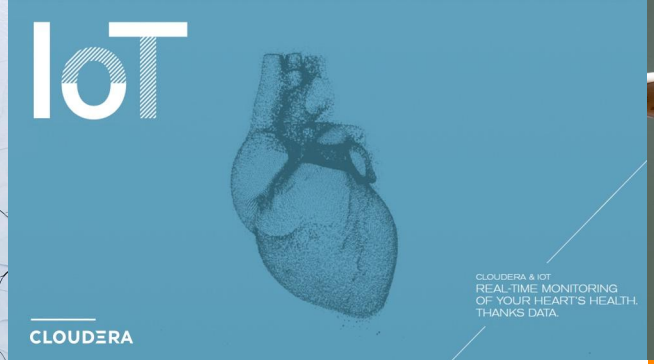
CLOUDERA

# Building Modern Data Streaming Apps with NiFi, Flink and Kafka

**Tim Spann**
**Principal Developer Advocate**

**8-June-2023**



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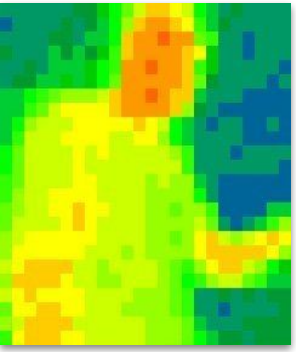
EDGE
2AI
CLOUDERA

ENTERPRISE
DATA
CLOUD
CLOUDERA

# FLiPN-FLaNK Stack



**Tim Spann**
@PaasDev // Blog: **www.datainmotion.dev**
**Principal Developer Advocate.**
Princeton Future of Data Meetup.
**ex-Pivotal, ex-Hortonworks, ex-StreamNative, ex-PwC**
https://github.com/tspannhw/EverythingApacheNiFi
https://medium.com/@tspann
**Apache NiFi x Apache Kafka x Apache Flink x Java**

# FLiP Stack Weekly

https://bit.ly/32dAJft

This week in Apache NiFi, Apache Flink, Apache Pulsar, Apache Spark, Apache Iceberg, Python, Java and Open Source friends.

# Future of Data - Princeton + Virtual

FUTURE OF DATA

https://www.meetup.com/futureofdata-princeton/

**From Big Data to AI to Streaming to Containers to Cloud to Analytics to Cloud Storage to Fast Data to Machine Learning to Microservices to ...**

ICEBERG

@PaasDev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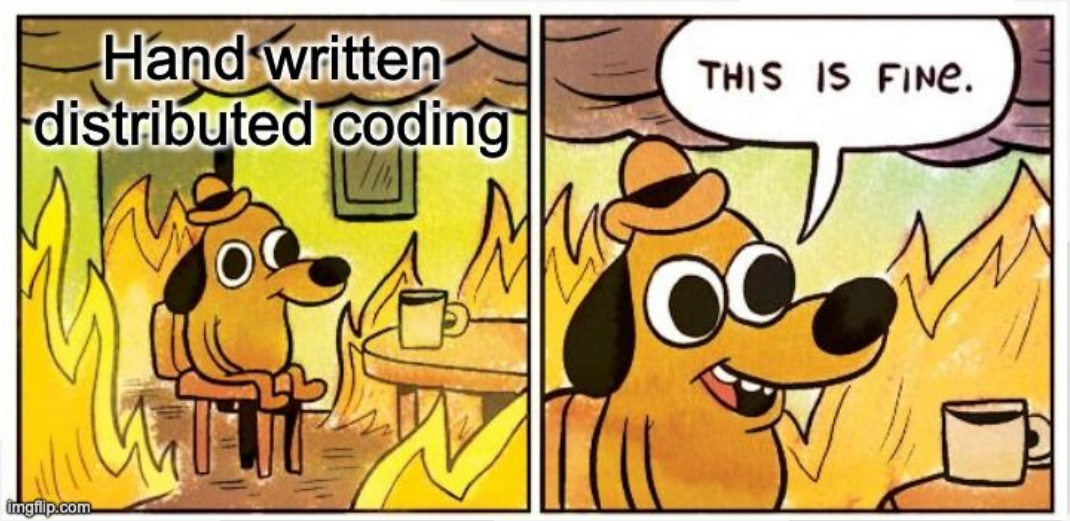
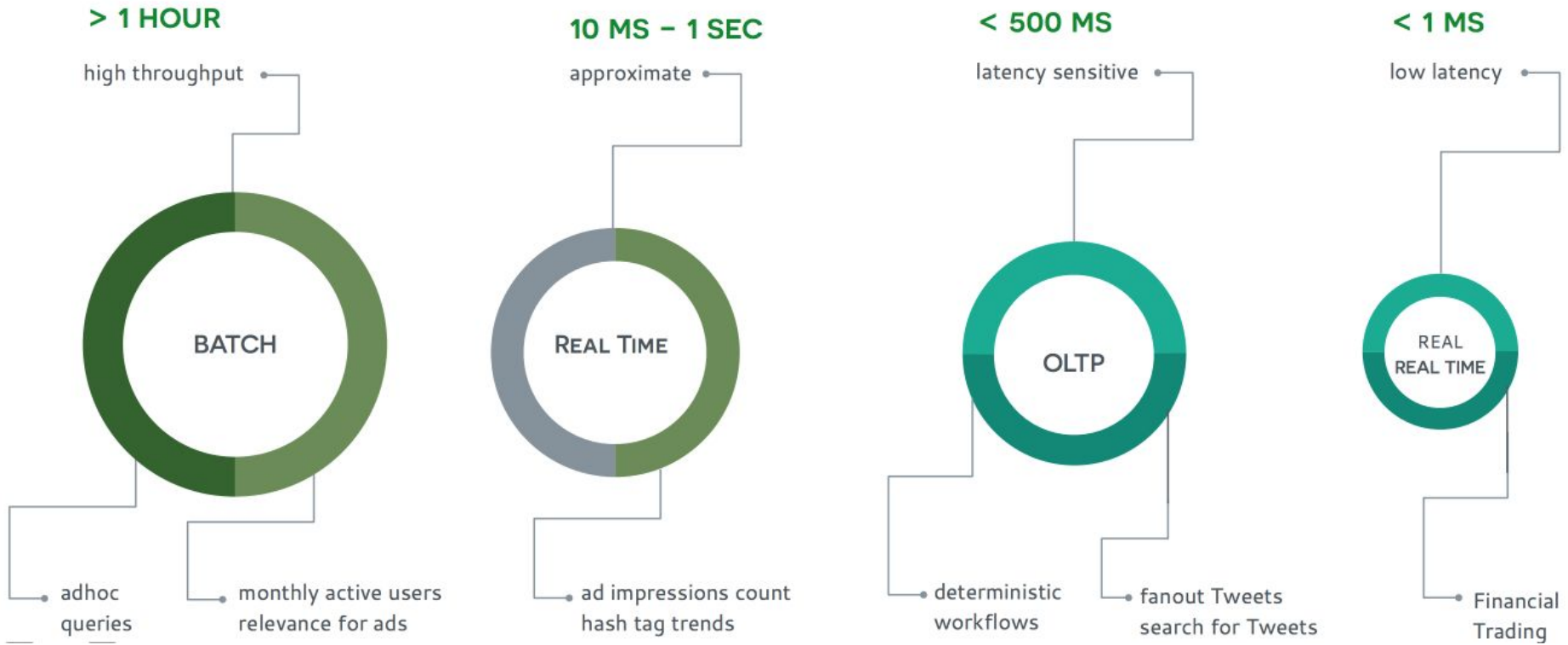
# STREAMING

