

# StateFul ServerLess – And the Elephant in the Room

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CTO @ Ververica, Apache Flink PMC

# The Motivation



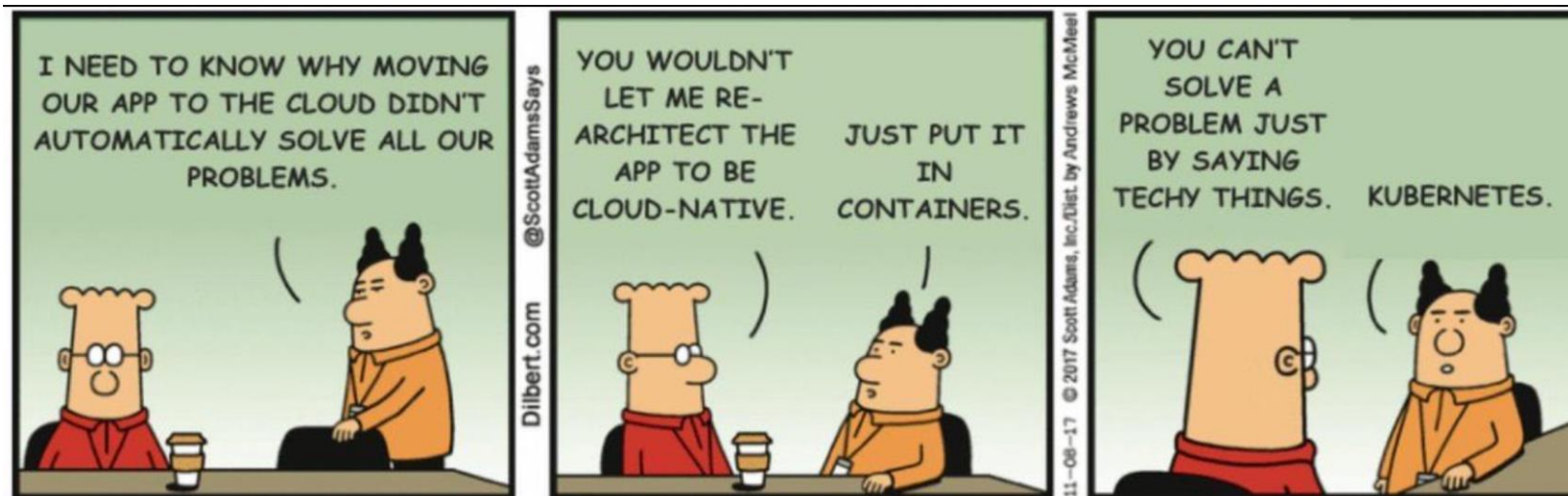
**Kelsey Hightower** ✓  
@kelseyhightower

There's a ton of effort attempting to "modernize" applications at the infrastructure layer, but without equal investment at the application layer, think frameworks and application servers, we're only solving half the problem.

- ✓ We are asking developers to implement all the best practices around security, performance, load shedding, and authorization, for every programming language.

Ideally we encapsulate it all and enable developers to do this:

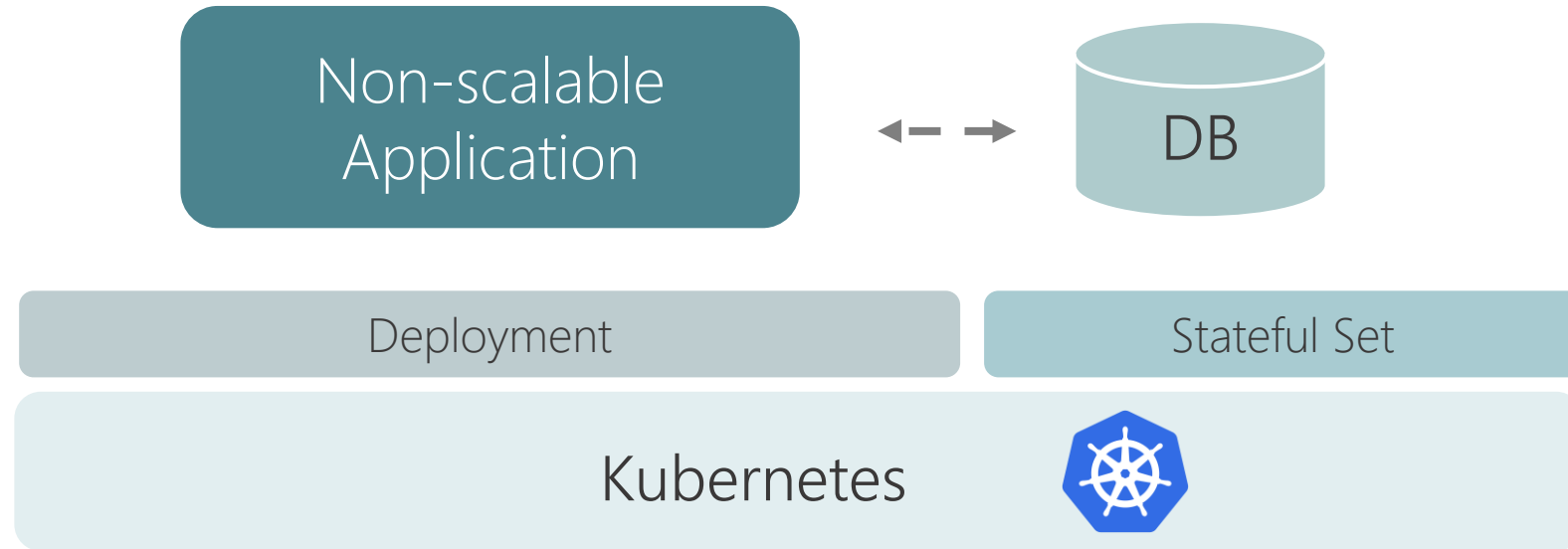
```
import "do/the/right/thing"
```



# A non-scalable application...



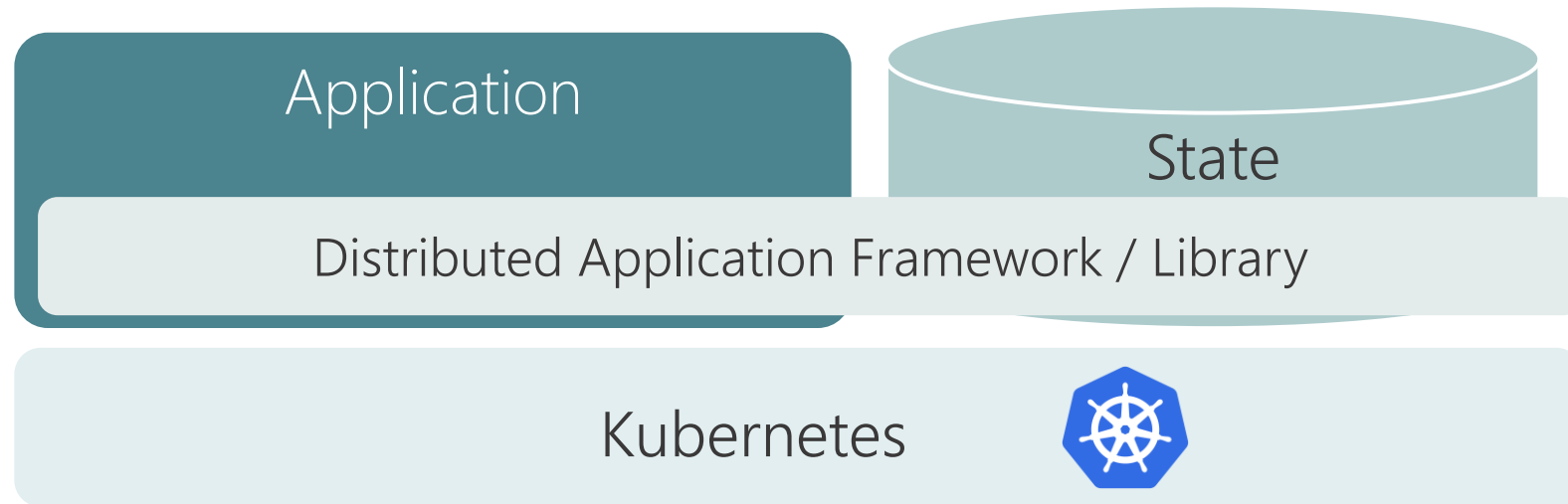
# A non-scalable application on scalable infrastructure



