Building event-driven (Micro)Services with Apache Kafka

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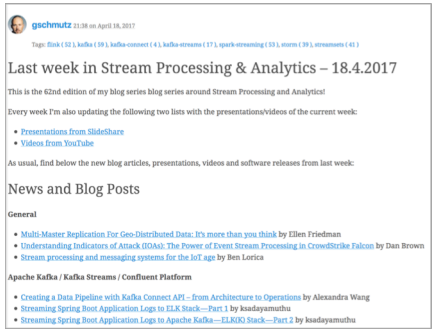

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Agenda

1. Where do we come from?
2. Using Microservices
3. Can we do (even) better?
4. Kafka for Event-Driven (Micro)Services
5. What about streaming sources?
6. What about integrating legacy applications?
7. What about (historical) data analytics?
8. Summary

Where do we come from?

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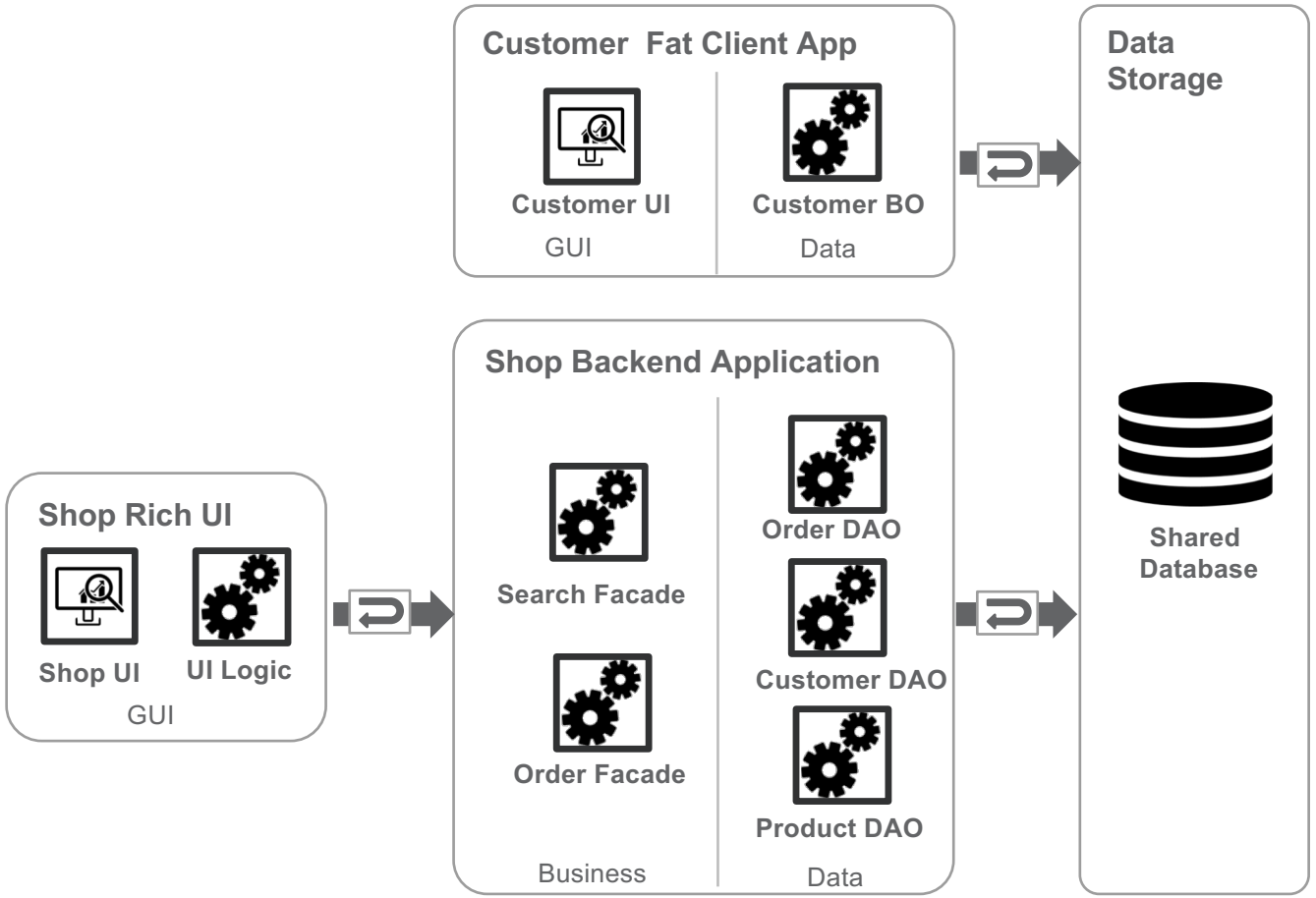
Traditional Approach



sync request/response

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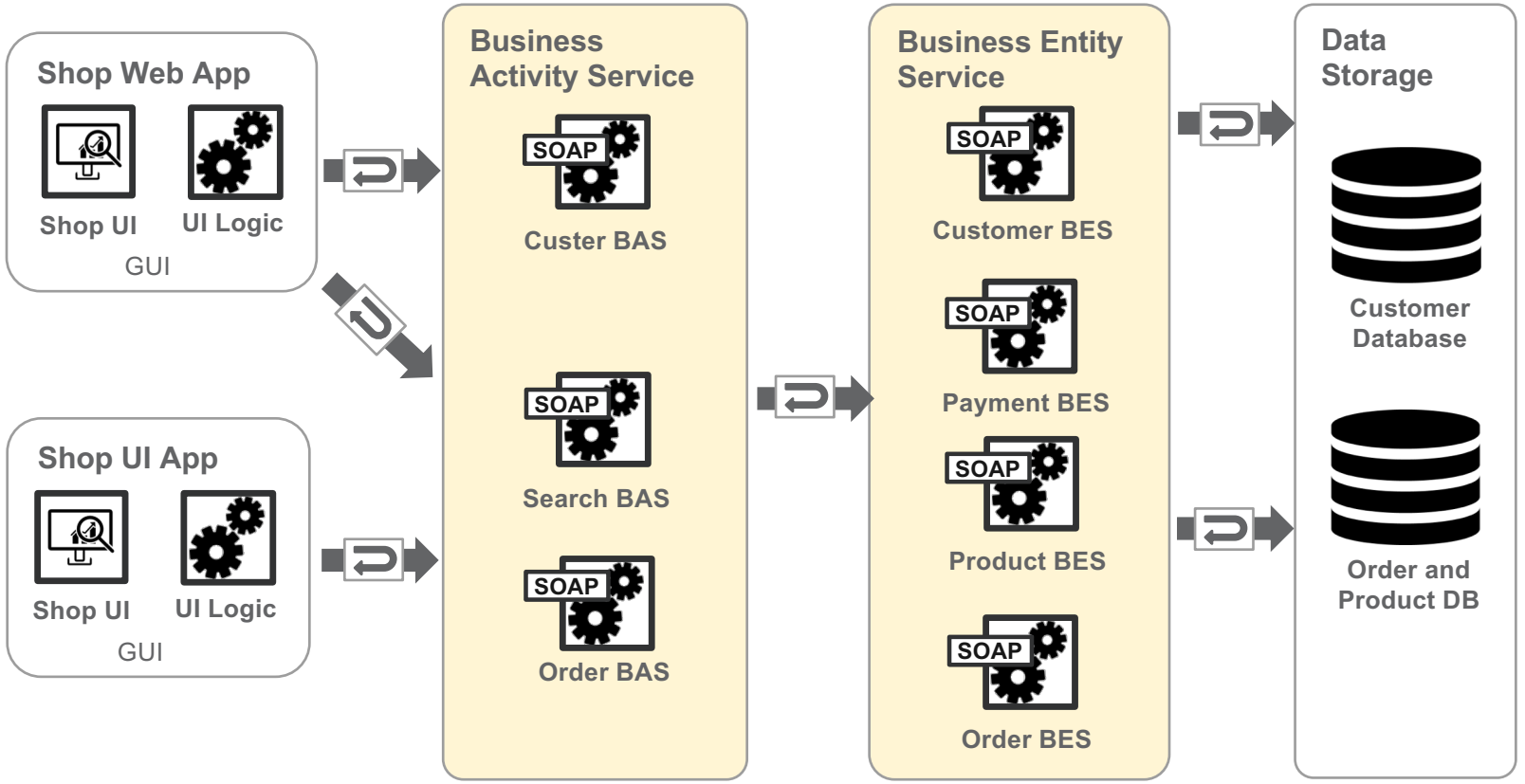
SOA Approach

Contract-first Web Services

Technical layers offer their own interfaces

Reuse on each level

Lower layer often wraps legacy code



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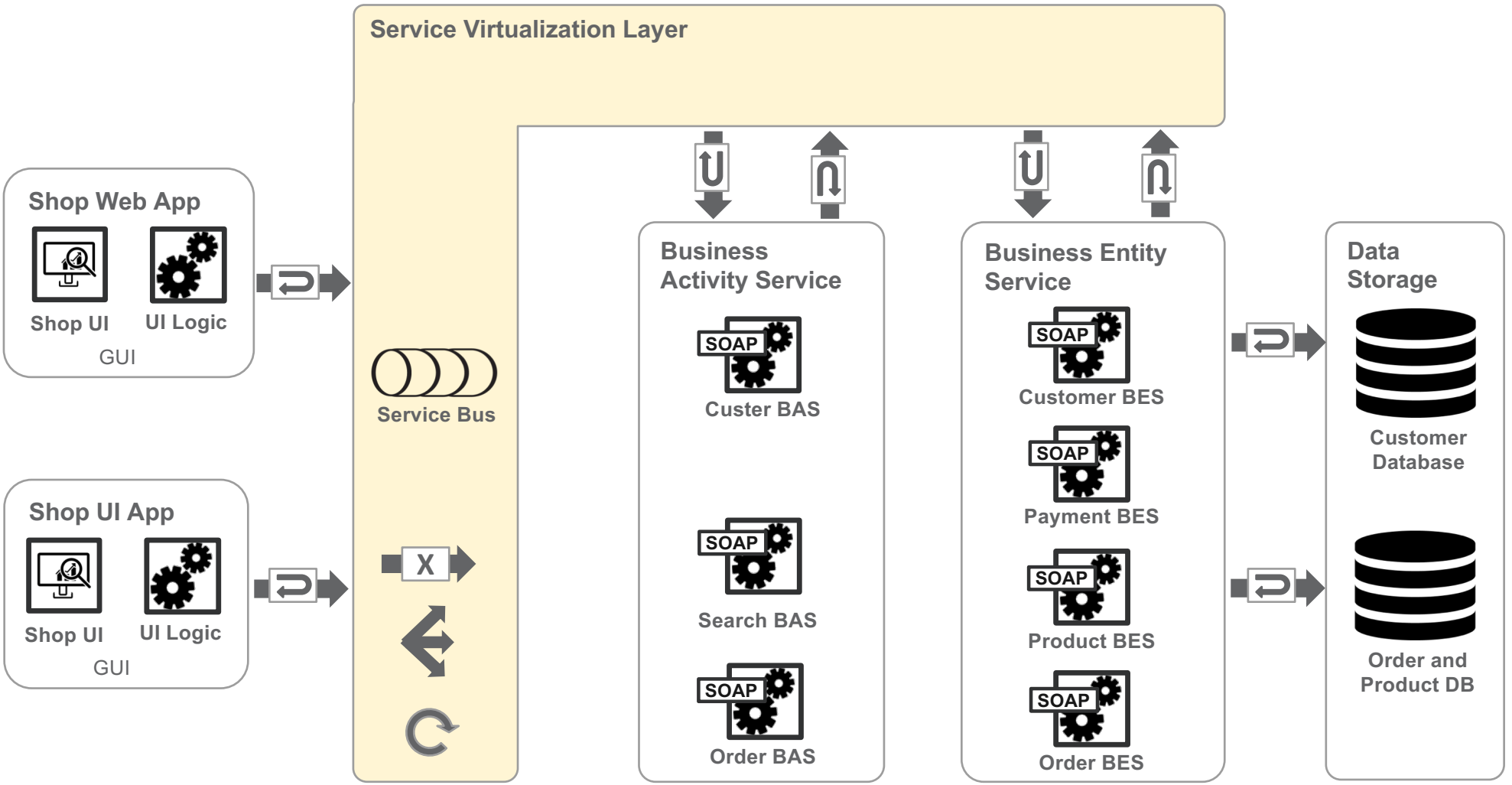
Virtualized SOA Approach



