Running a Massively Parallel Self-serve Distributed Data System At Scale

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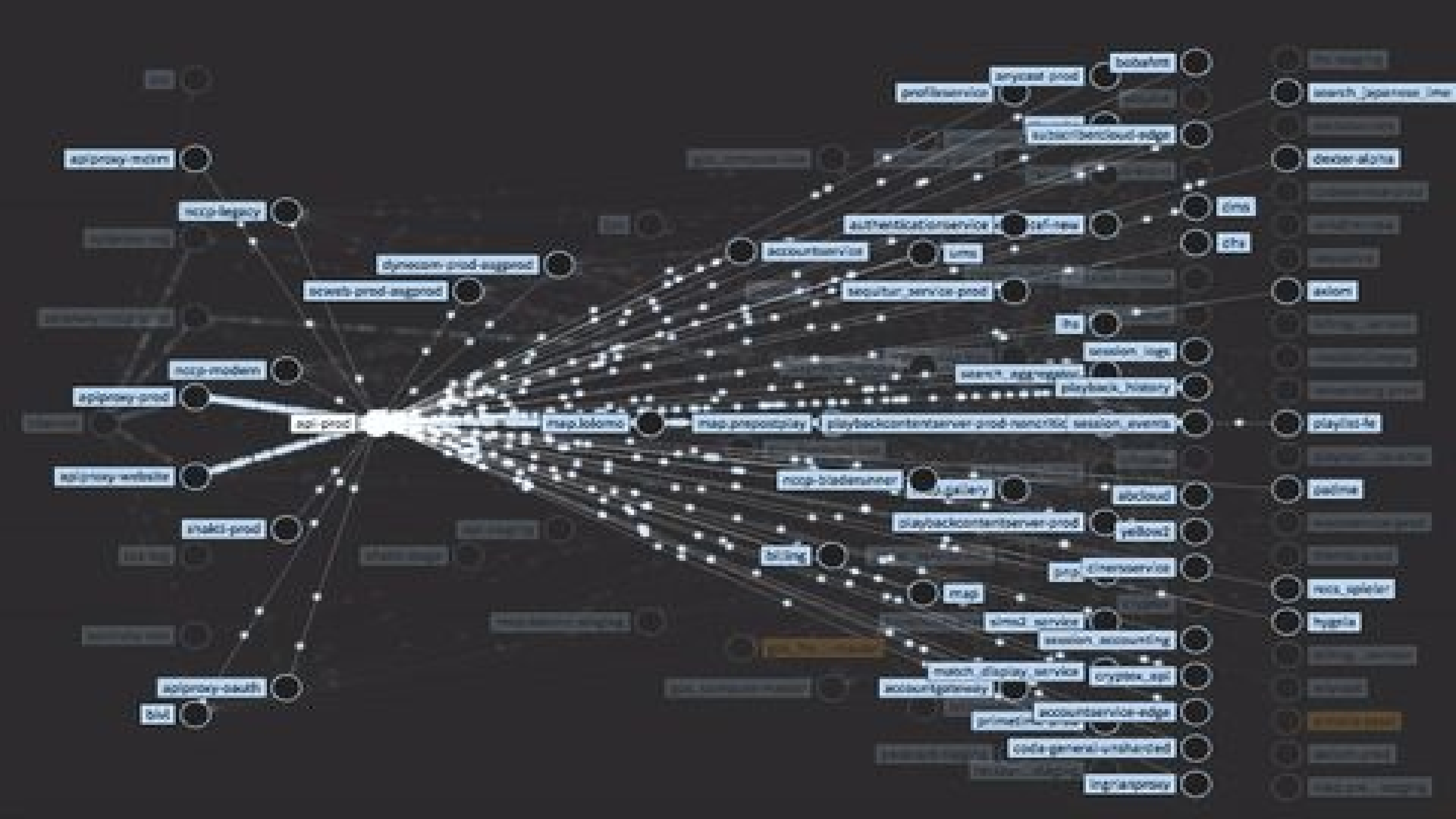
Real-time Data Infrastructure

NETFLIX


EXIT



api-prod
nccp-legacy
nccp-modern
anycast-prod
profileservice
subscribercloud-edge
dexter-alpha
accountservice
session_logs
playback_history
playlist-fe
playbackcontentserver-prod
billing
map
session_accounting
accountservice-edge
cinemaservice
hygeia

Running a Massively Parallel Self-serve Distributed Data System at Scale

- What is Netflix Real-time Data Infrastructure
- Challenges
- Solutions and Principles

What is ...

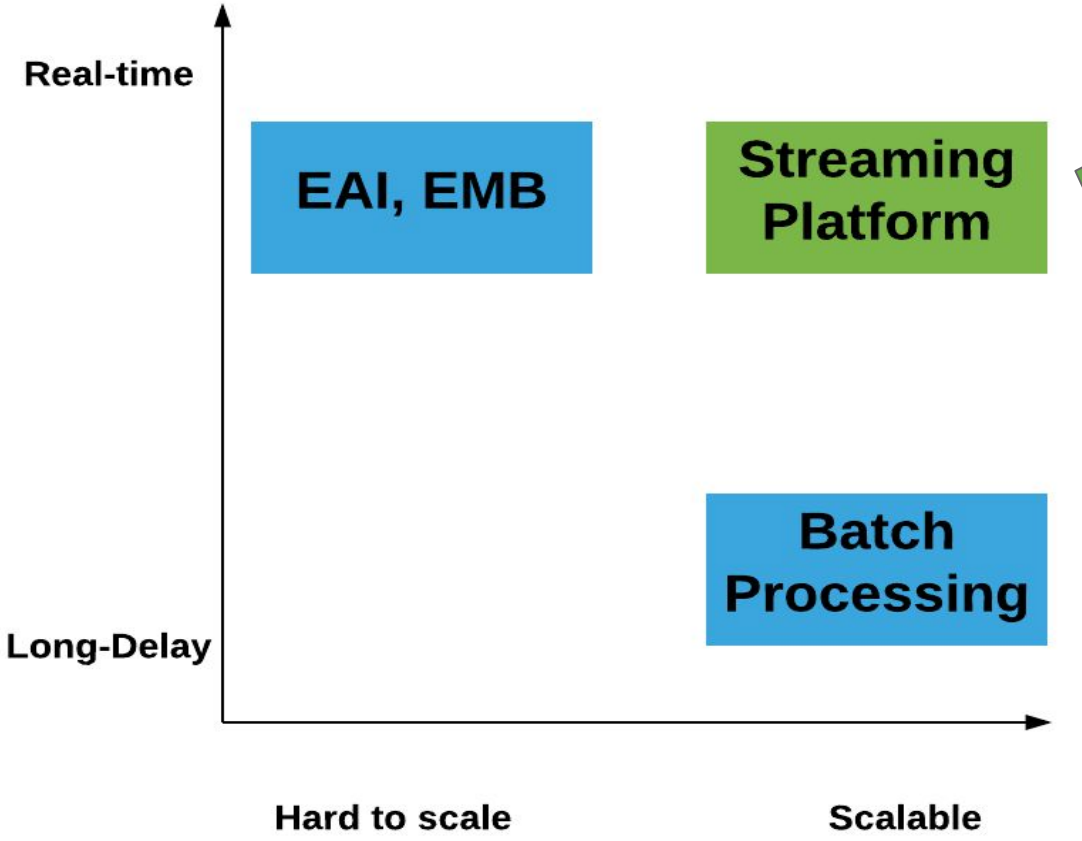
... Real-time Data Infrastructure at Netflix

Business/Product Driven Analytics

- Recommendations / Personalization Algorithms
- Customer Experience
- Content Operation
- A/B Testing
- Marketing
- etc

Rise of Event Driven Architecture

- Notification
- Event Sourcing
- CQRS
- etc



We need a data platform that's both scalable and real-time.

Data-driven Culture

So what exactly is Keystone Streaming Platform?

Publish, Collect, Move & Compute

event data in near real time @ Cloud Scale

Keystone is ...

