EVENT STREAM PROCESSING USING KAFKA STREAMS

Fredrik Vraalsen, Berlin Buzzwords 2018, 12.06.2018

SCHIBSTED MEDIA GROUP

GETTING STARTED

```
git clone https://github.com/fredriv/kafka-streams-workshop.git

cd kafka-streams-workshop

./gradlew build
```

AGENDA

- Intro
- Why streaming?
- Kafka & Kafka Streams
- The basics: Filter, transform and routing
- Next level: Aggregations and windowing

WHO AM I?

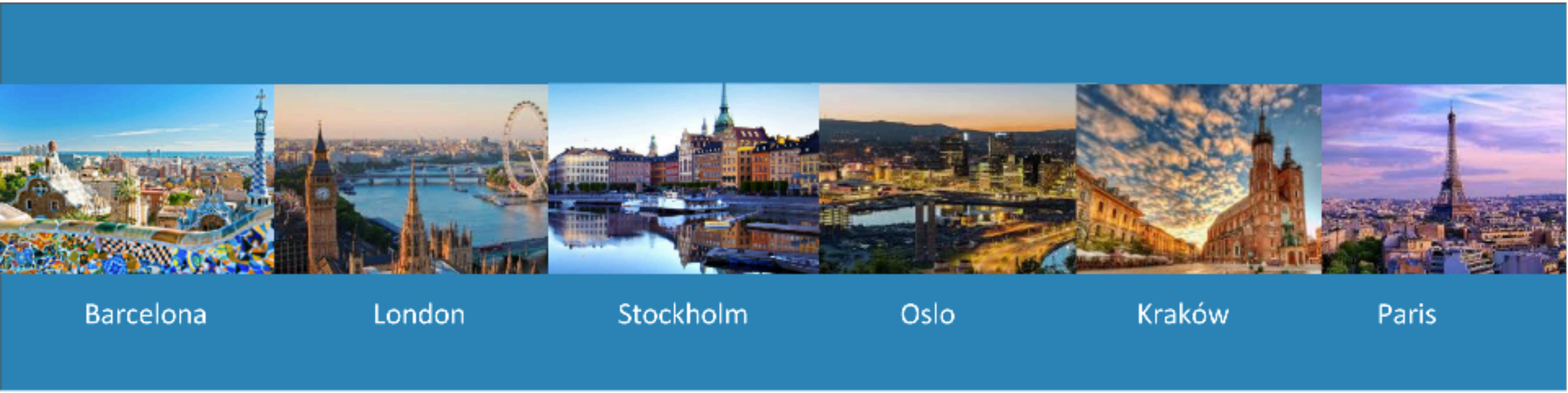
- Data Engineer
- Schibsted Data Platform

FREDRIK VRAALSEN

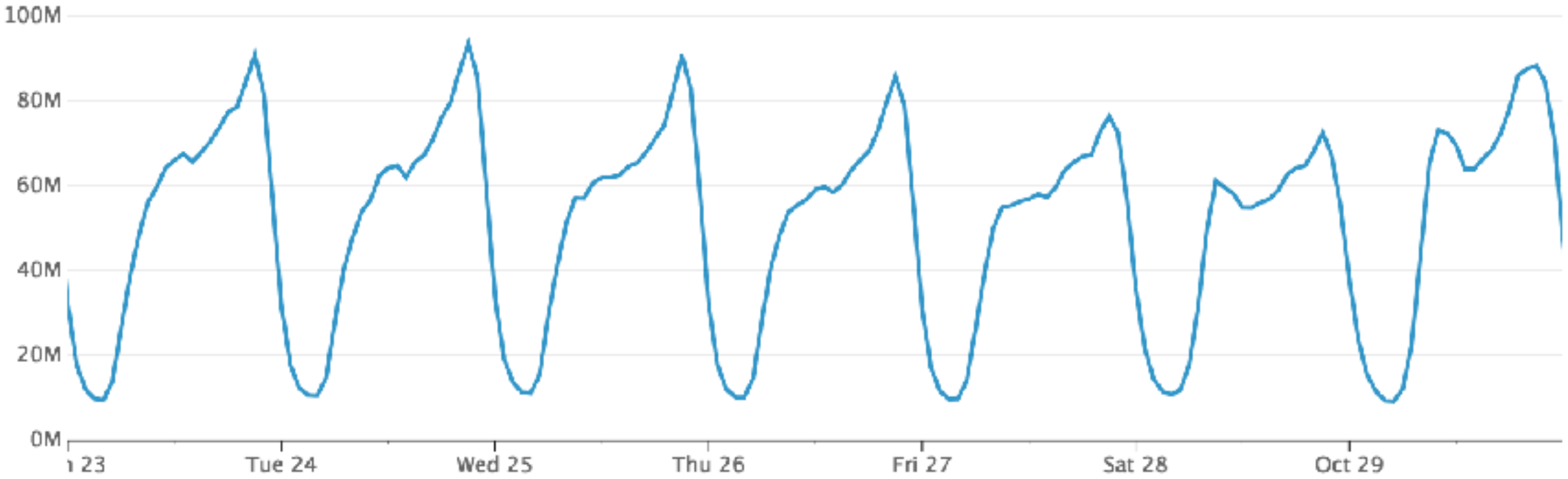
SCHIBSTED


MEDIAHOUSES
Aftenposten
VG
btno
AFTONBLADET
SvD
etc...
MARKETPLACES
FINN
WILLHABEN.AT
blocket.se
leboncoin
VIBBO
subito
DoneDeal.ie
bomnegócio.com
etc...
GROWTH
Compricer
Prisjakt
hitta.se
Lendo
Tripwell
let's deal
sh
shpock
etc...