Using Microservices

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Microservice Approach

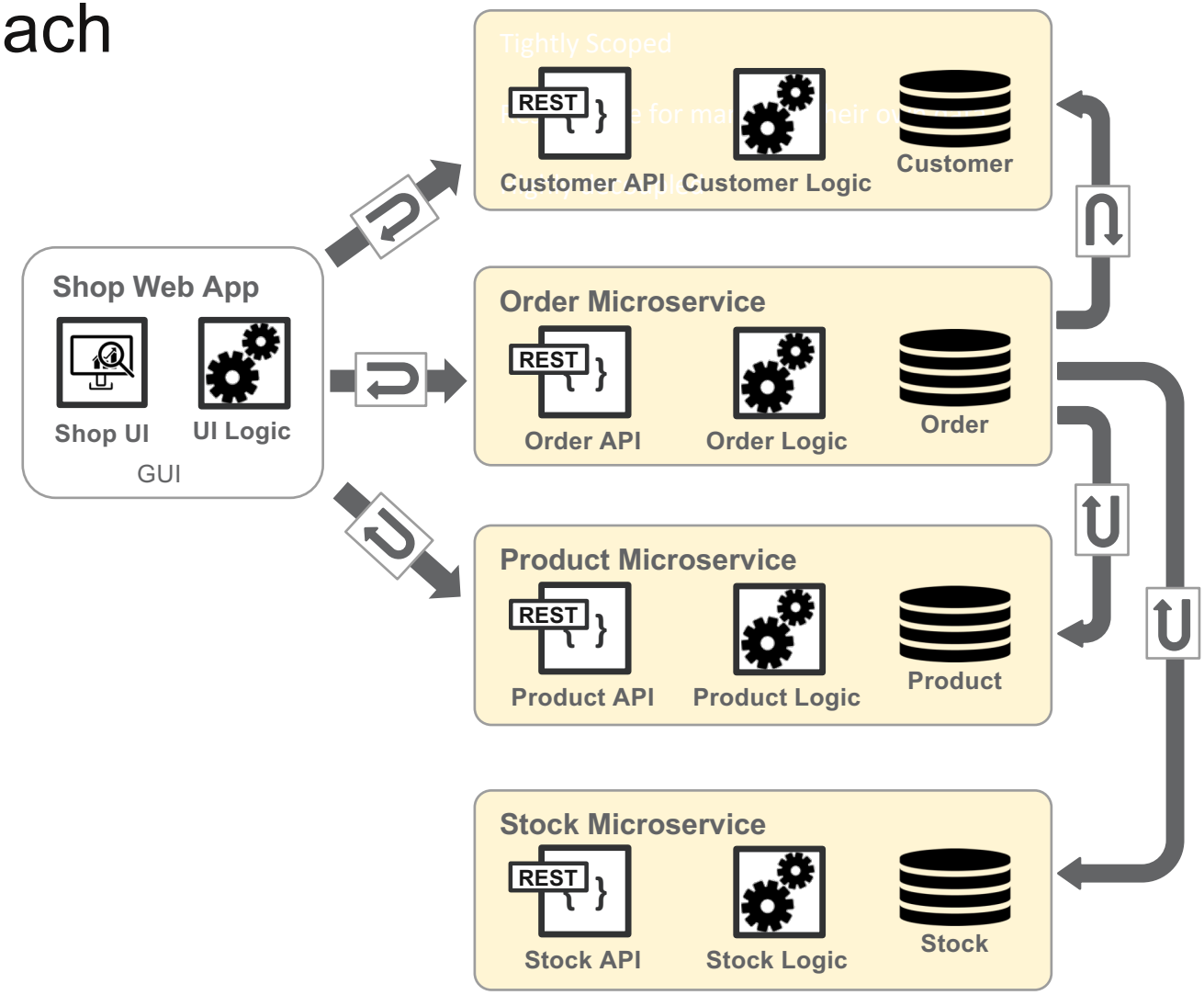
Tightly Scoped behind clear interfaces

Responsible for managing their own data (not necessarily the infrastructure)

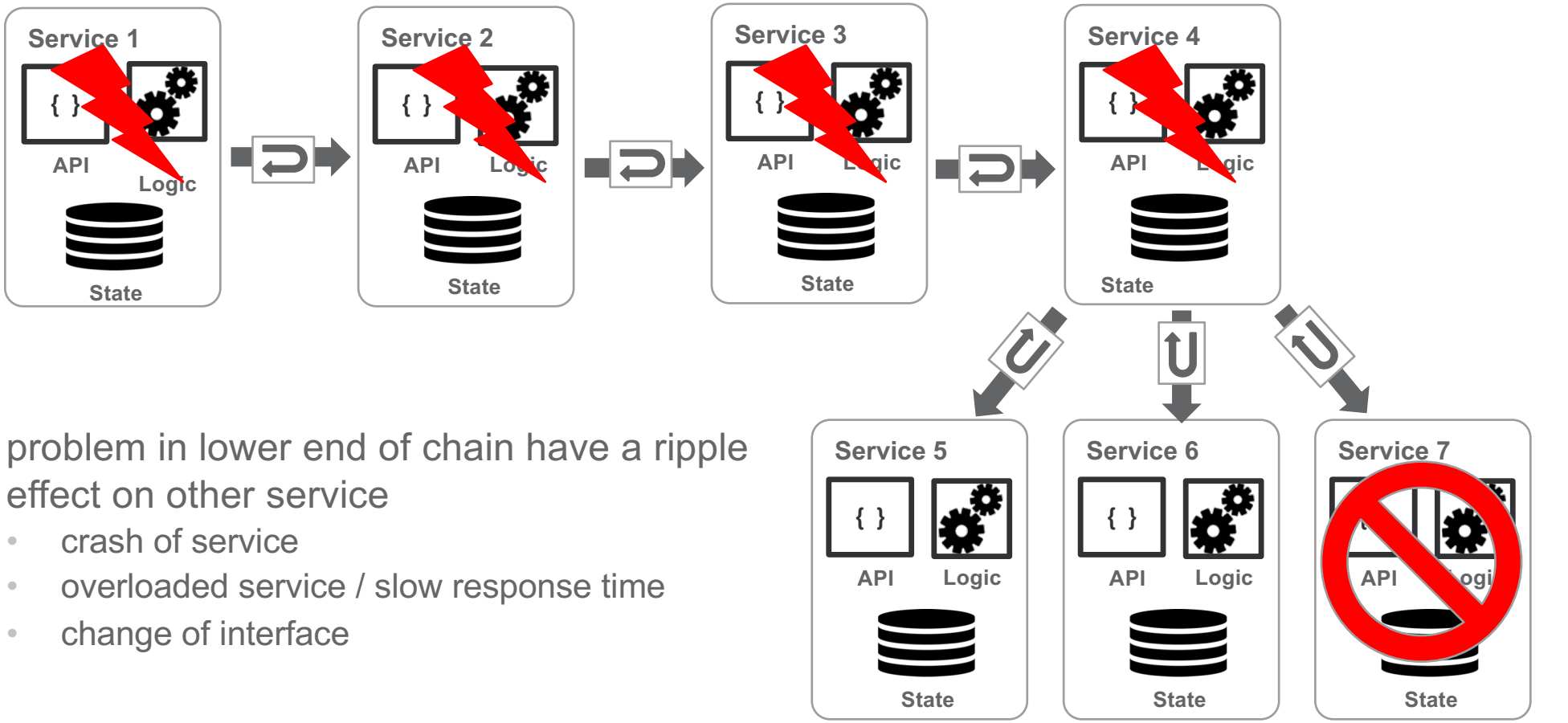
Should be highly decoupled

Independently deployable, self-contained and autonomous

SOA done right ?!



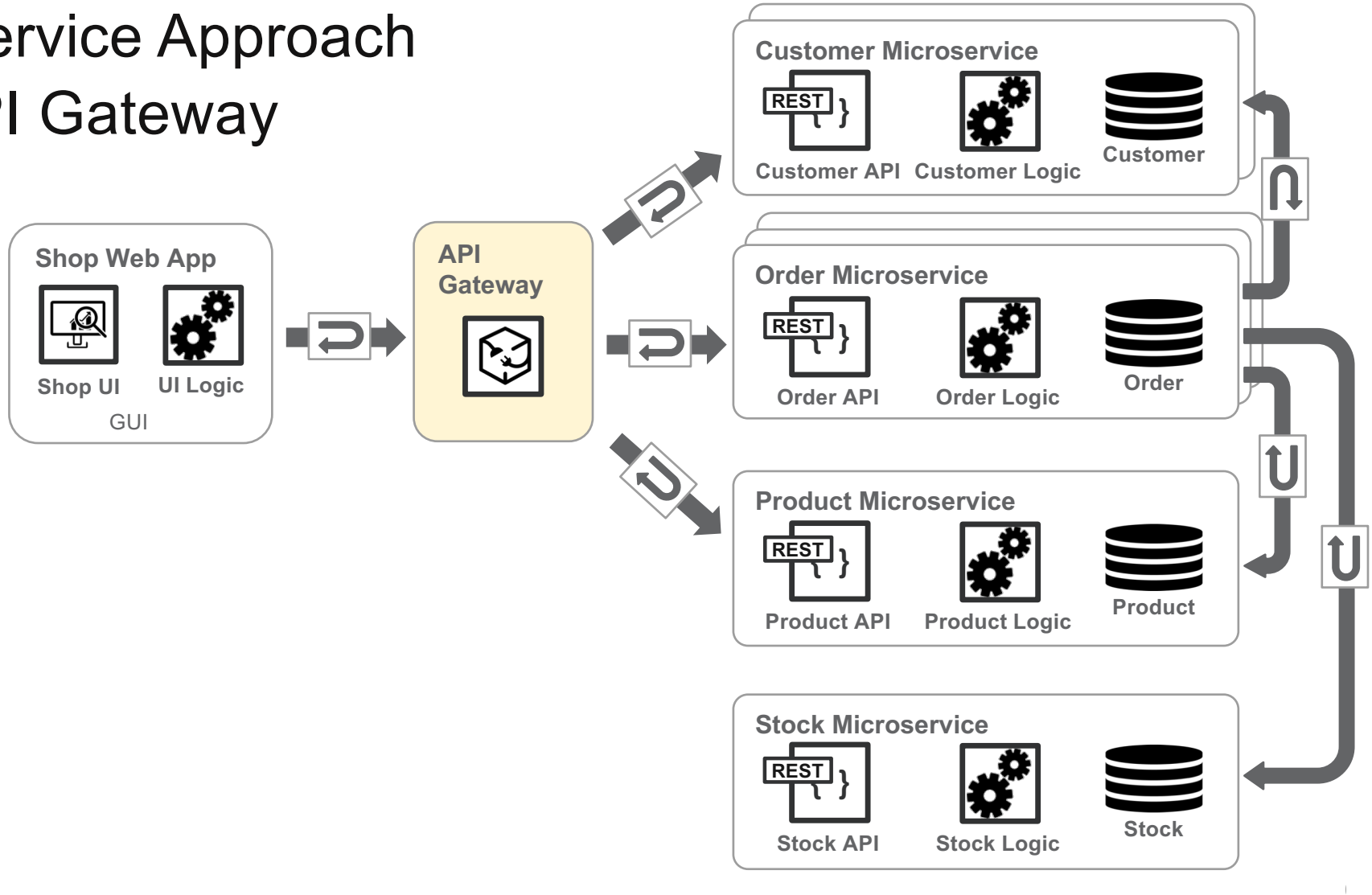
Synchronous World of Request-Response leads to tight, point-to-point couplings