... a collection of microservices & components

Self Service UI

Control Plane

Producer API

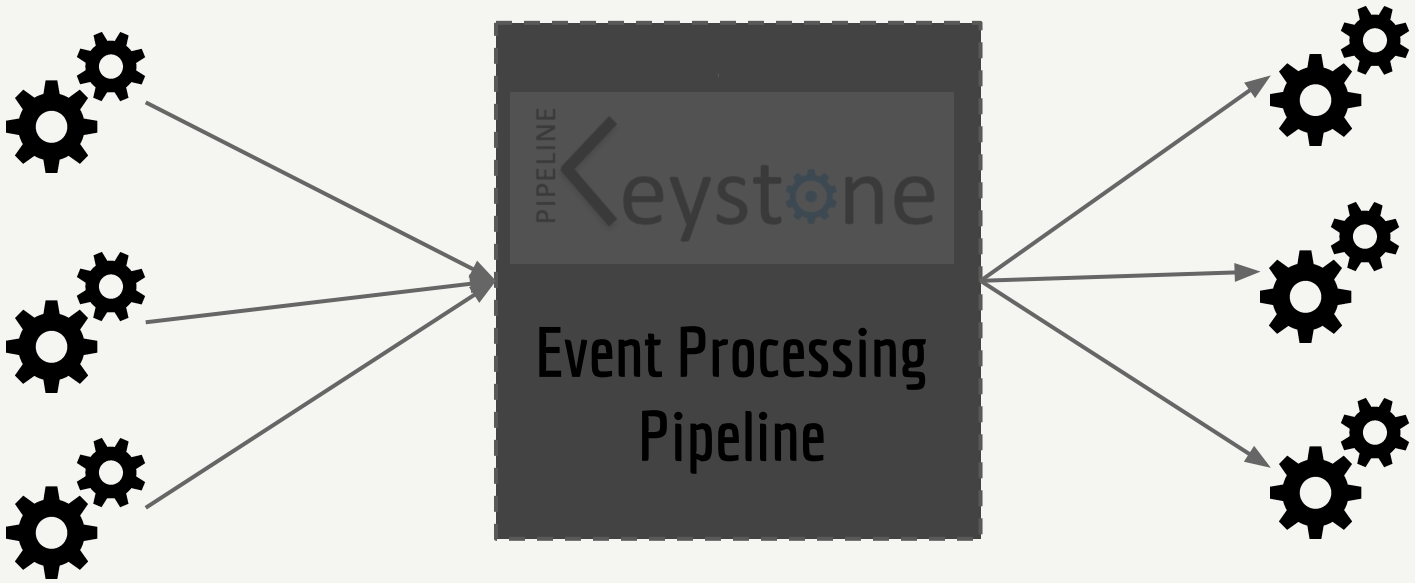
Pub/Sub Queuing Service

Stream Processing Service

Consumer API

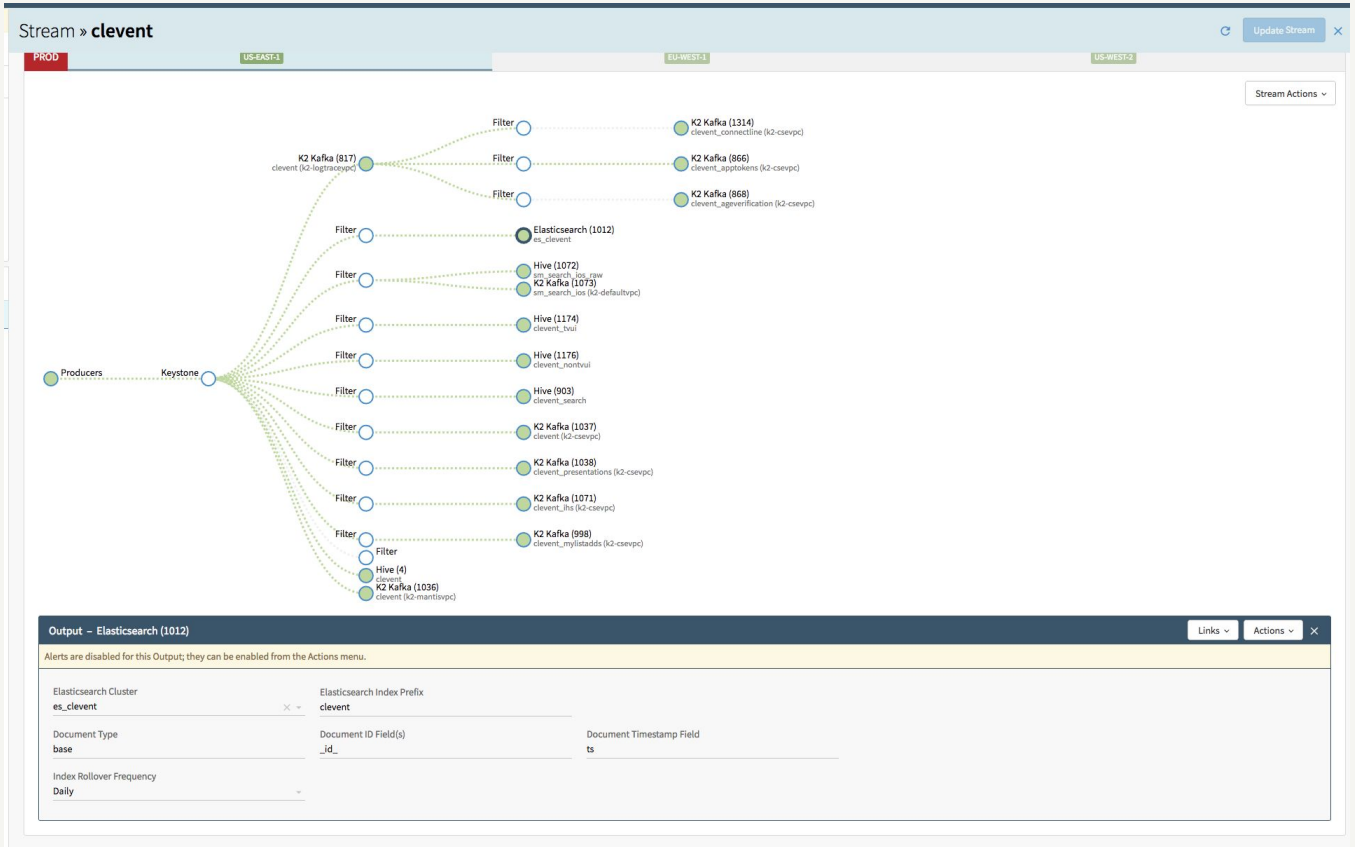
Keystone is ...

... a single self-contained logical PaaS



Keystone is ...

... a multi-tenants, self-serving tool

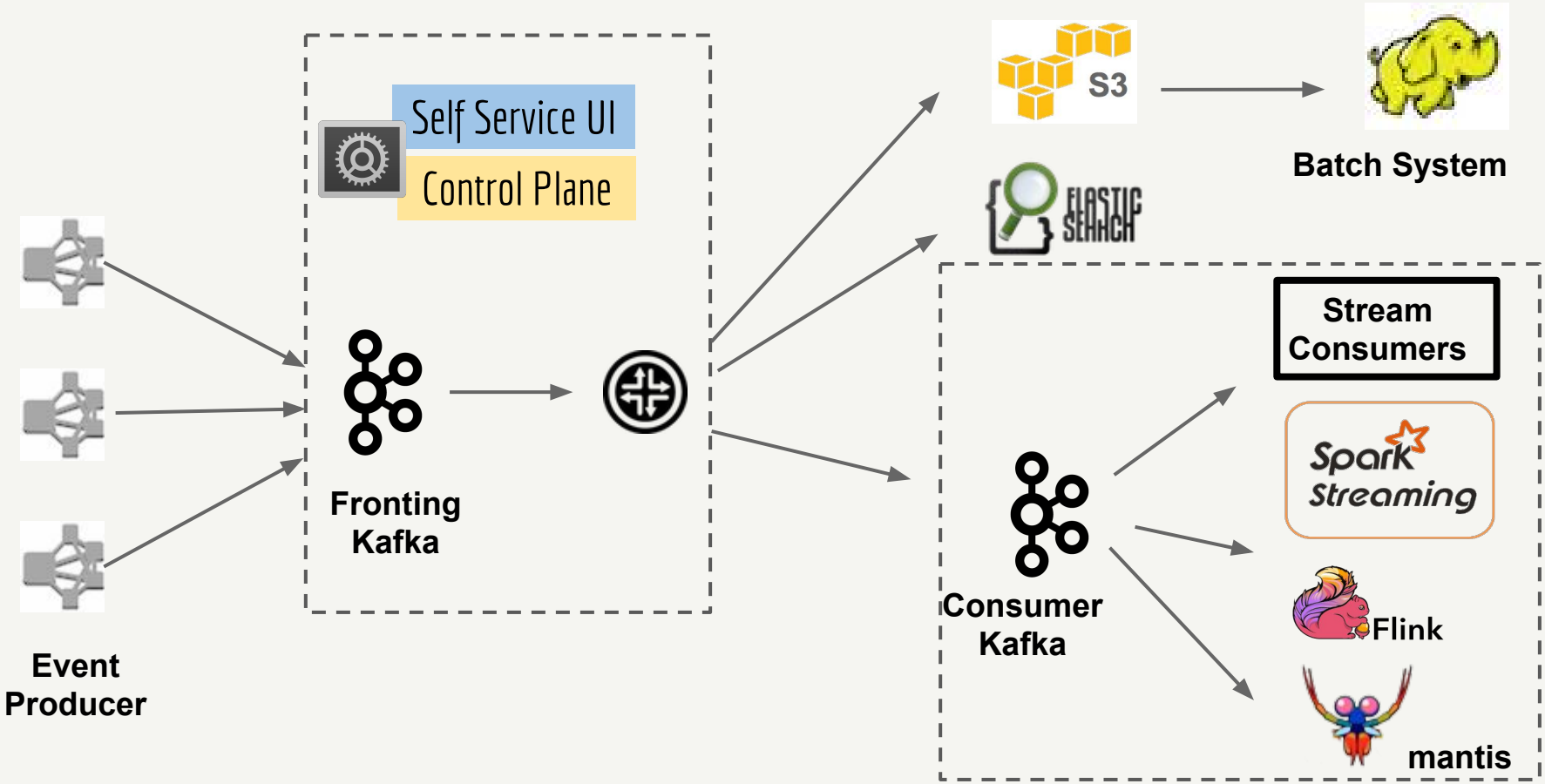


Keystone is ...

... a self healing, cloud failure tolerant service, guarantees at-least-once delivery semantics

... adaptable to changing environments

Putting together ...