→ *Still not scalable*



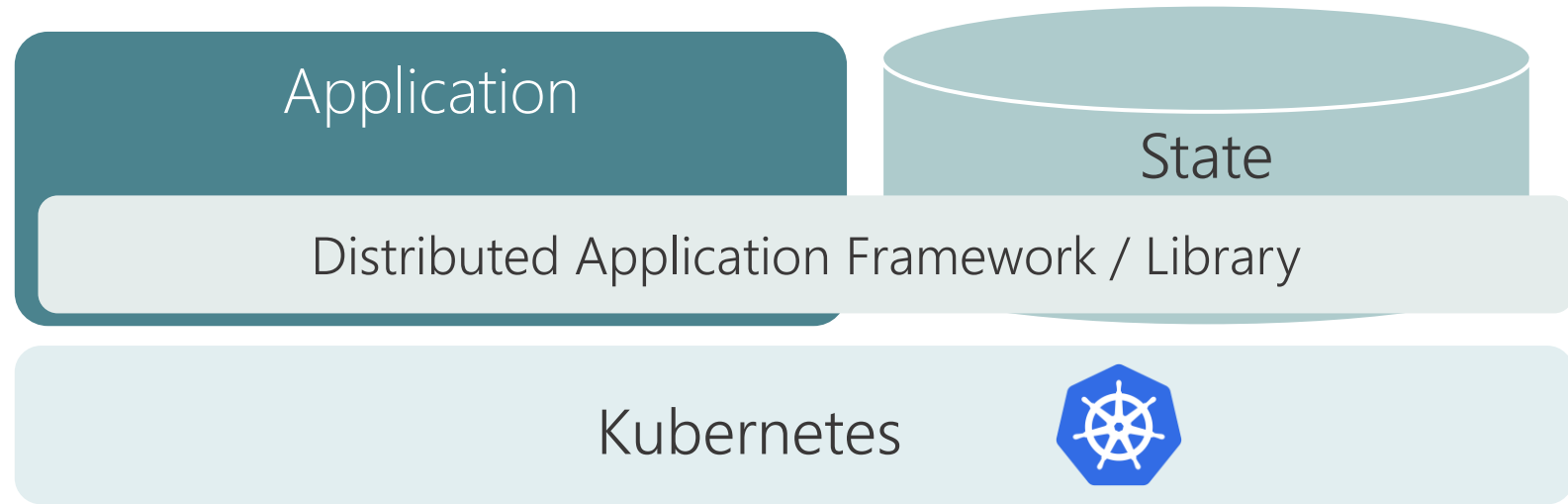
# Scalable Applications need Scalable Building Blocks



→ *Magically scalable* 



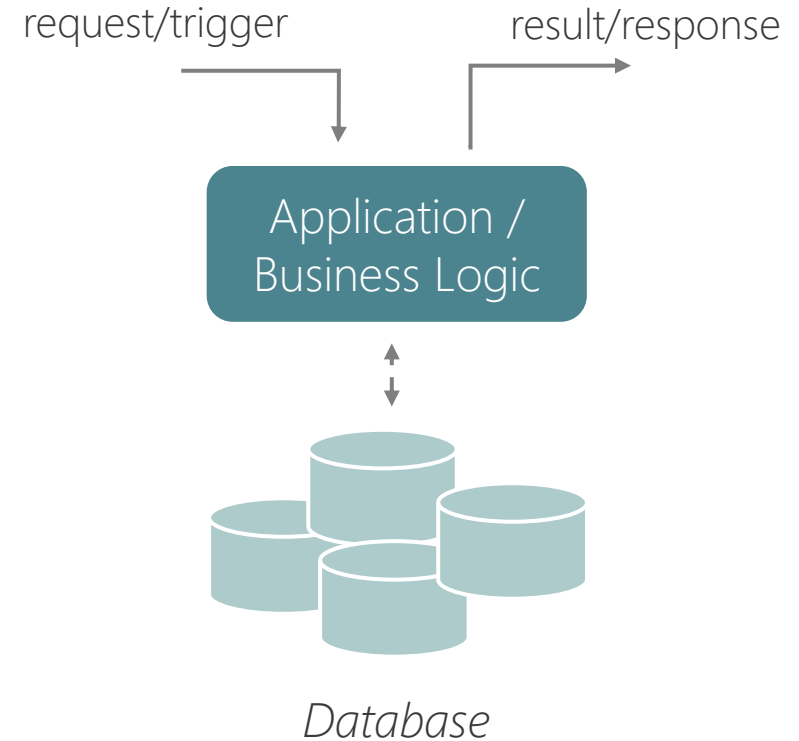
# Scalable Applications need Scalable Building Blocks



- *Inherently Scalable Computation*
- *Scalable State*
  - *Consistent State*
  - *Secure*
  - *Observable*



**Hypothesis:** The Request/Response model from traditional databases is not a great match for that



# **Life beyond Distributed Transactions: an Apostate's Opinion**

Position Paper

Pat Helland

→ Stateful Event-driven Entities / Actors







# Enter Stateful Functions

*Polyglot Event-Driven Functions for  
Distributed Stateful Applications*



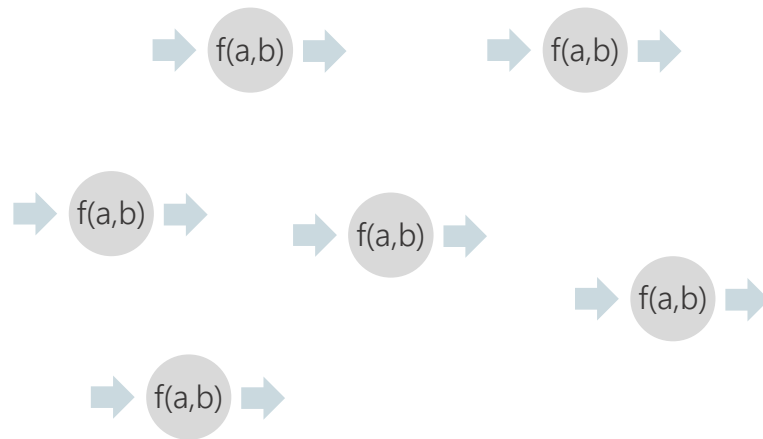
# What is Stateful Functions?

An API that simplifies building **distributed stateful applications** ...



# What is Stateful Functions?

An API that simplifies building **distributed stateful applications** ...



## Building block: Functions

- Small piece of logic that represents entities
- Invokable through messages
- Inactive functions don't consume resources



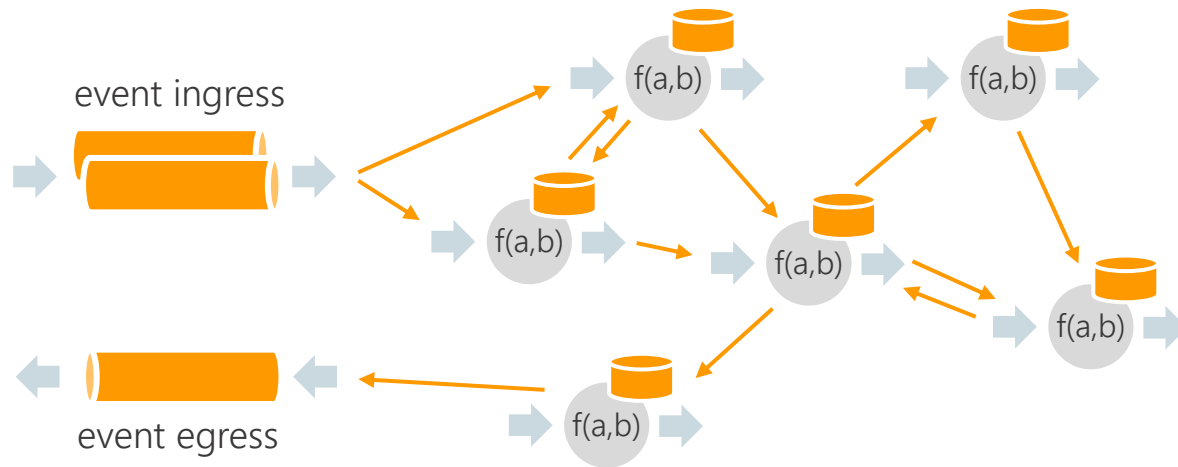
## Multi-language Support

- Can be implemented in any programming language



# What is Stateful Functions?

An API that simplifies building **distributed stateful applications** ...



