CLOUDERA

Utilizing Real-Time Transit Data for Travel Optimization

Tim Spann
Principal Developer Advocate

October-2023

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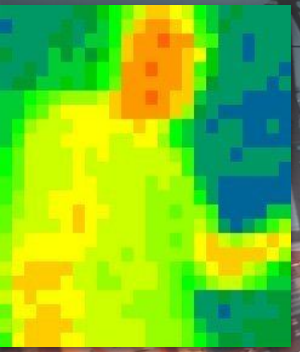


@PaasDev www.datainmotion.dev
github.com/tspannhw medium.com/@tspann
Principal Developer Advocate

Princeton Future of Data Meetup
ex-Pivotal, ex-Hortonworks, ex-StreamNative,
ex-PwC, ex-EY, ex-HPE.

Apache NiFi x Apache Kafka x Apache Flink

There are a lot of factors involved in determining how you can find our way around and avoid delays, bad weather,dangers and expenses. In this talk I will focus on public transport in the largest transit system in the United States, the MTA,
which is focused around New York City. Utilizing public and semi-public data feeds, this can be extended to most city and metropolitan areas around the world. As a personal example, I live in New Jersey and this is an extremely useful use of open source and public
data.

Once I am notified that I need to travel to Manhattan, I need to start my data streams flowing. Most of the data sources are REST feeds that are ingested by Apache NiFi to transform, convert, enrich and finalize it for usage in streaming tables with Flink SQL, but also keep that same contract with Kafka consumers, Iceberg tables and other users of this data. I do not need to many user interfaces to interopt with the system as I want my final decision sent in a Slack message to me and then I'll get moving. Along the way data will be visible in NiFi lineage, Kafka topic views, Flink SQL output, REST output and Iceberg tables.

Apache NiFi, Apache Kafka, Apache OpenNLP, Apache Tika, Apache Flink, Apache Avro, Apache Parquet, Apache Iceberg.
https://github.com/tspannhw/FLaNK-MTA/tree/main
https://medium.com/@tspann/finding-the-best-way-around-7491c76ca4cb
https://medium.com/@tspann/open-source-streaming-talks-in-progress-3e75af8848b0
https://medium.com/@tspann/watching-airport-traffic-in-real-time-32c522a6e386