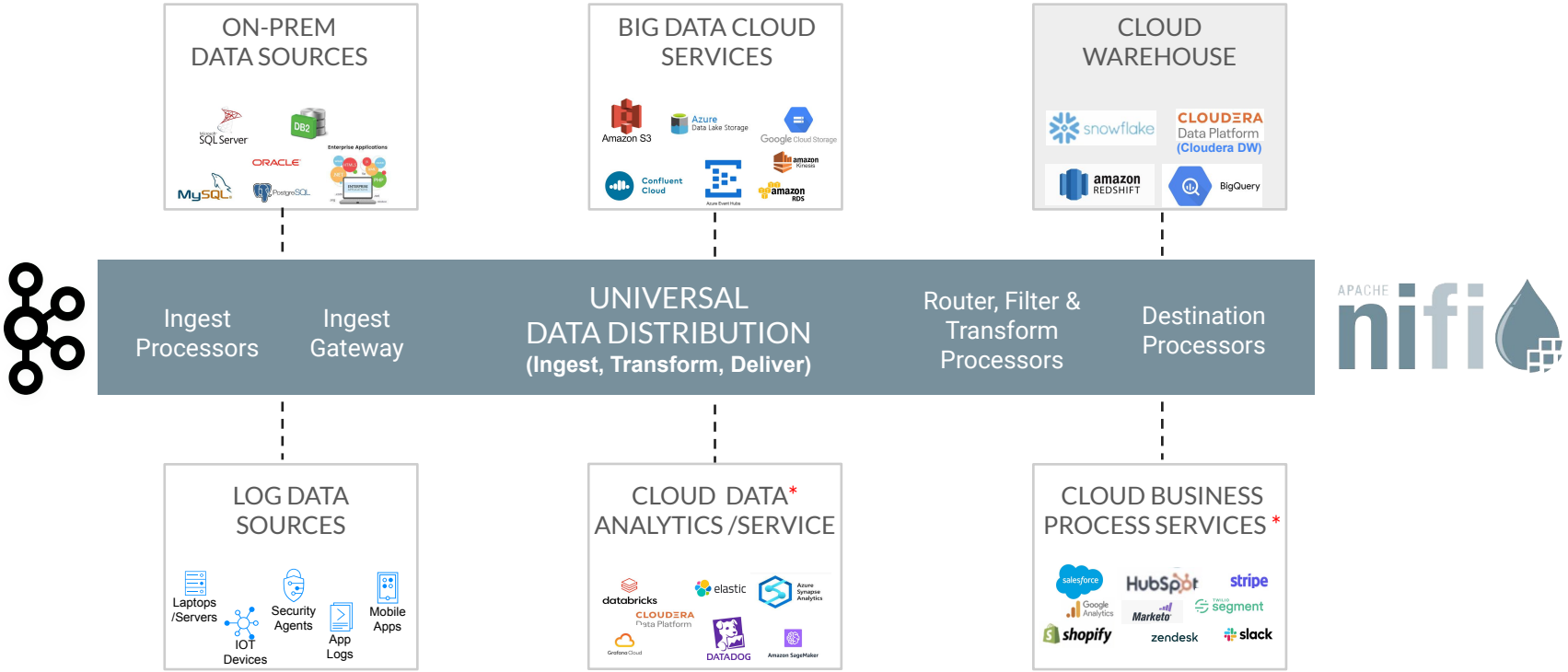


# What is Real-Time?



# Streaming From … To …

## Data distribution as a first class citizen



# BUILDING REAL-TIME REQUIRES A TEAM

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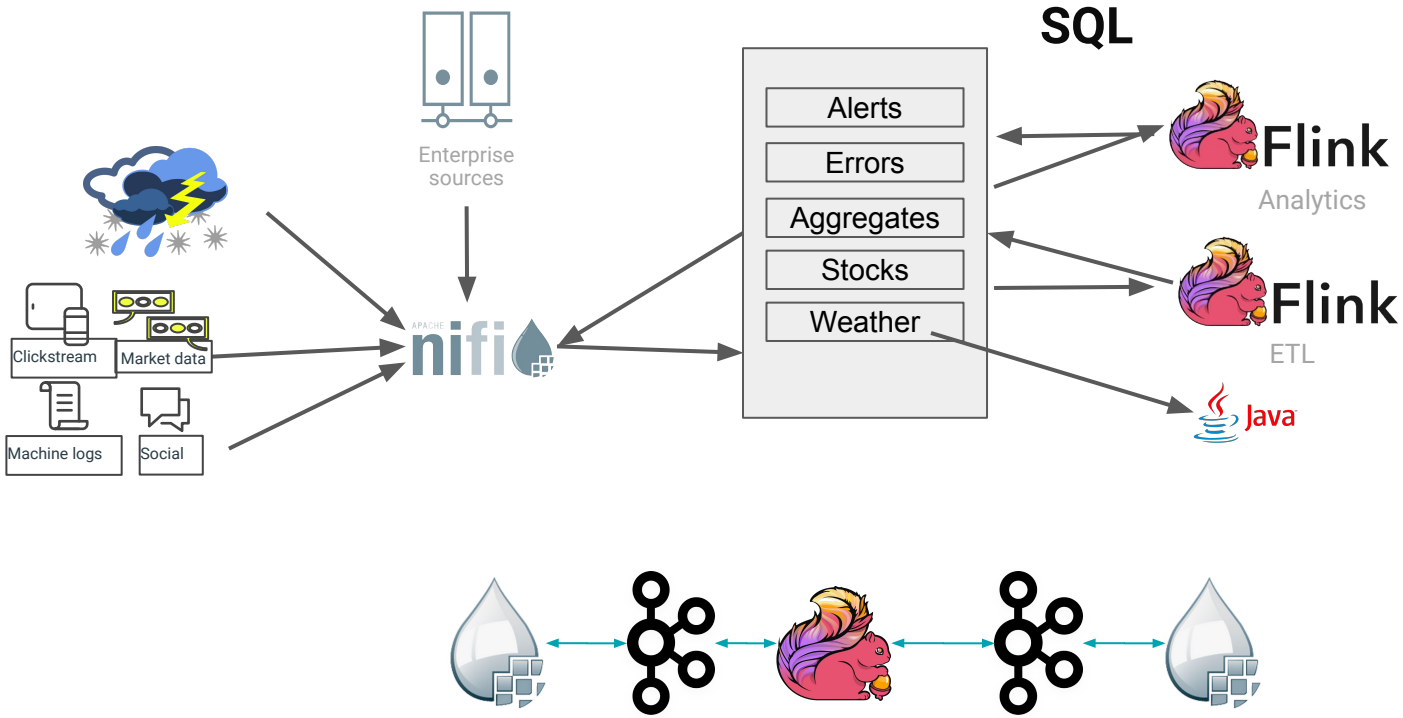
# End to End Streaming Pipeline Example





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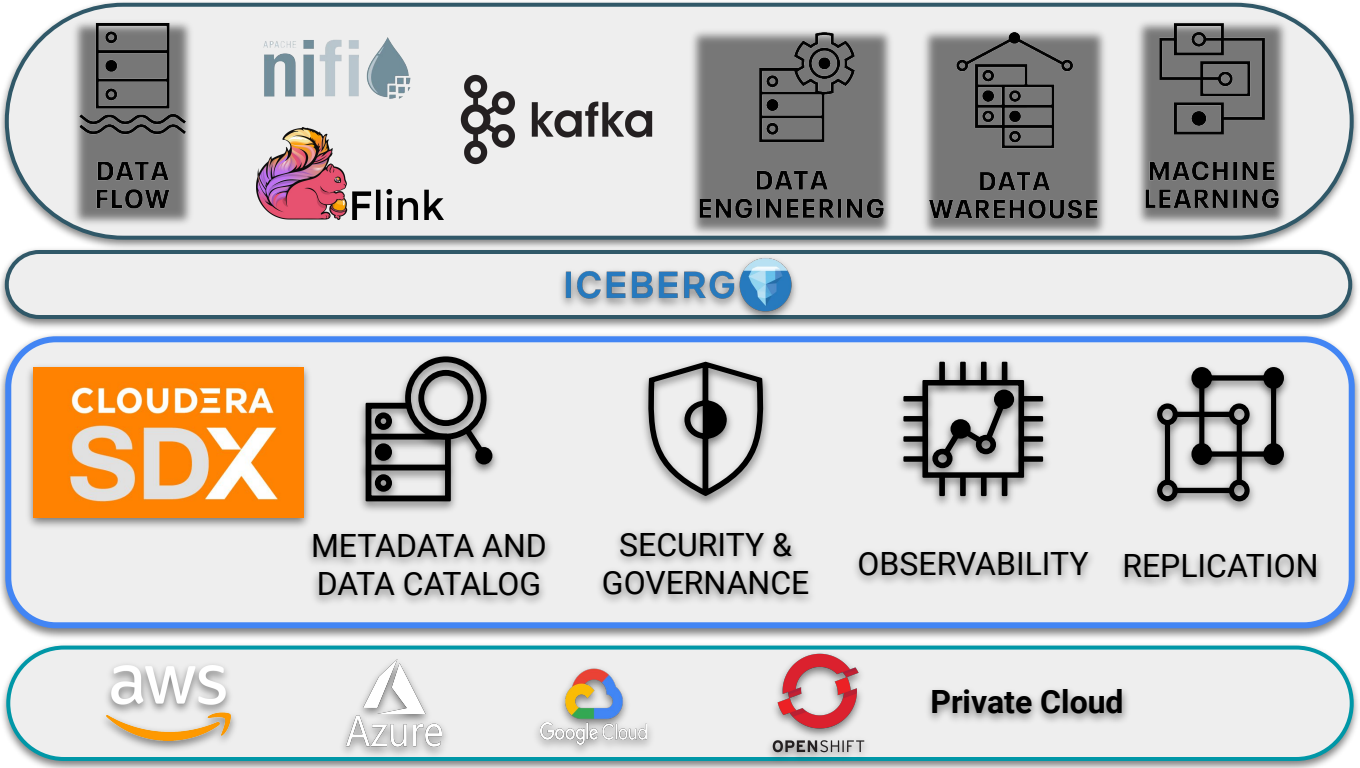
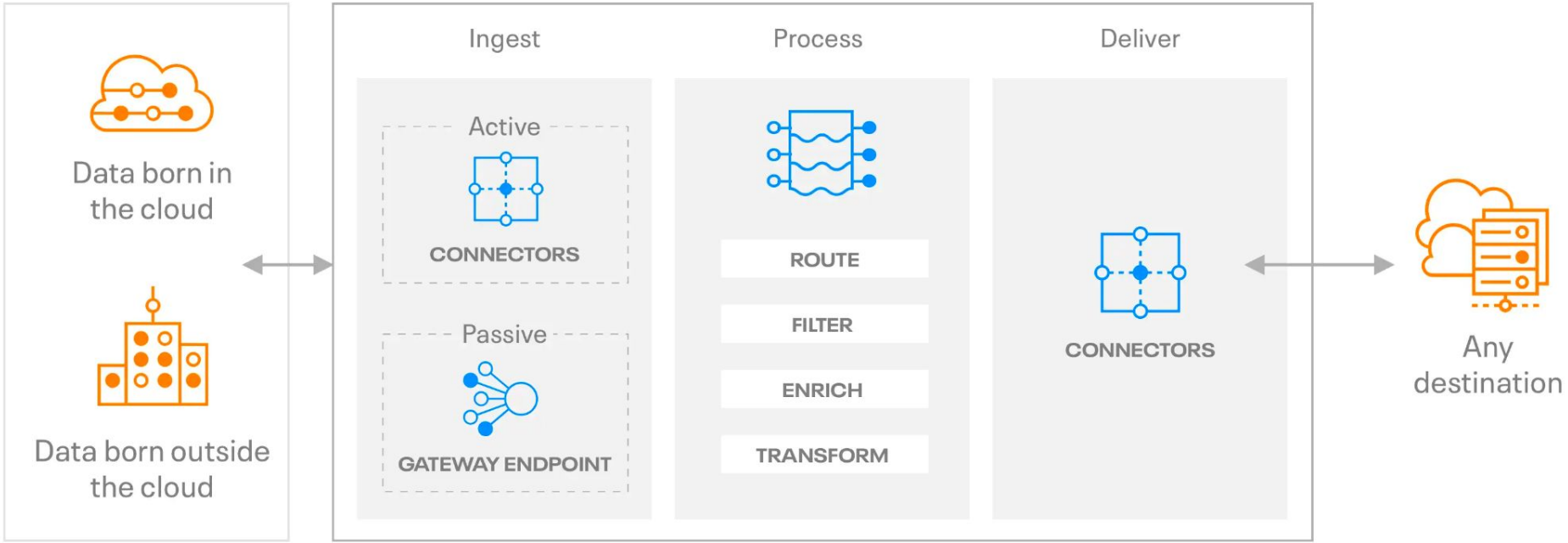
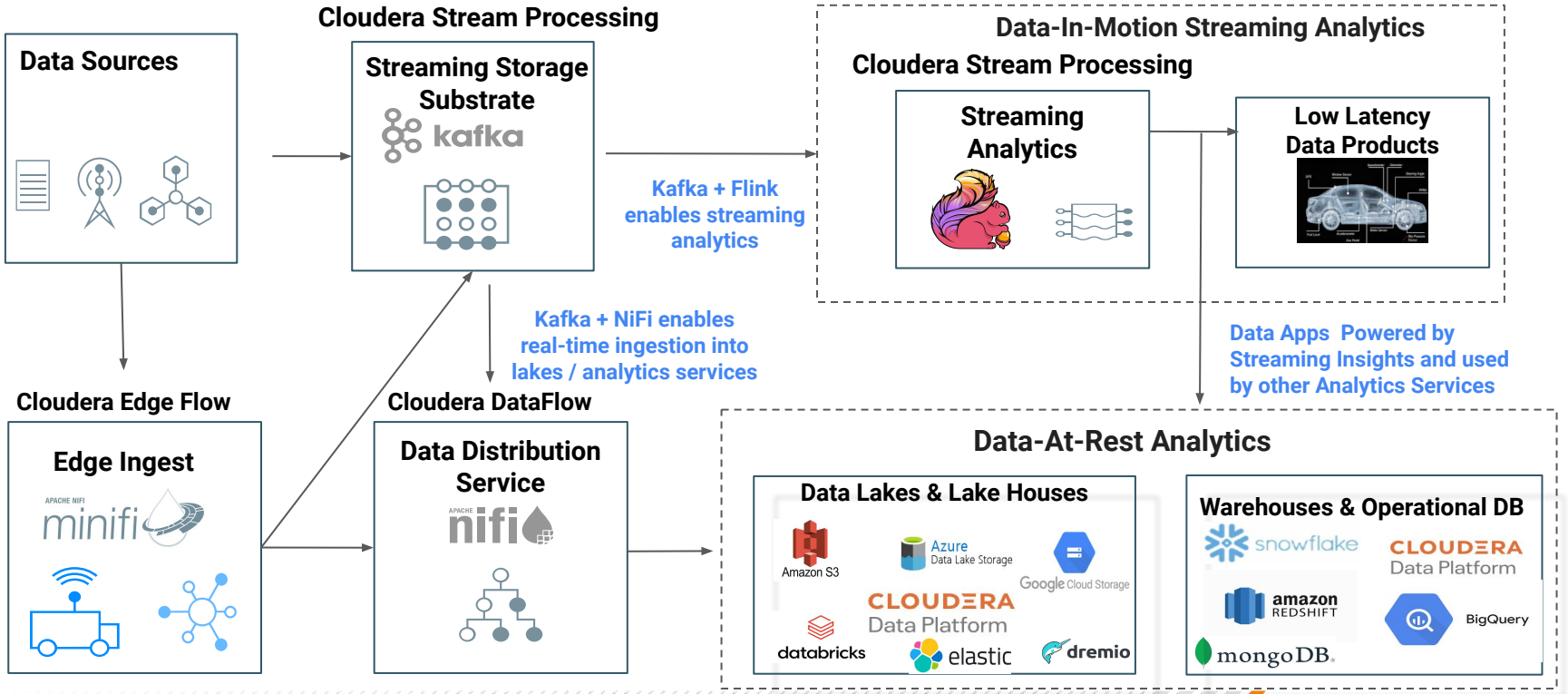
# CDP: AN OPEN DATA LAKEHOUSE