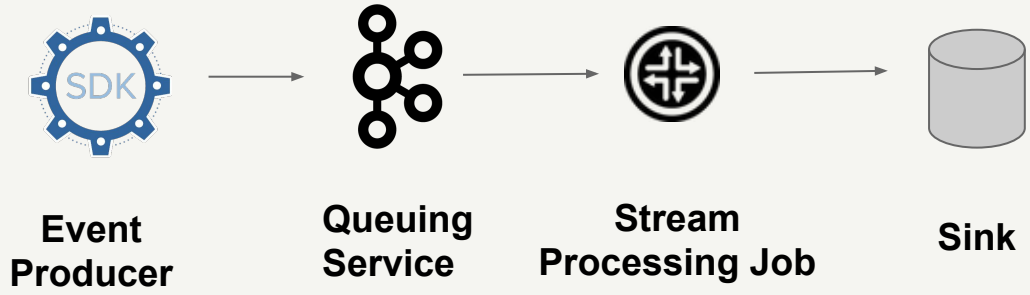
Challenges
Solutions & Principles

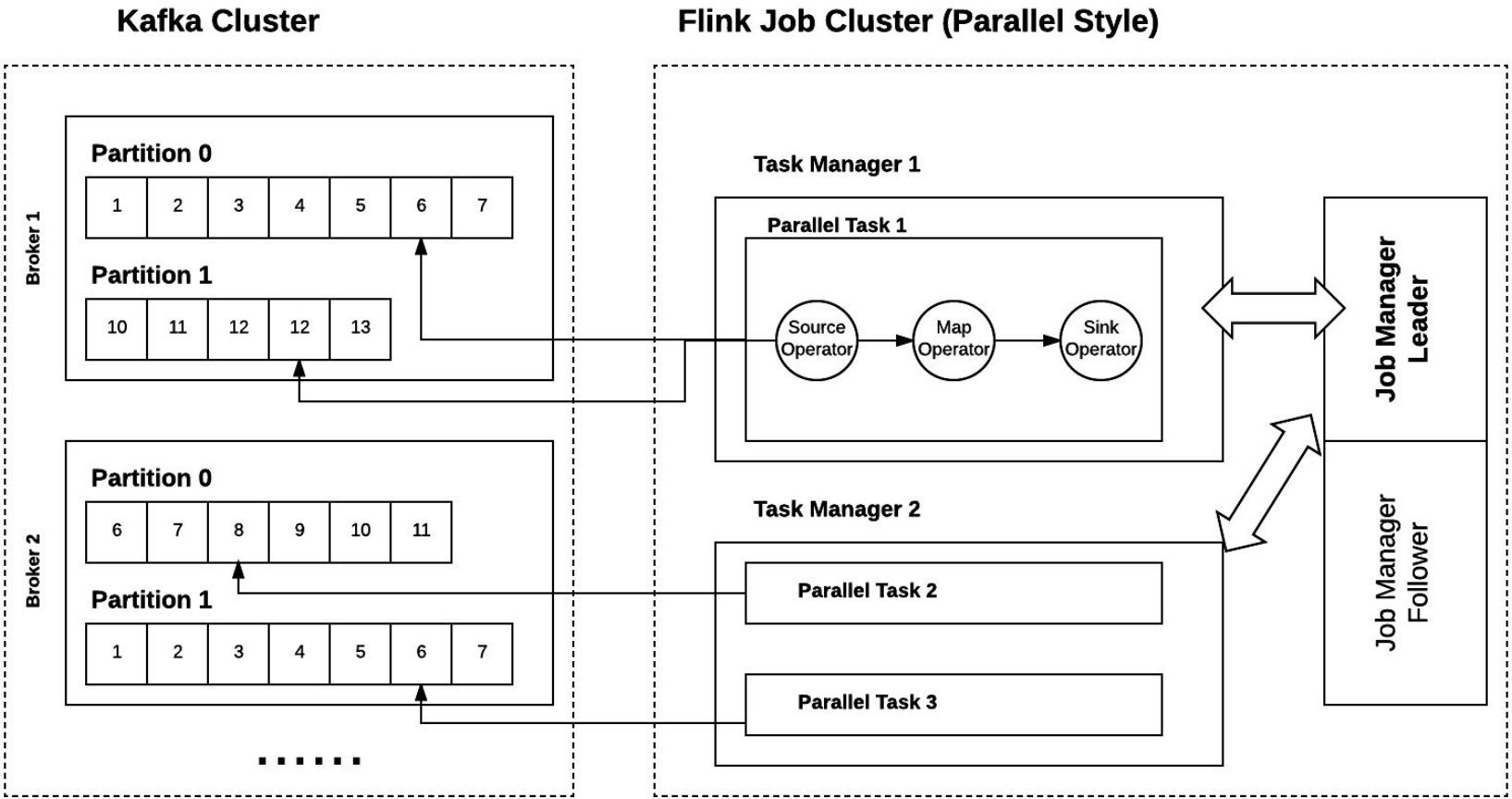
> ... the decisions we made to build scalable, reliable and maintainable systems.

Challenge 1:
Scale.

A Single Stream

Anatomy of a Single Stream



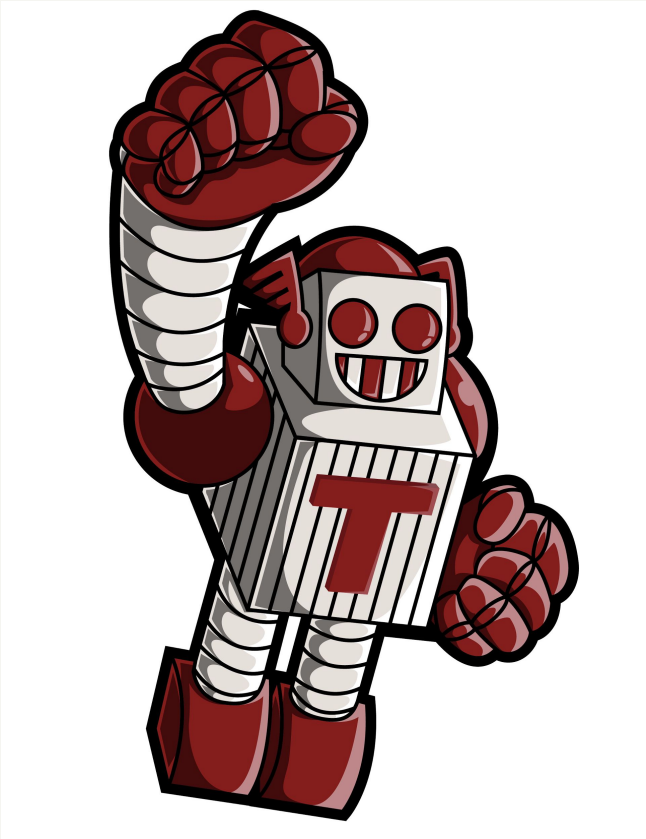

Kafka Cluster
Flink Job Cluster (Parallel Style)
Broker 1
Partition 0
1 2 3 4 5 6 7
Partition 1
10 11 12 12 13
Broker 2
Partition 0
6 7 8 9 10 11
Partition 1
1 2 3 4 5 6 7
Task Manager 1
Parallel Task 1
Source Operator
Map Operator
Sink Operator
Task Manager 2
Parallel Task 2
Parallel Task 3
Job Manager Leader
Job Manager Follower

Separation of Concerns

- Separation of Messaging and Stream Processing services.
- Each service scales individually.
- Each service manages its own states.
- Independently manage service dependencies.
    - Kafka brokers on EC2
    - Streaming Service job on Titus Container Runtime

Titus Container Runtime

- Resource Provisioning
- Scheduling and bin-packing
- Capacity Guarantees
- Resource isolation
- Per container IP address (underlay via VPN)