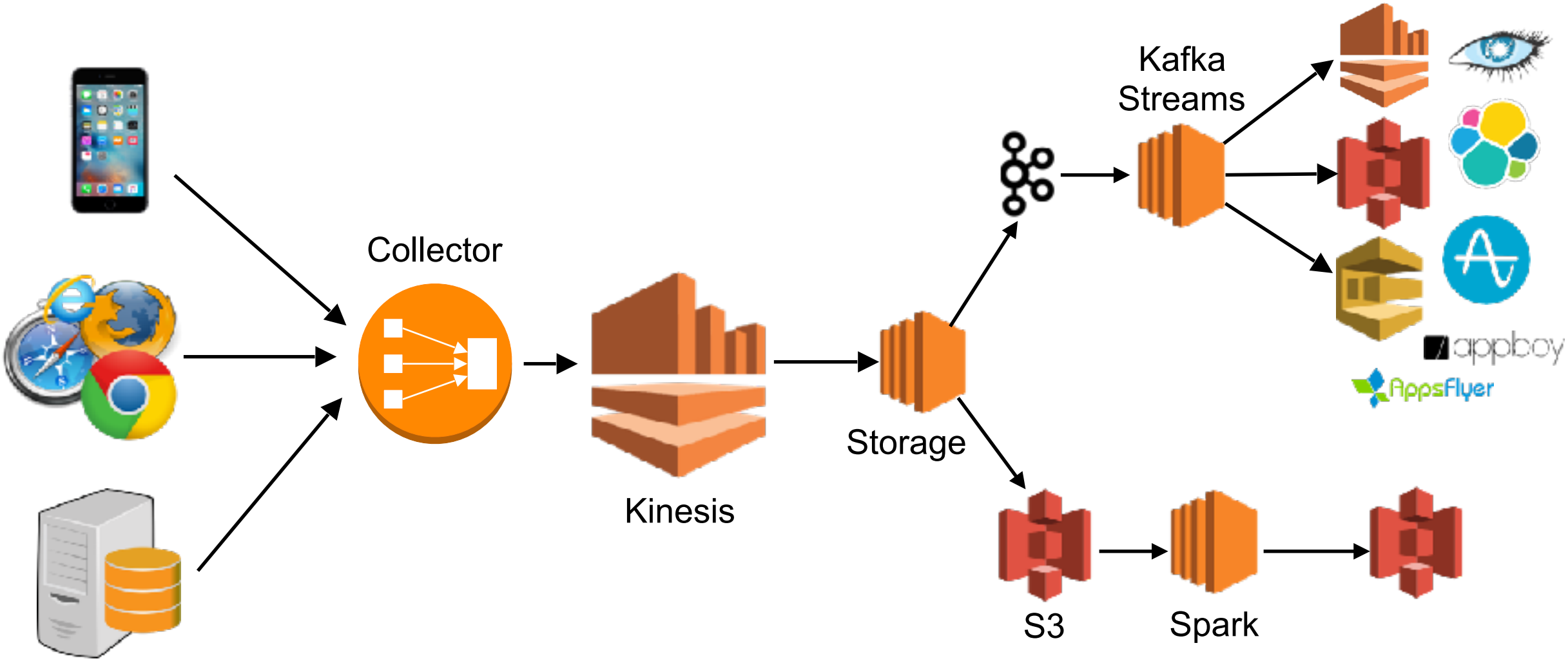
SCHIBSTED TECH HUBS



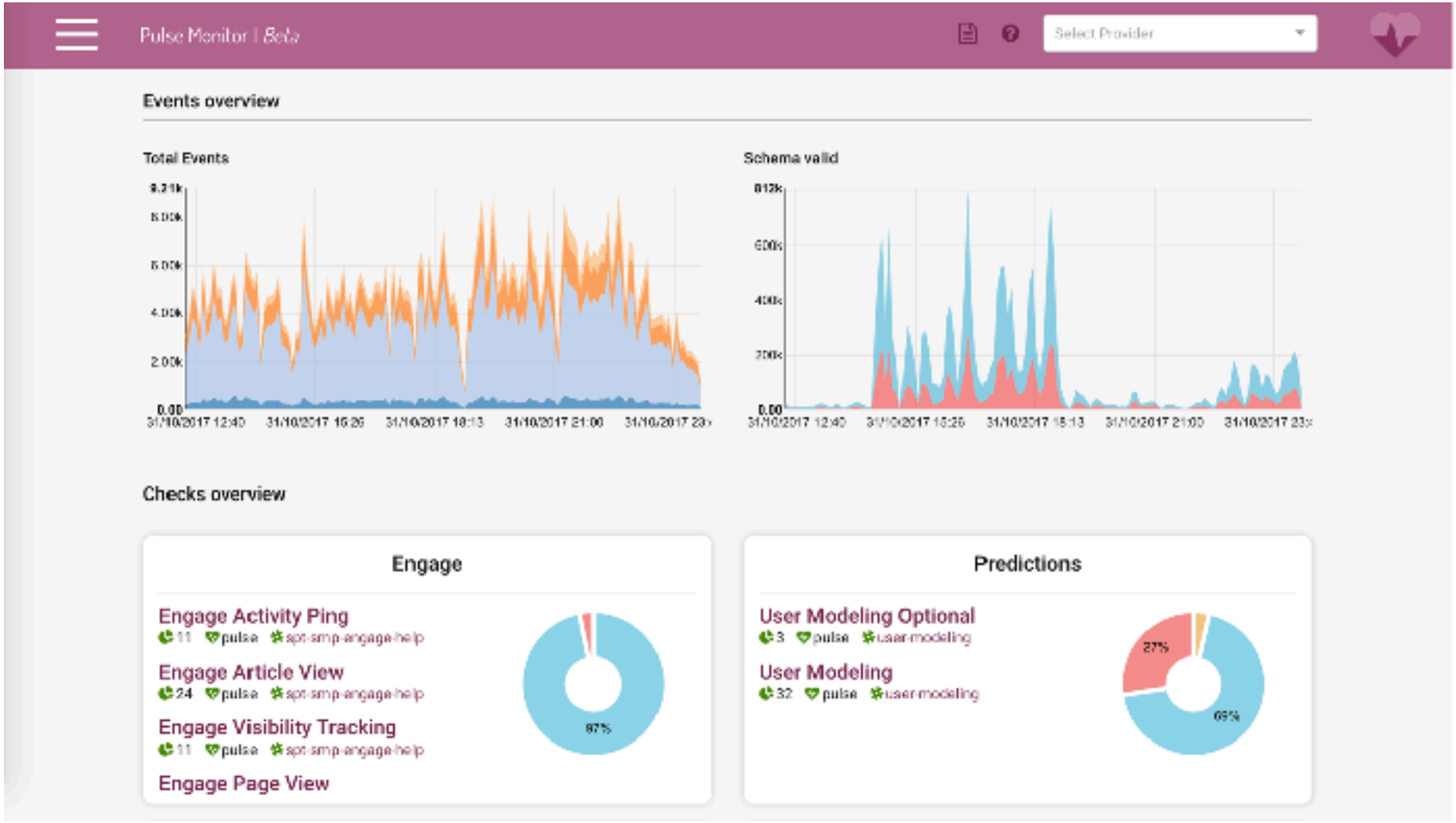
INCOMING EVENTS



DATA PIPELINE



DATA QUALITY



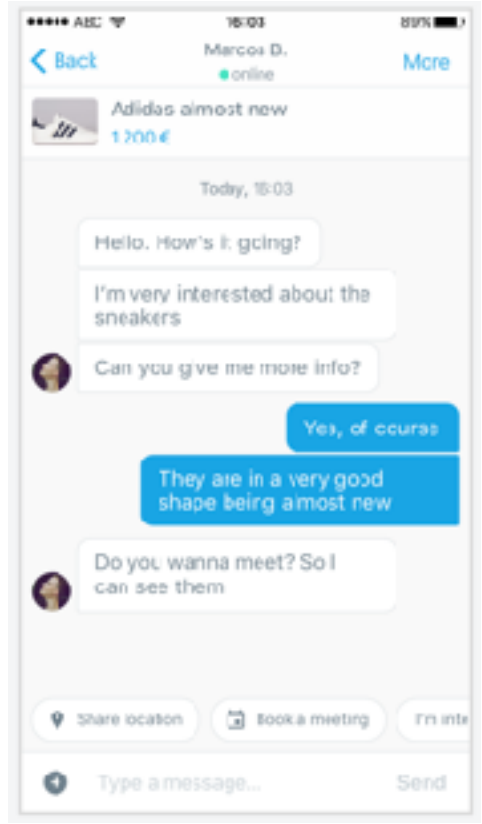
github.com/fredriv/kafka-streams-workshop

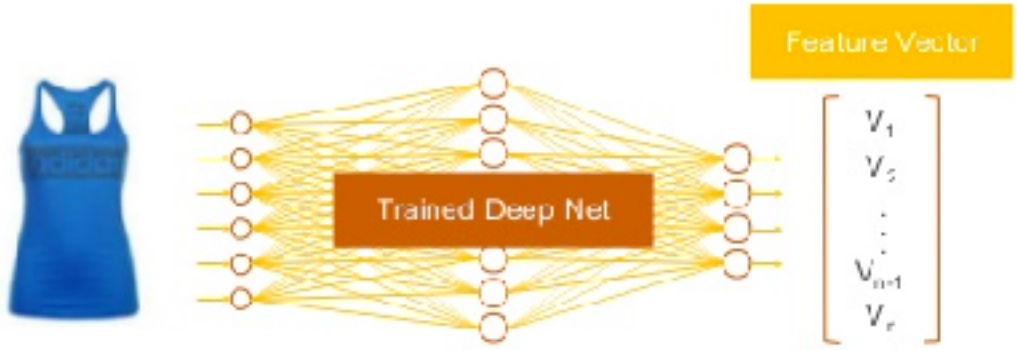
3RD PARTY ANALYTICS

DATA-DRIVEN APPLICATIONS

https://www.flickr.com/photos/rahulrodriguez/14683524180

https://pixabay.com/en/map-photoshop-geolocation-journey-947471/

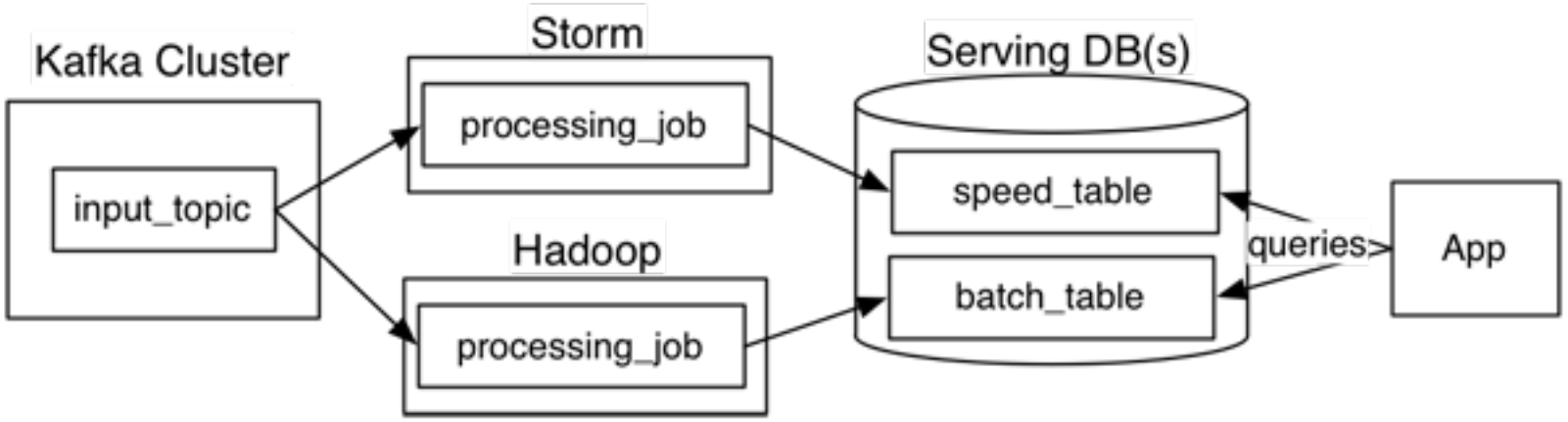




https://www.slideshare.net/DataStax/c-for-deep-learning-andrew-jefferson-tracktable-cassandra-summit-2016

WHY STREAMING?

- Real-time, low latency



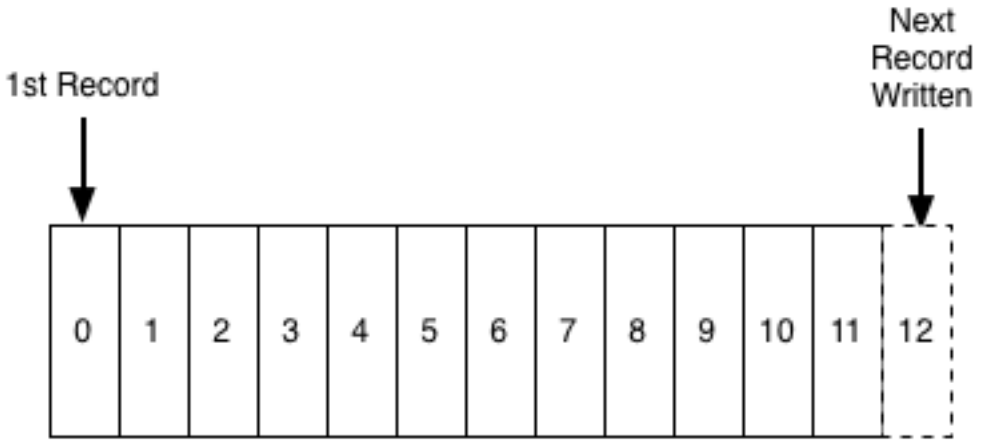
https://www.oreilly.com/ideas/questioning-the-lambda-architecture