# DATAFLOW FOR THE PUBLIC CLOUD

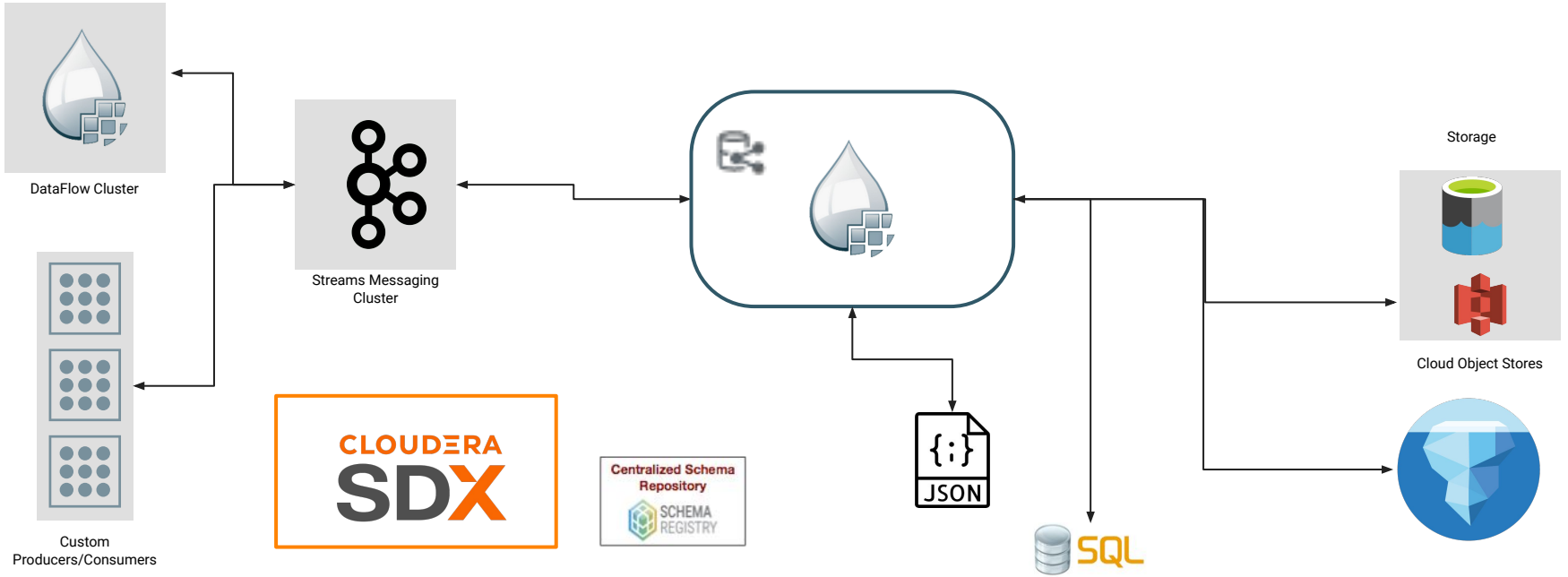


# Analytics-in-Stream



# Retail Use Case: Ingest Retail Goods Prices

## Codeless Data Movement





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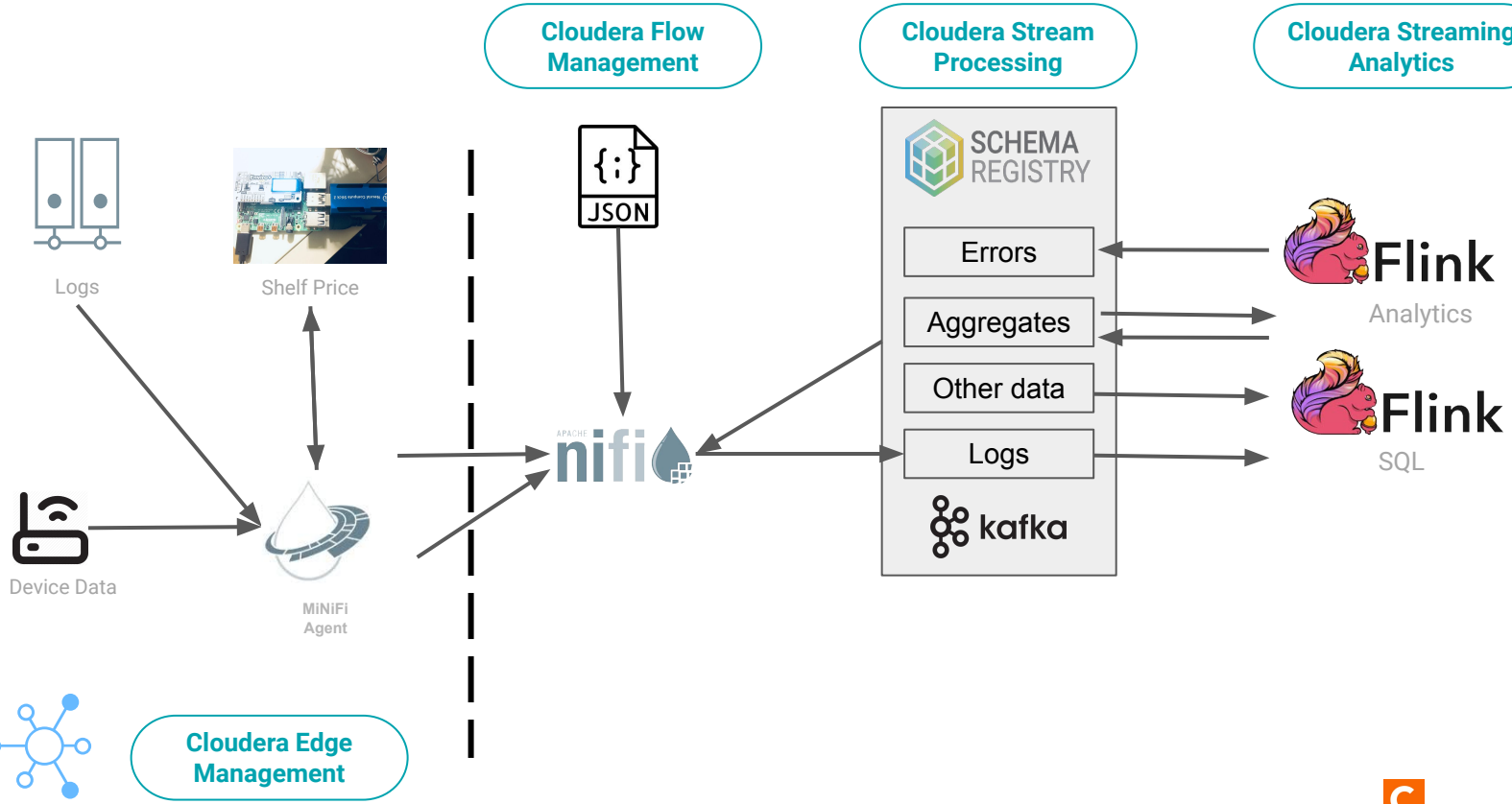
# Pricing Pipeline





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# APACHE KAFKA

# What is Apache Kafka?

**Distributed:** horizontally scalable

**Partitioned:** the data is split-up and distributed across the brokers

**Replicated:** allows for automatic failover

**Unique:** Kafka does not track the consumption of messages (the consumers do)

**Fast:** designed from the ground up with a focus on performance and throughput

Kafka was built at Linkedin in 2011

Open sourced as an Apache project


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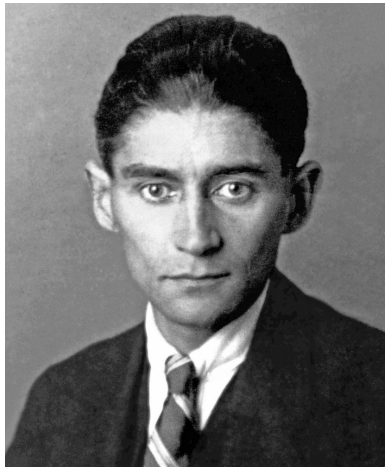
# Yes, Franz, It’s Kafka

Let’s do a metamorphosis on your data.  Don’t fear changing data.

**You don’t need to be a brilliant writer to stream data.**



Franz Kafka was a German-speaking Bohemian novelist and short-story writer, widely regarded as one of the major figures of 20th-century literature. His work fuses elements of realism and the fantastic.
**Wikipedia**

# What is Can You Do With Apache Kafka?

Web site activity: track page views, searches, etc. in real time

Events & log aggregation: particularly in distributed systems where messages come from multiple sources

Monitoring and metrics: aggregate statistics from distributed applications and build a dashboard application

Stream processing: process raw data, clean it up, and forward it on to another topic or messaging system

Real-time data ingestion: fast processing of a very large volume of messages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# Kafka Terms

- Kafka is a publish/subscribe messaging system comprised of the following components:

  - **Topic**: a message feed
  - **Producer**: a process that publishes messages to a topic
  - **Consumer**: a process that subscribes to a topic and processes its messages
  - **Broker**: a server in a Kafka cluster


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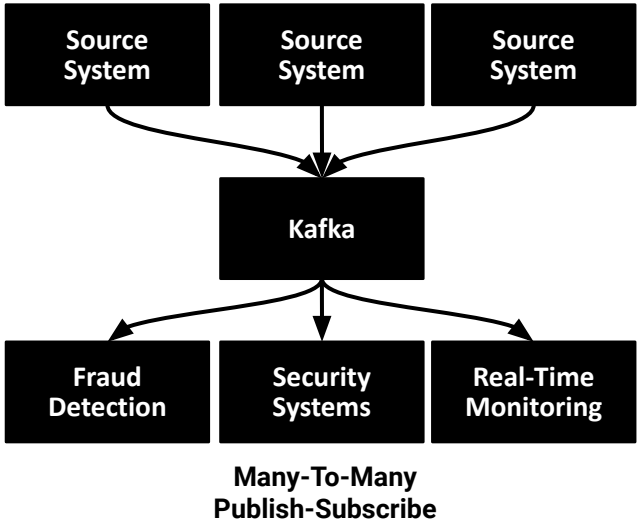
- Highly reliable distributed messaging system
- Decouple applications, enables many-to-many patterns
- Publish-Subscribe semantics
- Horizontal scalability
- Efficient implementation to operate at speed with big data volumes
- Organized by topic to support several use cases

