GREAT INTERNATIONAL DEVELOPER SUMMIT™

Empowering Software Practitioners since 2008

Change Data Capture Pipelines With Debezium and Kafka Streams

Gunnar Morling

Software Engineer

@gunnarmorling

Debezium

What's Change Data Capture?
Use Cases

1

2

Kafka Streams with Quarkus

Supersonic Subatomic Java
The Kafka Streams Extension

Debezium + Kafka Streams = 🧡

Data Enrichment
Auditing
Expanding Partial Update Events
Aggregate View Materialisation

3

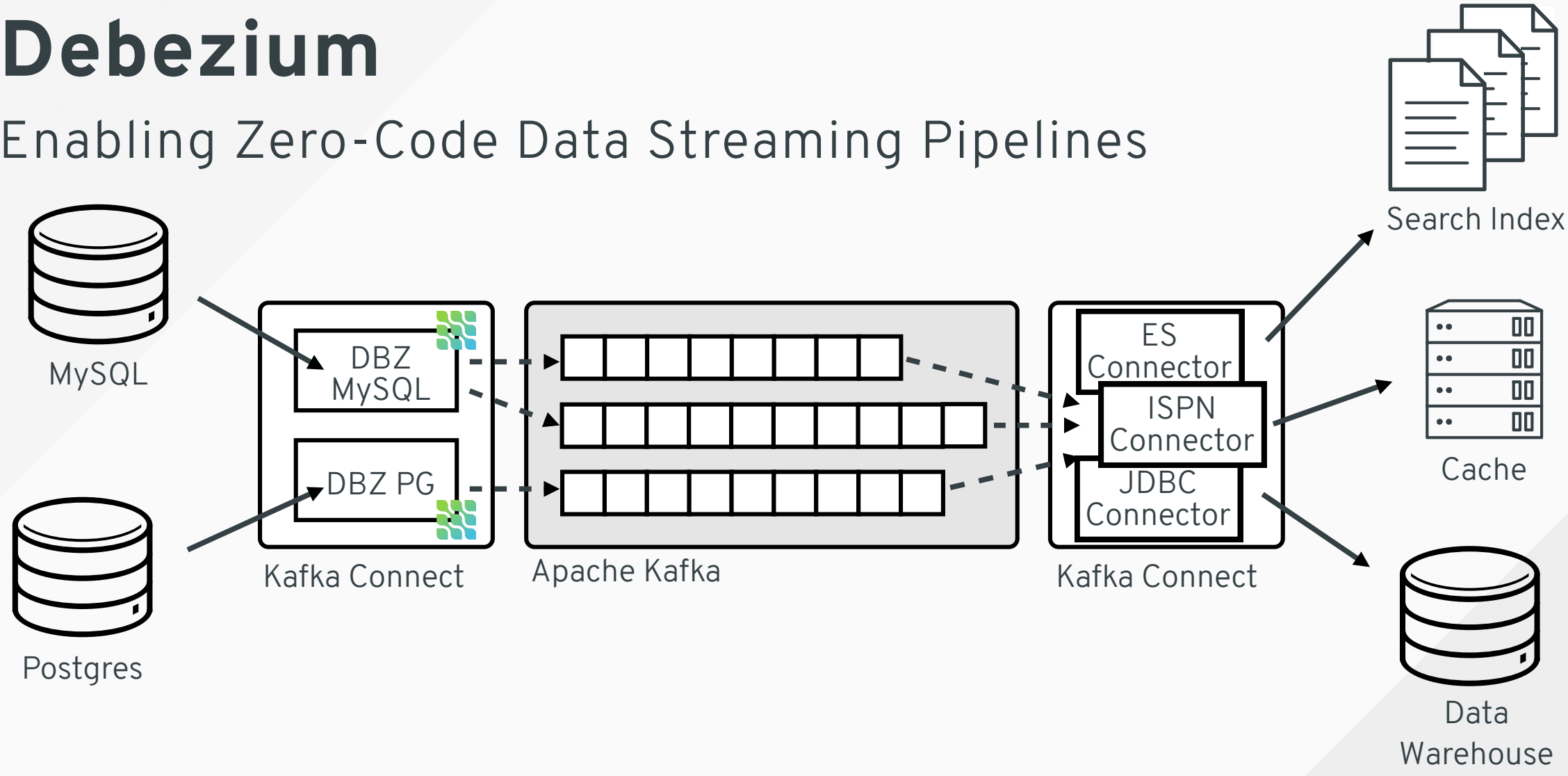
Gunnar Morling

- Open source software engineer at Red Hat
  - **Debezium**
  - Quarkus
  - Hibernate
- **Spec Lead** for Bean Validation 2.0 

