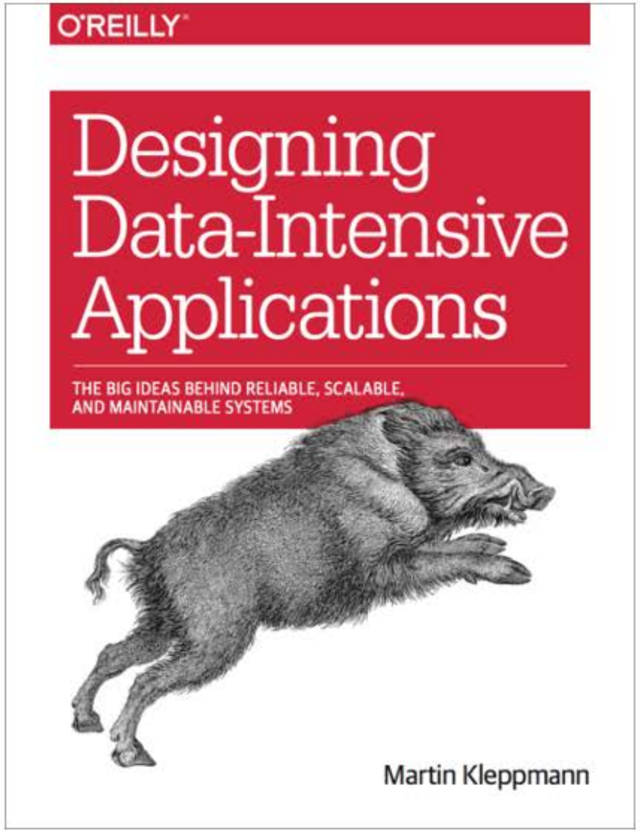
Data LIBERATION and data INTEGRATION with Apache Kafka