Introduction

Overview

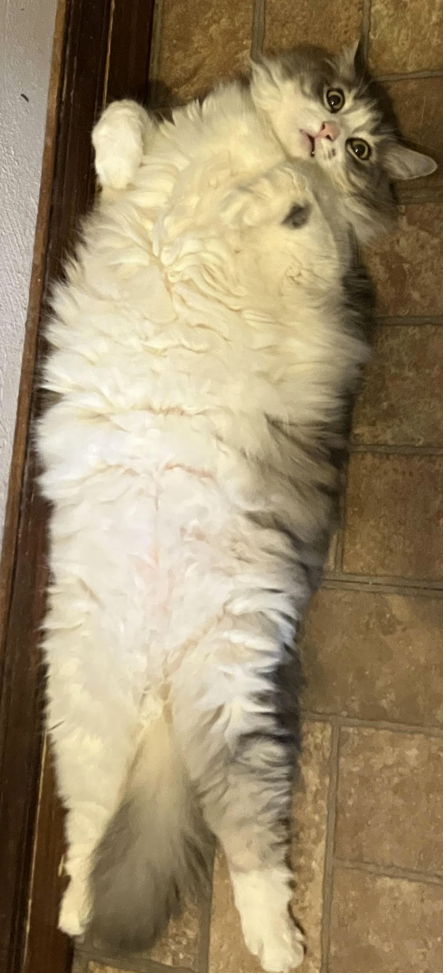
Sources & Code

Apache Kafka

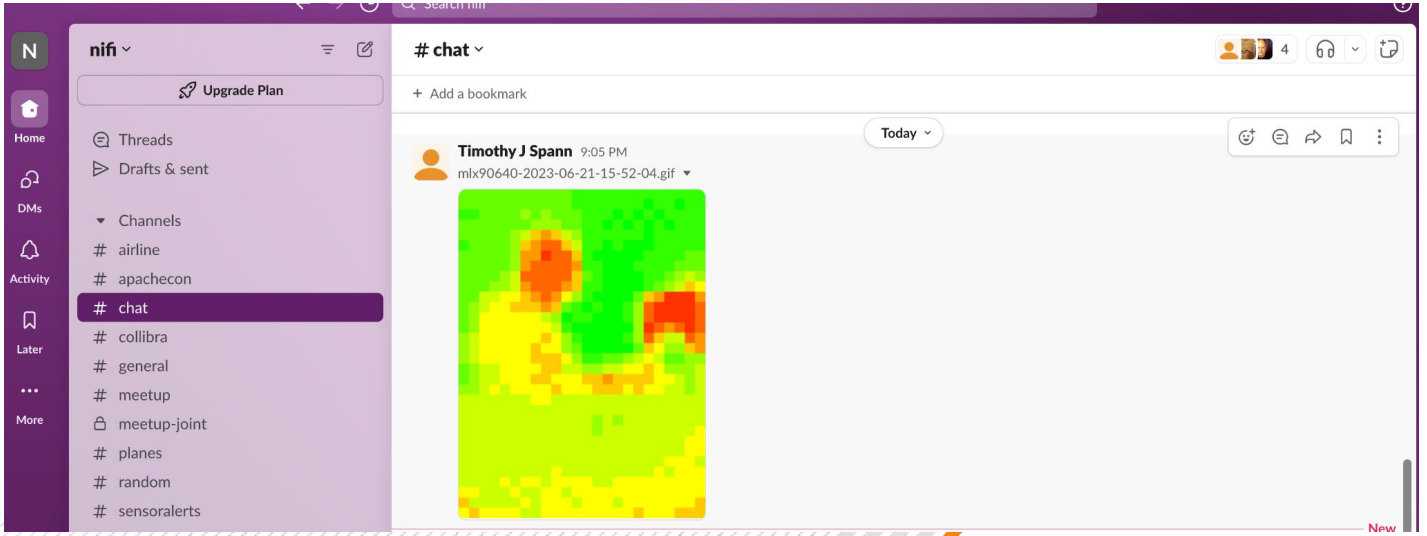
Apache Flink

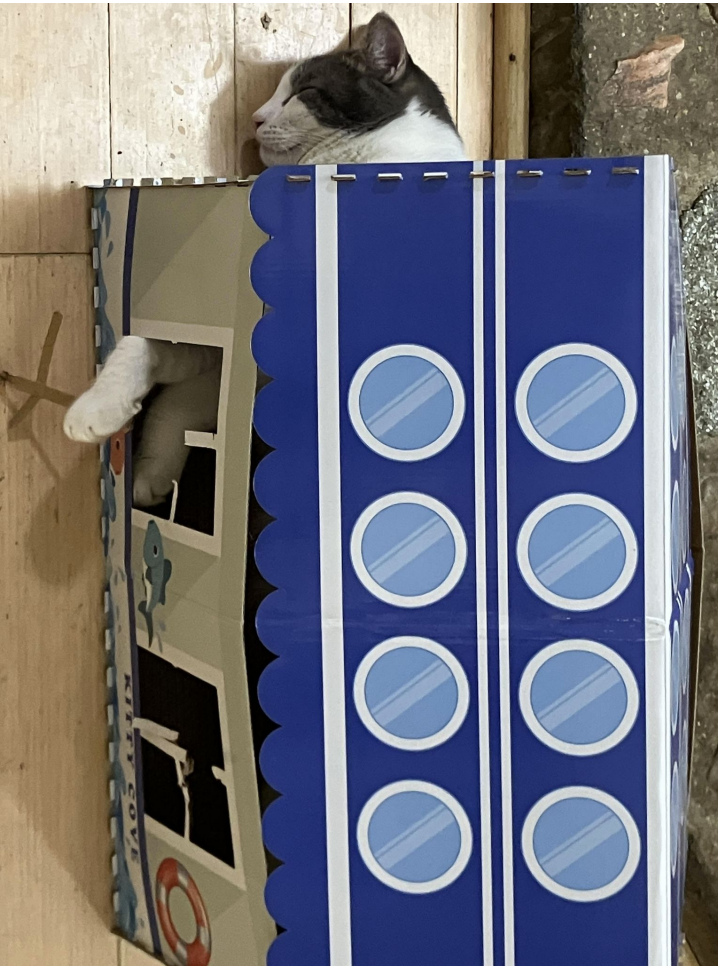
Apache NiFi

Demos



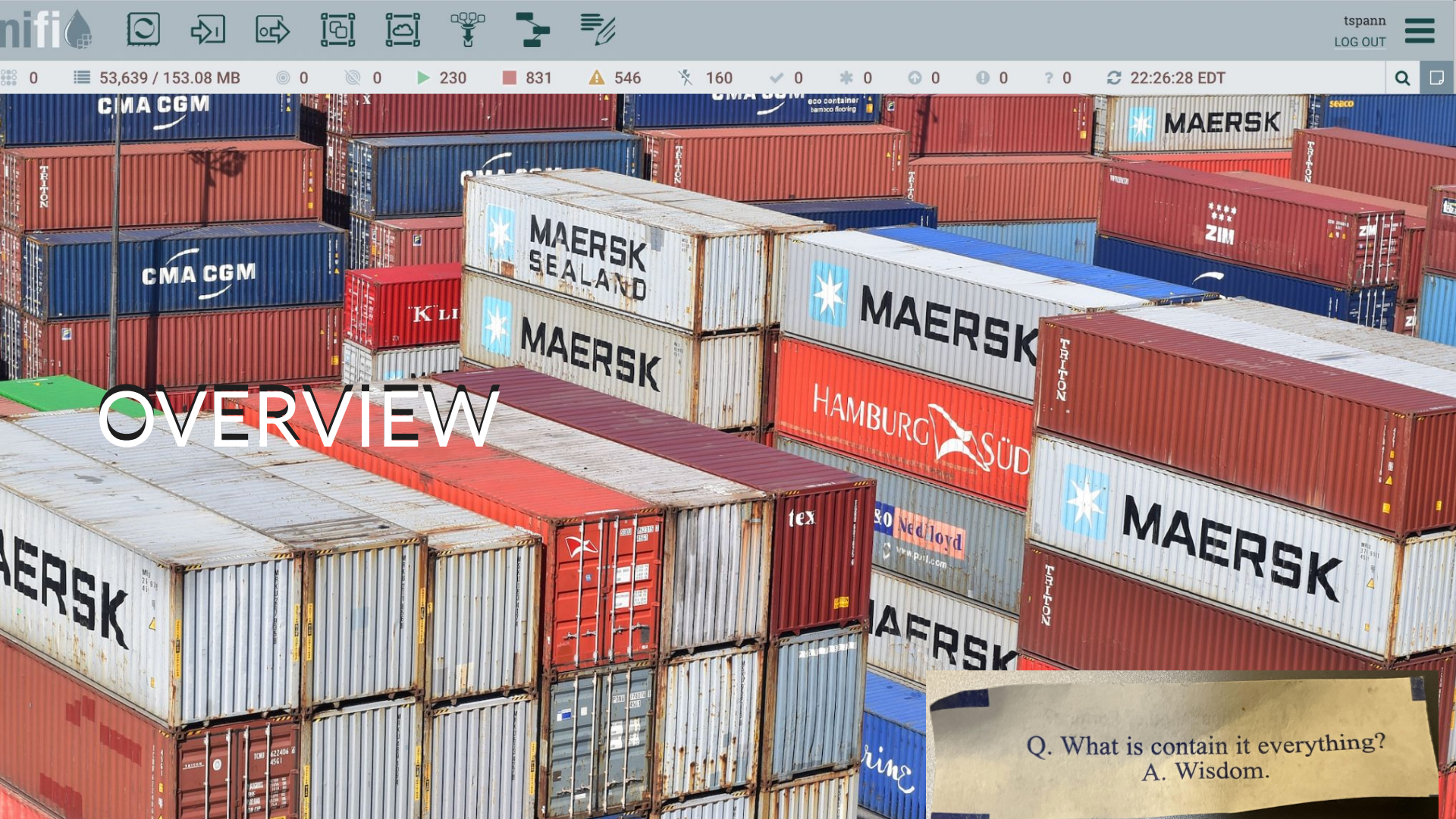