## Dynamic messaging

- Arbitrary communication between functions
- Functions message each other by logical addresses - no service discovery needed



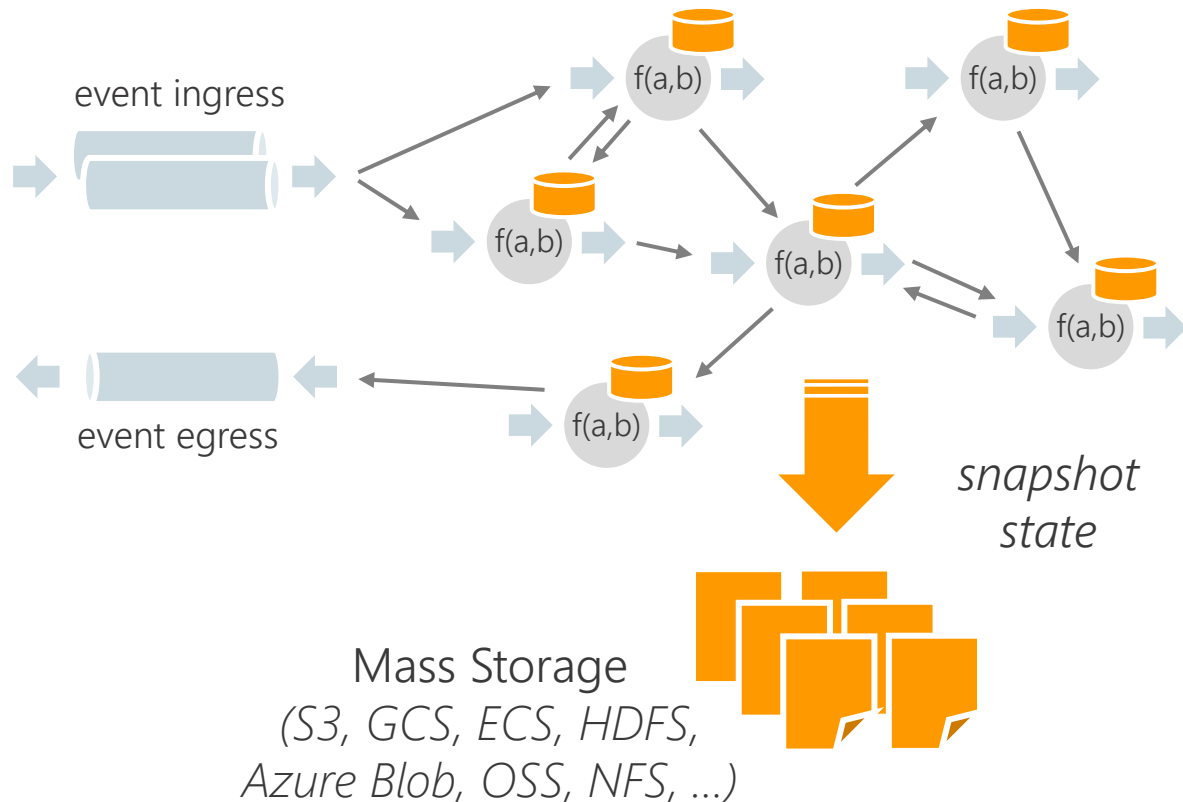
## Consistent state

- Functions keep local state that is persistent and integrated with messaging
- Out-of-box exactly-once state access / updates & messaging



# What is Stateful Functions?

... with a runtime build for **serverless architectures**.



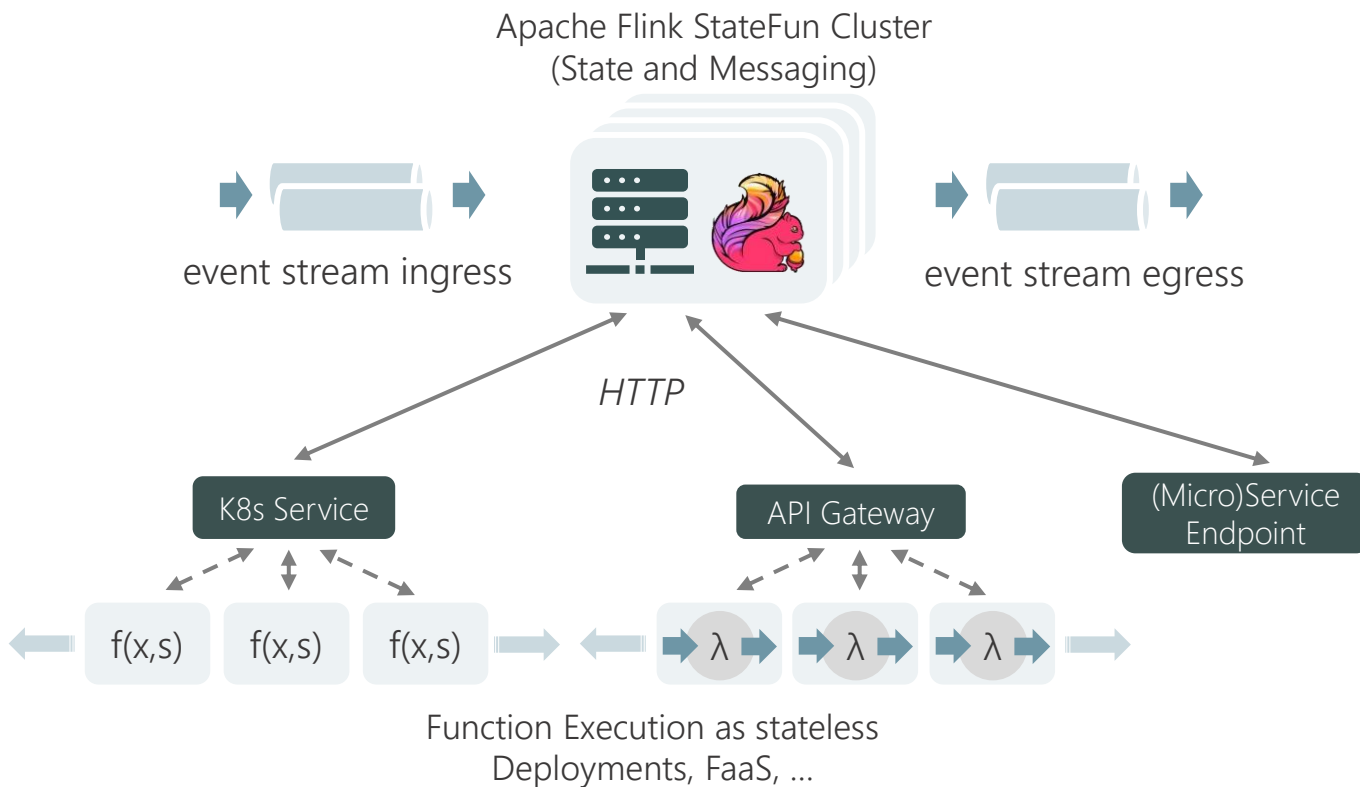
## Snapshots, no Database

- Uses Flink's distributed snapshots model for state durability and fault tolerance
- Requires only a simple blob storage tier to store state snapshots



# What is Stateful Functions?

... with a runtime build for **serverless architectures**.



## Cloud Native

- Can be combined with capabilities of modern orchestration platforms (Kubernetes, FaaS platforms, ...)