Martin Kleppmann @martinkl

UNIVERSITY OF CAMBRIDGE


O'REILLY

Designing Data-Intensive Applications

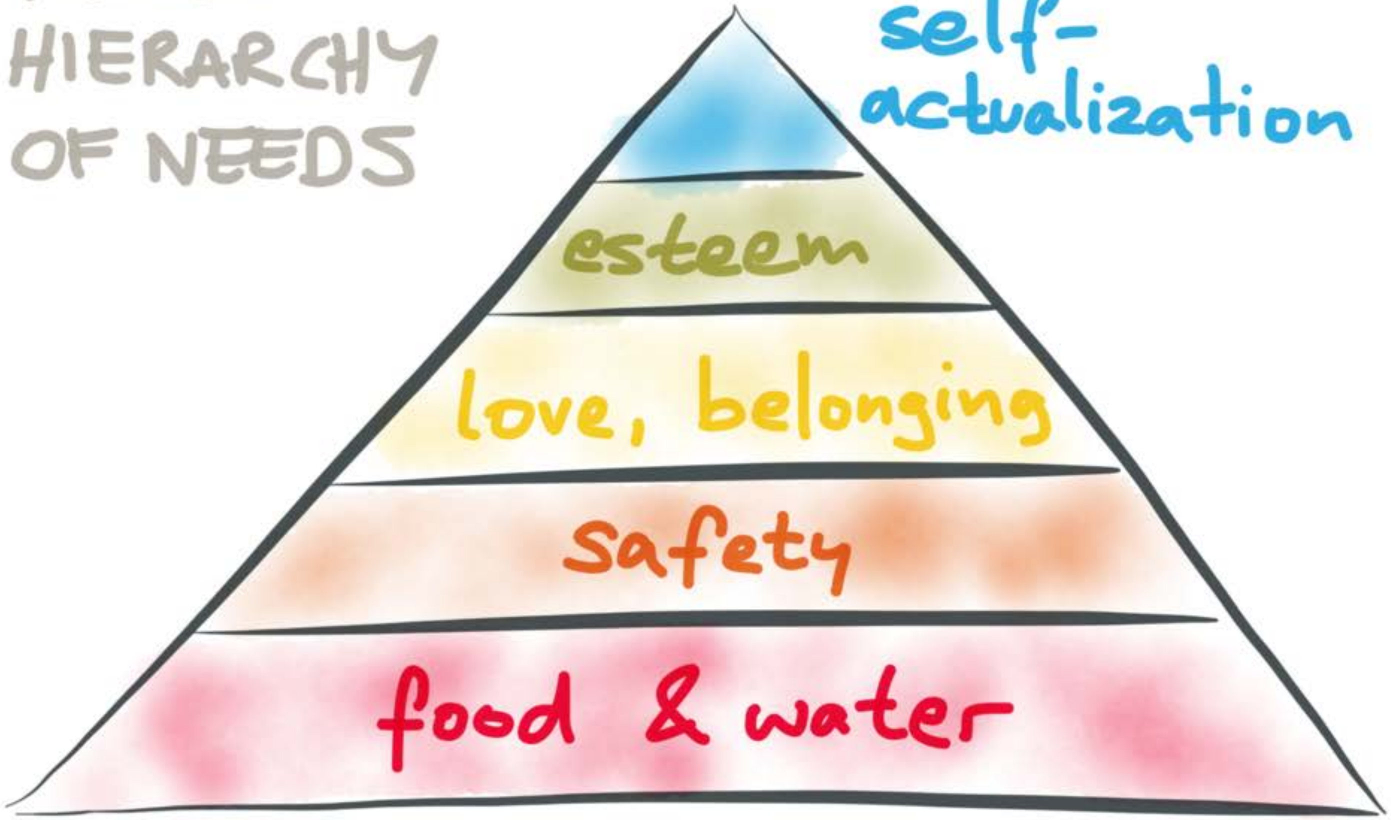
THE BIG IDEAS BEHIND RELIABLE, SCALABLE, AND MAINTAINABLE SYSTEMS

Martin Kleppmann

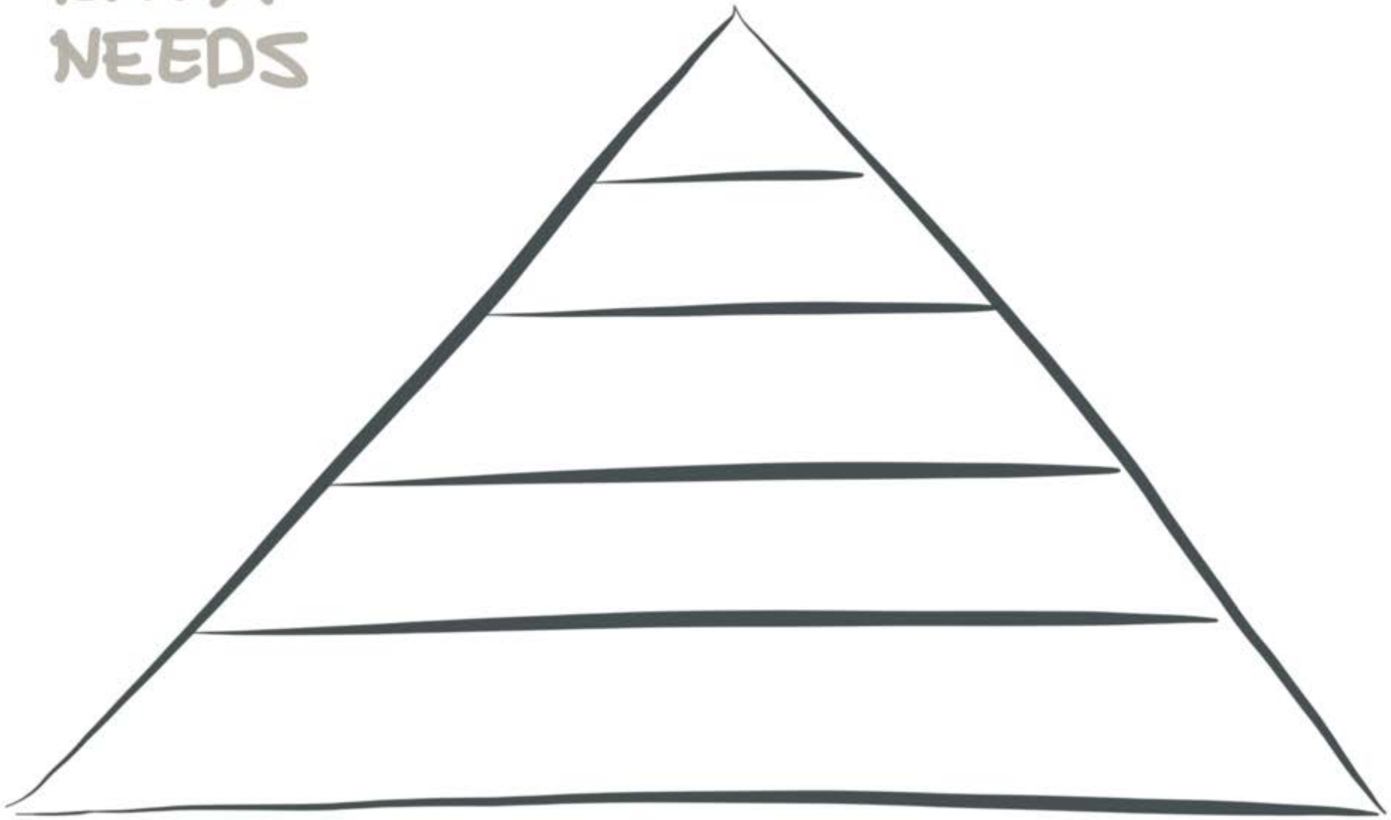
dataintensive.net

@martinkl

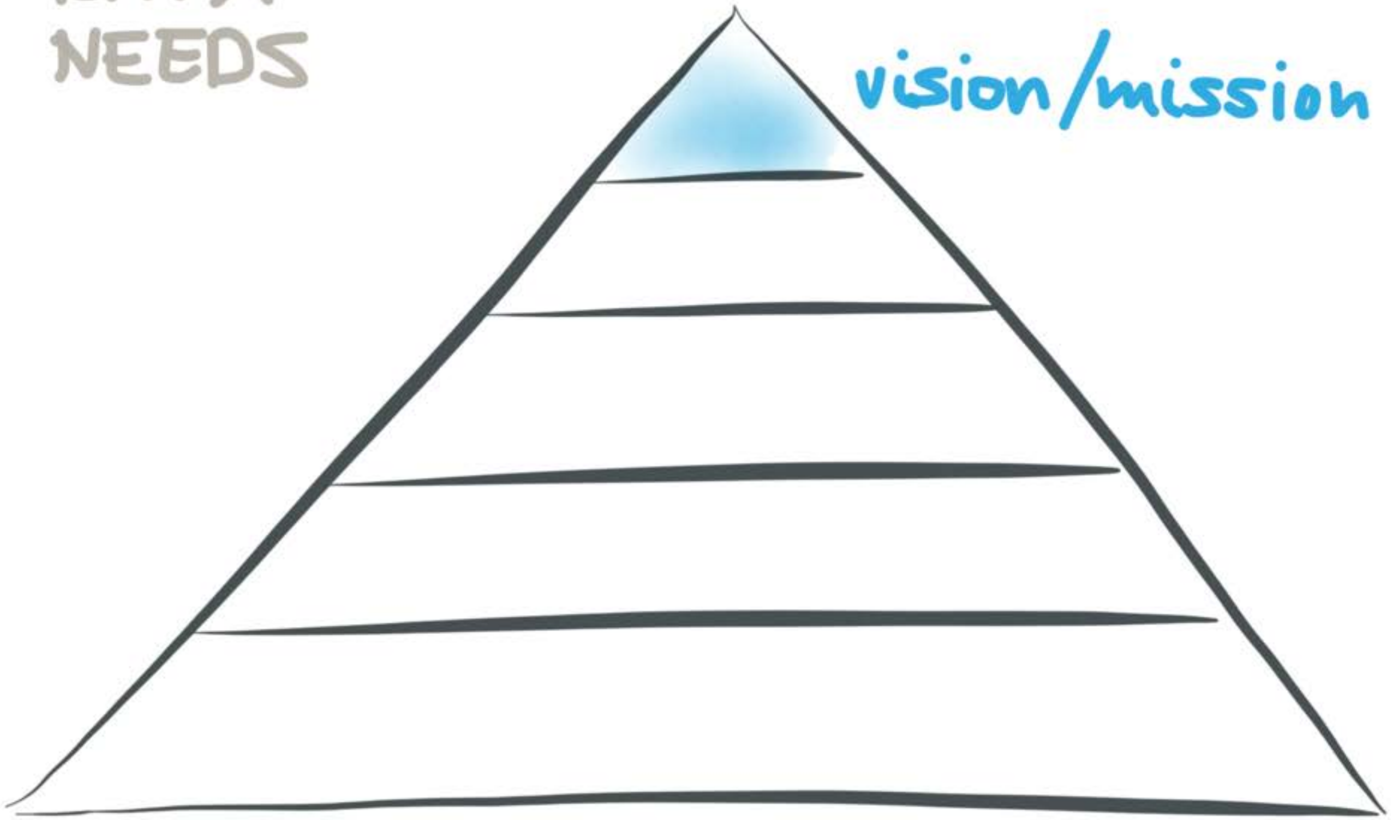
MASLOW'S HIERARCHY OF NEEDS



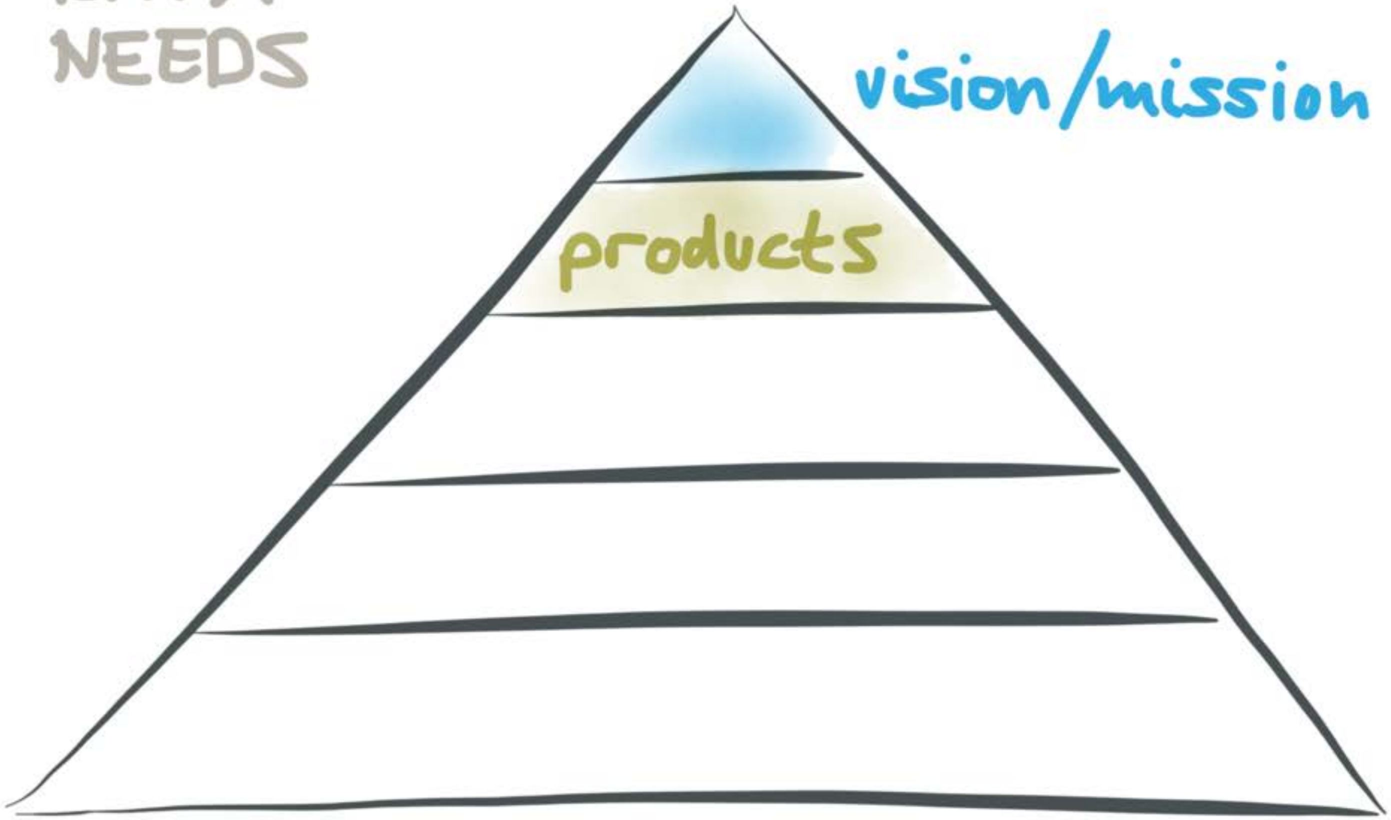
DATA NEEDS



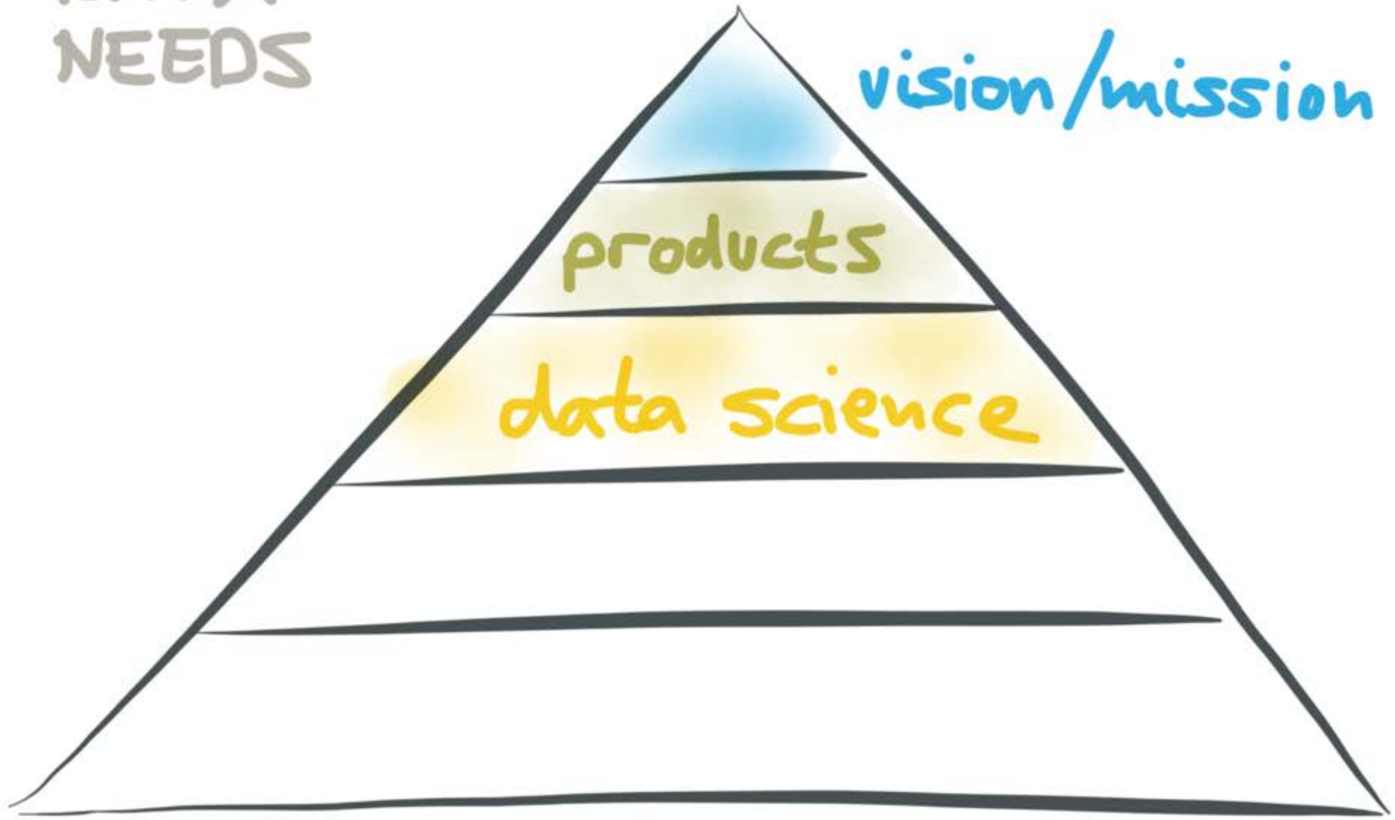
DATA NEEDS



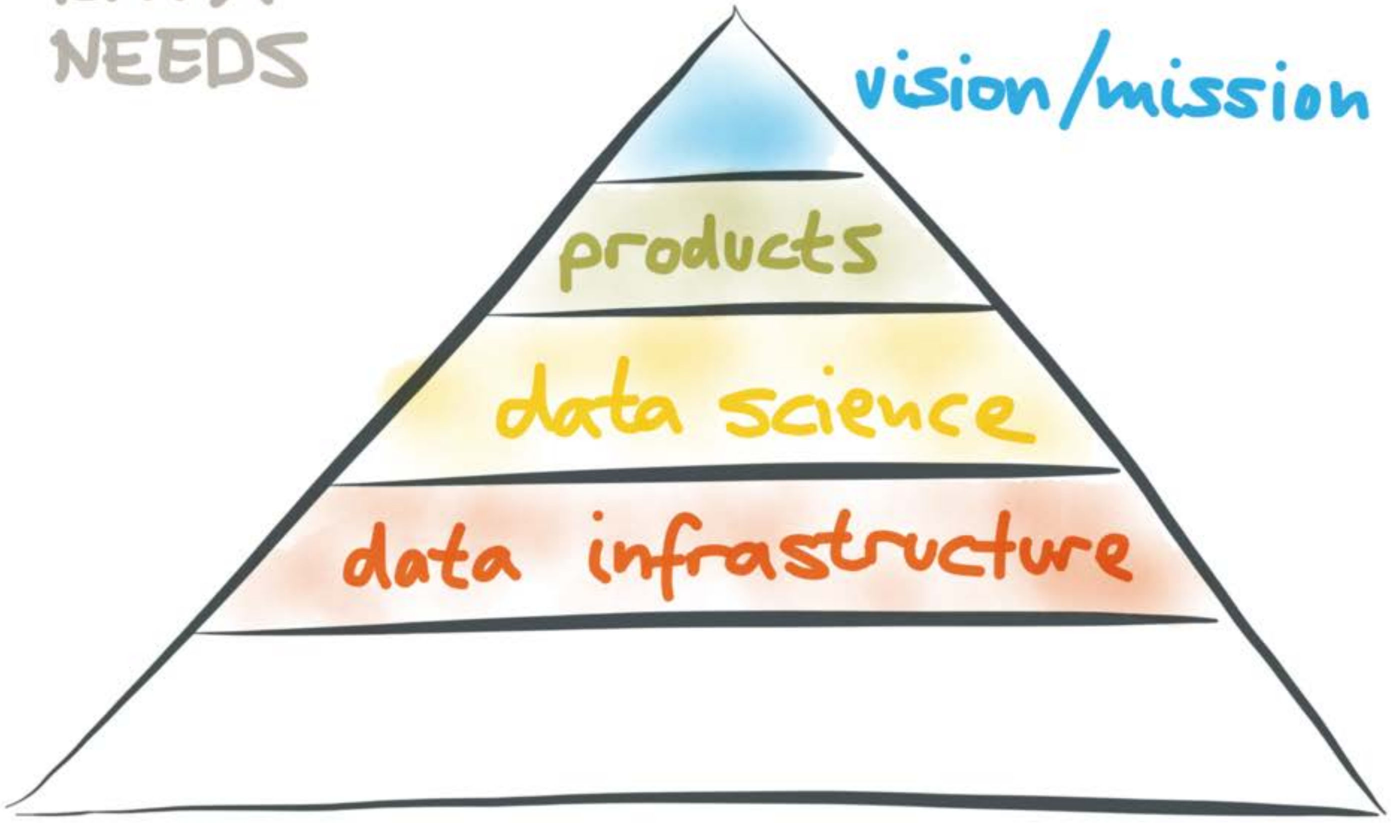
DATA NEEDS



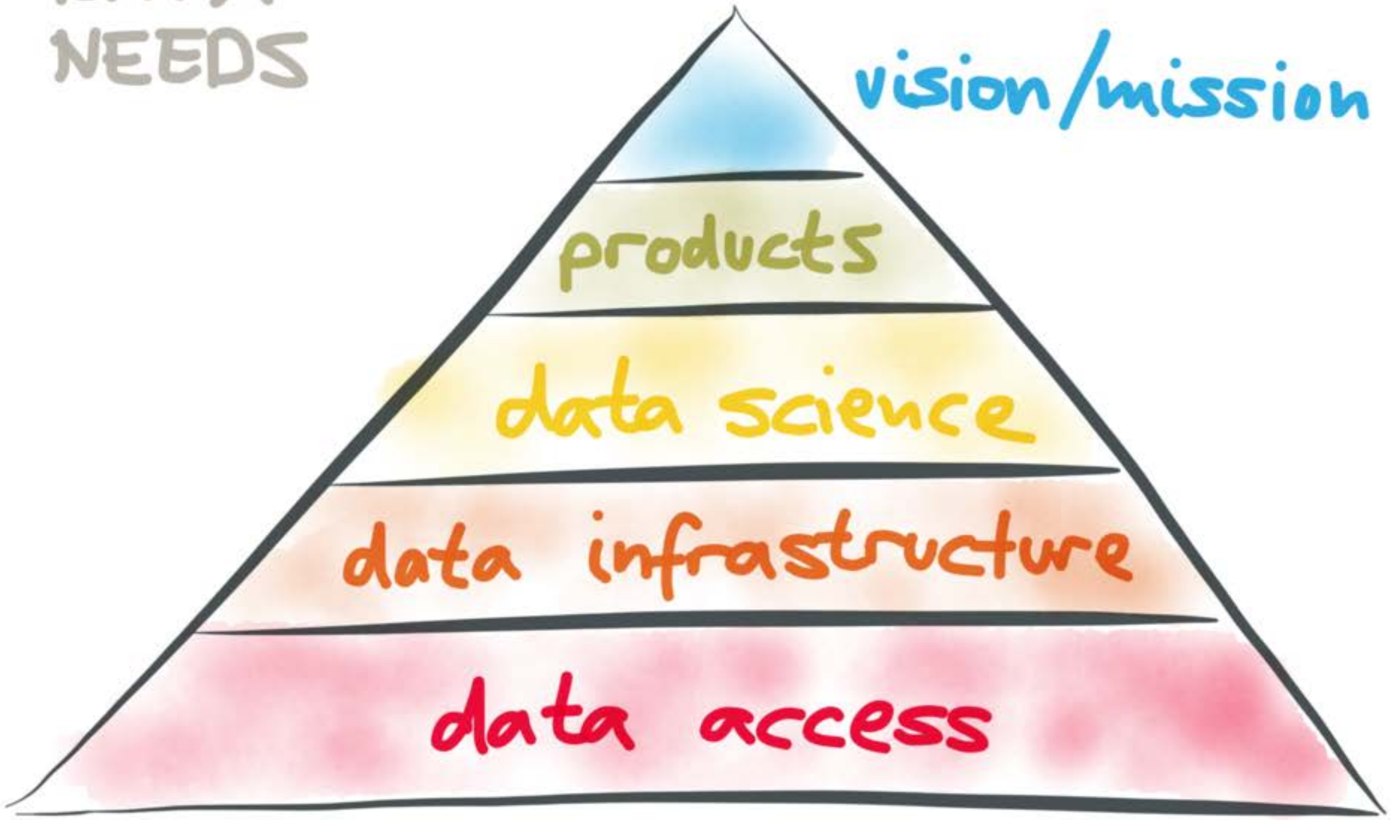
DATA NEEDS



DATA NEEDS


vision/mission
products
data science
data infrastructure

DATA NEEDS


vision/mission
products
data science
data infrastructure
data access

DATA FRAGMENTATION

Relational DBs

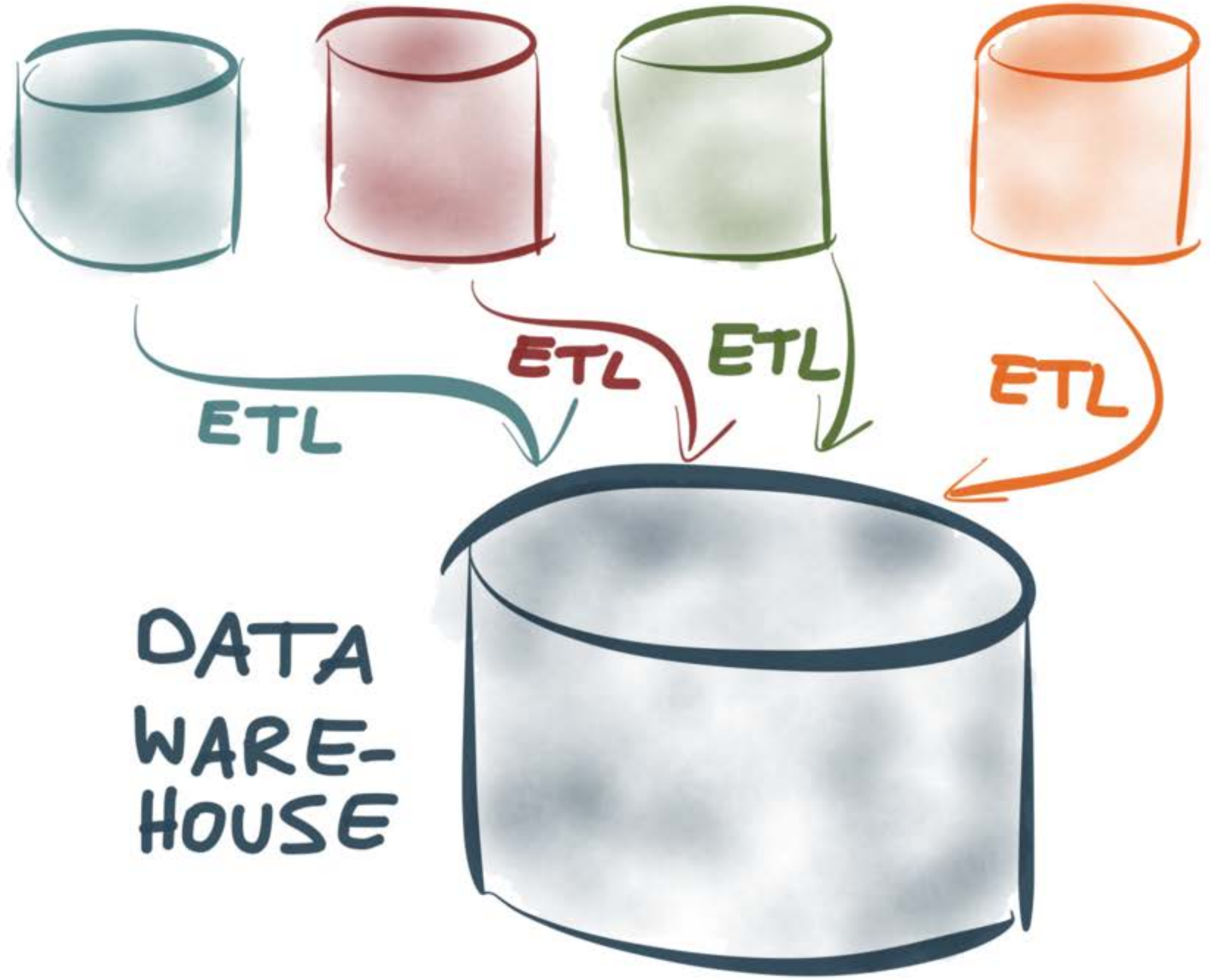
NoSQL DBs

Log files

Message queue

Search indexes

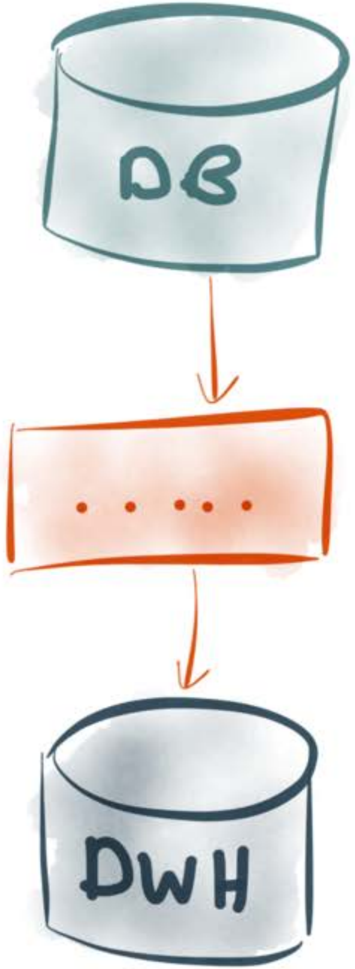
Monitoring


ETL
ETL
ETL
ETL
DATA WARE-HOUSE

EXTRACT

TRANSFORM

LOAD



1990 Data warehousing

1990 Data warehousing

$\downarrow$

2008 Hadoop & MapReduce

$$\begin{tikzcd} 1990 \arrow[d] \\ 2008 \end{tikzcd}$$

1990 Data warehousing

- Drop relational assumption
- Programmability
- Open source

2008 Hadoop & MapReduce

1990 Data warehousing

- Drop relational assumption
- Programmability
- Open source

2008 Hadoop & MapReduce

2015 Kafka & streaming data

1990 Data warehousing

- Drop relational assumption
- Programmability
- Open source

2008 Hadoop & MapReduce

- Batch ⇒ real-time
- Daily ⇒ continuous

2015 Kafka & streaming data

Kafka

APACHE
SOFTWARE
FOUNDATION

Event streams

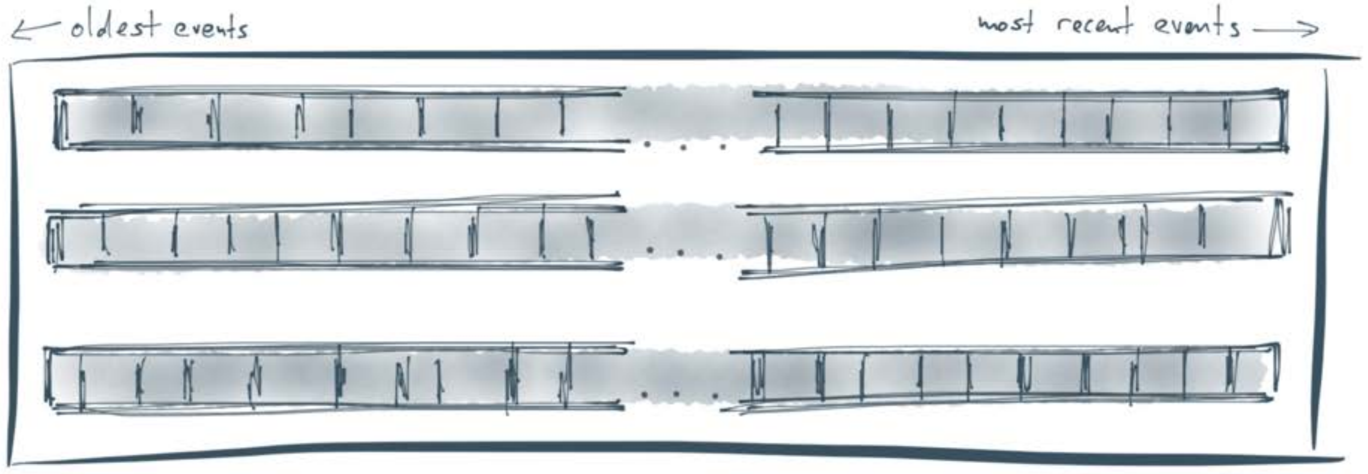
"something happened"