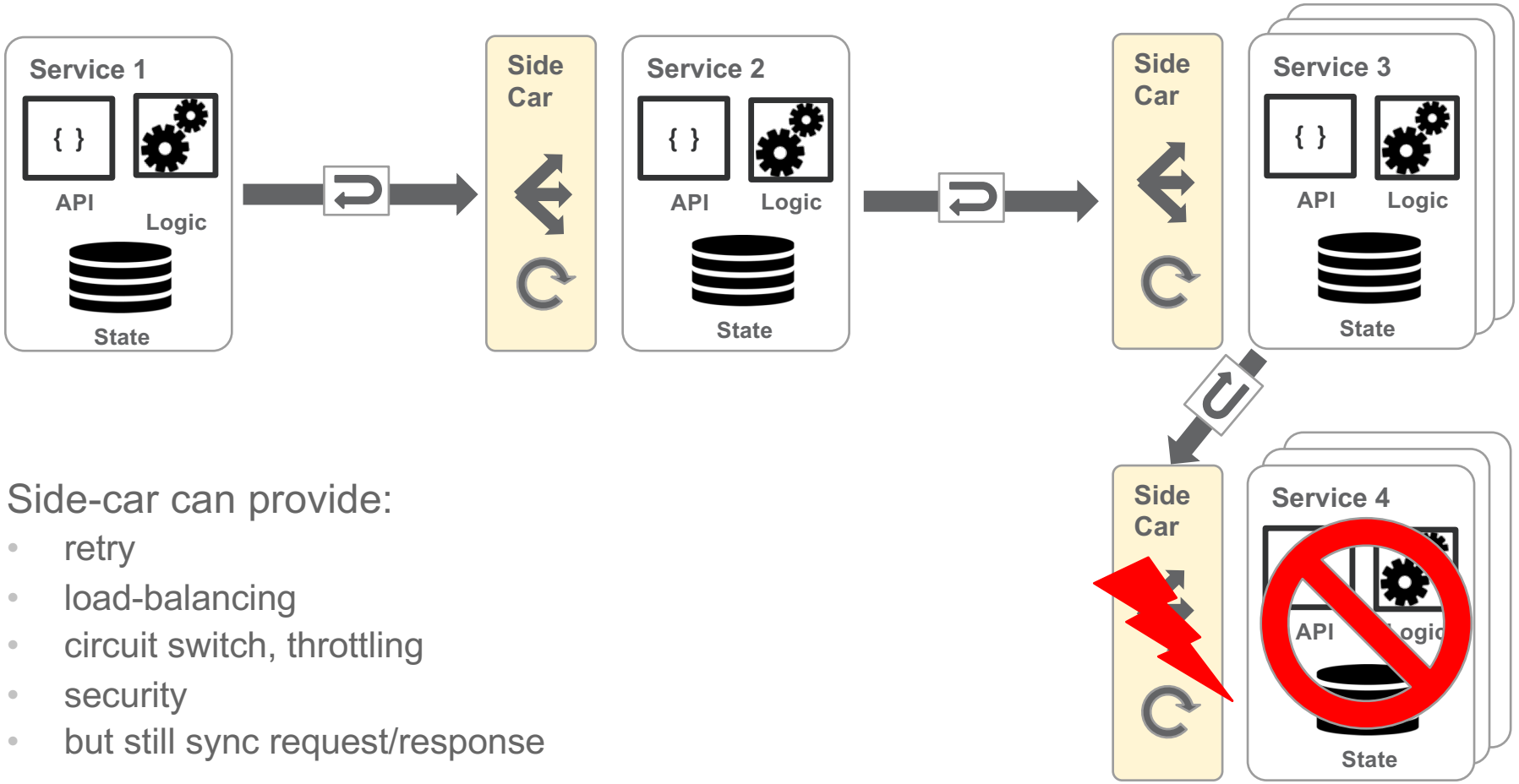
problem in lower end of chain have a ripple effect on other service

- crash of service
- overloaded service / slow response time
- change of interface

Microservice Approach with API Gateway



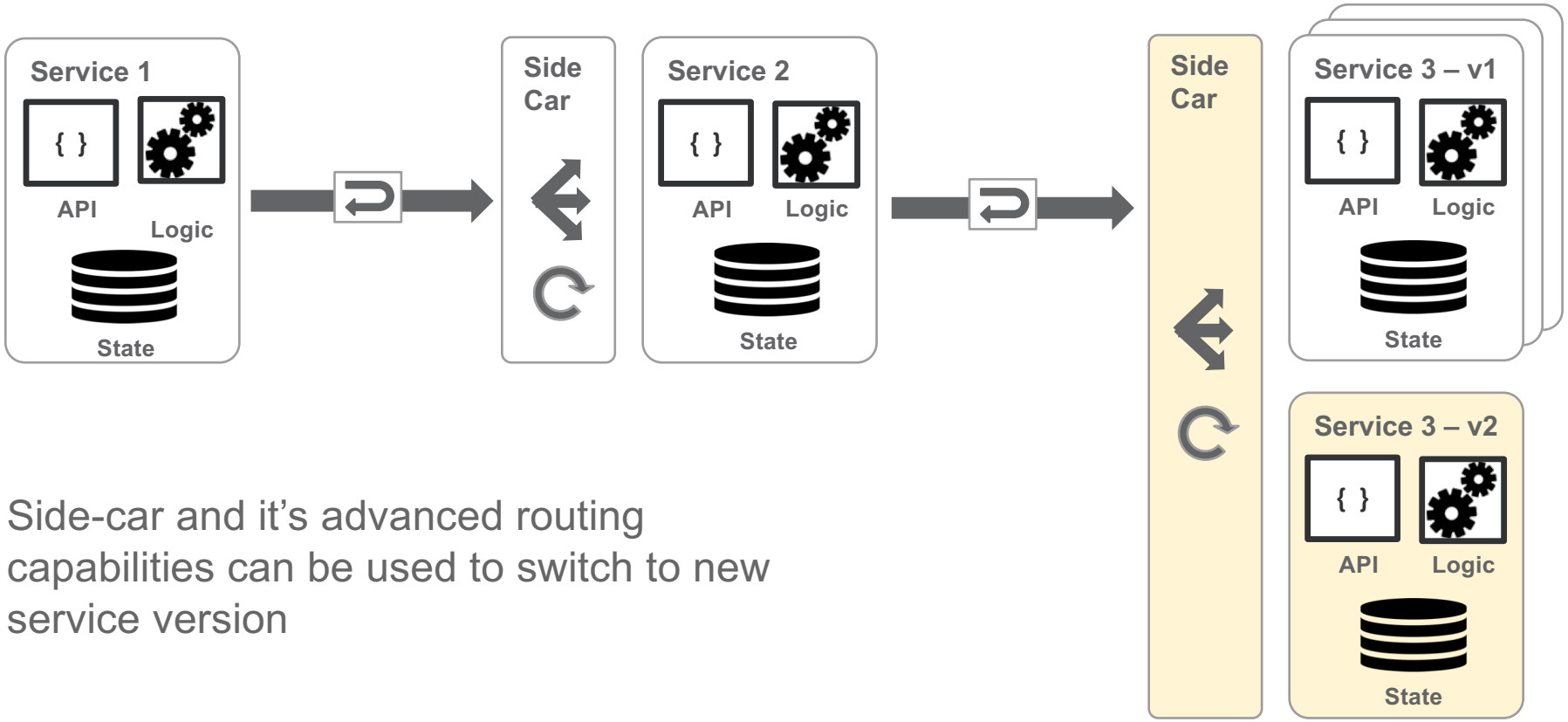
Microservice Approach with Side Car (i.e. K8s & Istio)



Side-car can provide:

- retry
- load-balancing
- circuit switch, throttling
- security
- but still sync request/response

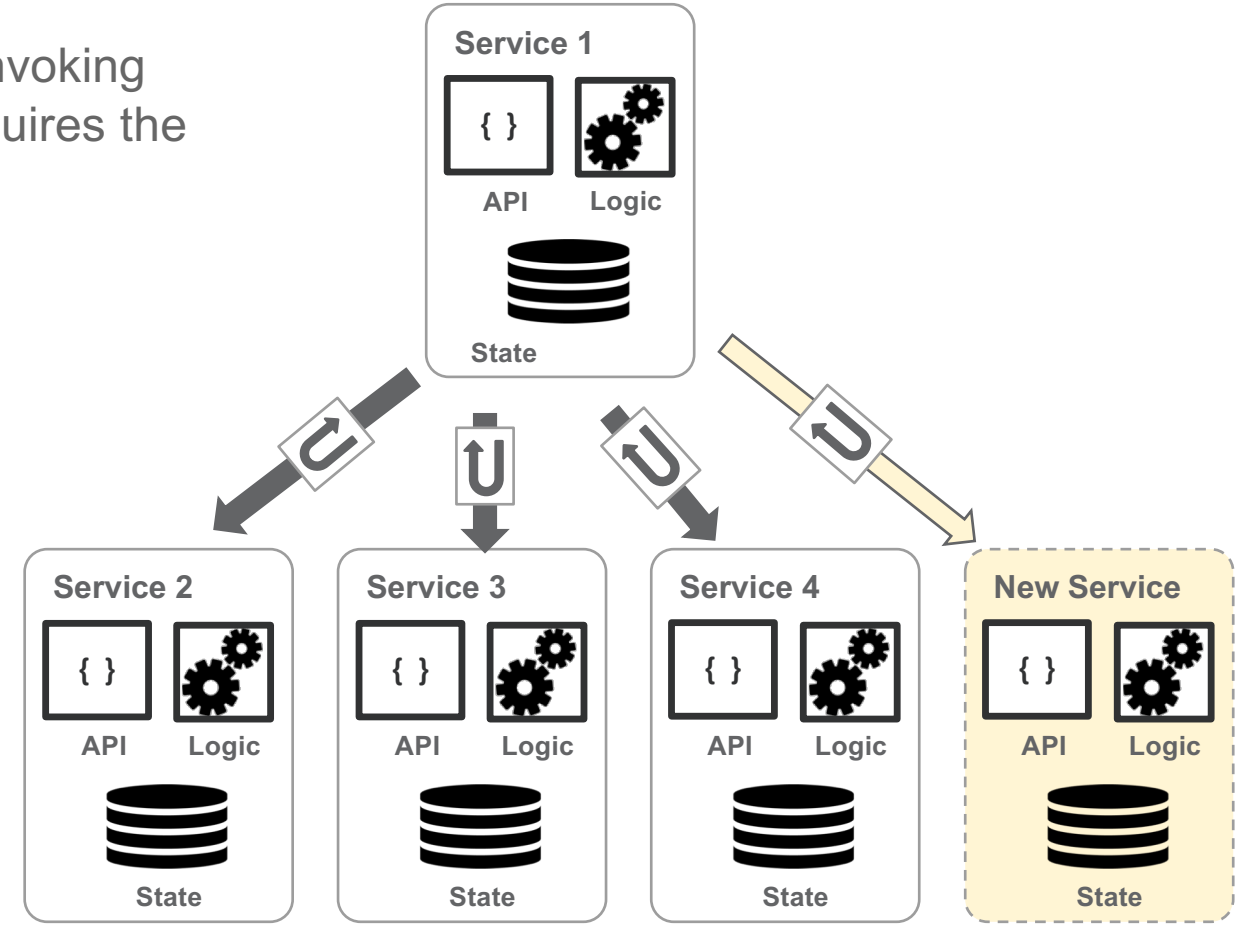
Microservice Approach with Side Car (i.e. K8s & Istio)



Side-car and it's advanced routing capabilities can be used to switch to new service version

Side Car provides abstraction ….

but we still have to change the invoking service …. If another service requires the same information



Can we do (even) better?

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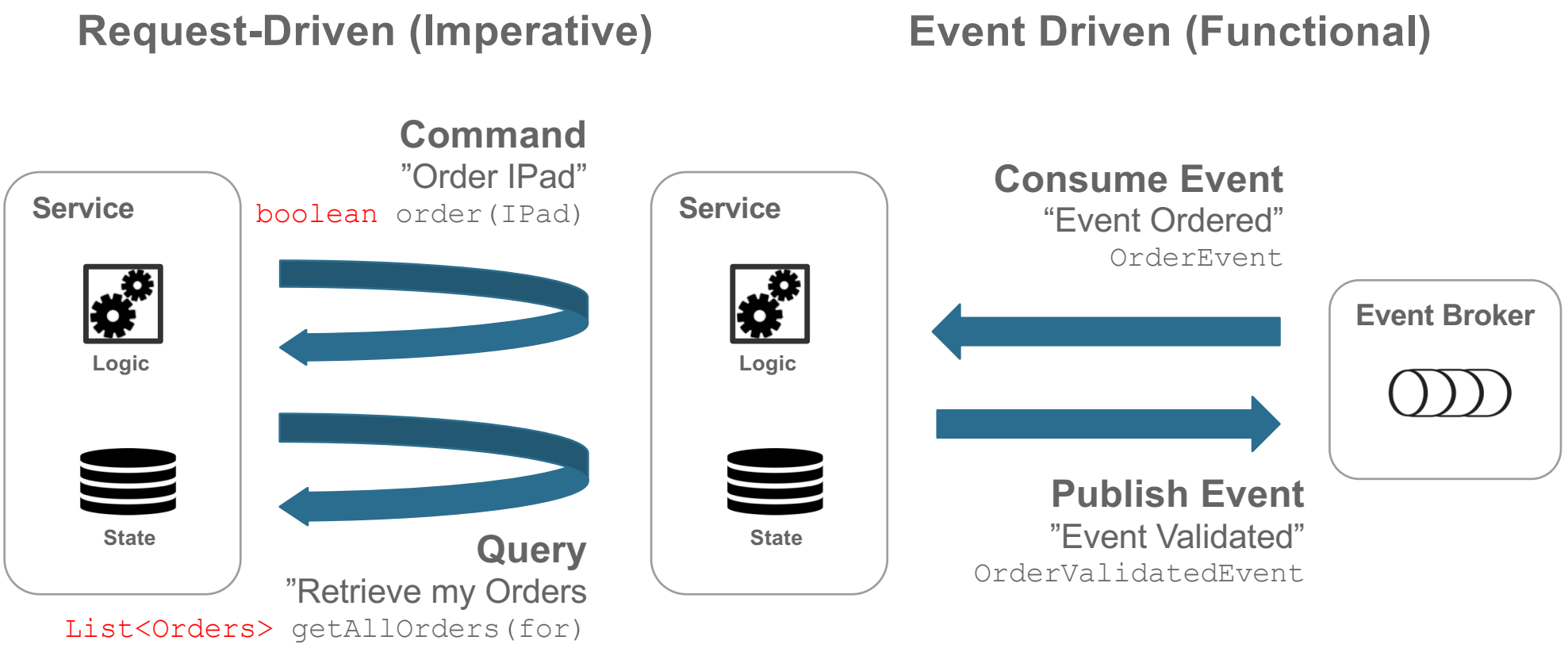
Three mechanisms through which services can interact