DATA OVERLOAD





OUTGROWING ONE SERVER

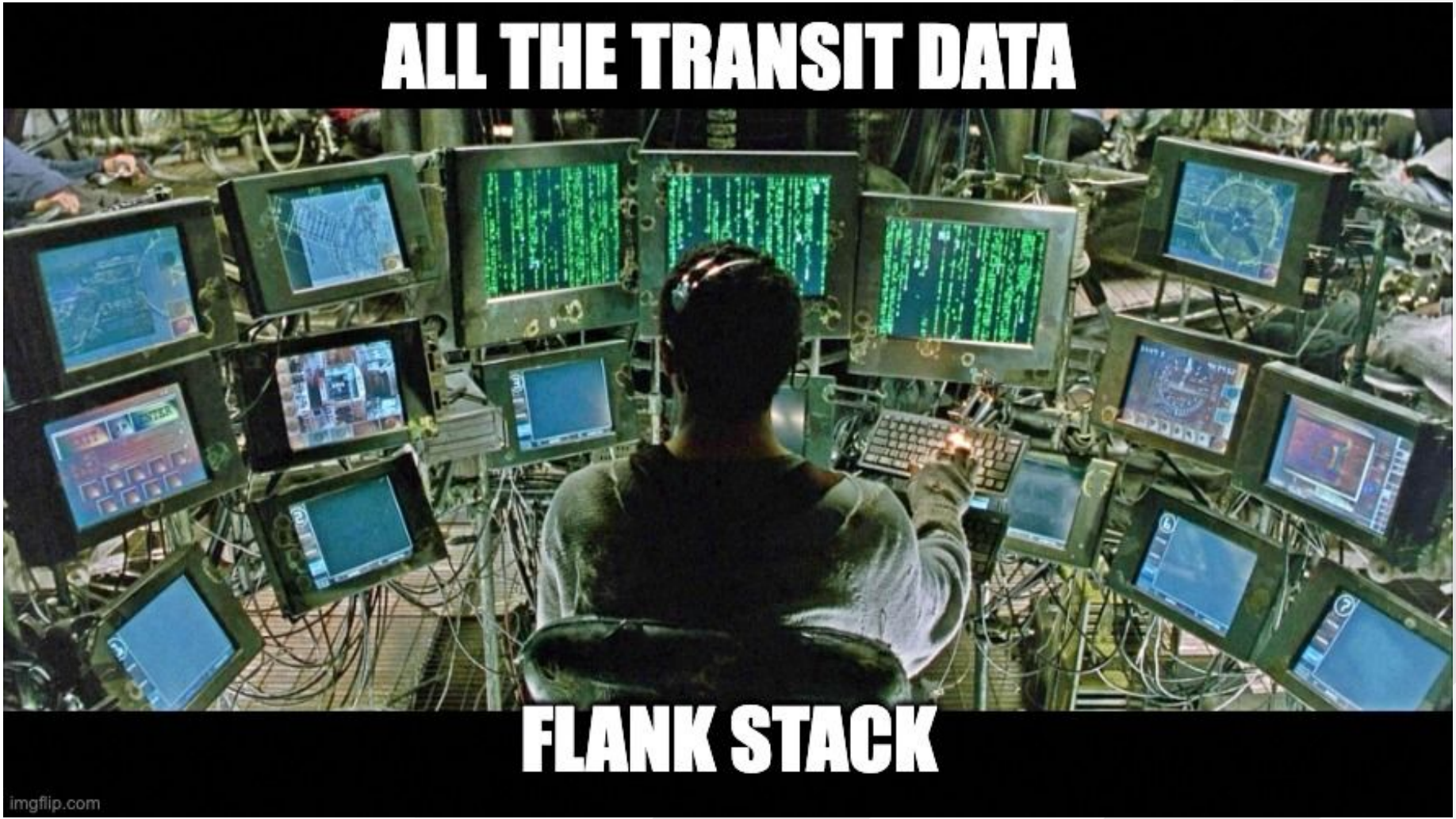
USERS JUST WANTED ONE TACO


nifi
tspann
LOG OUT
0
53,639 / 153.08 MB
0
0
230
831
546
160
0
0
0
0
0
22:26:28 EDT
OVERVIEW
Q. What is contain it everything?
A. Wisdom.