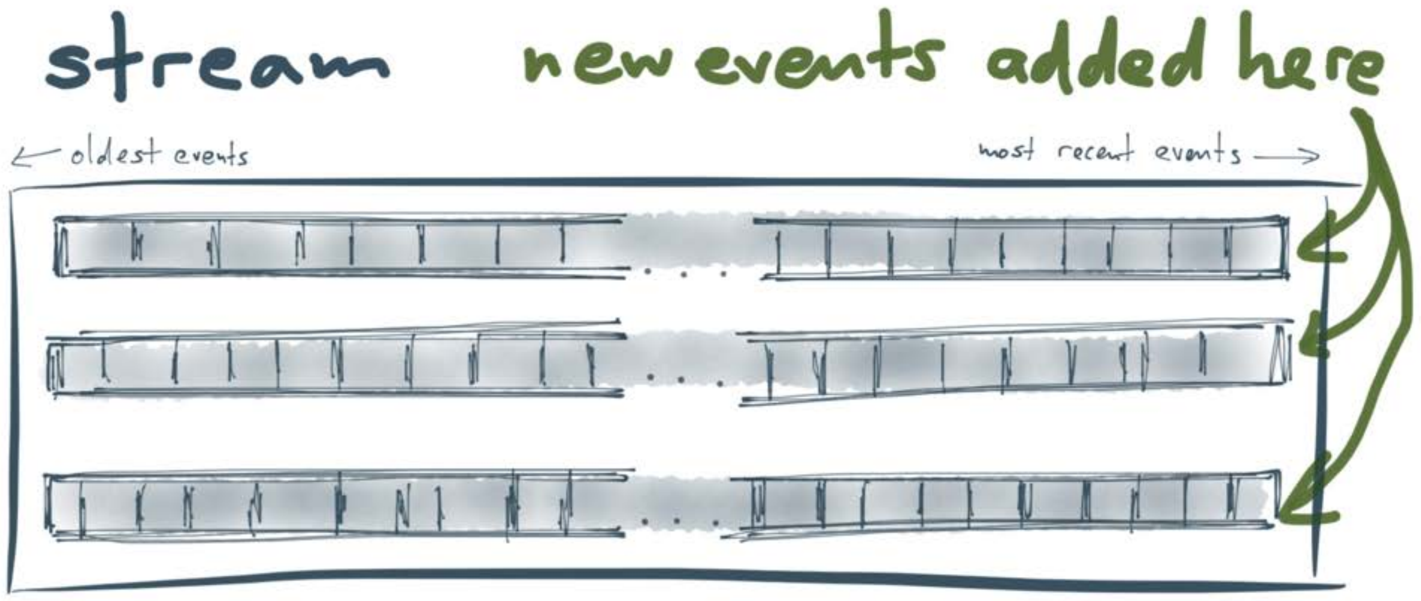
Event streams

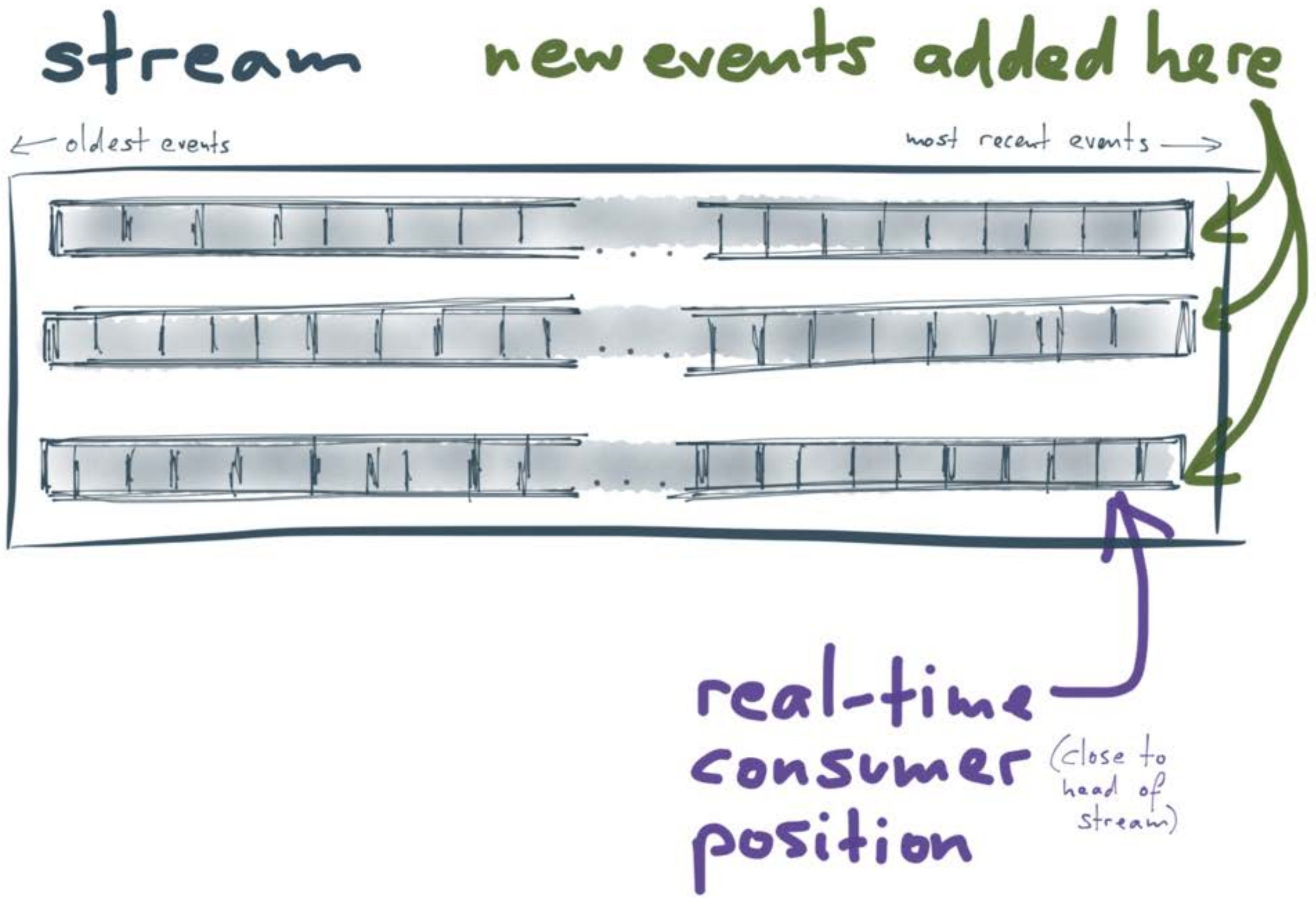
subscribe to it

```
216.58.210.78 - - [27/Feb/2015:17:55:11 +0000] "GET
/css/typography.css HTTP/1.1” 200 3377 "http://martin.
kleppmann.com/" "Mozilla/5.0 (Macintosh; Intel Mac OS X
10_9_5) AppleWebKit/537.36 (KHTML, like Gecko)
Chrome/40.0.2214.115 Safari/537.36"
```

stream




stream
new events added here
← oldest events
most recent events →


stream
new events added here
← oldest events
most recent events →
. . .
. . .
. . .
real-time consumer position
(close to head of stream)

"SOMETHING HAPPENED"

- User x clicked link y
  (activity event)

"SOMETHING HAPPENED"

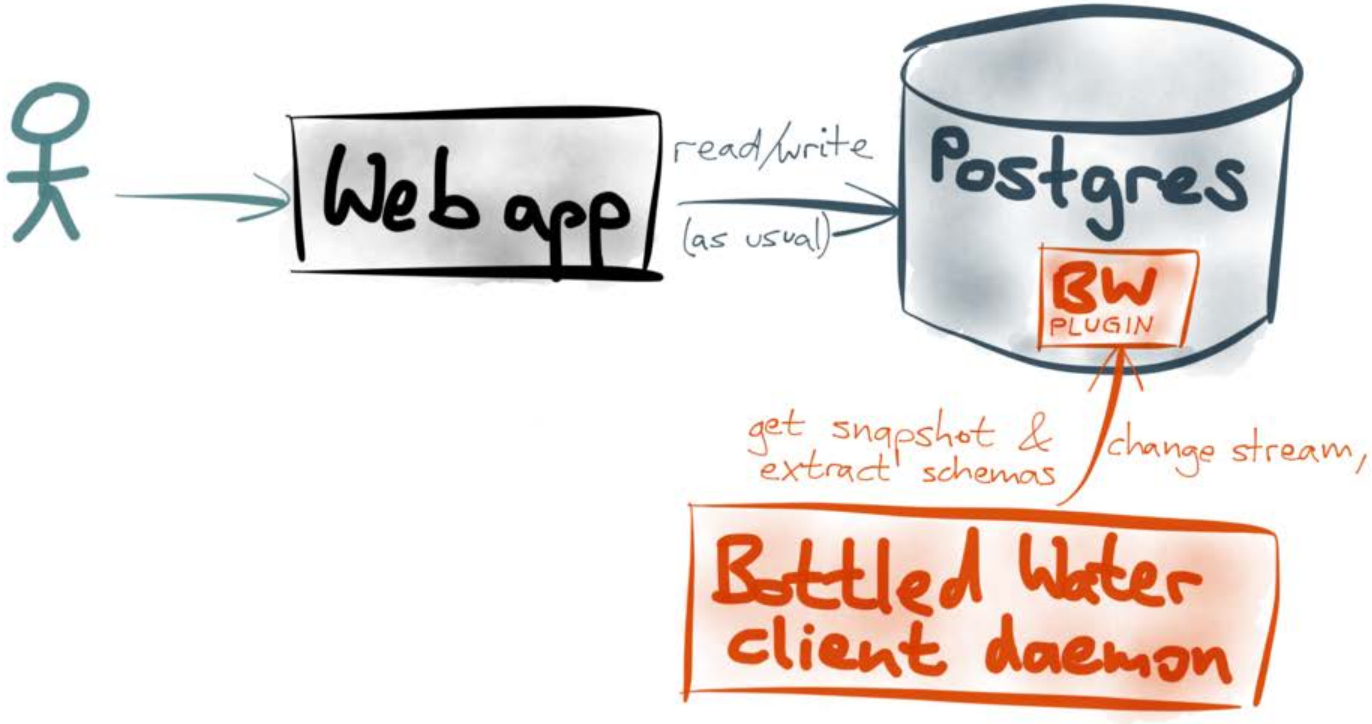
- User x clicked link y
  (activity event)
- Sensor x sent reading y
  (time series tick)

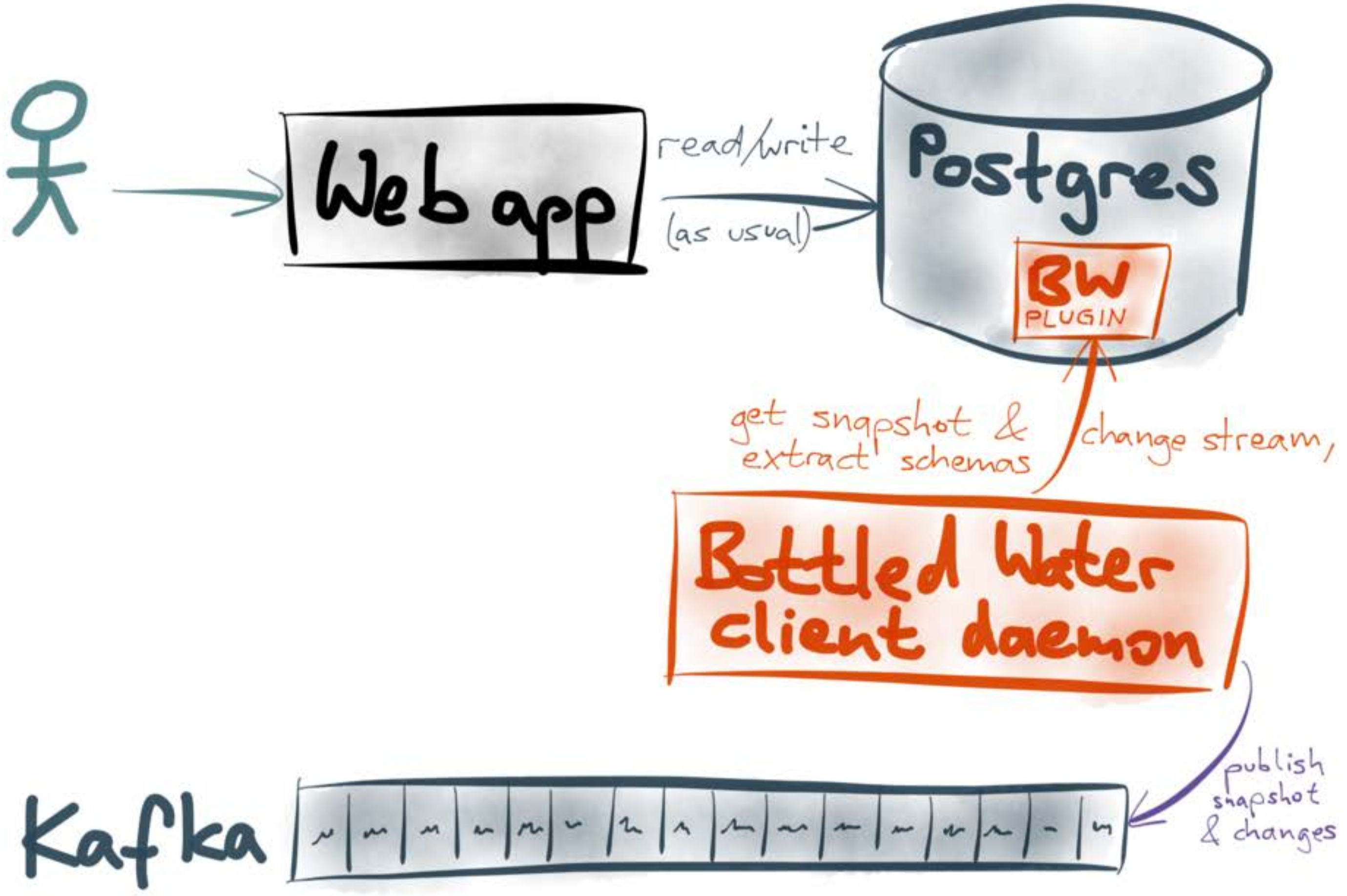
"SOMETHING HAPPENED"