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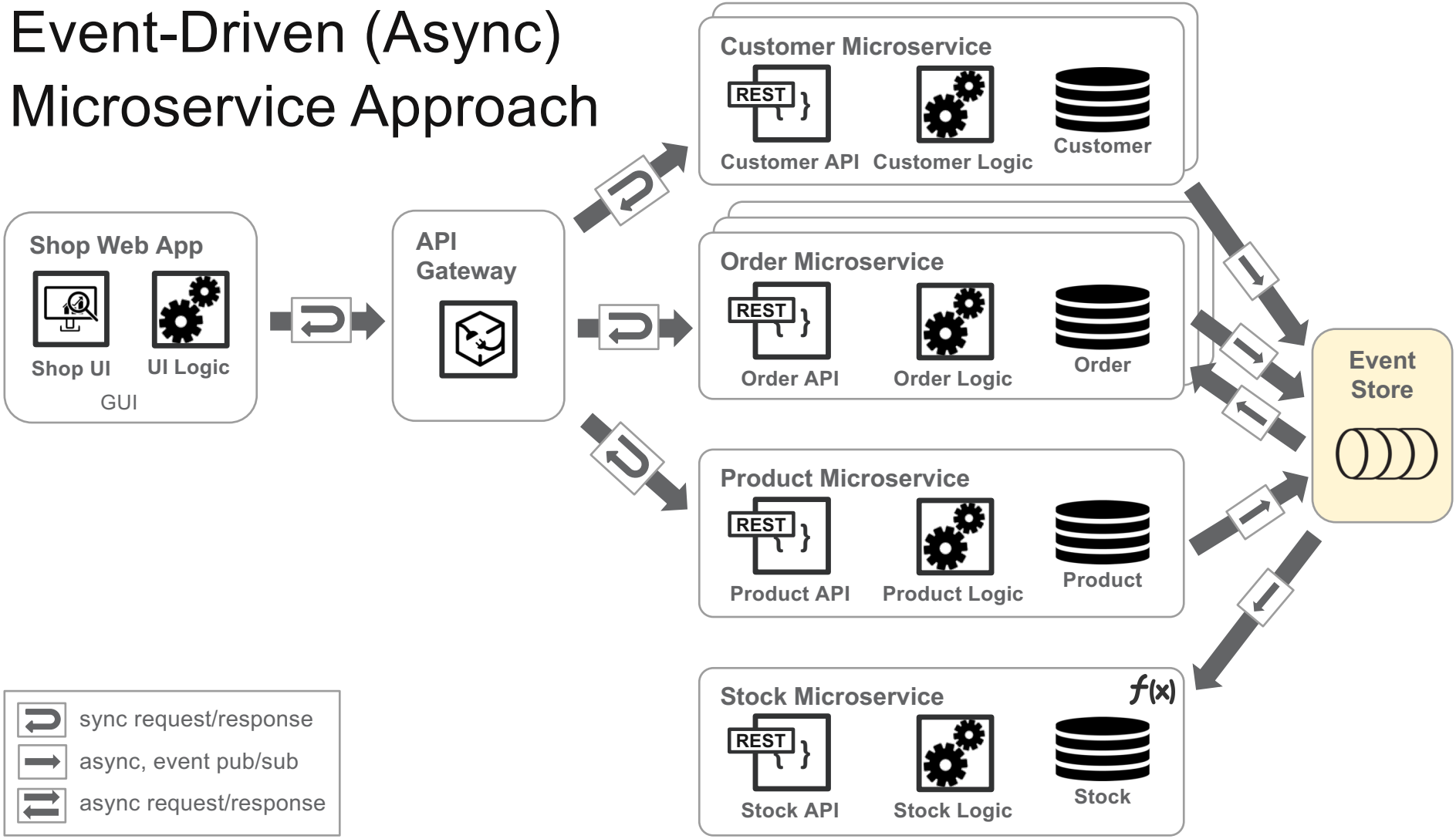
Event-Driven (Async) Microservice Approach



Kafka for Event-Driven (Micro)Services

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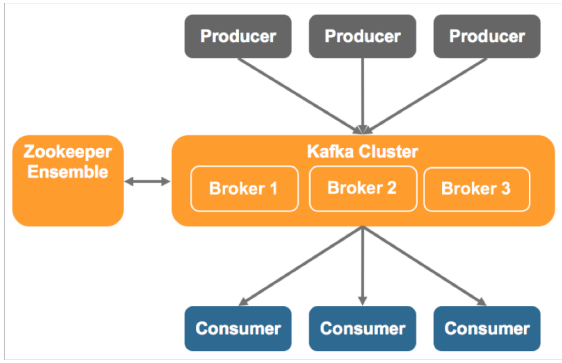
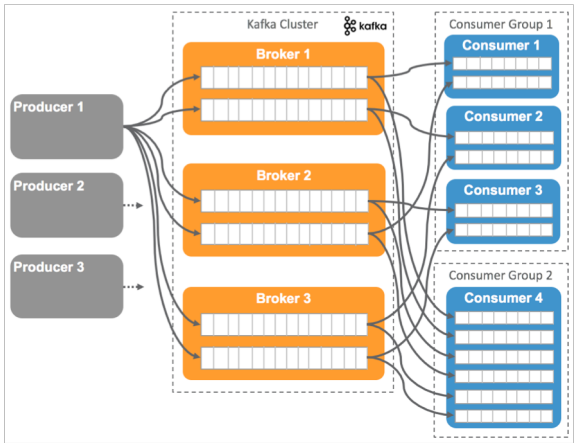
Apache Kafka – A Streaming Platform

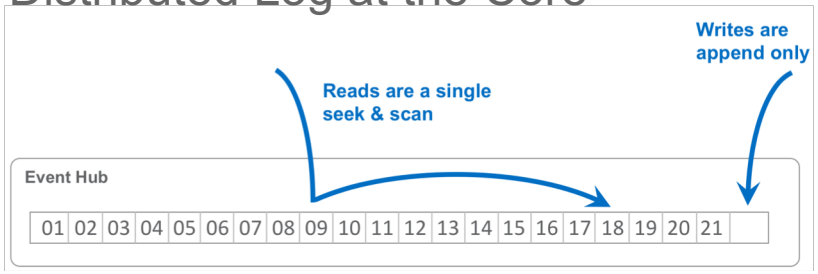
High-Level Architecture



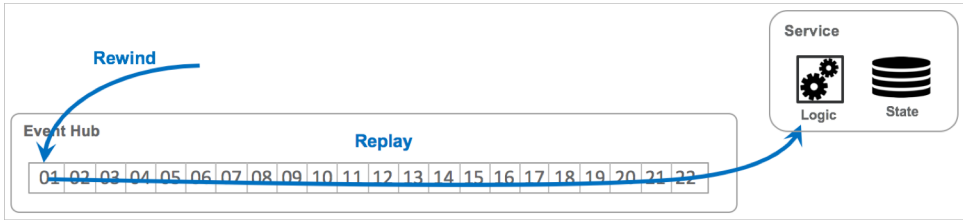
Scale-Out Architecture



Distributed Log at the Core



Logs do not (necessarily) forget



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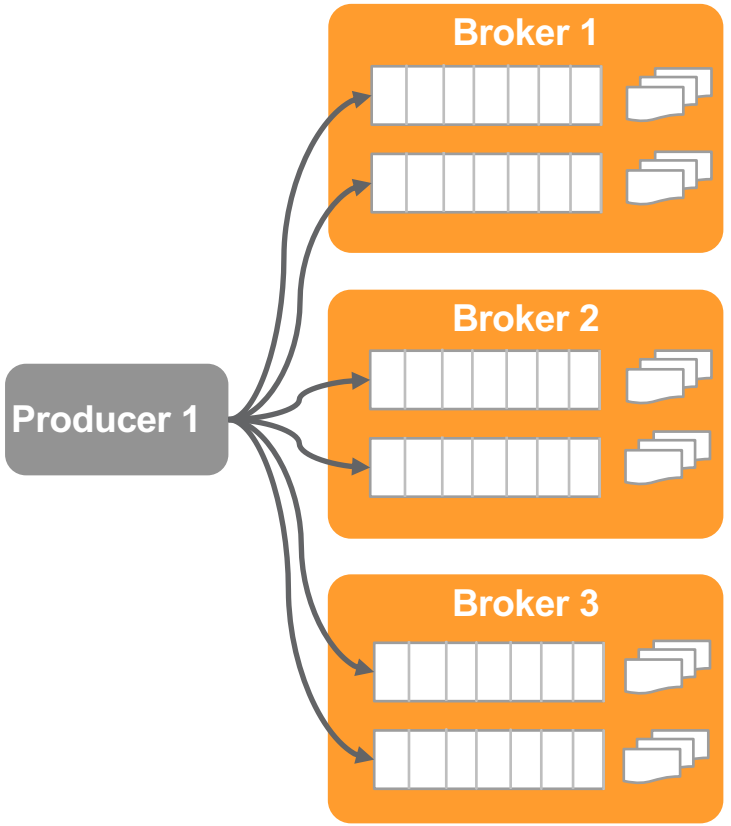
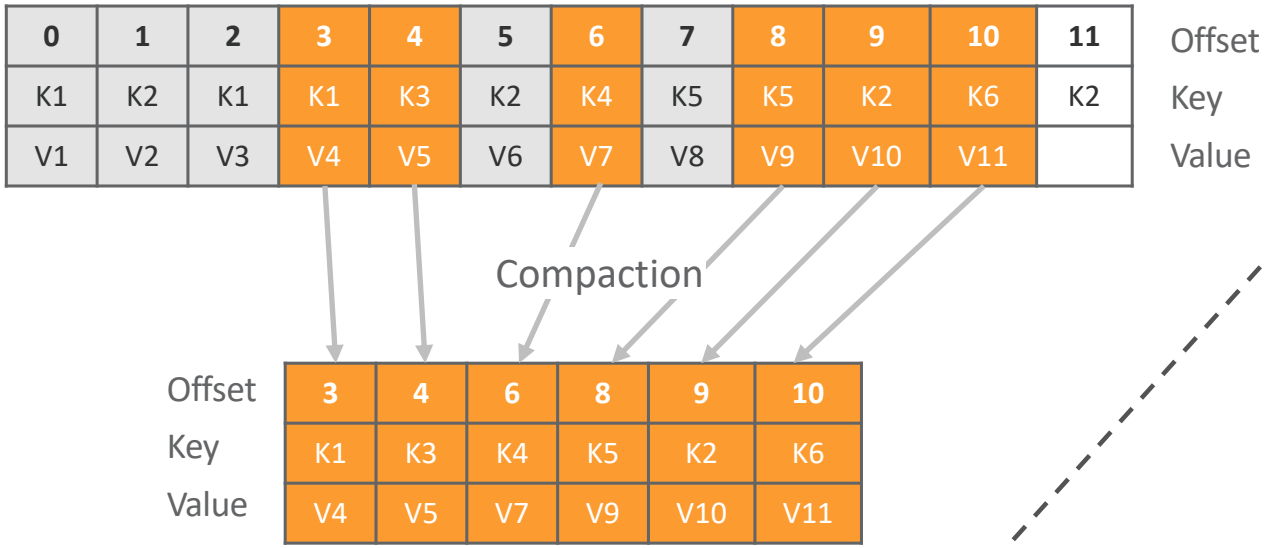
Hold Data for Long-Term – Data Retention

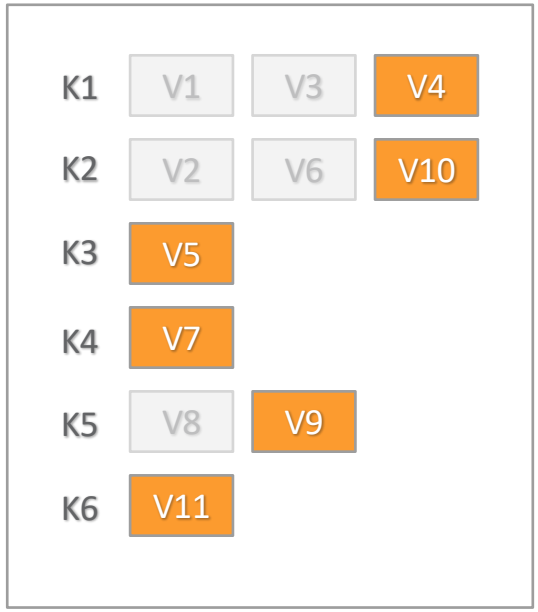
1. Never
2. Time based (TTL)
   `log.retention.{ms | minutes | hours}`
3. Size based
   `log.retention.bytes`
4. Log compaction based
   (entries with same key are removed):

```
kafka-topics.sh --zookeeper zk:2181 \
                --create --topic customers \
                --replication-factor 1 \
                --partitions 1 \
                --config cleanup.policy=compact
```