**EVENTS**





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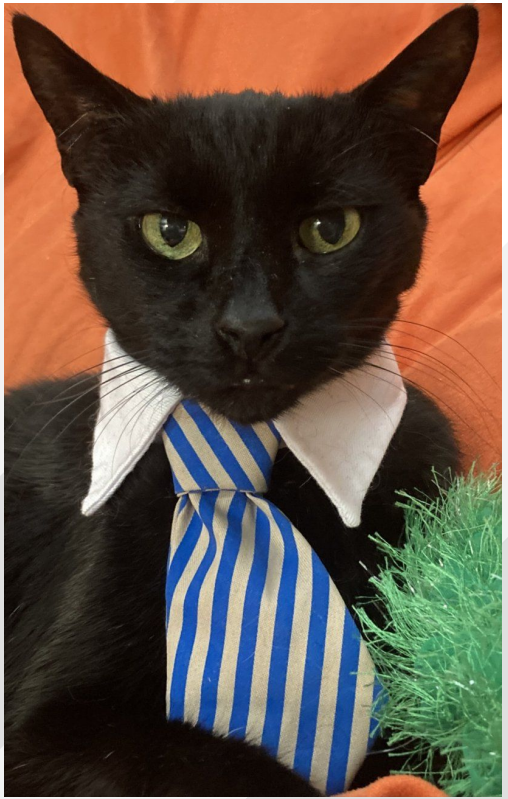
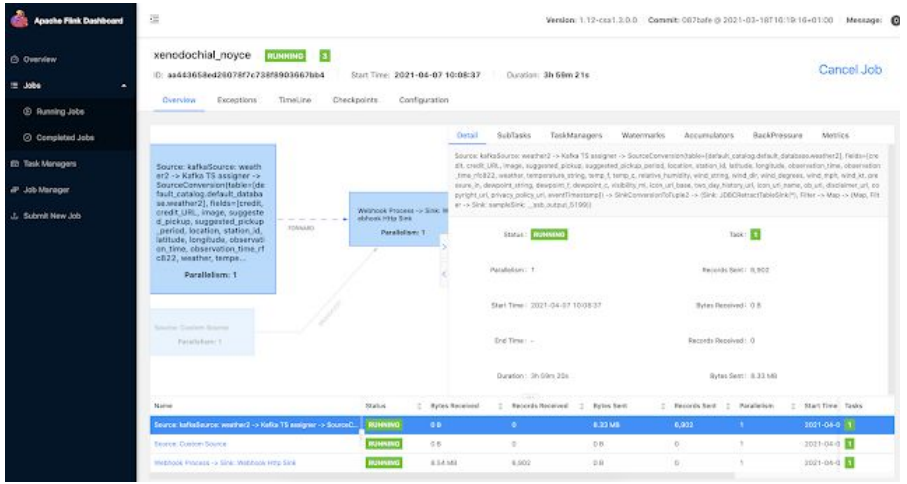
# APACHE FLINK



# Flink SQL

- Streaming Analytics
- Continuous SQL
- Continuous ETL
- Complex Event Processing
- Standard SQL Powered by Apache Calcite




https://www.datainmotion.dev/2021/04/cloudera-sql-stream-builder-ssb-updated.html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# Flink SQL

## Key Takeaway: Rich SQL grammar with advanced time and aggregation tools

```
-- specify Kafka partition key on output
SELECT foo AS _eventKey FROM sensors

-- use event time timestamp from kafka
-- exactly once compatible
SELECT eventTimestamp FROM sensors

-- nested structures access
SELECT foo.'bar' FROM table; -- must quote nested
column

-- timestamps
SELECT * FROM payments
WHERE eventTimestamp > CURRENT_TIMESTAMP-interval
'10' second;

-- unnest
SELECT b.*, u.*
FROM bgp_avro b,
UNNEST(b.path) AS u(pathitem)
```

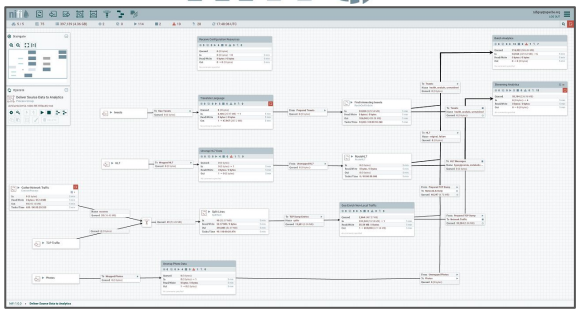
```
-- aggregations and windows
SELECT card,
MAX(amount) as theamount,
TUMBLE_END(eventTimestamp, interval '5' minute) as
ts
FROM payments
WHERE lat IS NOT NULL
AND lon IS NOT NULL
GROUP BY card,
TUMBLE(eventTimestamp, interval '5' minute)
HAVING COUNT(*) > 4  -- >4==fraud

-- try to do this ksql!
SELECT us_west.user_score+ap_south.user_score
FROM kafka_in_zone_us_west us_west
FULL OUTER JOIN kafka_in_zone_ap_south ap_south
ON us_west.user_id = ap_south.user_id;
```

# DATAFLOW APACHE NIFI

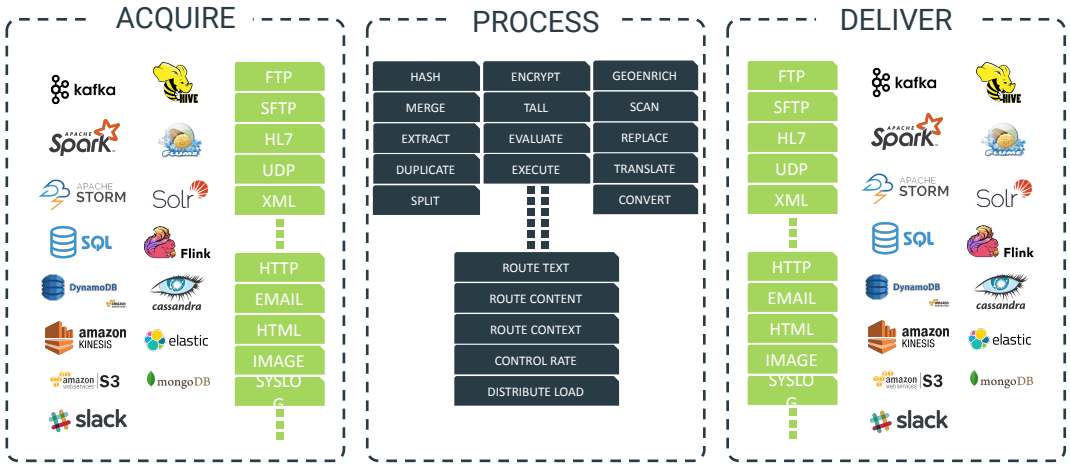
# Apache NiFi

Enable easy ingestion, routing, management and delivery of any data anywhere (Edge, cloud, data center) to any downstream system with built in end-to-end security and provenance



APACHE NIFI registry

Advanced tooling to industrialize flow development (Flow Development Life Cycle)




- Over 300 Prebuilt Processors
- Easy to build your own
- Parse, Enrich & Apply Schema
- Filter, Split, Merger & Route
- Throttle & Backpressure

- Guaranteed Delivery
- Full data provenance from acquisition to delivery
- Diverse, Non-Traditional Sources
- Eco-system integration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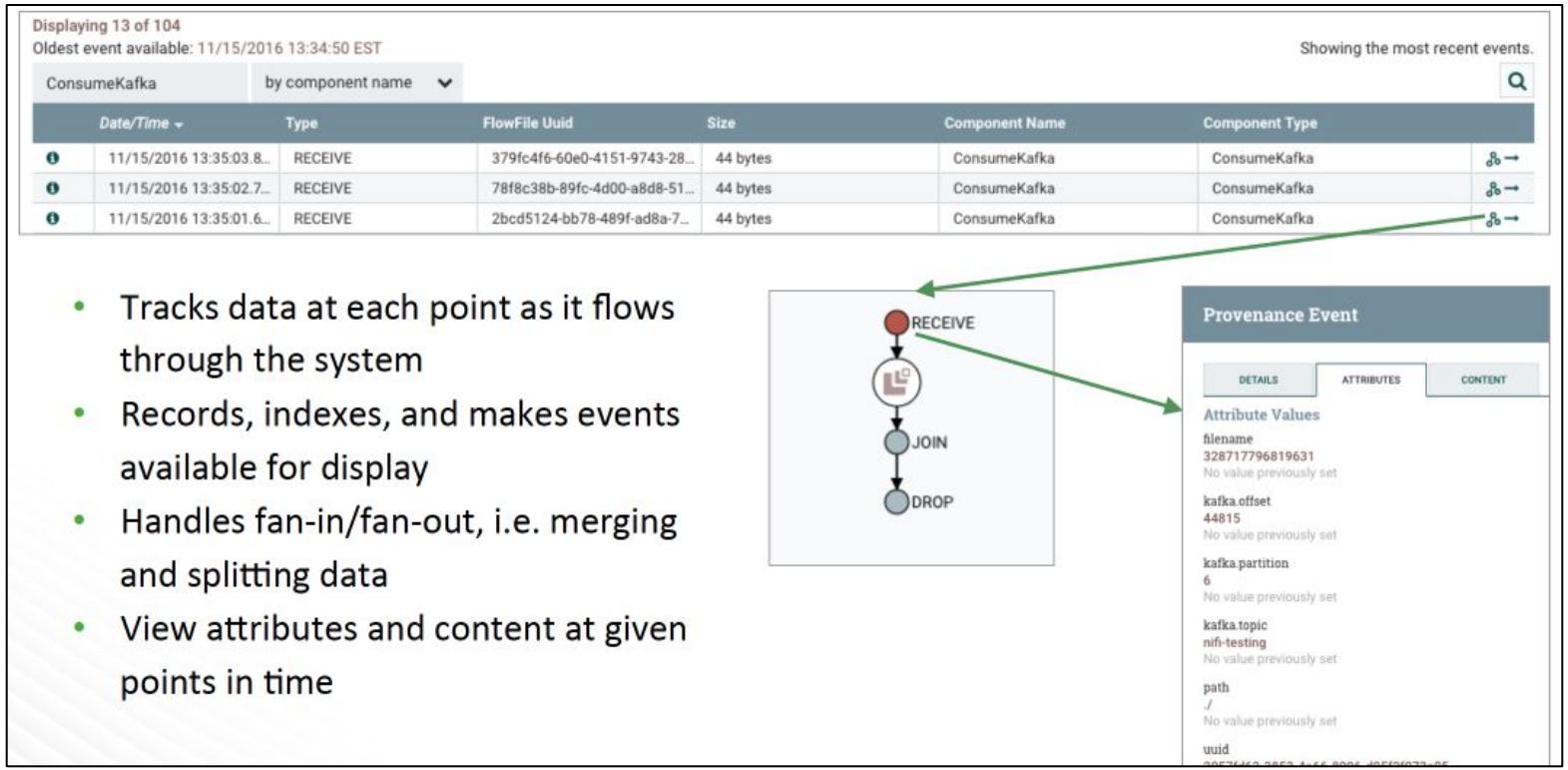
# Provenance