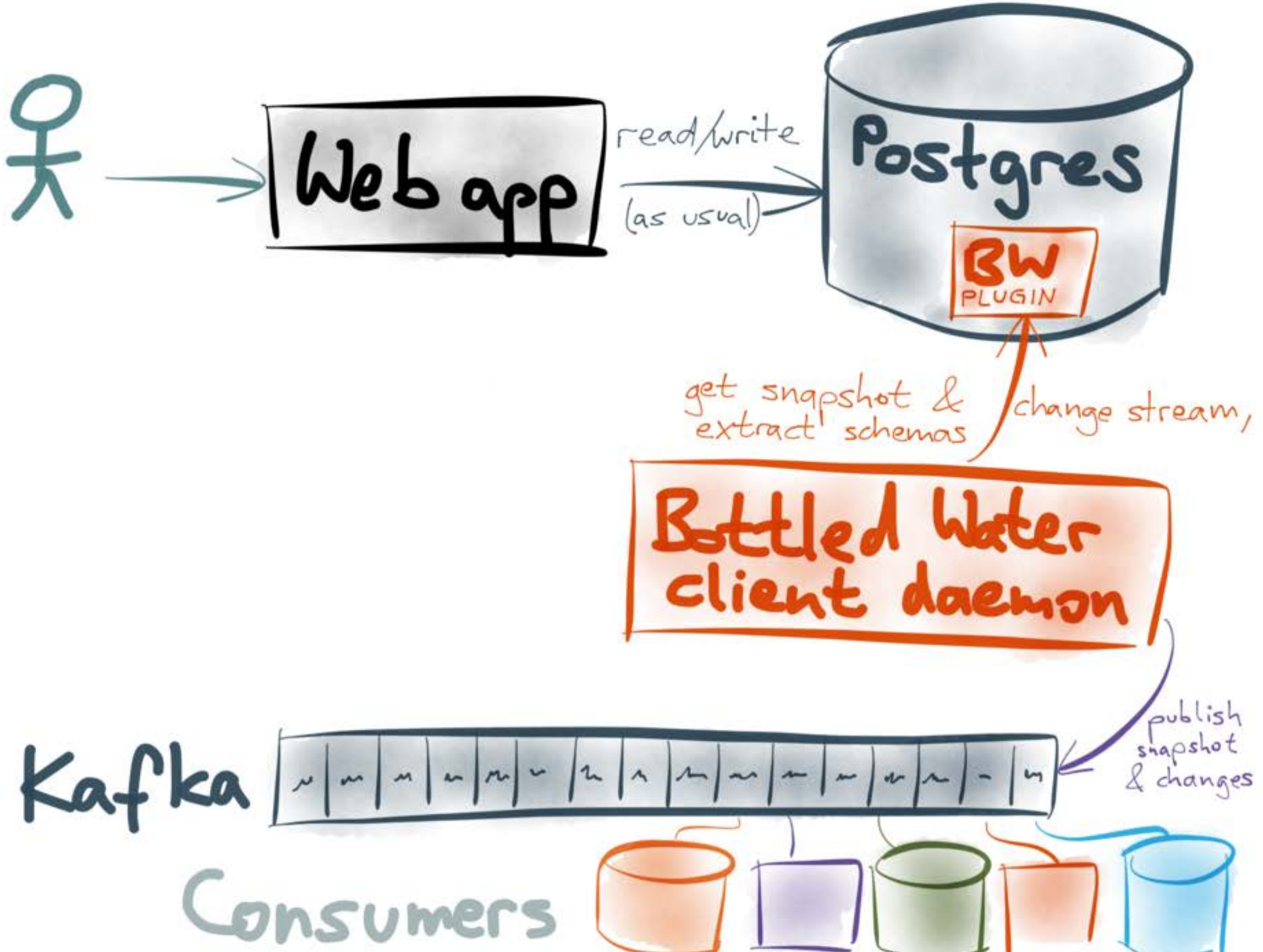
- User x clicked link y
  (activity event)
- Sensor x sent reading y
  (time series tick)
- Database record x updated to y
  (data change event)

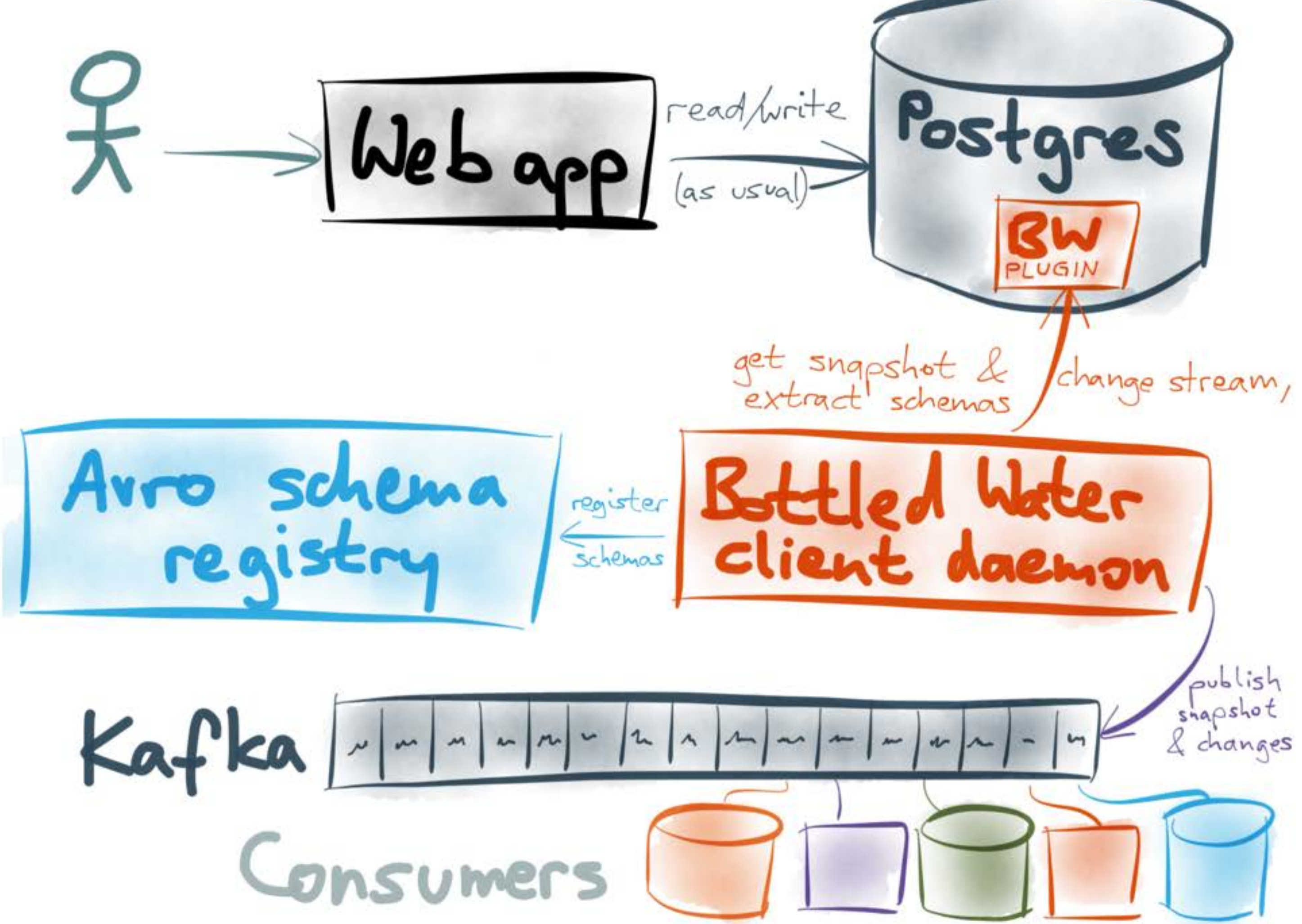
Immutable, point in time

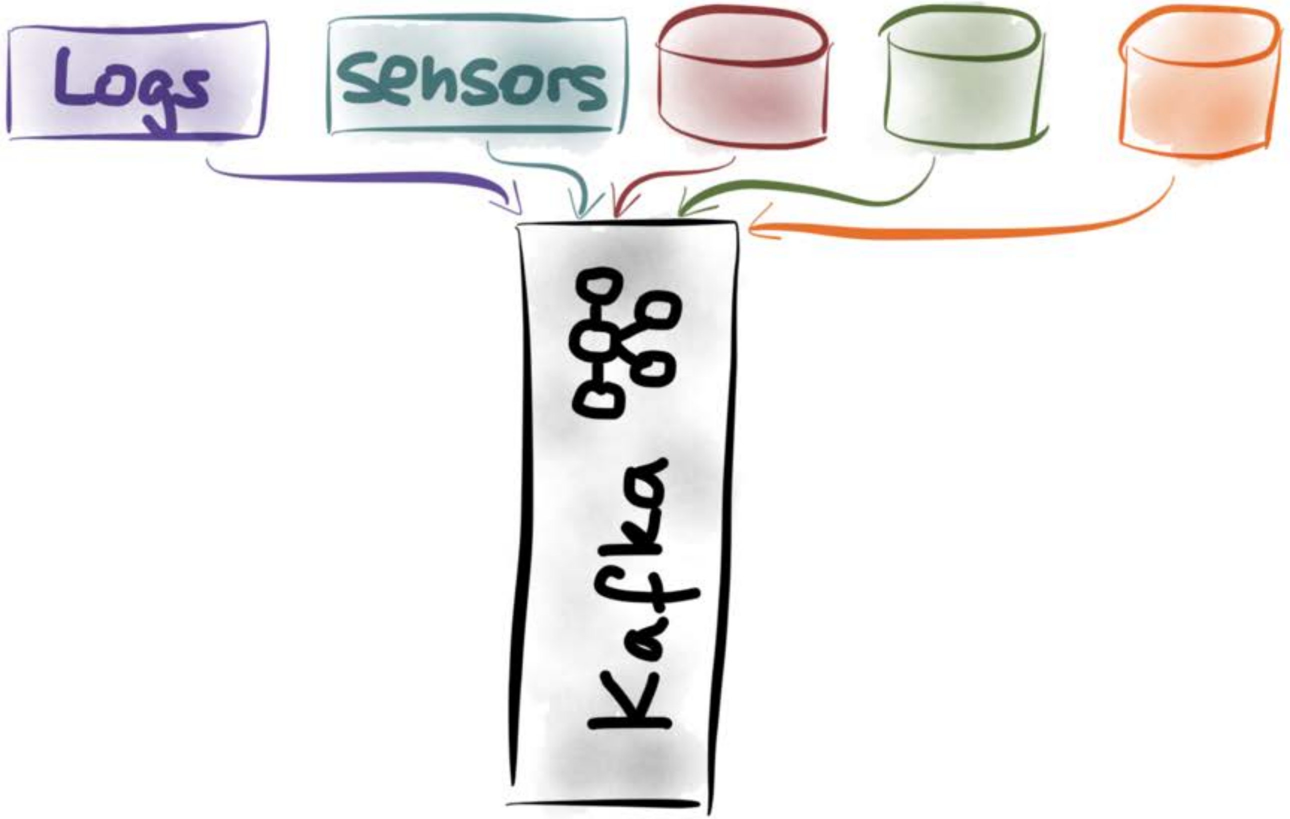
DATA STREAMS – FRESHLY BOTTLED AT SOURCE

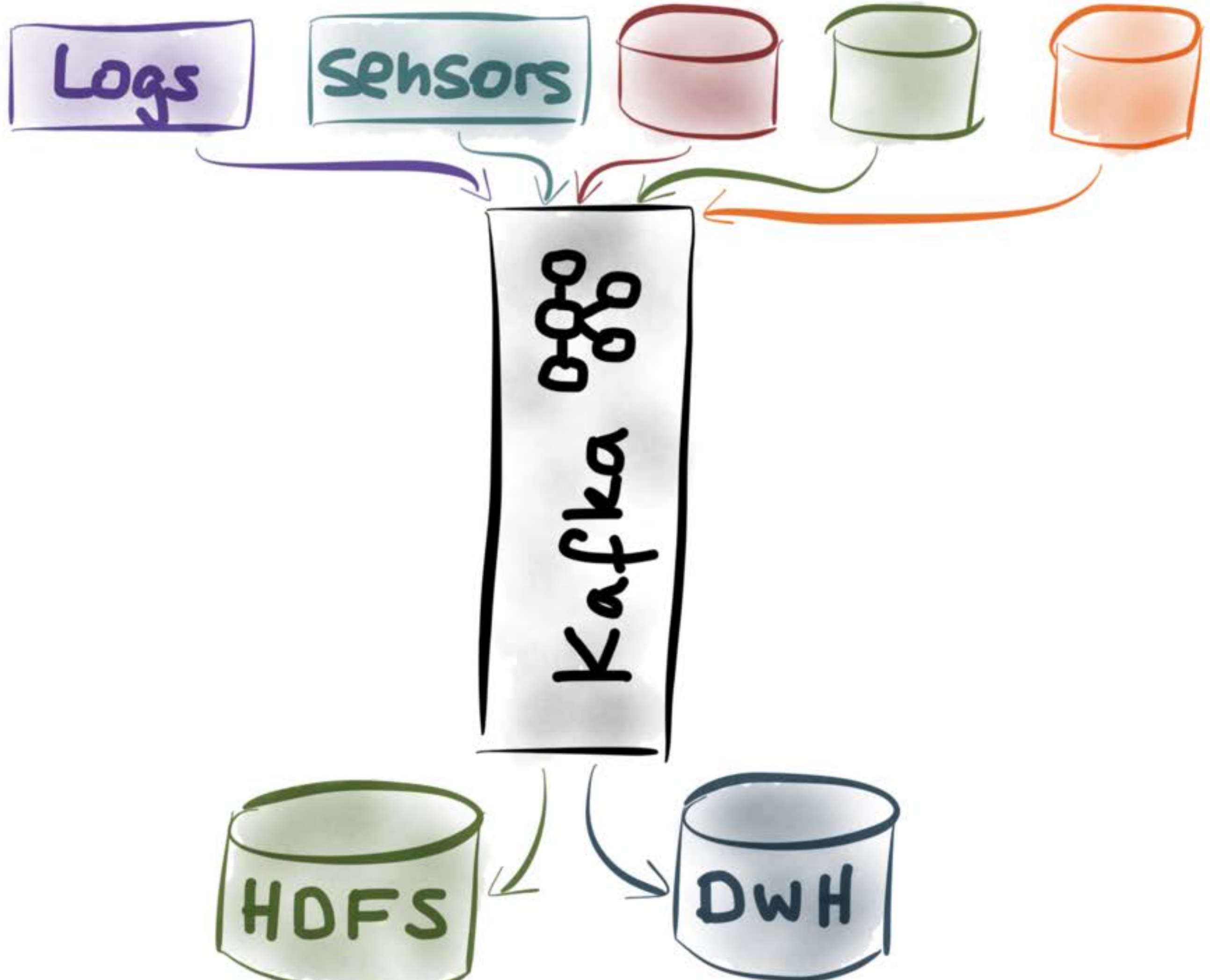

Web app
read/write
(as usual)
Postgres
BW
PLUGIN
get snapshot &
extract schemas
change stream,
Bottled Water
client daemon

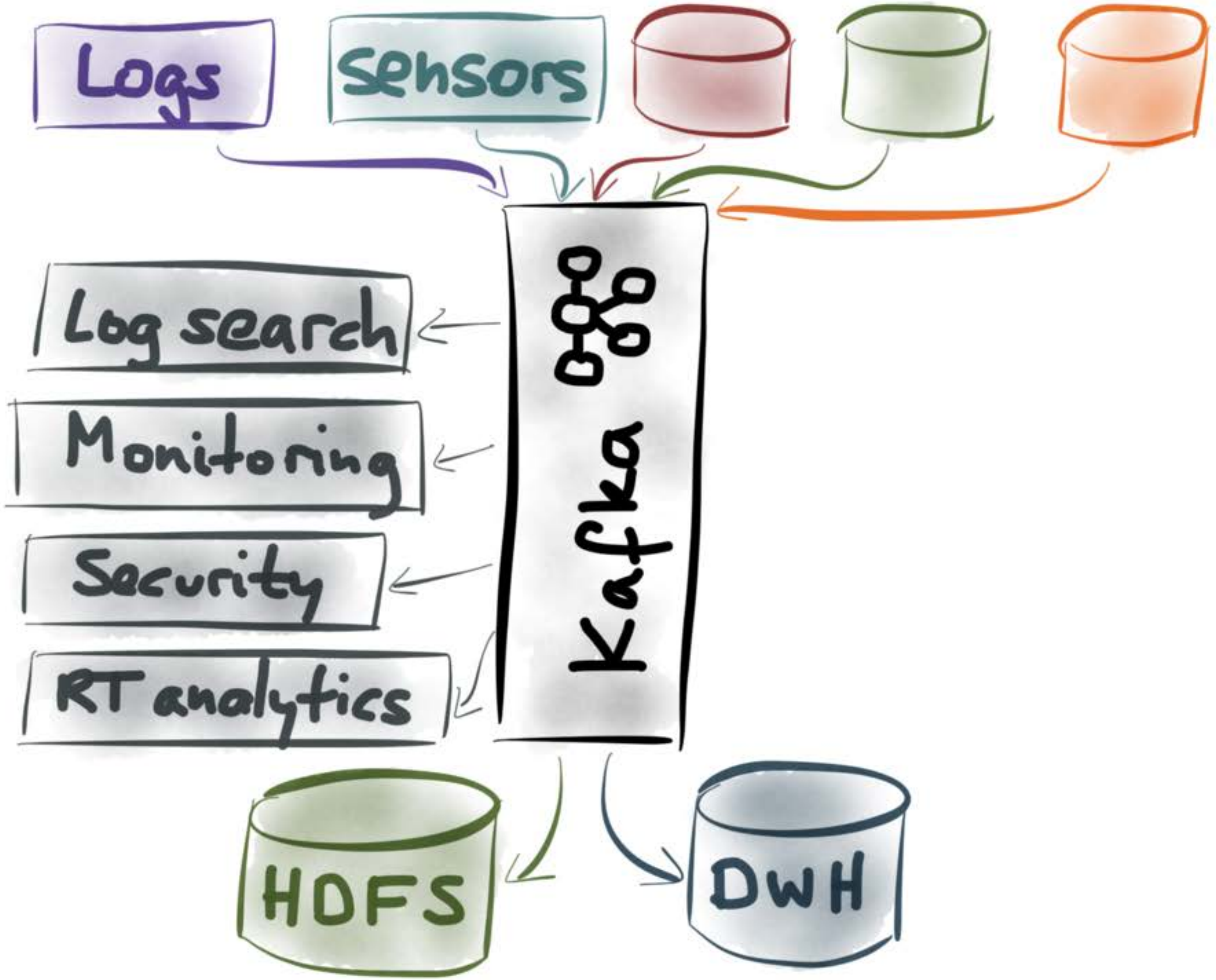

Web app
read/write
(as usual)
Postgres
BW
PLUGIN
get snapshot & extract schemas
change stream,
Bottled Water client daemon
publish snapshot & changes
Kafka