- Other projects: **Deptective**, MapStruct
- Java Champion 

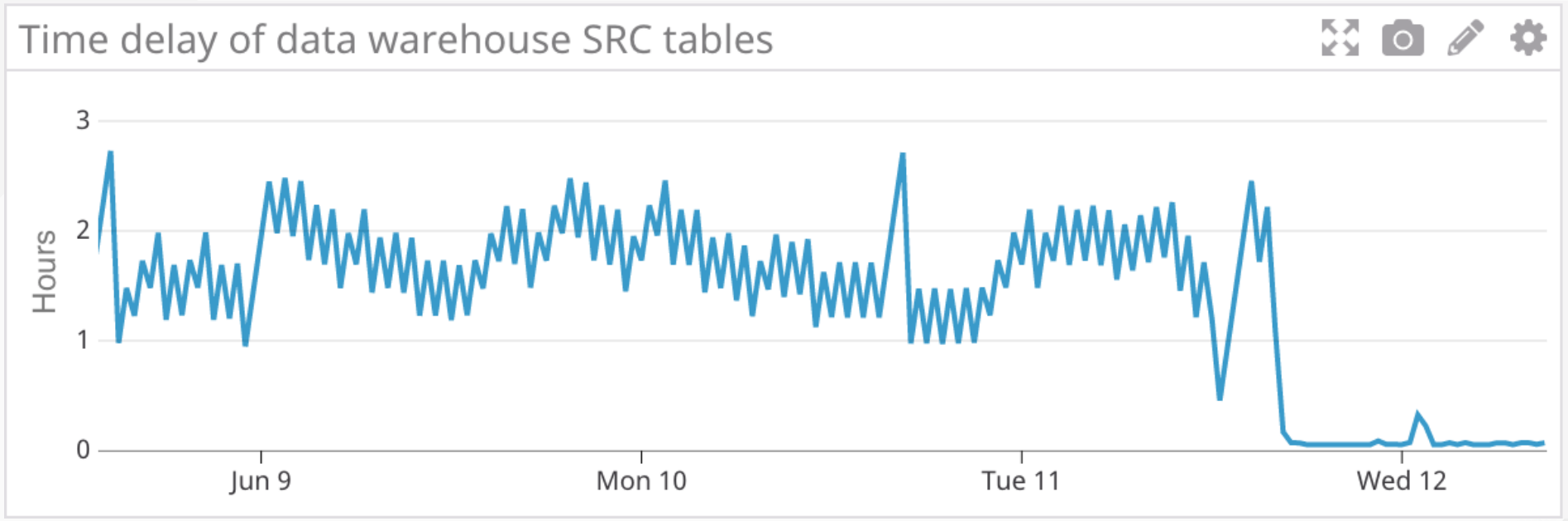
Debezium

Enabling Zero-Code Data Streaming Pipelines



Debezium

Low-Latency Change Data Streaming



https://medium.com/convoy-tech/

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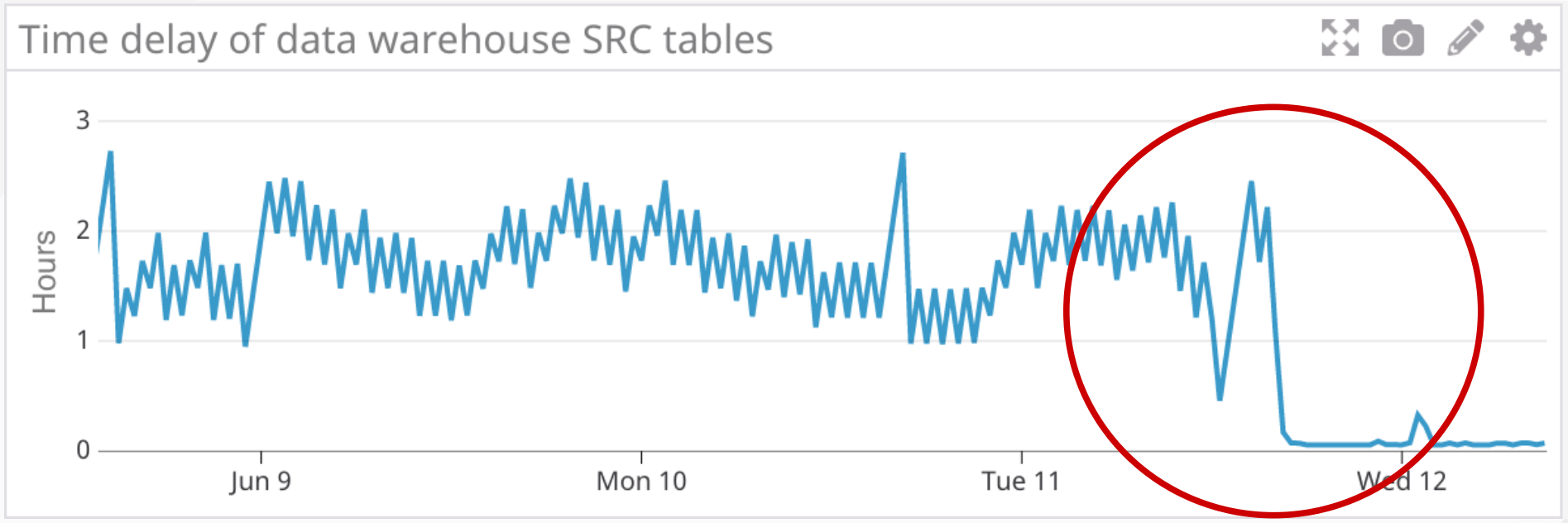

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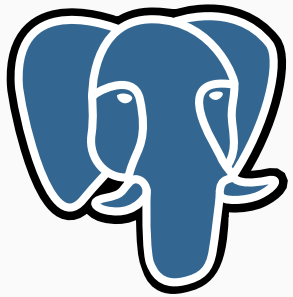
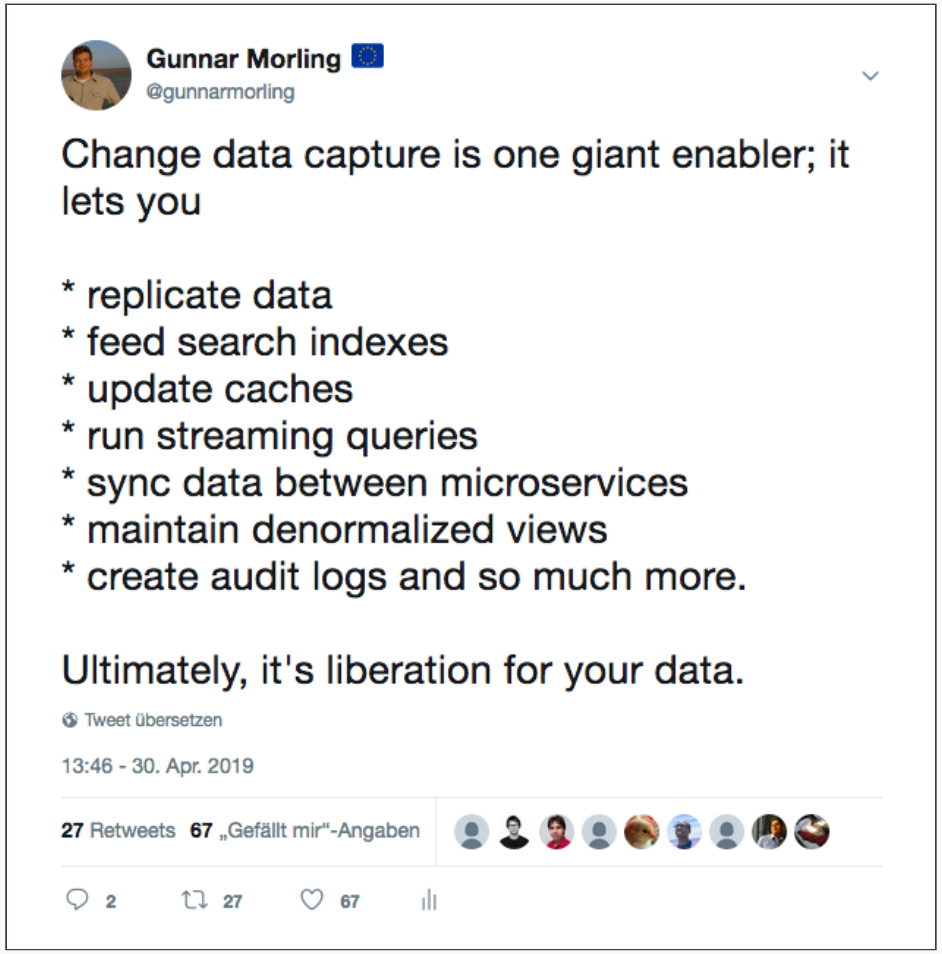
Debezium Connectors

- **MySQL**
- **Postgres**
- **MongoDB**
- **SQL Server**
- Cassandra (Incubating)
- Oracle (Incubating)
- Db2 (Incubating)
- Future additions: Vitess, MariaDB



CDC – "Liberation for Your Data"



Gunnar Morling
@gunnarmorling

Change data capture is one giant enabler; it lets you

* replicate data
* feed search indexes
* update caches
* run streaming queries
* sync data between microservices
* maintain denormalized views
* create audit logs and so much more.

Ultimately, it's liberation for your data.

