Apache Kafka + Apache Mesos

Highly Scalable Streaming Microservices with Kafka Streams

Kai Waehner

Technology Evangelist

kontakt@kai-waehner.de

LinkedIn

@KaiWaehner

www.confluent.io

www.kai-waehner.de

Agenda

1) Scalable Microservices
2) Apache Kafka and Confluent Platform
3) Kafka Streams
4) Scalable Microservices with Kafka and DC/OS
5) Use Case - Scalable Flight Prediction

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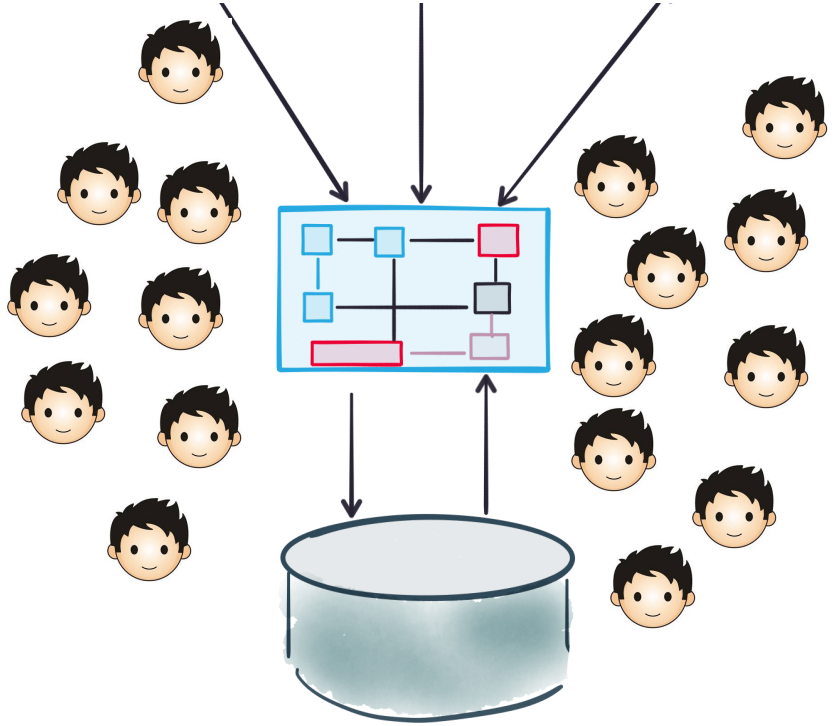
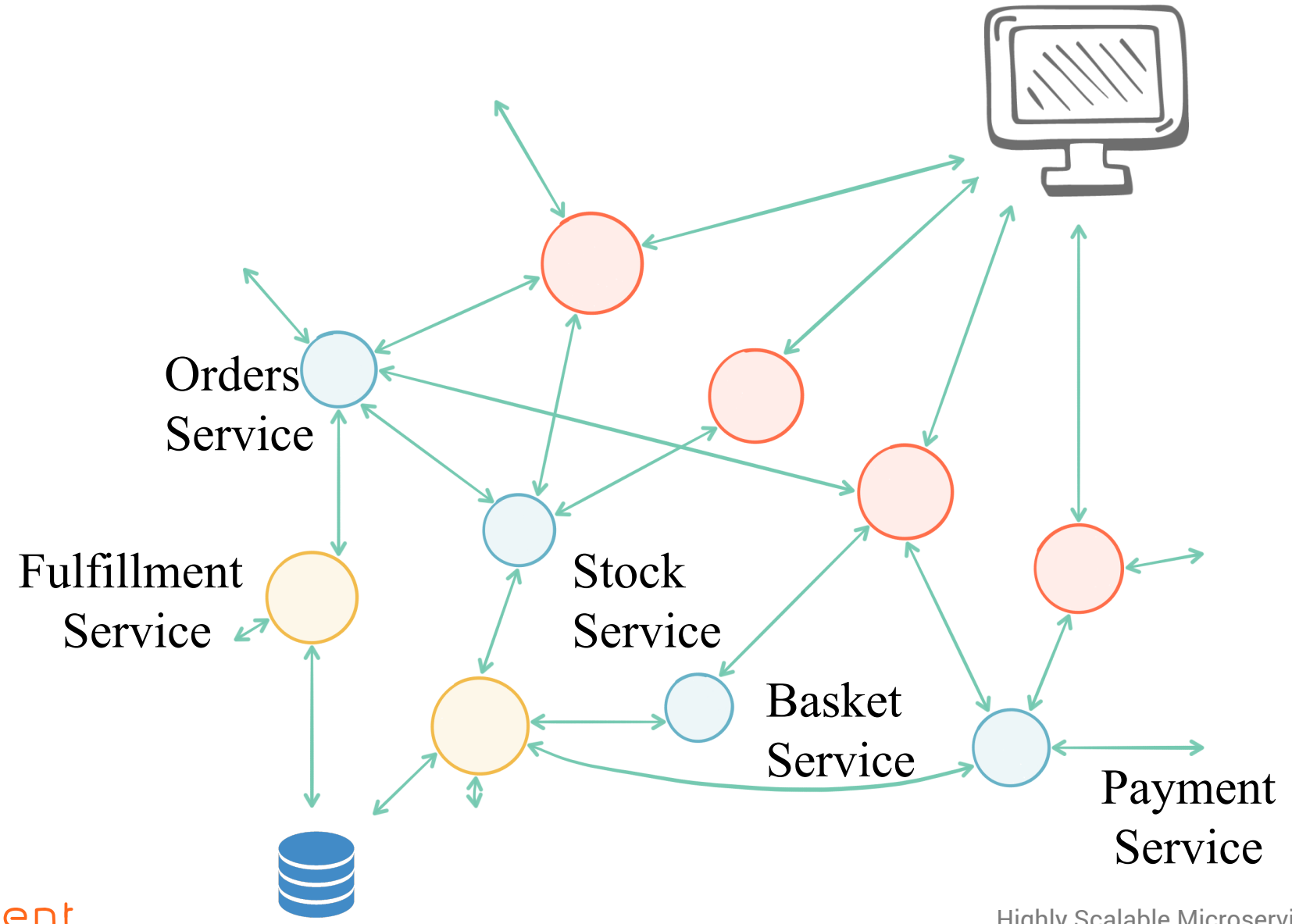
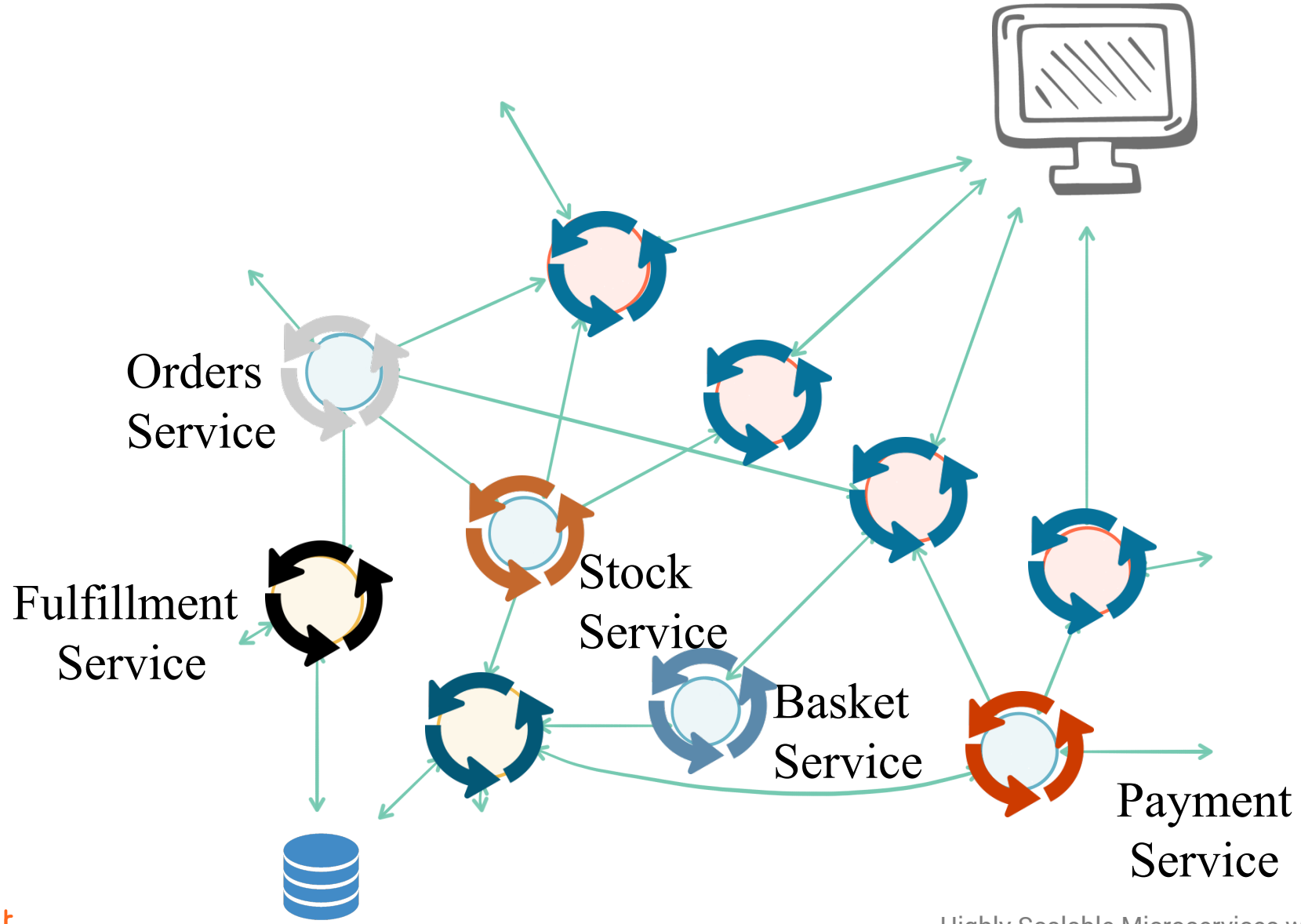
Moving away from the Monolith



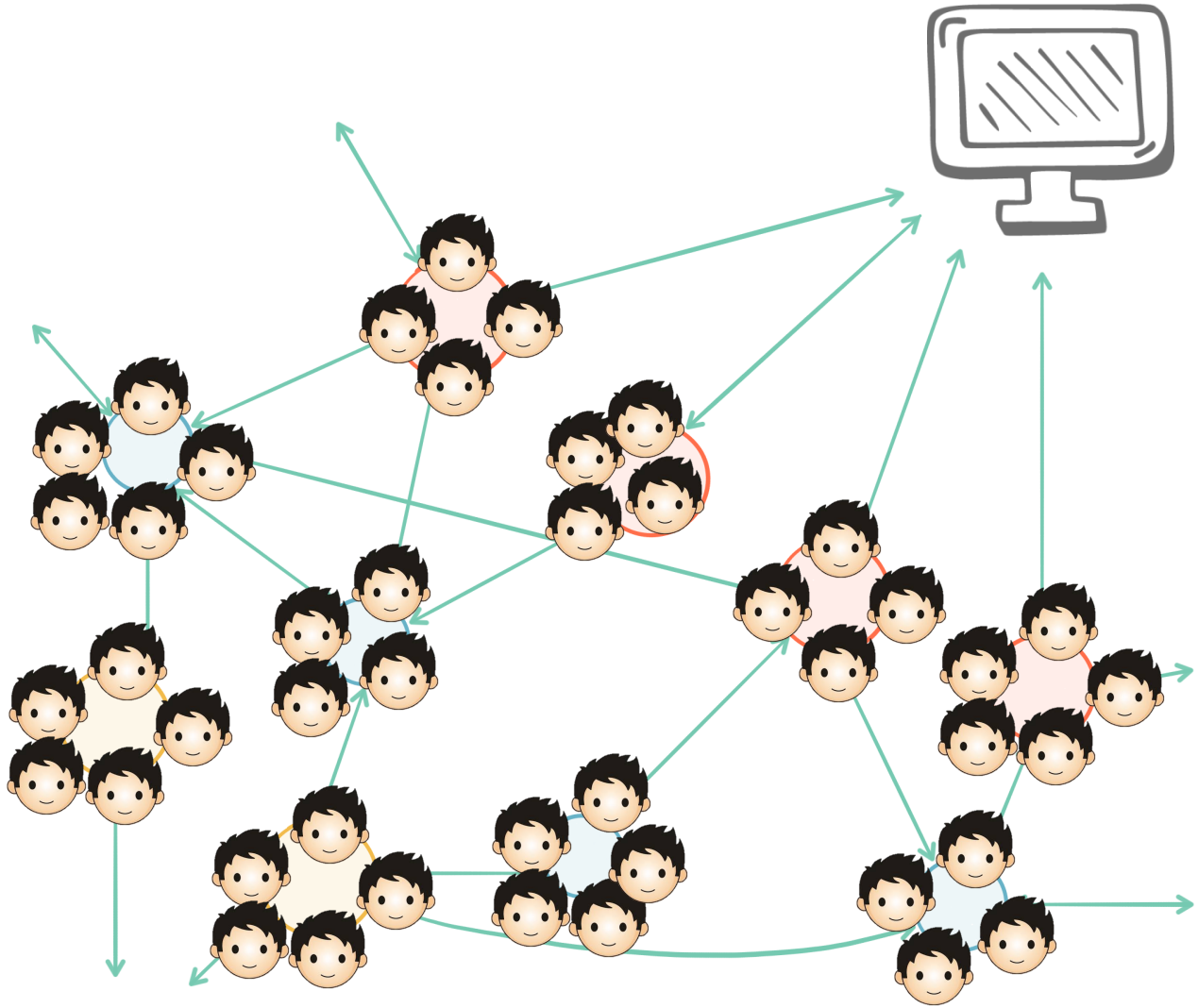
Microservices



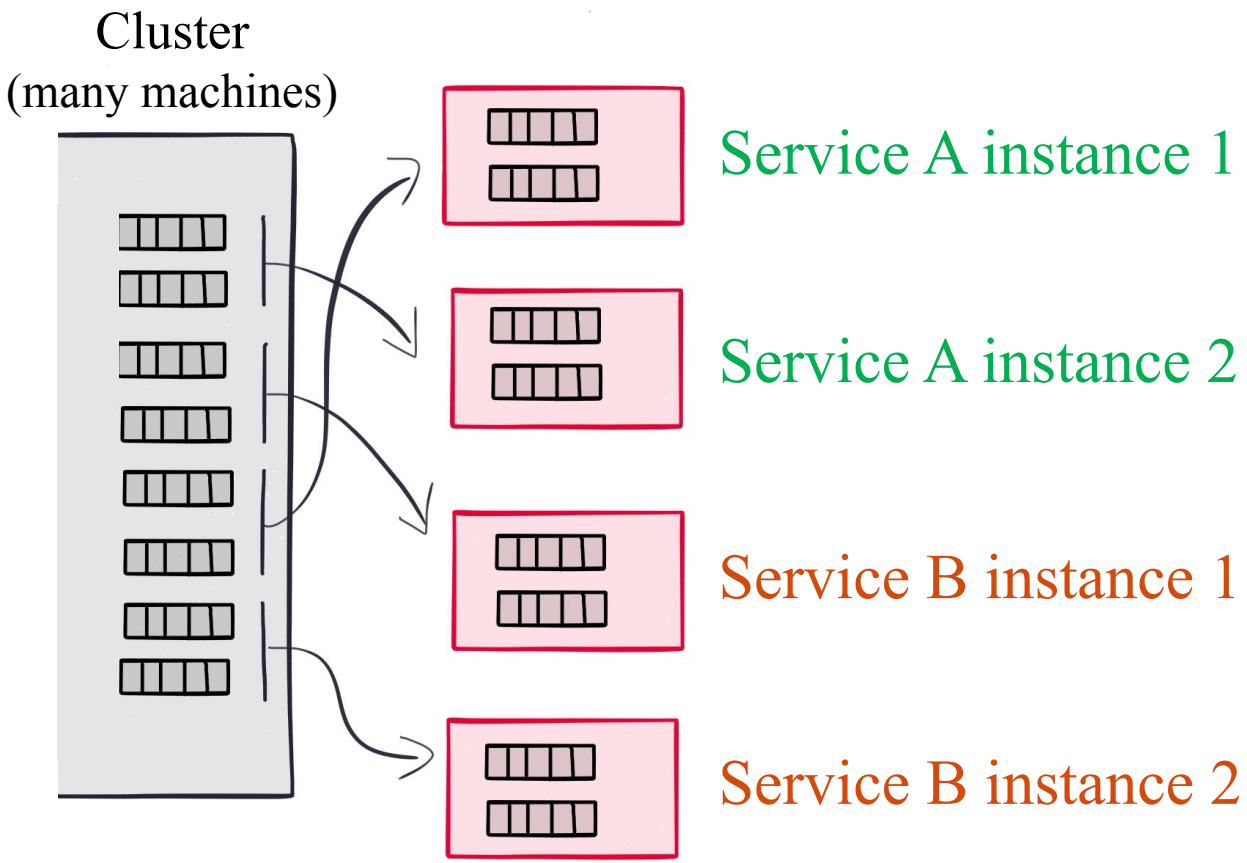
Microservices are Independently Deployable



Scale in People Terms



Scale in Infrastructure Terms



Scalable Microservices

How do we get there?