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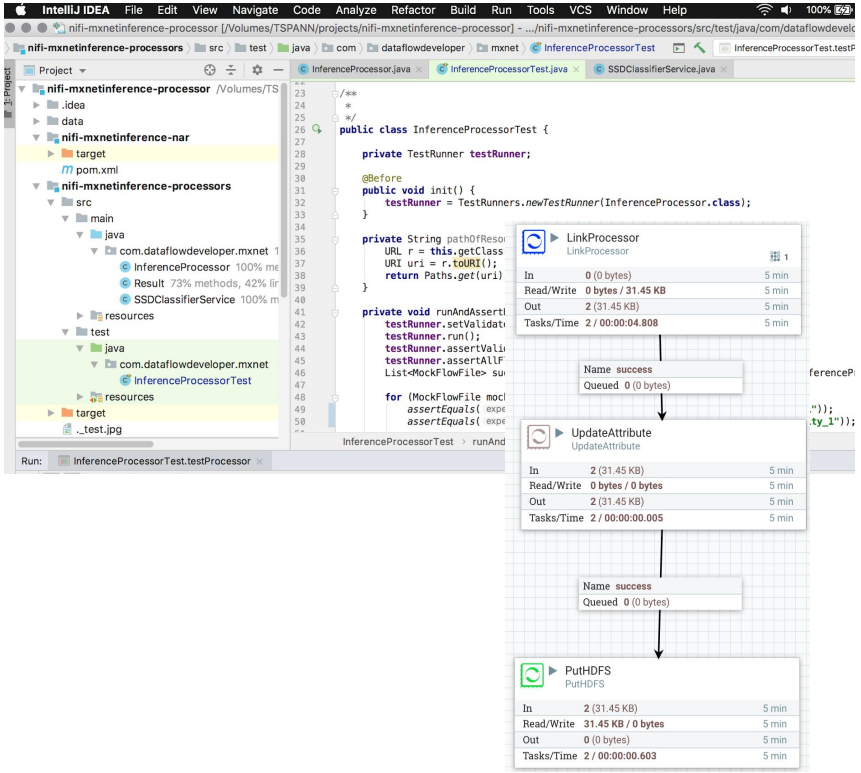
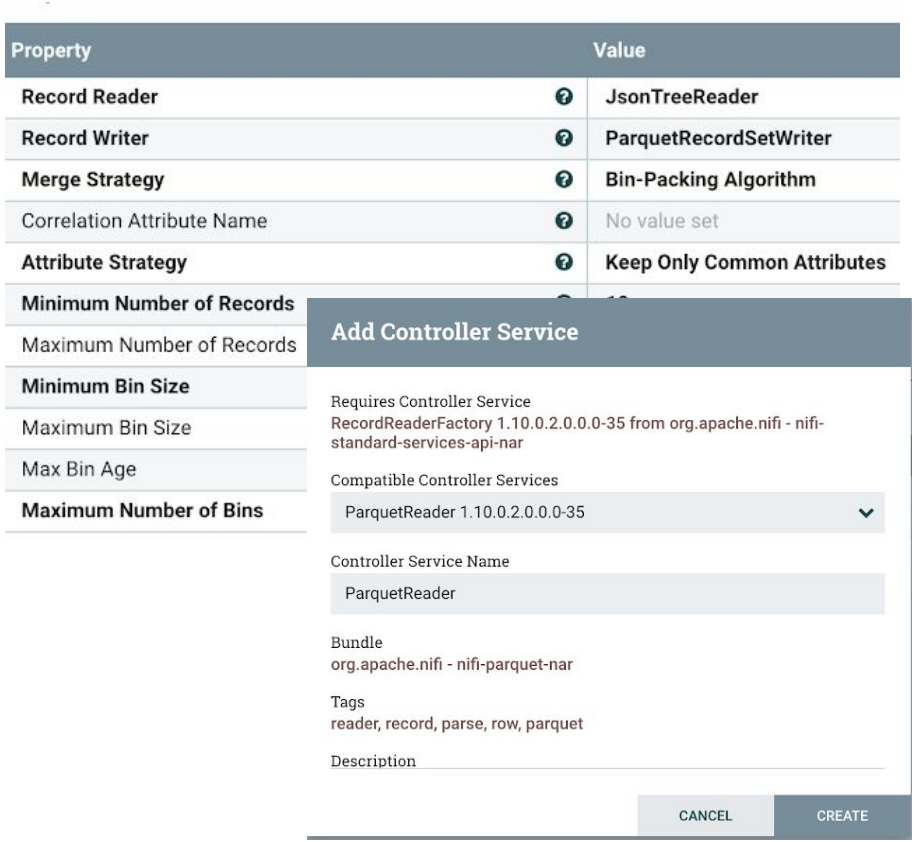
# Extensibility

- Built from the ground up with extensions in mind
- Service-loader pattern for…
  - Processors
  - Controller Services
  - Reporting Tasks
  - Prioritizers
- Extensions packaged as NiFi Archives (NARs)
  - Deploy NiFi lib directory and restart
  - Same model as standard components



# Parquet Reader/ Writers

- Native Record Processors for Apache Parquet Files!
- CSV <-> Parquet
- XML <-> Parquet
- AVRO <-> Parquet
- JSON <-> Parquet
- More...





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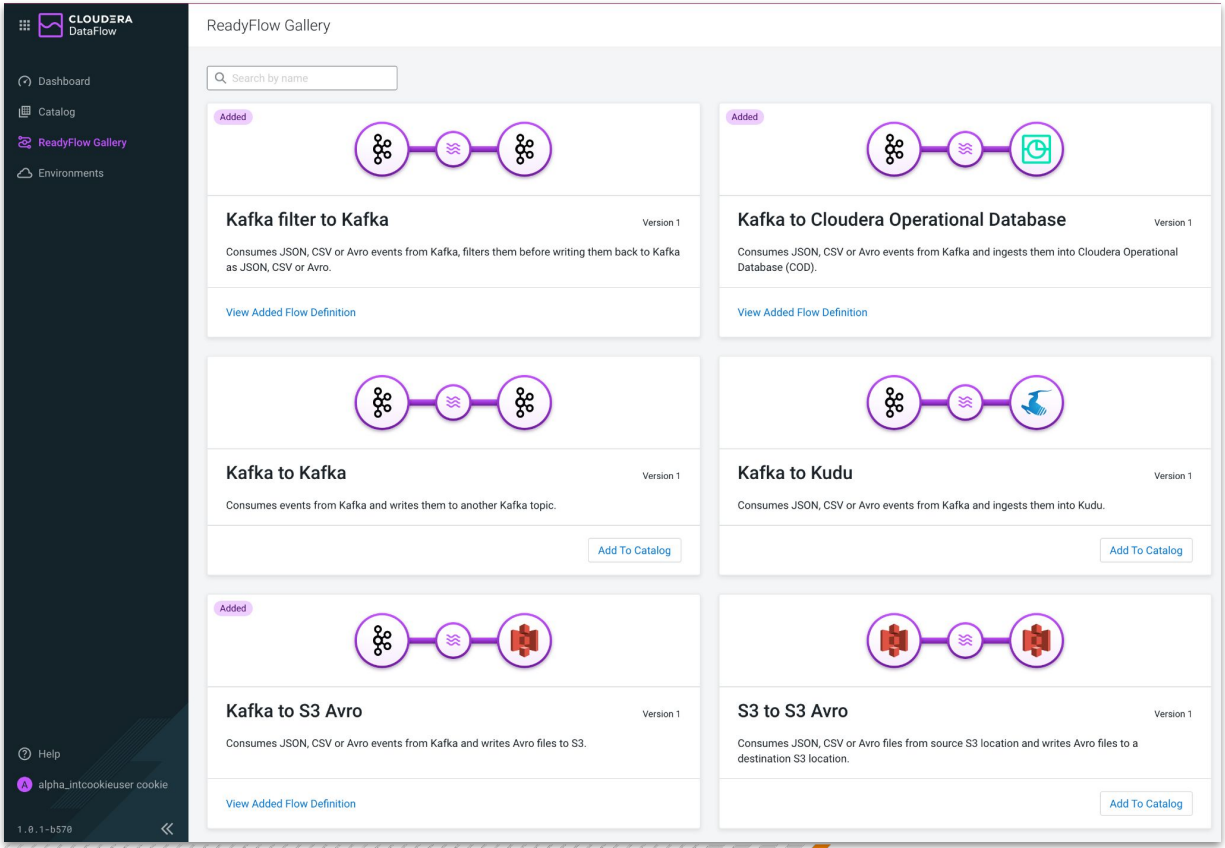
# ReadyFlow Gallery

- Cloudera provided flow definitions
- Cover most common data flow use cases
- Optimized to work with CDP sources/destinations
- Can be deployed and adjusted as needed





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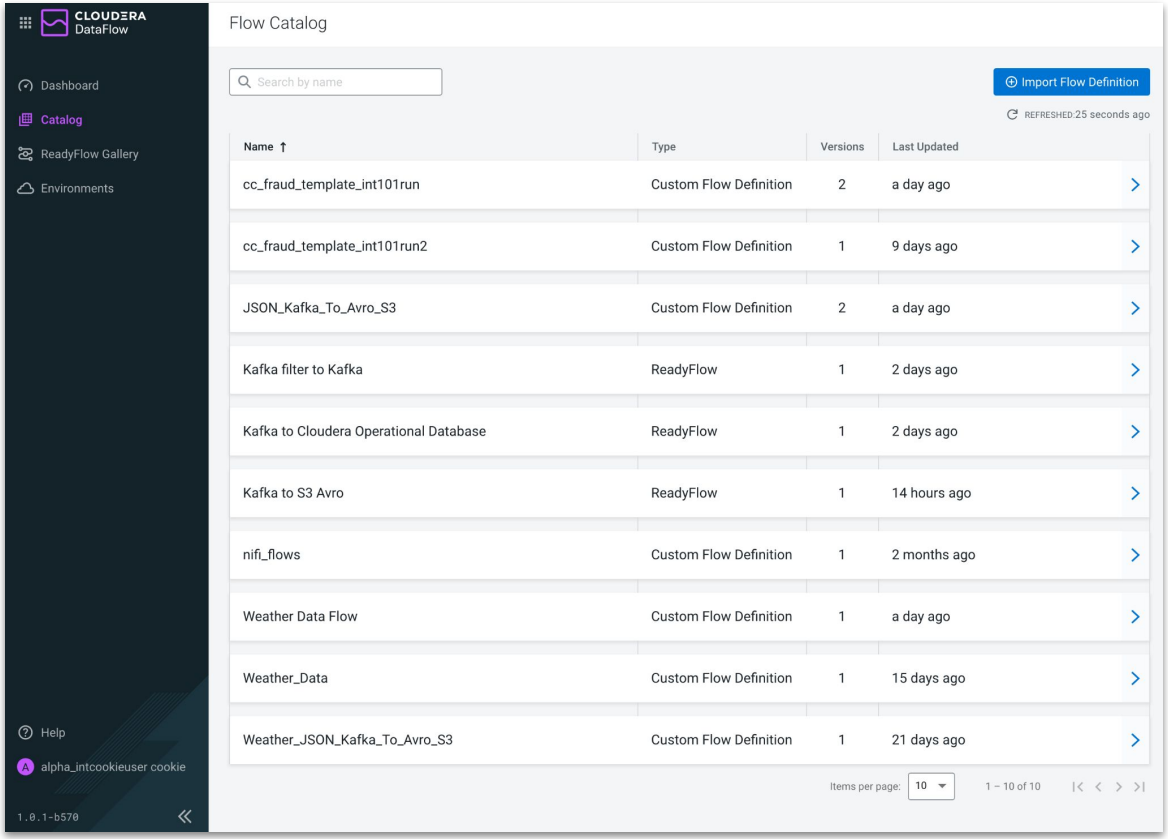
# Flow Catalog

- Central repository for flow definitions
- Import existing NiFi flows
- Manage flow definitions
- Initiate flow deployments