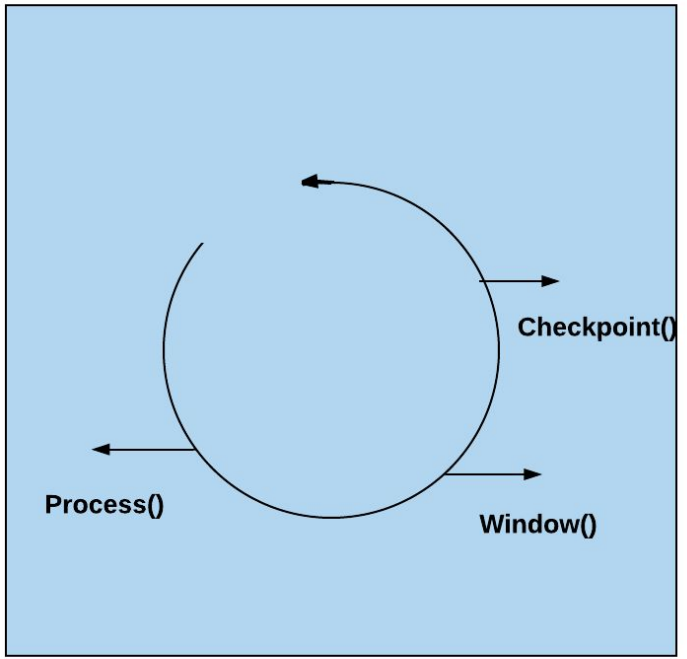


Delivery/Processing Semantics

- At-most once
- At-least once
- Exactly once

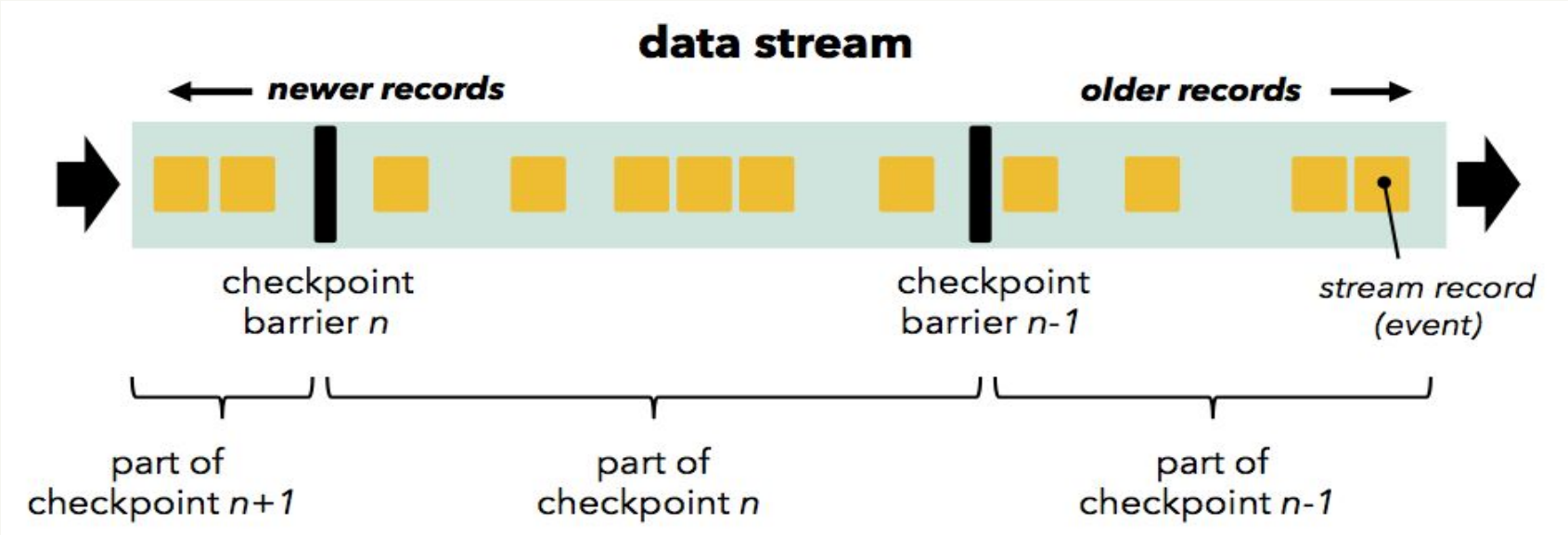
At-least Once Processing Checkpointing

- Synchronous checkpointing through event loop

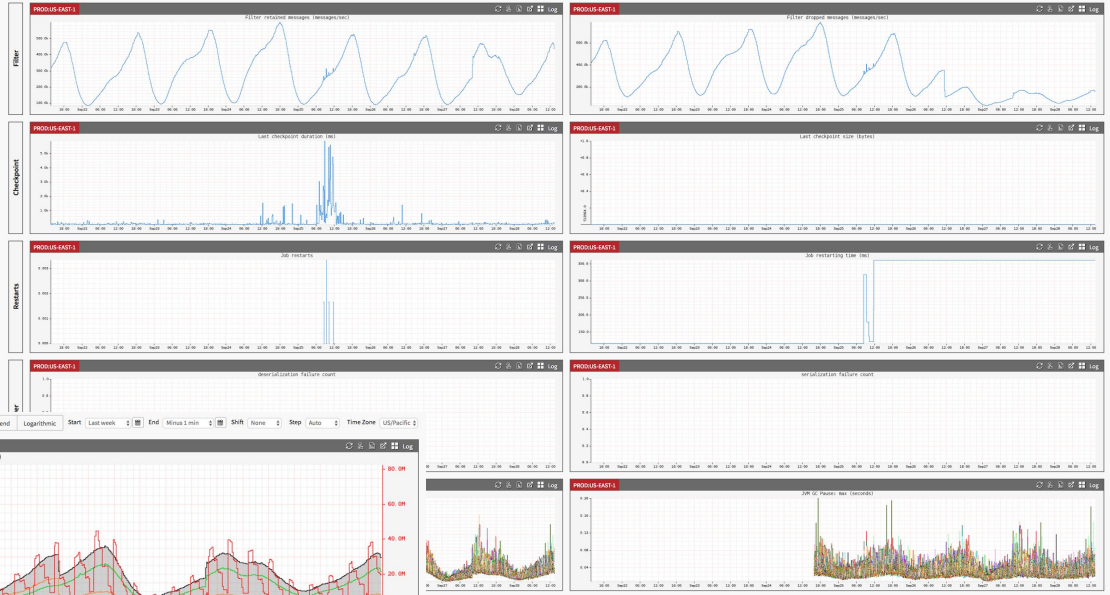


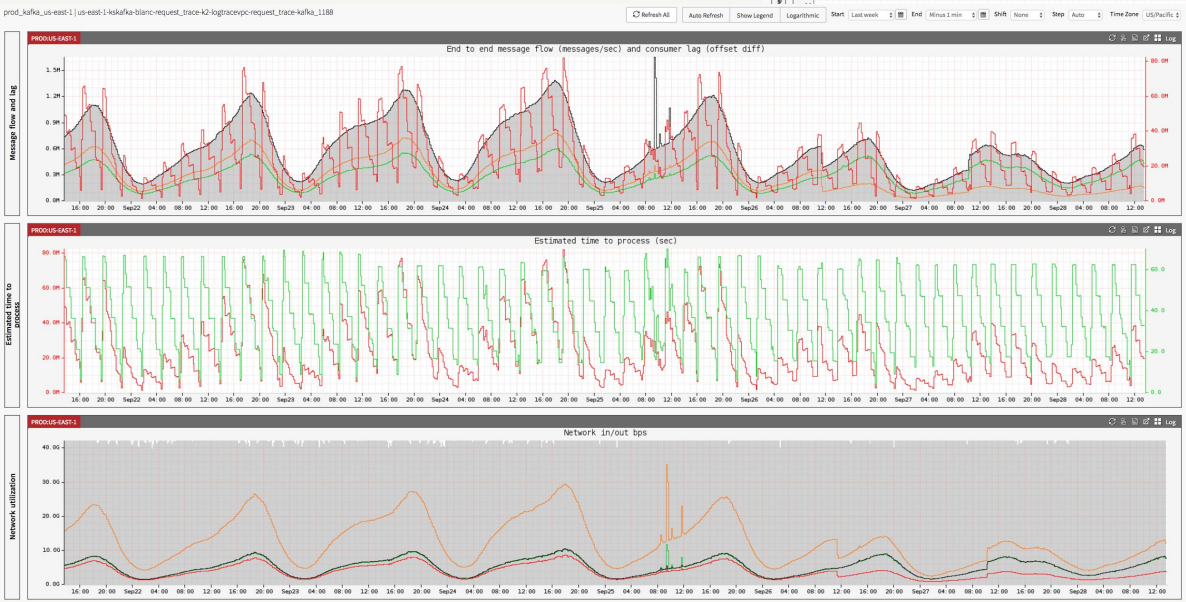
Exactly Once* Processing Semantics

- Lightweight Asynchronous Snapshot (Async Barrier Checkpointing)