- Loose Coupling
- Data Enabled
- Event Driven
- Operational Transparency

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2) **Apache Kafka and Confluent Platform**
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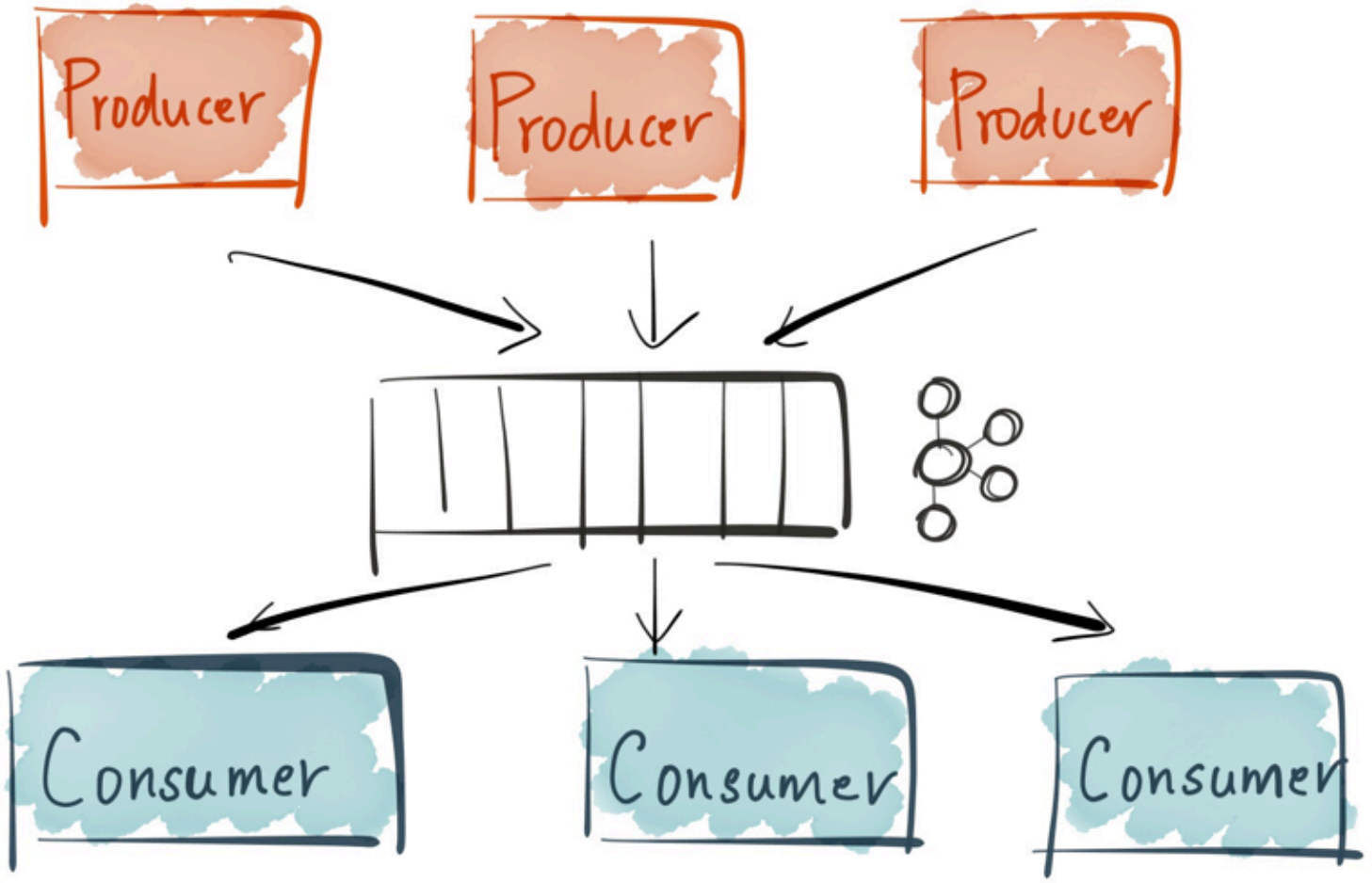
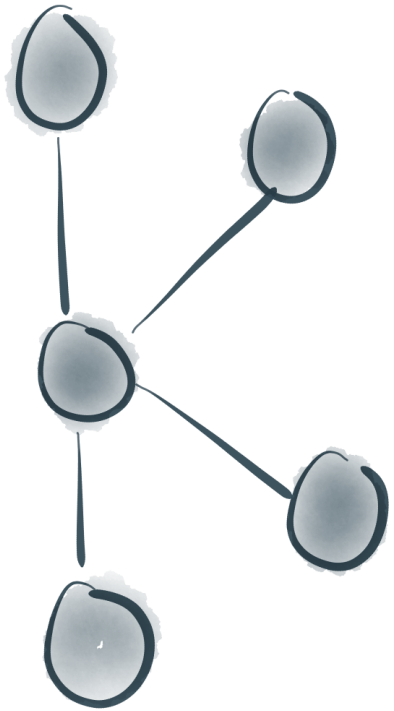
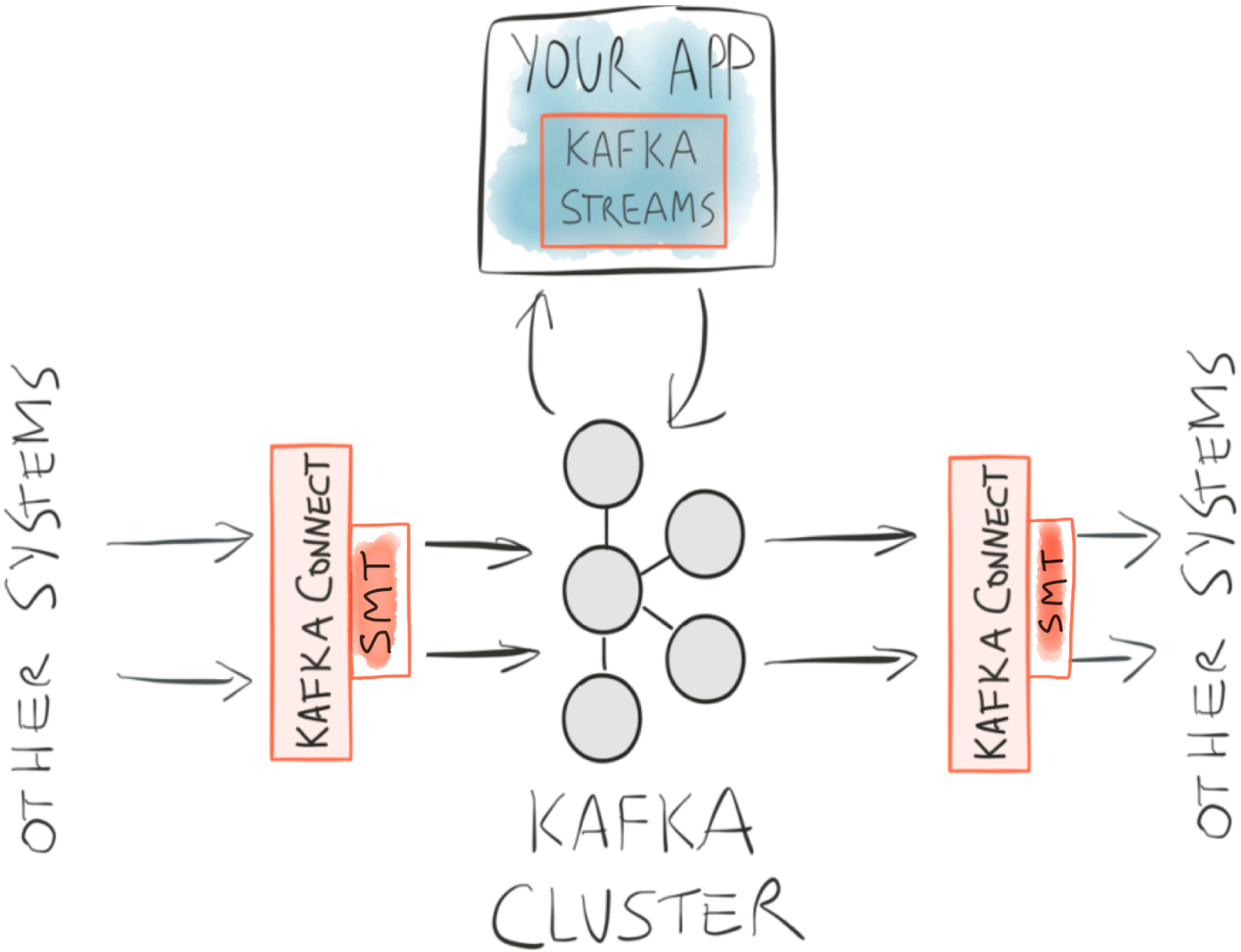
Apache Kafka – A Distributed, Scalable, Fault-Tolerant Commit Log