Tweet übersetzen

13:46 - 30. Apr. 2019

27 Retweets 67 „Gefällt mir"-Angaben

2 27 67

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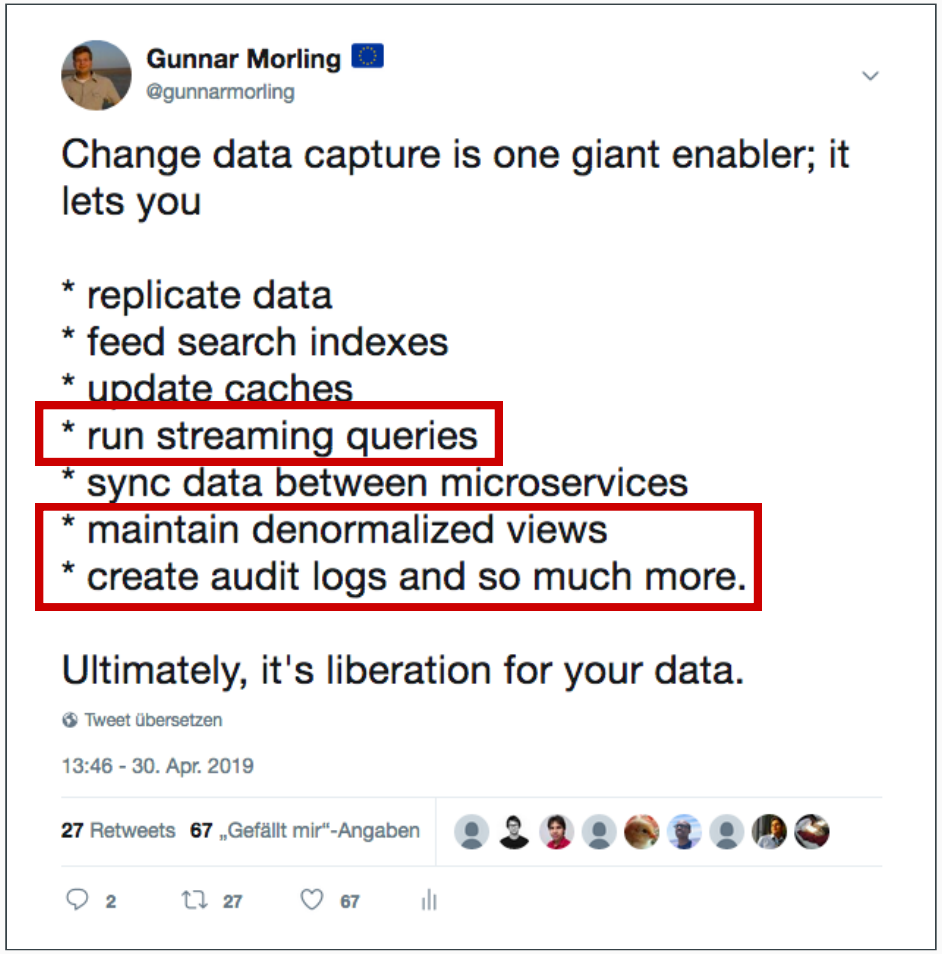

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2 27 67

Change Event Structure

- Key: Primary key of table
- Value: Describing the change event
  - **Old** row state
  - **New** row state
  - **Metadata**

```
{
  "before": null,
  "after": {
    "id": 1004,
    "first_name": "Anne",
    "last_name": "Kretchmar",
    "email": "annek@noanswer.org"
  },
  "source": {
    "name": "dbserver1",
    "server_id": 0,
    "ts_sec": 0,
    "file": "mysql-bin.000003",
    "pos": 154,
    "row": 0,
    "snapshot": true,
    "db": "inventory",
    "table": "customers"
  },
  "op": "c",
  "ts_ms": 1486500577691
}
```

Meme idea: Robin Moffatt

Log- vs. Query-Based CDC

	Query-Based	Log-Based
All data changes are captured	-	+
No polling delay or overhead	-	+
Transparent to writing applications and models	-	+
Can **capture deletes** and **old record state**	-	+
Installation/Configuration	+	-

Debezium

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Aggregate View Materialisation

Quarkus

Supersonic Subatomic Java

“ A Kubernetes Native Java stack tailored for OpenJDK HotSpot and GraalVM, crafted from the best of breed Java libraries and standards.


$ ./my-native-java-rest-app
Quarkus started in 0.008s
Memory (RSS) in Megabytes*
*Tested on a single-core machine
REST
Quarkus + Native (via GraalVM)
12 MB
Quarkus + JVM (via OpenJDK)
73 MB
Traditional Cloud-Native Stack
136 MB
REST + CRUD
Quarkus + Native (via GraalVM)
28 MB
Quarkus + JVM (via OpenJDK)
145 MB
Traditional Cloud-Native Stack
209MB
BOOT + First Response Time
REST
Quarkus + Native (via GraalVM)
0.016 Seconds
Quarkus + JIT (via OpenJDK)
0.943 Seconds
Traditional Cloud-Native Stack
4.3 Seconds
REST + CRUD
Quarkus + Native (via GraalVM)
0.042 Seconds
Quarkus + JIT (via OpenJDK)
2.033 Seconds
Traditional Cloud-Native Stack
9.5 Seconds

Quarkus

Supersonic Subatomic Java

- **Developer joy**
- **Imperative and Reactive**
- Best-of-breed **libraries**

Quarkus

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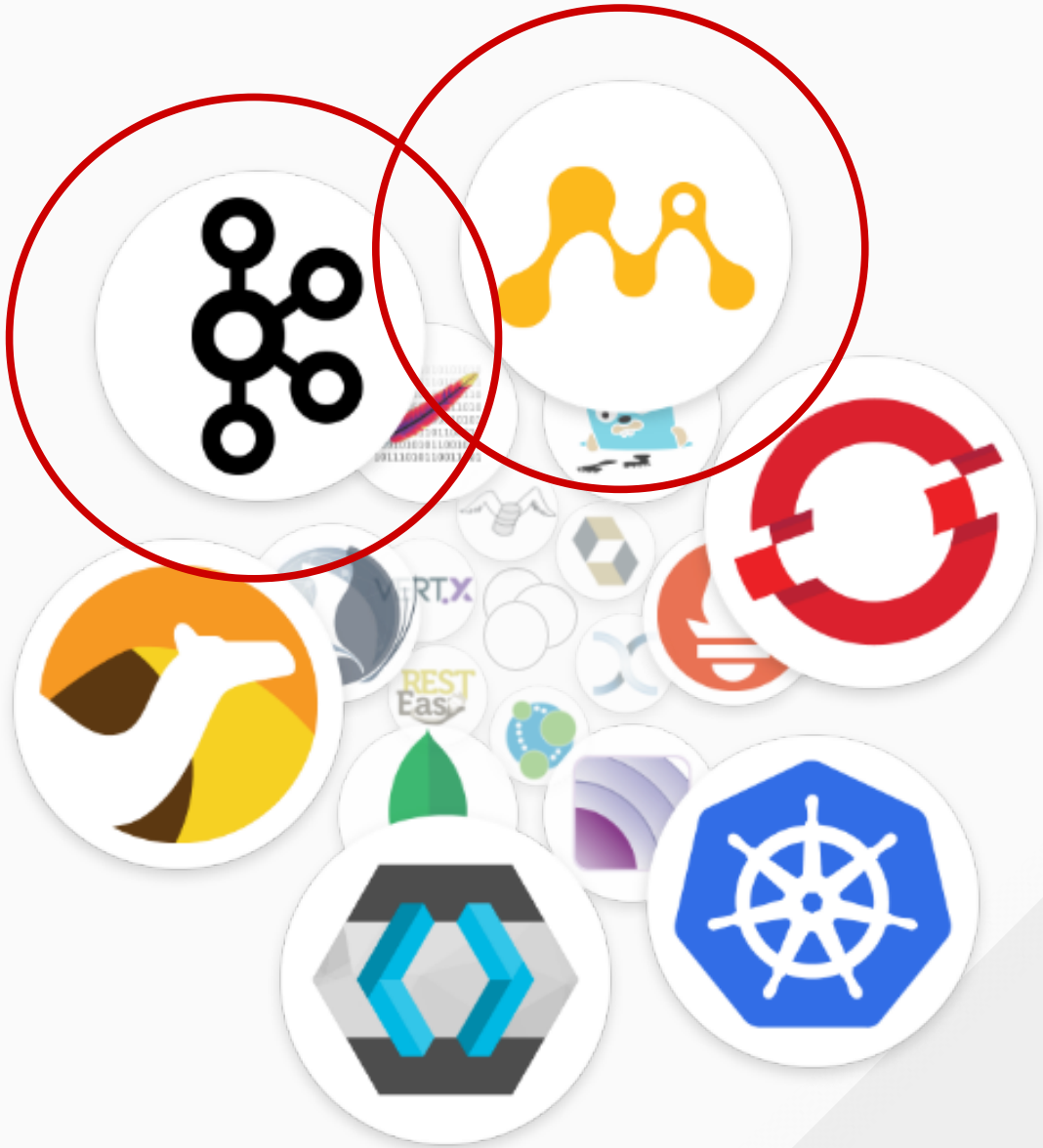
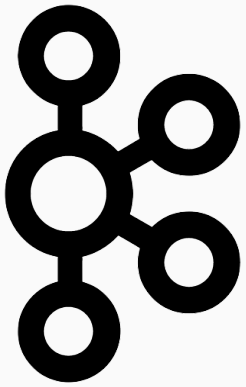