STREAM PROCESSING

- Unbounded datasets
- Unordered events
- Correctness
- Time

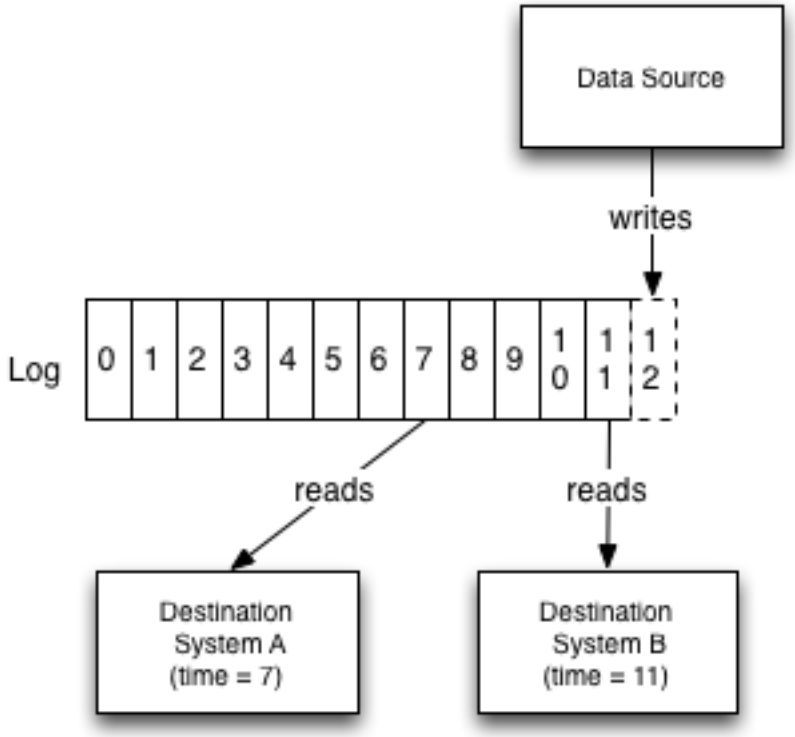

kafka

kafka AND THE DISTRIBUTED LOG



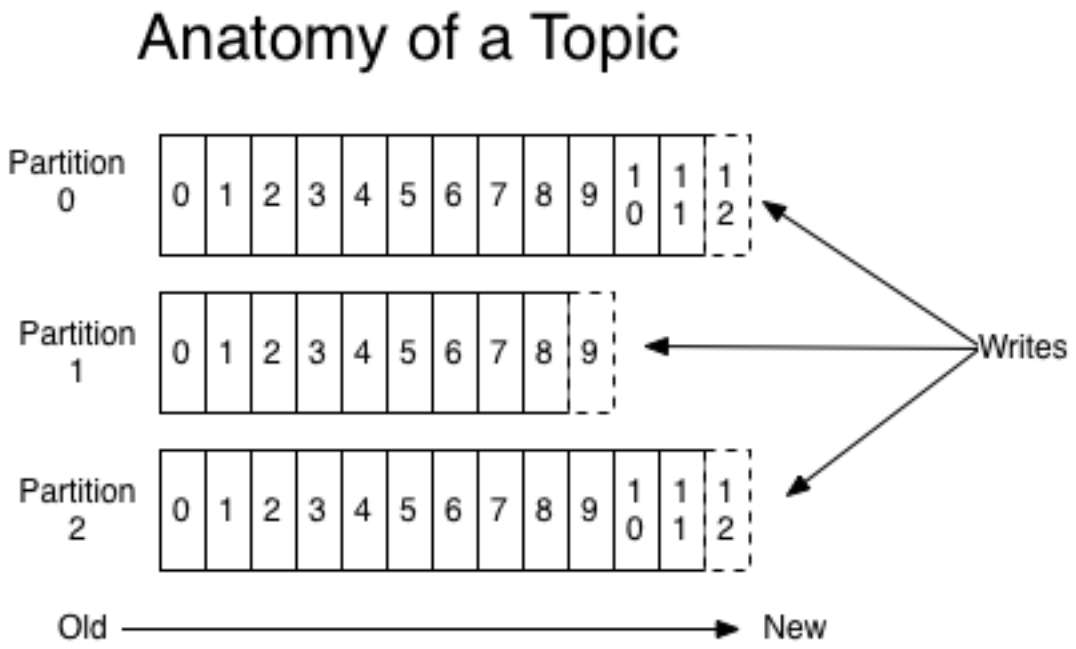
https://engineering.linkedin.com/distributed-systems/log-what-every-software-engineer-should-know-about-real-time-datas-unifying

kafka AND THE DISTRIBUTED LOG



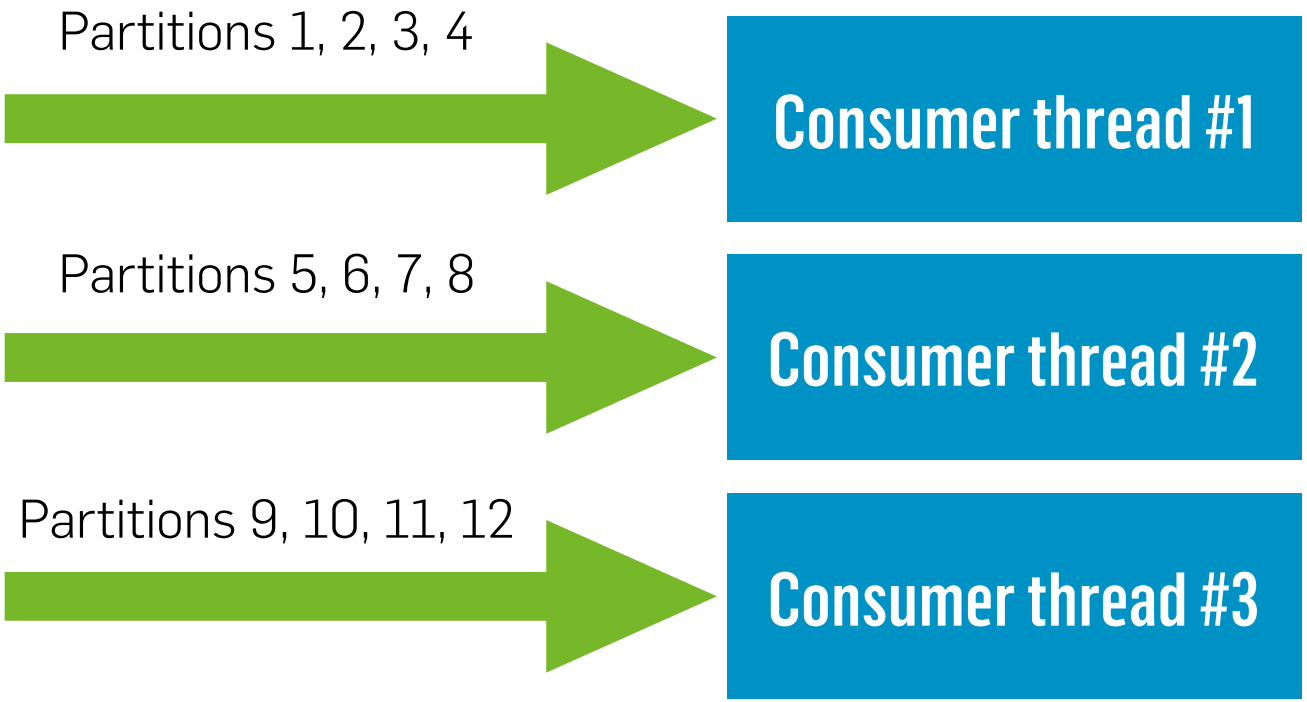
https://engineering.linkedin.com/distributed-systems/log-what-every-software-engineer-should-know-about-real-time-datas-unifying