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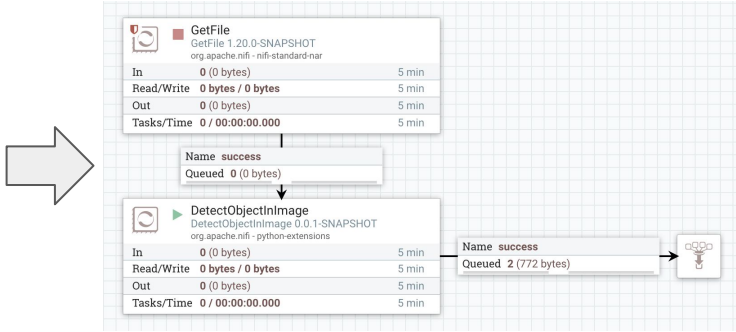
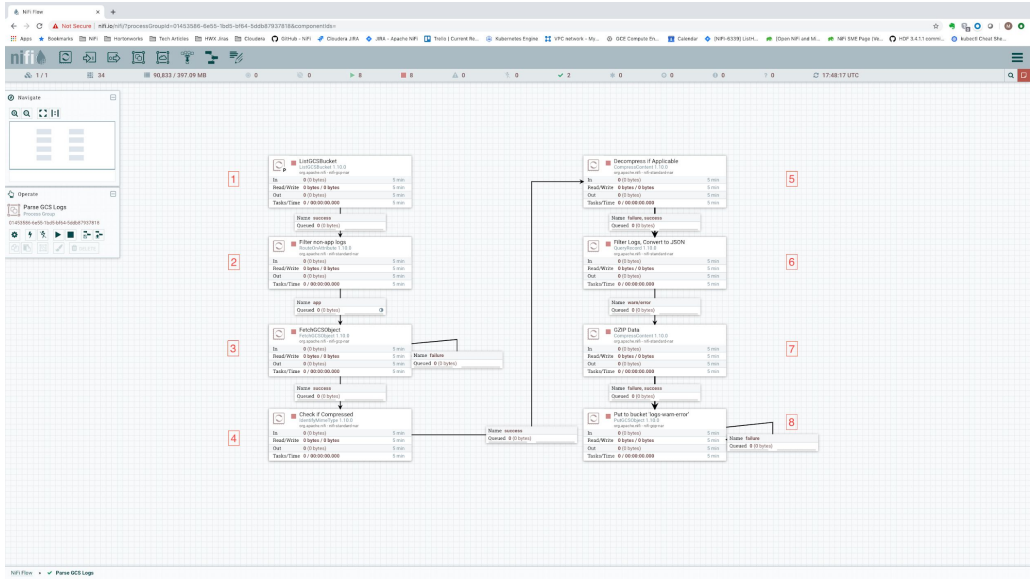
# Apache NiFi with Python Custom Processors

## Python as a 1st class citizen

```
import cv2
import numpy as np
import json
from nifiapi.properties import PropertyDescriptor
from nifiapi.properties import ResourceDefinition
from nifiapi.flowfiletransform import FlowFileTransformResult

SCALE_FACTOR = 0.00392
NMS_THRESHOLD = 0.4     # non-maximum suppression threshold
CONFIDENCE_THRESHOLD = 0.5

class DetectObjectInImage:
    class Java:
        implements = ['org.apache.nifi.python.processor.FlowFileTransform']
    class ProcessorDetails:
        version = '0.0.1-SNAPSHOT'
        dependencies = ['numpy >= 1.23.5', 'opencv-python >= 4.6']

    def __init__(self, jvm=None, **kwargs):
        self.jvm = jvm

        # Build Property Descriptors
        self.model_file = PropertyDescriptor(
            name = 'Model File',
            description = 'The binary file containing the trained Deep Neural Network weights. Supports Caffe (*.caffemodel), TensorFlow (*.pb), Torch (*.t7, *.net), Darknet (*.weights), ' +
                          'DLDT (*.bin), and ONNX (*.onnx)',
            required = True,
            resource_definition = ResourceDefinition(allow_file = True)
        )
        self.config_file = PropertyDescriptor(
            name = 'Network Config File',
            description = 'The text file containing the Network configuration. Supports Caffe (*.prototxt), TensorFlow (*.pbtxt), Darknet (*.cfg), and DLDT (*.xml)',
            required = False,
            resource_definition = ResourceDefinition(allow_file = True)
        )
        self.class_name_file = PropertyDescriptor(
            name = 'Class Names File',
            description = 'A text file containing the names of the classes that may be detected by the model. Expected format is one class name per line, new-line terminated."',
            required = True,
            resource_definition = ResourceDefinition(allow_file = True)
        )
        self.descriptors = [self.model_file, self.config_file, self.class_name_file]

    def getPropertyDescriptors(self):
        return self.descriptors

    def onScheduled(self, context):
        # read class names from text file
        class_name_file = context.getProperty(self.class_name_file.name).getValue()
        if class_name_file is None:
```



# Processing one million events per second with NiFi



| Nodes | Data rate/sec | Events/sec | Data rate/day | Events/day |
|---|---|---|---|---|
| 1 | 192.5 MB | 946,000 | 16.6 TB | 81.7 Billion |
| 5 | 881 MB | 4.97 Million | 76 TB | 429.4 Billion |
| 25 | 5.8 GB | 26 Million | 501 TB | 2.25 Trillion |
| 100 | 22 GB | 90 Million | 1.9 PB | 7.8 Trillion |
| 150 | 32.6 GB | 141.3 Million | 2.75 PB | 12.2 Trillion |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# SOURCES AND SINKS

# APACHE ICEBERG

## A Flexible, Performant & Scalable Table Format

- Donated by Netflix to the Apache Foundation in 2018
- Flexibility
  - Hidden partitioning
  - Full schema evolution
- Data Warehouse Operations
  - Atomic Consistent Isolated Durable (ACID) Transactions
  - Time travel and rollback
- Supports best in class SQL performance
  - High performance at Petabyte scale

AMQP

AWS Lambda

Airtable

Amazon API Gateway

Amazon CloudWatch

Amazon DynamoDB

Amazon Kinesis Data Firehose

Amazon Kinesis Data Streams

Amazon SQS

Amazon Simple Notification Services (SNS)

Amazon Simple Storage Service (S3)

Apache Accumulo

Apache Cassandra

Apache HBase

Apache Hive

Apache Iceberg

Apache Ignite

Apache Kafka

Apache Kudu

Apache Solr

# FREE LEARNING ENVIRONMENT

# **CSP** Community Edition

- Kafka, KConnect, SMM, SR, Flink, and SSB in Docker
- Runs in Docker
- Try new features quickly
- Develop applications locally

- Docker compose file of CSP to run from command line w/o any dependencies, including Flink, SQL Stream Builder, Kafka, Kafka Connect, Streams Messaging Manager and Schema Registry
  - `$>docker compose up`
- Licensed under the Cloudera Community License
- **Unsupported**
- Community Group Hub for CSP
- Find it on docs.cloudera.com under Applications

**CSP Community Edition**

A readily available, dockerized deployment of Apache Kafka and Apache Flink that allows you to test the features and capabilities of Cloudera Stream Processing.

Learn More

https://www.cloudera.com/downloads/cdf/csp-community-edition.html

# Open Source Edition

- Apache NiFi in Docker
- Runs in Docker
- Try new features quickly
- Develop applications locally

- Docker NiFi
  - `docker run --name nifi -p 8443:8443 -d -e SINGLE_USER_CREDENTIALS_USERNAME=admin -e SINGLE_USER_CREDENTIALS_PASSWORD=ctsBtRBKHRAx69EqUghvvgEvjnaLjFEB apache/nifi:latest`

- Licensed under the ASF License
- **Unsupported**

https://hub.docker.com/r/apache/nifi

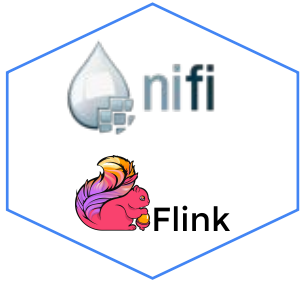
# DEMO AND CODE

## **Collect**: Bring Together

Aggregate all data from sensors, drones, logs, geo-location devices, images from cameras, results from running predictions on pre-trained models.

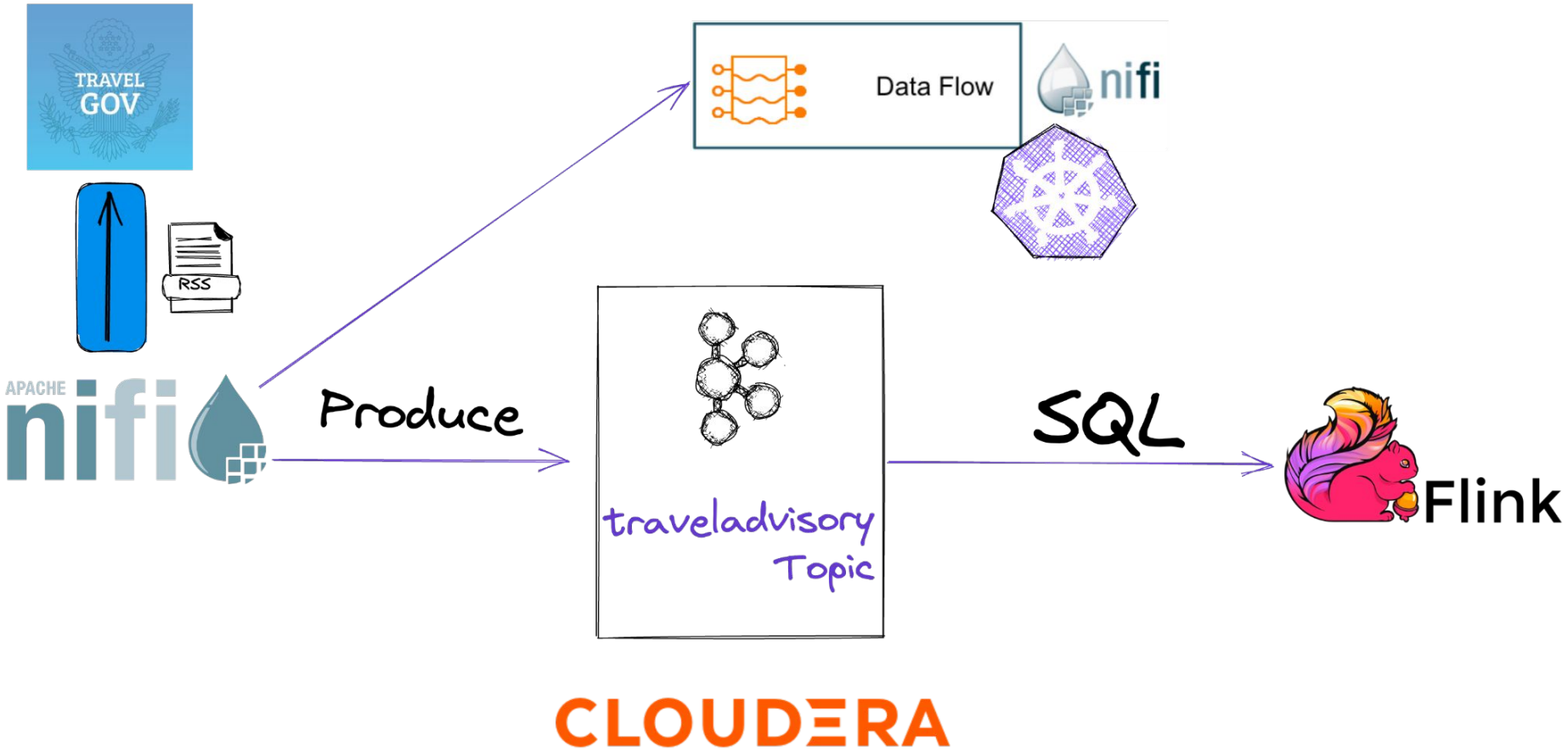
## **Conduct:** Mediate the Data Flow

Mediate point-to-point and bi-directional data flows, distribute, delivering data reliably to Apache Iceberg, S3, SnowFlake, Slack and Email.




## **Curate:** Gain Insights

Orchestrate, parse, merge, aggregate, filter, join, transform, fork, query, sort, dissect, store, enrich with weather, location, sentiment analysis, image analysis, object detection, image recognition and more with Apache Tika, Apache OpenNLP and Machine Learning.