Quarkus

The Kafka Streams Extension

- **Management** of topology
- **Health** checks
- **Dev Mode**
- Support for **native binaries** via GraalVM



GraalVM™

Debezium

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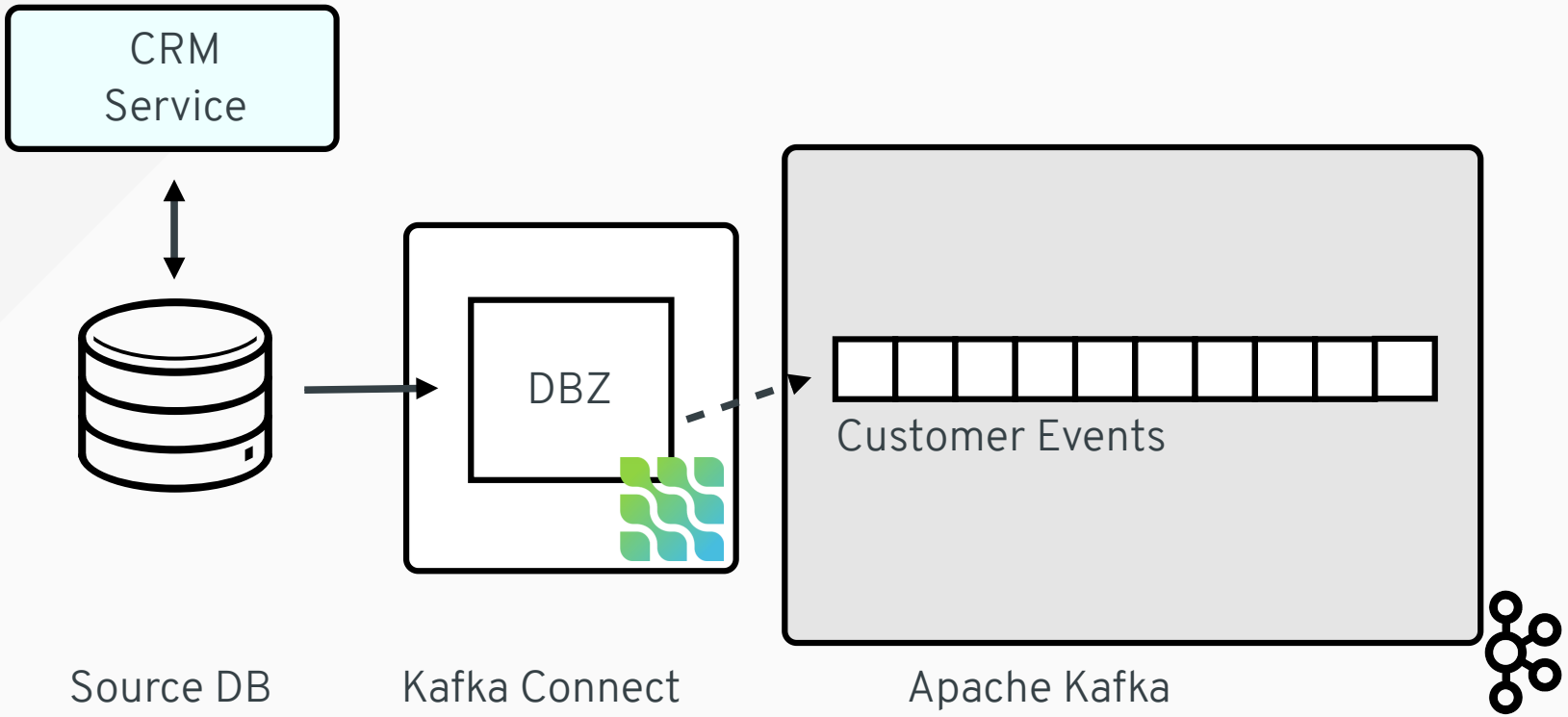
Data Enrichment - Demo