kafka AND THE DISTRIBUTED LOG

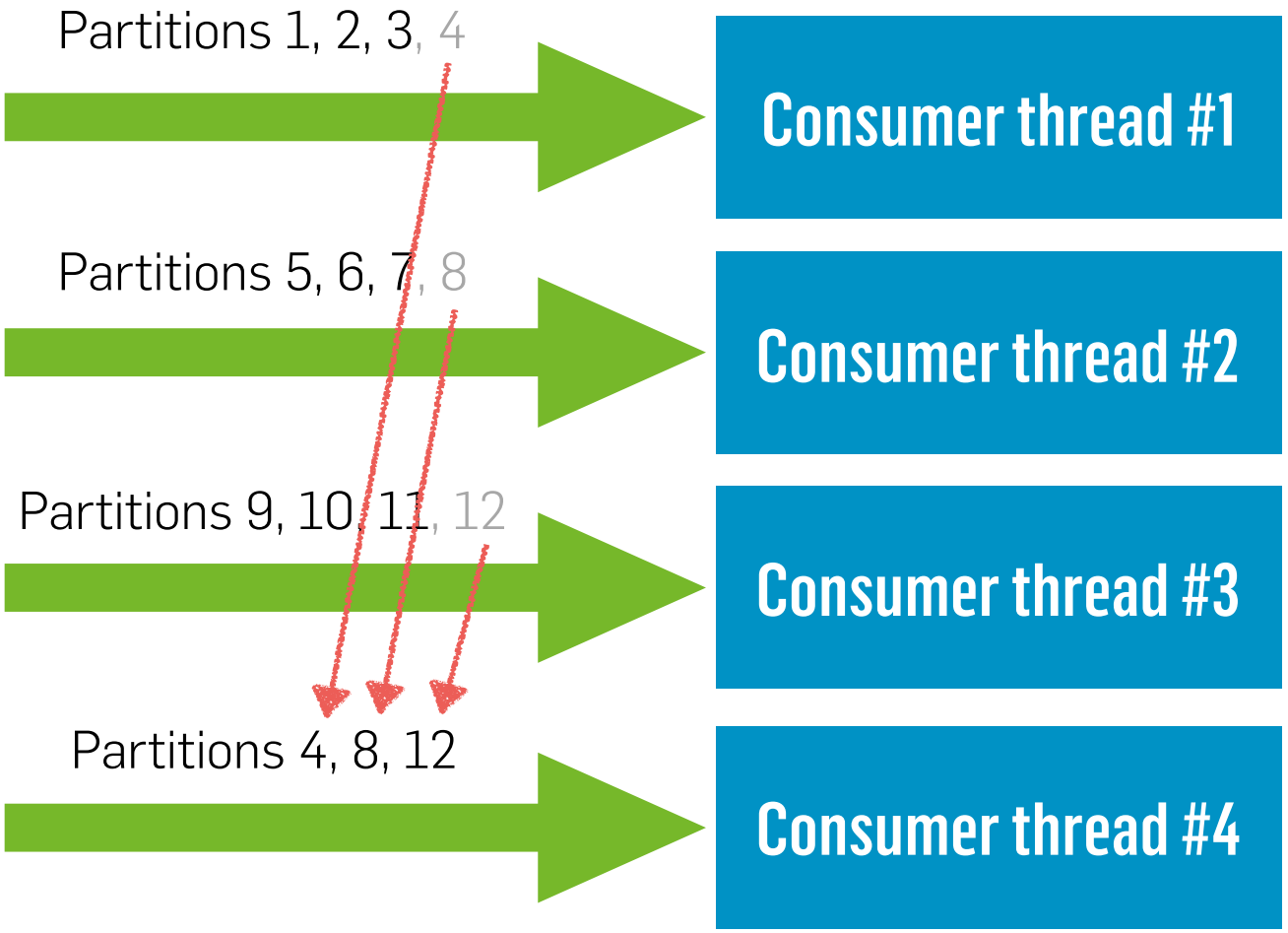


http://kafka.apache.org/documentation.html

kafka CONSUMER GROUPS



kafka CONSUMER GROUPS



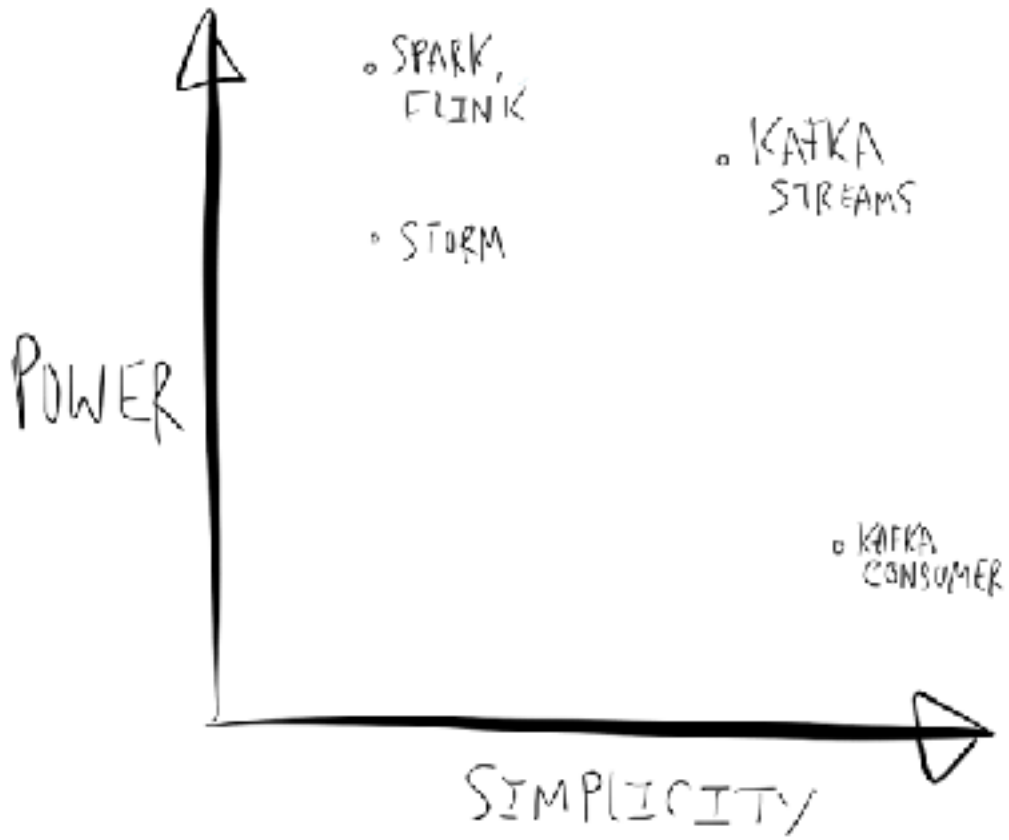
kafka LOG EVENTS

(Key, Value)

STREAM PROCESSING

KAFKA STREAMS

- Lightweight library
- Streams and tables
- High-level DSL
- Low level API



KAFKA STREAMS FEATURES

- Filter
- Transform
- Aggregate
- Time windows
- Join


ANATOMY OF A
KAFKA STREAMS APP

ANATOMY OF A KAFKA STREAMS APP

```
Properties config = new Properties();
config.put(StreamsConfig.APPLICATION_ID_CONFIG, "hello-world-app");
config.put(StreamsConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:29092");
```

ANATOMY OF A KAFKA STREAMS APP

```
Properties config = new Properties();
config.put(StreamsConfig.APPLICATION_ID_CONFIG, "hello-world-app");
config.put(StreamsConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:29092");



StreamsBuilder builder = new StreamsBuilder();
// TODO Build topology
```

ANATOMY OF A KAFKA STREAMS APP

```
Properties config = new Properties();
config.put(StreamsConfig.APPLICATION_ID_CONFIG, "hello-world-app");
config.put(StreamsConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:29092");



StreamsBuilder builder = new StreamsBuilder();
// TODO Build topology



KafkaStreams streams = new KafkaStreams(topology, config);
streams.start();

Runtime.getRuntime().addShutdownHook(new Thread(() ->
        streams.close(10, TimeUnit.SECONDS)
));
```

ANATOMY OF A KAFKA STREAMS APP

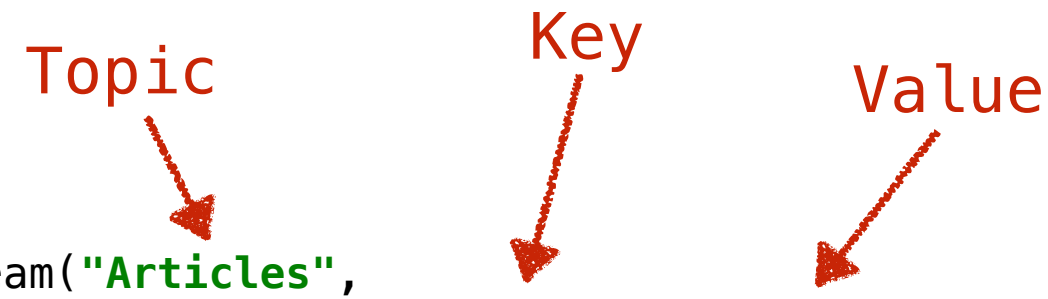
```
Properties config = new Properties();
config.put(StreamsConfig.APPLICATION_ID_CONFIG, "hello-world-app");
config.put(StreamsConfig.BOOTSTRAP_SERVERS_CONFIG, "localhost:29092");


StreamsBuilder builder = new StreamsBuilder();
// TODO Build topology


KafkaStreams streams = new KafkaStreams(topology, config);
streams.start();

Runtime.getRuntime().addShutdownHook(new Thread(() ->
        streams.close(10, TimeUnit.SECONDS)
));
```

HELLO KAFKA STREAMS

```
StreamBuilder builder = new StreamBuilder();

Serde<String> strings = Serdes.String();
```

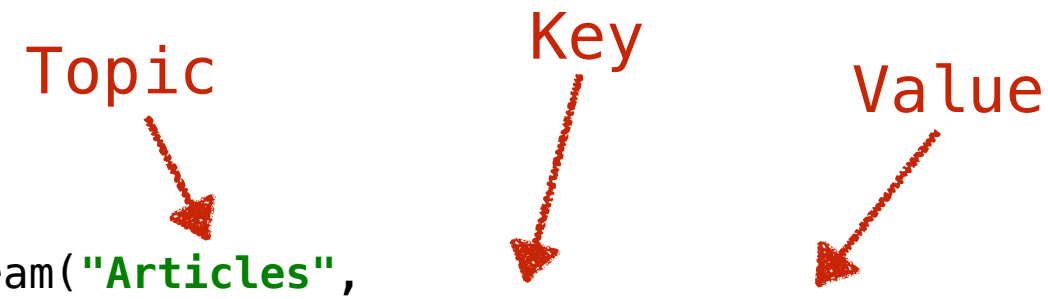
HELLO KAFKA STREAMS

```
StreamBuilder builder = new StreamBuilder();

Serde<String> strings = Serdes.String();


KStream<String, String> articles = builder.stream("Articles",
                                                  Consumed.with(strings, strings));
```



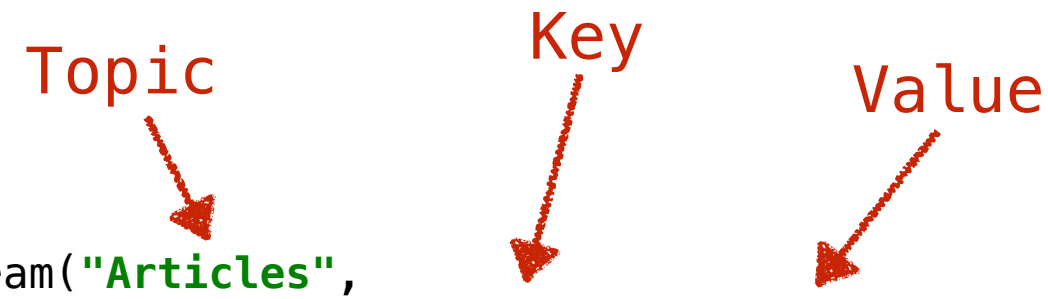
HELLO KAFKA STREAMS

```
StreamBuilder builder = new StreamBuilder();

Serde<String> strings = Serdes.String();


KStream<String, String> articles = builder.stream("Articles",
                                                  Consumed.with(strings, strings));

articles.print(Printed.toSysOut());
```



HELLO KAFKA STREAMS

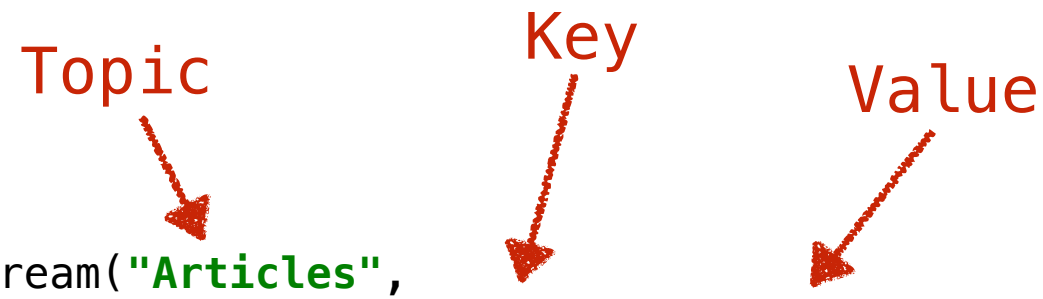
```
StreamBuilder builder = new StreamBuilder();

Serde<String> strings = Serdes.String();


KStream<String, String> articles = builder.stream("Articles",
                                                  Consumed.with(strings, strings));

articles.print(Printed.toSysOut());
```




```
2, {"site": "foxnews", "title": "Russia internet wars continue, to Trump's ..."}
3, {"site": "bbc", "title": "Employees urged to let staff 'rest'"}
4, {"site": "cnn", "title": "Italian town sells homes for $1"}
6, {"site": "cnn", "title": "US: More Russia sanctions in 'near future'"}
1, {"site": "cnn", "title": "Ex-Googlers create a self driving car ..."}
5, {"site": "bbc", "title": "What to watch for in Trump's SOTU speech"}
7, {"site": "foxnews", "title": "FBI officials review damning surveillance memo ..."}
8, {"site": "bbc", "title": "The truth about the origin of macaroni cheese"}
```