Trains, Planes and Automobiles +++

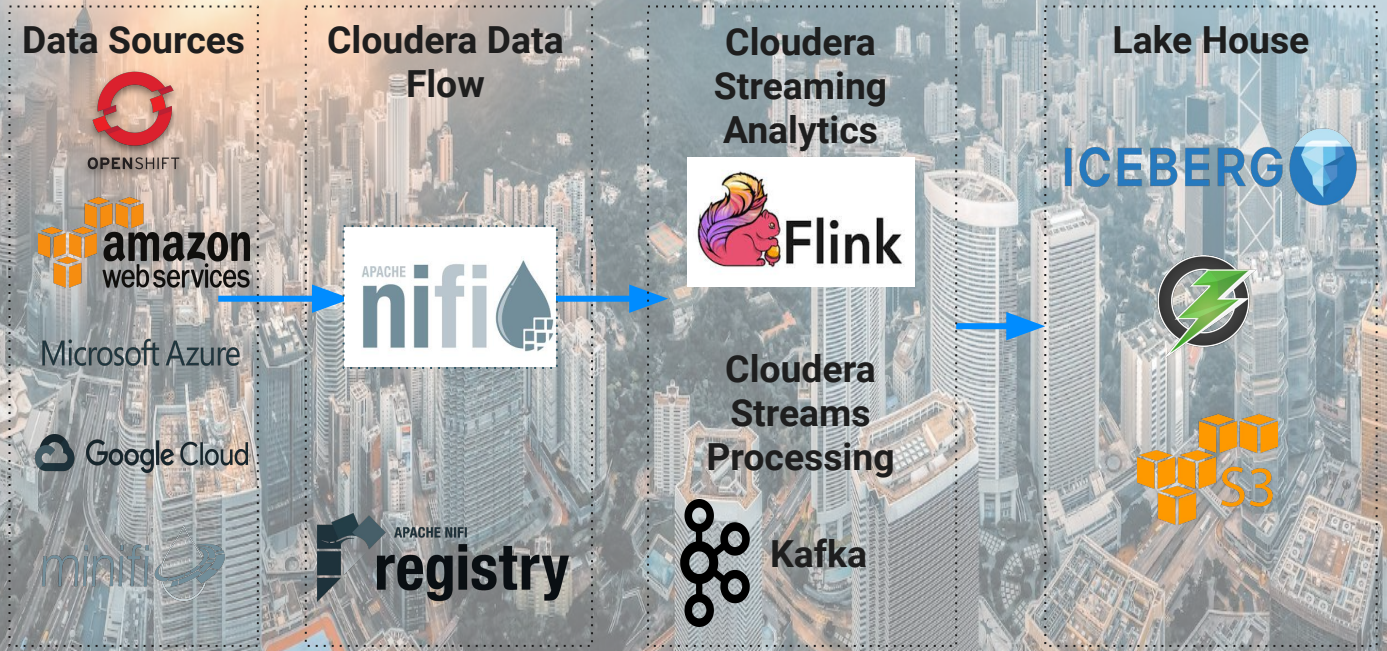
Information Needed	Data Feed(s)
Local weather conditions	• XML, JSON, RSS
Mass transit status & alerts	• XML, JSON, RSS
Regional highways & tunnels	• GeoRSS, XML, ProtoBuf, JSON
Local social media	• JSON
ADS-B Plane Data	• JSON
Local air quality	• JSON