Auditing

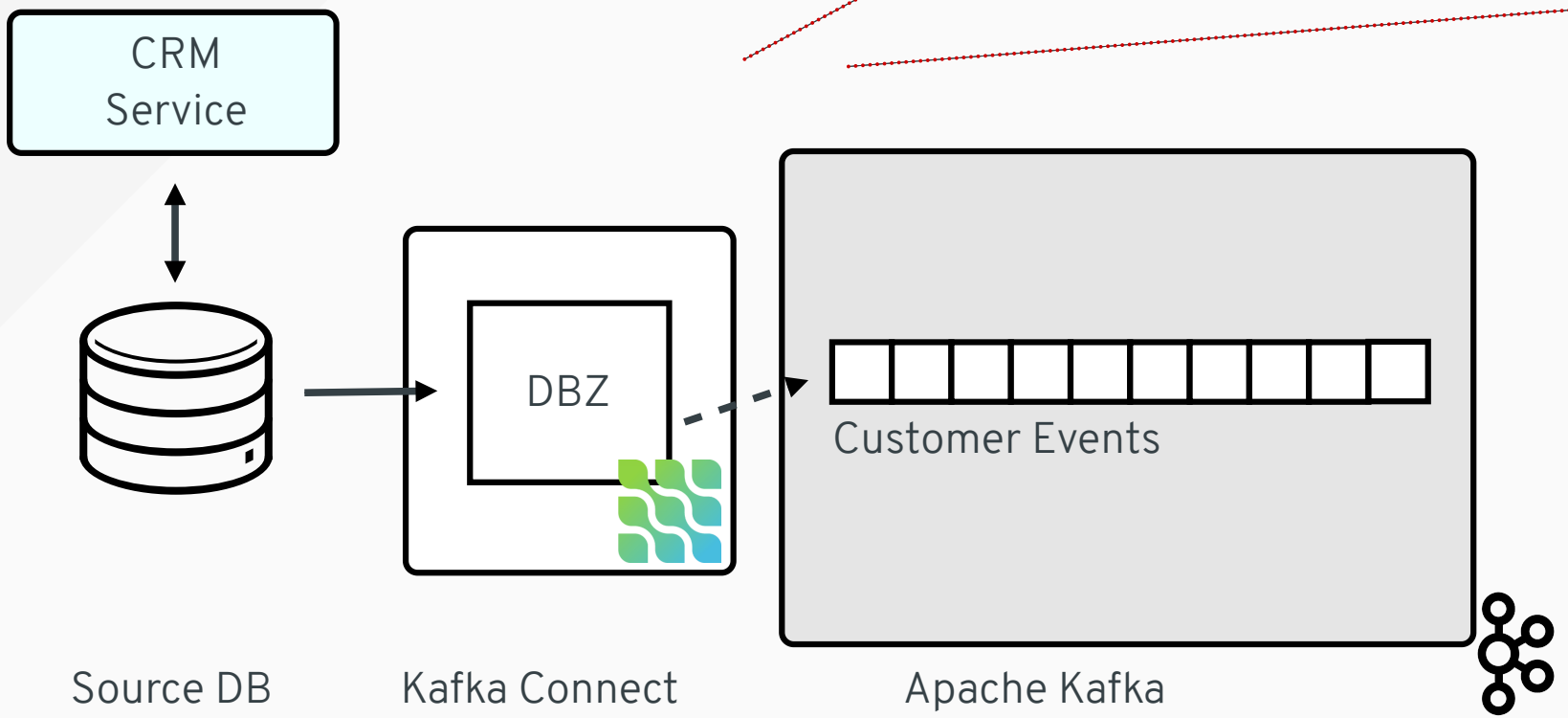
Auditing


CRM
Service
DBZ
Customer Events
Source DB
Kafka Connect
Apache Kafka

Auditing

"Transactions" table

Id	User	Use Case
tx-1	Bob	Create Customer
tx-2	Sarah	Delete Customer
tx-3	Rebecca	Update Customer



Auditing

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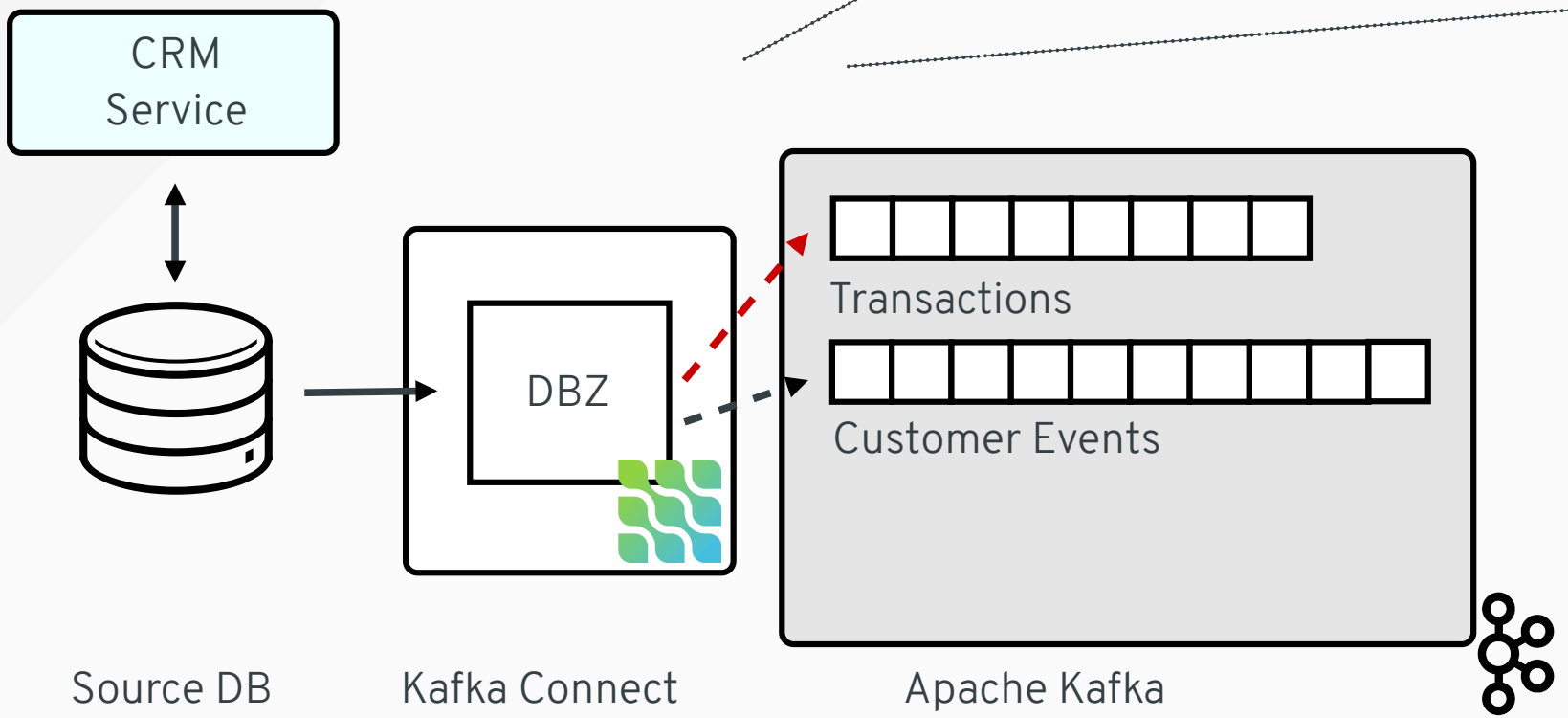

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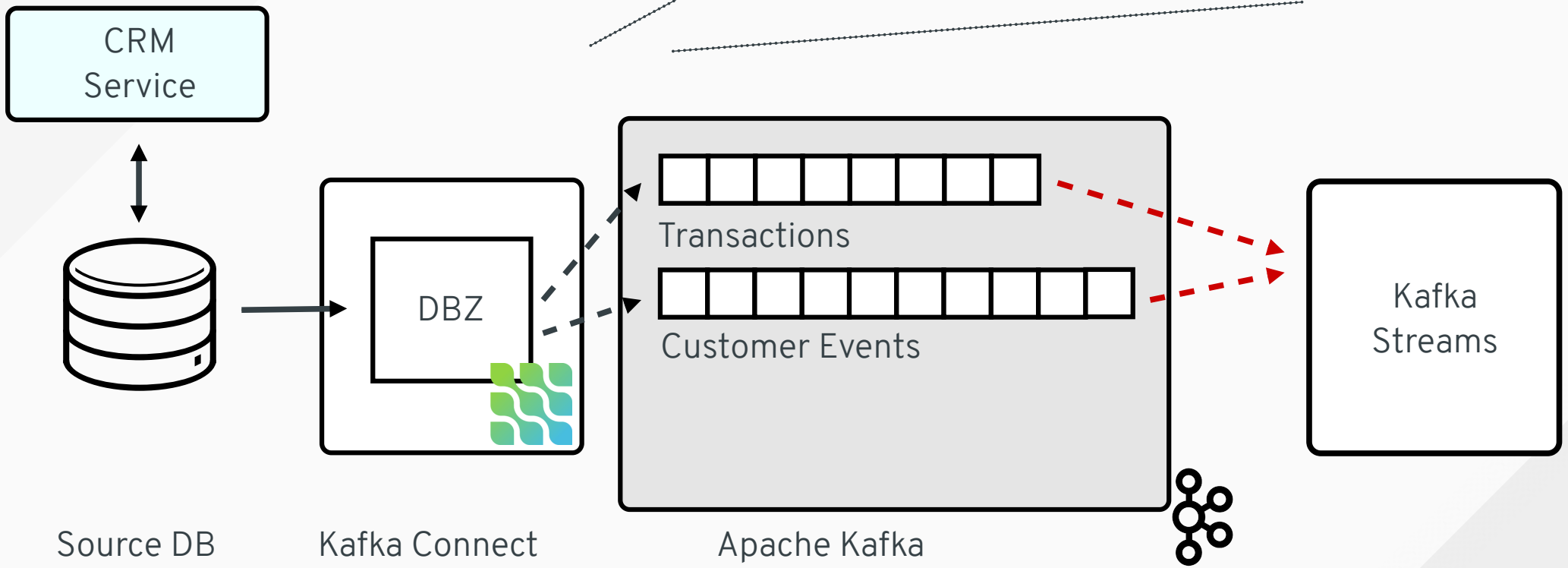