JSON

```
StreamBuilder builder = new StreamBuilder();

Serde<String> strings = Serdes.String();
Serde<JsonNode> json = new JsonNodeSerde();

KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

articles.print(Printed.toSysOut());
```




```
2, {"site": "foxnews", "title": "Russia internet wars continue, to Trump's ..."}
3, {"site": "bbc", "title": "Employees urged to let staff 'rest'"}
4, {"site": "cnn", "title": "Italian town sells homes for $1"}
6, {"site": "cnn", "title": "US: More Russia sanctions in 'near future'"}
1, {"site": "cnn", "title": "Ex-Googlers create a self driving car ..."}
5, {"site": "bbc", "title": "What to watch for in Trump's SOTU speech"}
7, {"site": "foxnews", "title": "FBI officials review damning surveillance memo ..."}
8, {"site": "bbc", "title": "The truth about the origin of macaroni cheese"}
```

DEFAULT SERDES

```
config.put(StreamsConfig.DEFAULT_KEY_SERDE_CLASS_CONFIG, Serdes.String().getClass());
config.put(StreamsConfig.DEFAULT_VALUE_SERDE_CLASS_CONFIG, JsonNodeSerde.class);



StreamBuilder builder = new StreamBuilder();

KStream<String, JsonNode> articles = builder.stream("Articles");
```


THE BASICS

FILTER

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));
```

FILTER

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, JsonNode> bbcArticles = articles
       ???
```

FILTER

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, JsonNode> bbcArticles = articles
        .filter((key, article) -> "bbc".equals(article.path("site").asText()));
```

FILTER

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, JsonNode> bbcArticles = articles
        .filter((key, article) -> "bbc".equals(article.path("site").asText()));
```

```
bbcArticles.print(Printed.toSysOut());
```

```
3, {"site": "bbc", "title": "Employees urged to let staff 'rest'"}
5, {"site": "bbc", "title": "What to watch for in Trump's SOTU speech"}
8, {"site": "bbc", "title": "The truth about the origin of macaroni cheese"}
```

TRANSFORM

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, JsonNode> bbcArticles = articles
        .filter((key, article) -> "bbc".equals(article.path("site").asText()));
```

TRANSFORM

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, JsonNode> bbcArticles = articles
        .filter((key, article) -> "bbc".equals(article.path("site").asText()));

KStream<String, String> bbcTitles = bbcArticles
        ???
```

TRANSFORM

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, JsonNode> bbcArticles = articles
        .filter((key, article) -> "bbc".equals(article.path("site").asText()));

KStream<String, String> bbcTitles = bbcArticles
        .mapValues(article -> article.path("title").asText());
```

TRANSFORM

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, JsonNode> bbcArticles = articles
        .filter((key, article) -> "bbc".equals(article.path("site").asText()));

KStream<String, String> bbcTitles = bbcArticles
        .mapValues(article -> article.path("title").asText());



bbcTitles.print(Printed.toSysOut());

3, Employees urged to let staff 'rest'
5, What to watch for in Trump's SOTU speech
8, The truth about the origin of macaroni cheese
```

FILTER AND TRANSFORM

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, String> bbcTitles = articles
        .filter((key, article) -> "bbc".equals(article.path("site").asText()))
        .mapValues(article -> article.path("title").asText());
```

```
bbcTitles.print(Printed.toSysOut());

3, Employees urged to let staff 'rest'
5, What to watch for in Trump's SOTU speech
8, The truth about the origin of macaroni cheese
```

WRITING BACK TO KAFKA

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KStream<String, String> bbcTitles = articles
        .filter((key, article) -> "bbc".equals(article.path("site").asText()))
        .mapValues(article -> article.path("title").asText());

bbcTitles.to("BBC-Titles", Produced.with(strings, strings));
```

```
fredriv@fredriv-mac 20:30:33
~ master $ kafka-console-consumer.sh --bootstrap-server localhost:29092 --topic BBC-Titles --from-beginning
What to watch for in Trump's SOTU speech
Employees urged to let staff 'rest'
The truth about the origin of macaroni cheese
^CProcessed a total of 3 messages
```

TRANSFORM

- Convert 1 input event to sequence of output events
  - Zero, one or many

- flatMap / flatMapValues
  - value -> Iterable
    - e.g. Collection, Arrays.asList, Iterator(*ish*)

FLATMAP

```
KStream<String, JsonNode> articles = builder.stream("Articles");


KStream<String, String> authors = articles
        .flatMapValues(json -> json.path("authors").elements())     // fails :-(
        .mapValues(author -> author.asText());
```

FLATMAP

```
KStream<String, JsonNode> articles = builder.stream("Articles");


KStream<String, String> authors = articles
        .flatMapValues(json -> new Iterable<JsonNode>() {
            @Override
            public Iterator<JsonNode> iterator() {
                return json.path("authors").elements();
            }
        })
        .mapValues(author -> author.asText());
```

FLATMAP

```
KStream<String, JsonNode> articles = builder.stream("Articles");


KStream<String, String> authors = articles
        .flatMapValues(json -> () -> json.path("authors").elements())
        .mapValues(author -> author.asText());
```

BRANCHING

```
KStream<String, JsonNode> articles = builder.stream("Articles");

KStream<String, JsonNode>[] articlesBySite = articles.branch(



);
```

BRANCHING

```
KStream<String, JsonNode> articles = builder.stream("Articles");


KStream<String, JsonNode>[] articlesBySite = articles.branch(
        (key, value) -> "bbc".equals(value.path("site").asText()),
        (key, value) -> "cnn".equals(value.path("site").asText()),
        (key, value) -> "foxnews".equals(value.path("site").asText()),
        (key, value) -> true
);
```

BRANCHING

```
KStream<String, JsonNode> articles = builder.stream("Articles");


KStream<String, JsonNode>[] articlesBySite = articles.branch(
        (key, value) -> "bbc".equals(value.path("site").asText()),
        (key, value) -> "cnn".equals(value.path("site").asText()),
        (key, value) -> "foxnews".equals(value.path("site").asText()),
        (key, value) -> true
);

articlesBySite[0].to("BBC-Articles");
articlesBySite[1].to("CNN-Articles");
articlesBySite[2].to("FoxNews-Articles");
articlesBySite[3].to("Other-Articles");
```

EXERCISE 1

- Open `Exercise_1_FilterAndTransform`
- Implement methods to make tests pass
  - Run in IDE or with: `./gradlew test`
  - Tests in `Exercise_1_FilterAndTransformTest`
  - Test data in `ClickEvents`

- Should be sufficient with: filter, mapValues, flatMapValues, branch

- For more:
  - https://kafka.apache.org/10/javadoc/index.html
  - https://docs.confluent.io/4.0.0/streams/developer-guide/dsl-api.html


NEXT LEVEL

AGGREGATIONS

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));
```

Number of articles per site?

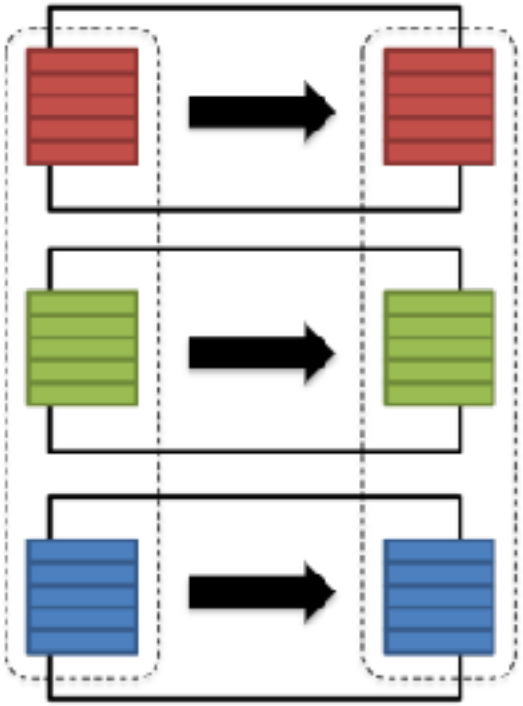
AGGREGATIONS

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KGroupedStream<String, JsonNode> grouped = articles
        .groupBy((key, value) -> value.path("site").asText(),
                Serialized.with(strings, json));
```

REPARTITIONING

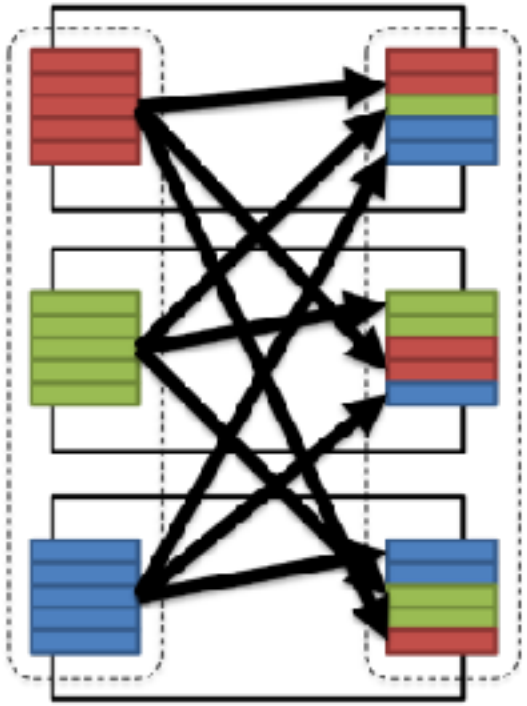
Narrow transformation

- Input and output stays in same partition
- No data movement is needed



Wide transformation

- Input from other partitions are required
- Data shuffling is needed before processing



http://horicky.blogspot.com.es/2013/12/spark-low-latency-massively-parallel.html

REPARTITIONING

- map, flatMap, selectKey
- groupByKey
- groupBy

AGGREGATIONS

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KGroupedStream<String, JsonNode> grouped = articles
        .groupBy((key, value) -> value.path("site").asText(),
                Serialized.with(strings, json));
```

AGGREGATIONS

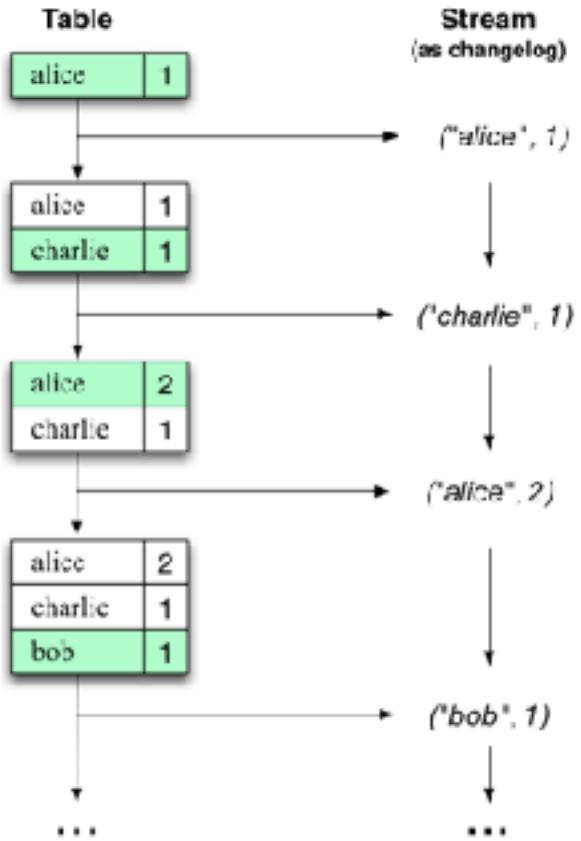
```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KGroupedStream<String, JsonNode> grouped = articles
        .groupBy((key, value) -> value.path("site").asText(),
                Serialized.with(strings, json));