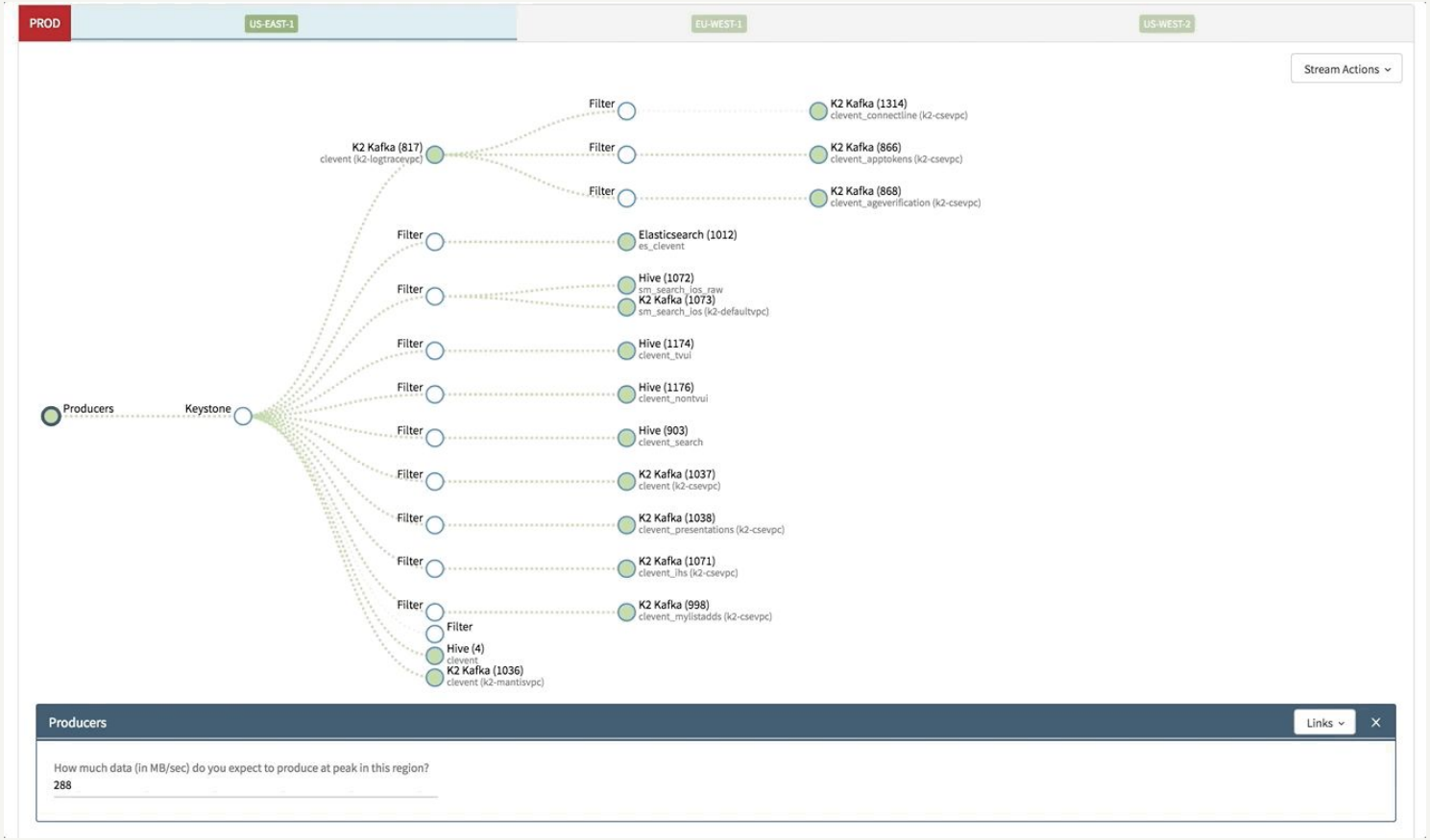


Per Stream Monitoring & Alerting

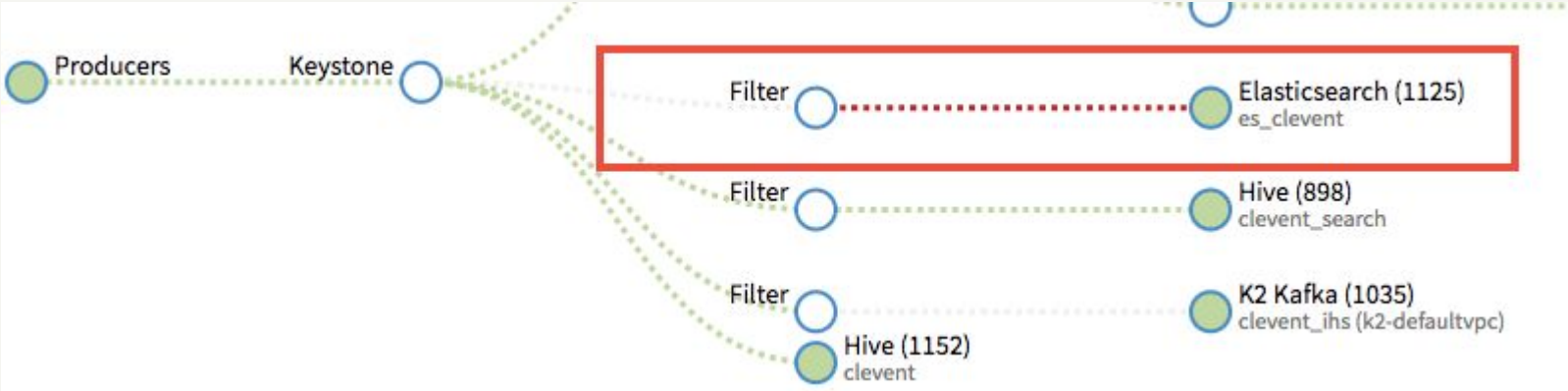




Streams with Fanout



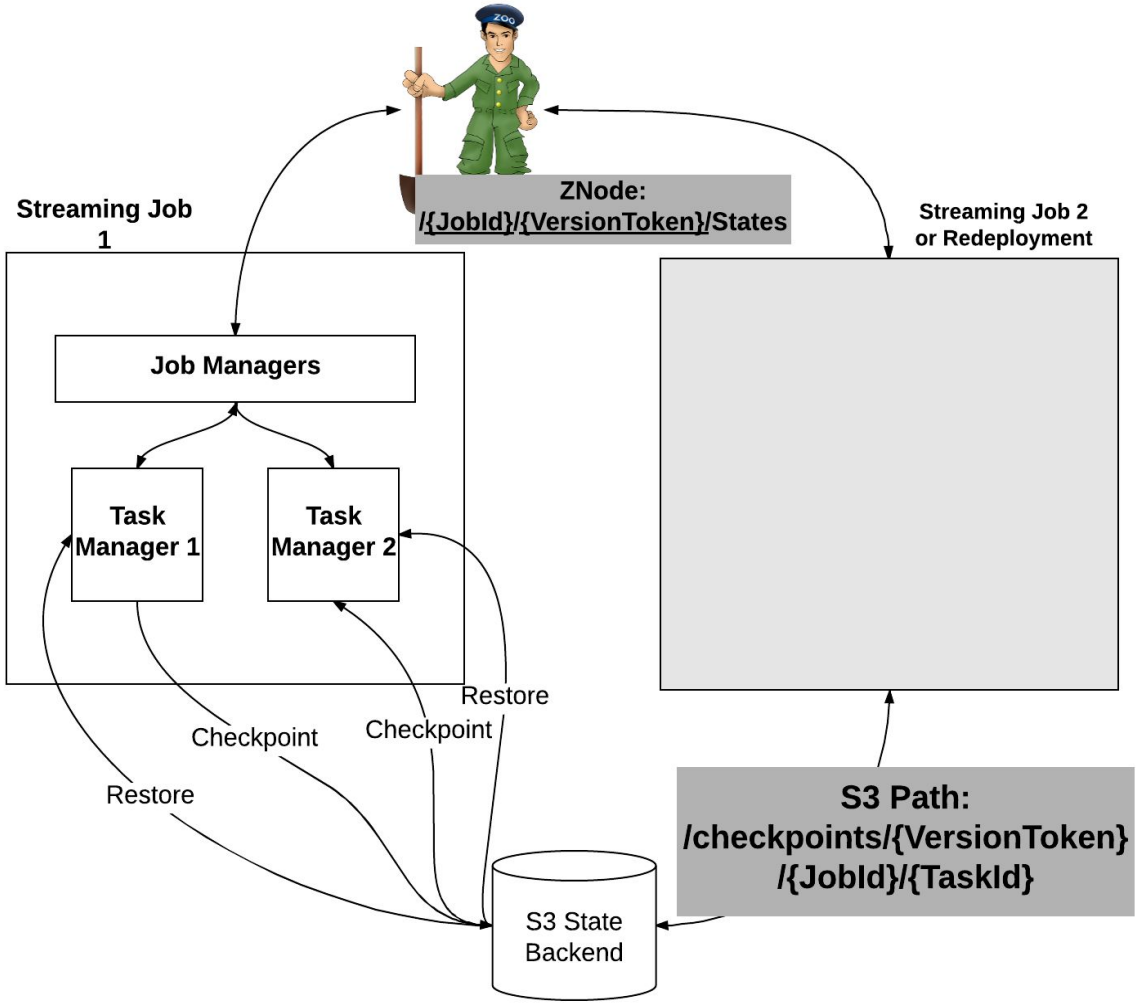
Logical Isolation



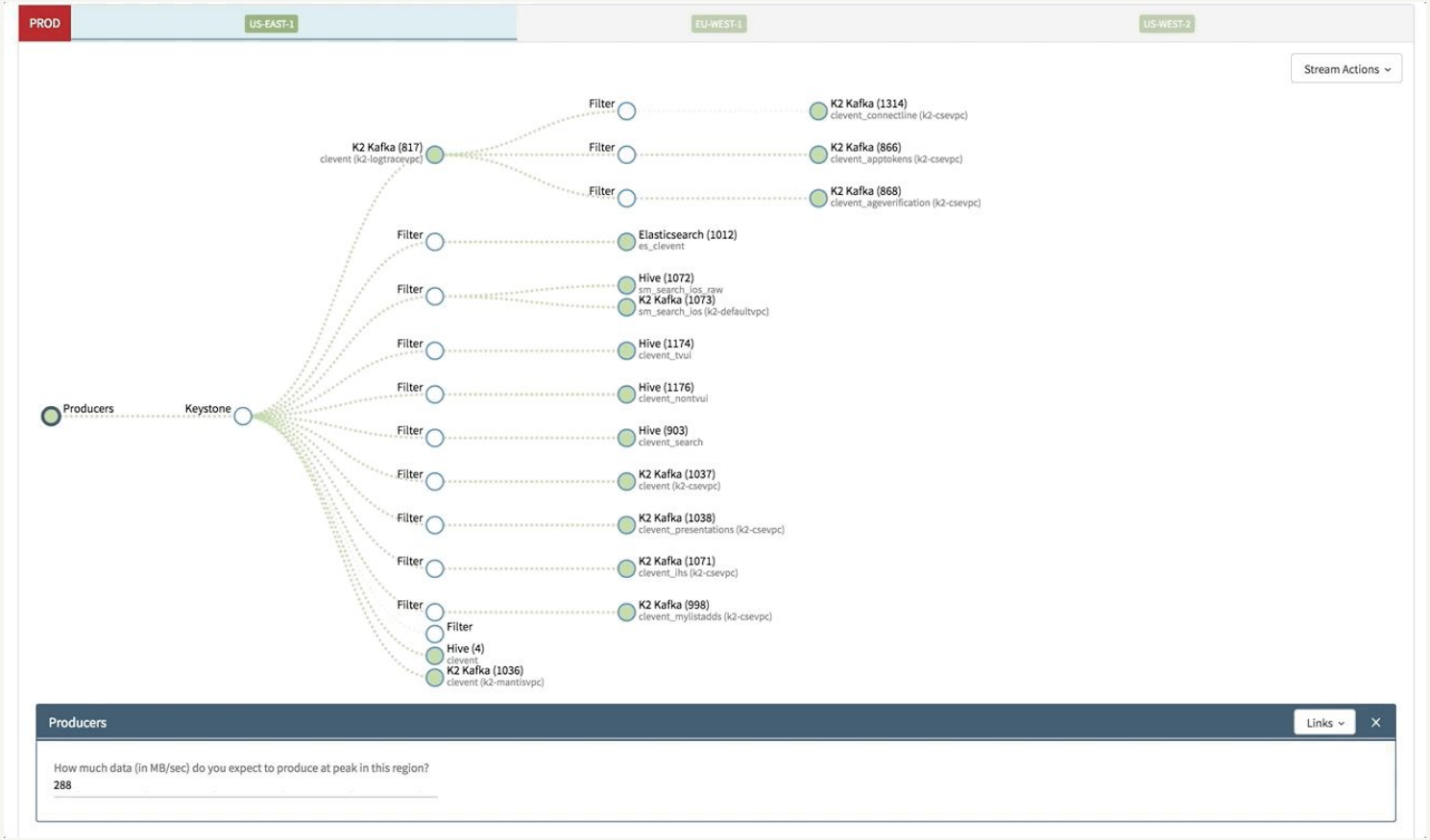
Logical Isolation

- Streams Level
- Deployments Level
- What about regional

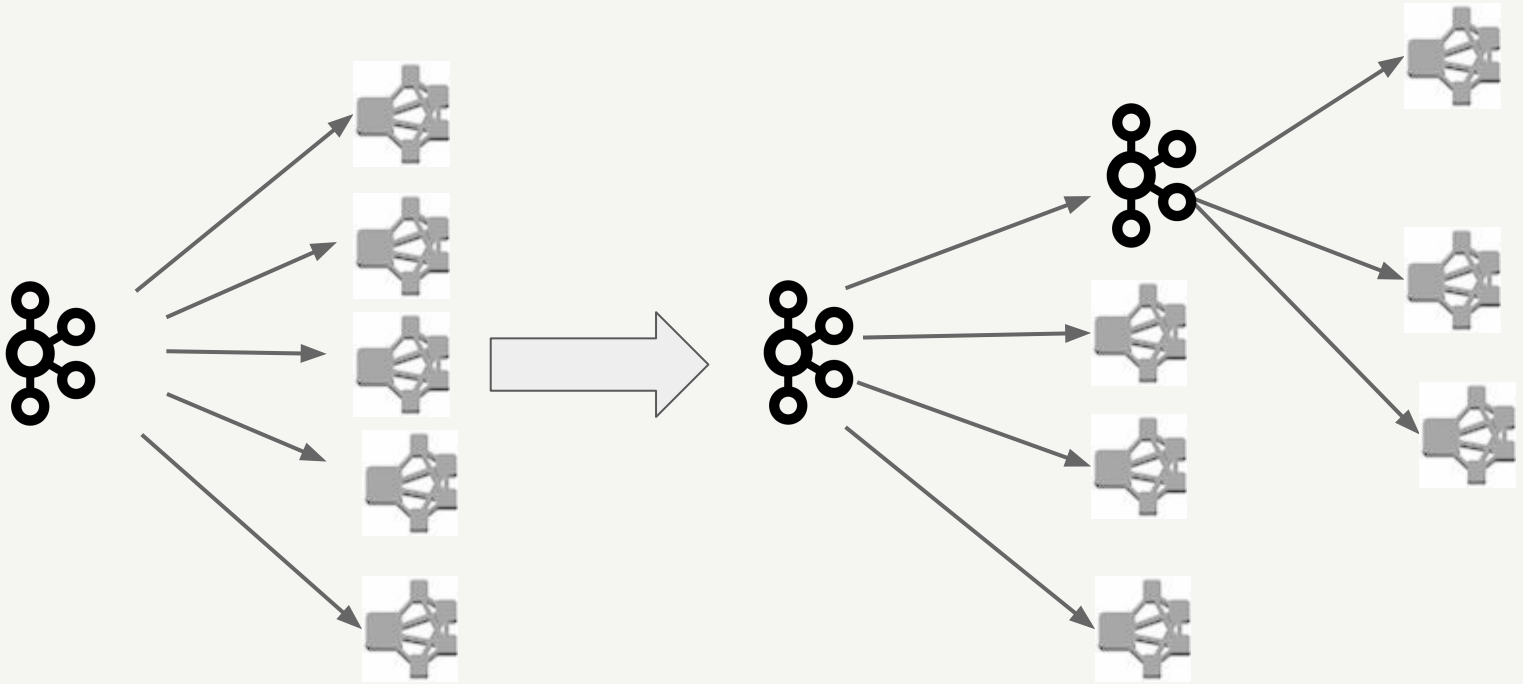
  Island Isolation?



Total Bytes Out = (num Of Consumers + replication factor - 1) * Bytes In



Solve Consumer Fanout with Hierarchies



Total Infrastructure Scale

- 500+ Billion events generated per day
- 1+ Trillian events processed per day
- ~800 Topics
- ~1,800 Streams
- 4000+ Kafka Instances
- ~9,000 Stream Processing Containers

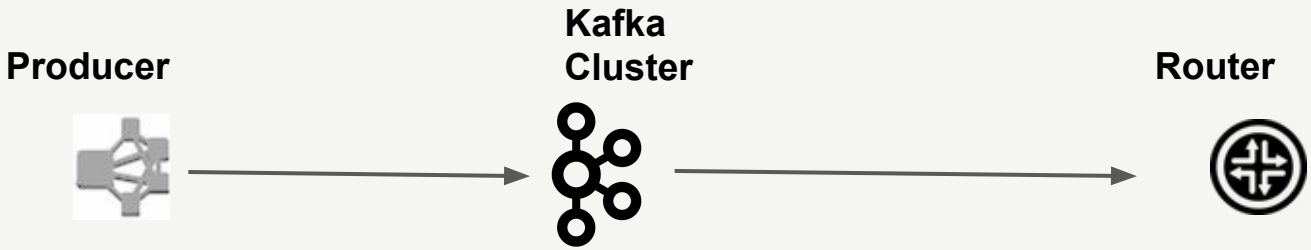
Kafka Clusters

Search for a Cluster...