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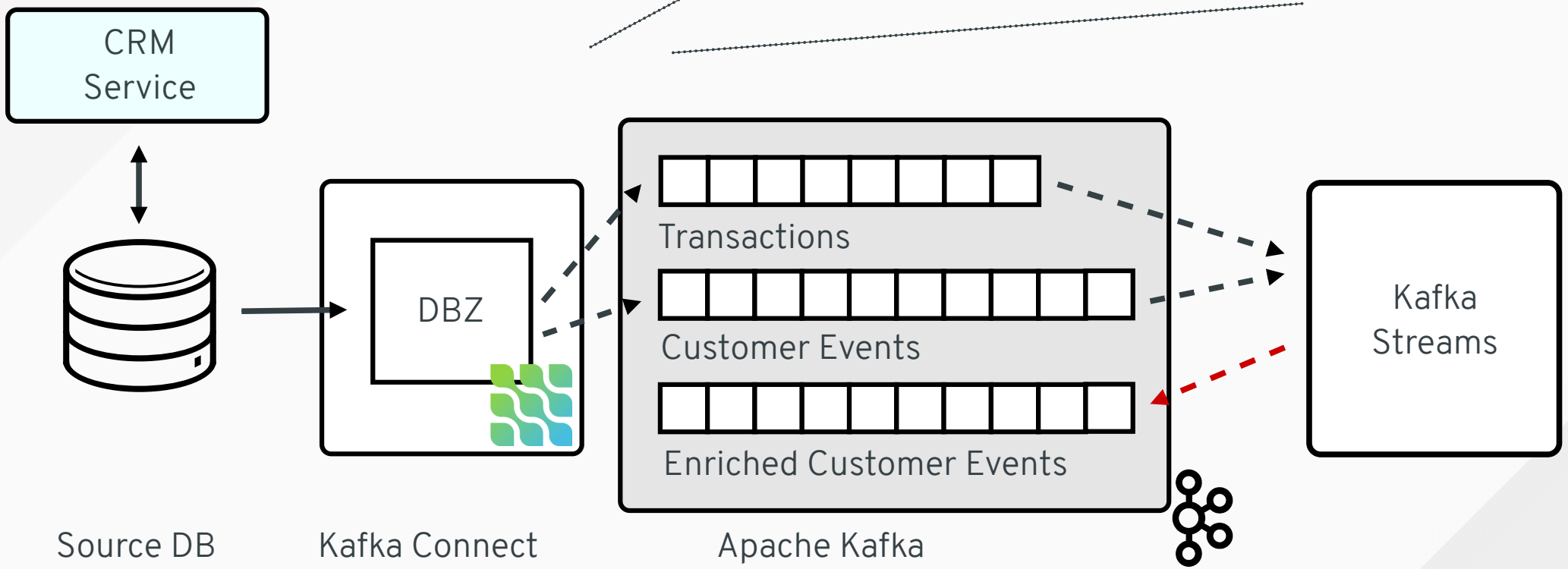
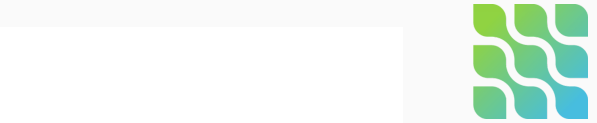


Auditing

```
{
  "before": {
    "id": 1004,
    "last_name": "Kretchmar",
    "email": "annek@example.com"
  },
  "after": {
    "id": 1004,
    "last_name": "Kretchmar",
    "email": "annek@noanswer.org"
  },
  "source": {
    "name": "dbserver1",
    "table": "customers",
    "txId": "tx-3"
  },
  "op": "u",
  "ts_ms": 1486500577691
}
```

Customers



```
{
  "id": "tx-3"
}
```

```
{
  "before": null,
  "after": {
    "id": "tx-3",
    "user": "Rebecca",
    "use_case": "Update customer"
  },
  "source": {
    "name": "dbserver1",
    "table": "transactions",
    "txId": "tx-3"
  },
  "op": "c",
  "ts_ms": 1486500577691
}
```

Transactions

```
{
  "before": {
    "id": 1004,
    "last_name": "Kretchmar",
    "email": "annek@example.com"
  },
  "after": {
    "id": 1004,
    "last_name": "Kretchmar",
    "email": "annek@noanswer.org"
  },
  "source": {
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    "table": "customers",
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  "op": "u",
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}
```

Customers

```
{
  "id": "tx-3"
}
```

```
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  "after": {
    "id": "tx-3",
    "user": "Rebecca",
    "use_case": "Update customer"
  },
  "source": {
    "name": "dbserver1",
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  },
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```

Transactions

```
{
  "before": {
    "id": 1004,
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}
```

Customers

Auditing


{
"before": {
"id": 1004,
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"table": "customers",
"txId": "tx-3",
"user": "Rebecca",
"use_case": "Update customer"
},
"op": "u",
"ts_ms": 1486500577691
}
Enriched Customers

Auditing

- Non-trivial join implementation
  - **no ordering** across topics
  - need to **buffer change events** until TX data available
- bit.ly/debezium-auditlogs

```
@Override
public KeyValue<JsonObject, JsonObject>
    transform(JsonObject key, JsonObject value) {

  boolean enrichedAllBufferedEvents =
      enrichAndEmitBufferedEvents();

  if (!enrichedAllBufferedEvents) {
    bufferChangeEvent(key, value);
    return null;
  }

  KeyValue<JsonObject, JsonObject> enriched =
      enrichWithTxMetaData(key, value);
  if (enriched == null) {
    bufferChangeEvent(key, value);
  }

  return enriched;
}
```


Expanding Partial
Update Events

Expanding Partial Update Events

Examples

- MongoDB update events (**"patch"**)
- Postgres
  - Replica identity **not FULL**
  - **TOAST-ed** columns
- Cassandra update events
- MySQL with row image minimal