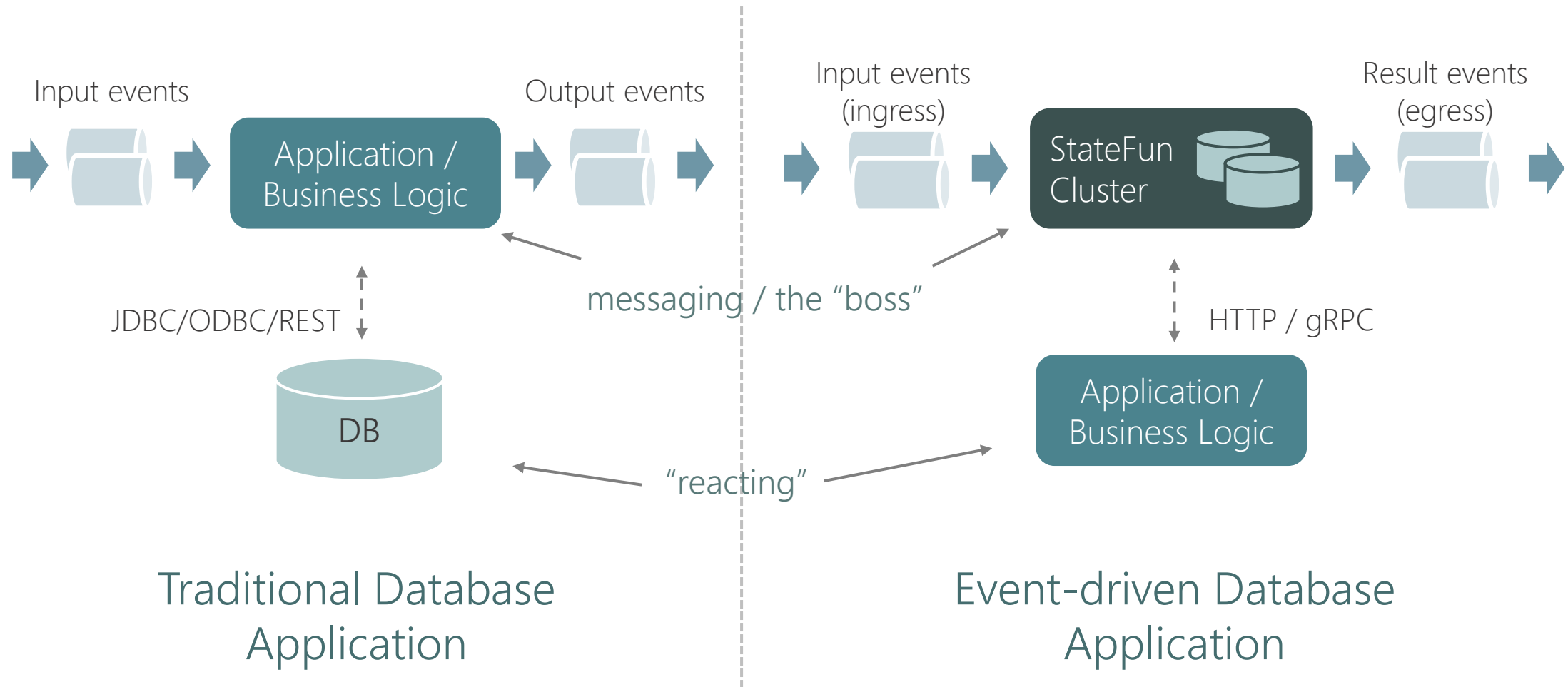


## "Stateless" Operation

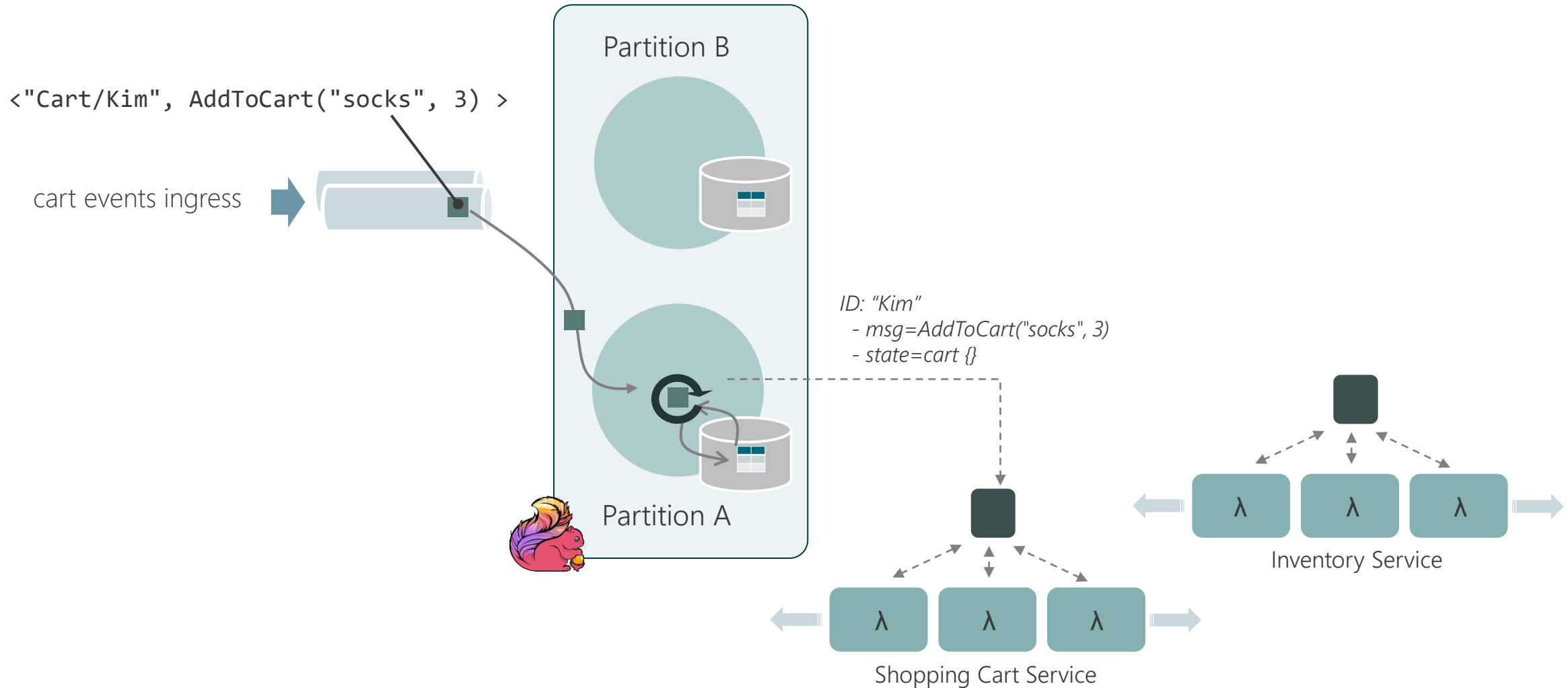
- State access / updates is part of the invocations / responses
- Function deployments have benefits of stateless processes - rapid scalability, scale-to-zero, zero-downtime upgrades