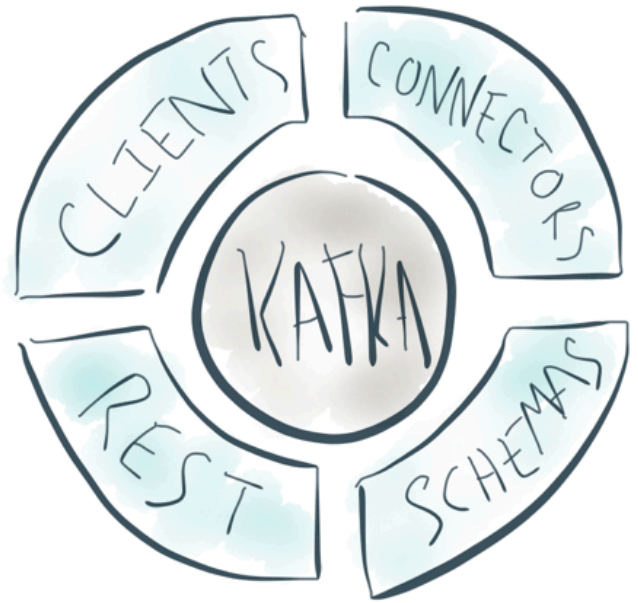


A MAJOR NEW ECOSYSTEM

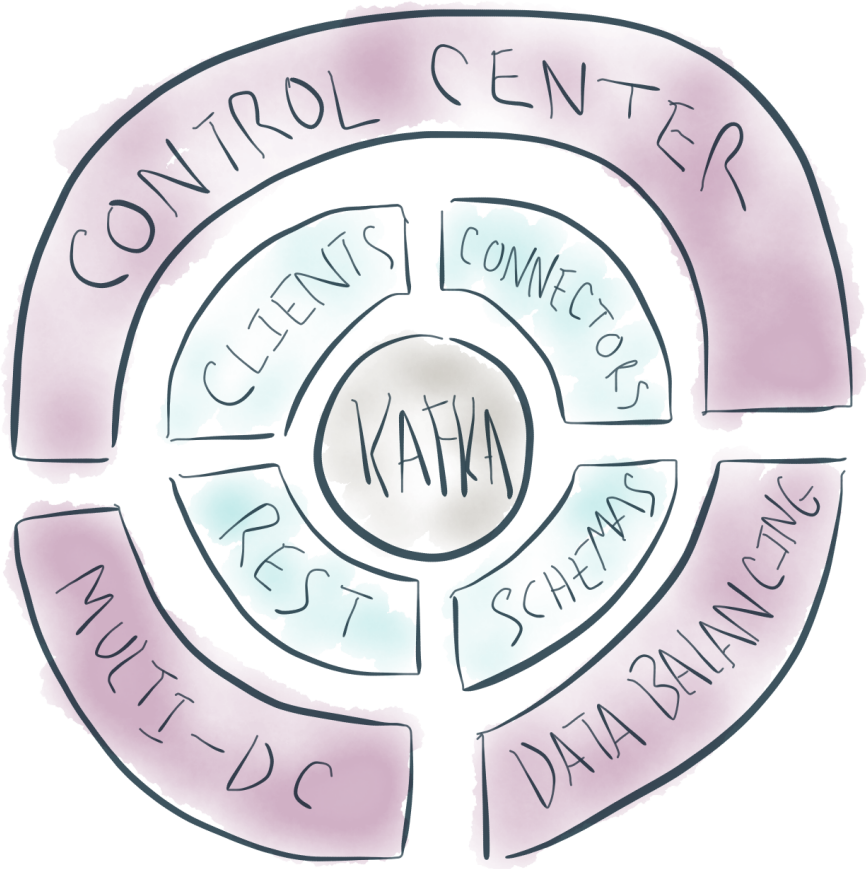



YOUR APP
KAFKA STREAMS
OTHER SYSTEMS
KAFKA CONNECT
SMT
KAFKA CLUSTER
KAFKA CONNECT
SMT
OTHER SYSTEMS

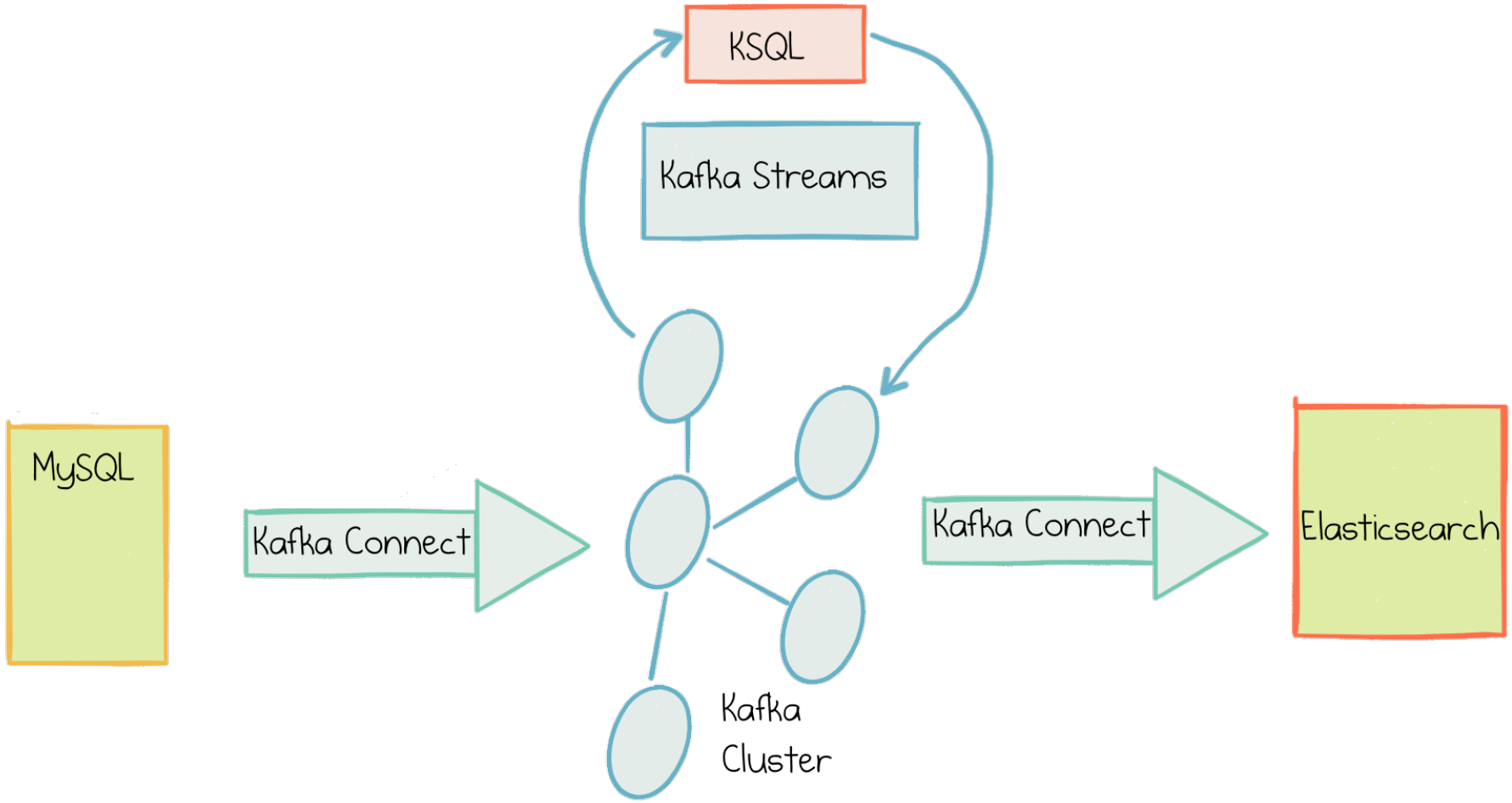
CONFLUENT OPEN SOURCE



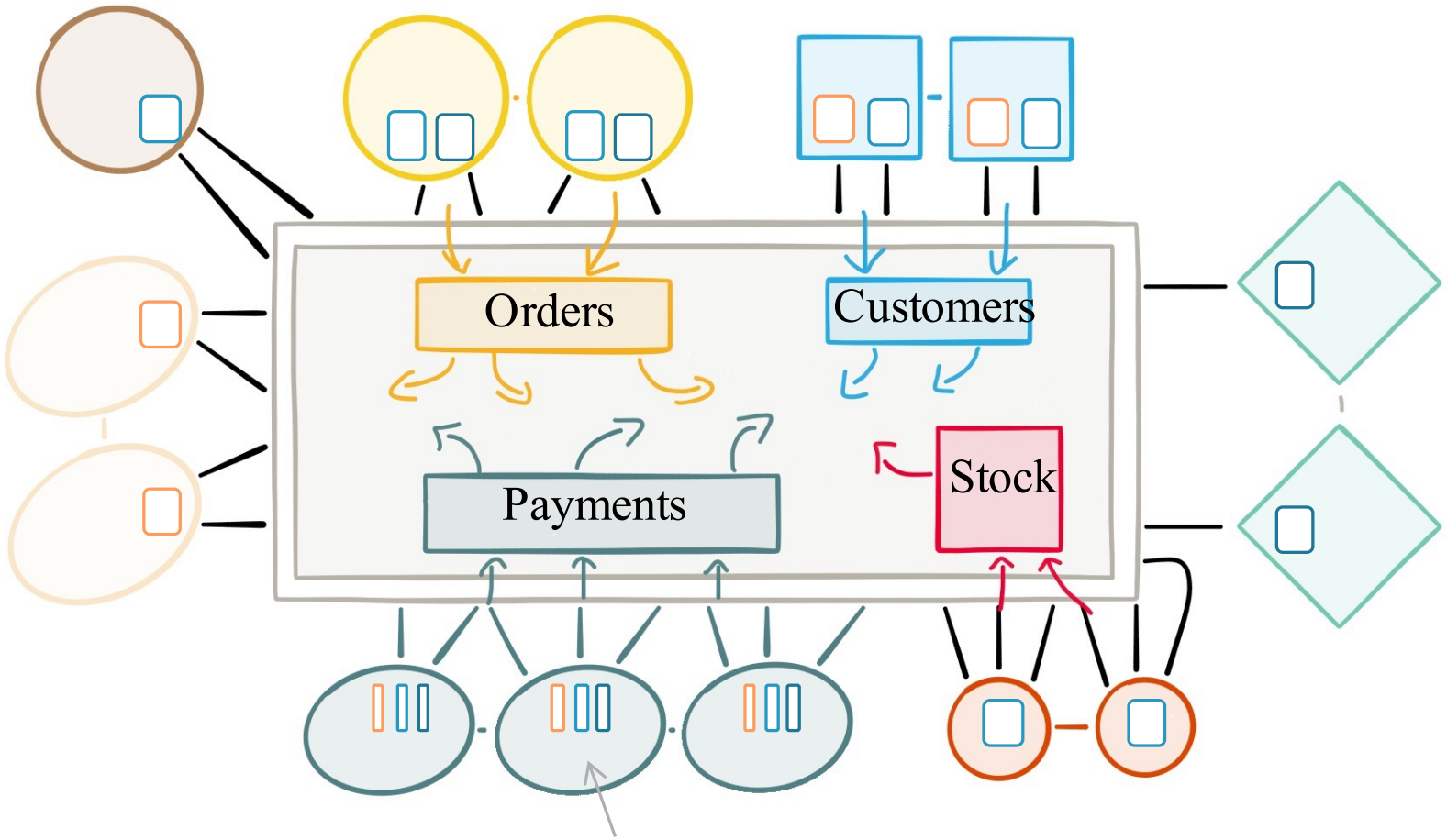
CONFLUENT ENTERPRISE



Apache Kafka – A Streaming Platform



Kafka as Single, Shared Source of Truth for Microservices



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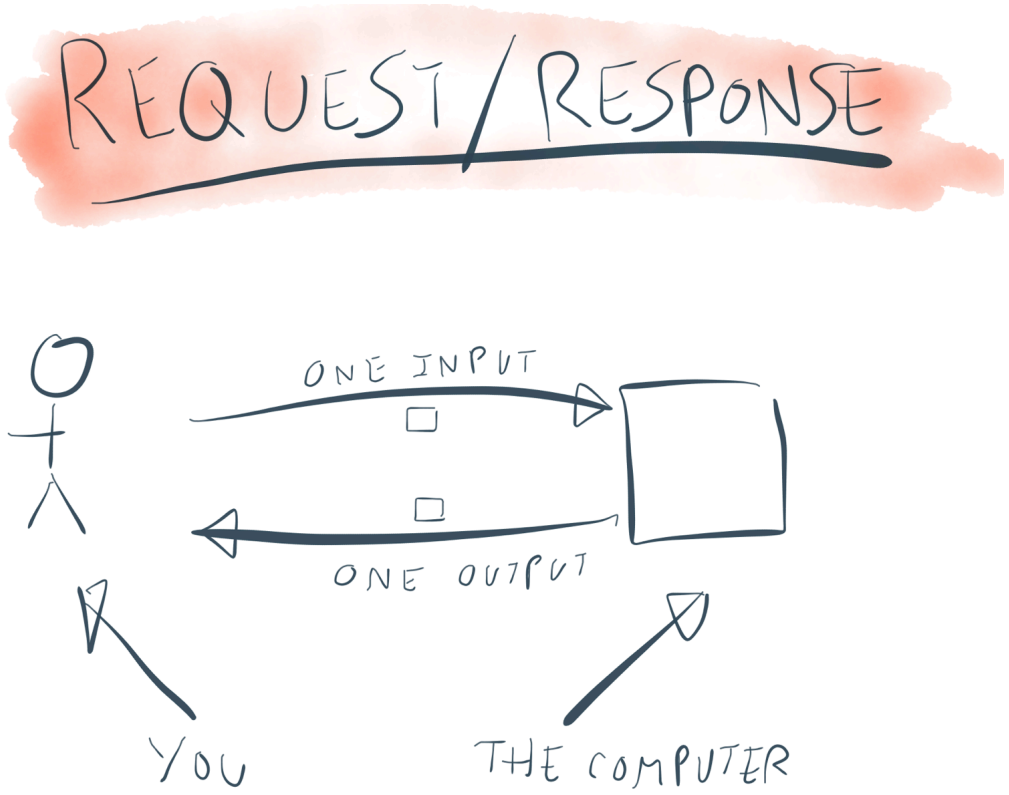
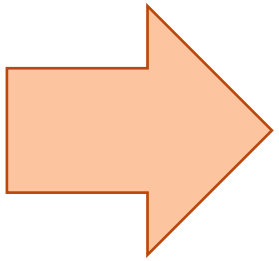
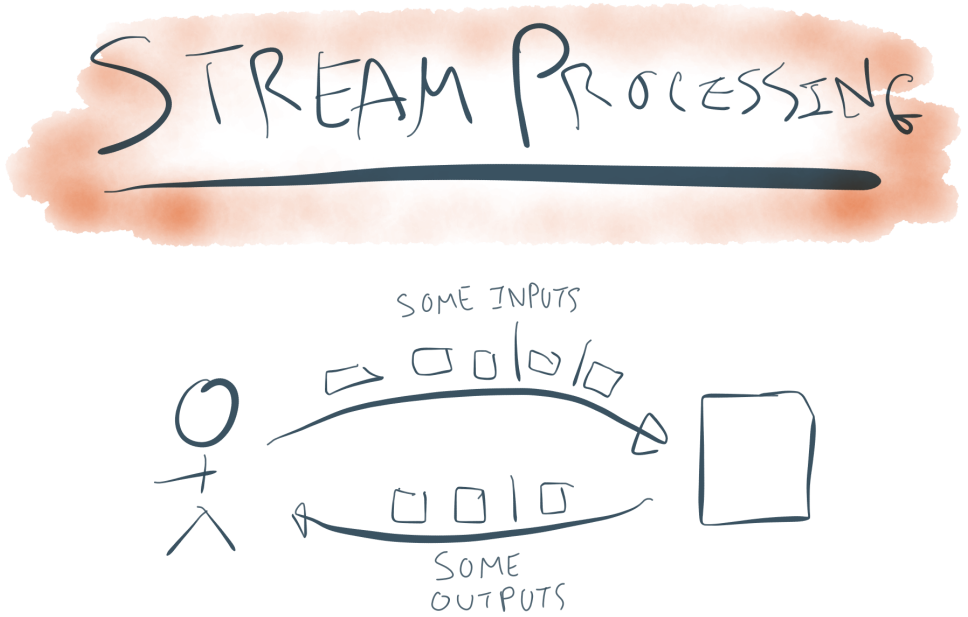
Stream Processing