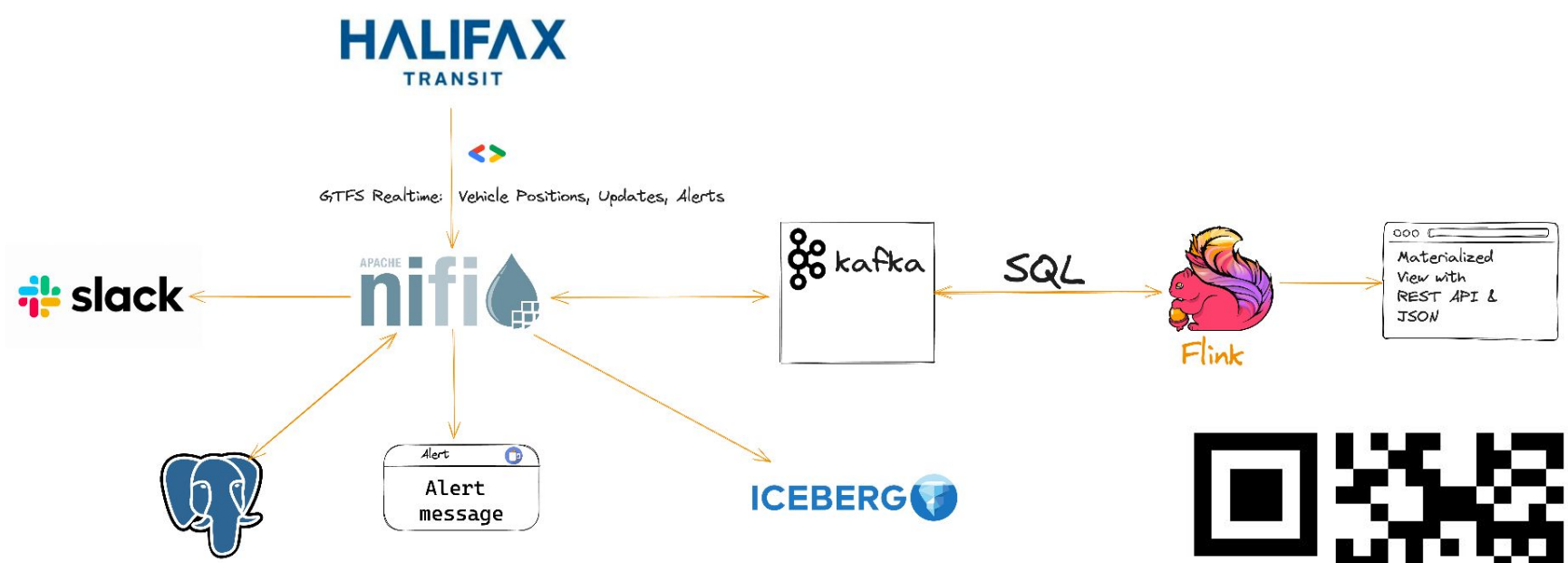
REAL-TIME REQUIRES A PLATFORM


ALL THE TRANSIT DATA
FLANK STACK
imgflip.com

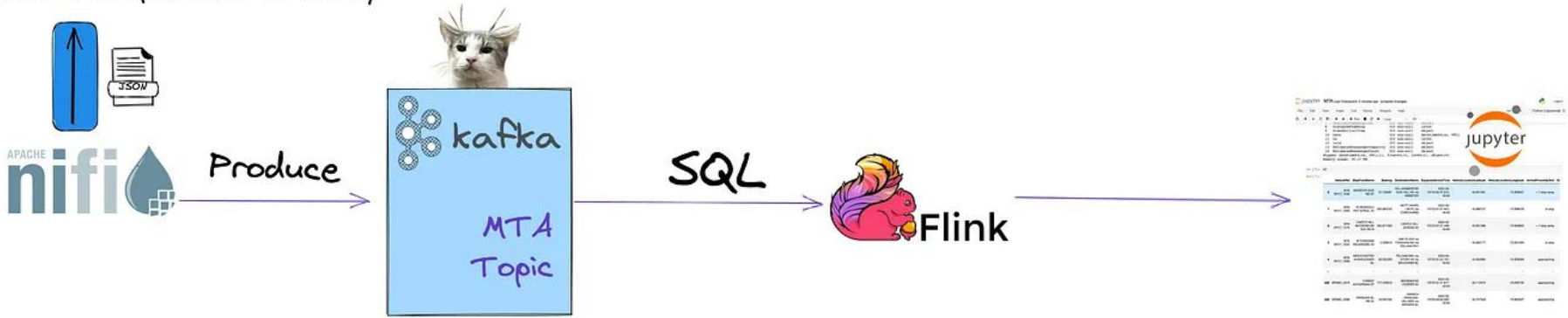
INGEST OF ALL TRANSIT DATA

Run collection and streaming on any cloud, server, container or VM