# Inverting the Roles of Application and Database

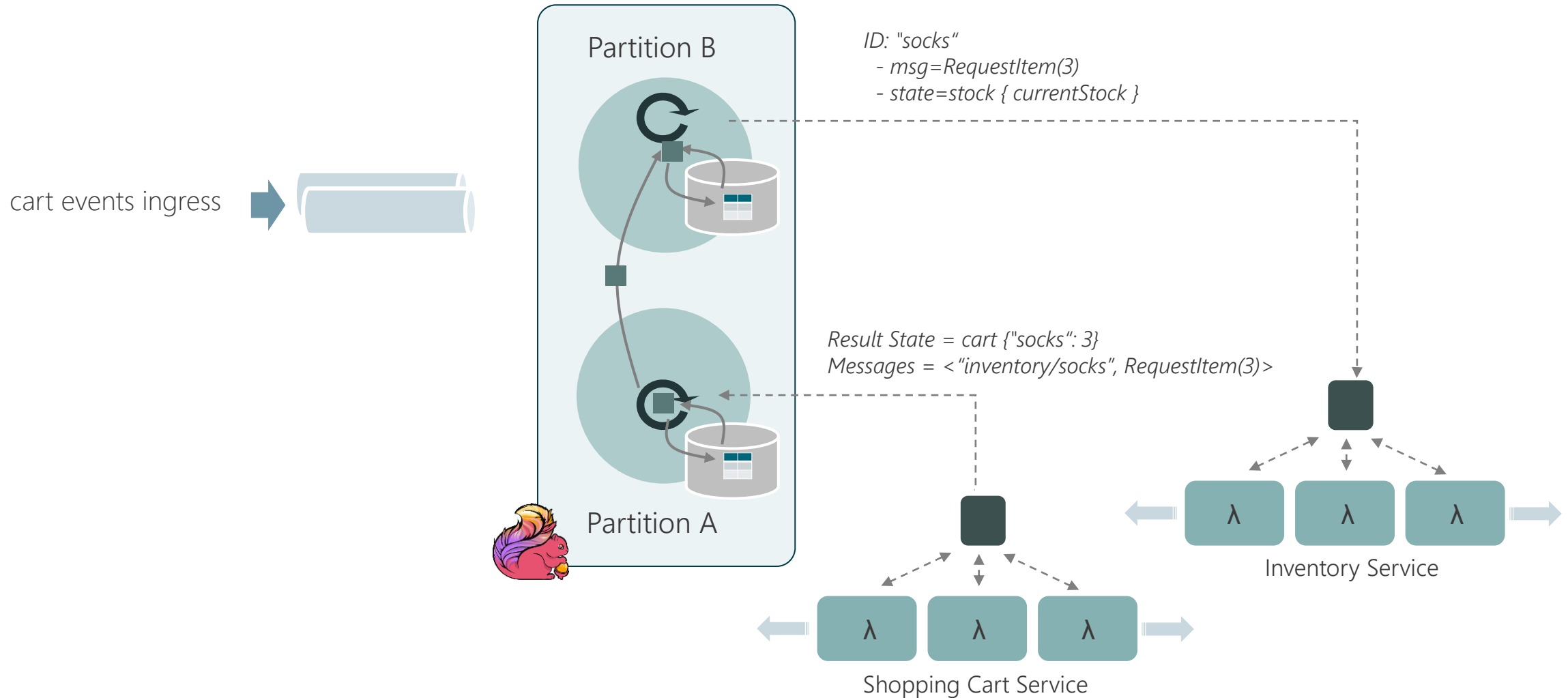


# State and Messages

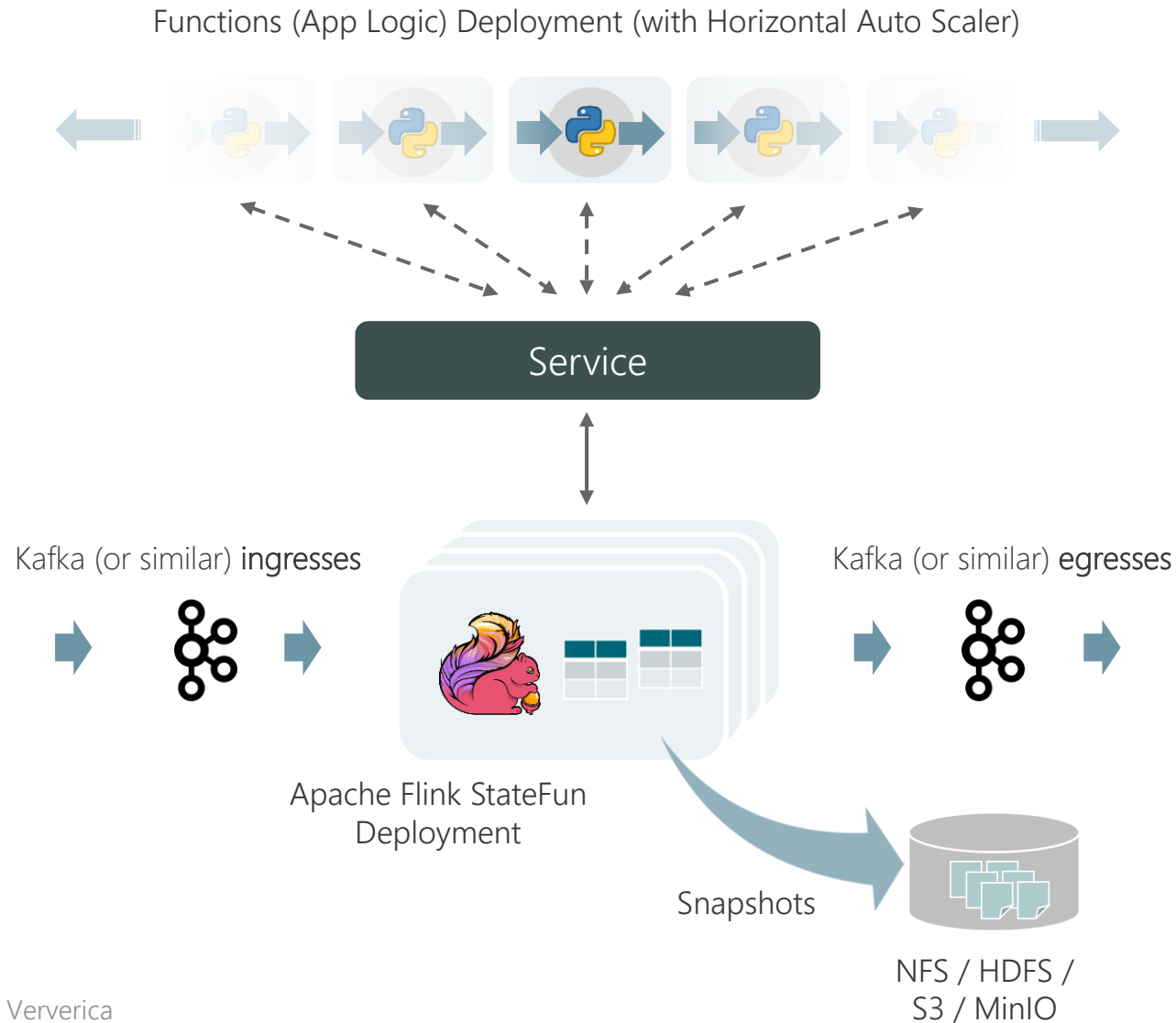




# State and Messages



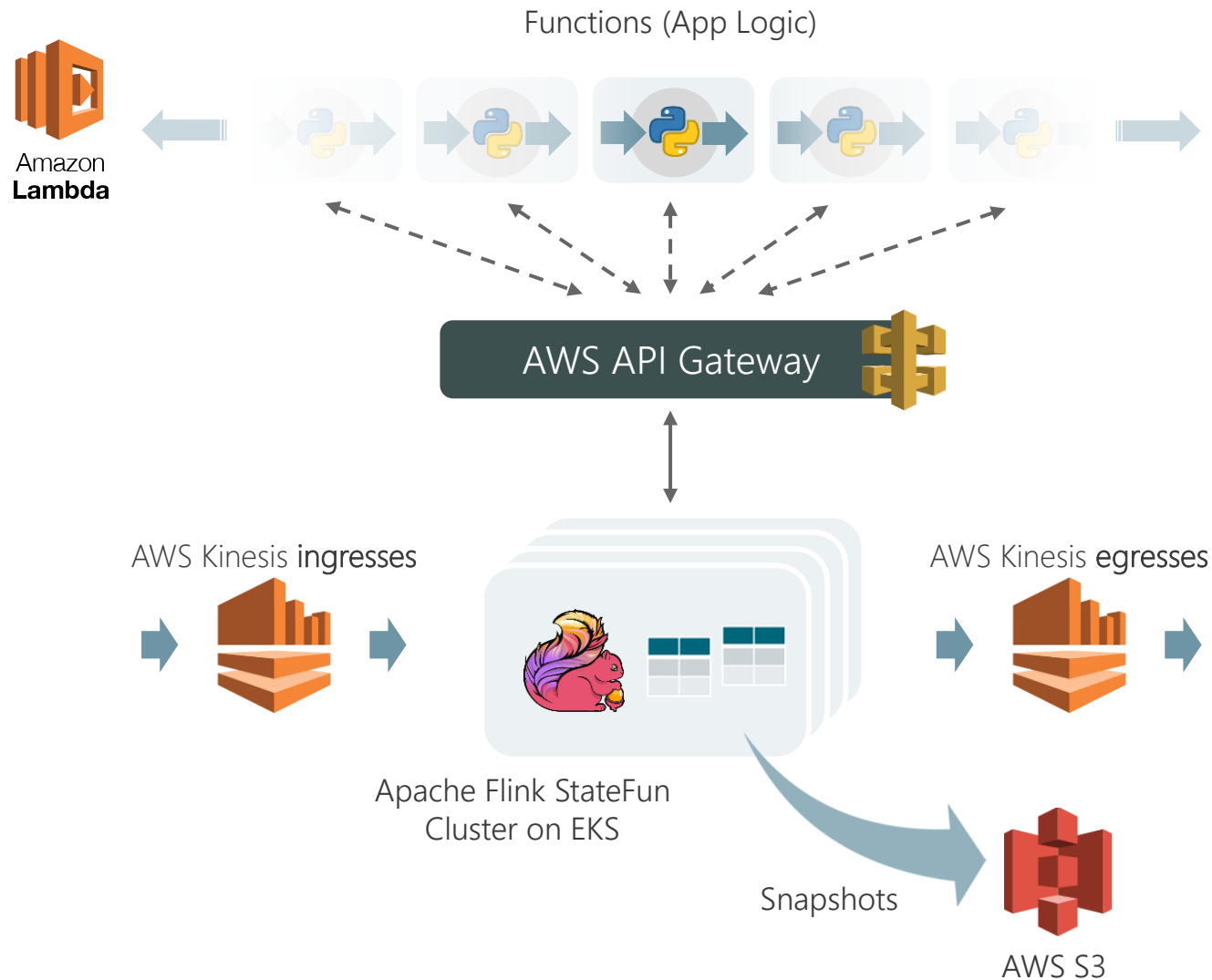
# Putting it all together: A Deployment on Kubernetes