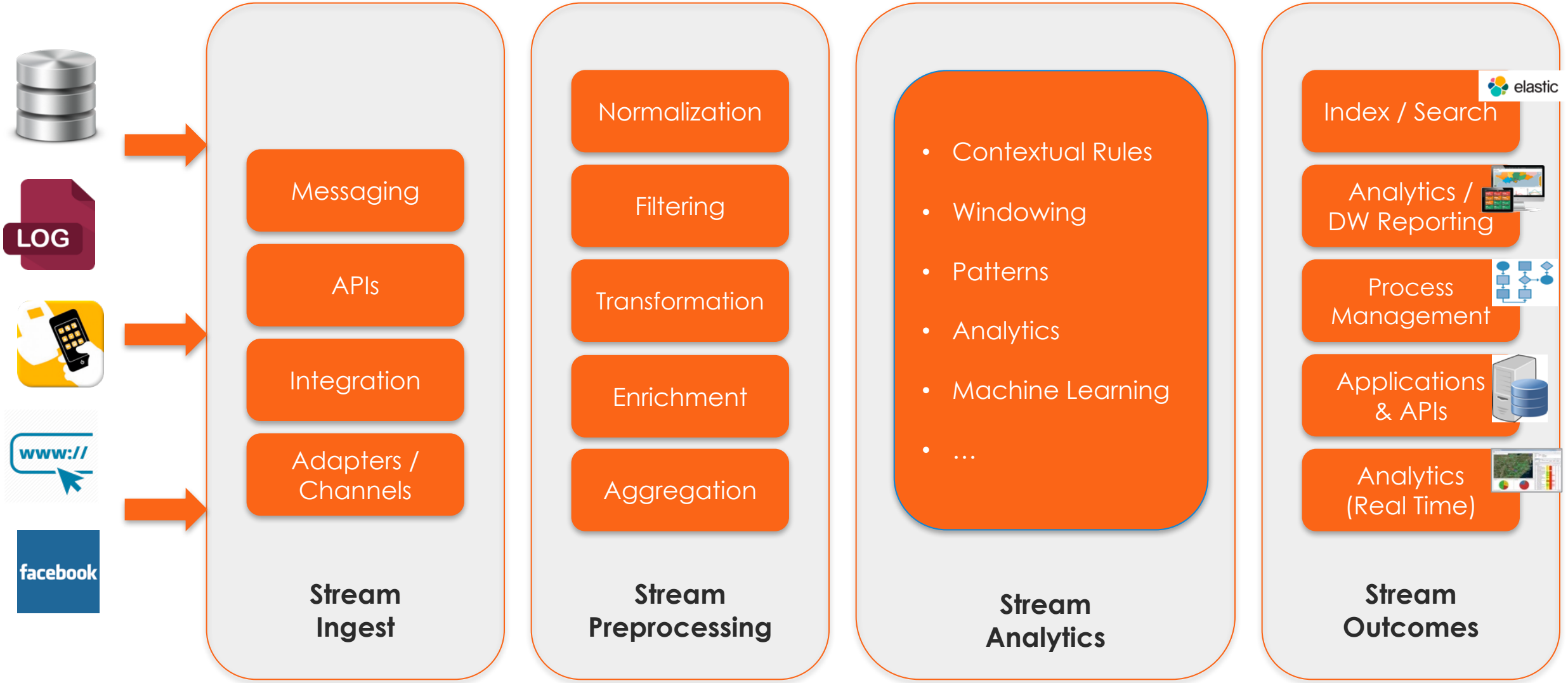




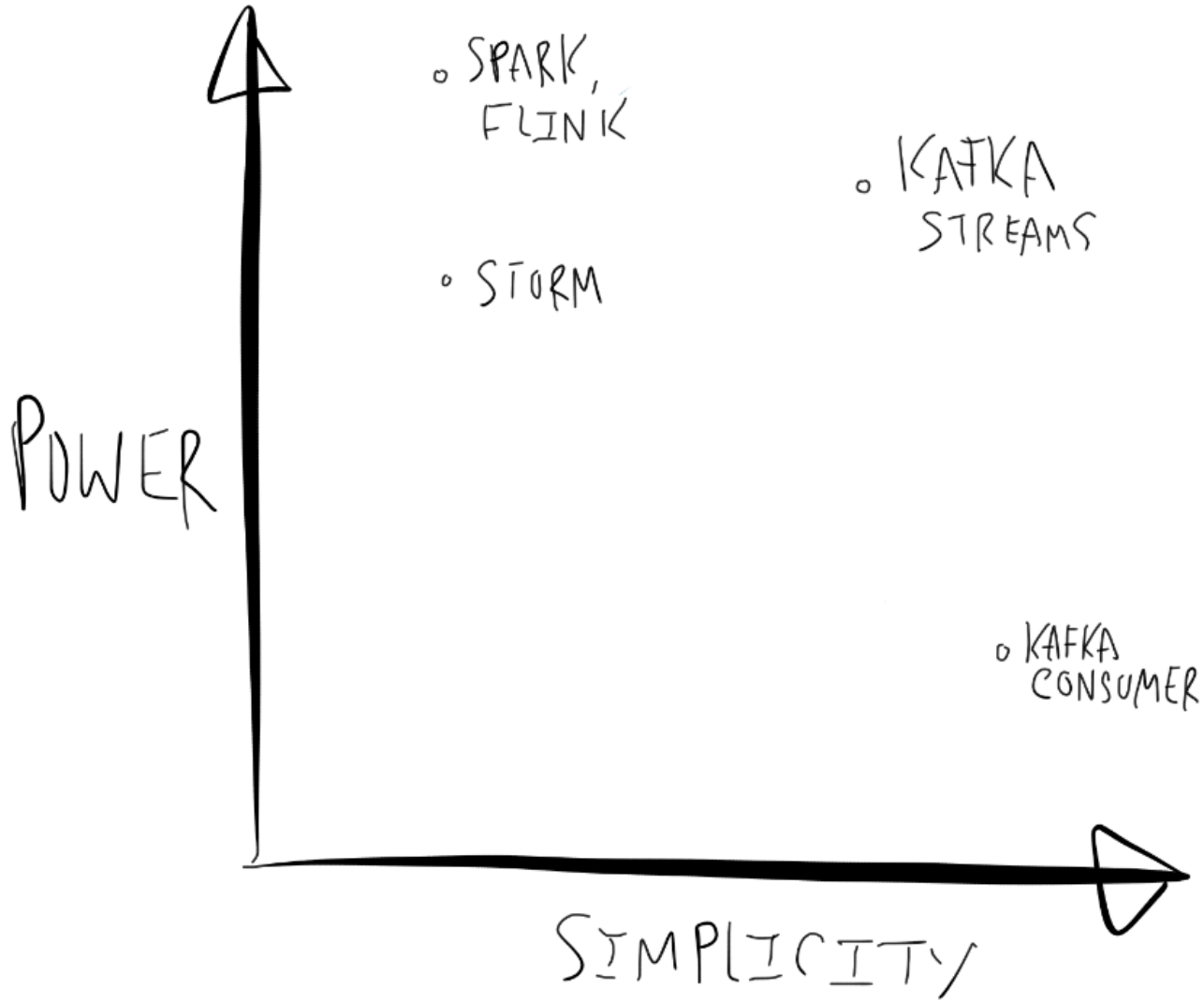
Data at Rest

Data in Motion

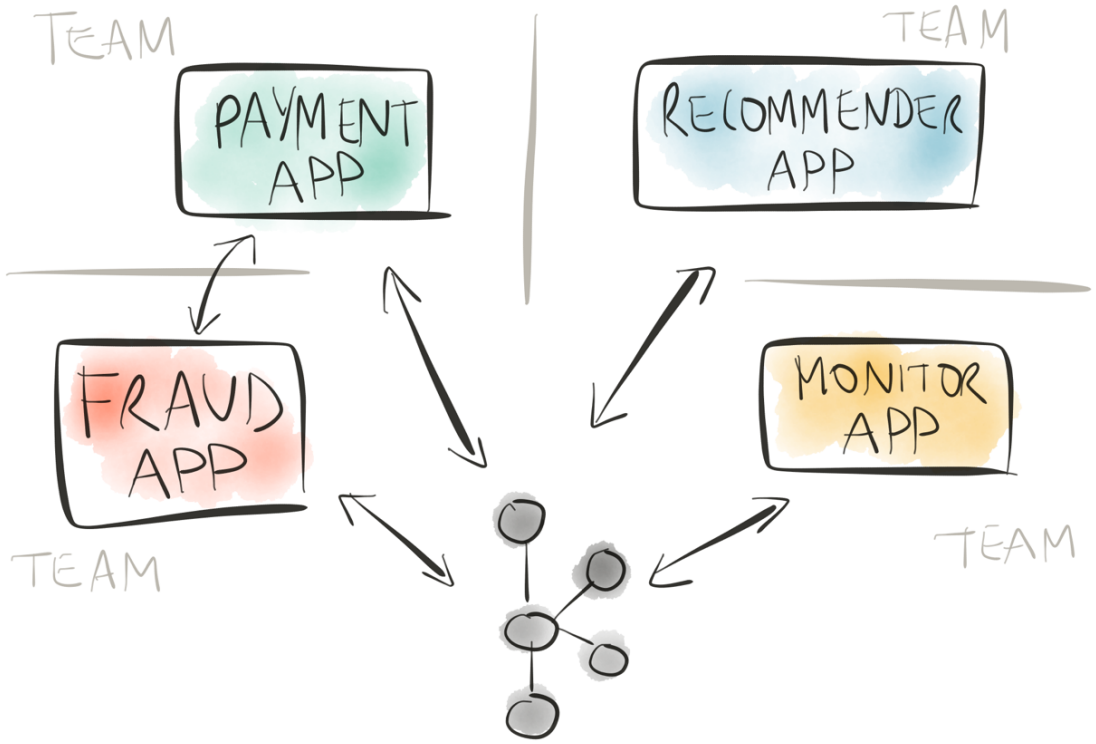
Stream Processing Pipeline

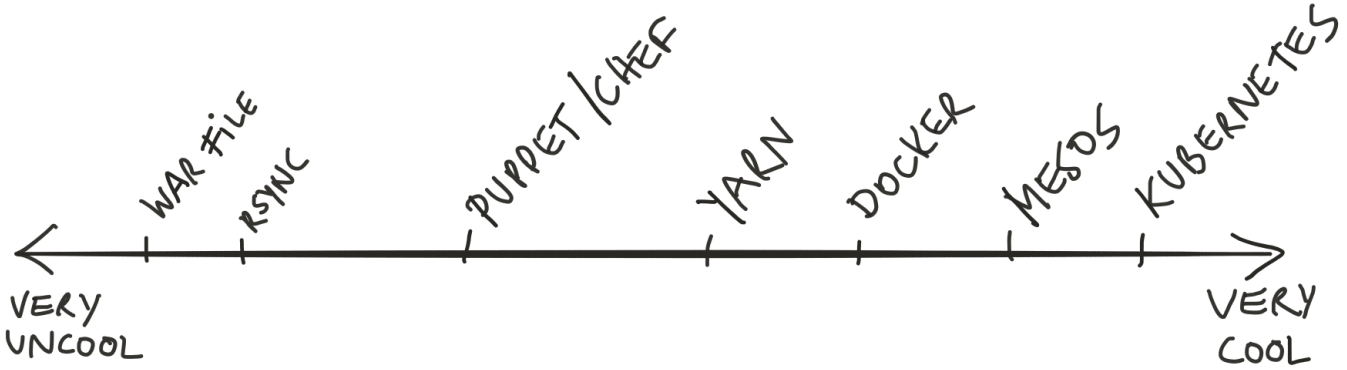


When to use Kafka Streams for Stream Processing?



Lightweight, Independent, Scalable Streaming Microservices





KAFKA STREAMS

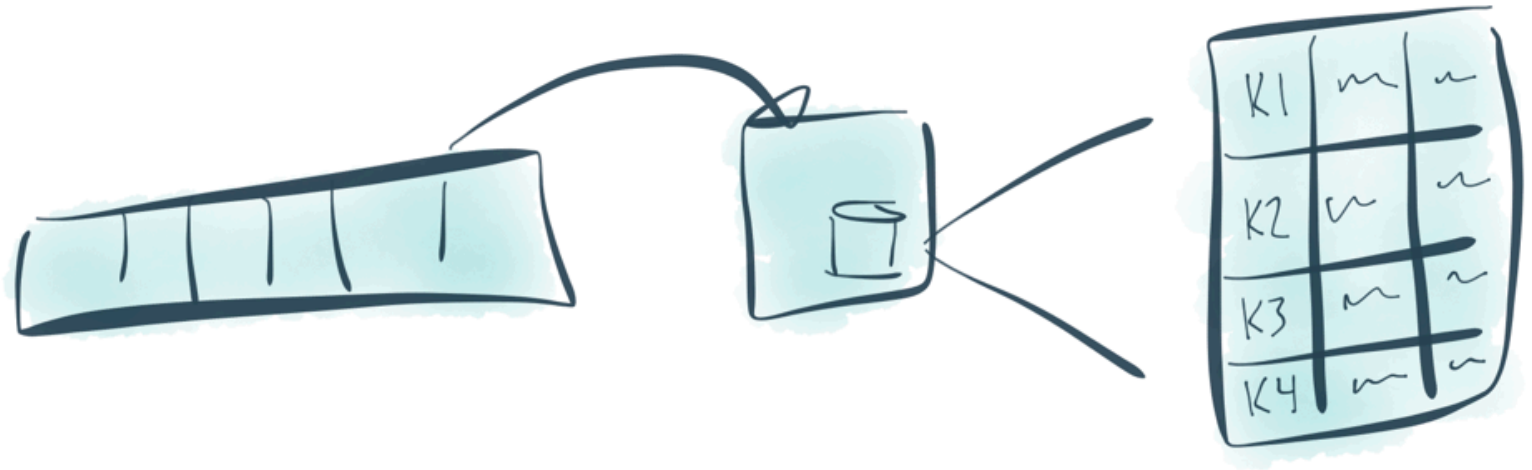
- SIMPLE LIBRARY
- CONVENIENT DSL
- DATAFLOW STYLE WINDOWING
- REPROCESSING
- NO MICROBATCH
- LOCAL STATE

KEY OPERATIONS

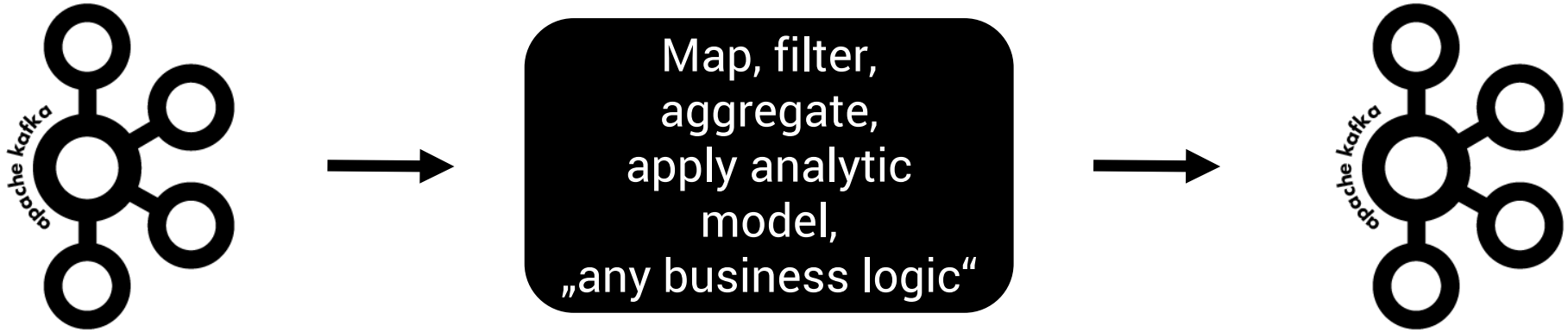
- MAP
- FILTER
- AGGREGATE (COUNT, SUM, ETC)
- JOIN

UNIFY

TABLES & STREAMS



Kafka Streams (shipped with Apache Kafka)



Input Stream
(Kafka Topic)

Stream Processing Microservice
(Kafka Streams)

Output Stream
(Kafka Topic)

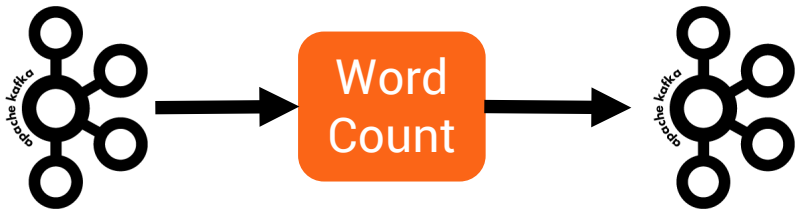
Kafka Cluster

Deployed Anywhere

Java App, Docker,
Kubernetes, Mesos,
“you-name-it”

Kafka Cluster

A complete streaming microservice, ready for production at large-scale



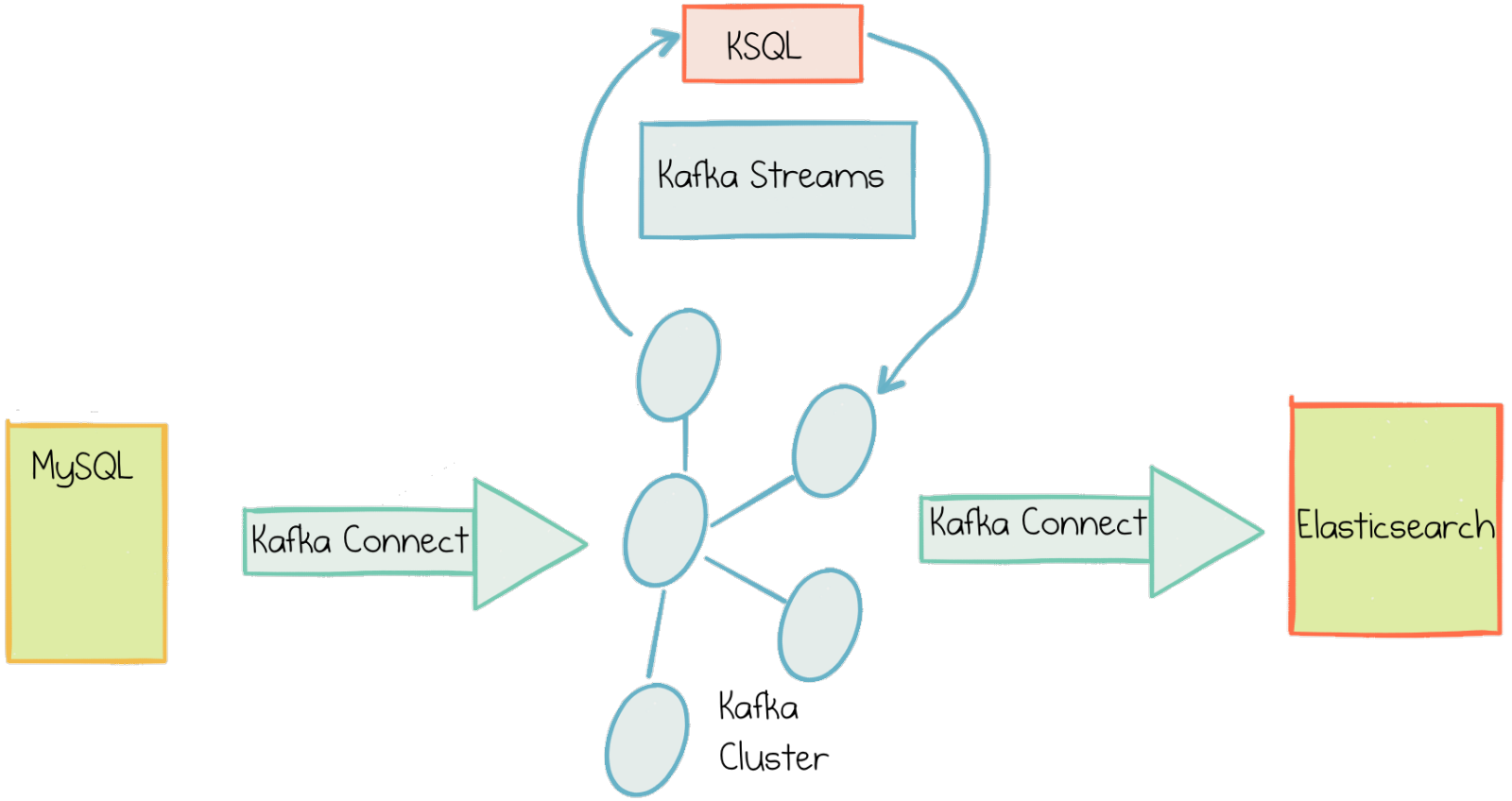

```
1  public static void main(final String[] args) throws Exception {
2    Properties config = new Properties();
3    config.put(StreamsConfig.APPLICATION_ID_CONFIG, "wordcount-example");
4    config.put(StreamsConfig.BOOTSTRAP_SERVERS_CONFIG, "kafka-broker1:9092");
5    config.put(StreamsConfig.KEY_SERDE_CLASS_CONFIG, Serdes.String().getClass().getName());
6    config.put(StreamsConfig.VALUE_SERDE_CLASS_CONFIG, Serdes.String().getClass().getName());
7
8    KStreamBuilder builder = new KStreamBuilder();
9    KStream<String, String> textLines = builder.stream("TextLinesTopic");
10   KStream<String, Long> wordCounts = textLines
11     .flatMapValues(value -> Arrays.asList(value.toLowerCase().split("\\W+")))
12     .groupBy((key, word) -> word)
13     .count("Counts")
14     .toStream();
15   wordCounts.to(Serdes.String(), Serdes.Long(), "WordsWithCountsTopic");
16
17   KafkaStreams streams = new KafkaStreams(builder, config);
18   streams.start();
19 }
```