KTable<String, Long> counts = grouped.count();
```

AGGREGATIONS

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KTable<String, Long> articlesPerSite = articles
        .groupBy((key, value) -> value.path("site").asText(),
                 Serialized.with(strings, json))
        .count();



articlesBySite.toStream().print(Printed.toSysOut());
```

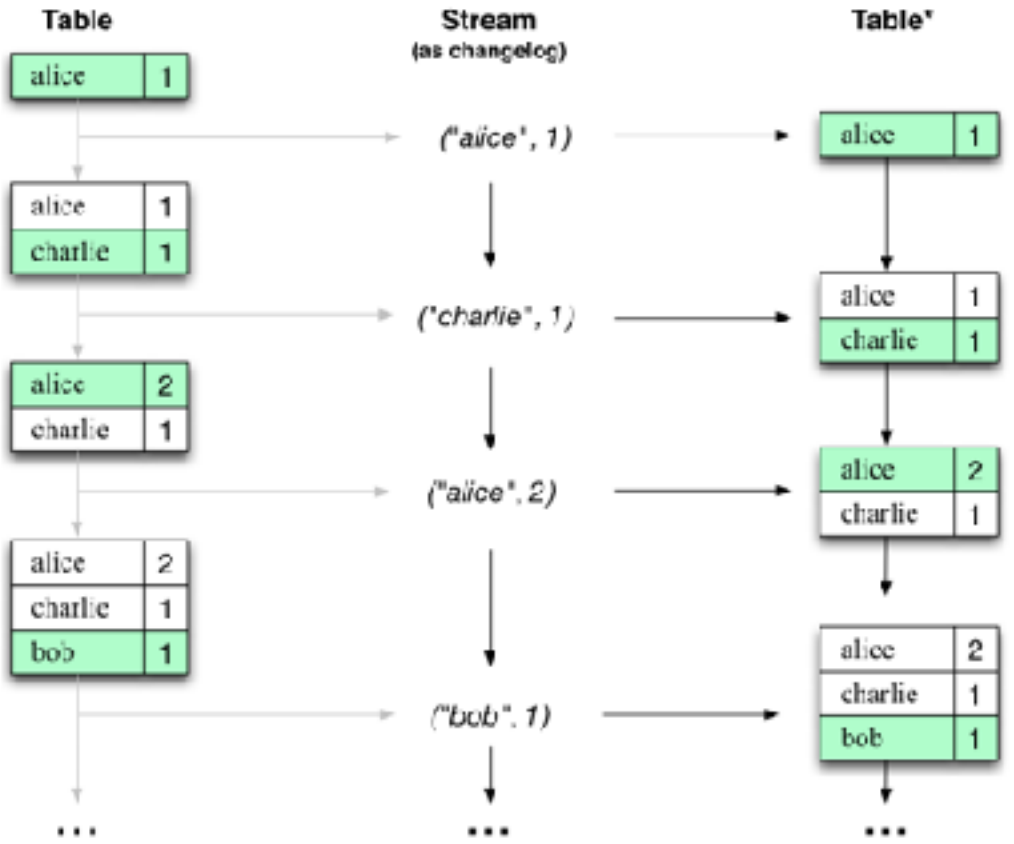
```
foxnews, 2
cnn, 3
bbc, 3
```

TABLES VS STREAMS



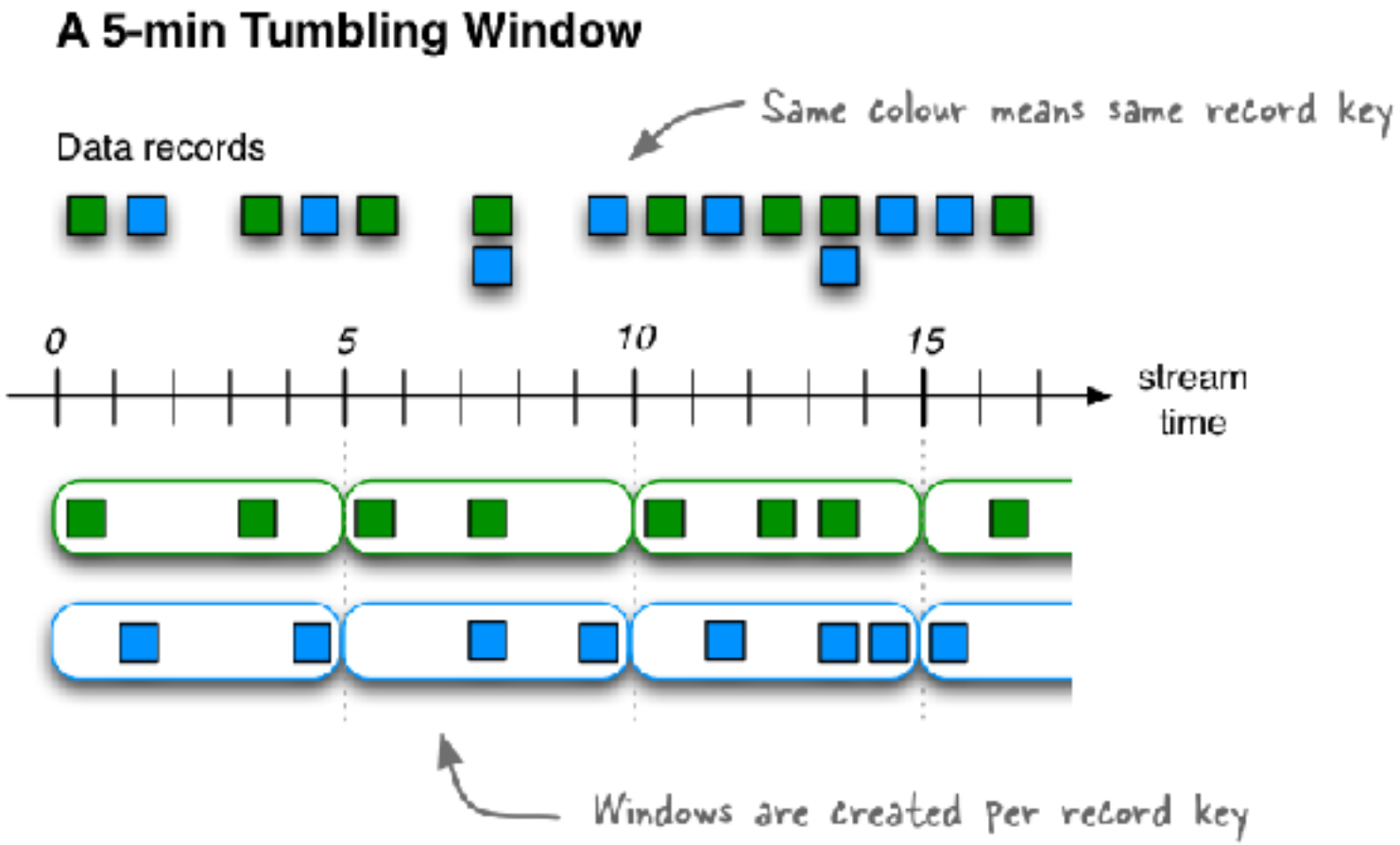
http://kafka.apache.org/documentation/streams/developer-guide#streams_duality

