Beyond FaaS
Towards Stateful Serverless

Jonas Bonér
@jboner

“We predict that Serverless Computing will grow to dominate the future of Cloud Computing.”

- BERKELEY CS DEPARTMENT

Cloud computing simplified: a Berkeley view on serverless computing

FaaS

FaaS = Function-as-a-Service

FaaS

IS VISIONARY

FaaS = Function-as-a-Service

FaaS

IS VISIONARY

PAVED THE WAY

FaaS = Function-as-a-Service

FaaS

IS VISIONARY
PAVED THE WAY
JUST THE FIRST STEP

FaaS = Function-as-a-Service

SERVERLESS $\neq$ FAAS

GOOD USE-CASES FOR FAAS?

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Use-cases where throughput is key rather than low latency and requests can be completed in a short time window

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Use-cases where throughput is key rather than low latency and requests can be completed in a short time window

1. Embarrassingly parallel processing tasks—invoked on demand & intermittently, examples include: image processing, object recognition, log analysis
2. Low traffic applications—enterprise IT services, and spiky workloads
3. Stateless web applications—serving static content form S3 (or similar)
4. Orchestration functions—integration/coordination of calls to third-party services
5. Composing chains of functions—stateless workflow management, connected via data dependencies
6. Job scheduling—CRON jobs, triggers, etc.

FAAS: HARD TO BUILD

GENERAL-PURPOSE APPLICATIONS

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GENERAL-PURPOSE APPLICATIONS

1. Functions are stateless, ephemeral, short-lived:
   expensive to lose computational context & rehydrate
2. Durable state is always "somewhere else"
3. No co-location of state and processing
4. No direct addressability—all communication over external storage
5. Limited options for managing & coordinating distributed state
6. Limited options for modelling data consistency guarantees


STATE

We Need Serverless Support For...

- Managing in-memory durable session state across individual requests

  E.g. User Sessions, Shopping Carts, Caching
- Low-latency serving of dynamic in-memory models

  E.g. Serving of Machine Learning Models
- Real-time stream processing

  E.g. Recommendation, Anomaly Detection, Prediction Serving
- Distributed resilient transactional workflows

  E.g. Saga Pattern, Workflow Orchestration, Rollback/Compensating Actions
- Shared collaborative workspaces

  E.g. Collaborative Document Editing, Blackboards, Chat Rooms
- Leader election, counting, voting

  . . . .and other distributed systems patterns/protocols for coordination

Technical Requirements

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1. Stateful long-lived addressable virtual components

   Actors

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   In startup time, communication/coordination, and storage of data

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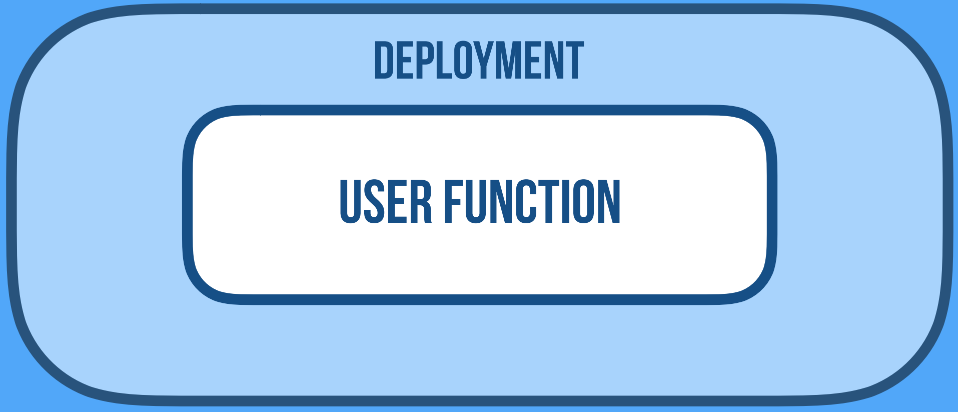
6. Ways of managing end-to-end guarantees and correctness