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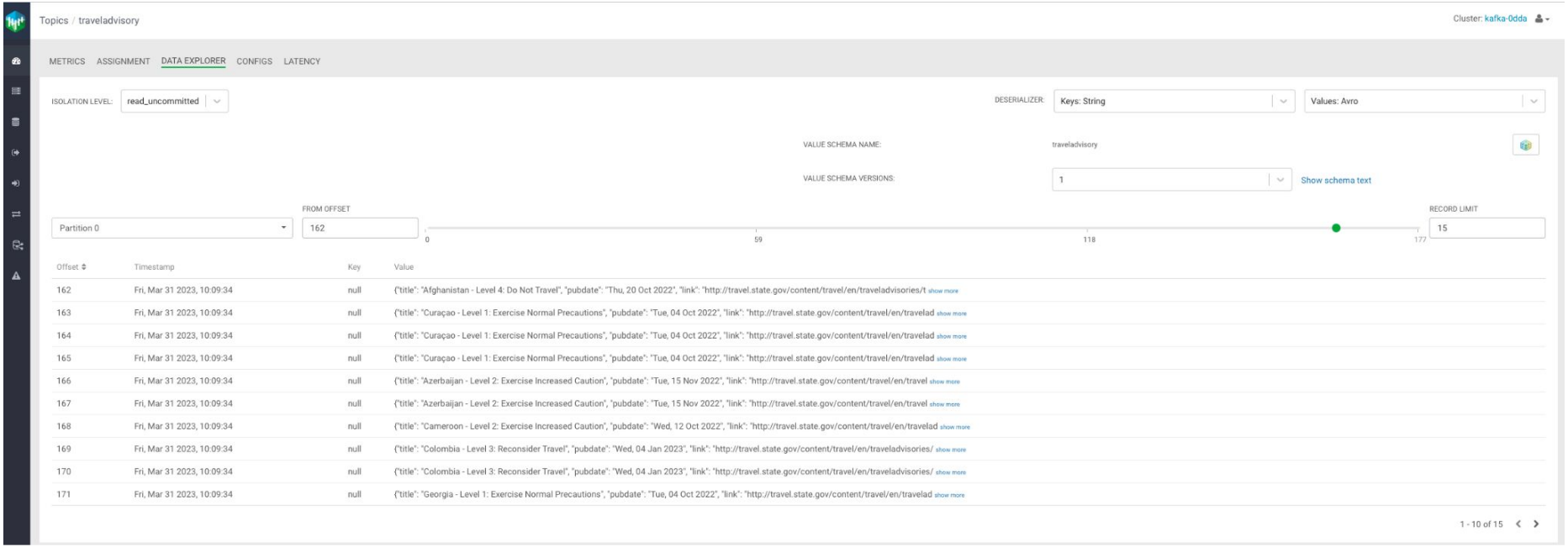
https://github.com/tspannhw/FLaNK-TravelAdvisory


Topics / traveladvisory
Cluster: kafka-0dda
METRICS ASSIGNMENT DATA EXPLORER CONFIGS LATENCY
ISOLATION LEVEL: read_uncommitted
DESERIALIZER: Keys: String Values: Avro
VALUE SCHEMA NAME: traveladvisory
VALUE SCHEMA VERSIONS: 1 Show schema text
Partition 0
FROM OFFSET 162
0 59 118 177
RECORD LIMIT 15
Offset Timestamp Key Value
162 Fri, Mar 31 2023, 10:09:34 null {"title": "Afghanistan - Level 4: Do Not Travel", "pubdate": "Thu, 20 Oct 2022", "link": "http://travel.state.gov/content/travel/en/traveladvisories/t show more
163 Fri, Mar 31 2023, 10:09:34 null {"title": "Curaçao - Level 1: Exercise Normal Precautions", "pubdate": "Tue, 04 Oct 2022", "link": "http://travel.state.gov/content/travel/en/travelad show more
164 Fri, Mar 31 2023, 10:09:34 null {"title": "Curaçao - Level 1: Exercise Normal Precautions", "pubdate": "Tue, 04 Oct 2022", "link": "http://travel.state.gov/content/travel/en/travelad show more
165 Fri, Mar 31 2023, 10:09:34 null {"title": "Curaçao - Level 1: Exercise Normal Precautions", "pubdate": "Tue, 04 Oct 2022", "link": "http://travel.state.gov/content/travel/en/travelad show more
166 Fri, Mar 31 2023, 10:09:34 null {"title": "Azerbaijan - Level 2: Exercise Increased Caution", "pubdate": "Tue, 15 Nov 2022", "link": "http://travel.state.gov/content/travel/en/travel show more
167 Fri, Mar 31 2023, 10:09:34 null {"title": "Azerbaijan - Level 2: Exercise Increased Caution", "pubdate": "Tue, 15 Nov 2022", "link": "http://travel.state.gov/content/travel/en/travel show more
168 Fri, Mar 31 2023, 10:09:34 null {"title": "Cameroon - Level 2: Exercise Increased Caution", "pubdate": "Wed, 12 Oct 2022", "link": "http://travel.state.gov/content/travel/en/travelad show more
169 Fri, Mar 31 2023, 10:09:34 null {"title": "Colombia - Level 3: Reconsider Travel", "pubdate": "Wed, 04 Jan 2023", "link": "http://travel.state.gov/content/travel/en/traveladvisories/ show more
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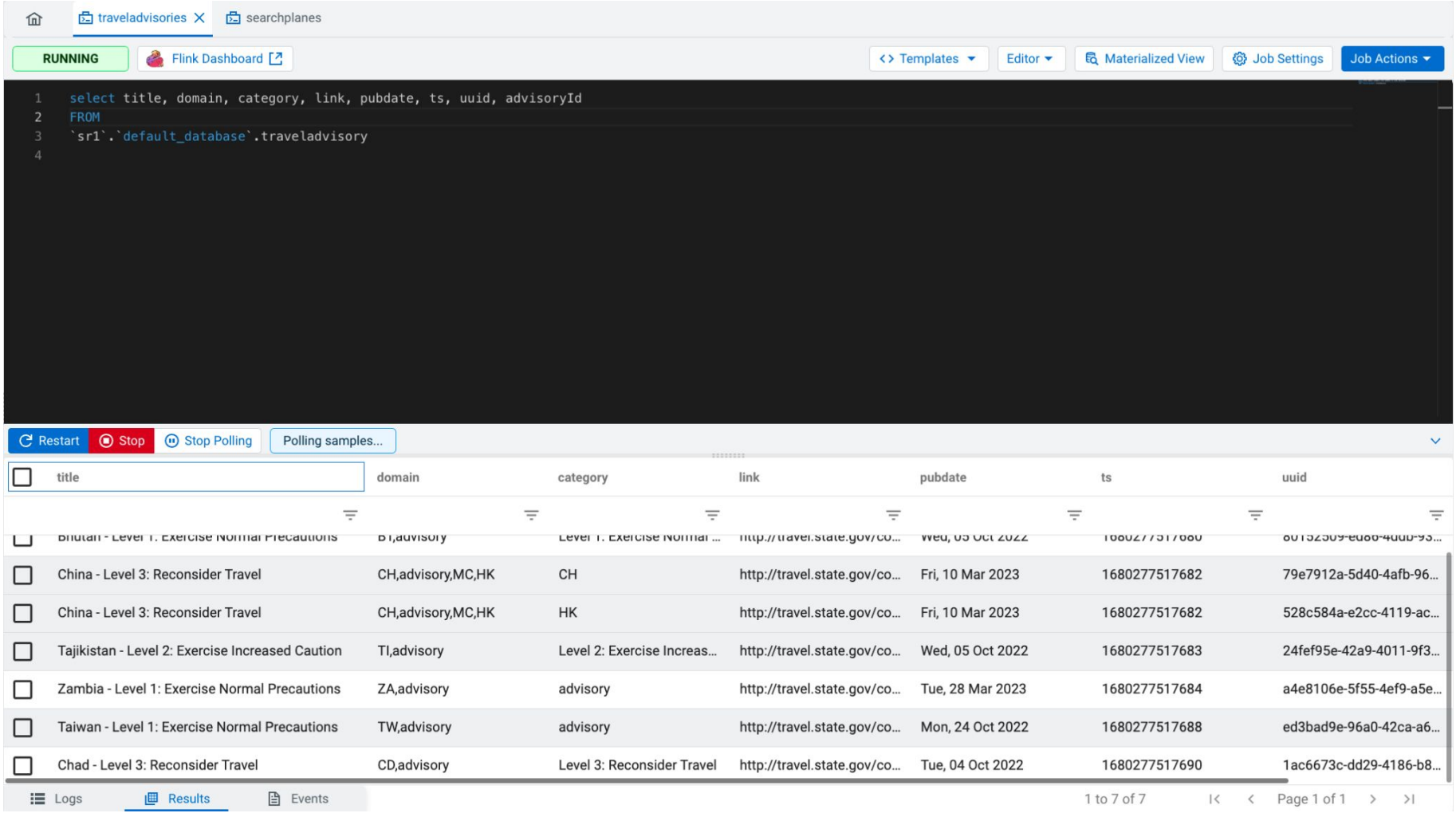
traveladvisories
searchplanes
RUNNING
Flink Dashboard
Templates
Editor
Materialized View
Job Settings
Job Actions
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FROM
`sr1`.`default_database`.traveladvisory
Restart
Stop
Stop Polling
Polling samples...
title
domain
category
link
pubdate
ts
uuid
China - Level 3: Reconsider Travel
CH,advisory,MC,HK
CH
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Tajikistan - Level 2: Exercise Increased Caution
TI,advisory
Level 2: Exercise Increas...
http://travel.state.gov/co...
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Zambia - Level 1: Exercise Normal Precautions
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Taiwan - Level 1: Exercise Normal Precautions
TW,advisory
advisory
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Mon, 24 Oct 2022
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Chad - Level 3: Reconsider Travel
CD,advisory
Level 3: Reconsider Travel
http://travel.state.gov/co...
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Logs
Results
Events
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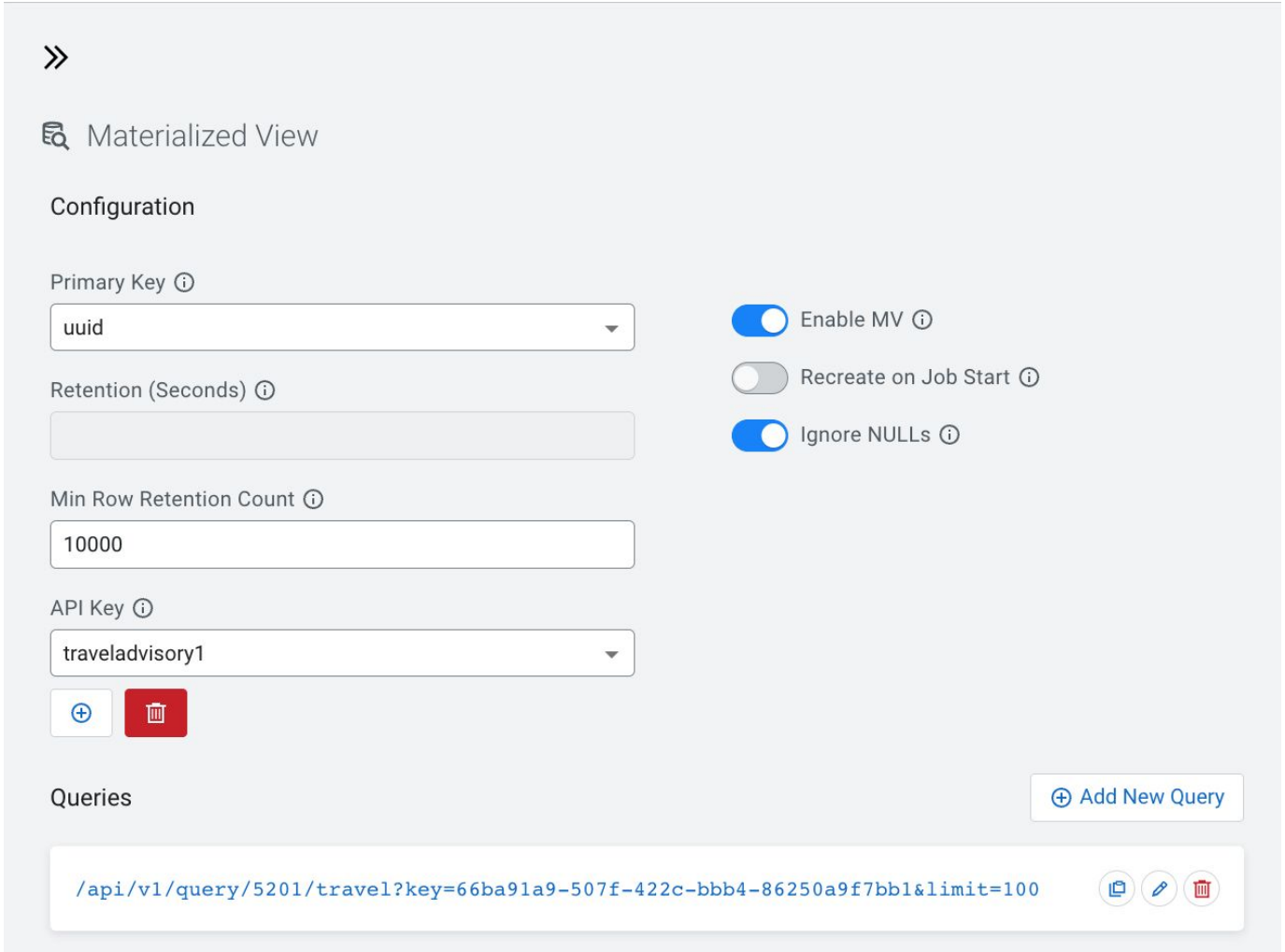
Page 1 of 1