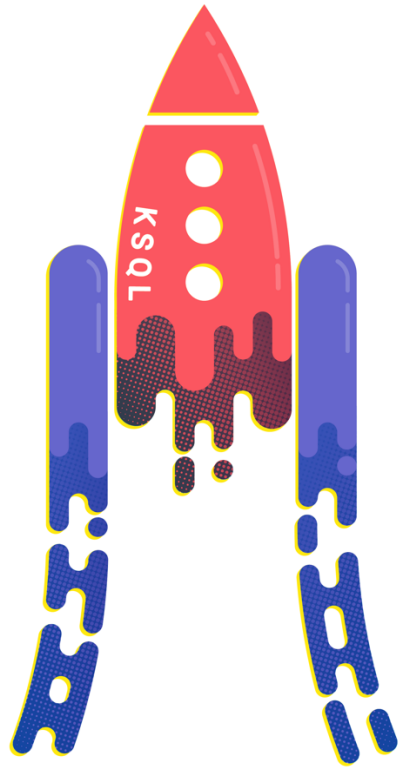
App configuration

Define processing (here: WordCount)

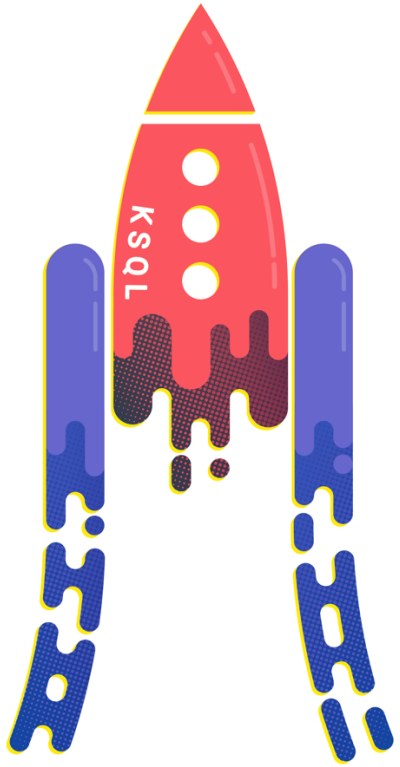
Start processing

KSQL – An Open Source Streaming SQL Engine for Apache Kafka





Highly Scalable KSQL Streaming Microservices




```
CREATE STREAM vip_actions AS
SELECT userid, page, action FROM clickstream c
LEFT JOIN users u ON c.userid = u.user_id
WHERE u.level = 'Platinum';
```

```
CREATE TABLE possible_fraud AS
SELECT card_number, count(*)
FROM authorization_attempts
WINDOW TUMBLING (SIZE 5 MINUTES)
GROUP BY card_number
HAVING count(*) > 3;
```

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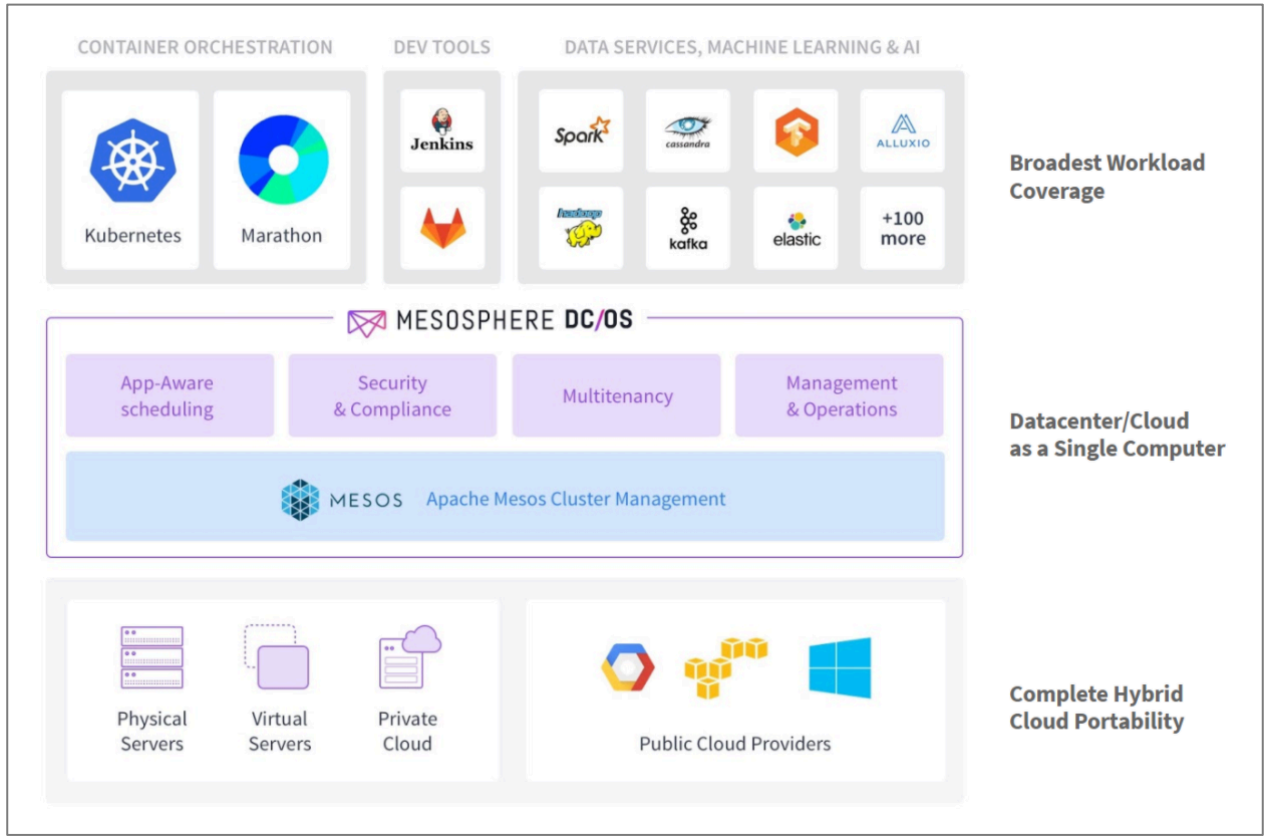
Apache Mesos and DC/OS



„... **bring together all of the tools needed to operate data-intensive modern applications at scale** such as container orchestration, distributed databases, message queues, data streaming and processing, machine learning, monitoring and management capabilities, etc."

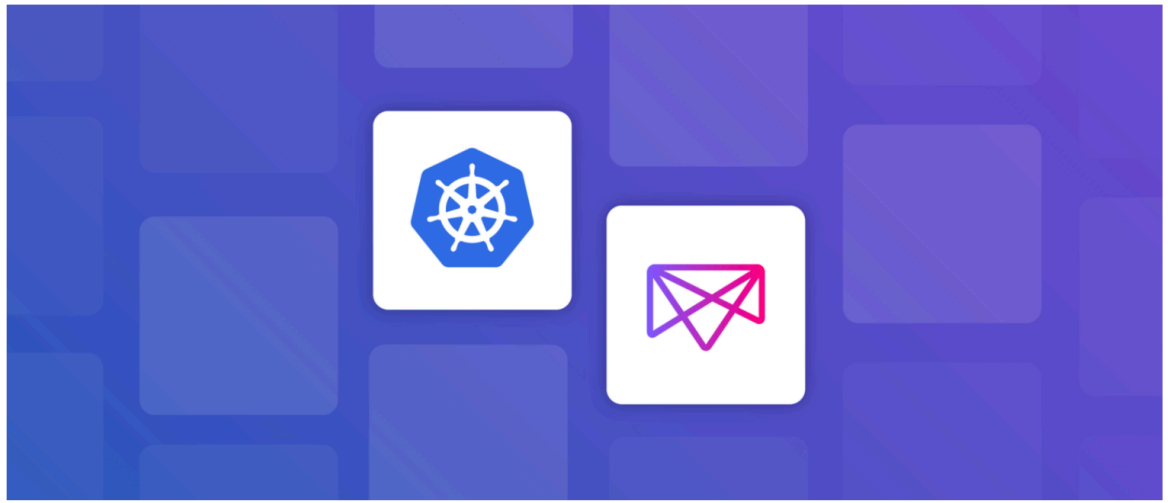
https://mesosphere.com/blog/kubernetes-dcos/

Support for Kubernetes added in late 2017…

COMPANY, PARTNERS

Announcing: Kubernetes on DC/OS

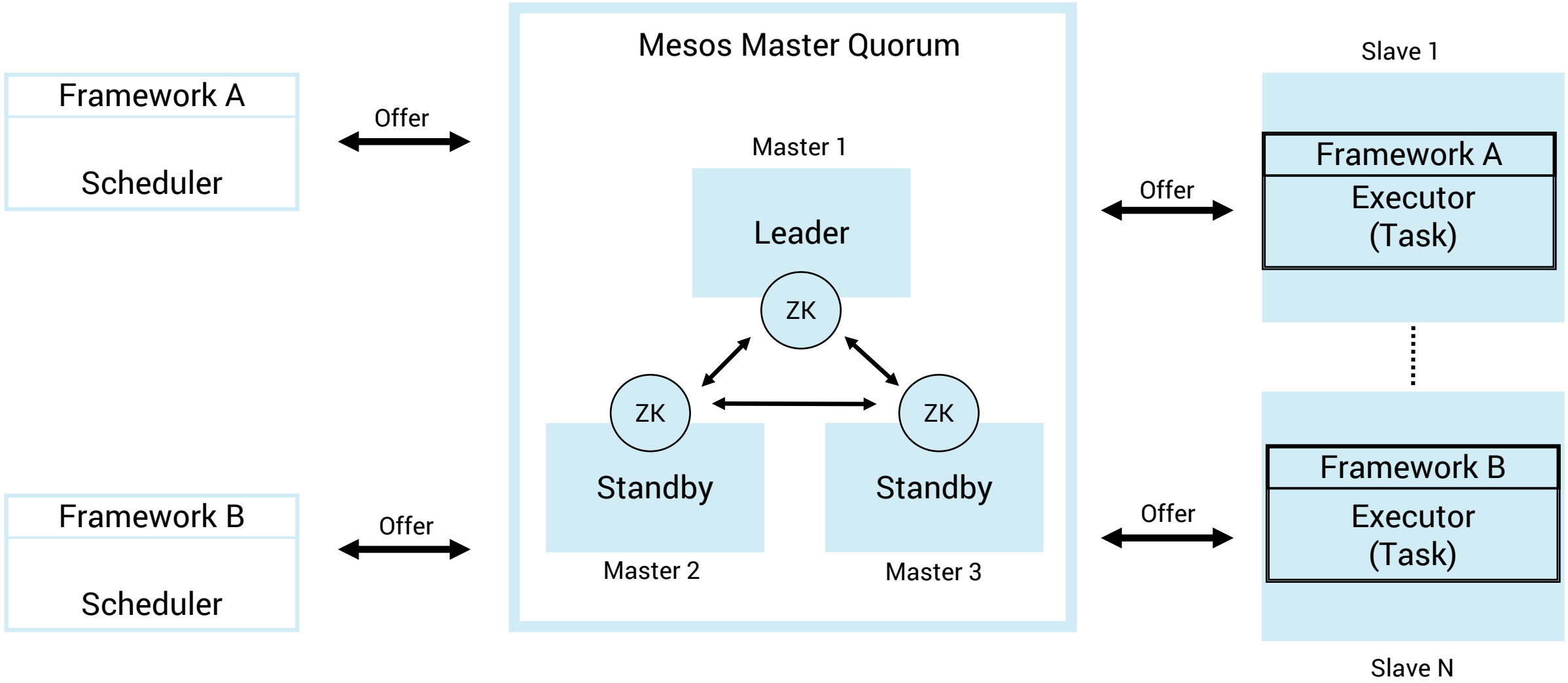
Announcing the beta availability of Kubernetes on DC/OS. Learn why this is the first step towards making DC/OS the best place to run K8s.



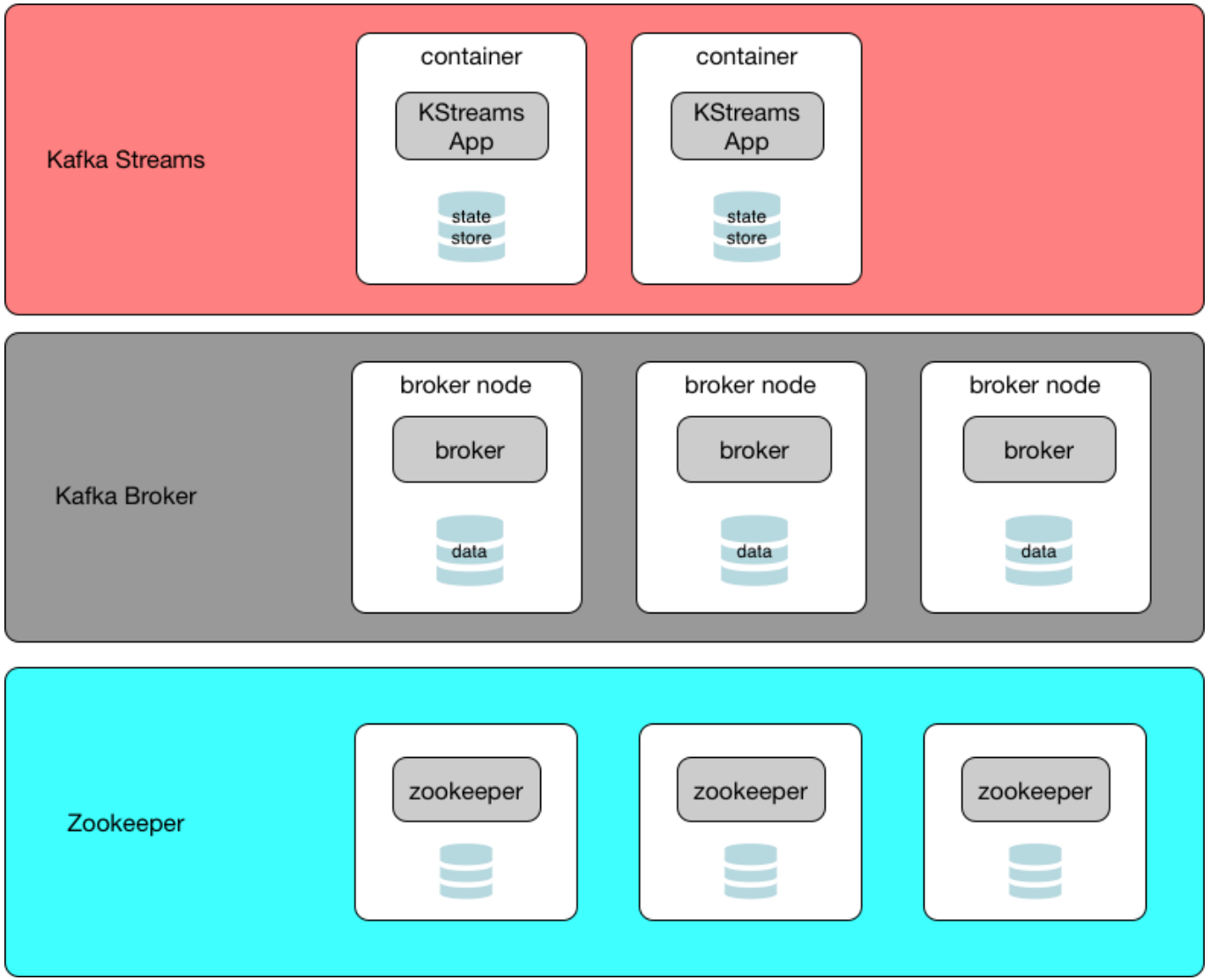
"Kubernetes on top of Mesos through DC/OS allows our customers to **deploy the popular container orchestrator on top of a powerful distributed systems platform**. With this unique architectural approach, Mesosphere DC/OS can provide an experience like the public cloud providers' container engines within our customers' data centers or across hybrid cloud."