FaaS
Abstracting Over Communication



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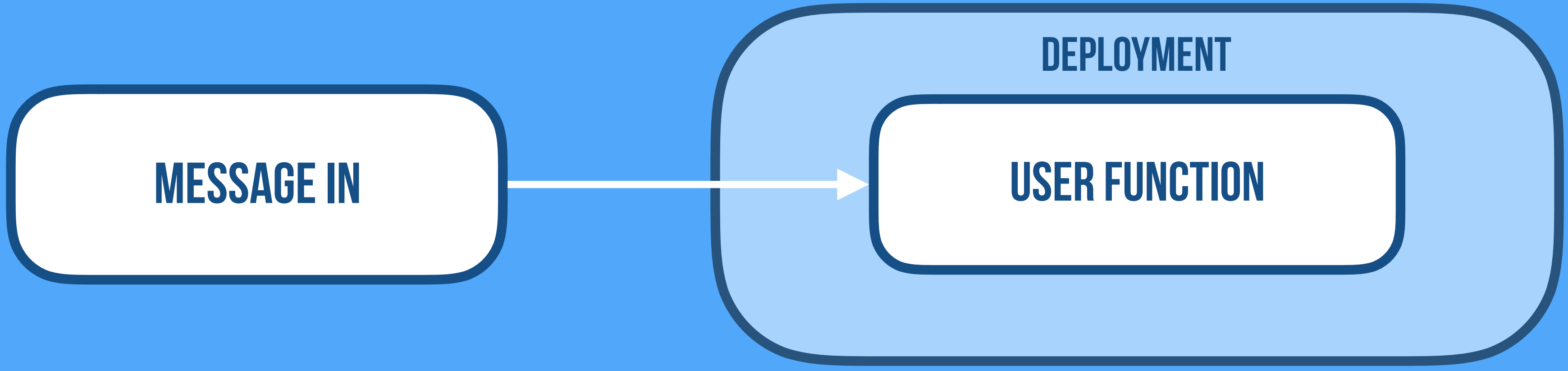