Keep Topics in Compacted Form





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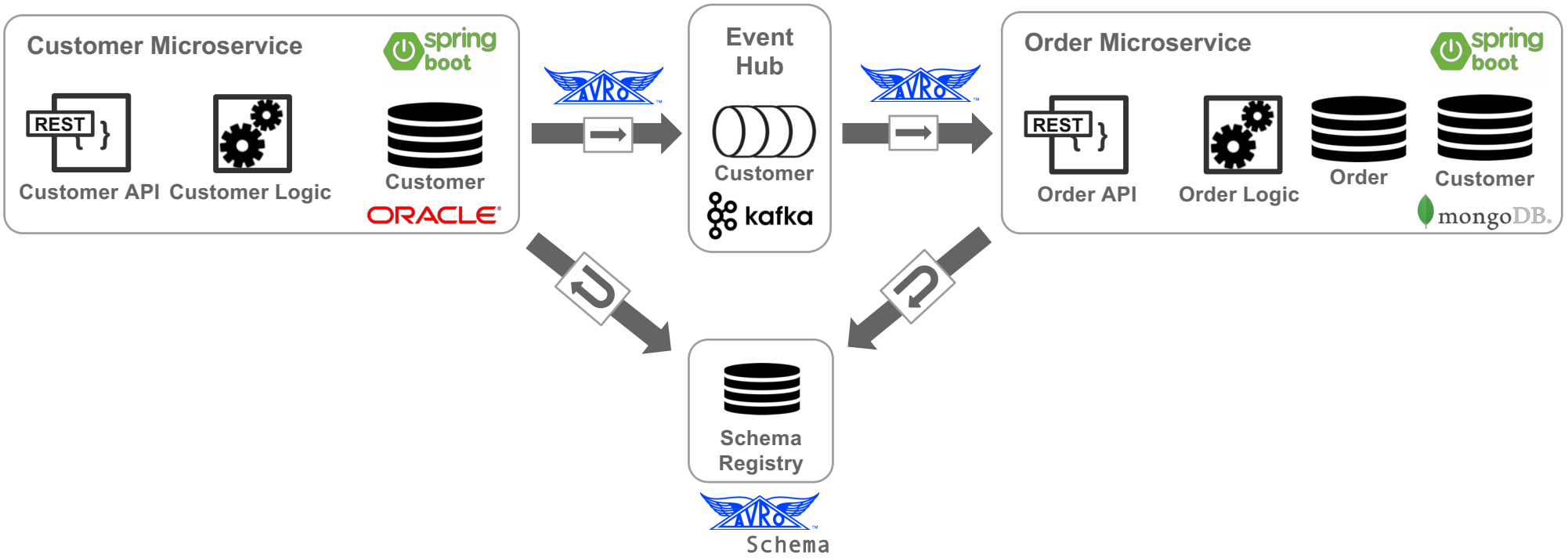
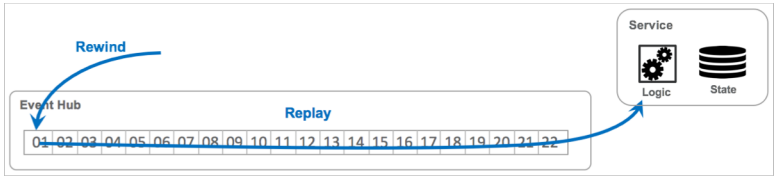
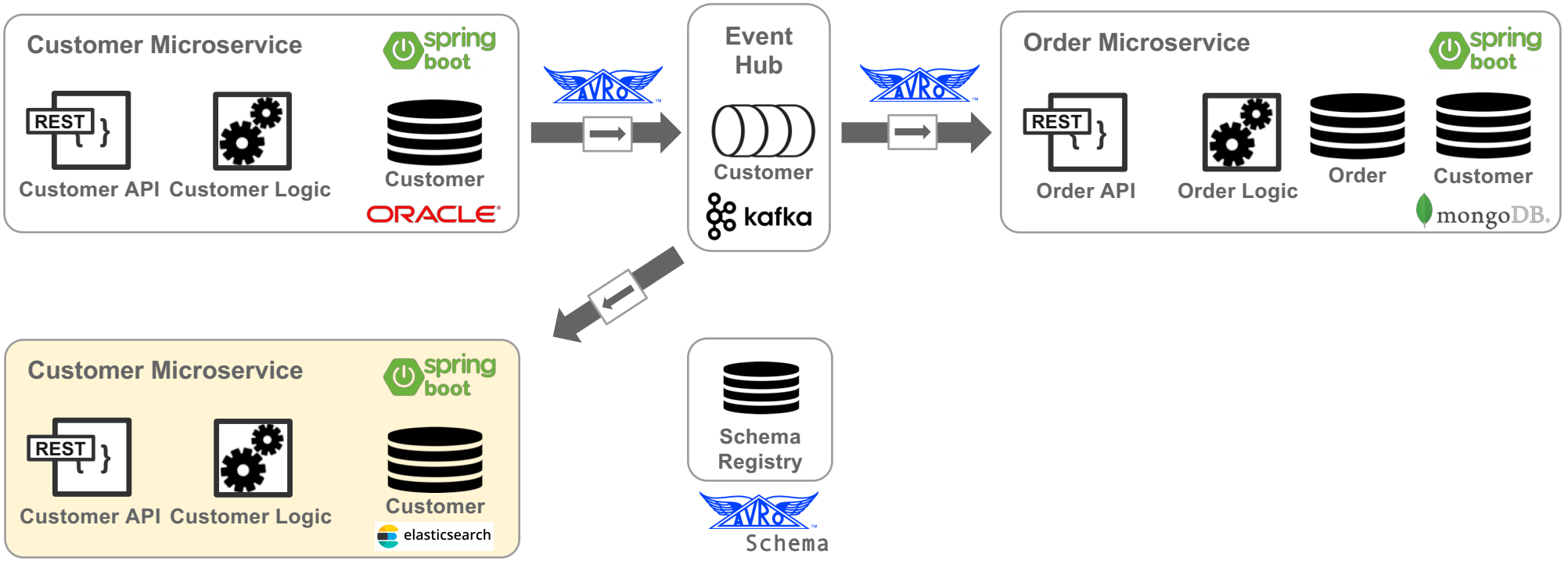
Demo



https://github.com/gschmutz/various-demos/tree/master/event-driven-microservices

Adding a new service by bootstrapping from Event Hub





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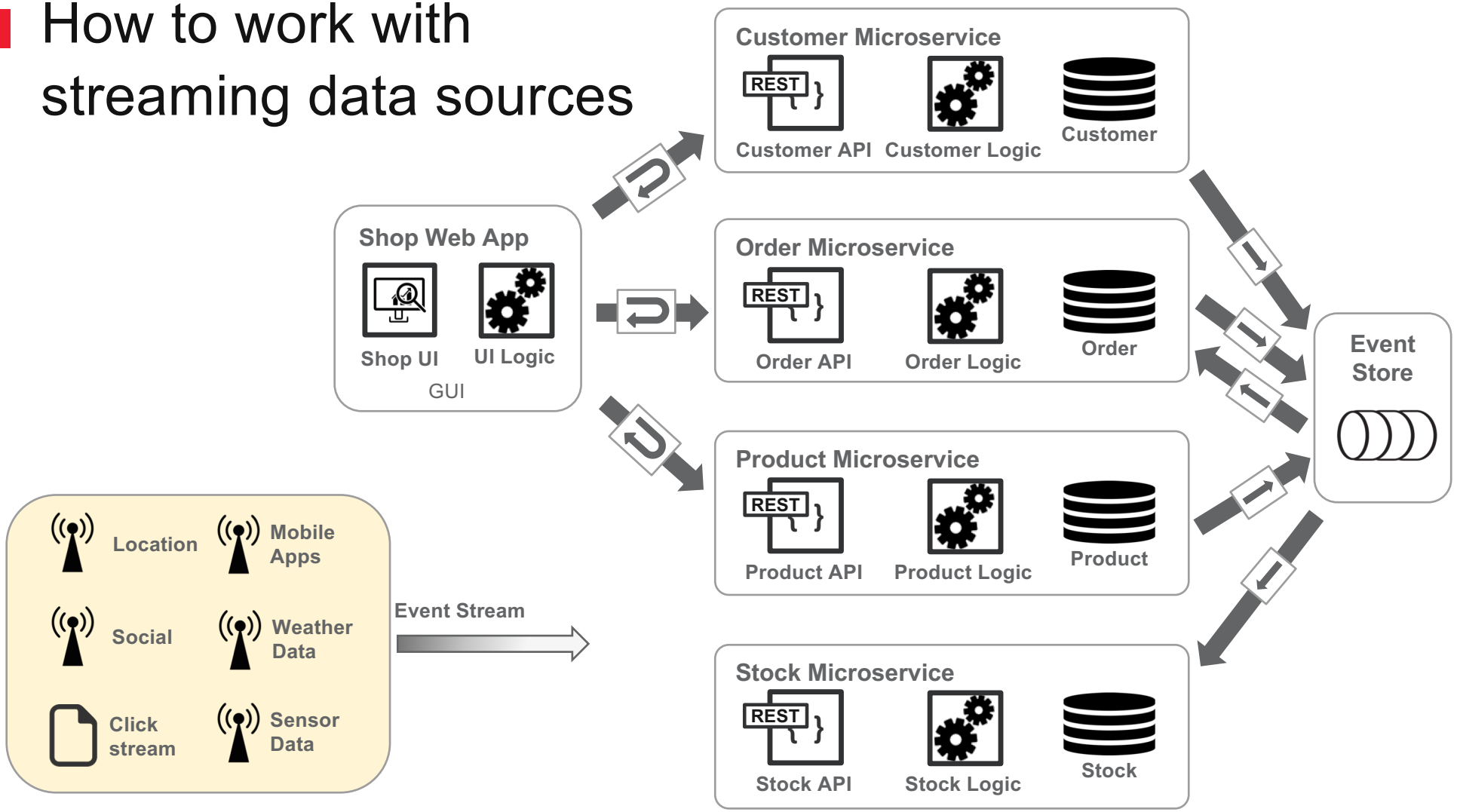
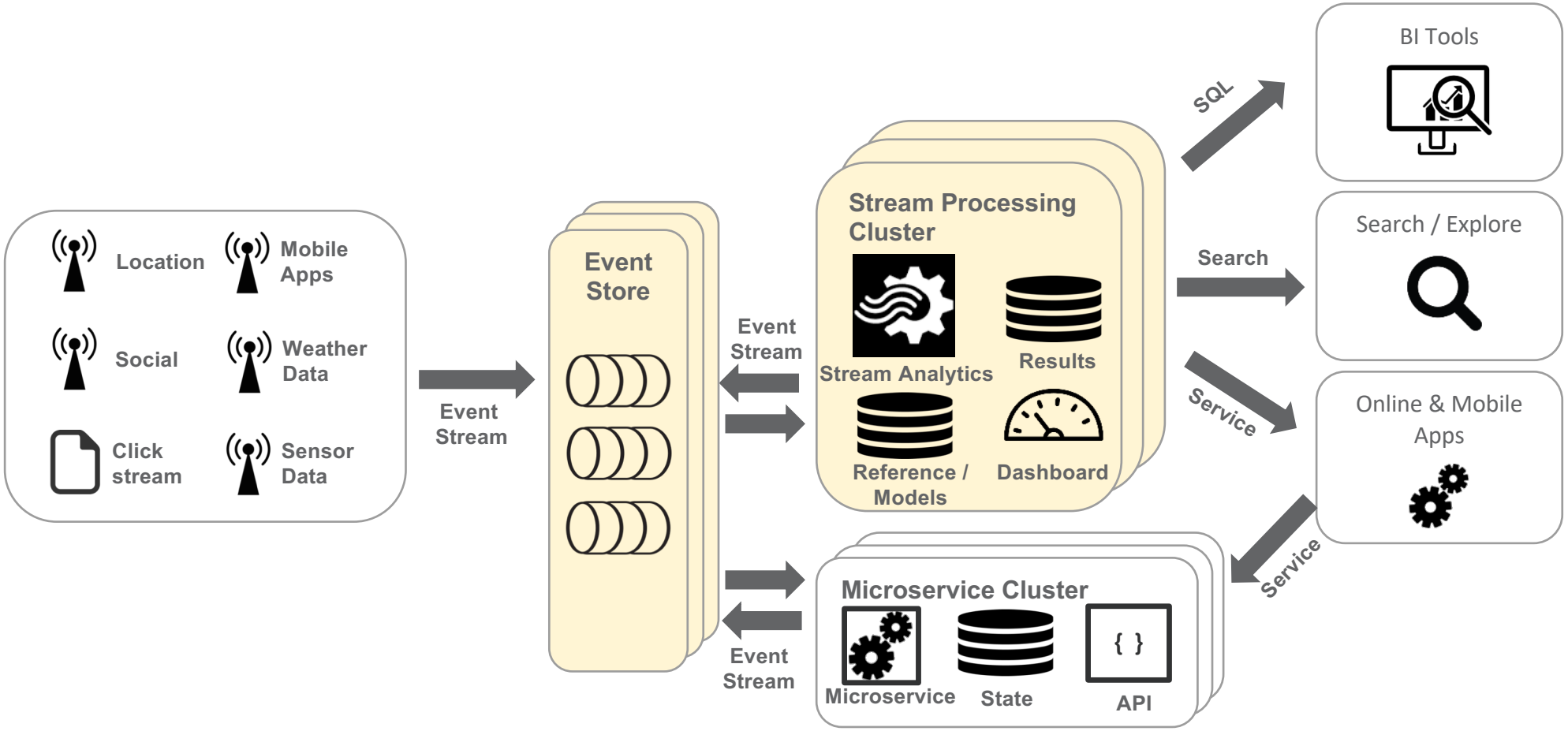
What about streaming sources?