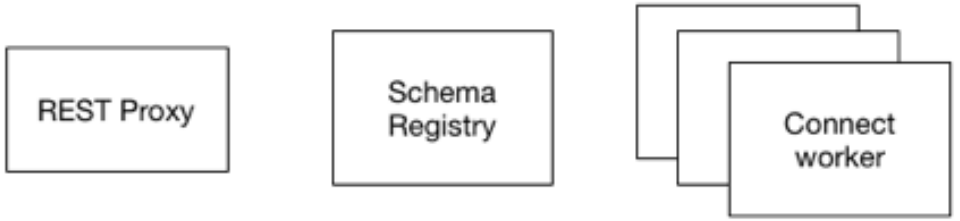
https://mesosphere.com/blog/kubernetes-dcos/

Mesos Architecture

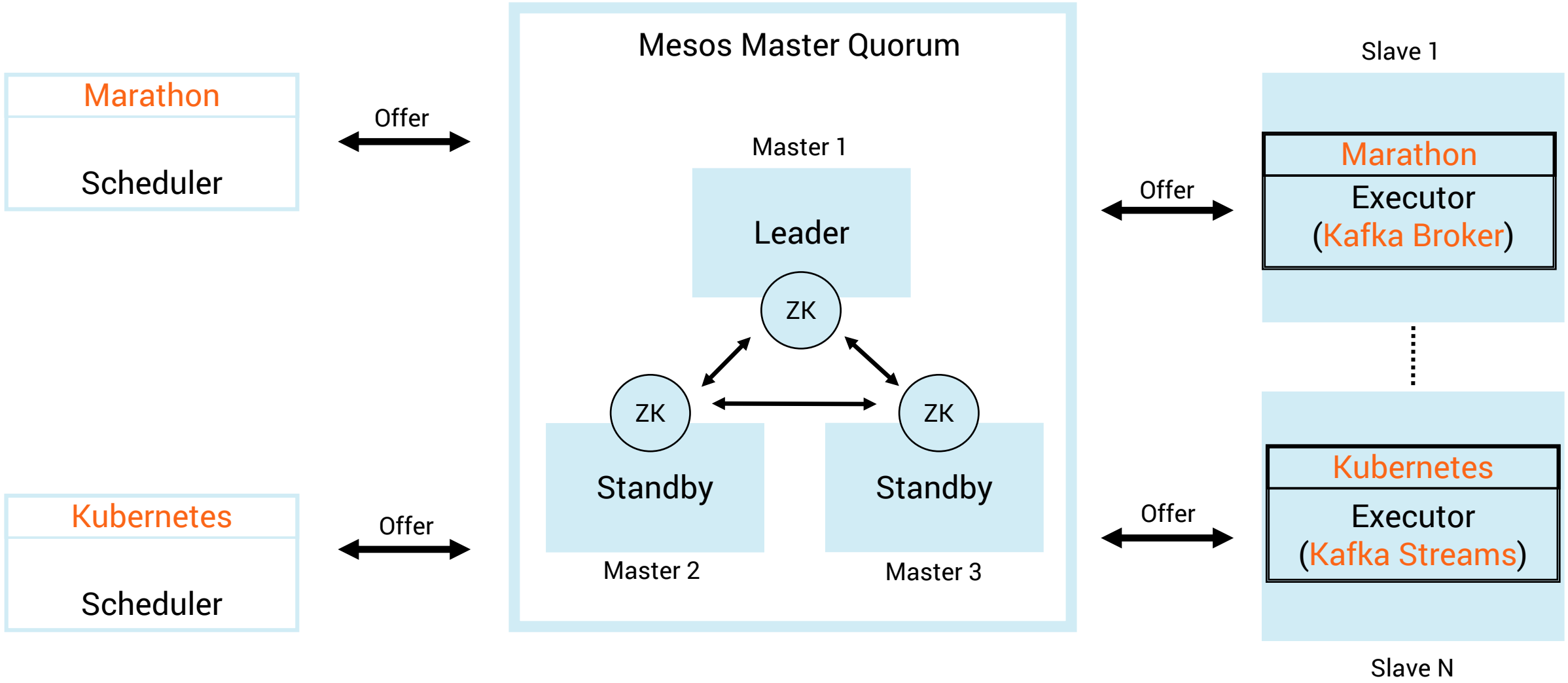


Components of a Kafka Cluster





Mesos Architecture



Why DC/OS for the Kafka Ecosystem?

- **Automated provisioning and upgrading of Kafka components**
  - Broker, REST Proxy, Schema Registry, Connect …
  - Kafka applications (Java / Go / .NET / Python Clients, Kafka Streams, KSQL)
  - Monitoring (Confluent Control Center, etc.)

- **Unified management and monitoring**
  - Easy interactive installation
  - Multiple Kafka Cluster on one infrastructure + multi-tenancy
  - Combination with other Big Data components (Spark, Cassandra, etc.) on one infrastructure
  - Integration with syslog-compatible logging services for diagnostics and troubleshooting

- **Elastic scaling, fault tolerance and self-healing**
  - Stateful and stateless services
  - Service discovery and routing (using the corresponding Mesos framework, i.e. Marathon or Kubernetes)
  - Kafka VIP Connection (one “static” bootstrap server url)
  - Storage volumes for enhanced data durability, known as Mesos Dynamic Reservations and Persistent Volumes

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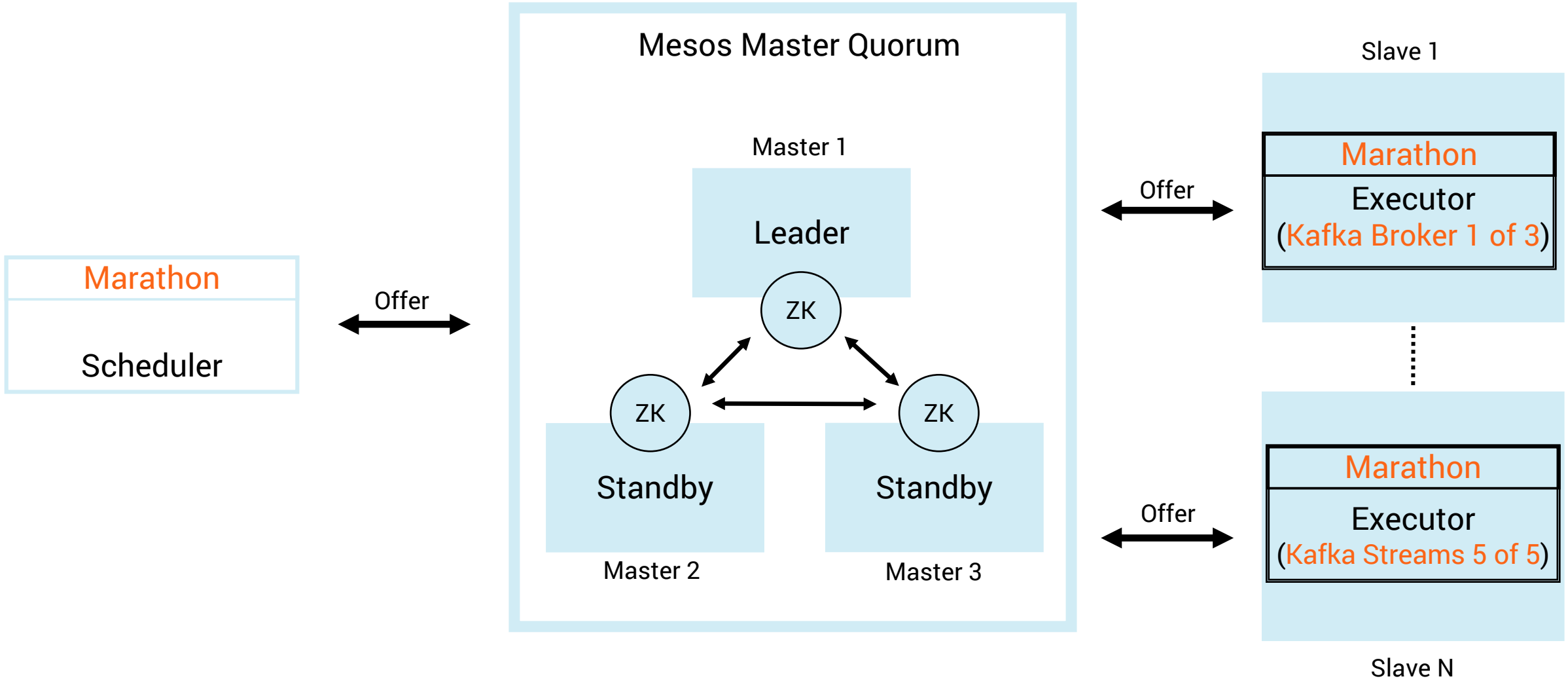
Scenario for Highly Scalable Microservices

Use Case:
Airline Flight Delay Prediction

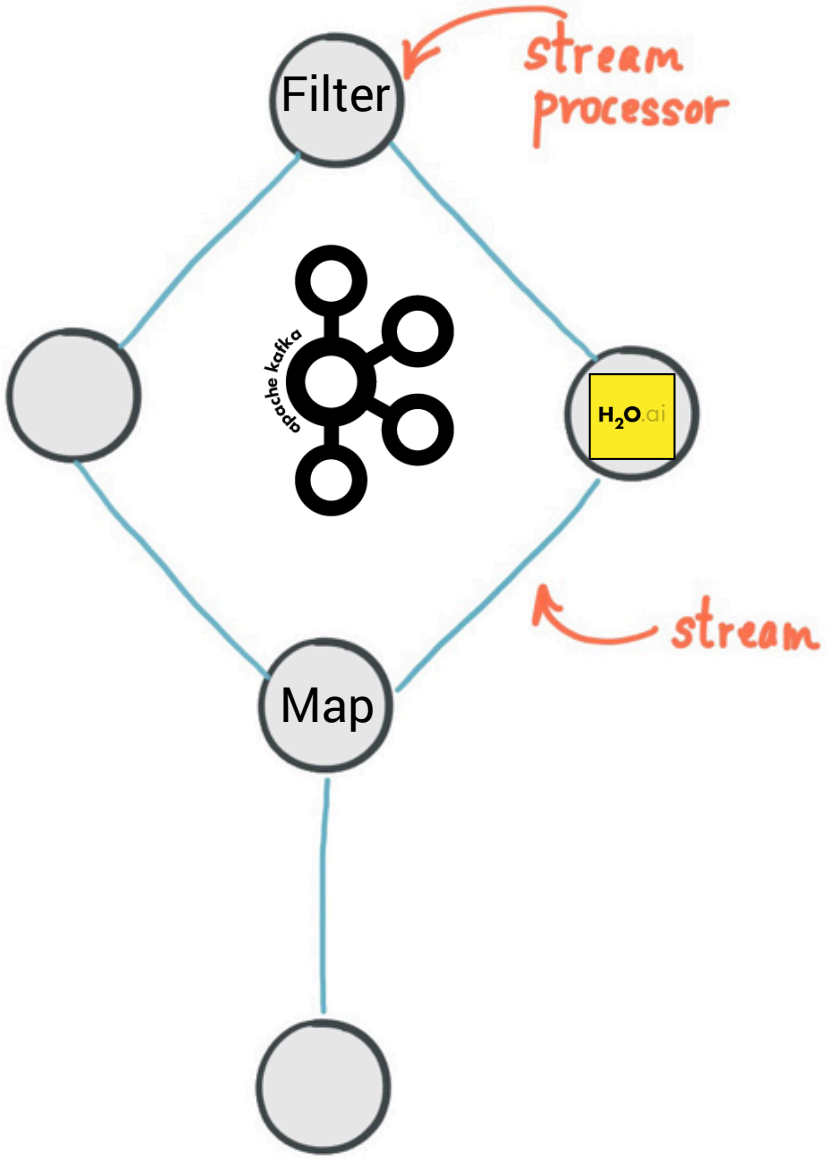
Machine Learning Algorithm:
Gradient Boosting (GBM)
using Decision Trees

Technologies:
DC/OS
Kafka Broker
Kafka Streams
H2O.ai

Architecture – Live Demo



H2O.ai Model + Kafka Streams



1) Create H2O ML Model

```
// Create H2O object (see gbm_pojo_test.java)
hex.genmodel.GenModel rawModel;
rawModel = (hex.genmodel.GenModel) Class.forName(modelClassName).newInstance();
EasyPredictModelWrapper model = new EasyPredictModelWrapper(rawModel);
```

2) Configure Kafka Streams Application

```
// Configure Kafka Streams Application
final String bootstrapServers = args.length > 0 ? args[0] : "localhost:9092";
final Properties streamsConfiguration = new Properties();
// Give the Streams application a unique name. The name must be unique
// in the Kafka cluster
// against which the application is run.
streamsConfiguration.put(StreamsConfig.APPLICATION_ID_CONFIG, "machine-learning-example");
// Where to find Kafka broker(s).
streamsConfiguration.put(StreamsConfig.BOOTSTRAP_SERVERS_CONFIG, bootstrapServers);
```

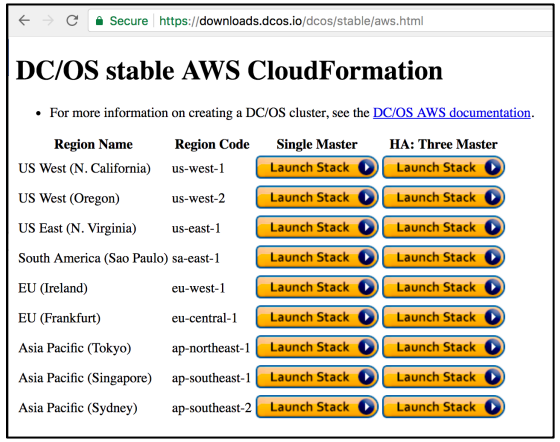
3) Apply H2O ML Model to Streaming Data

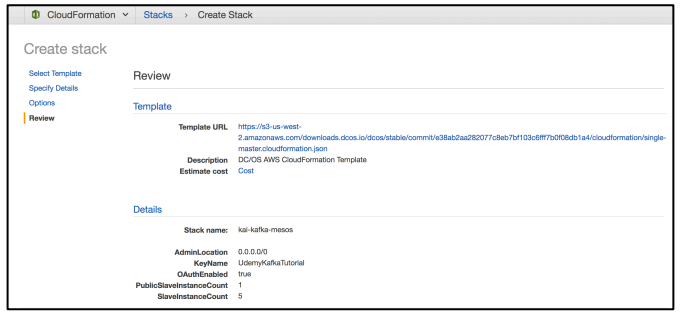
```
airlineInputLines.foreach(new ForeachAction<String, String>() {
    public void apply(String key, String value) {

        // Year,Month,DayofMonth,DayOfWeek,DepTime,CRSDepTime,ArrTime,CRSArrTime,UniqueCarrier,FlightNum,TailNum,Actu
        // value:
        // 1987,10,14,3,741,730,912,849,PS,1451,NA,91,79,NA,23,11,SAN,SFO,447,NA,NA,0,NA,0,NA,NA,NA,NA,NA,YES,YES

        if (value != null && !value.equals("")) {
            System.out.println("####################");
            System.out.println("Flight Input:" + value);

            String[] valuesArray = value.split(",");

            RowData row = new RowData();
            row.put("Year", valuesArray[0]);
            row.put("Month", valuesArray[1]);
            row.put("DayofMonth", valuesArray[2]);
            row.put("DayOfWeek", valuesArray[3]);
            row.put("CRSDepTime", valuesArray[5]);
            row.put("UniqueCarrier", valuesArray[8]);
            row.put("Origin", valuesArray[16]);
            row.put("Dest", valuesArray[17]);
            BinomialModelPrediction p = null;
            try {
                p = model.predictBinomial(row);
            } catch (PredictException e) {
                e.printStackTrace();
            }

            System.out.println("Label (aka prediction) is flight departure delayed: " + p.label);
            System.out.print("Class probabilities: ");
            for (int i = 0; i < p.classProbabilities.length; i++) {
                if (i > 0) {
                    System.out.print(",");
                }
                System.out.print(p.classProbabilities[i]);
            }
```

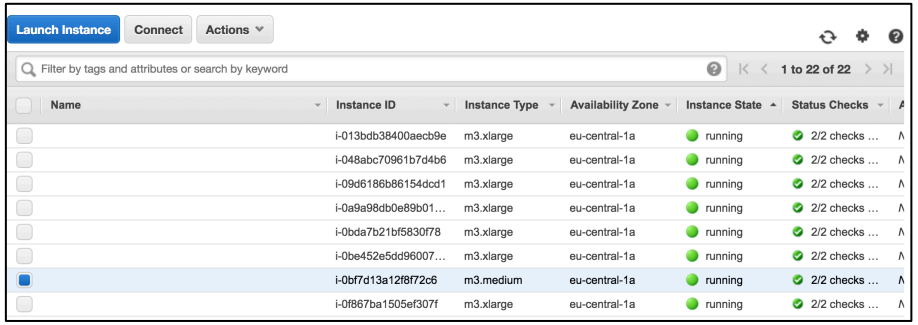
4) Start Kafka Streams App

```
KStream<String, Object> transformedMessage = airlineInputLines.mapValues(value -> "KAI");

transformedMessage.to("AirlineOutputTopic");

final KafkaStreams streams = new KafkaStreams(builder, streamsConfiguration);

streams.start();
```