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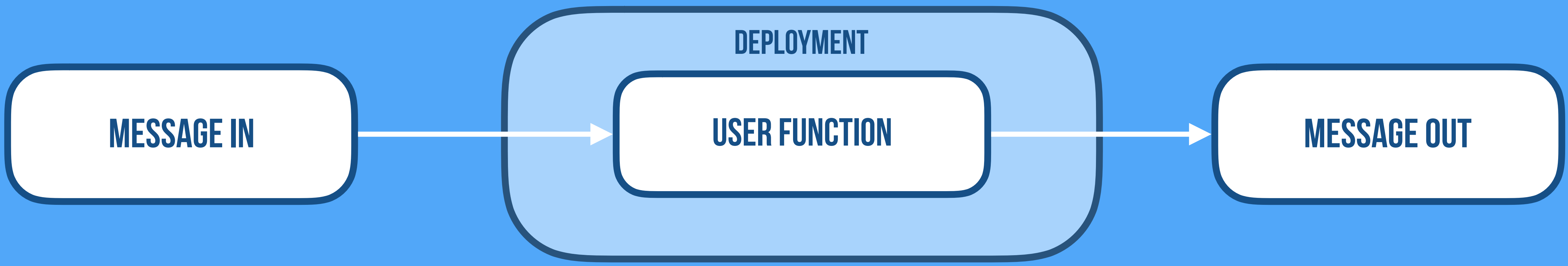
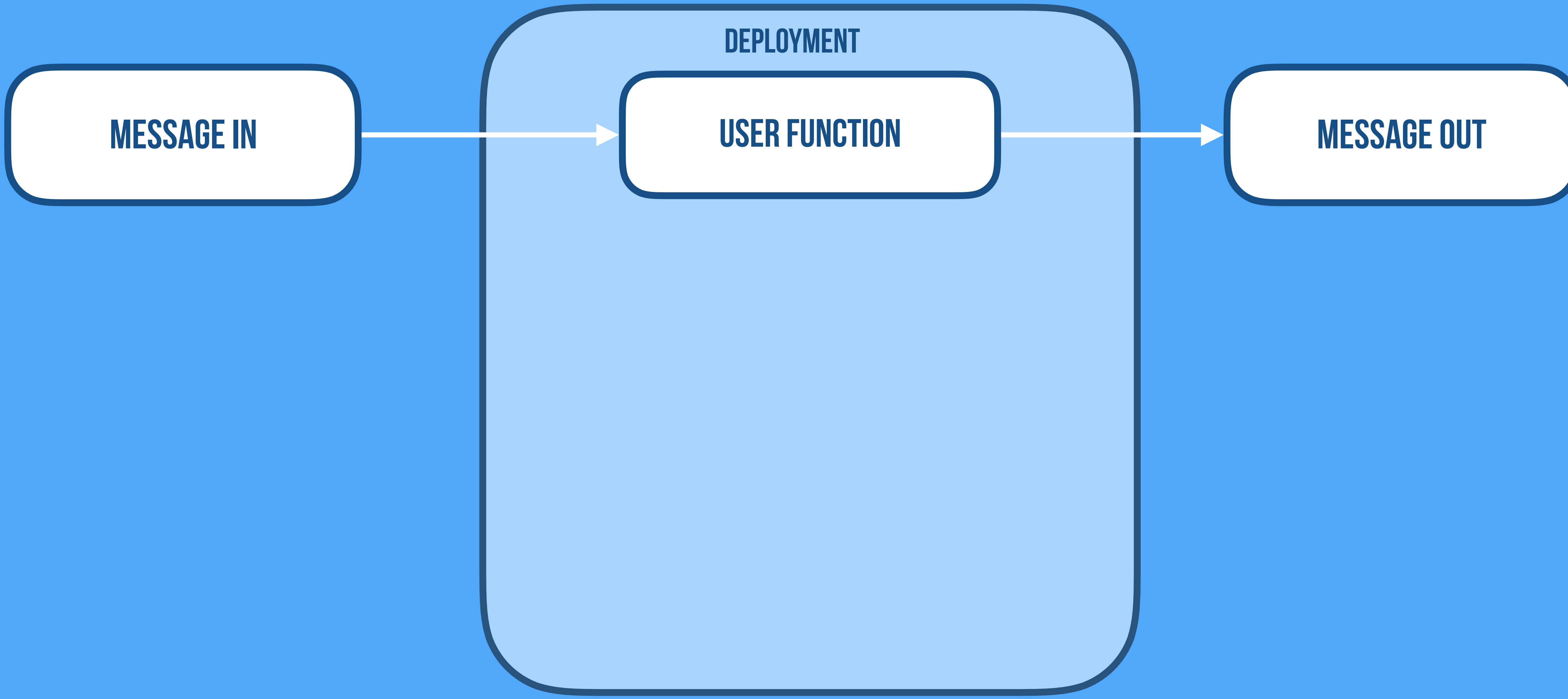