How to work with streaming data sources



Streaming Processing & Microservices Architecture



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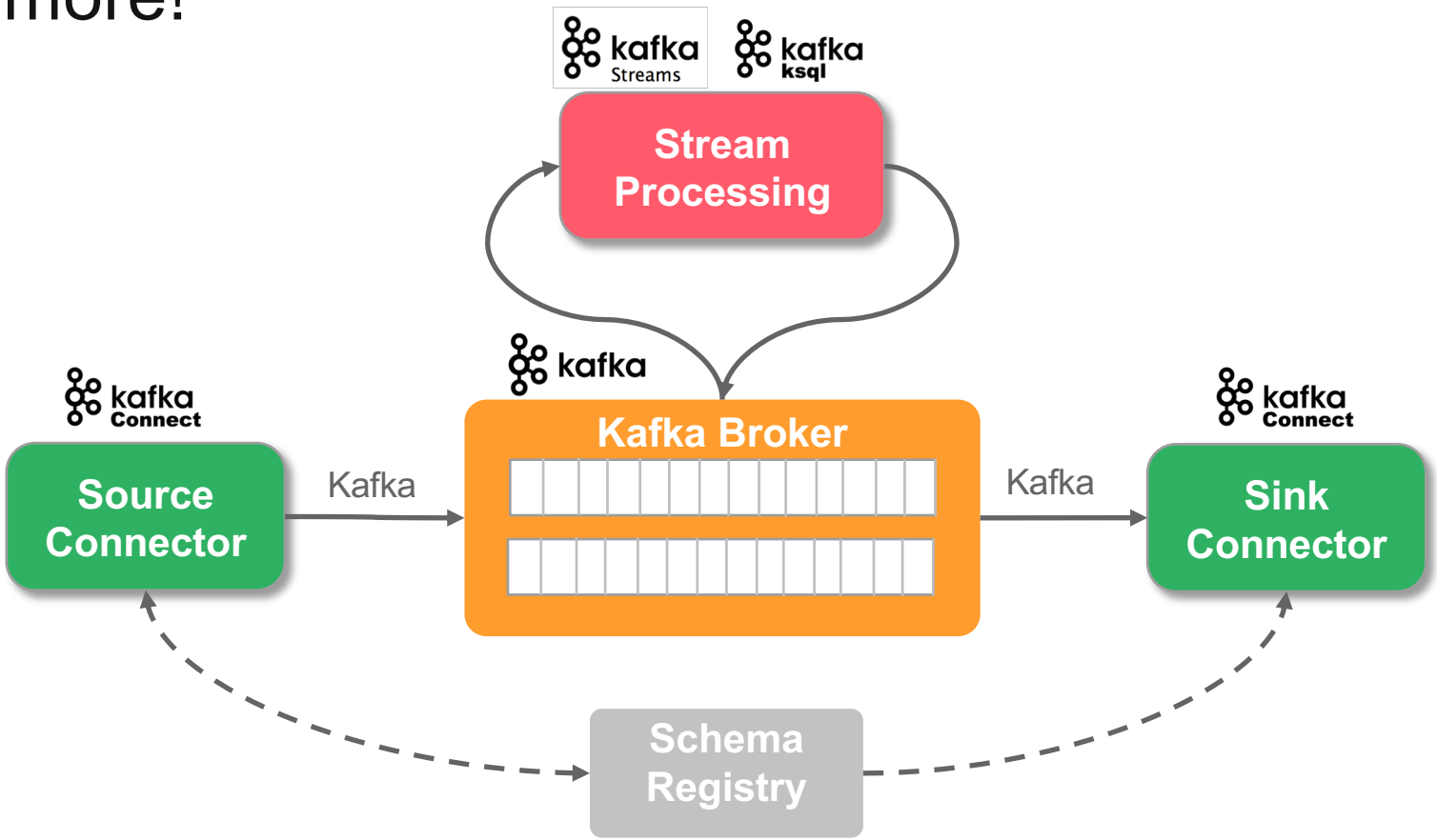
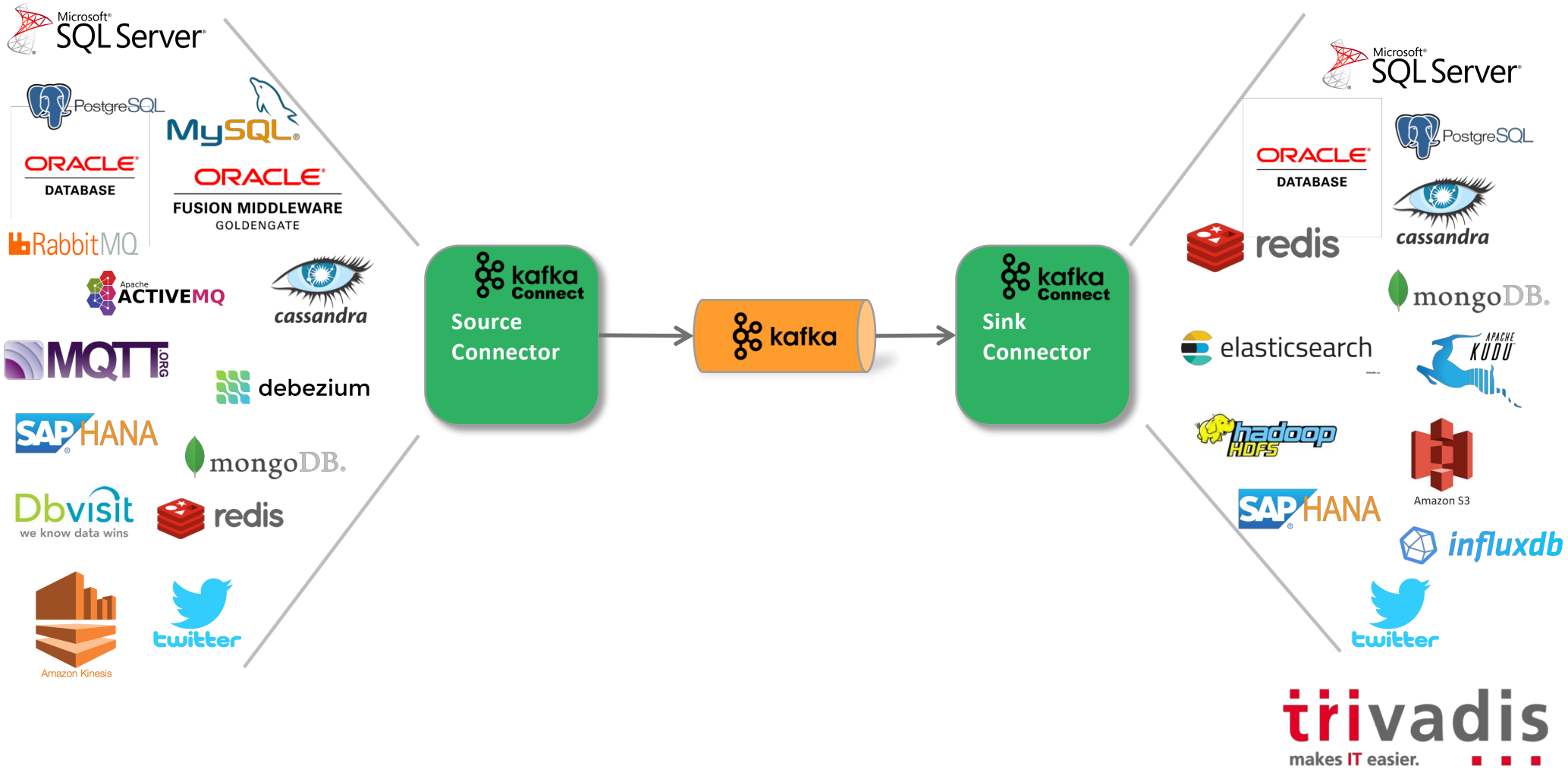
- Apache Kafka – scalable message processing and more!



Kafka Connect - Overview



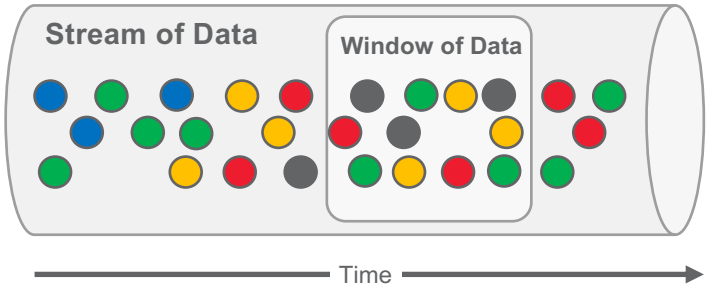
Stream Processing Capability - Windowing

Computations over events done using **windows of data**

Due to size and never-ending nature of it, it's not feasible to keep entire stream of data in memory

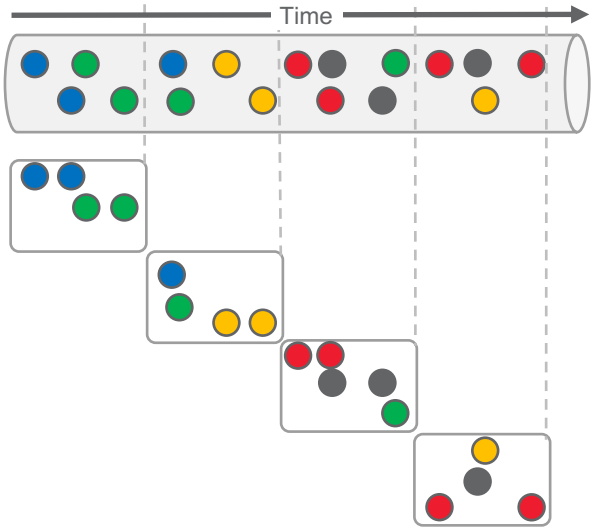
A window of data represents a certain amount of data where we can perform computations on

Windows give the power to keep a working memory and look back at recent data efficiently

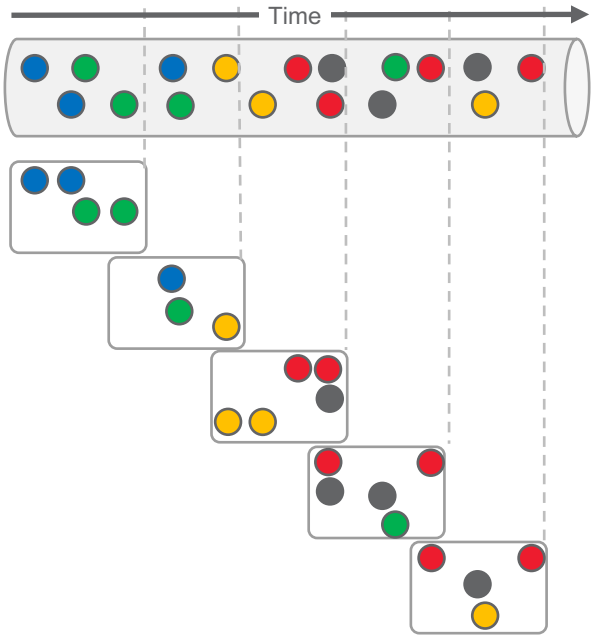


Stream Processing Capability - Windowing

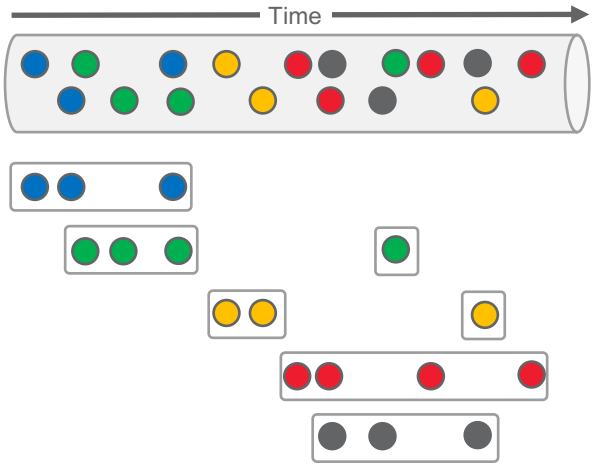
Fixed Window (aka Tumbling Window) - eviction policy always based on the window being full and trigger policy based on either the count of items in the window or time