- Deployment for Flink StateFun Cluster (stateful part)
- One or more deployments for the actual functions.
- Some Log or MQ for event ingress and egress.
- Some file system (or object store) for durability



# Putting it all together: A Deployment on AWS Serverless Stack



- Deployment on managed Kubernetes for Flink StateFun Cluster (stateful part)
- Functions run on Lambda
- Kinesis event ingress and egress.
- S3 for durability

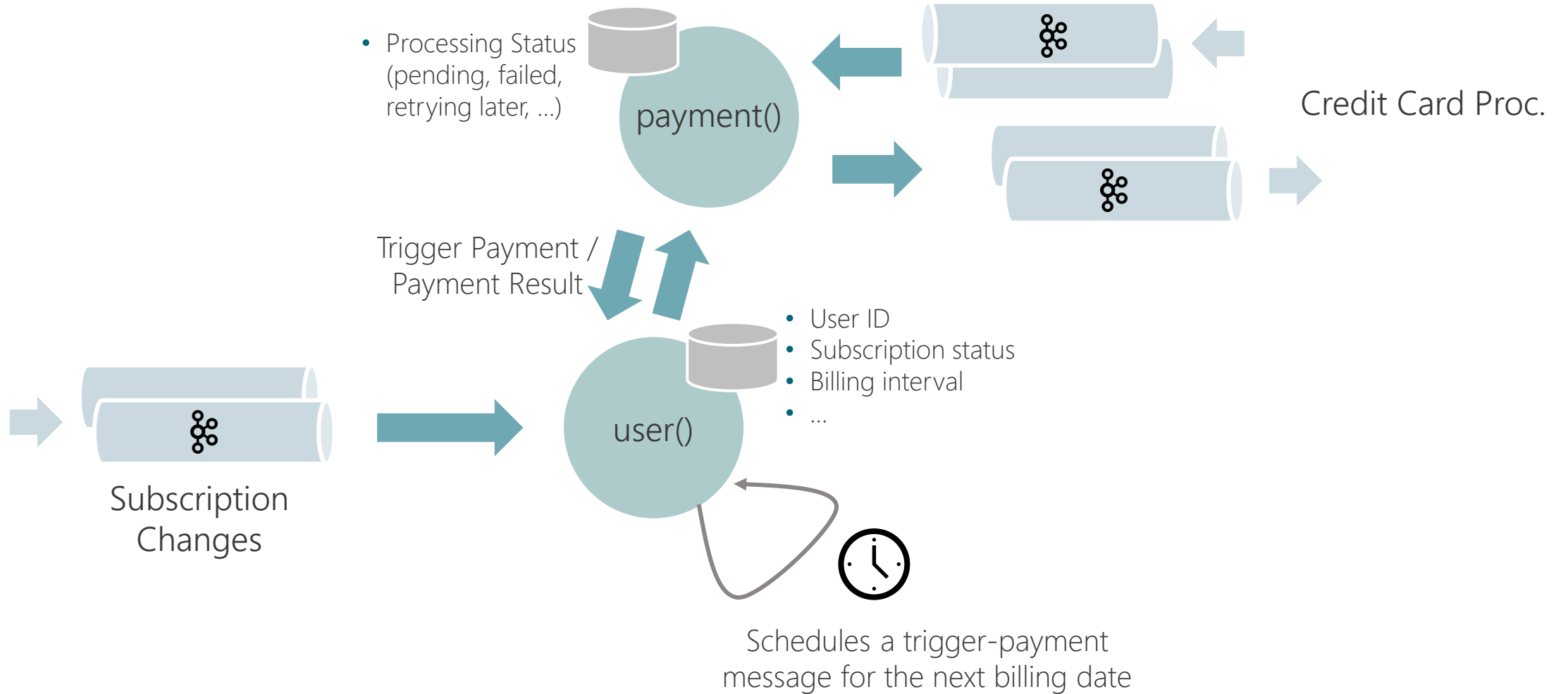


# An Example and Demo

## A Billing Application



# Billing Application



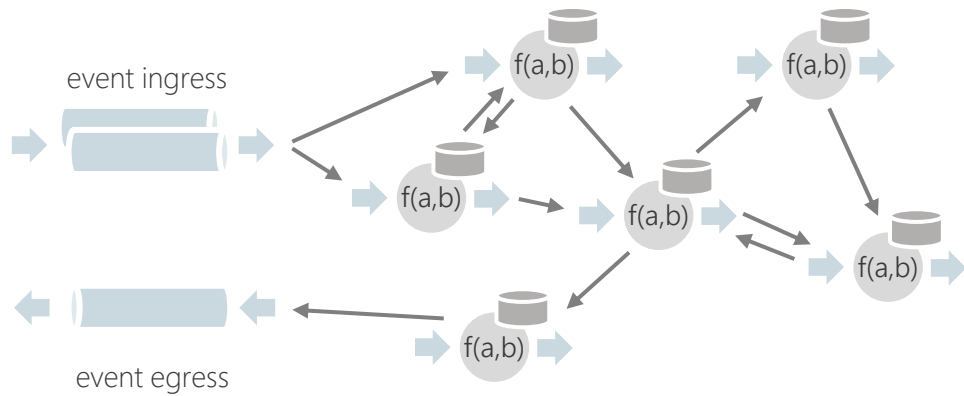
# Code Samples

```
13 @functions.bind("demo/subscription")
14 def model(context, message):
15     if message.Is(NewSubscription.DESRIPTOR):
16         handle_new_subscription(context, message)
17     elif message.Is(TimerMessage.DESRIPTOR):
18         handle_timer(context, message)
19     elif message.Is(PaymentResult.DESRIPTOR):
20         handle_payment_result(context, message)
21     else:
22         raise ValueError('unknown message type ' + message)
23
24
25 def handle_new_subscription(context, message):
26     sub = NewSubscription()
27     message.Unpack(sub)
28
29     # remember the subscription details in state
30     state = SubscriptionState()
31     state.user_id = sub.user_id
32     state.next_payment_due = pay_date(sub.pay_interval)
33
34     context.state('subscription').pack(state)
35
36     # send to ourselves a reminder to start a payment process.
37     schedule(context, state.next_payment_due.seconds_left)