```
{
  "before": { ... },
  "after": {
    "id": 1004,
    "first_name": "Dana",
    "last_name": "Kretchmar",
    "email": "annek@noanswer.org",
    "biography":
      "__debezium_unavailable_value"
  },
  "source": { ... },
  "op": "u",
  "ts_ms": 1570448151611
}
```

Expanding Partial Update Events

Examples

- MongoDB update events (**"patch"**)
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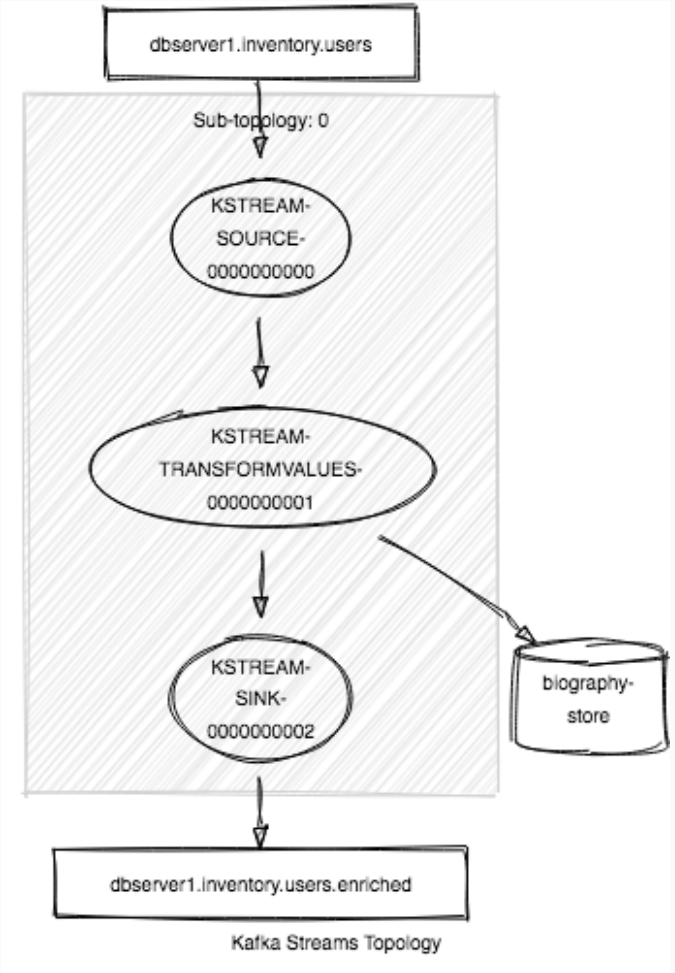
}
```

Expanding Partial Update Events

Topology



https://zz85.github.io/kafka-streams-viz/

Expanding Partial Update Events

Obtaining missing values from a state store

```
class ToastColumnValueProvider implements ValueTransformerWithKey<JsonObject, JsonObject, JsonObject>

  private KeyValueStore<JsonObject, String> biographyStore;

  @Override
  public void init(ProcessorContext context) {
    biographyStore = (KeyValueStore<JsonObject, String>) context.getStateStore(
        TopologyProducer.BIOGRAPHY_STORE);
  }

  @Override
  public JsonObject transform(JsonObject key, JsonObject value) {
    // ...
  }
}
```

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    // ...
  }
}
```

Expanding Partial Update Events

Obtaining missing values from a state store

```
JsonObject payload = value.getJsonObject("payload");
JsonObject newRowState = payload.getJsonObject("after");
String biography = newRowState.getString("biography");

if (isUnavailableValueMarker(biography)) {
  String currentValue = biographyStore.get(key);
  newRowState = Json.createObjectBuilder(newRowState)
    .add("biography", currentValue)
    .build();
  // ...
}
else {
  biographyStore.put(key, biography);
}
return value;
```

Expanding Partial Update Events

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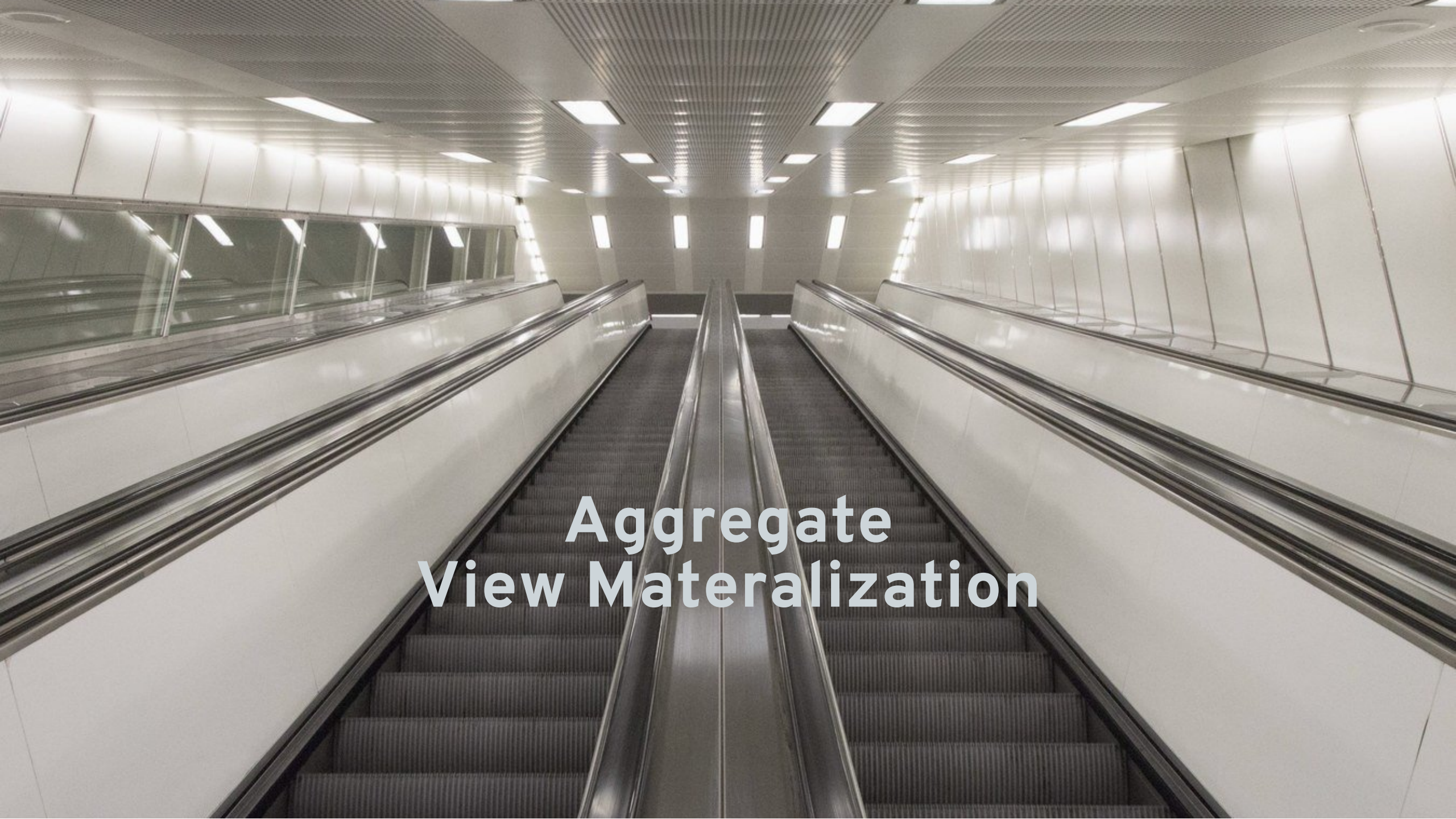
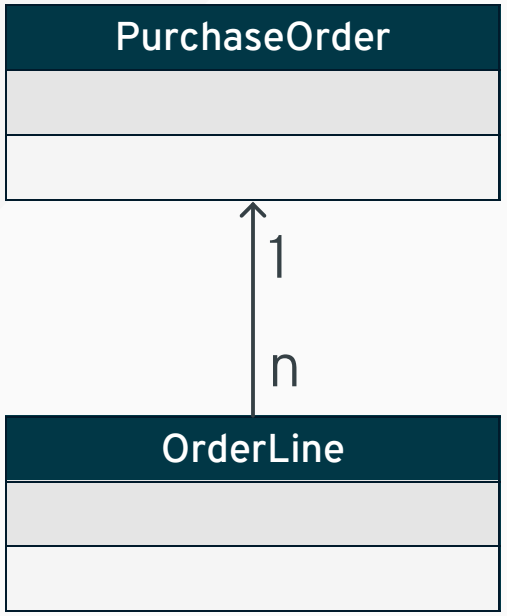
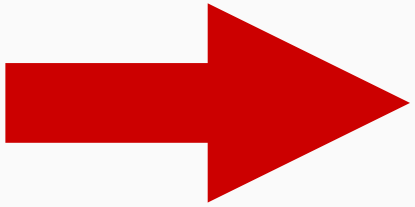


Aggregate View Materalization

Aggregate View Materialization

From Multiple Topics to One View