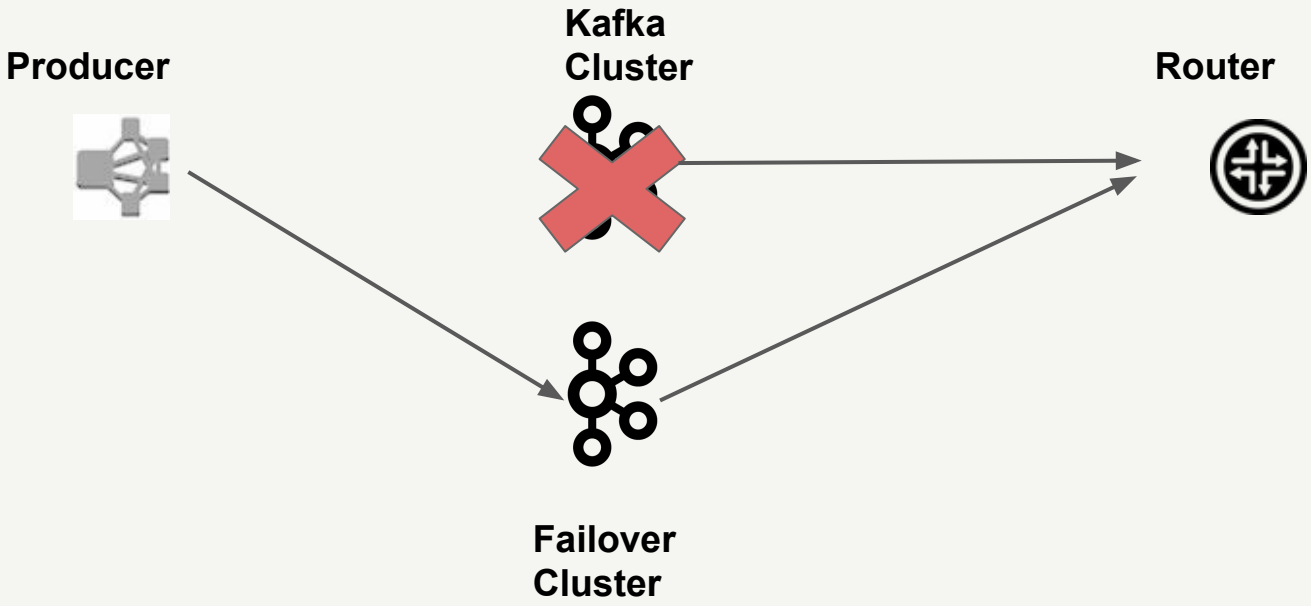
Filter: prod | test | us-east-1 | eu-west-1 | us-west-2

Cluster	Env	Region	State
k whitney	prod	us-east-1	NORMAL
k ocky	prod	us-east-1	NORMAL
k obson	prod	us-east-1	NORMAL
k imalayas	prod	us-east-1	NORMAL
k everest	prod	us-east-1	NORMAL
k lbert	prod	us-east-1	NORMAL
k denali	prod	us-east-1	NORMAL
k blanc	prod	us-east-1	NORMAL

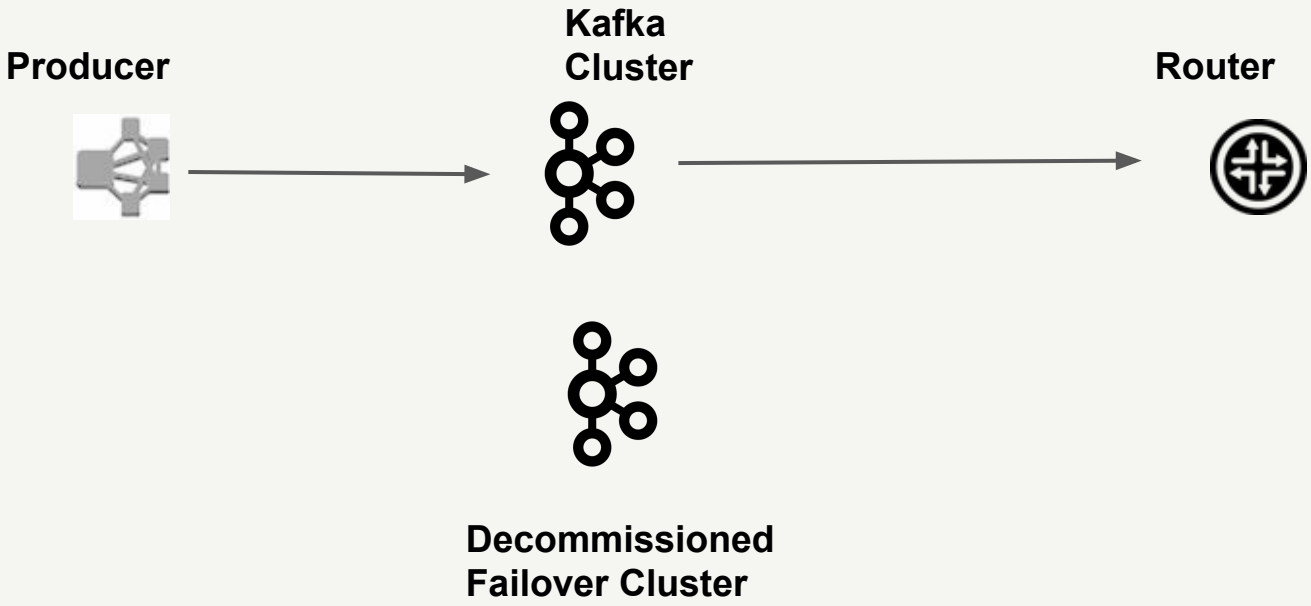
Kafka Cluster Failover



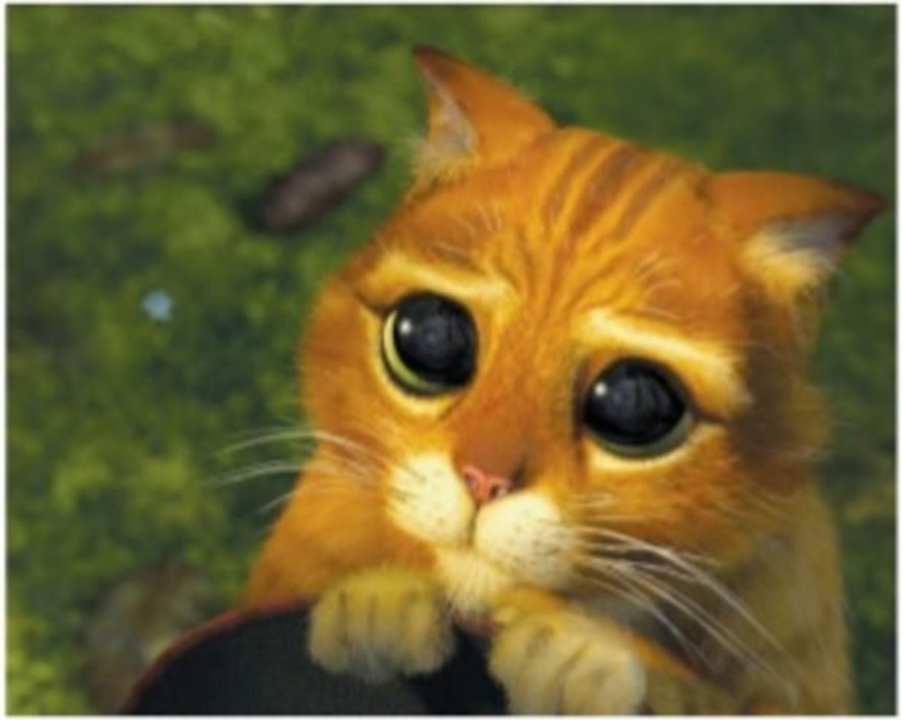
Failover



Failback


Producer
Kafka
Cluster
Router
Decommissioned
Failover Cluster

Pet vs Cattle



Immutable Kafka Clusters ?

Principles:

Failure as a First Class Citizen

Separation of Concerns

Embrace Immutability

Challenge 2:
Self-serv & Multi-tenants

Diverse Customer Requirements

- Diverse combination of features
- Diverse platform tradeoffs


“Change is the Only Constant”

Change Is the Only Constant

- New streams deployed in a few mins
- Customer changing needs
- Scaling activity
- Infrastructure Upgrades