```

```
40 def handle_timer(context, message):
41     """it's time to pay - send out a payment request."""
42     state = context.state('subscription').unpack(SubscriptionState)
43     payment = Payment()
44     payment.user_id = state.user_id
45
46     context.pack_and_send("demo/payment", context.address.identity, payment)
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64 def schedule(context, seconds_remaining):
65     # send to ourselves a reminder to start a payment process.
66     context.pack_and_send_after(timedelta(seconds=seconds_remaining),
67                                 context.address.type_name(),
68                                 context.address.identity,
69                                 TimerMessage())
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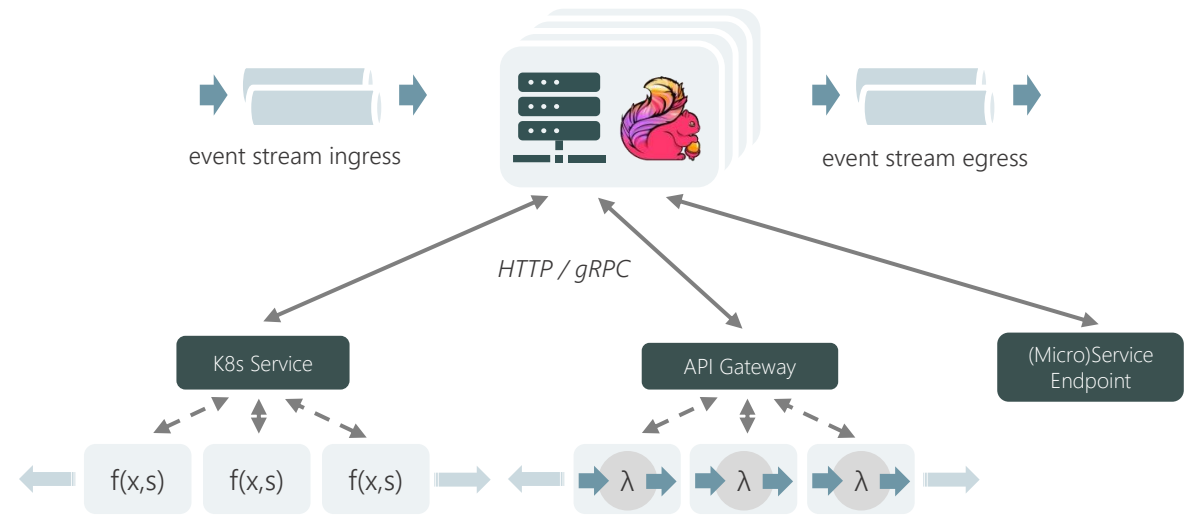


# Stateful Functions



Programming Abstraction  
Based on Stateful Entities

&



Distributed Architecture using an  
Event-driven Database



# Stateful Functions is developed by the Apache Flink Community



But these folks deserve a special shout out:  
Igal, Marta, Seth, Tzu-Li (Gordon)





# Thank you for listening!

If you are interested in this project, please get in touch with the Apache Flink community

- Try it out, help us improve it
- We are open to all sorts of contributions, like docs, code, tutorials
- Join a meetup or (virtual) conference



@StephanEwen

@ApacheFlink

@StateFun\_IO

<https://statefun.io/>