FaaS With CRUD



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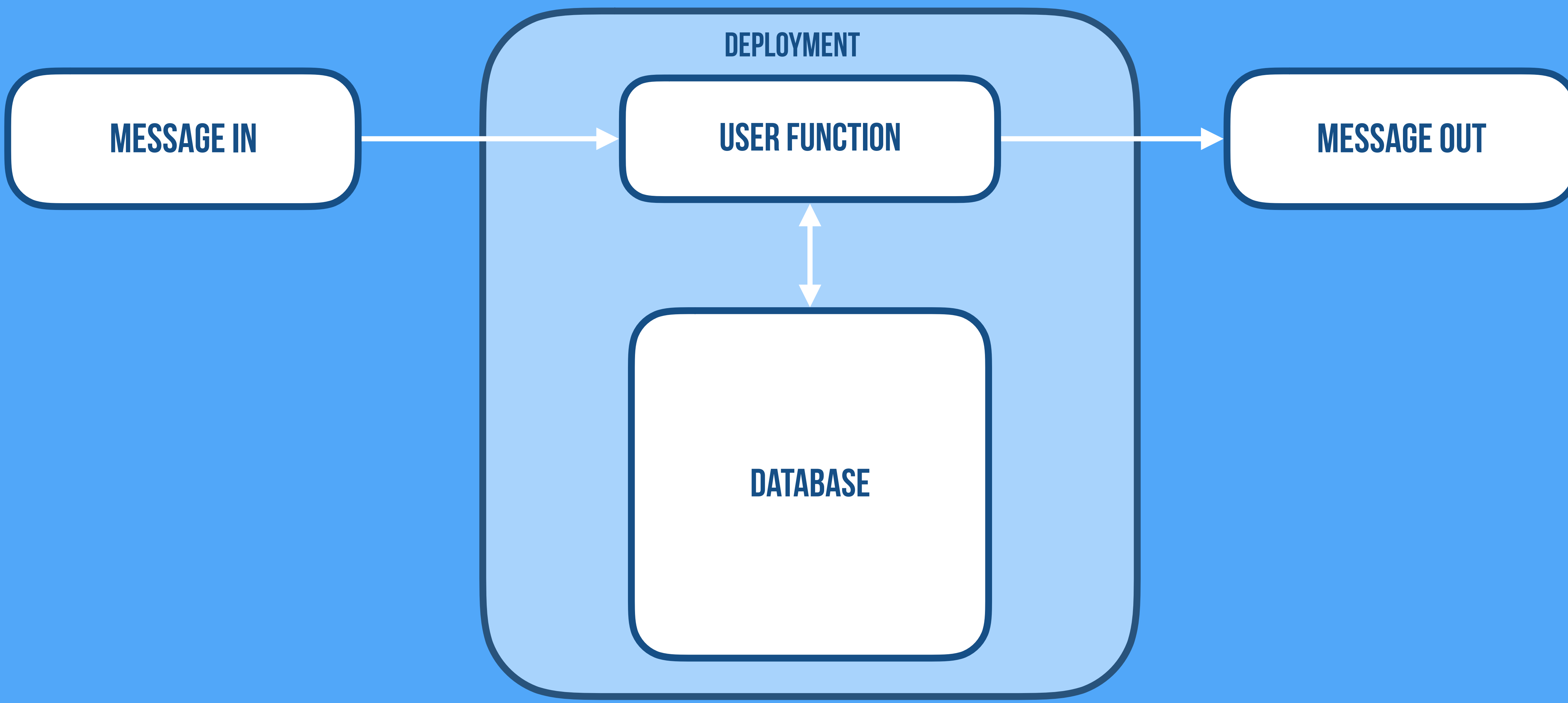
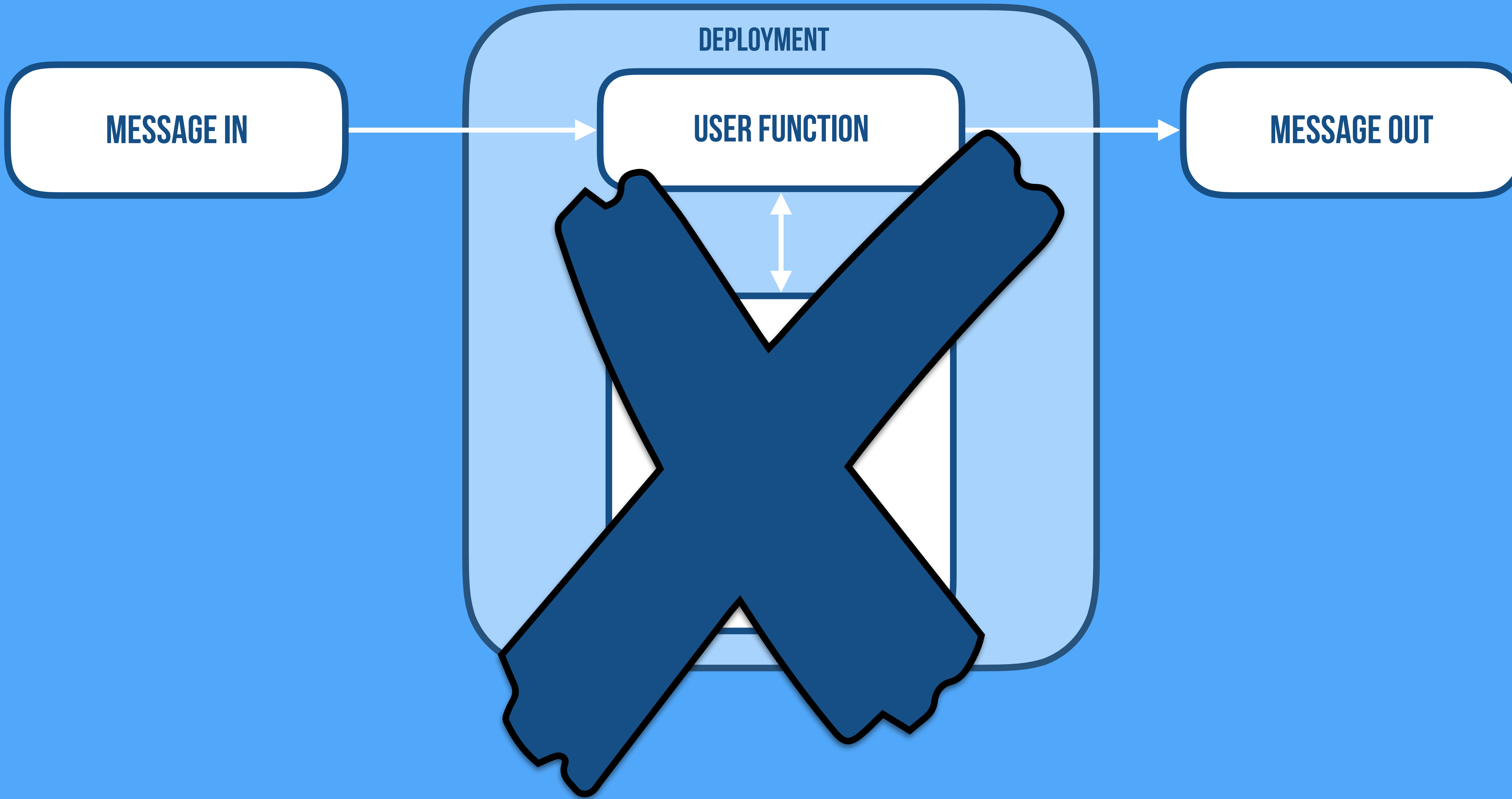