Web app
read/write
(as usual)
Postgres
BW PLUGIN
get snapshot & extract schemas
change stream,
Bottled Water client daemon
publish snapshot & changes
Kafka
Consumers

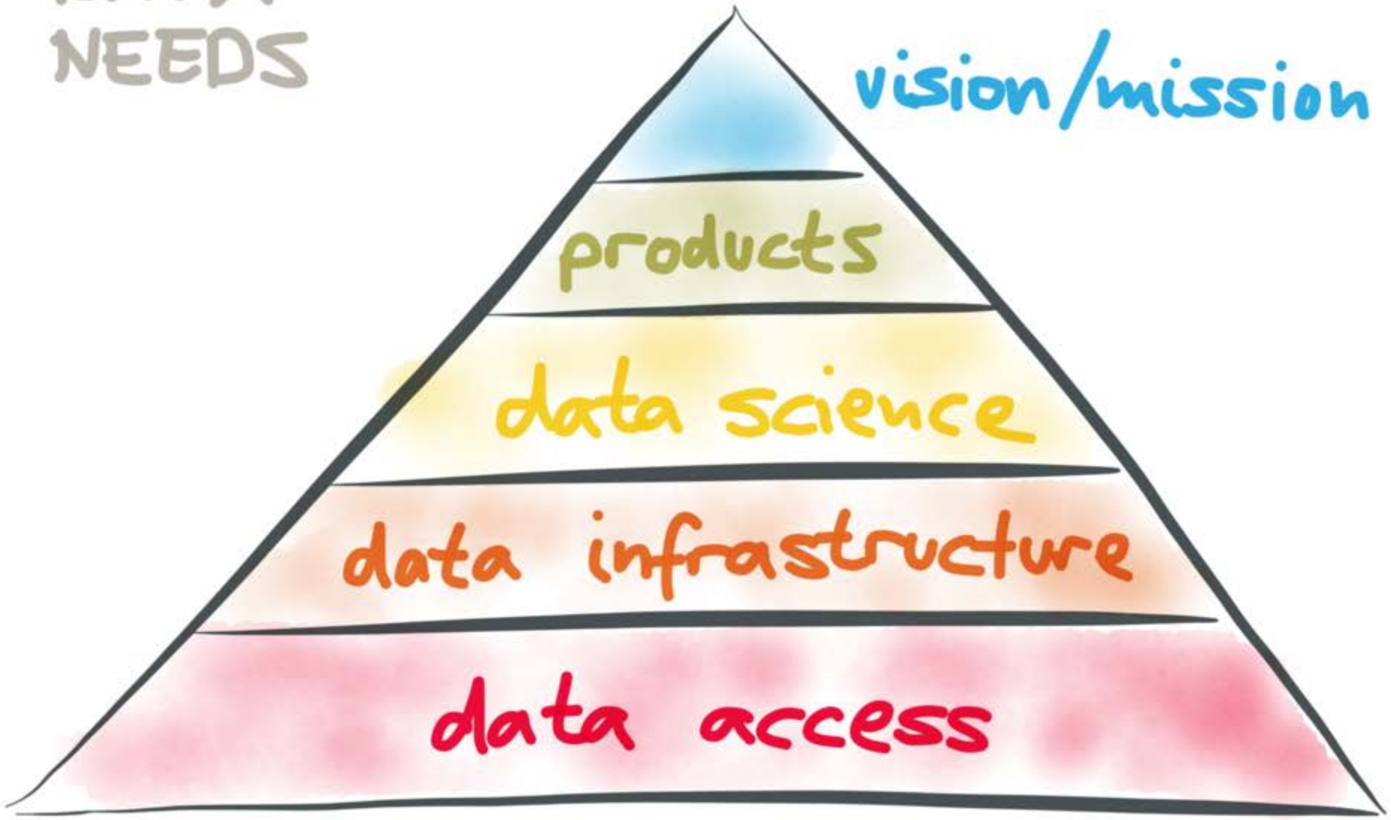

Web app
read/write
(as usual)
Postgres
BW PLUGIN
get snapshot & extract schemas
change stream,
Avro schema registry
register
schemas
Bottled Water client daemon
publish snapshot & changes
Kafka
Consumers

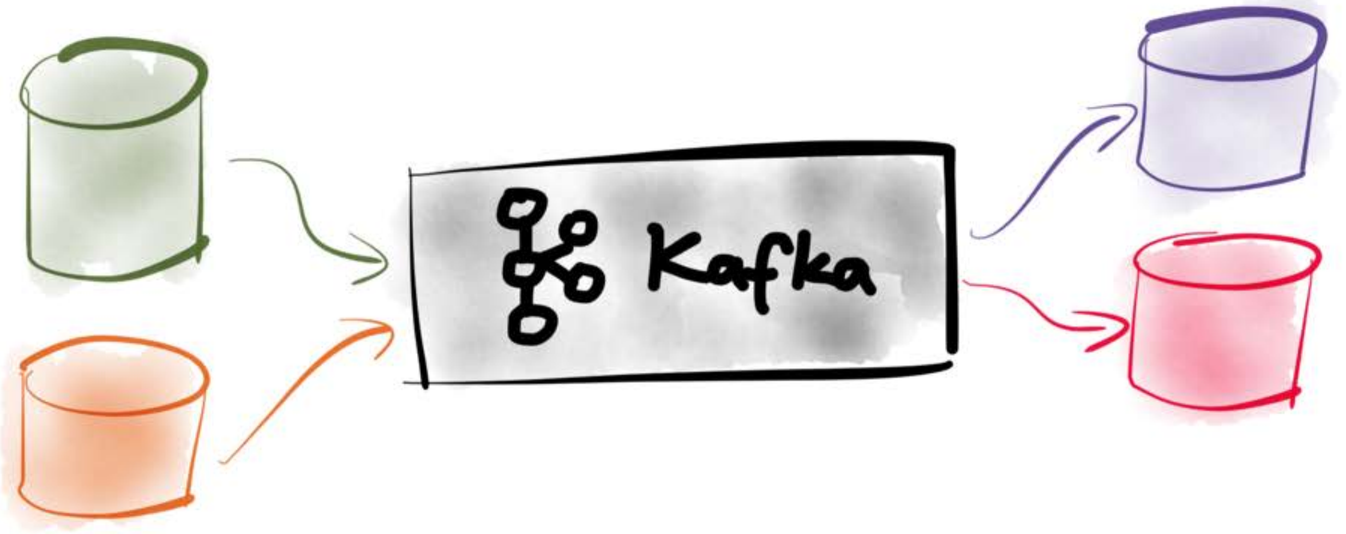

Logs
Sensors
Kafka

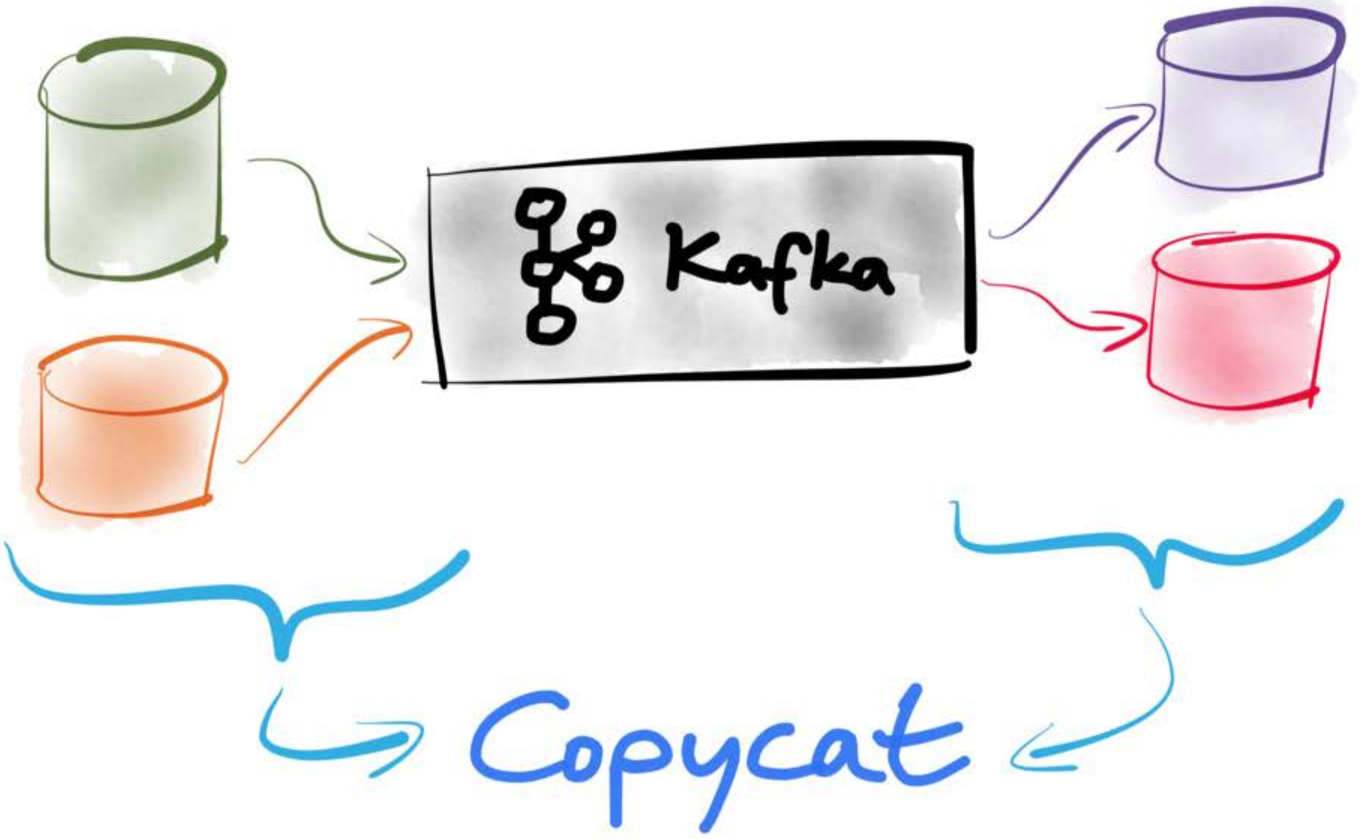

Logs
Sensors
Kafka
HDFS
DWH


Logs
sensors
Kafka
Log search
Monitoring
Security
RT analytics
HDFS
DWH

DATA NEEDS


vision/mission
products
data science
data infrastructure
data access


Kafka



→ Neha Narkhede's talk, Thu 1.15pm

1. Data access

Make all data available as streams, including DBs

1. **Data access**

   Make all data available as streams, including DBs

2. **Common data format**

   Metadata: schema, semantics, provenance, evolution

Local optimum

Using your favorite data format

Local optimum

Using <u>your</u> favorite data format

Global optimum

Standardizing on <u>one</u> format

JSON

+ widely supported

+ human-readable (ish)

JSON

+ widely supported

+ human-readable (ish)

- integer/floating-point mess

JSON

+ widely supported

+ human-readable (ish)

- integer/floating-point mess

- no binary strings

JSON

- + widely supported
- + human-readable (ish)
- − integer/floating-point mess
- − no binary strings
- − verbose & slow

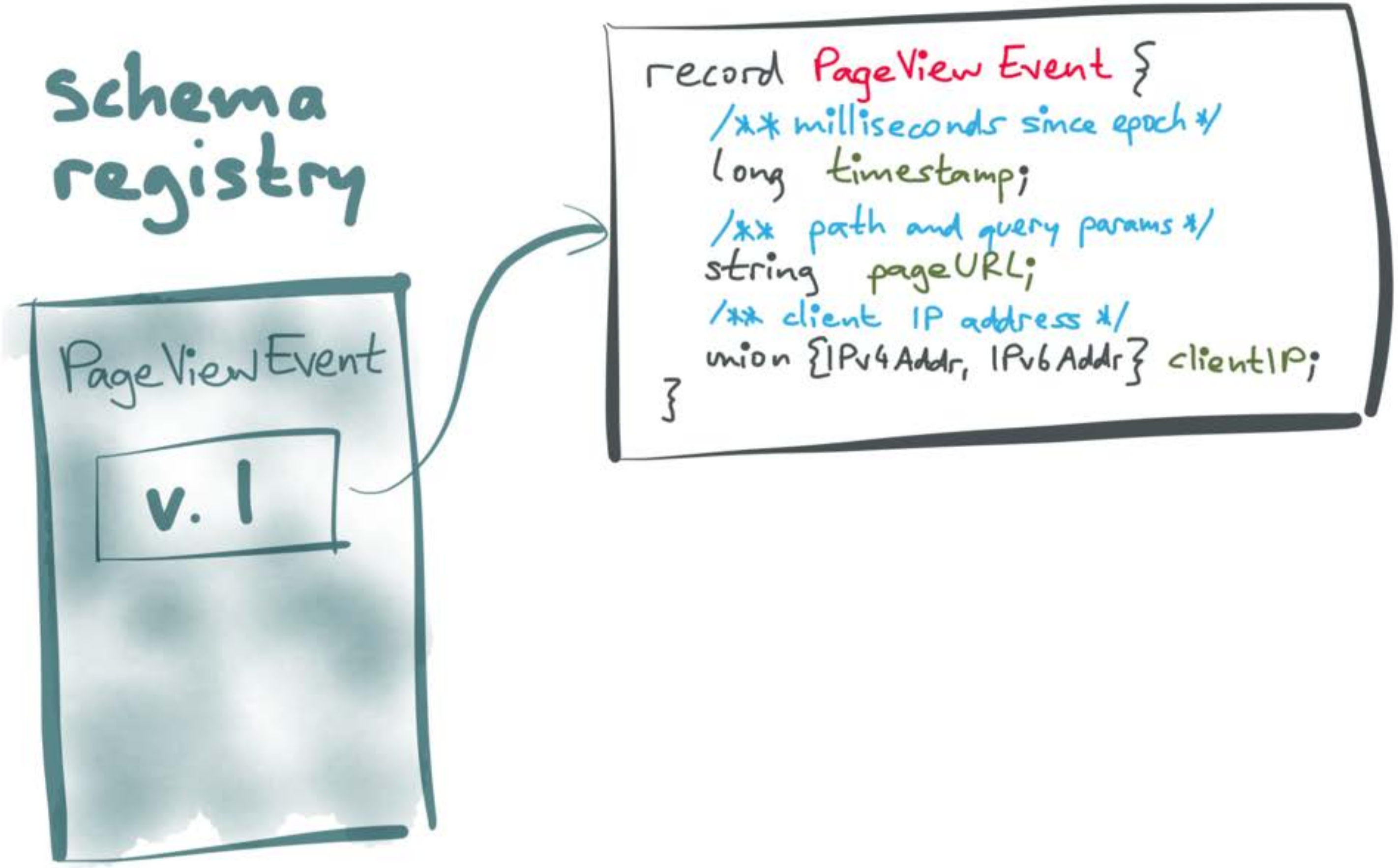
AVRO TM

```
record PageViewEvent {
    long timestamp;
    string pageURL;
    union{ IPv4Addr, IPv6Addr }
                clientIP;
}
```