Failure Modes

- Infrastructure Disaster
- Any component can become temporarily unavailable

Provide Building Blocks

Declarative Reconciliation

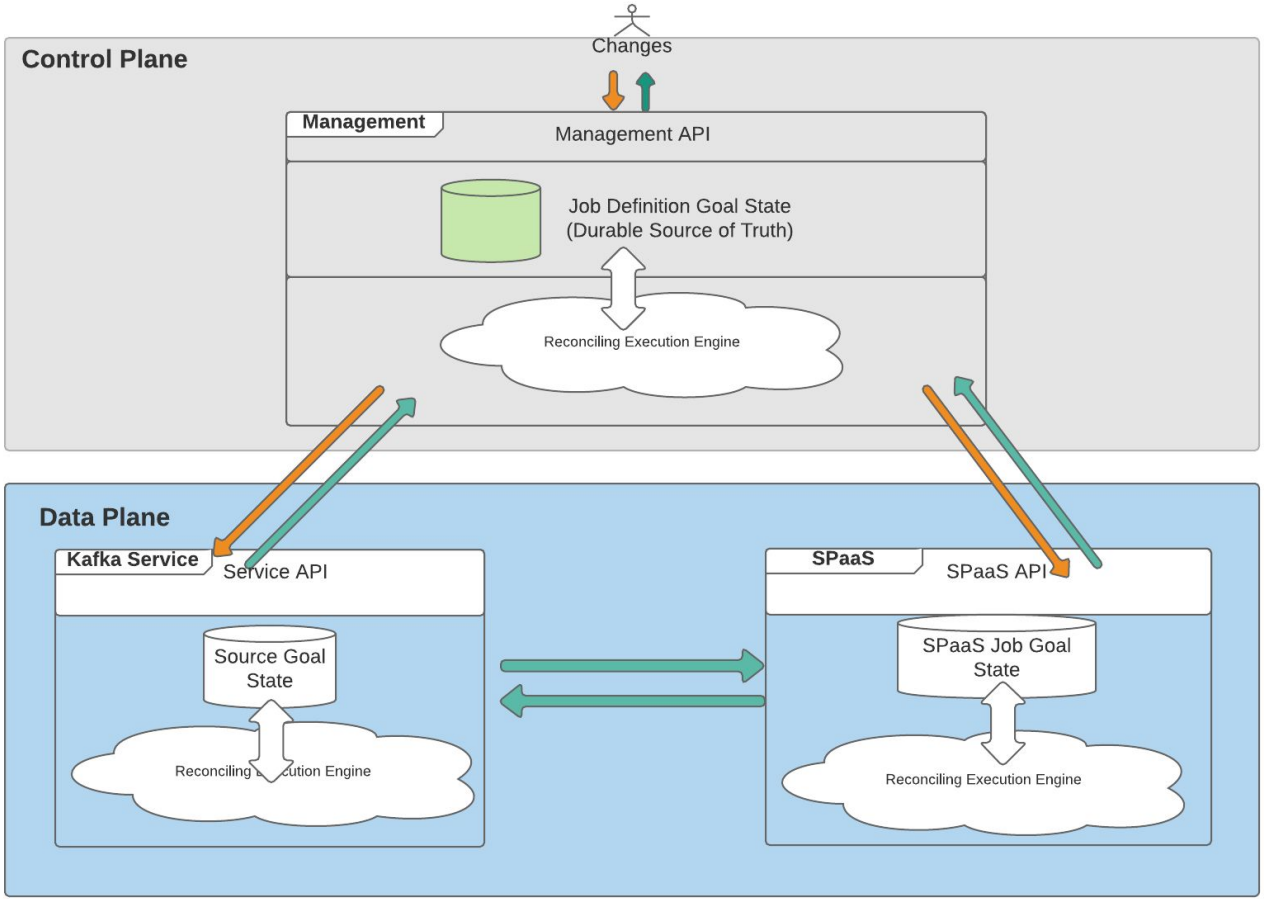
Declarative Reconciliation

- “Declarative” is a communication pattern
- “Reconciliation” to drive the entire system towards goal