Not Serverless
In An Ideal World



UNCONSTRAINED DATABASE ACCESS MAKES IT HARD TO AUTOMATE OPERATIONS

Enter
Stateful
Serverless

Guiding Principles

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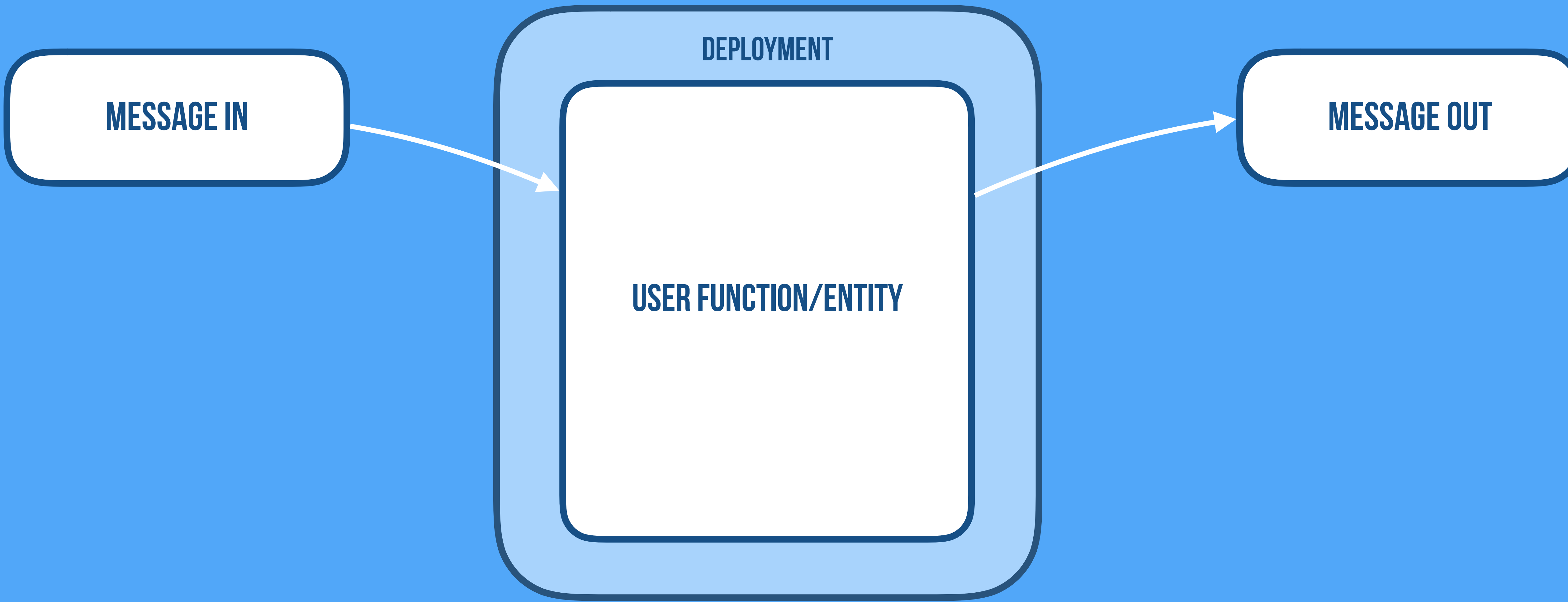
6. **Avoid Coupling in Time and Space**

