper.readValue(value, ChangeEvent.class);
  String op = changeEvent.getOp();
  String txId = changeEvent.getSource().get("txId").asText();

  // decoding message
  if (op.equals("m")) {
    Message message = changeEvent.getMessage();

    // an audit metadata message -> put metadata to state
    if (message.getPrefix().equals("audit")) {
      localAuditState = new AuditState(txId, message.getContent());
      return;
    }
    else {
      out.collect(value);
    }
  }
```

```
  // a change event -> enrich with state stored before
  else {
    if (txId != null && localAuditState != null) {
      if (txId.equals(localAuditState.getTxId())) {
        changeEvent.setAuditData(localAuditState.getState());
      }
      else {
        localAuditState = null;
      }
    }

    changeEvent.setTransaction(null);
    out.collect(mapper.writeValueAsString(changeEvent));
  }
}
```


Wrap-Up

Take Aways

- The **fresher data** is, the more valuable it is
- **Change Data Capture** and **Debezium**: Powerful tools for realtime change event feeds
- Combining CDC with **stream processing**: Many more possibilities

Thank You!

Q & A

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decodable

Debezium

Correlating Events From Same Transaction

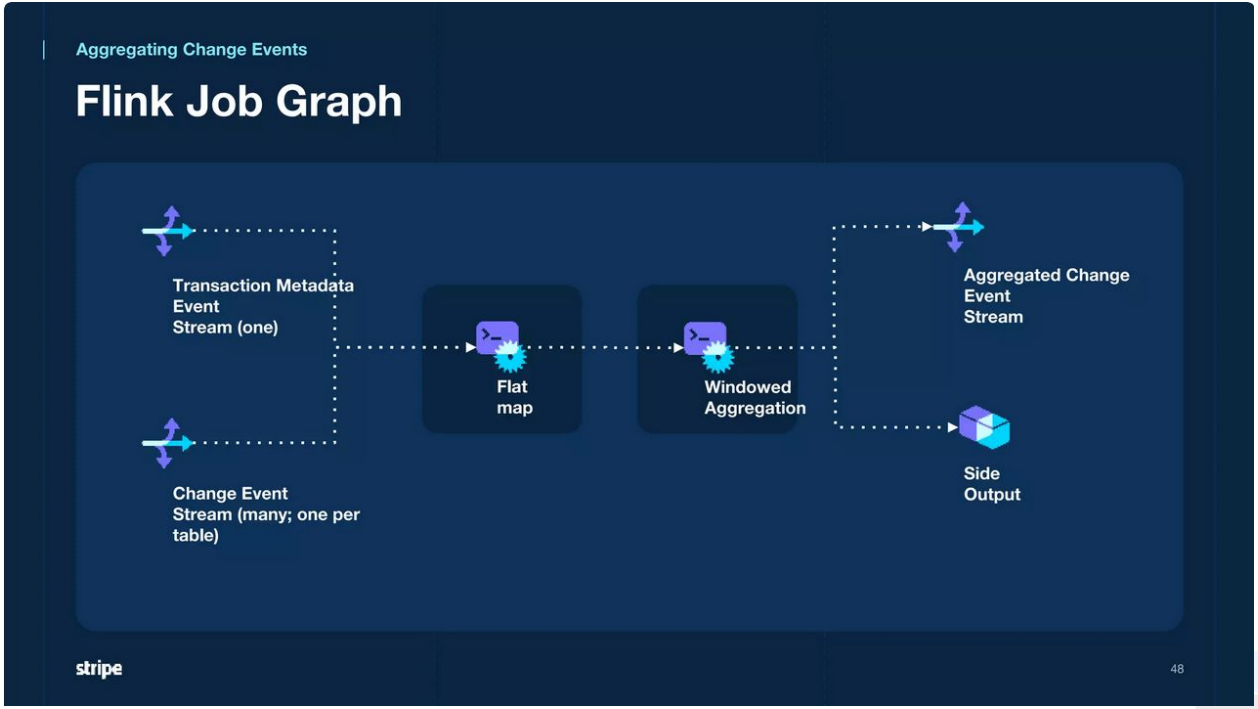
```
{
  "before": null,
  "after": {
    "pk": "2",
    "aa": "1"
  },
  "source": {
   ...
  },
  "op": "c",
  "ts_ms": "1580390884335",
  "transaction": {
    "id": "571:53195832",
    "total_order": "1",
    "data_collection_order": "1"
  }
}
```

```
{
  "status": "BEGIN",
  "id": "571:53195829",
  "ts_ms": 1486500577125
}

{
  "status": "END",
  "id": "571:53195832",
  "ts_ms": 1486500577691,
  "event_count": 2,
  "data_collections": [
    {
      "data_collection": "s1.a",
      "event_count": 1
    },
    {
      "data_collection": "s2.a",
      "event_count": 1
    }
  ]
}
```

Debezium

Correlating Events From Same Transaction



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