Materialized View
Configuration
Primary Key
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Min Row Retention Count
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API Key
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Recreate on Job Start
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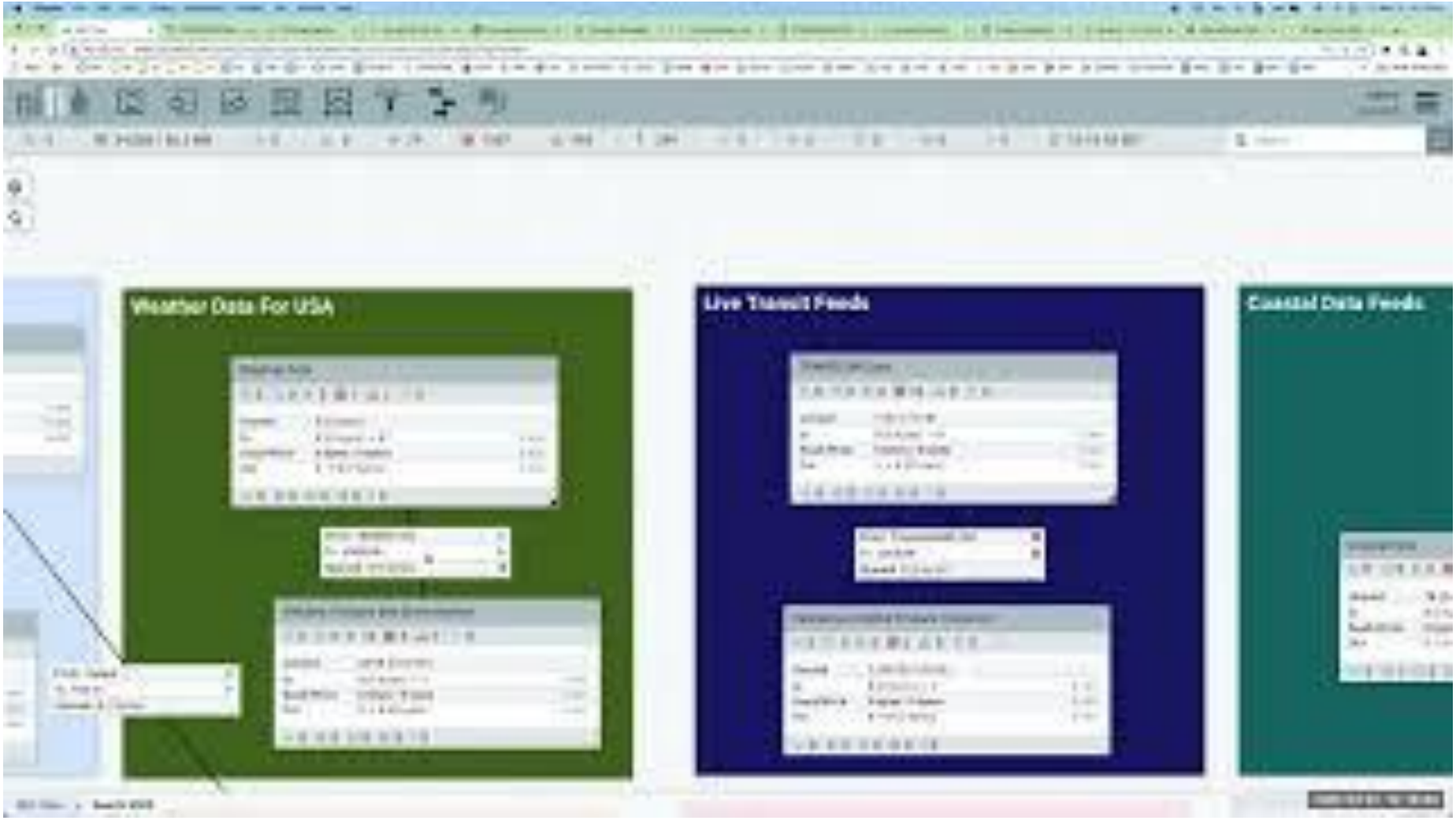
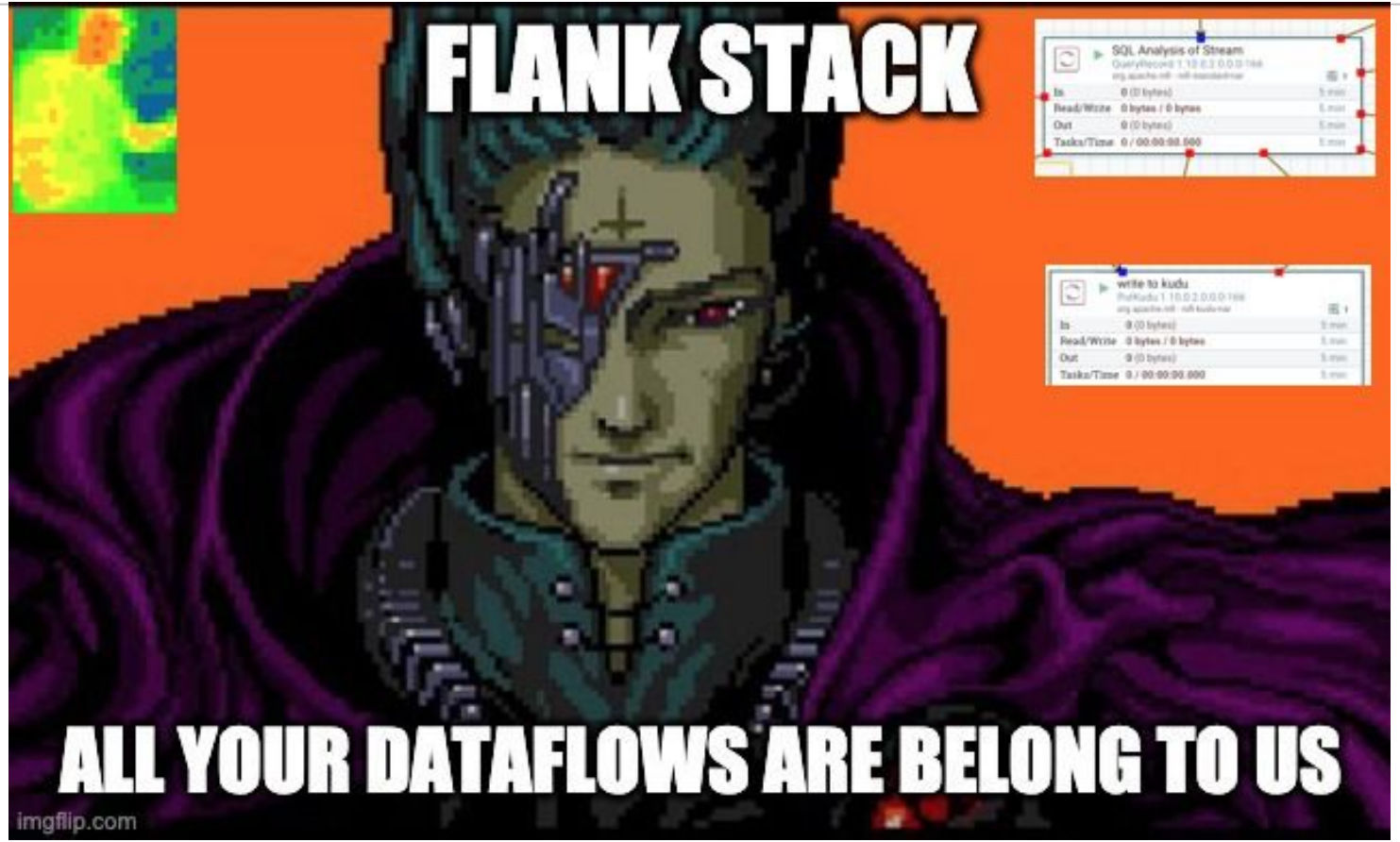

Weather Data For USA
Live Transit Feeds
Coastal Data Feeds

# RESOURCES AND WRAP-UP

# Streaming Resources

- https://dzone.com/articles/real-time-stream-processing-with-hazelcast-and-streamnative
- https://flipstackweekly.com/
- https://www.datainmotion.dev/
- https://www.flankstack.dev/
- https://github.com/tspannhw
- https://medium.com/@tspann
- https://medium.com/@tspann/predictions-for-streaming-in-2023-ad4d7395d714
- https://www.apachecon.com/acna2022/slides/04_Spann_Tim_Citizen_Streaming_Engineer.pdf

# Resources





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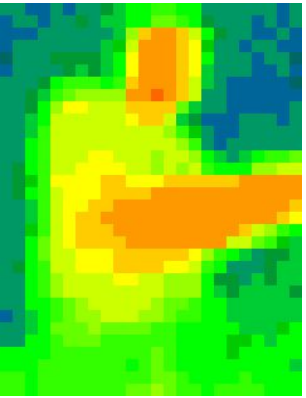

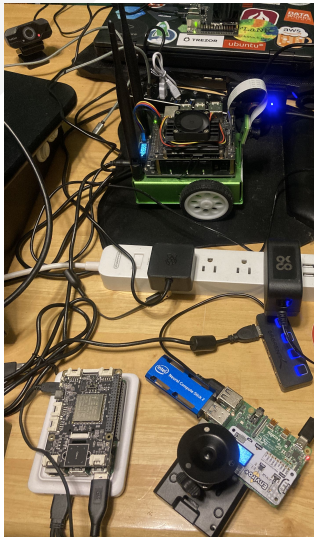
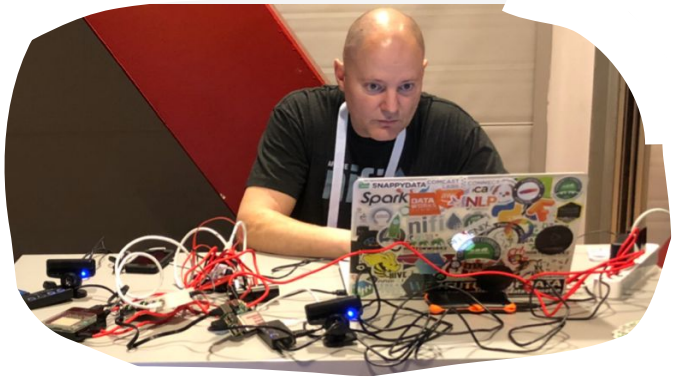
THANK YOU