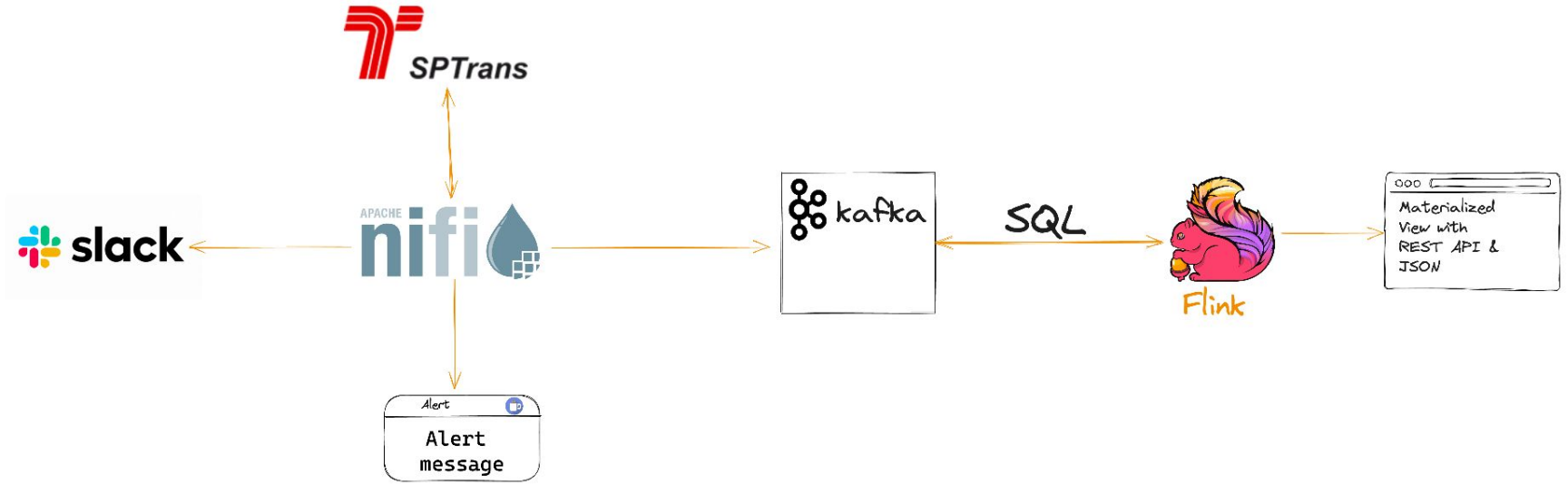


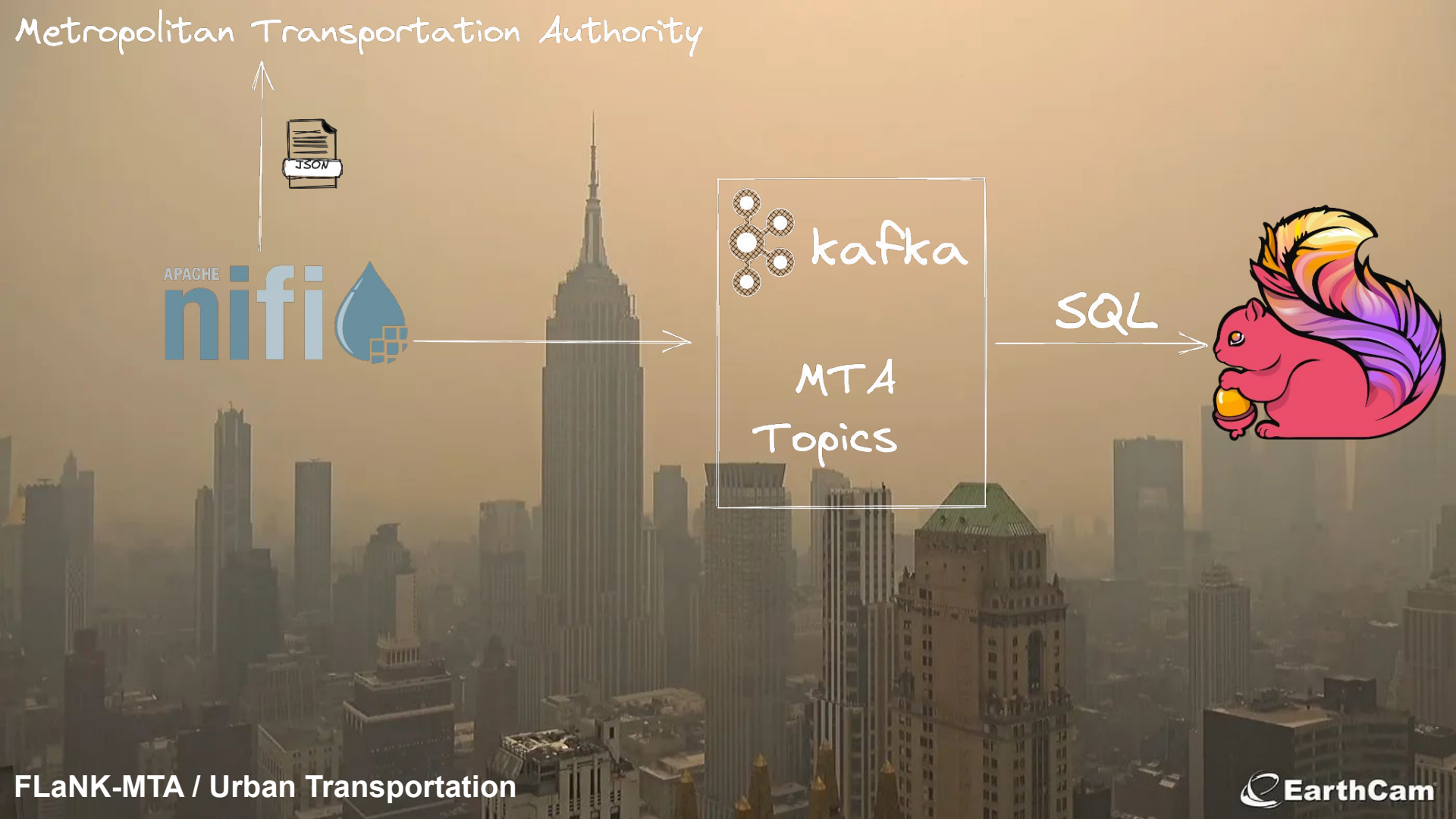

HALIFAX
TRANSIT
GTFS Realtime: Vehicle Positions, Updates, Alerts
slack
APACHE
nifi
kafka
SQL
Flink
Materialized
View with
REST API &
JSON
Alert
Alert
message
ICEBERG