```
{
  "purchaseOrderId" : "order-123",
  "orderDate" : "2020-08-24",
  "customerId": "customer-123",
  "orderLines" : [
   {
     "orderLineId" : "orderLine-456",
     "productId" : "product-789",
     "quantity" : 2,
     "price" : 59.99
   },
   {
     "orderLineId" : "orderLine-234",
     "productId" : "product-567",
     "quantity" : 1,
     "price" : 14.99
   }
```

Aggregate View Materialization

Non-Key Joins (KIP-213)

```
KTable<Long, OrderLine> orderLines = ...;
KTable<Integer, PurchaseOrder> purchaseOrders = ...;

KTable<Integer, PurchaseOrderWithLines> purchaseOrdersWithOrderLines = orderLines
  .join(
    purchaseOrders,
    orderLine -> orderLine.purchaseOrderId,
    (orderLine, purchaseOrder) -> new OrderLineAndPurchaseOrder(orderLine, purchaseOrder))
  .groupBy(
    (orderLineId, lineAndOrder) -> KeyValue.pair(lineAndOrder.purchaseOrder.id, lineAndOrder))
  .aggregate(
    PurchaseOrderWithLines::new,
    (Integer key, OrderLineAndPurchaseOrder value, PurchaseOrderWithLines agg) -> agg.addLine(value),
    (Integer key, OrderLineAndPurchaseOrder value, PurchaseOrderWithLines agg) -> agg.removeLine(value)
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```

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```
KTable<Long, OrderLine> orderLines = ...;
KTable<Integer, PurchaseOrder> purchaseOrders = ...;

KTable<Integer, PurchaseOrderWithLines> purchaseOrdersWithOrderLines = orderLines
  .join(
    purchaseOrders,
    orderLine -> orderLine.purchaseOrderId,
    (orderLine, purchaseOrder) -> new OrderLineAndPurchaseOrder(orderLine, purchaseOrder))
  .groupBy(
    (orderLineId, lineAndOrder) -> KeyValue.pair(lineAndOrder.purchaseOrder.id, lineAndOrder))
  .aggregate(
    PurchaseOrderWithLines::new,
    (Integer key, OrderLineAndPurchaseOrder value, PurchaseOrderWithLines agg) -> agg.addLine(value),
    (Integer key, OrderLineAndPurchaseOrder value, PurchaseOrderWithLines agg) -> agg.removeLine(value)
   );
```

Aggregate View Materialization

Awareness of Transaction Boundaries

- TX metadata in change events (e.g. dbserver1.inventory.orderline)

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

Aggregate View Materialization

Awareness of Transaction Boundaries

- Topic with **BEGIN/END markers**
- Enable consumers to buffer all events of one transaction

```
{
  "transactionId" : "571",
  "eventType" : "begin transaction",
  "ts_ms": 1486500577125
}
```

BEGIN

```
{
  "transactionId" : "571",
  "ts_ms": 1486500577691,
  "eventType" : "end transaction",
  "eventCount" : [
    {
      "name" : "dbserver1.inventory.order",
      "count" : 1
    },
    {
      "name" : "dbserver1.inventory.orderLine",
      "count" : 5
    }
  ]
}
```

END

Takeaways

Many Use Cases for Debezium and Kafka Streams

- Data **enrichment**
- Creating **aggregated events**
- **Stream queries**
- **Interactive query** services for legacy databases

Takeaways

Many Use Cases for Debezium and Kafka Streams

- Data **enrichment**
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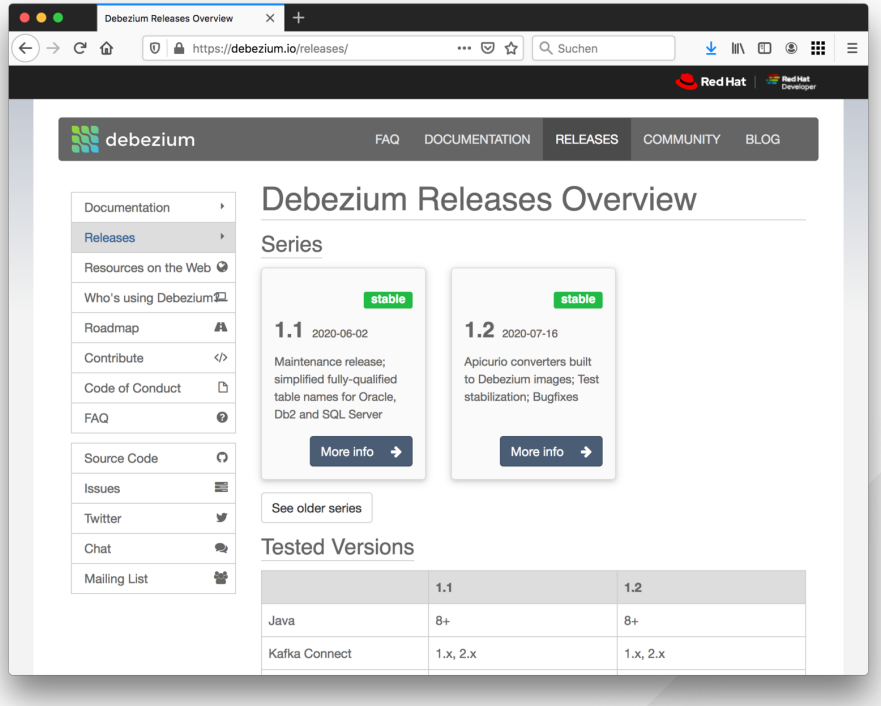
- **Stream queries**
- **Interactive query** services for legacy databases

Debezium + Kafka Streams = ❤️

Resources

- **Website:** debezium.io
- **Examples:** github.com/debezium/debezium-examples/
- **Latest news:** @debezium



Q&A

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