TABLES VS STREAMS



http://kafka.apache.org/documentation/streams/developer-guide#streams_duality

WINDOWED AGGREGATIONS



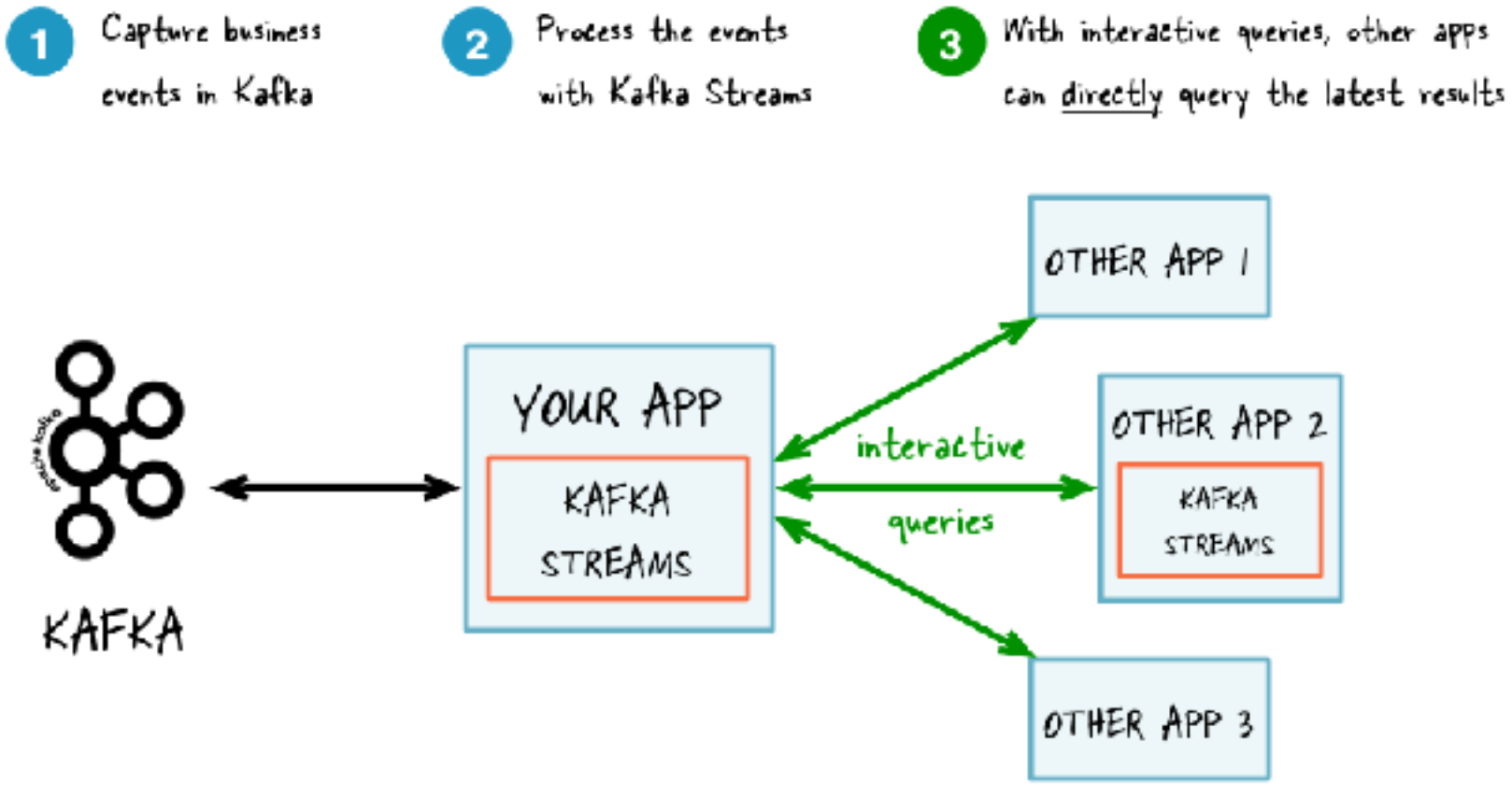
https://docs.confluent.io/current/streams/developer-guide.html#windowing

WINDOWING

```
KStream<String, JsonNode> articles = builder.stream("Articles",
                                                    Consumed.with(strings, json));

KGroupedStream<String, JsonNode> grouped = articles
        .groupBy((key, value) -> value.path("site").asText(),
                Serialized.with(strings, json));

KTable<Windowed<String>, Long> articlesPerHour = grouped
        .windowedBy(TimeWindows.of(TimeUnit.HOURS.toMillis(1)))
        .count(Materialized.as("articles-per-hour"));
```


CONNECTING TO THE WORLD

QUERYABLE STATE STORES



https://docs.confluent.io/current/streams/developer-guide.html#streams-developer-guide-interactive-queries

QUERYING STATE STORES

```
ReadOnlyWindowStore<String, Long> articlesPerHour =
        streams.store("articles-per-hour", QueryableStoreTypes.windowStore());
```

QUERYING STATE STORES

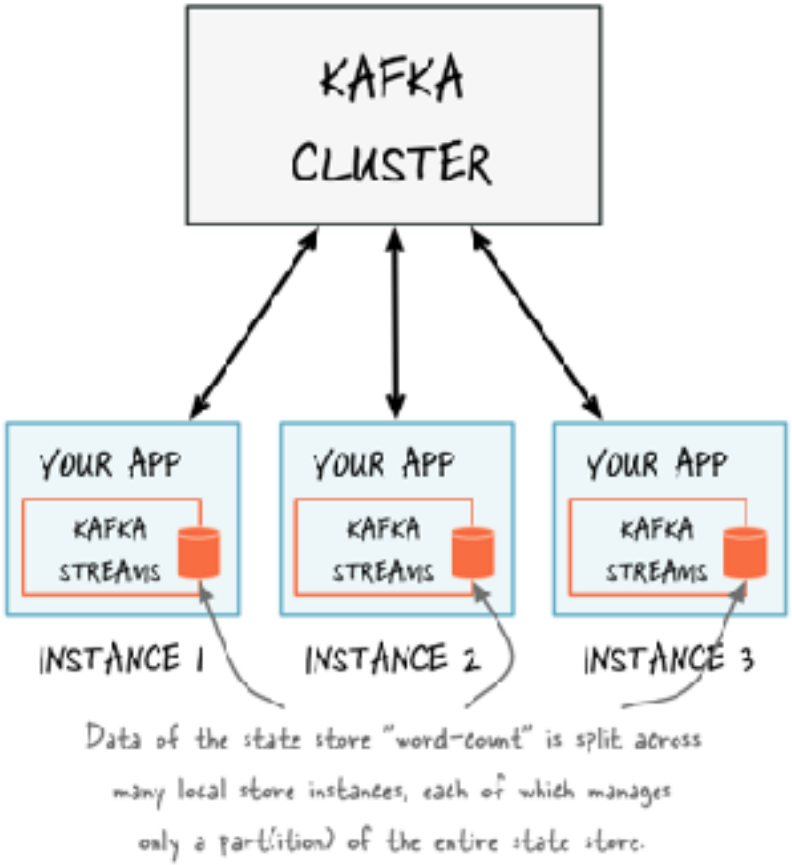
```
ReadOnlyWindowStore<String, Long> articlesPerHour =
        streams.store("articles-per-hour", QueryableStoreTypes.windowStore());

long from = 0L; // Jan 1st 1970
long to = System.currentTimeMillis();
WindowStoreIterator<Long> articles = articlesPerHour.fetch("bbc", from, to);
```

QUERYING STATE STORES

```
ReadOnlyWindowStore<String, Long> articlesPerHour =
        streams.store("articles-per-hour", QueryableStoreTypes.windowStore());

long from = 0L; // Jan 1st 1970
long to = System.currentTimeMillis();
WindowStoreIterator<Long> articles = articlesPerHour.fetch("bbc", from, to);

articles.forEachRemaining(kv -> {
    Instant timestamp = Instant.ofEpochMilli(kv.key);
    System.out.println("BBC published " + kv.value +
            " article(s) in hour " + timestamp);
});
```

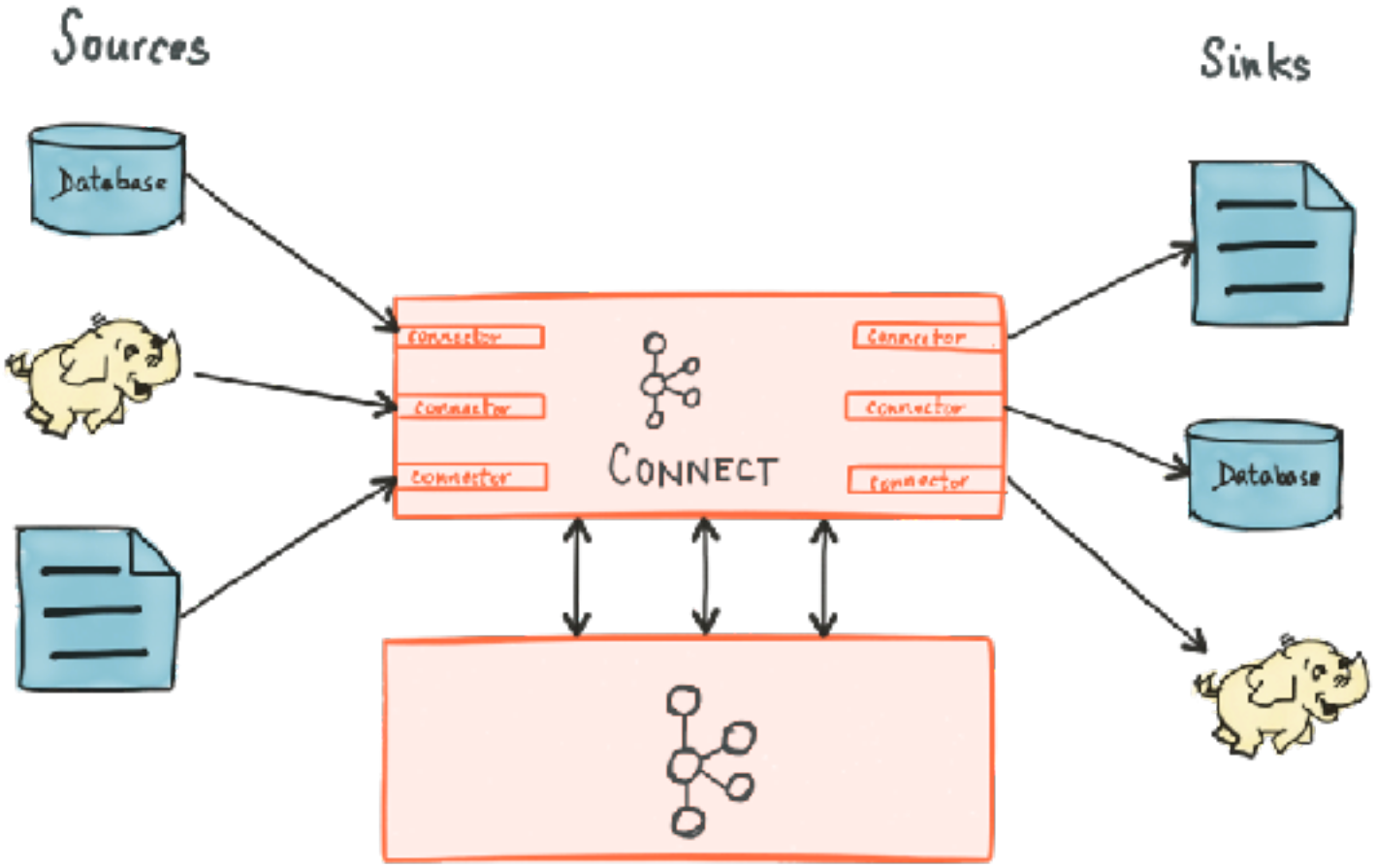
```
BBC published 1 article(s) in hour 2018-02-04T22:00:00Z
```