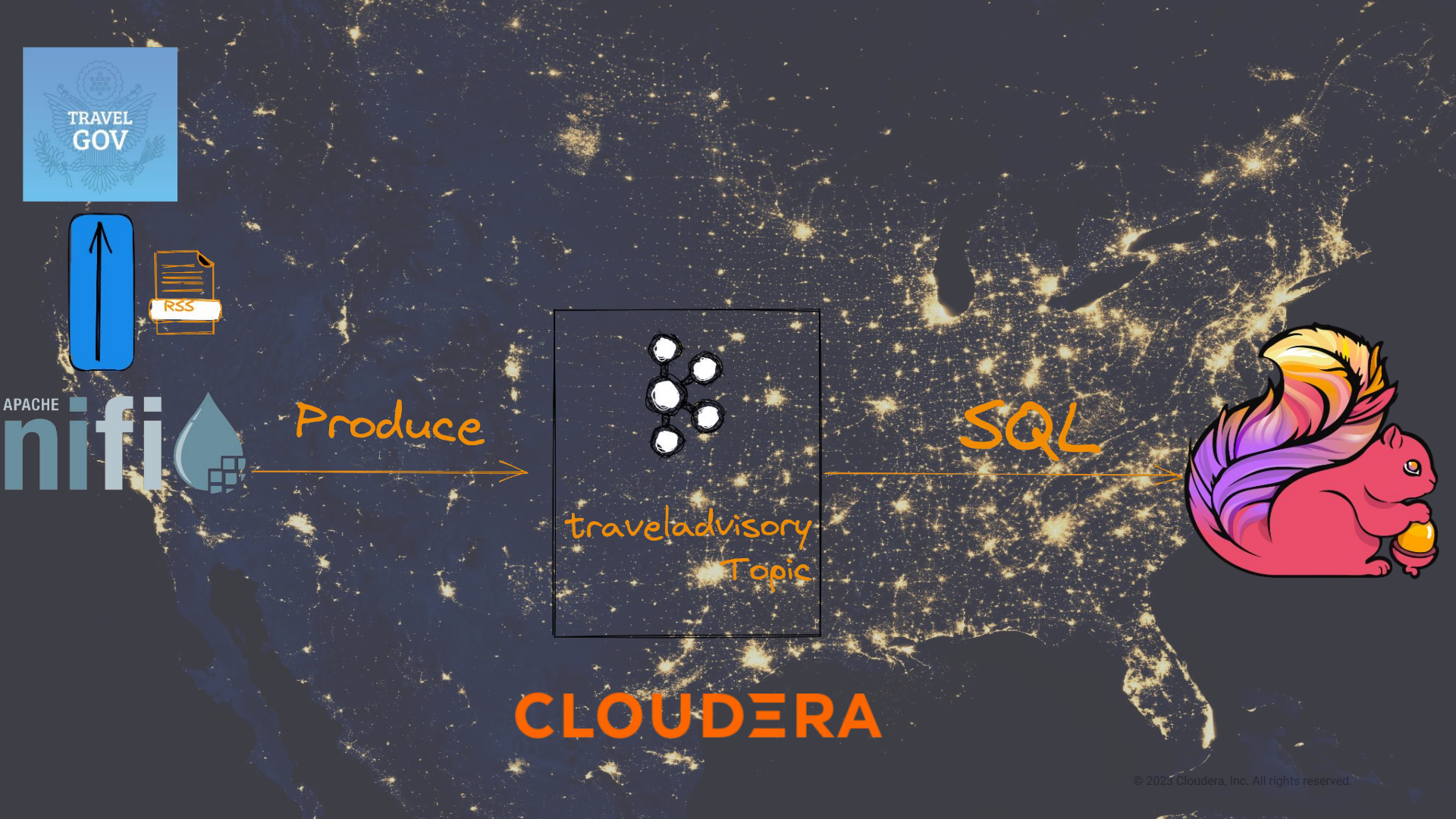
Metropolitan Transportation Authority



CLOUDERA


SPTrans
slack
APACHE
nifi
kafka
SQL
Flink
Materialized
View with
REST API &
JSON
Alert
Alert
message


Metropolitan Transportation Authority
JSON
APACHE nifi
kafka
MTA Topics
SQL
FLaNK-MTA / Urban Transportation
EarthCam



CLOUDERA


AirNow
Developer Tools
APACHE
nifi
openaq

APACHE KAFKA

Apache Kafka

MiNiFi

DATA COLLECTION AT THE EDGE

US-West Fleet

US-Central Fleet

US-East Fleet

Apache Kafka

INGEST GATEWAY POWERED BY KAFKA

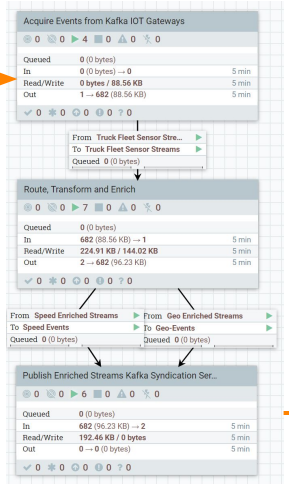
gateway-west-raw-sensors

gateway-central-raw-sensors

gateway-east-raw-sensors

Apache NiFi

DATA FLOW APPS POWERED BY NIFI



Apache Kafka

KAFKA CLUSTER GEO 1 DATA SYNDICATE SERVICES

Kafka Topic syndicate-transmission	Kafka Topic syndicate-speed
Kafka Topic syndicate-temp	Kafka Topic syndicate-geo

Replication / Data Deployment

KAFKA CLUSTER GEO 2 DATA SYNDICATE SERVICES

Kafka Topic syndicate-transmission	Kafka Topic syndicate-speed
Kafka Topic syndicate-temp	Kafka Topic syndicate-geo