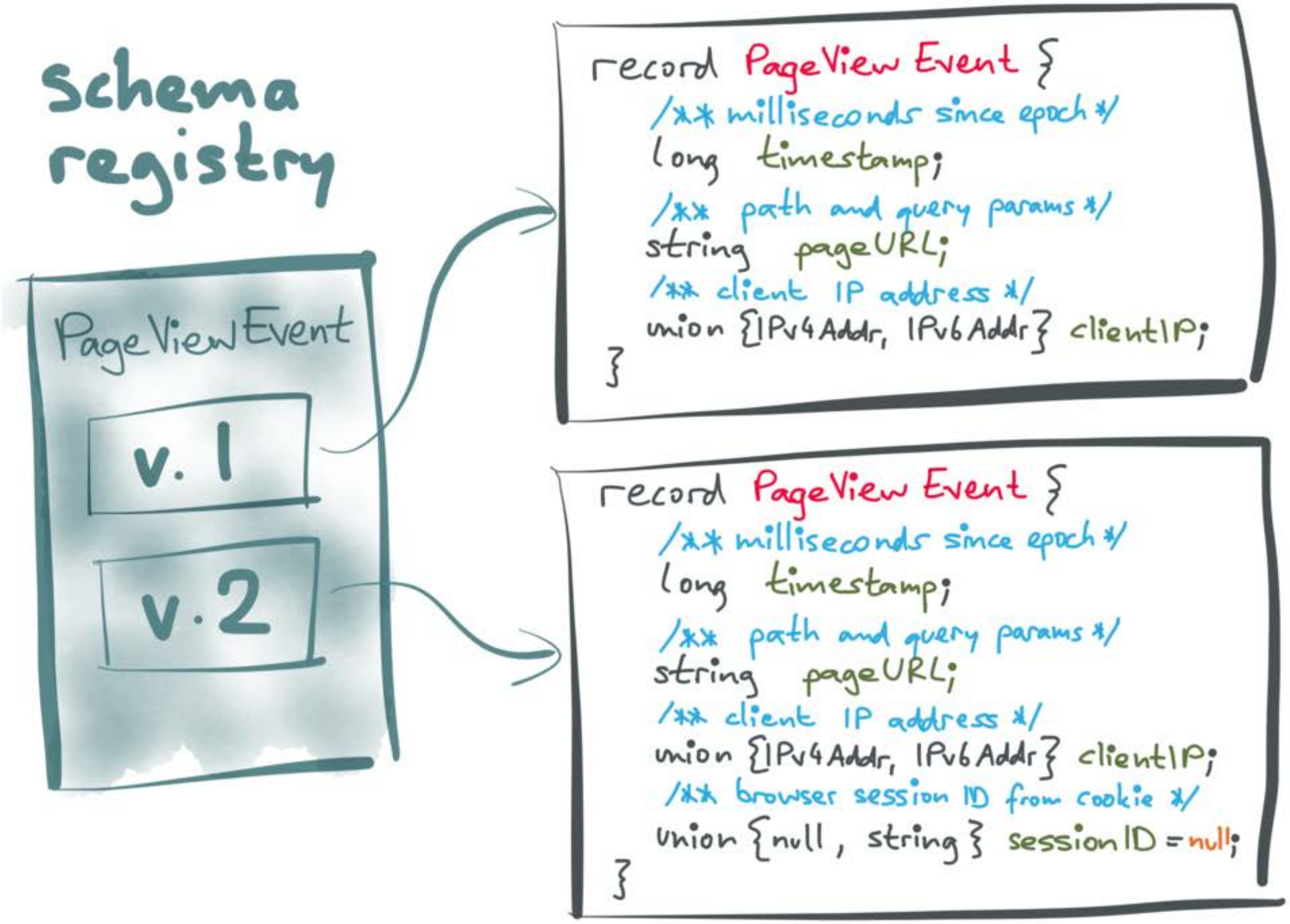
```
record PageViewEvent {
    /** milliseconds since epoch */
    Long timestamp;
    /** path and query params */
    string pageURL;

    /** IP address of client */
    union{ IPv4Addr, IPv6Addr }
              clientIP;
...
```

```
record PageViewEvent {
    long timestamp;
    string pageURL;
    union{ IPv4Addr, IPv6Addr }
             clientIP;
   union { null, string }
             sessionID = null;
}
```

Schema registry

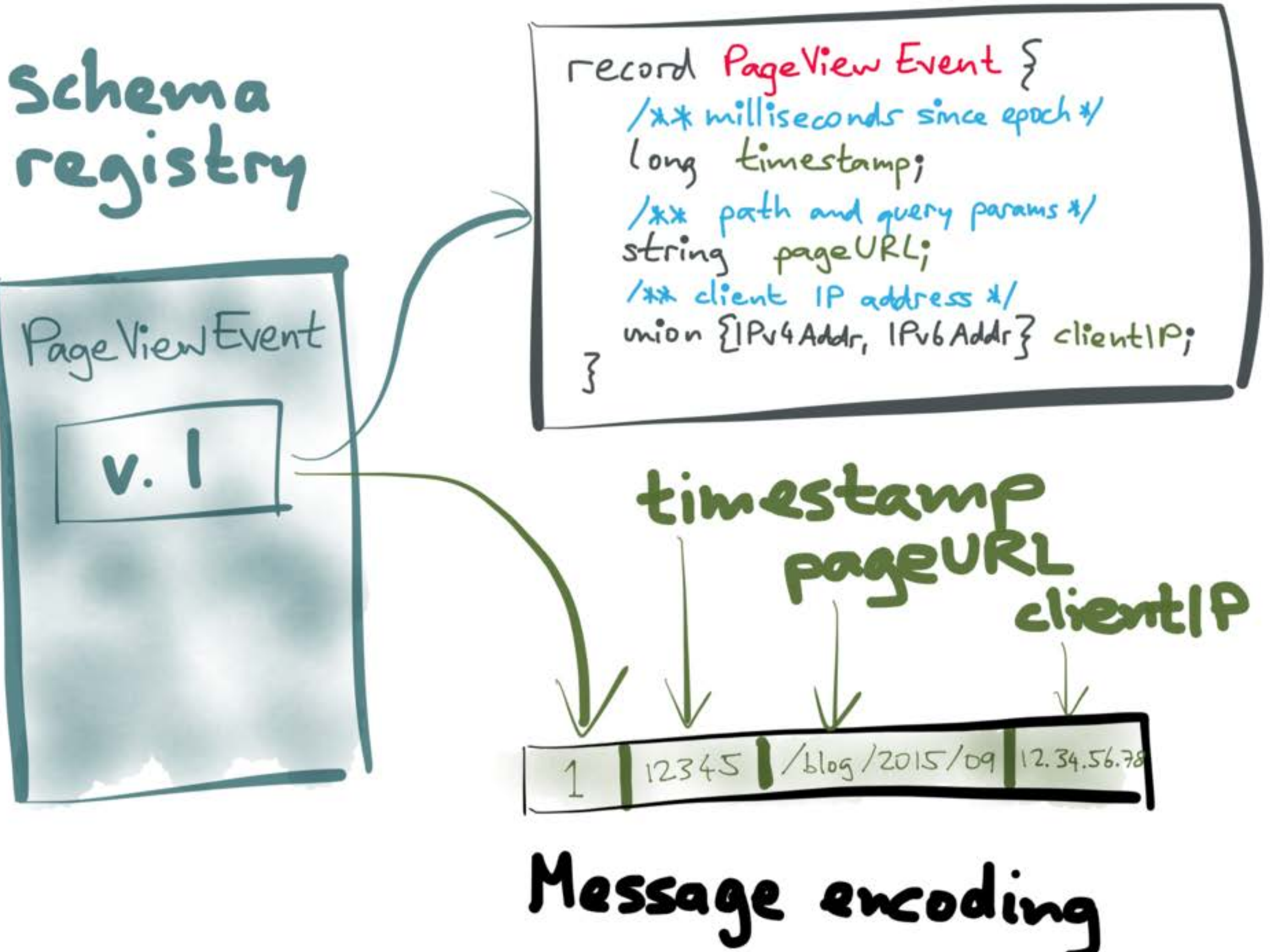


```
record PageViewEvent {
    /** milliseconds since epoch */
    long timestamp;
    /** path and query params */
    string pageURL;
    /** client IP address */
    union {IPv4Addr, IPv6Addr} clientIP;
}
```

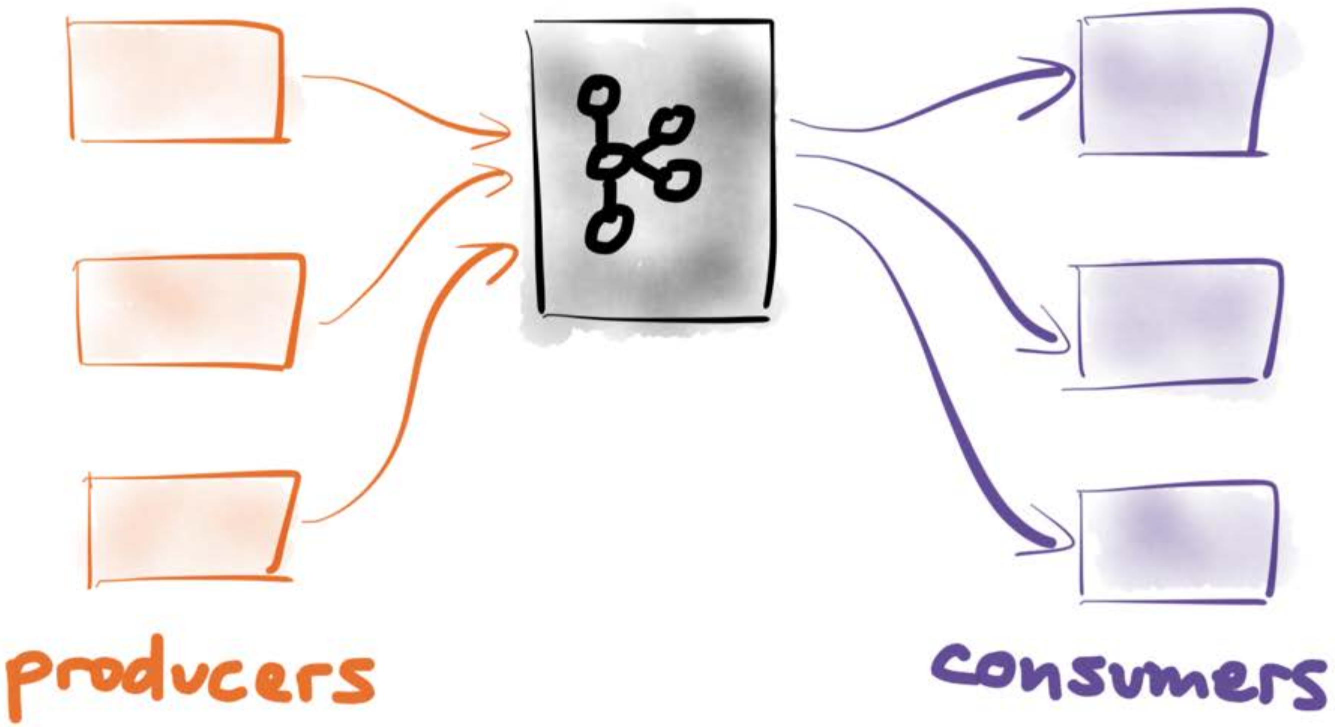


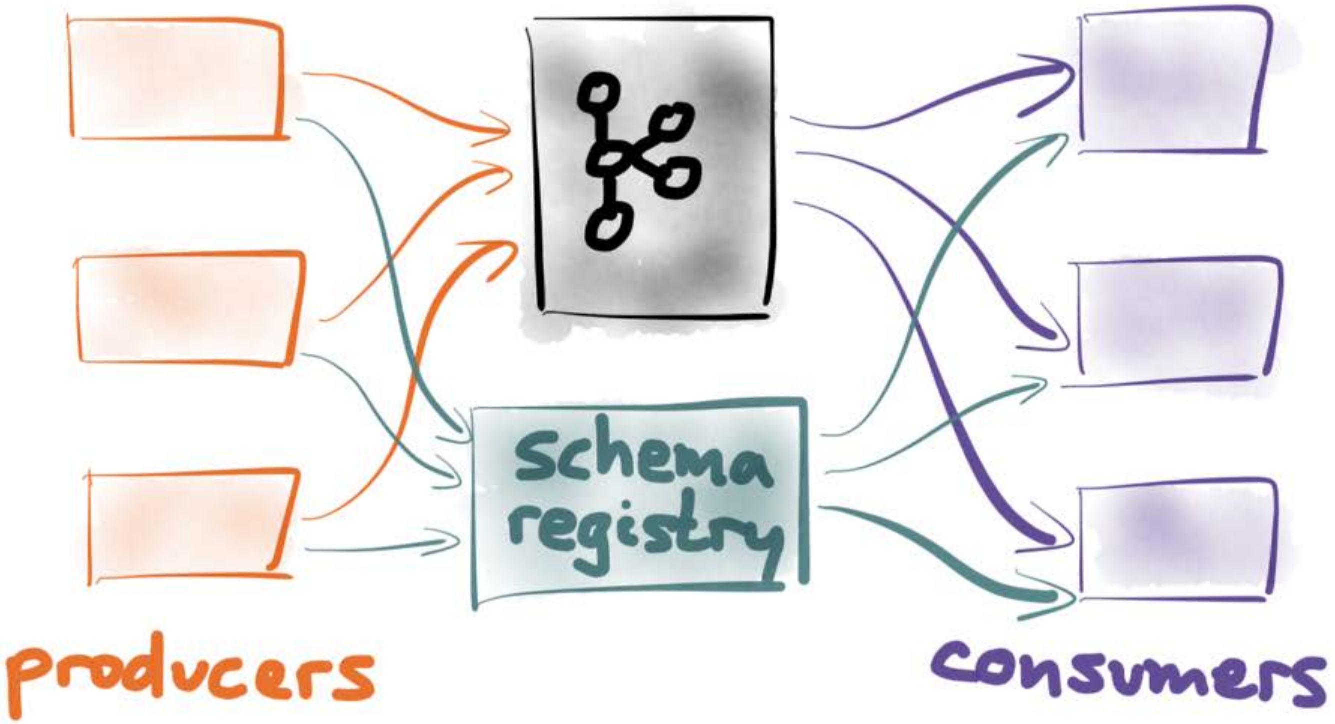
```
record PageViewEvent {
  /** milliseconds since epoch */
  long  timestamp;
  /** path and query params */
  string  pageURL;
  /** client IP address */
  union {IPv4Addr, IPv6Addr} clientIP;
}
```

```
record PageViewEvent {
  /** milliseconds since epoch */
  long  timestamp;
  /** path and query params */
  string  pageURL;
  /** client IP address */
  union {IPv4Addr, IPv6Addr} clientIP;
  /** browser session ID from cookie */
  union {null, string} sessionID = null;
}
```

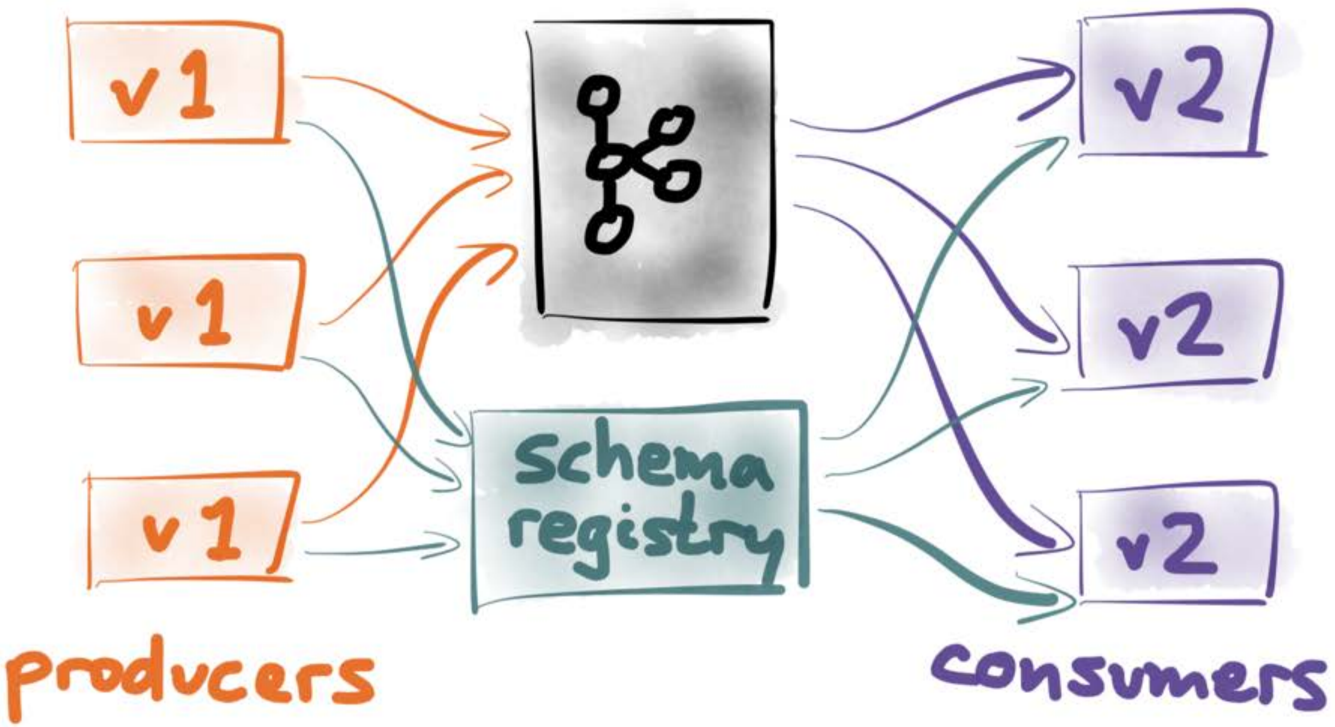


```
record PageViewEvent {
  /** milliseconds since epoch */
  long timestamp;
  /** path and query params */
  string pageURL;
  /** client IP address */
  union {IPv4Addr, IPv6Addr} clientIP;
}
```