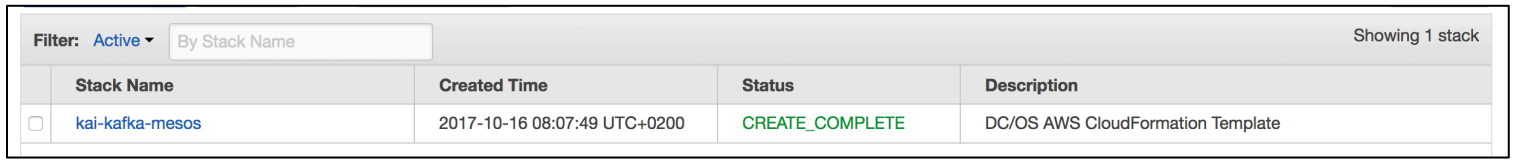
DC/OS on AWS





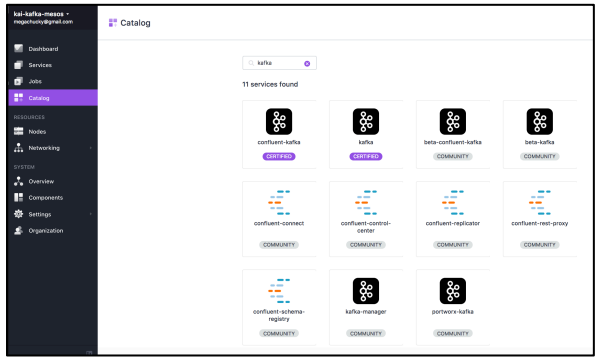


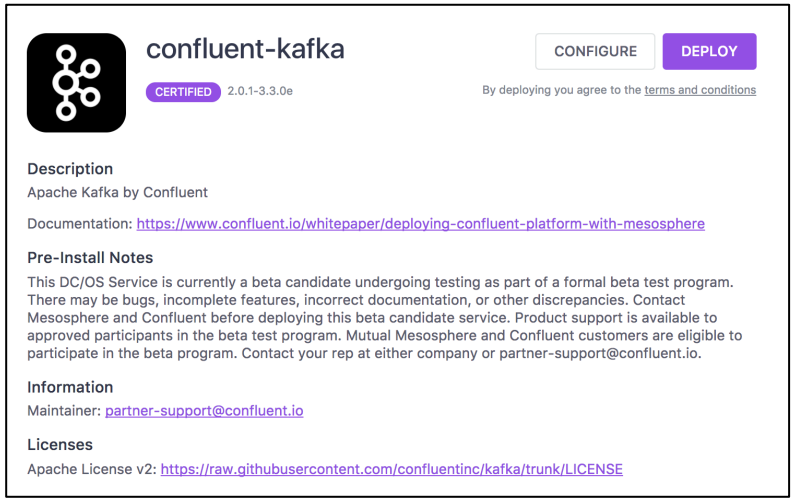
Logical ID	Physical ID	Type	Status
AdminSecurityGroup	sg-4ddf0c27	AWS::EC2::SecurityGroup	CREATE_COMPLETE
DHCPOptions	dopt-3d785355	AWS::EC2::DHCPOptions	CREATE_COMPLETE
ElasticLoadBalancer	kai-kafka-ElasticL-1CC7BQF1NQU83	AWS::ElasticLoadBalancing::...	CREATE_COMPLETE
ExhibitorS3Bucket	kai-kafka-mesos-exhibitors3bucket-fvl6h731h5i8	AWS::S3::Bucket	CREATE_COMPLETE
GatewayToInternet	kai-k-Gatew-N67EBATROY0G	AWS::EC2::VPCGatewayAtta...	CREATE_COMPLETE
InboundNetworkAclEntry	kai-k-Inbou-15NK4D5HF8YIL	AWS::EC2::NetworkAclEntry	CREATE_COMPLETE
InternalMasterLoadBal...	kai-kafka-Internal-1MH6OA6BQ9G5D	AWS::ElasticLoadBalancing::...	CREATE_COMPLETE
InternetGateway	igw-e2f4288a	AWS::EC2::InternetGateway	CREATE_COMPLETE
LbSecurityGroup	sg-4cdf0c26	AWS::EC2::SecurityGroup	CREATE_COMPLETE
MasterInstanceProfile	kai-kafka-mesos-MasterInstanceProfile-J0UX3T5WNR0K	AWS::IAM::InstanceProfile	CREATE_COMPLETE
MasterLaunchConfig	kai-kafka-mesos-MasterLaunchConfig-1MB0MEPZ4DD7O	AWS::AutoScaling::LaunchCo...	CREATE_COMPLETE
MasterRole	kai-kafka-mesos-MasterRole-1UCTGMIDFEWKC	AWS::IAM::Role	CREATE_COMPLETE
MasterSecurityGroup	sg-4ede0d24	AWS::EC2::SecurityGroup	CREATE_COMPLETE
MasterServerGroup	kai-kafka-mesos-MasterServerGroup-4O40KL2JNEPL	AWS::AutoScaling::AutoScali...	CREATE_COMPLETE
MasterToMasterIngress	MasterToMasterIngress	AWS::EC2::SecurityGroupIngr...	CREATE_COMPLETE
MasterToPublicSlaveIn...	MasterToPublicSlaveIngress	AWS::EC2::SecurityGroupIngr...	CREATE_COMPLETE

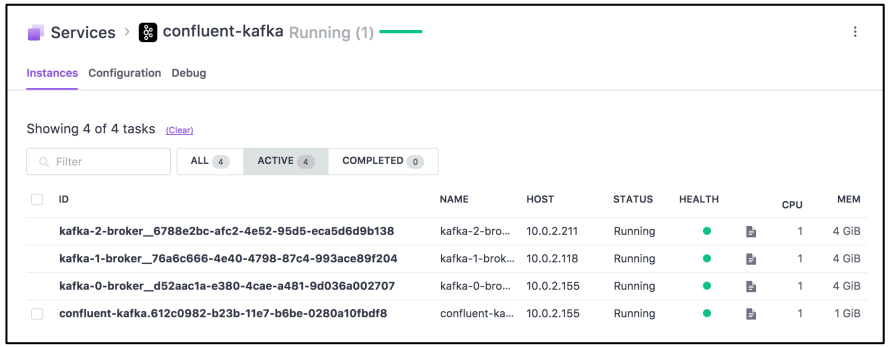


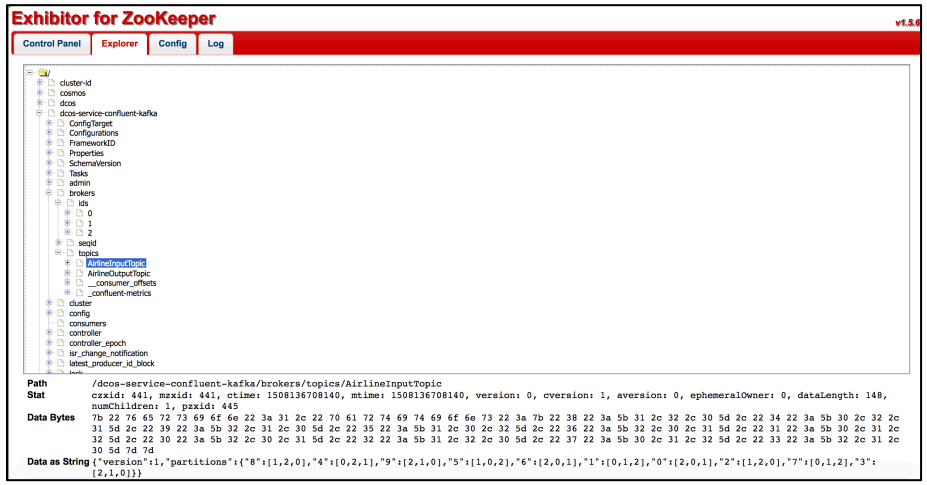
https://downloads.dcos.io/dcos/stable/aws.html

Kafka Brokers on DC/OS



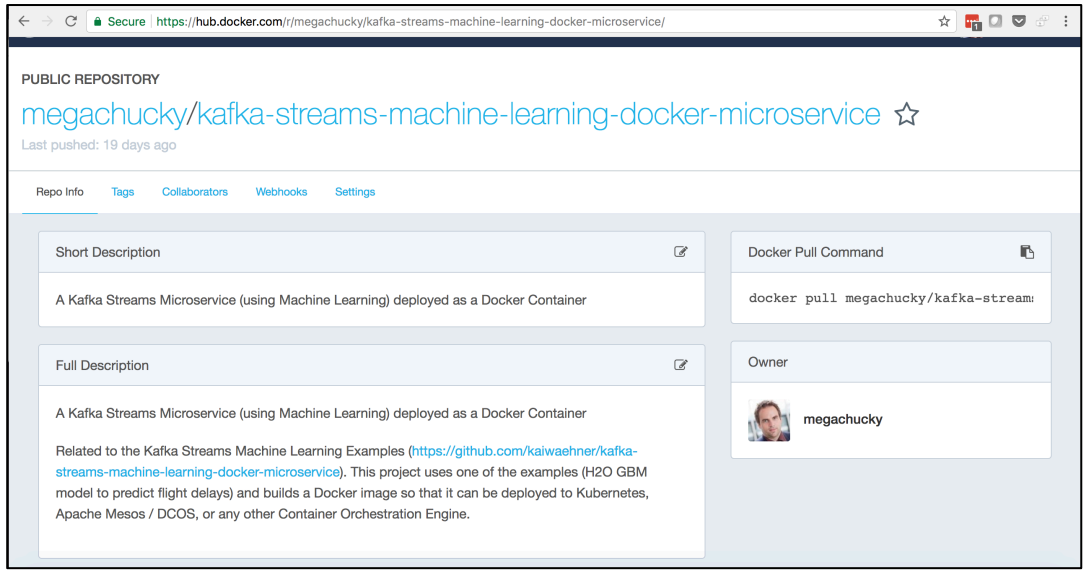


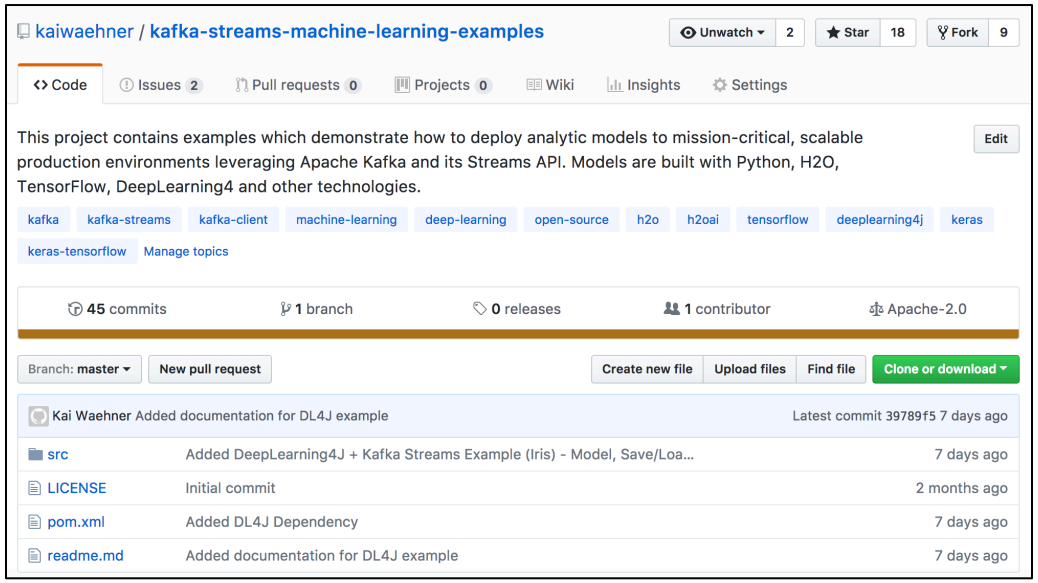





```
[~: dcos kafka --name confluent-kafka endpoints broker
{
  "address": [
    "10.0.2.155:1025",
    "10.0.2.118:1025",
    "10.0.2.211:1025"
  ],
  "dns": [
    "kafka-0-broker.confluent-kafka.autoip.dcos.thisdcos.directory:1025",
    "kafka-1-broker.confluent-kafka.autoip.dcos.thisdcos.directory:1025",
    "kafka-2-broker.confluent-kafka.autoip.dcos.thisdcos.directory:1025"
  ],
  "vip": "broker.confluent-kafka.l4lb.thisdcos.directory:9092"
}
```

Kafka Streams Microservice



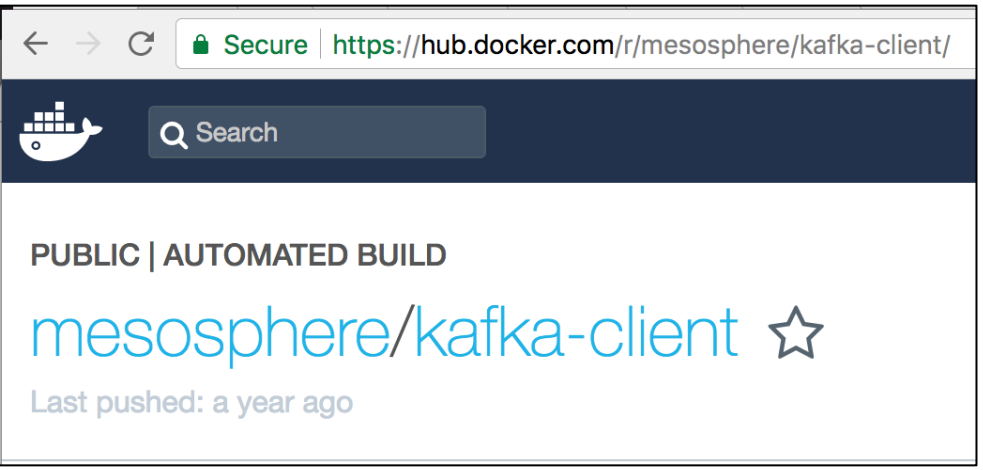


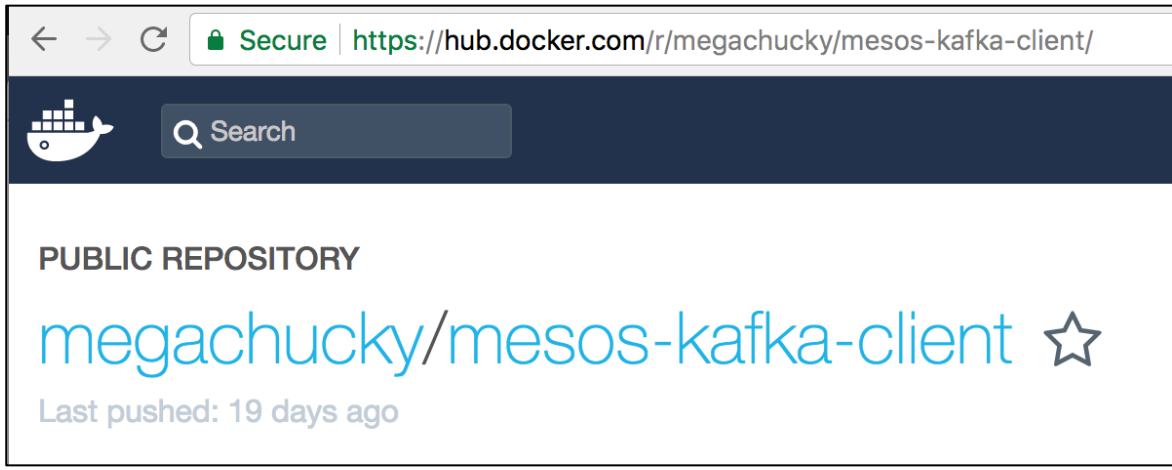
Dockerfile:
```
FROM java:8
ADD /opt/kafka-streams-h2o-docker-microservice-1.0-SNAPSHOT-jar-with-dependencies.jar /opt/
ENTRYPOINT ["java", "-jar", "/opt/kafka-streams-h2o-docker-microservice-1.0-SNAPSHOT-jar-with-dependencies.jar"]
```

dcos kafka --name confluent-kafka topic create AirlineInputTopic --partitions 10 --replication 3
dcos kafka --name confluent-kafka topic create AirlineOutputTopic --partitions 10 --replication 3

https://hub.docker.com/r/megachucky/kafka-streams-machine-learning-docker-microservice/
https://github.com/kaiwaehner/kafka-streams-machine-learning-docker-microservice