<https://flink.apache.org/>



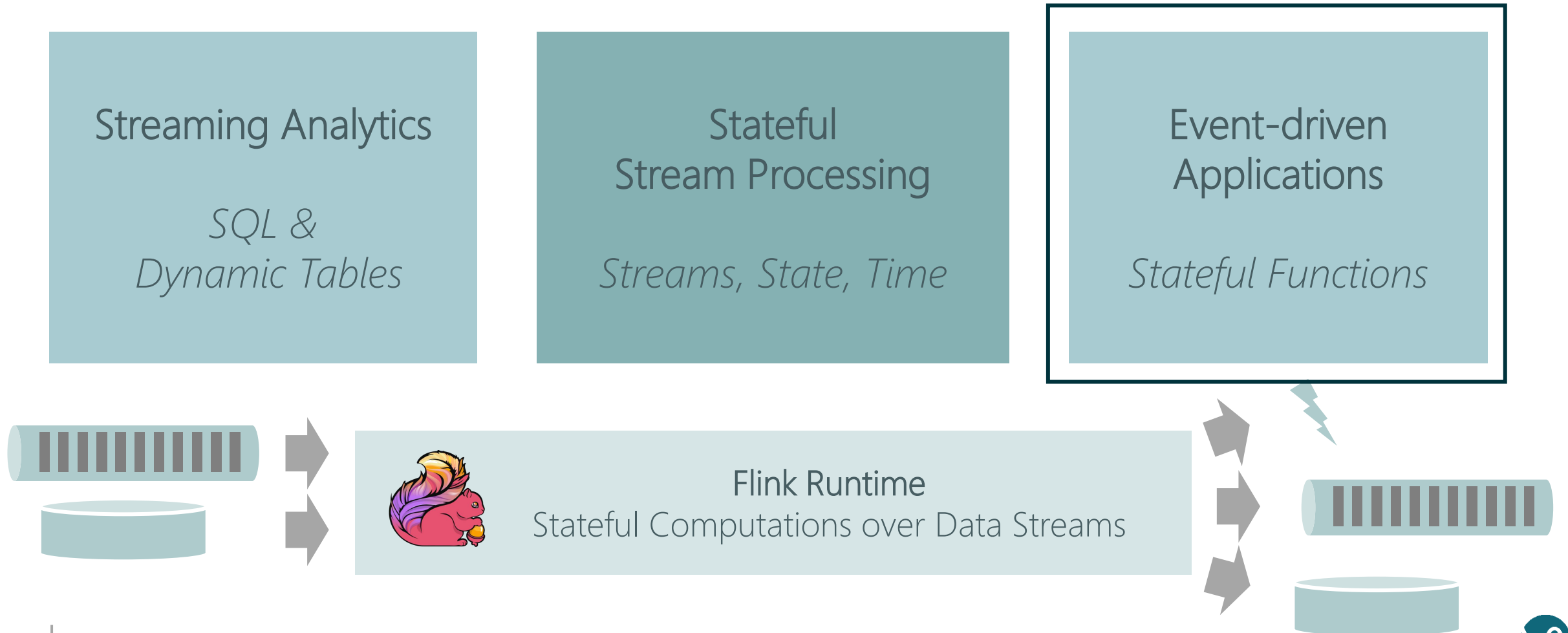
Backup

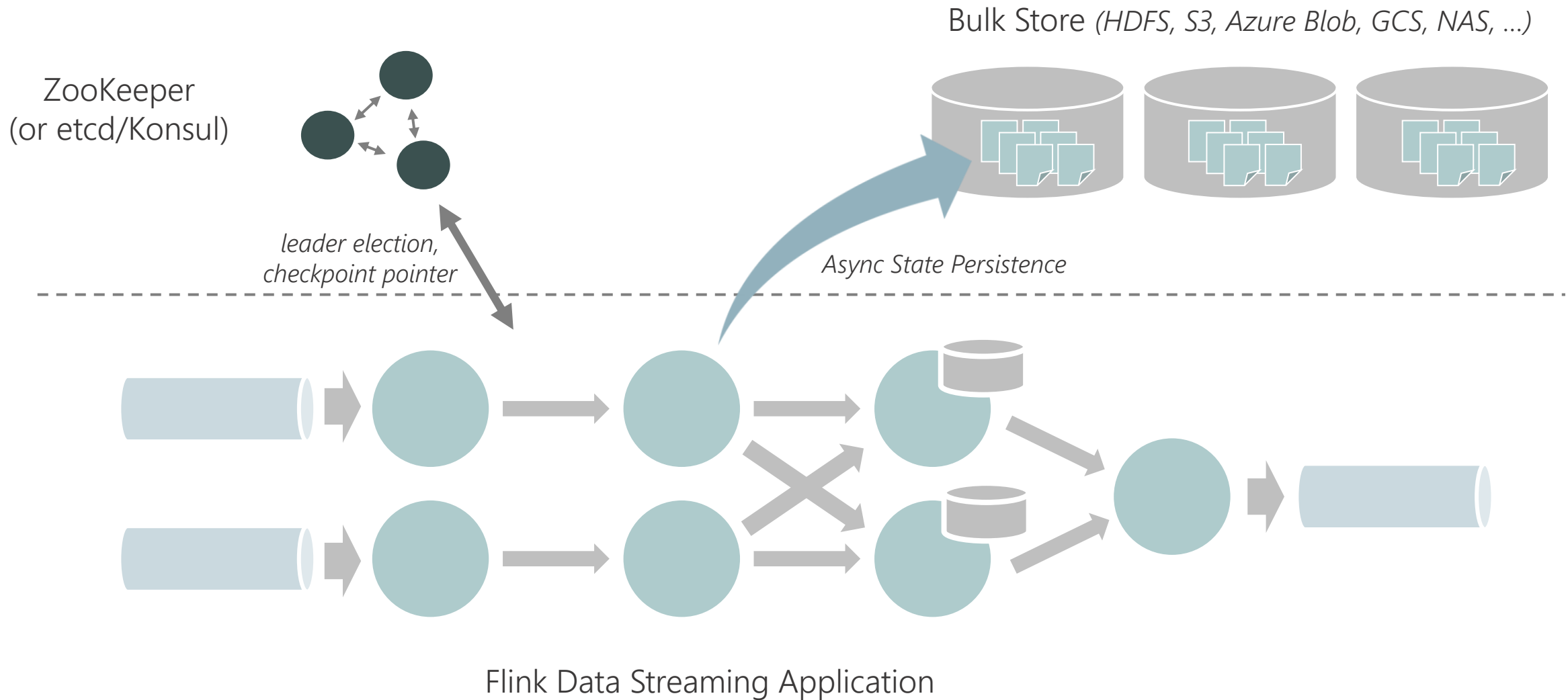
# A Brief Excursion into Apache Flink

*Which takes the role similar  
to the Database here*



# Apache Flink: Analytics and Applications on Streaming Data





*Data keeps flowing directly between processes. Persistence is an "asynchronous background task".*



# How big can you go? - Alibaba: Double 11 / Singles Day

## Real-time Data Applications

incl. sub-second updates to the GMV dashboard

Search

Rec.

Ads

BI

Security



## Infrastructure

>5K  
nodes



>500K  
CPU cores

## Data Size



985PB

## State Size (Biggest)



100TB

## Throughput (Peak)



2.5B  
events/sec

## Latency



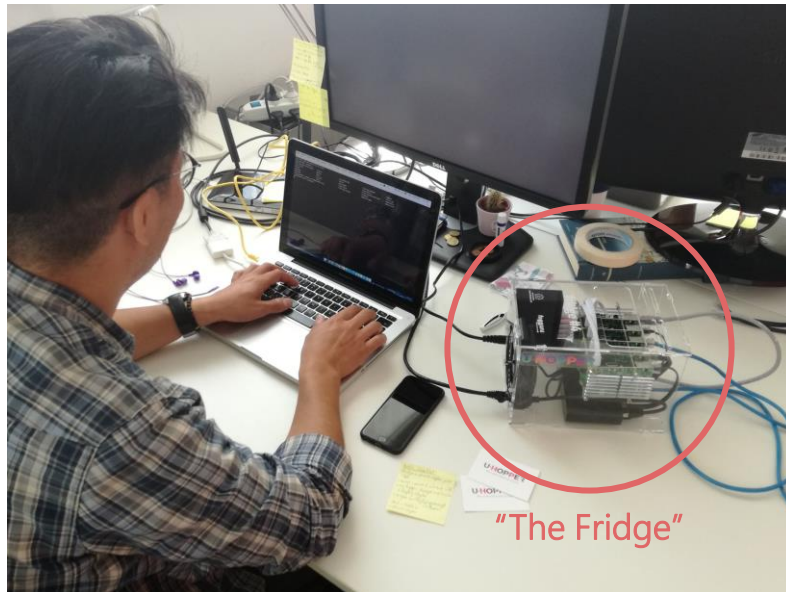
Sub-sec



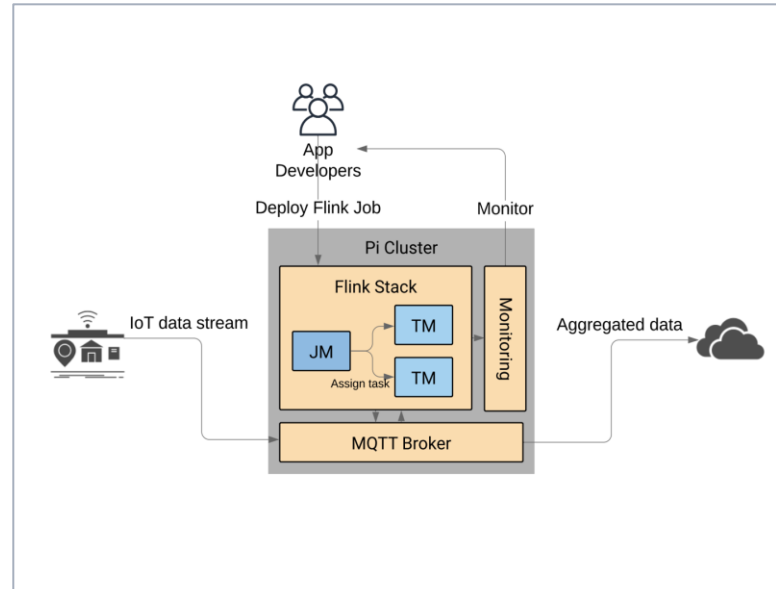
# How small can you go? - U-Hopper FogGuru

FogGuru is a platform for developing and deploying fog applications in resource-constrained devices.

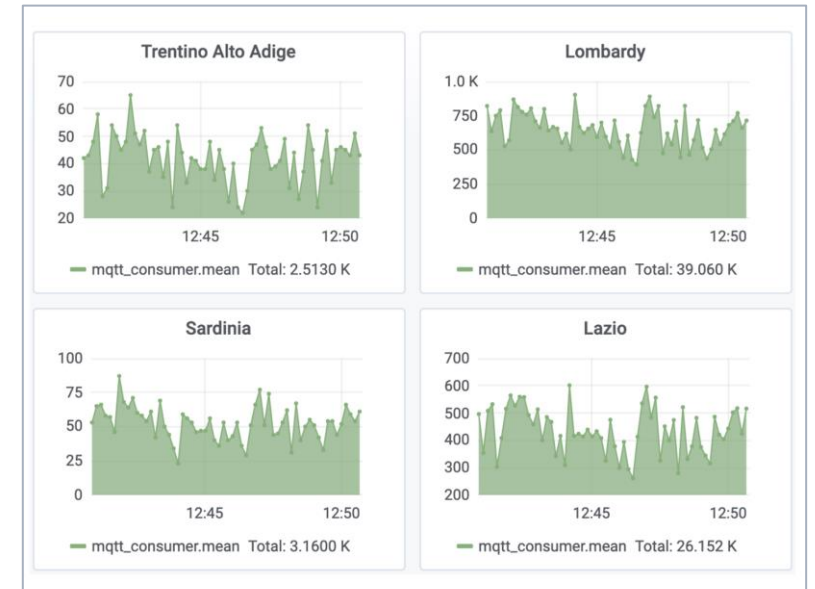
Cluster of 5 Raspberry Pi 3b+



Docker Swarm + Flink + Mosquitto



Data volume: 800 events/sec



# Some Apache Flink Users



Sources: [Powered by Flink](#), [Speakers – Flink Forward San Francisco 2019](#), [Speakers – Flink Forward Europe 2019](#)





# Stateful Functions API versus Stream Processing APIs

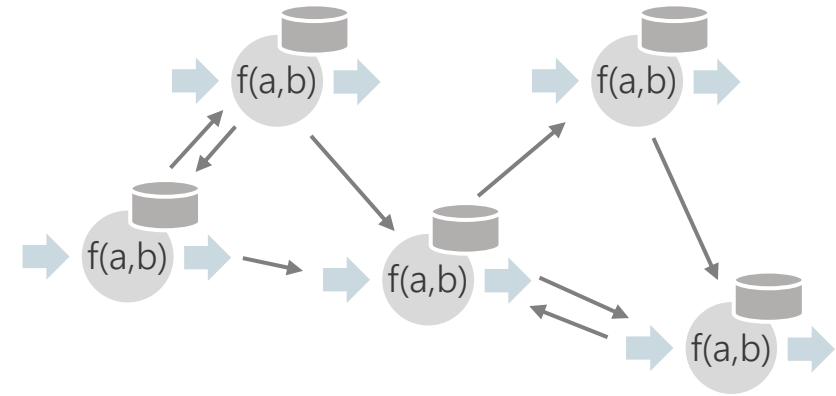


## Stream Processing

Predefined Flow

Directed Acyclic Graph

Reserved Resources



## Stateful Functions

Dynamic Messaging

Acyclic or Cyclic

Dynamic / Elastic