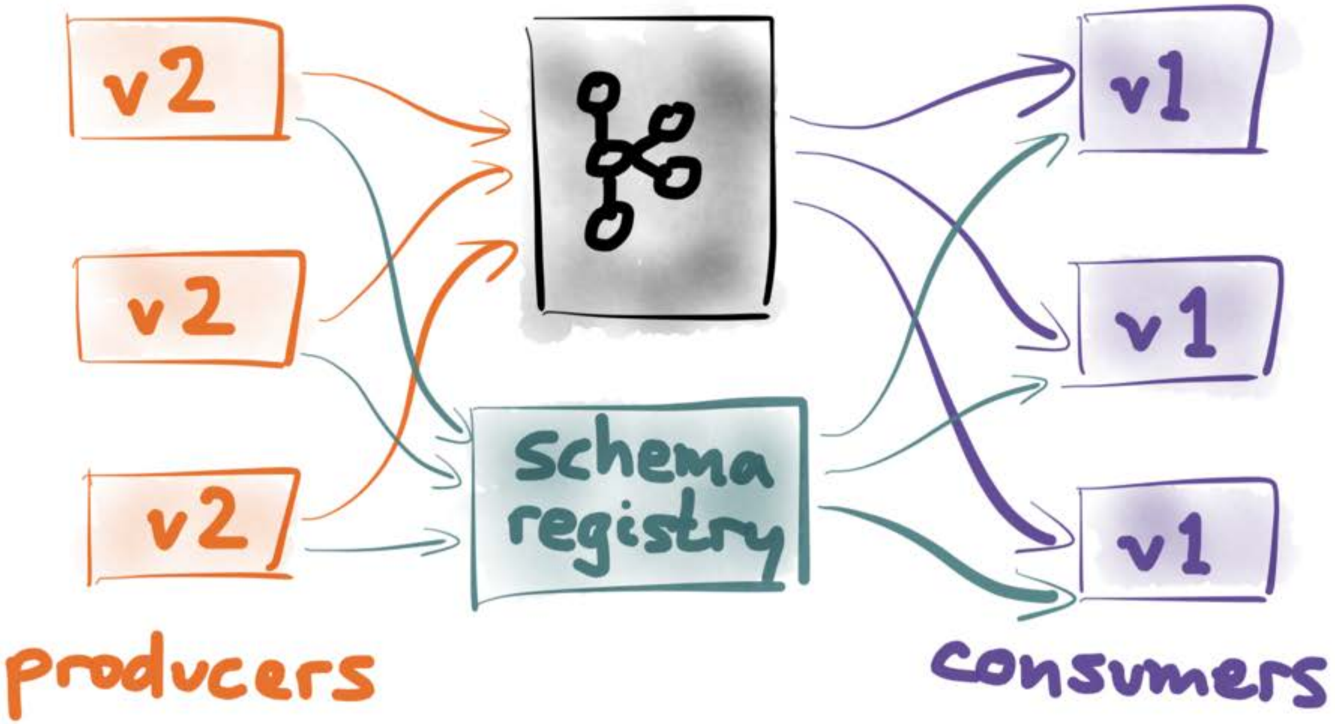

producers
consumers


schema registry
producers
consumers

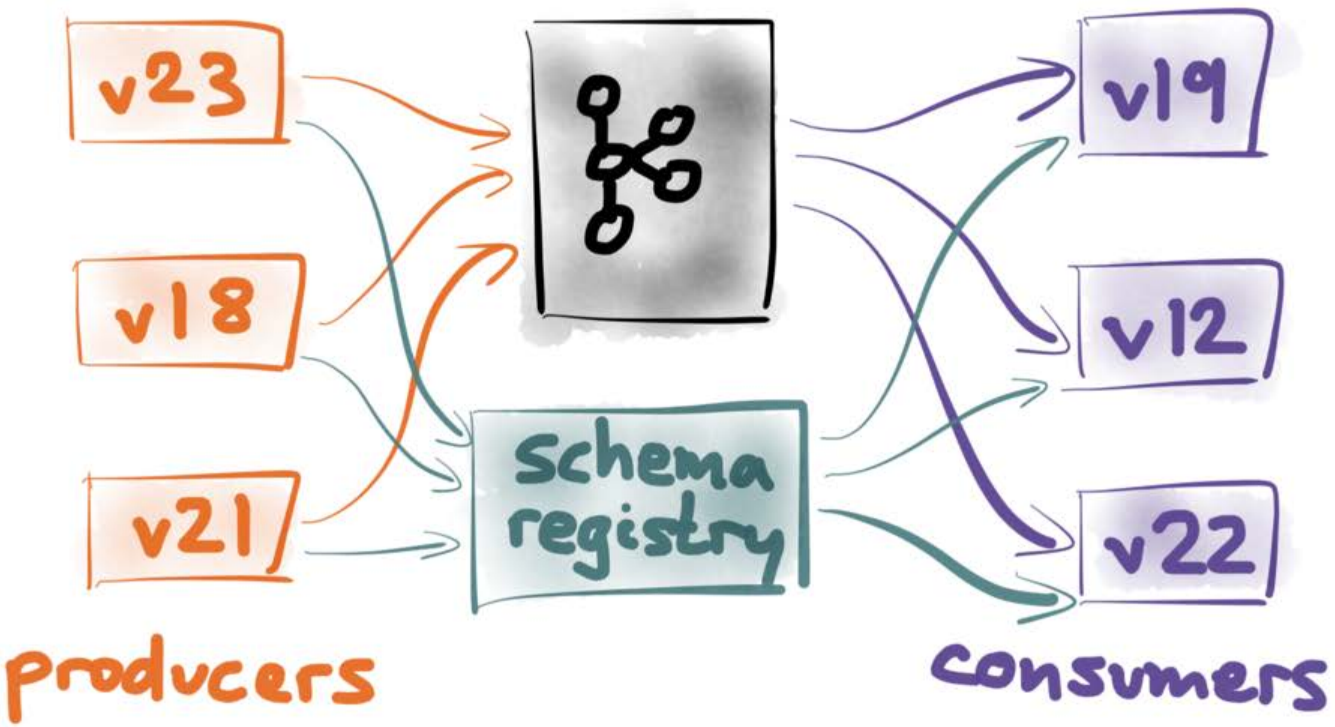
Backward compatibility



Forward compatibility



Mixed versions



Schema registry

Version number assignment

Compatibility check

Documentation

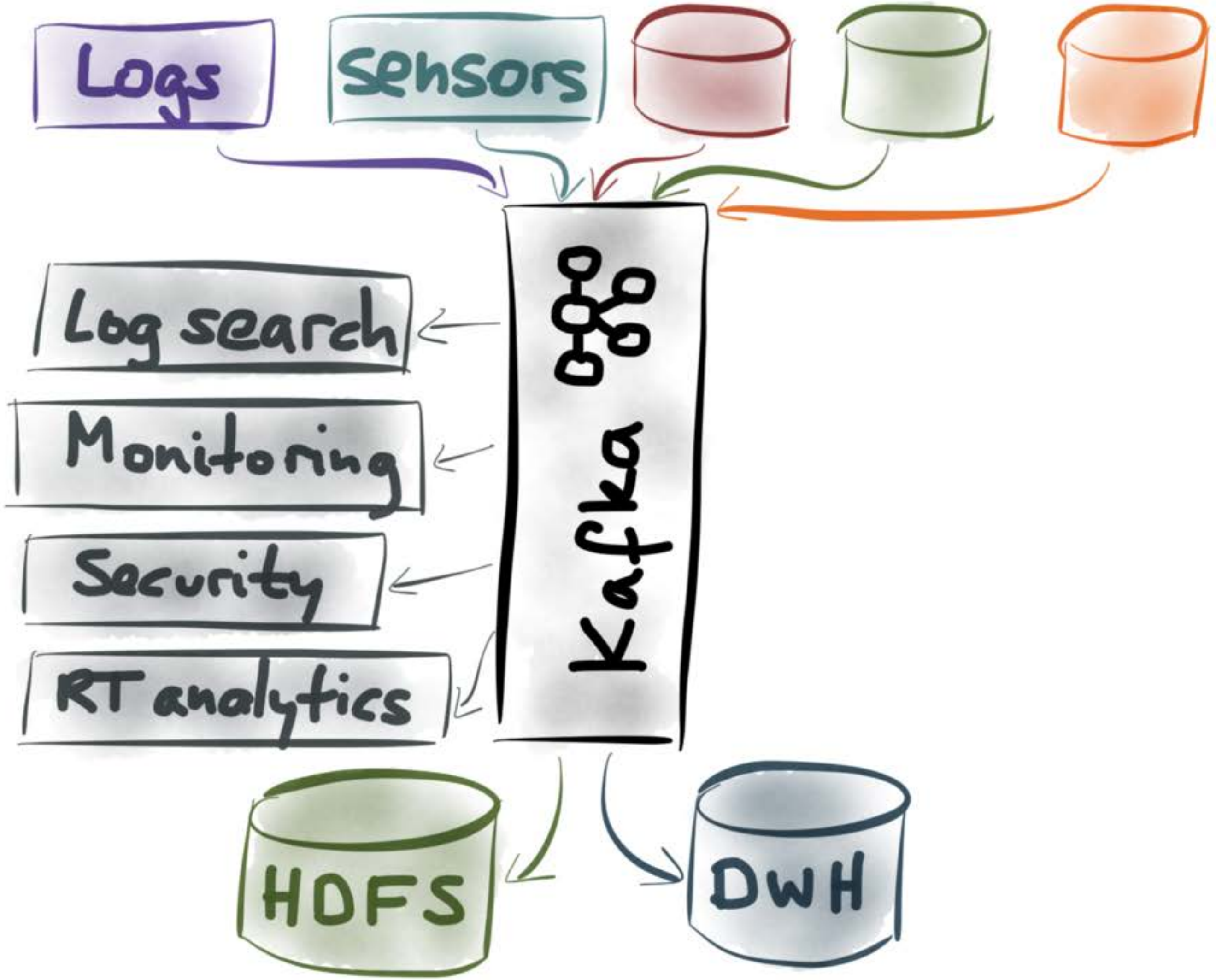
1. Data access

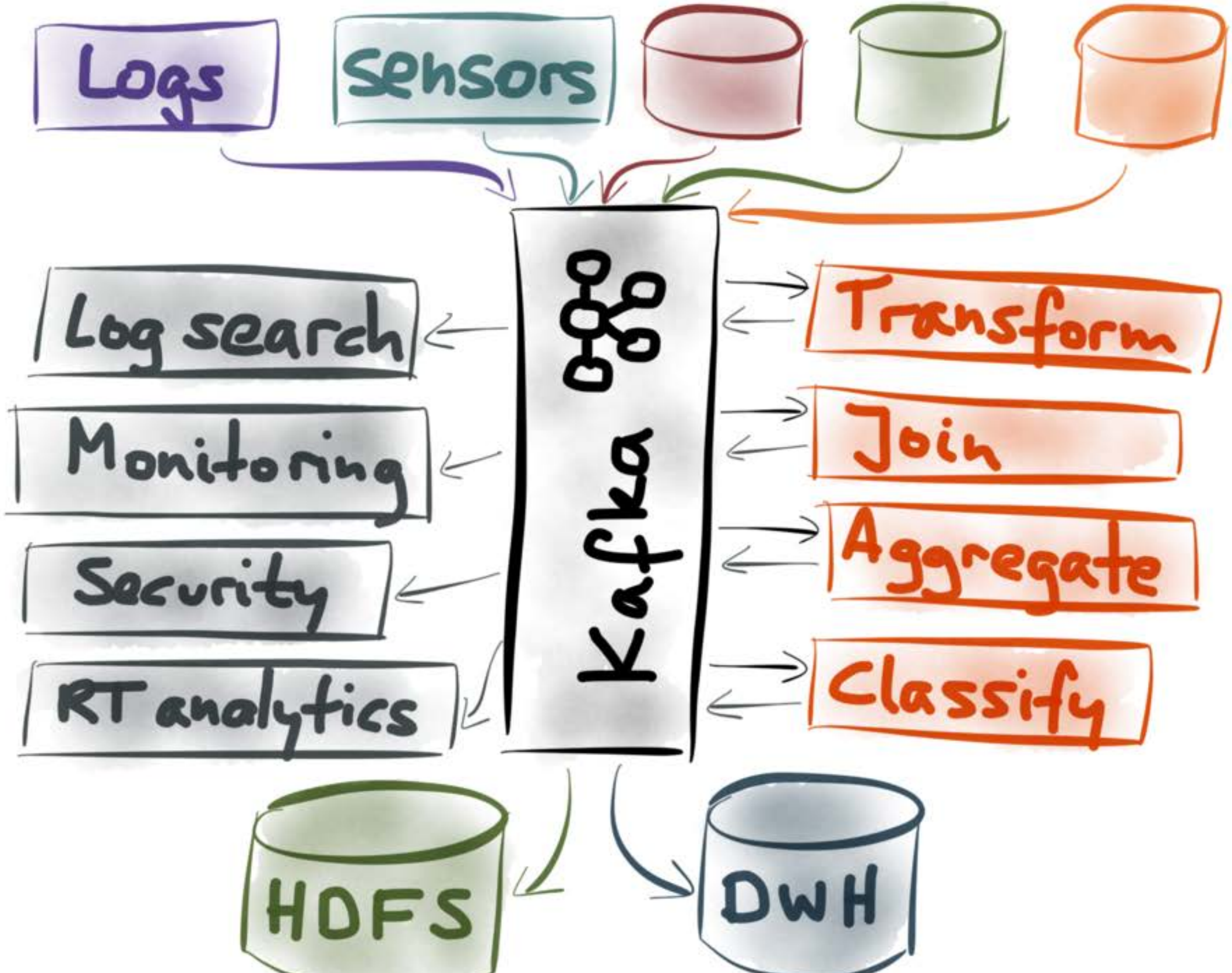
   Make all data available as streams, including DBs

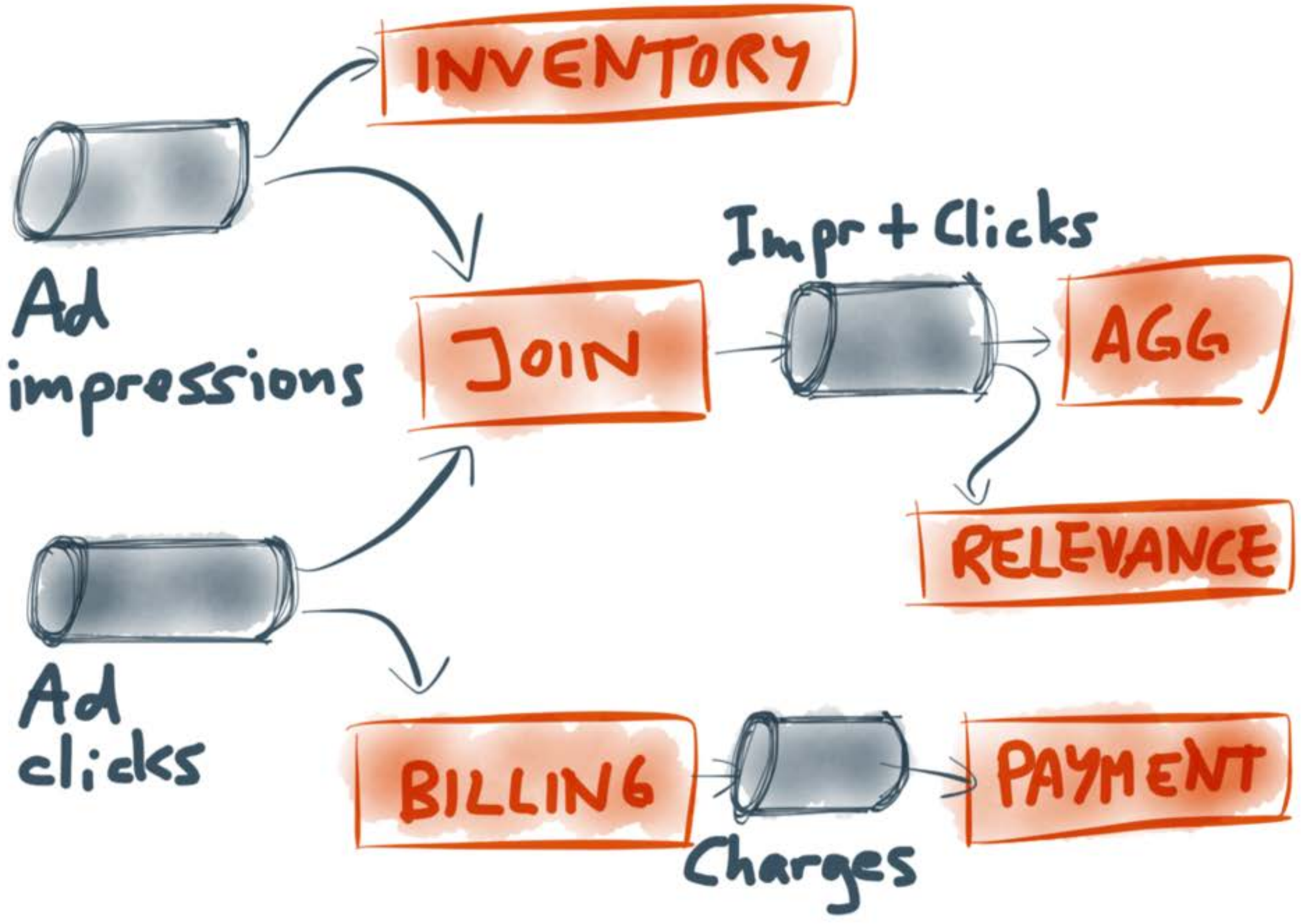
2. Common data format

   Metadata: schema, semantics, provenance, evolution

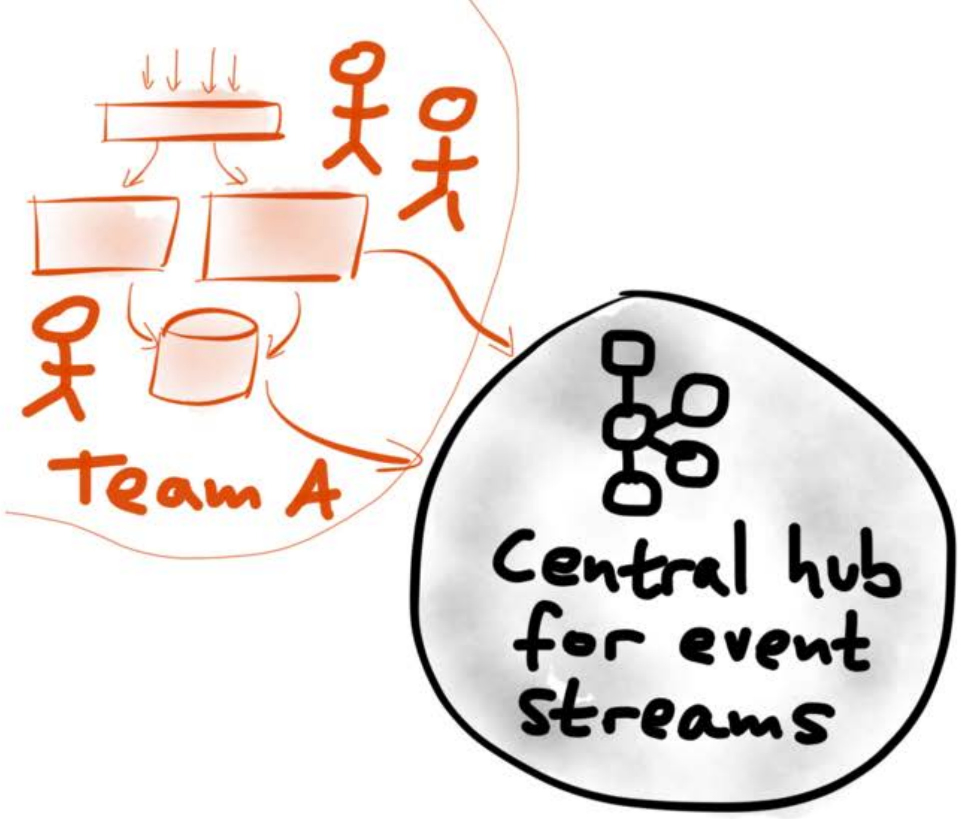
1. **Data access**
   Make all data available as streams, including DBs
2. **Common data format**
   Metadata: schema, semantics, provenance, evolution
3. **Composability**
   Loosely coupled stream processors, Kafka as pipe