Apache Flink

STREAMING ANALYTICS APPS

Micro Batch Analytics Stream Analytics App

Apache Spark Structured Streaming

Micro Services Stream Analytics App

kafka

Complex Low Latent Stream Analytics App

Apache Flink

APACHE FLINK

Apache Flink SQL

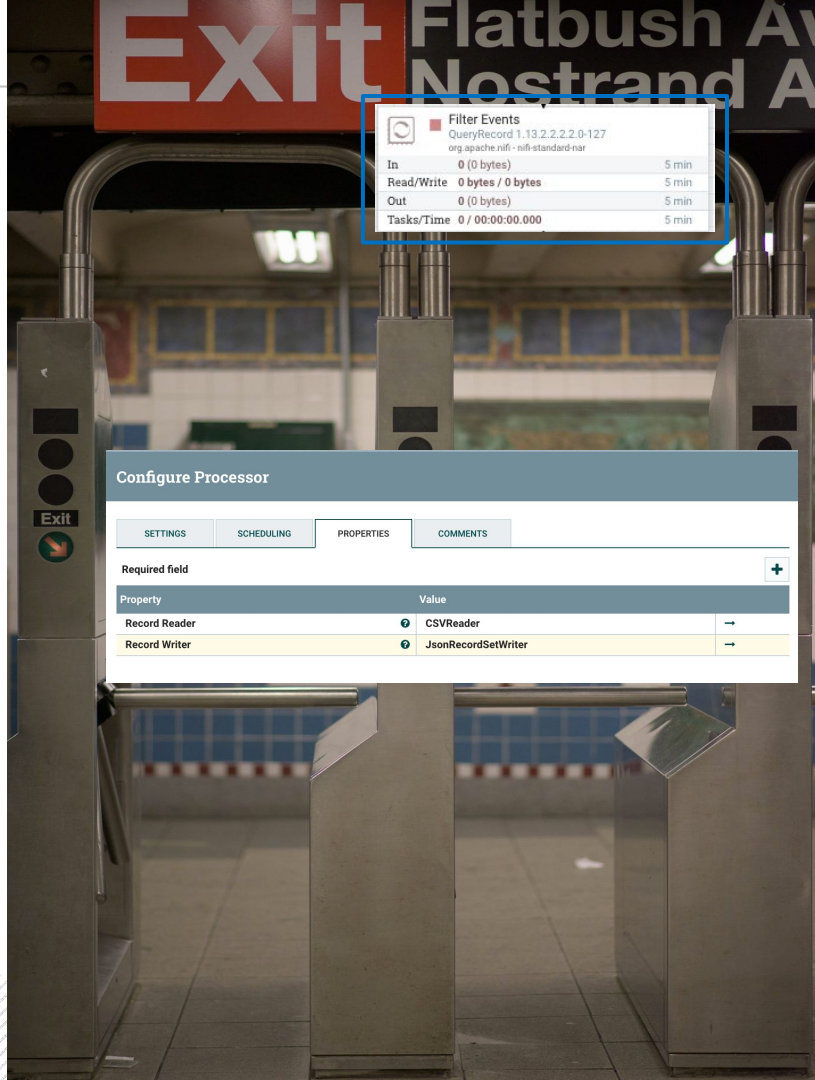
Democratize access to real-time data with just SQL

```
CREATE TABLE `ssb`.`Meetups`.`hfbloom` (
  `generated_text` VARCHAR(2147483647),
  `ts` VARCHAR(2147483647),
  `x_compute_type` VARCHAR(2147483647),
  `inputs` VARCHAR(2147483647),
  `x_compute_time` VARCHAR(2147483647),
  `x_inference_time` VARCHAR(2147483647),
  `uuid` VARCHAR(2147483647),
  `x_time_per_token` VARCHAR(2147483647),
  `x_compute_characters` VARCHAR(2147483647),
  `eventTimeStamp` TIMESTAMP(3) WITH LOCAL TIME ZONE METADATA FROM 'timestamp',
  WATERMARK FOR `eventTimeStamp` AS `eventTimeStamp` - INTERVAL '3' SECOND
) WITH (
  'scan.startup.mode' = 'group-offsets',
  'properties.request.timeout.ms' = '120000',
  'properties.auto.offset.reset' = 'earliest',
  'format' = 'json',
  'properties.bootstrap.servers' = 'kafka:9092',
  'connector' = 'kafka',
  'properties.transaction.timeout.ms' = '900000',
  'topic' = 'hfbloom',
  'properties.group.id' = 'llmBloomProps'
)
```

APACHE NIFI

RECORD-ORIENTED DATA WITH NIFI

- **Record Readers** - Avro, CSV, Grok, IPFIX, JSAN1, JSON, Parquet, Scripted, Syslog5424, Syslog, WindowsEvent, XML
- **Record Writers** - Avro, CSV, FreeFromText, Json, Parquet, Scripted, XML
- Record Reader and Writer support referencing a schema registry for retrieving schemas when necessary.
- Enable processors that accept any data format without having to worry about the parsing and serialization logic.
- Allows us to keep FlowFiles larger, each consisting of multiple records, which results in far better performance.



PROVENANCE

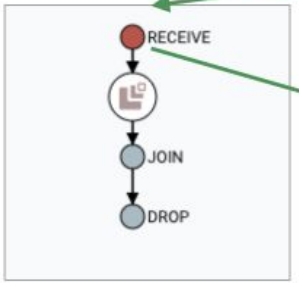
Displaying 13 of 104
Oldest event available: 11/15/2016 13:34:50 EST

Showing the most recent events.

ConsumeKafka | by component name

Date/Time	Type	FlowFile Uuid	Size	Component Name	Component Type
11/15/2016 13:35:03.8...	RECEIVE	379fc4f6-60e0-4151-9743-28...	44 bytes	ConsumeKafka	ConsumeKafka
11/15/2016 13:35:02.7...	RECEIVE	78f8c38b-89fc-4d00-a8d8-51...	44 bytes	ConsumeKafka	ConsumeKafka
11/15/2016 13:35:01.6...	RECEIVE	2bcd5124-bb78-489f-ad8a-7...	44 bytes	ConsumeKafka	ConsumeKafka

- Tracks data at each point as it flows through the system
- Records, indexes, and makes events available for display
- Handles fan-in/fan-out, i.e. merging and splitting data
- View attributes and content at given points in time



Provenance Event

DETAILS | ATTRIBUTES | CONTENT

Attribute Values

filename
328717796819631
No value previously set

kafka.offset
44815
No value previously set

kafka.partition
6
No value previously set

kafka.topic
nifi-testing
No value previously set

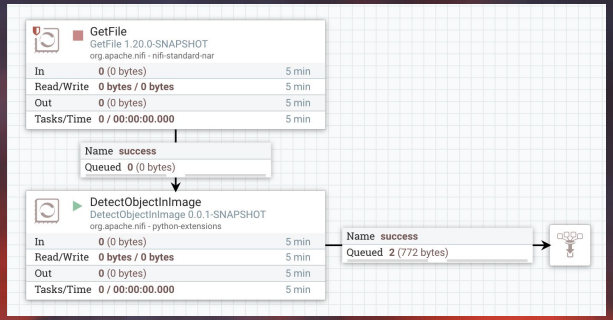
path
./
No value previously set

uuid

APACHE NIFI WITH PYTHON CUSTOM PROCESSORS

Python as a First 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:
```



https://github.com/apache/nifi/blob/614947e4ac6798ad80817e82514c39349d5faacb/nifi-docs/src/main/asciidoc/python-developer-guide.adoc

Future of Data - NYC / Princeton + Virtual

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

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 ...

FUTURE OF DATA

AN OPEN SOURCE COMMUNITY

@PaasDev

FLaNK Stack Weekly

https://bit.ly/32dAJft

This week in Apache NiFi, Apache Flink, Apache Kafka, Apache Spark, Apache Iceberg, Python, Java, AI, ML, LLM and Open Source friends.

DEMO

THANK YOU