Kafka Client (compatible with Kafka Streams) on DC/OS





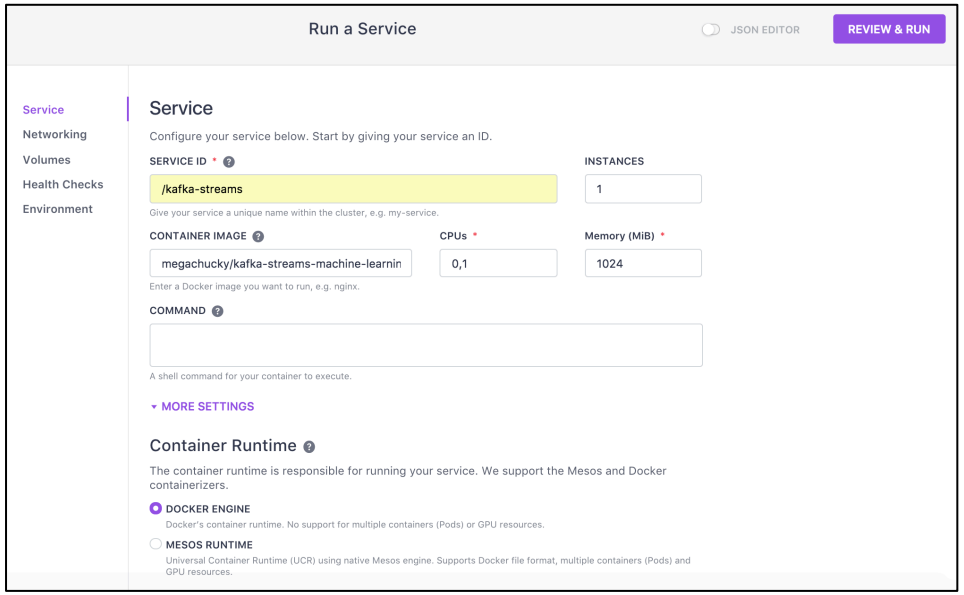
From Apache Kafka 0.9 to 0.11 (Kafka Streams messages require timestamps)

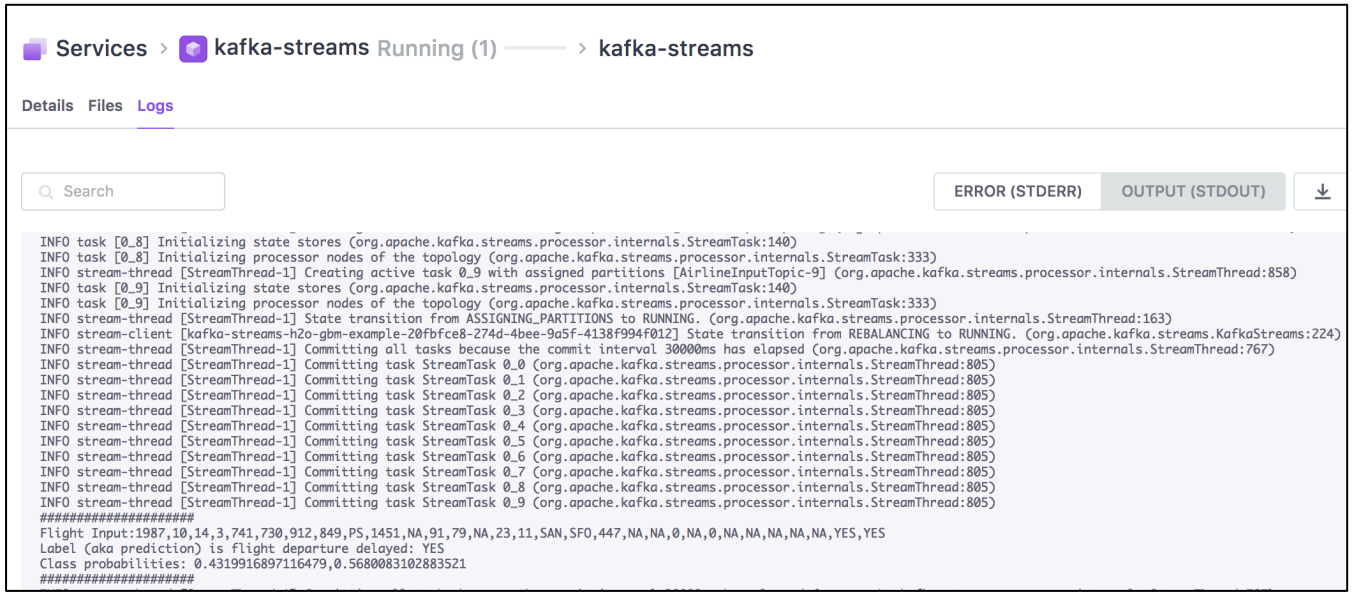
dcos node ssh --master-proxy –leader
docker run -it megachucky/mesos-kafka-client

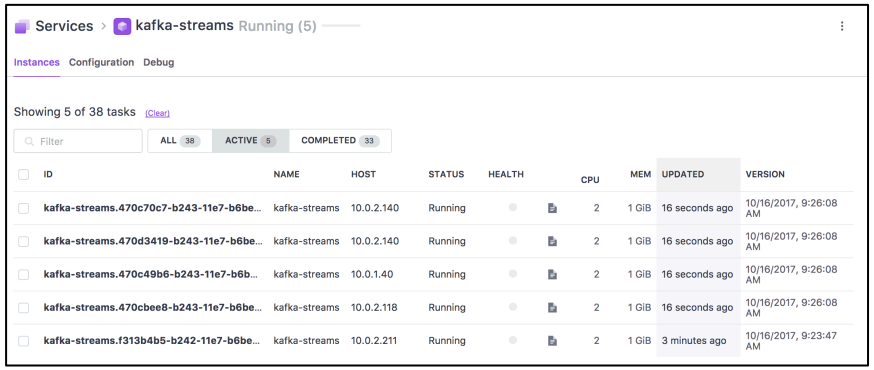
Dockerfile:
FROM java:openjdk-8-jreMAINTAINER Kai Waehner
curl http://apache.mirrors.spacedump.net/kafka/0.11.0.1/kafka_2.11-0.11.0.1.tgz | tar xvz --strip-components=1
WORKDIR /bin

https://hub.docker.com/r/mesosphere/kafka-client/
https://hub.docker.com/r/megachucky/mesos-kafka-client/

Kafka Streams Microservice on DC/OS





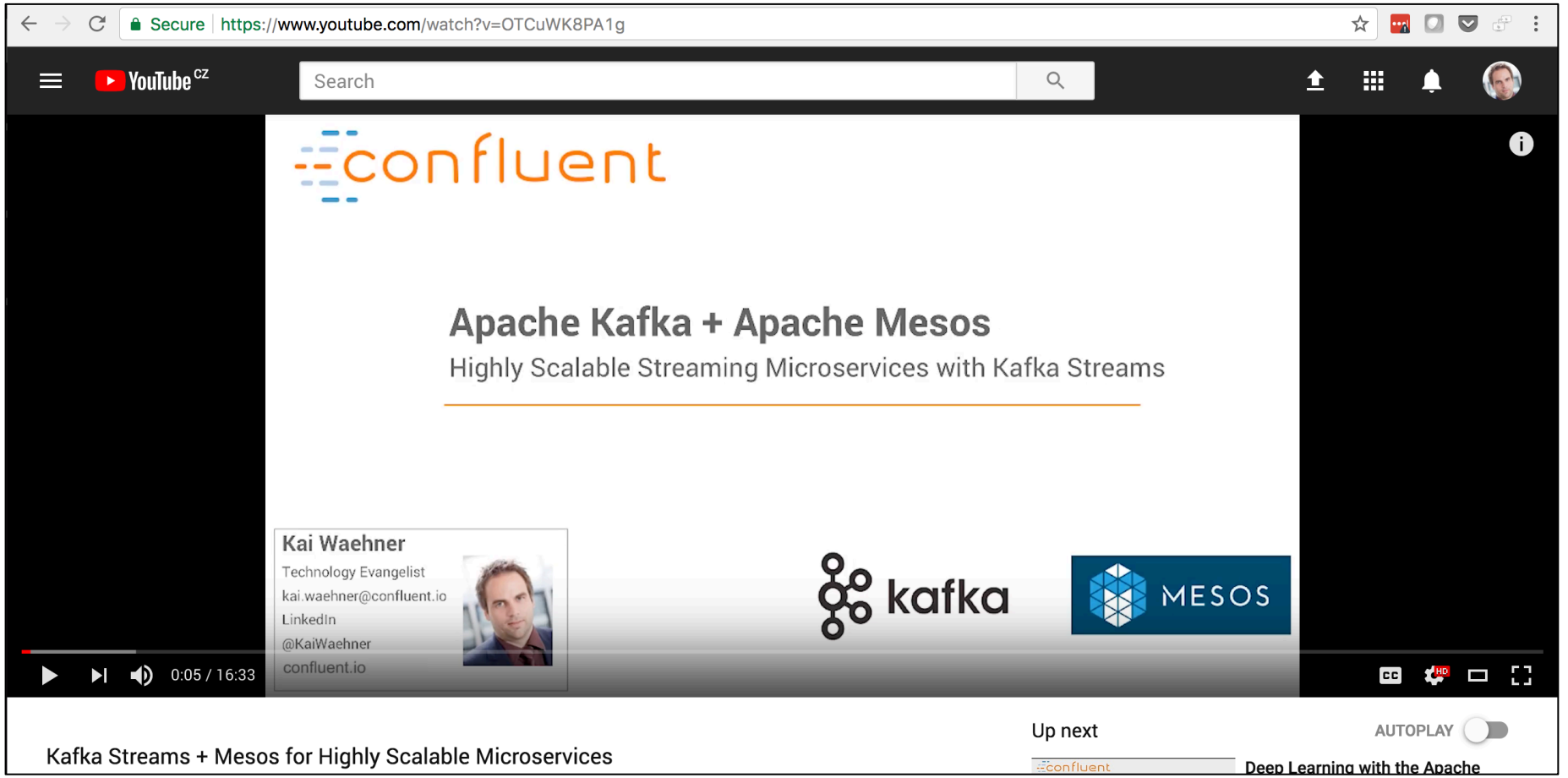


Live Demo

kafka

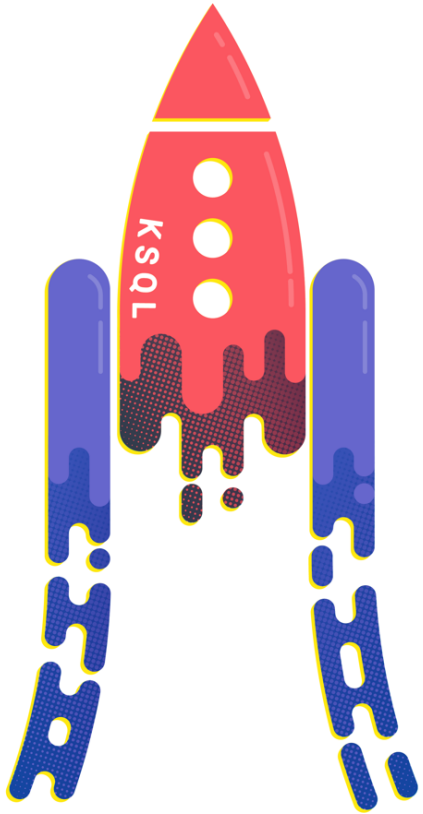
MESOS

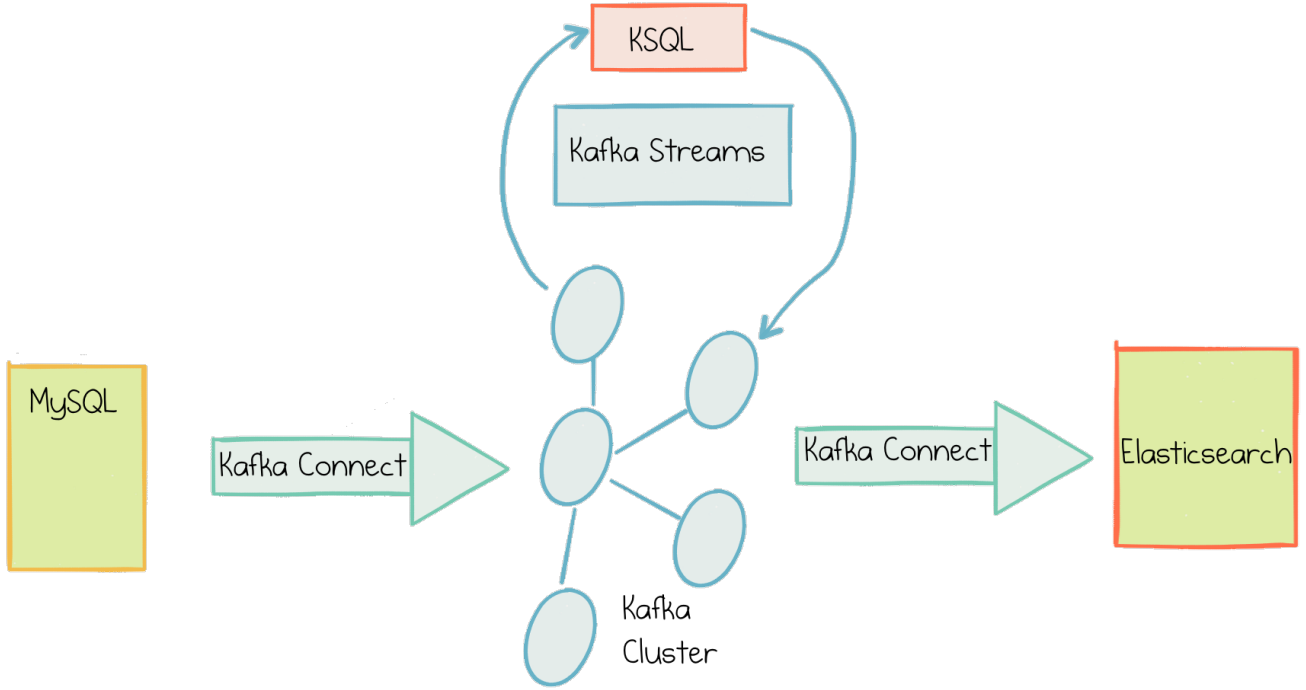
Video Recording of the Live Demo



https://www.youtube.com/watch?v=OTCuWK8PA1g

KSQL on DC/OS – It is a Kafka Streams app under the hood!






```
SELECT STREAM
  CEIL(timestamp TO HOUR) AS timeWindow, productId, COUNT(*) AS hourlyOrders, SUM(units) AS units
FROM Orders GROUP BY CEIL(timestamp TO HOUR), productId;

 timeWindow | productId | hourlyOrders | units
------------+-----------+--------------+-------
   08:00:00 |        10 |            2 |     5
   08:00:00 |        20 |            1 |     8
   09:00:00 |        10 |            4 |    22
   09:00:00 |        40 |            1 |    45
        ... |       ... |          ... |   ...
```

Key Take-Aways

- Apache Kafka Ecosystem on DC/OS for Highly Scalable, Fault-Tolerant Microservices
- DC/OS offers many Kafka Features out-of-the-box (one-click-provisioning, VIP connection, …)
- Kafka Streams and KSQL Microservices run and scale on DC/OS via Marathon or Kubernetes

Questions? Feedback? Please contact me!

Kai Waehner

Technology Evangelist

kontakt@kai-waehner.de
@KaiWaehner
www.confluent.io
www.kai-waehner.de
LinkedIn