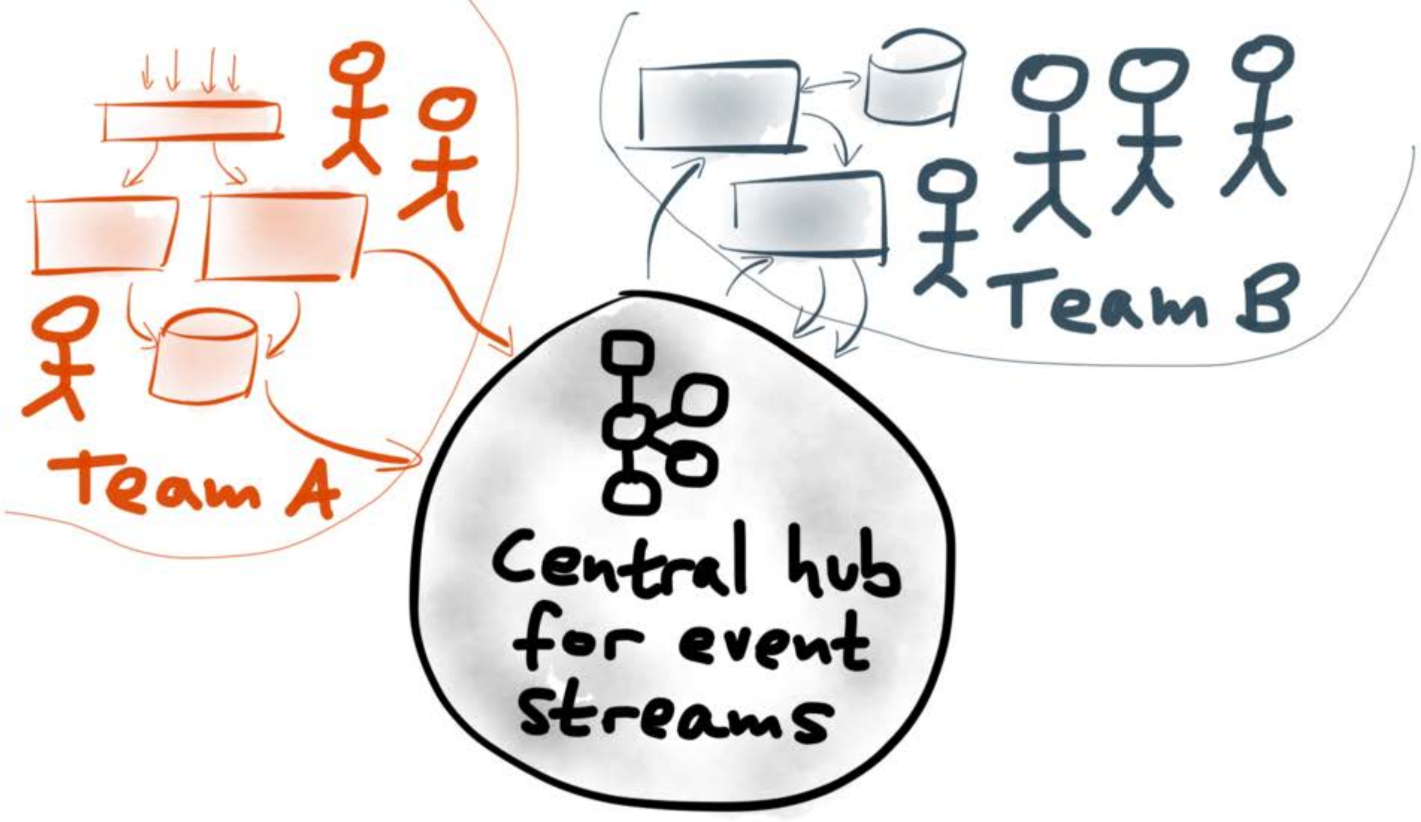

Logs
sensors
Log search
Monitoring
Security
RT analytics
Kafka
HDFS
DWH

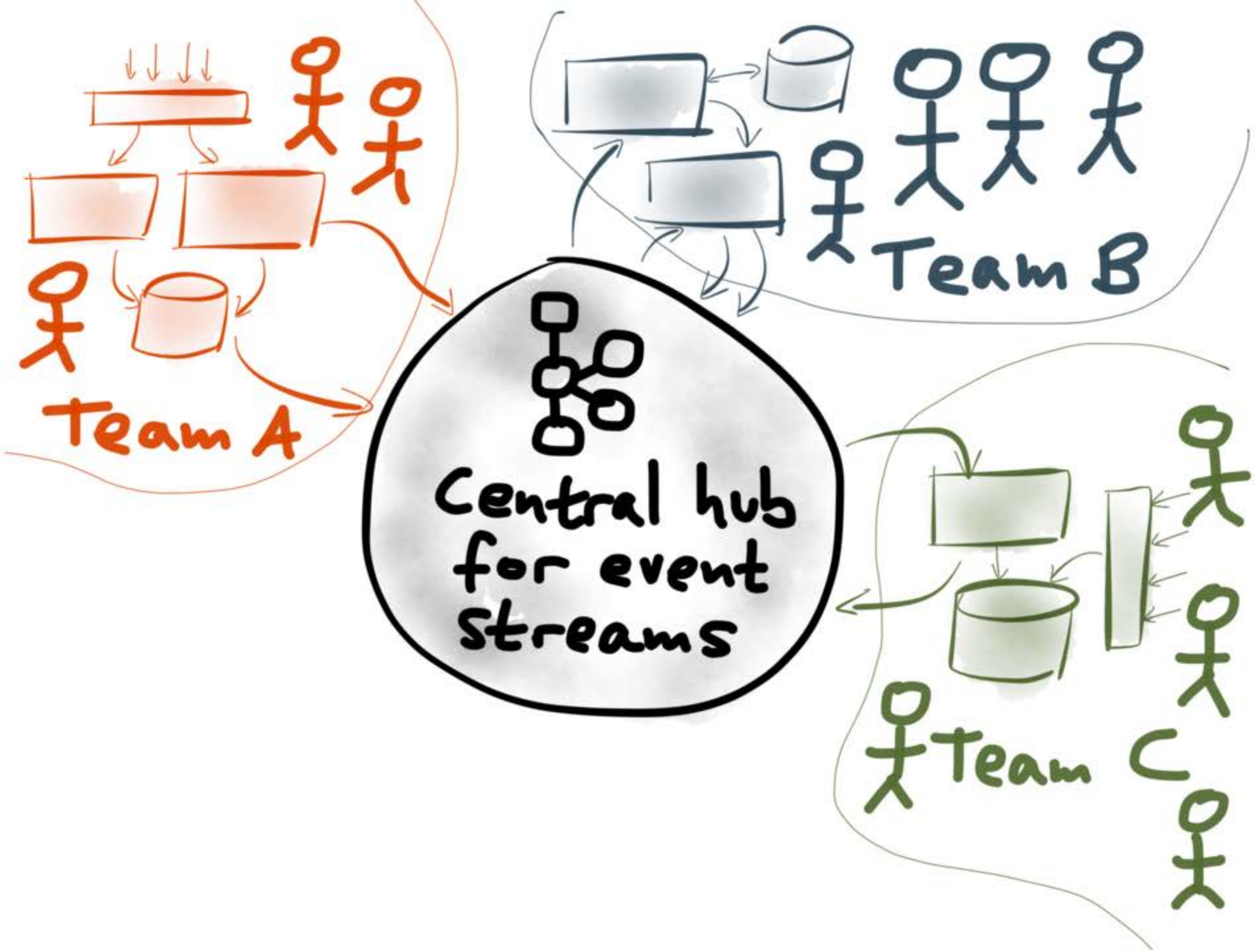

Logs
Sensors
Log search
Monitoring
Security
RT analytics
Kafka
Transform
Join
Aggregate
Classify
HDFS
DWH

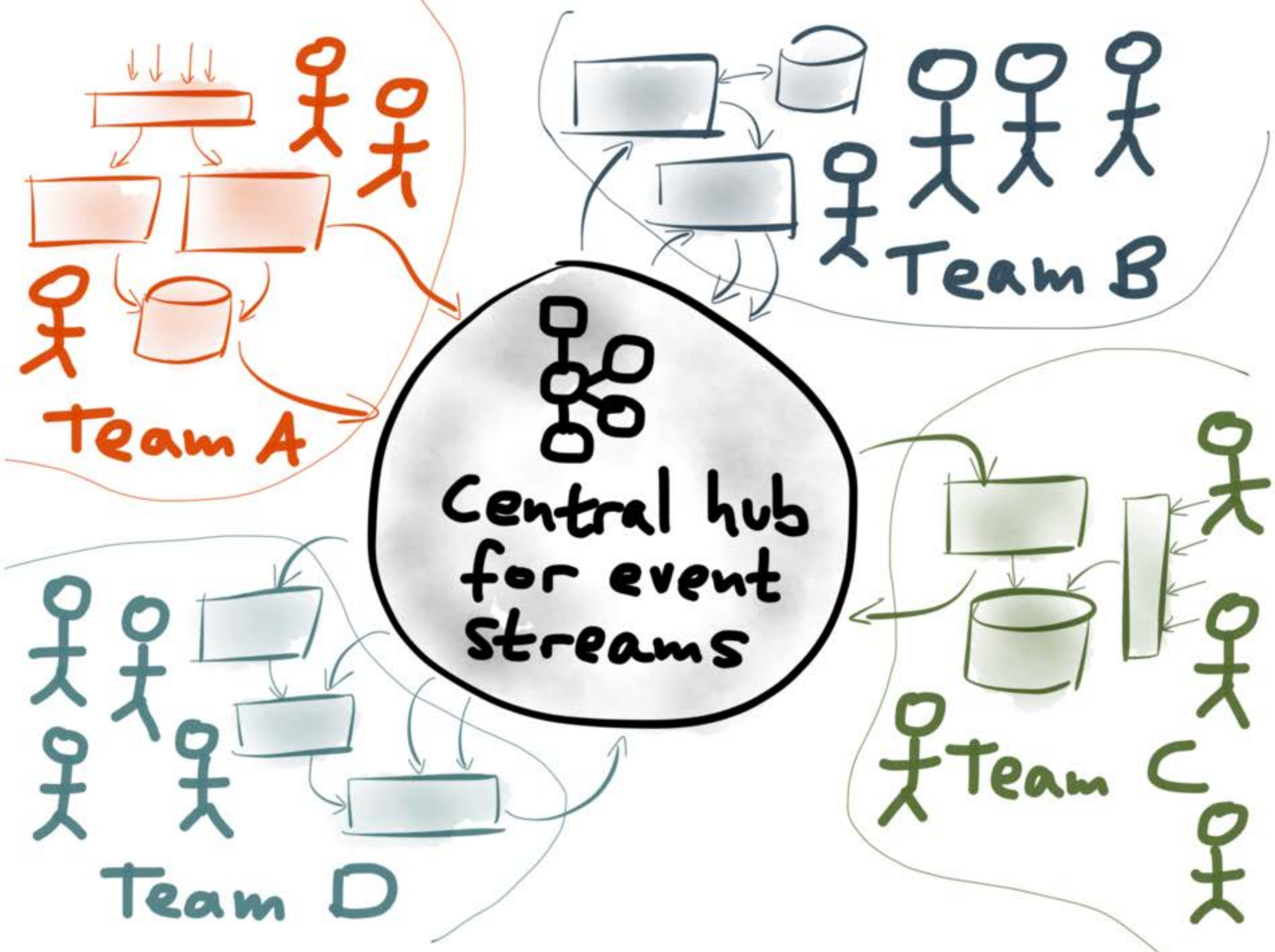

INVENTORY
Ad impressions
JOIN
Impr + Clicks
AGG
RELEVANCE
Ad clicks
BILLING
Charges
PAYMENT

Central hub
for event
streams


Team A
Central hub for event streams


Team A
Team B
Central hub for event streams


Team A
Team B
Central hub for event streams
Team C


Team A
Team B
Central hub for event streams
Team C
Team D

References

1. Jay Kreps: "Putting Apache Kafka to use: A practical guide to building a stream data platform (part 1)." 25 February 2015. http://blog.confluent.io/2015/02/25/stream-data-platform-1/
2. Gwen Shapira: "The problem of managing schemas," 4 November 2014. http://radar.oreilly.com/2014/11/the-problem-of-managing-schemas.html
3. Martin Kleppmann: "Schema evolution in Avro, Protocol Buffers and Thrift," 5 December 2012. http://martin.kleppmann.com/2012/12/05/schema-evolution-in-avro-protocol-buffers-thrift.html
4. Martin Kleppmann: "Bottled Water: Real-time integration of PostgreSQL and Kafka." 23 April 2015. http://blog.confluent.io/2015/04/23/bottled-water-real-time-integration-of-postgresql-and-kafka/
5. Martin Kleppmann: "Designing data-intensive applications." O'Reilly Media, to appear. http://dataintensive.net
6. Shirshanka Das, Chavdar Botev, Kapil Surlaker, et al.: "All Aboard the Databus!," at *ACM Symposium on Cloud Computing* (SoCC), October 2012. http://www.socc2012.org/s18-das.pdf

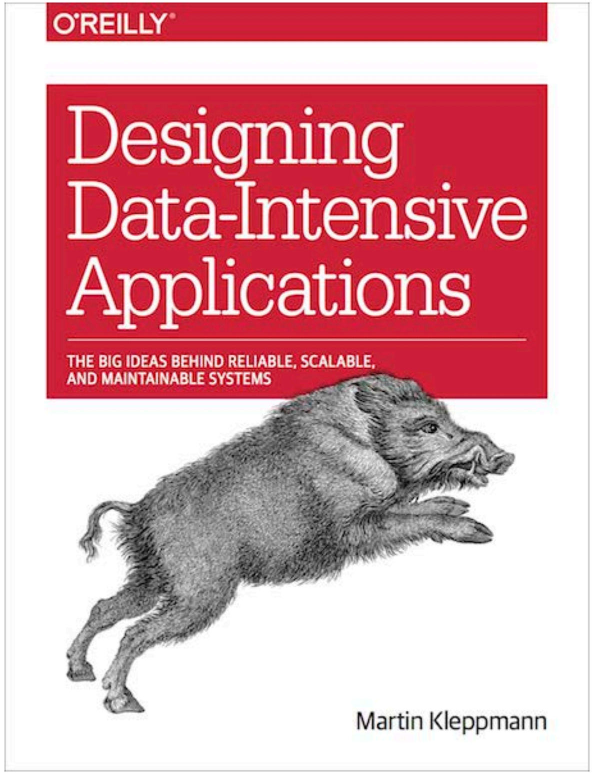
Office hours:

5.25pm today

O'Reilly Booth
Expo Hall

Discount code: **TS2015**
50% off ebooks

dataintensive.net



O'REILLY

Designing Data-Intensive Applications

THE BIG IDEAS BEHIND RELIABLE, SCALABLE, AND MAINTAINABLE SYSTEMS

Martin Kleppmann

Free signed copies!

Thu 3.35pm
@O'Reilly Booth
Expo Hall