Sliding Window (aka Hopping Window) - uses eviction and trigger policies that are based on time: *window length* and *sliding interval length*



Session Window – composed of sequences of temporarily related events terminated by a gap of inactivity greater than some timeout



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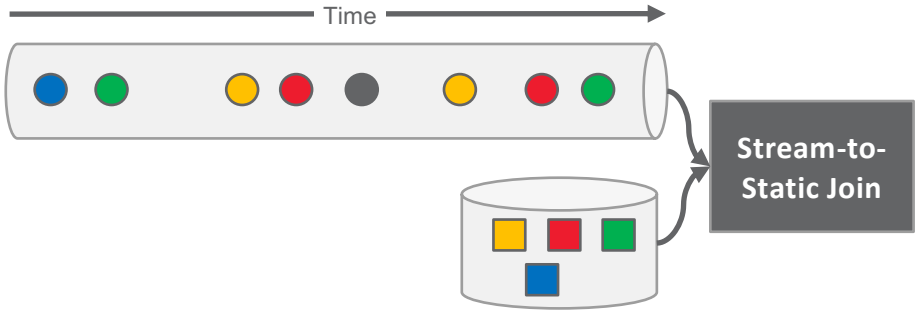
Stream Processing Capability - Joining

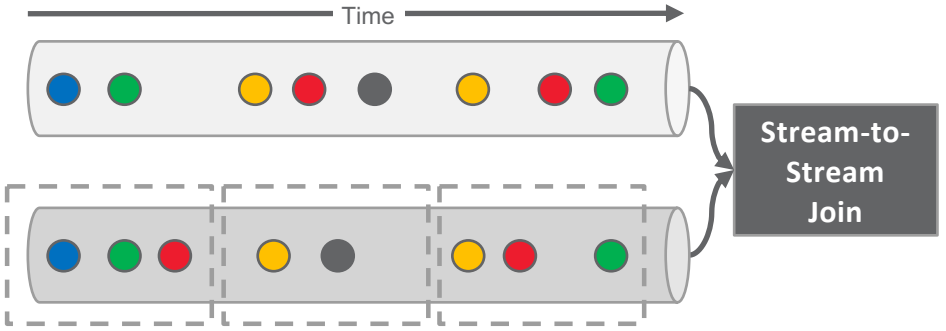
Challenges of joining streams

1. Data streams need to be aligned as they come because they have different timestamps
2. since streams are never-ending, the joins must be limited; otherwise join will never end
3. join needs to produce results continuously as there is no end to the data

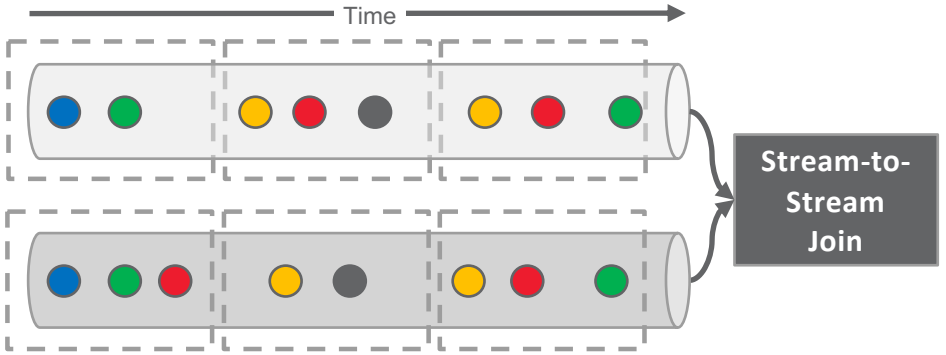
Stream to Static (Table) Join



Stream to Stream Join (one window join)



Stream to Stream Join (two window join)



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Stream Processing Capability - State Management

Necessary if stream processing use case is dependent on previously seen data or external data

Windowing, **Joining** and **Pattern Detection** use State Management behind the scenes

State Management services can be made available for custom state handling logic

State needs to be managed as close to the stream processor as possible

Options for State Management

How does it handle failures? If a machine crashes and the/some state is lost?

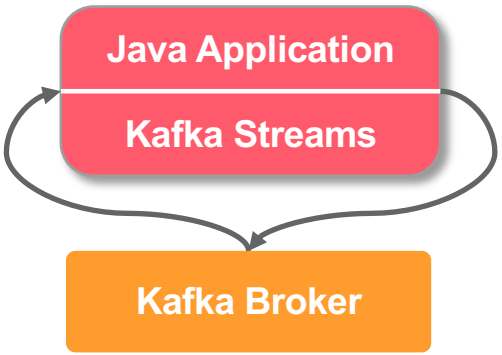
Kafka Streams - Overview

Designed as a **simple and lightweight library in Apache Kafka**

no other dependencies than Kafka

Supports **fault-tolerant local state**

Supports **Windowing** (Fixed, Sliding and Session) and **Stream-Stream / Stream-Table Joins**



Millisecond processing latency, no micro-batching

At-least-once **and exactly-once** processing guarantees

```
KTable<Integer, Customer> customers =
   builder.stream("customer");

KStream<Integer, Order> orders =
   builder.stream("order");

KStream<Integer, String> enriched =
   orders.leftJoin(customers, …);

joined.to("orderEnriched");
```

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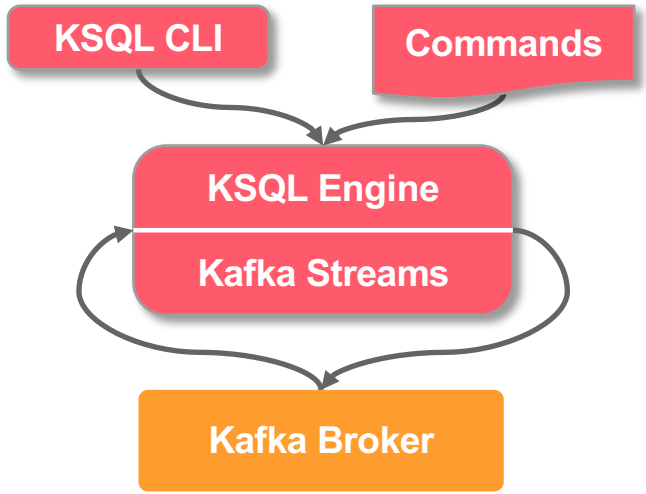
KSQL - Overview

Stream Processing with zero coding using SQL-like language

Built on top of Kafka Streams

Interactive (CLI) and headless (command file)



STREAM and TABLE as first-class citizens

- STREAM = data in motion
- TABLE = collected state of a stream

```
ksql> CREATE STREAM customer_s \
      WITH (kafka_topic='customer', \
        value_format='AVRO');

 Message
----------------
 Stream created

ksql> SELECT * FROM customer_s \
WHERE address->country = 'Switzerland';
...
```

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What about integrating legacy applications?

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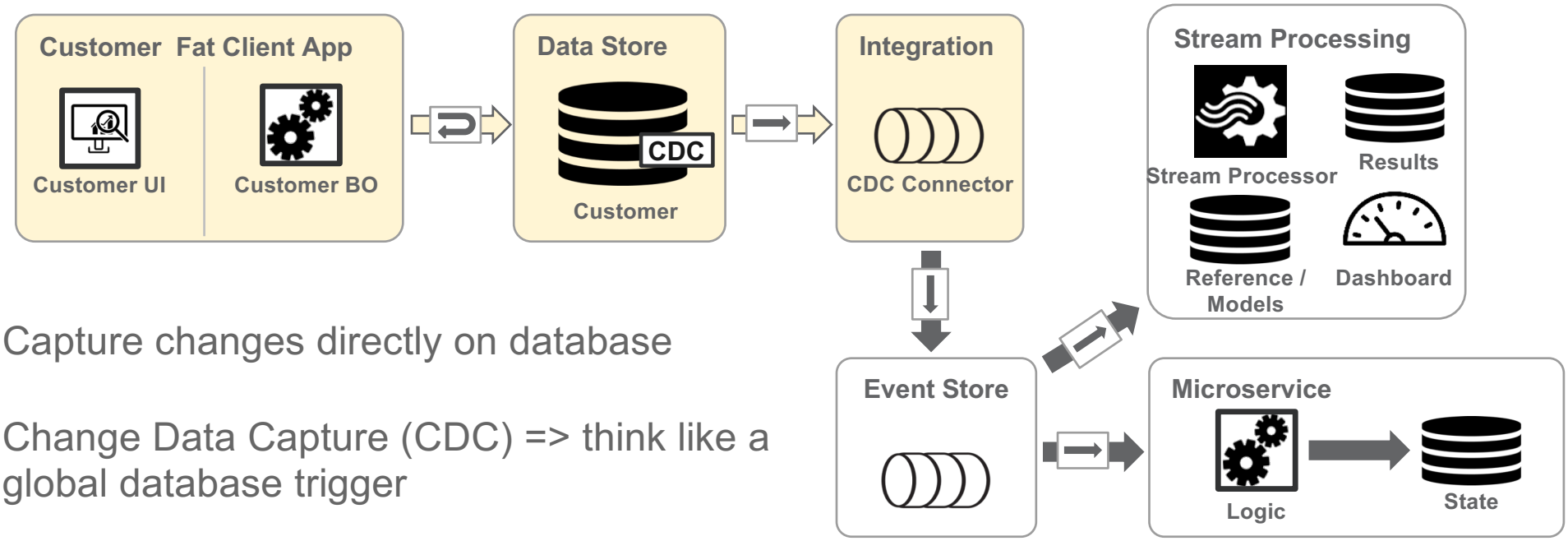
Integrate existing systems through CDC



Capture changes directly on database

Change Data Capture (CDC) => think like a global database trigger

Transform existing systems to event producer

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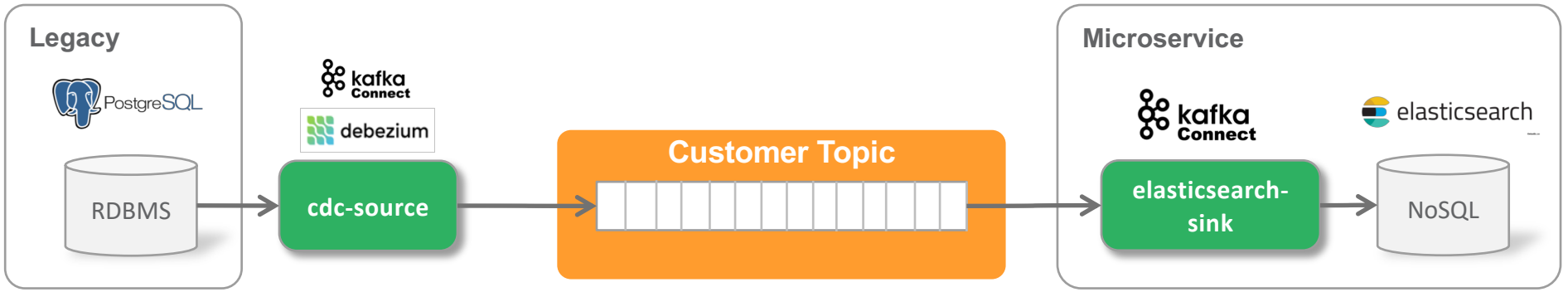
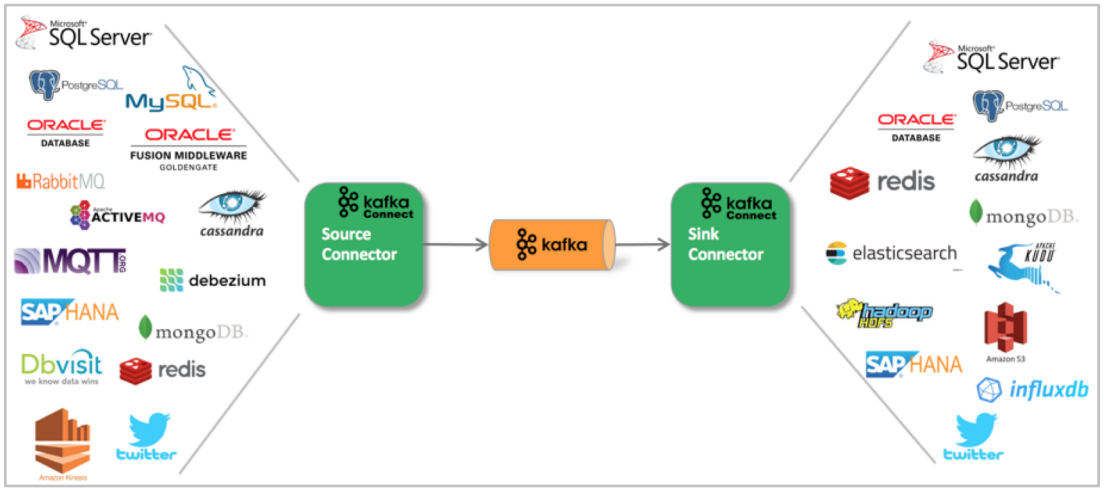
Change Data Capture (CDC) with Kafka