QUERYABLE STATE STORES



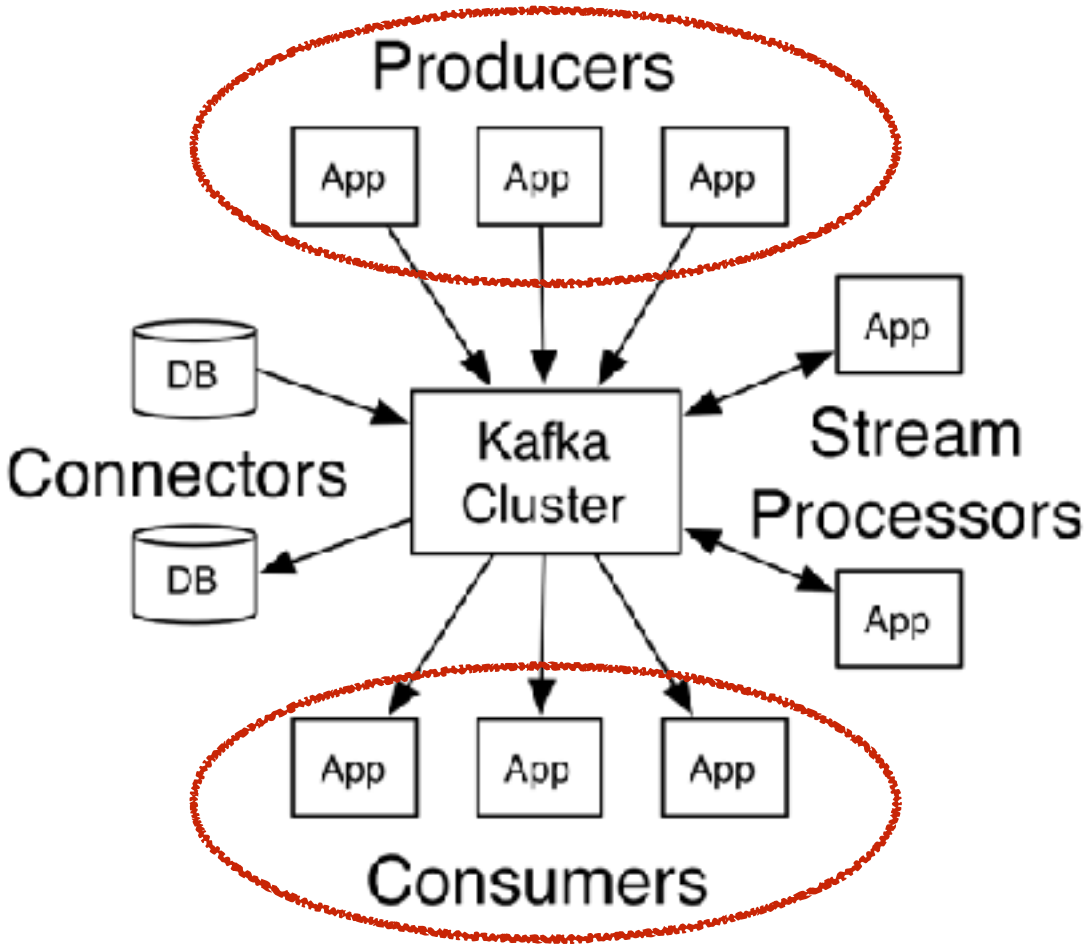
https://docs.confluent.io/current/streams/developer-guide.html#streams-developer-guide-interactive-queries

GETTING DATA IN AND OUT



https://www.confluent.io/blog/announcing-kafka-connect-building-large-scale-low-latency-data-pipelines/

GETTING DATA IN AND OUT



http://kafka.apache.org/documentation.html

EXERCISE 2

- Open `Exercise_2_Aggregations`

- Implement methods to make tests pass
  - Run in IDE or with: `./gradlew test`
  - Tests in `Exercise_2_AggregationTest`
  - Test data in `ClickEvents`

- Should be sufficient with:
  - map, selectKey, groupBy, groupByKey, count, reduce


JOINS AND ENRICHMENTS

JOINING STREAMS

https://churchtecharts.org/home/2014/10/5/important-safety-tip-with-dante-dont-cross-the-streams

JOINS

Join operands	Type	(INNER) JOIN	LEFT JOIN	OUTER JOIN
KStream-to-KStream	Windowed	Supported	Supported	Supported
KTable-to-KTable	Non-windowed	Supported	Supported	Supported
KStream-to-KTable	Non-windowed	Supported	Supported	Not Supported
KStream-to-GlobalKTable	Non-windowed	Supported	Supported	Not Supported
KTable-to-GlobalKTable	N/A	Not Supported	Not Supported	Not Supported

JOINS

```
KStream<String, String> reads = builder.stream("ArticleReads",
                                               Consumed.with(strings, strings));

KTable<String, JsonNode> users = builder.table("Users",
                                               Consumed.with(strings, json));
```

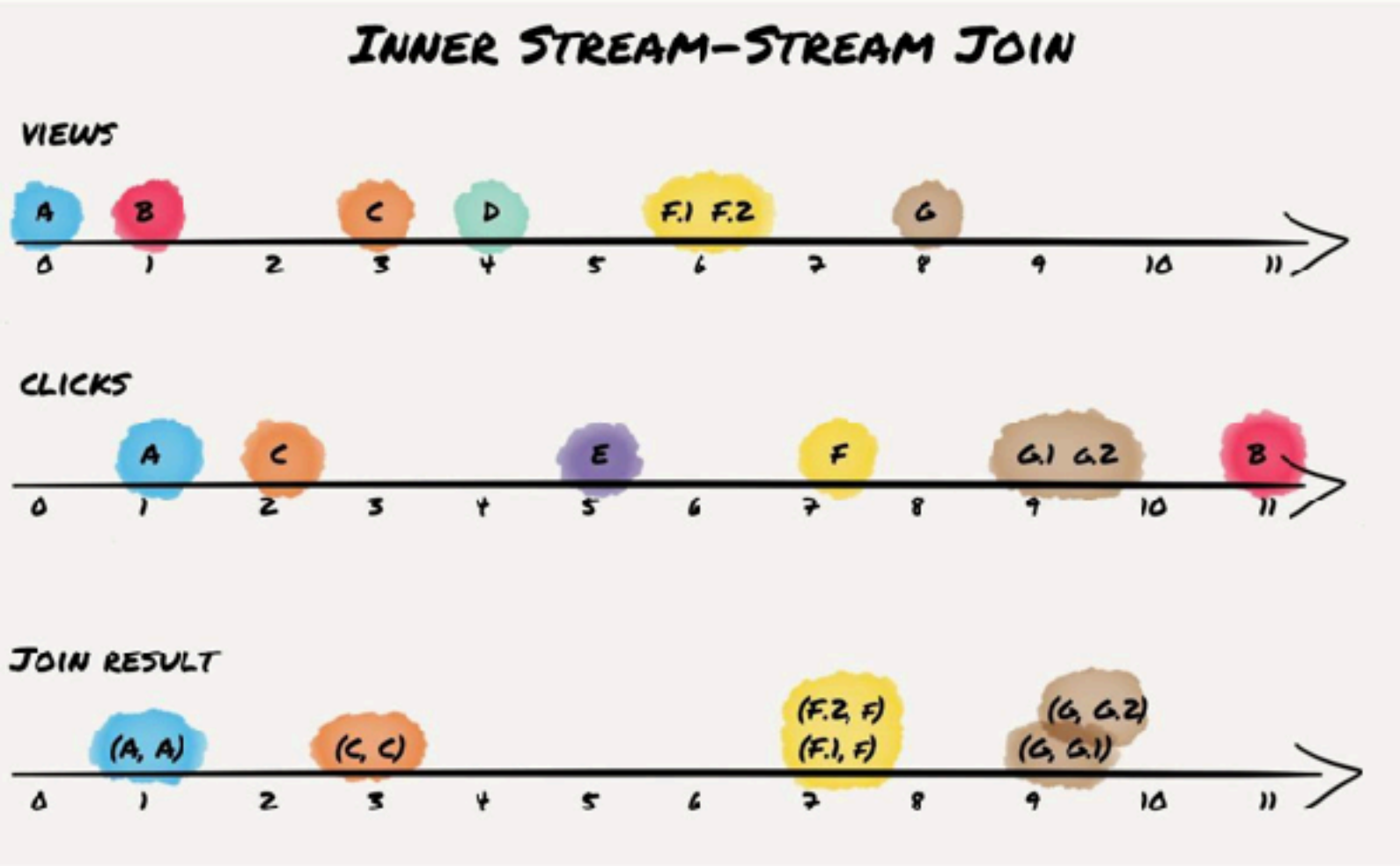
JOINS

```
KStream<String, String> reads = builder.stream("ArticleReads",
                                               Consumed.with(strings, strings));

KTable<String, JsonNode> users = builder.table("Users",
                                               Consumed.with(strings, json));


KStream<String, JsonNode> readsByCountry = reads
        .join(users, (article, user) -> user.path("country"));
```

JOINS

```
KStream<String, String> reads = builder.stream("ArticleReads",
                                               Consumed.with(strings, strings));

KTable<String, JsonNode> users = builder.table("Users",
                                               Consumed.with(strings, json));


KStream<String, JsonNode> readsByCountry = reads
        .join(users, (article, user) -> user.path("country"));


KTable<String, Long> readsPerCountry = readsByCountry
        .groupBy((userId, country) -> country.asText(),
                 Serialized.with(strings, json))
        .count();
```

JOINS



https://www.confluent.io/blog/crossing-streams-joins-apache-kafka/

ENRICHMENTS

- Enrich events with information from external sources
- Call 3rd party service in mapValues
- Use Processor API for batching


700,000,000 events/day
Lars Marius Garshol, lars.marius.garshol@schibsted.com
2016-09-07, JavaZone 2016
http://twitter.com/larsga
SCHIBSTED
MEDIA GROUP

JavaZone

4

TRANSLATING 700 MILLION EVENTS FROM IP TO COORDINATES EACH DAY USING KAFKA STREAMS

JavaZone 2017

Håkon Åmdal, 14.09.2017

SCHIBSTED MEDIA GROUP

FURTHER READING

- https://www.oreilly.com/ideas/the-world-beyond-batch-streaming-101
- https://www.oreilly.com/ideas/the-world-beyond-batch-streaming-102
- https://www.confluent.io/blog/
- https://www.confluent.io/blog/crossing-streams-joins-apache-kafka/

- https://docs.confluent.io/current/streams/
- http://kafka.apache.org/documentation/streams/


THANK YOU!
@FREDRIV
FREDRIK.VRAALSEN@SCHIBSTED.COM