Declarative Reconciliation

- Goal States
- Current States

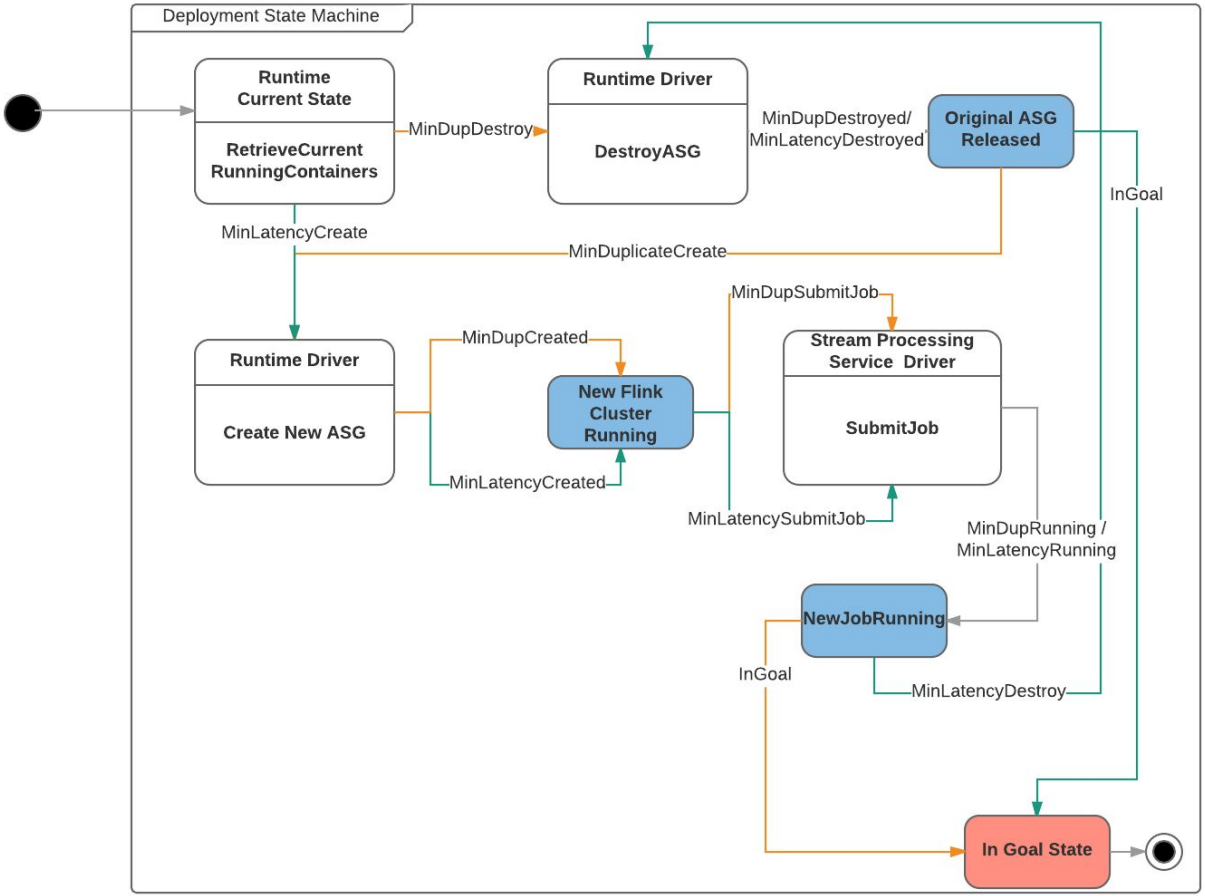
Layered Reconciliation

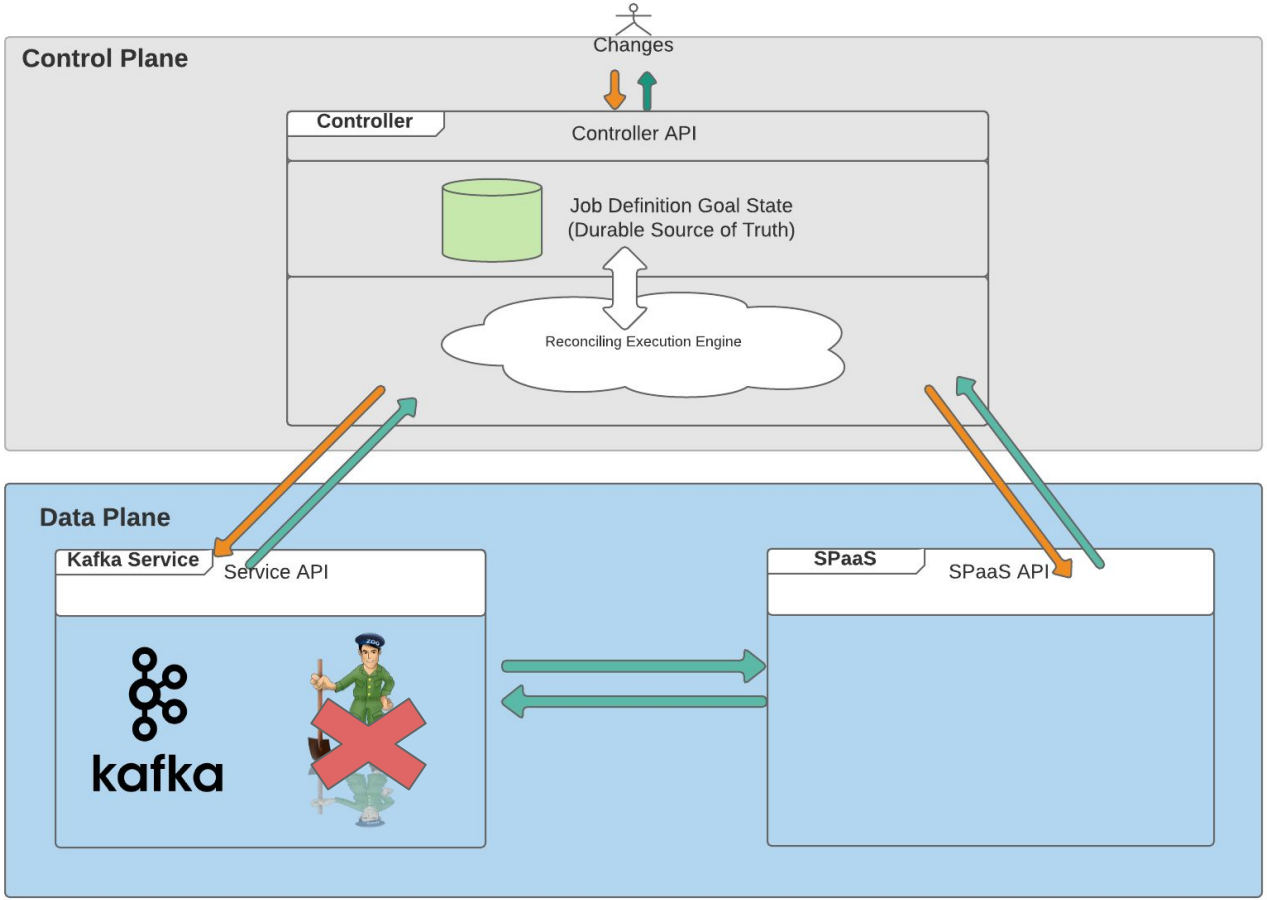


Declarative Reconciliation

- Goal States
- Current States
- State Machine Driven Reconciliation

State Machine
Goal State Driver

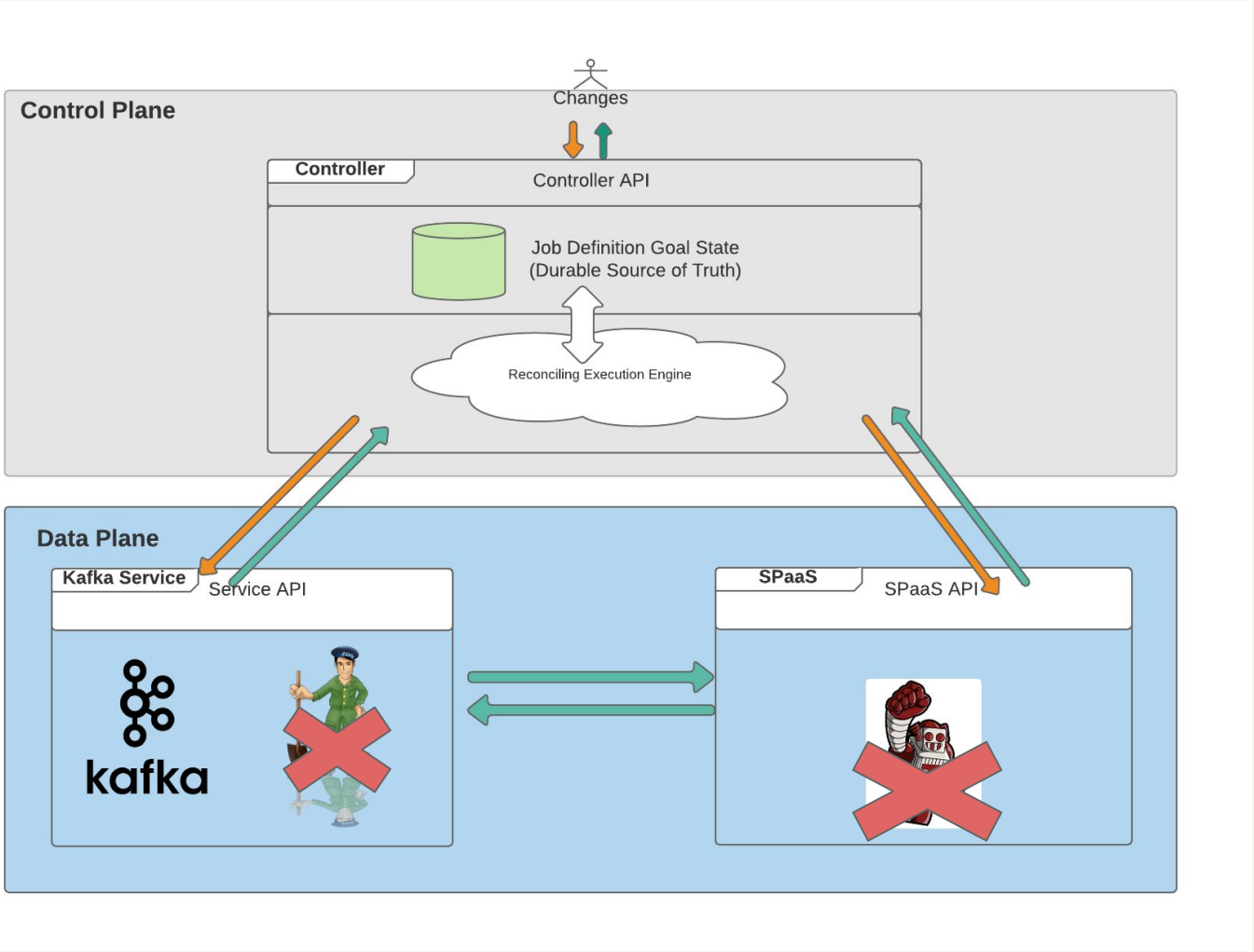



Changes
Control Plane
Controller
Controller API
Job Definition Goal State
(Durable Source of Truth)
Reconciling Execution Engine
Data Plane
Kafka Service
Service API
kafka
SPaaS
SPaaS API

Single
Source of Truth

Allows Eventual Consistency

Convergence on Goal State



Single
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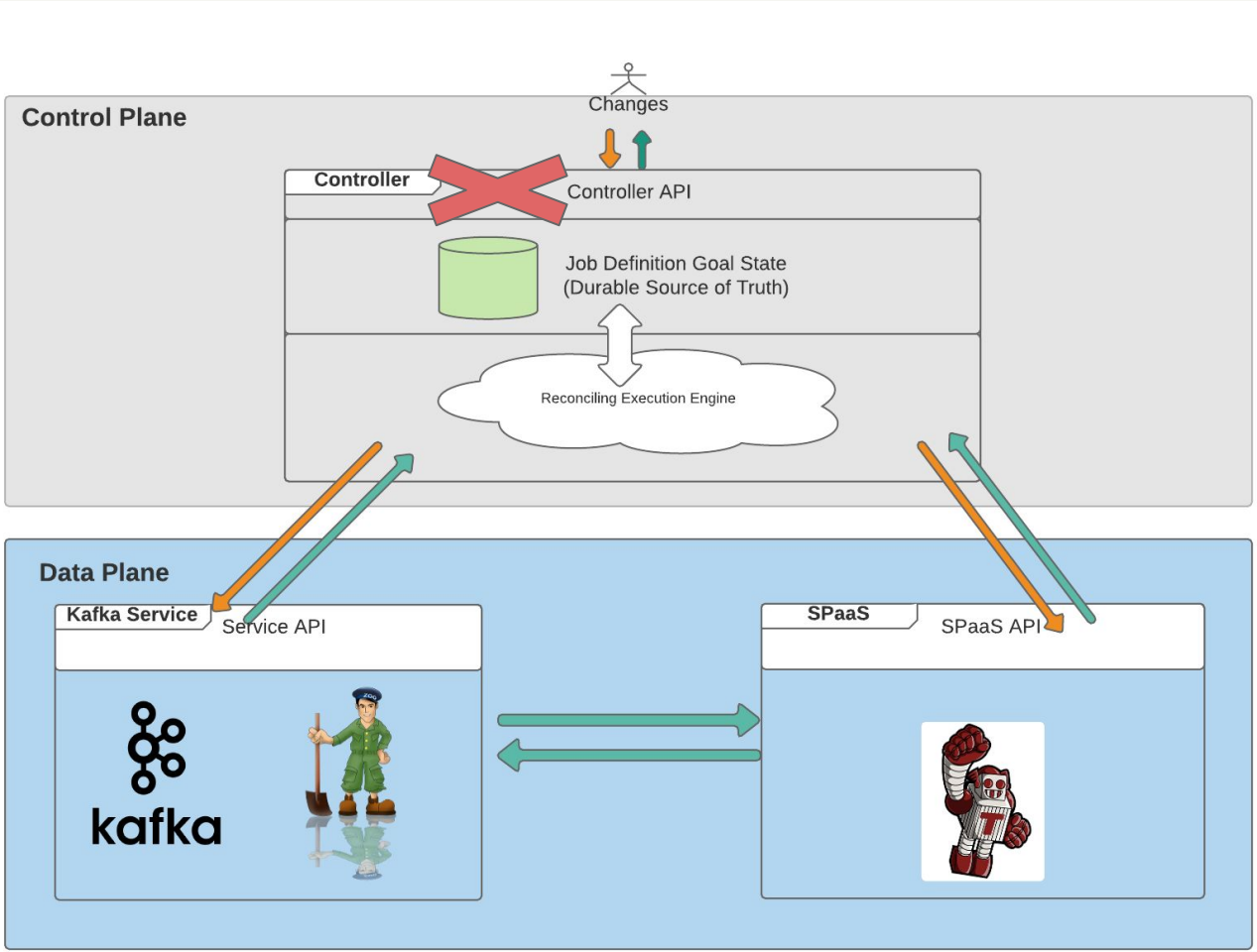


Principle:

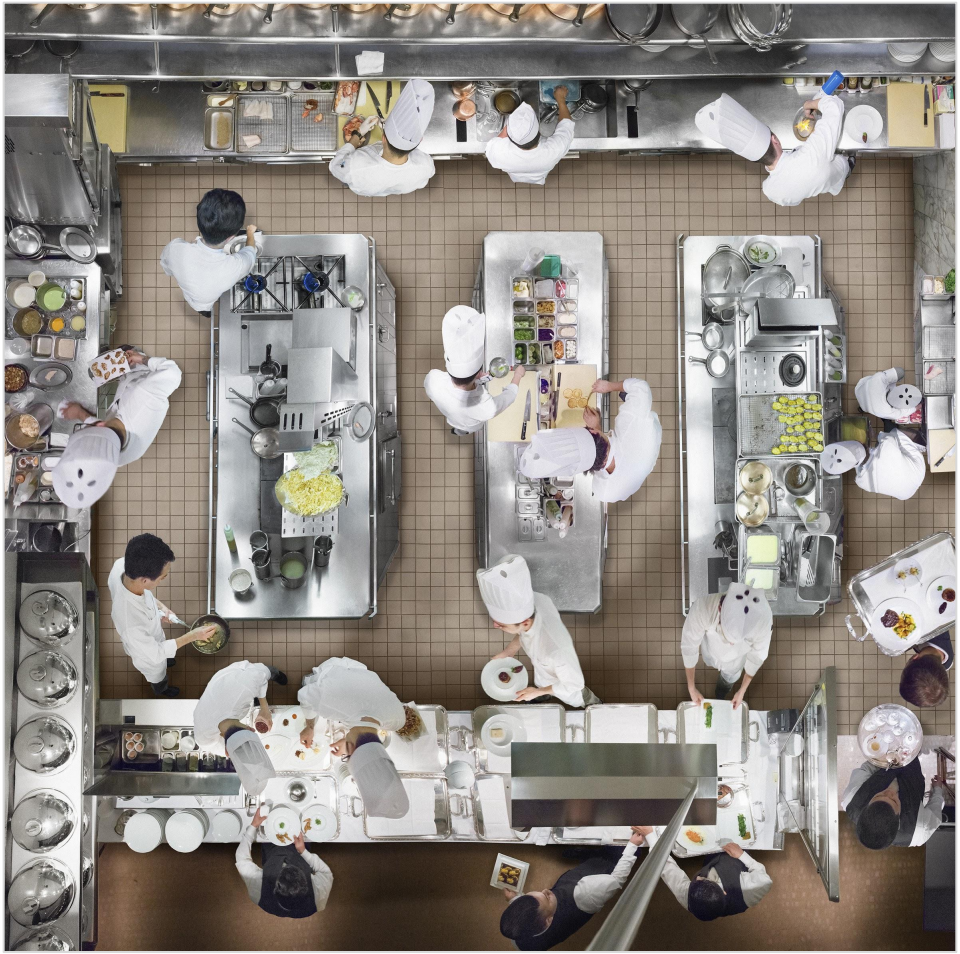
Leverage Reusable Building Blocks

Declarative Reconciliation

Single Source of Truth

Thought Experiment:

Kitchen Management vs Distributed Architecture?



Thank you.

References:
https://medium.com/netflix-techblog

https://www.confluent.io/kafka-summit-sf17/multitenant-multicluster-and-hieracrchical-kafka-messaging-service

We're hiring - http://bit.ly/NetflixSPaaS

@ZhenzhongXu (tweet me questions!)

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