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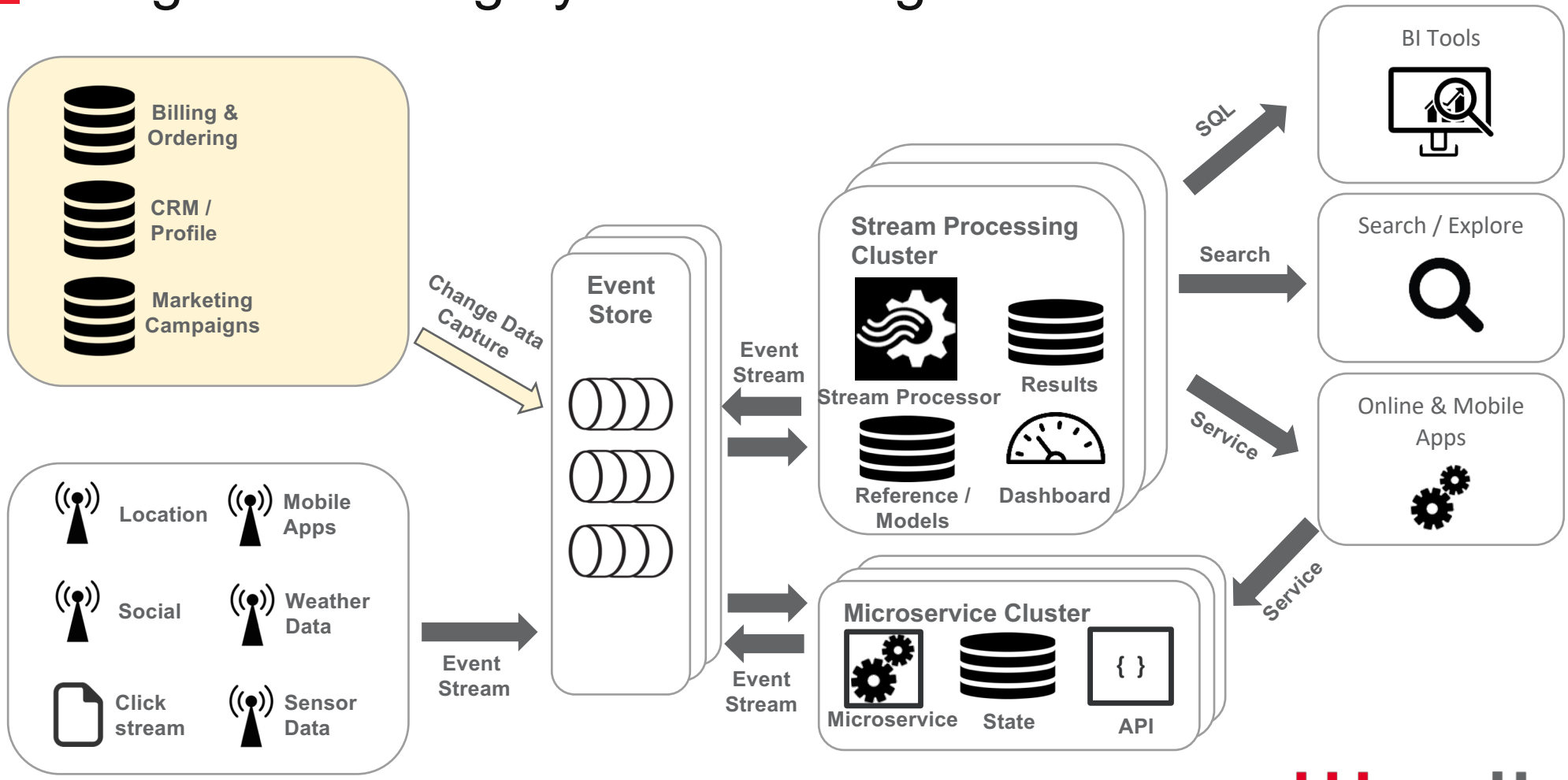
Integrate existing systems through CDC



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What about (historical) data analytics?

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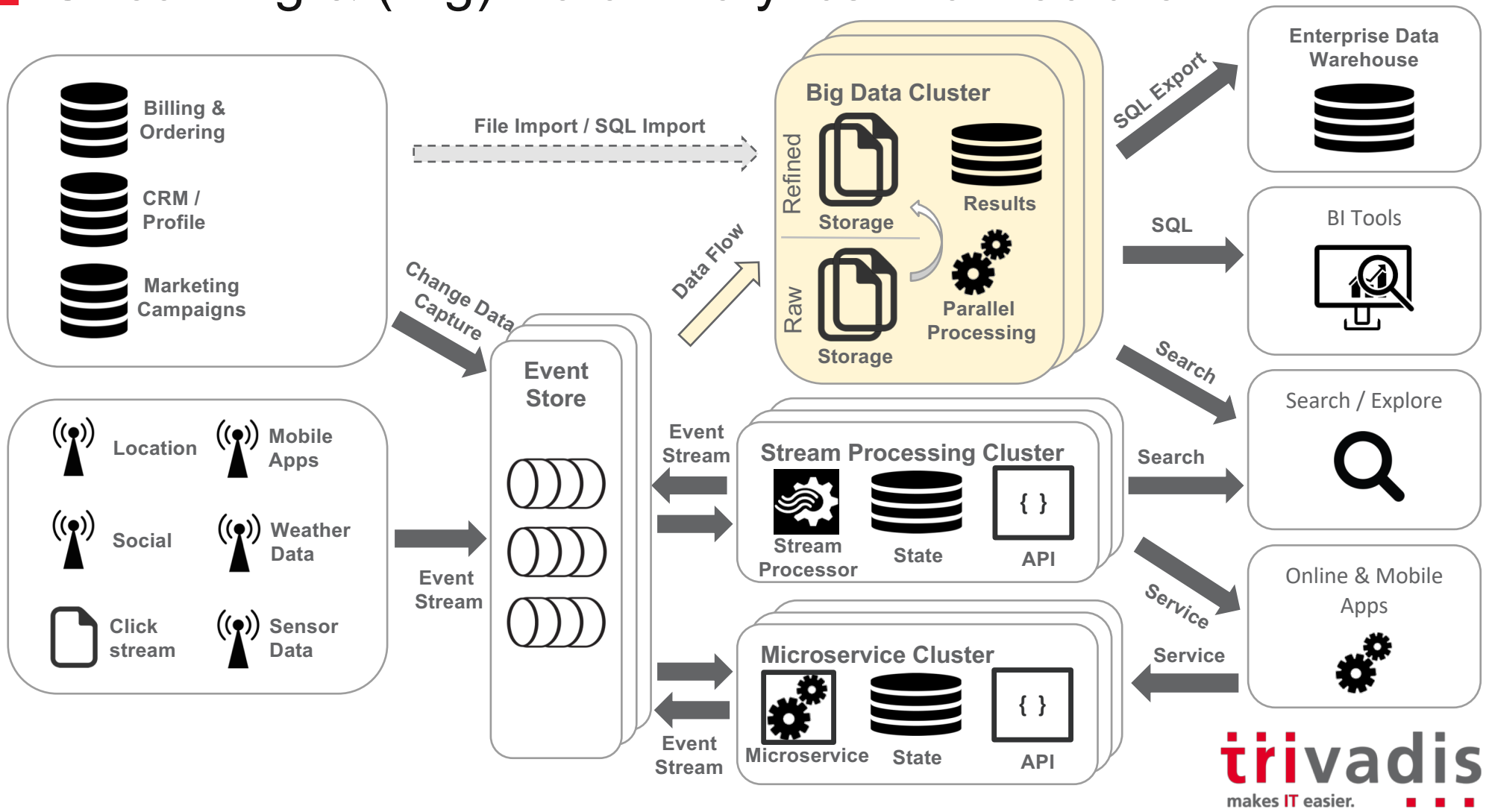
Streaming & (Big) Data Analytics Architecture



Summary

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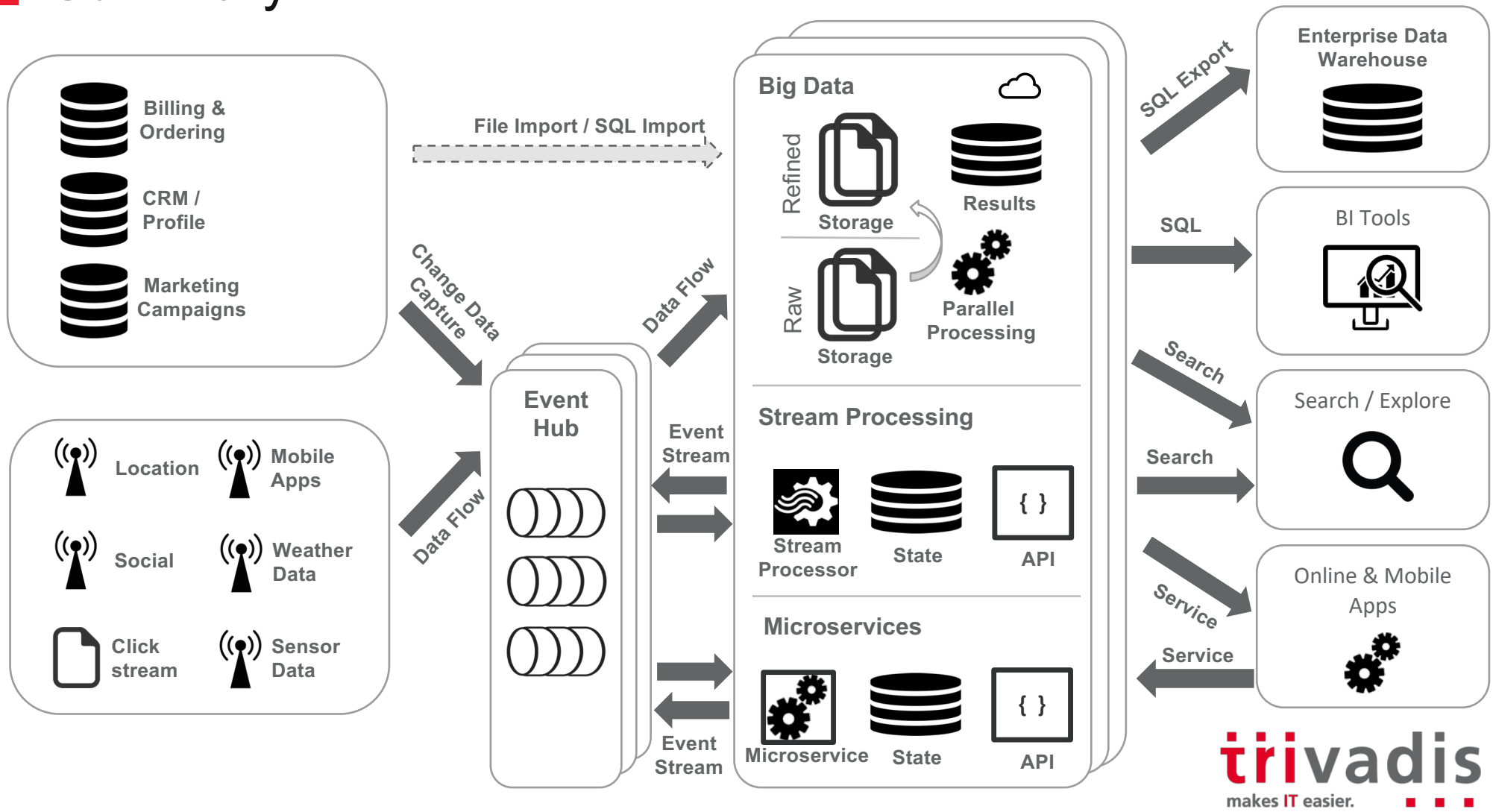
Summary


Billing & Ordering
CRM / Profile
Marketing Campaigns
Location
Mobile Apps
Social
Weather Data
Click stream
Sensor Data
File Import / SQL Import
Change Data Capture
Data Flow
Data Flow
Event Hub
Event Stream
Event Stream
Big Data
Refined
Storage
Results
Raw
Storage
Parallel Processing
Stream Processing
Stream Processor
State
API
Microservices
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State
API
SQL Export
SQL
Search
Search
Service
Service
Enterprise Data Warehouse
BI Tools
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Summary

- service autonomy is key in a Microservices Architecture!
- not all communication need to be synchronous => separate into
  - commands
  - events
  - queries
- Kafka is well suited as an event broker / event store
  - brings many more interesting features beyond just “message passing”

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