   Go Async. Don't Block. Location Transparency. Guess/Apologize/Compensate.

Stateful Serverless
Abstracting Over State



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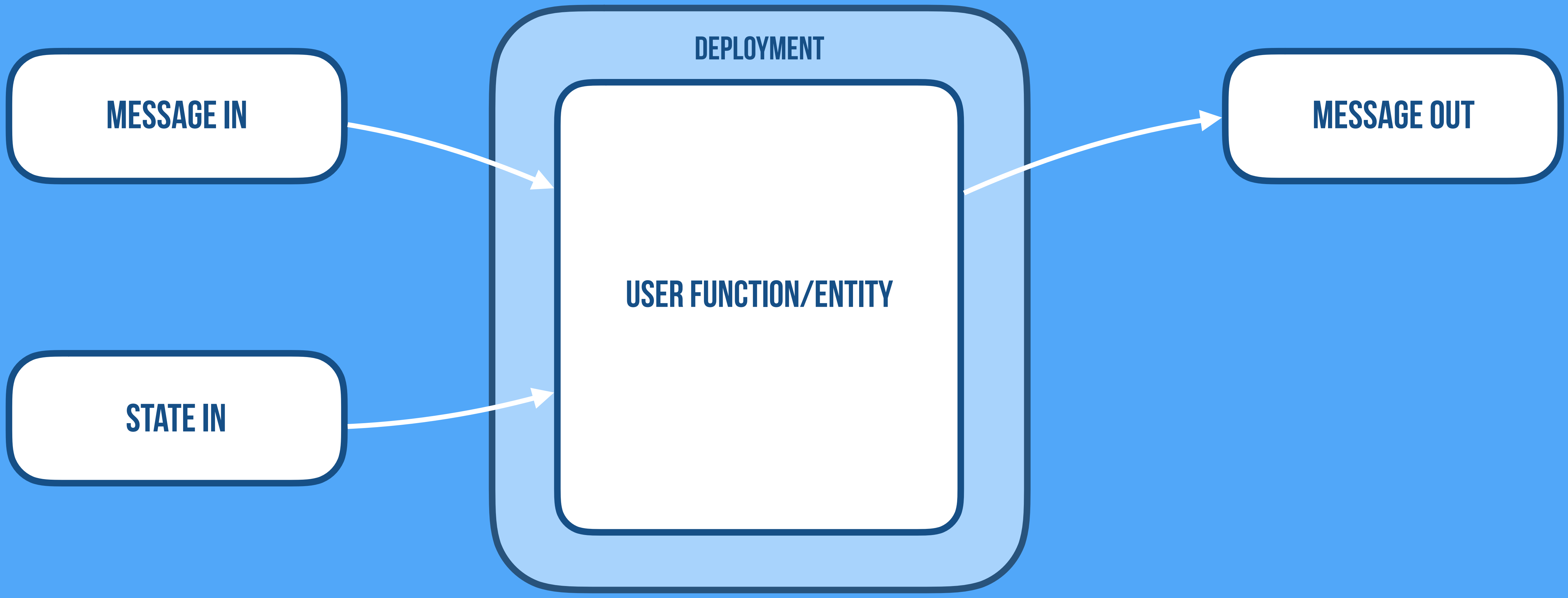

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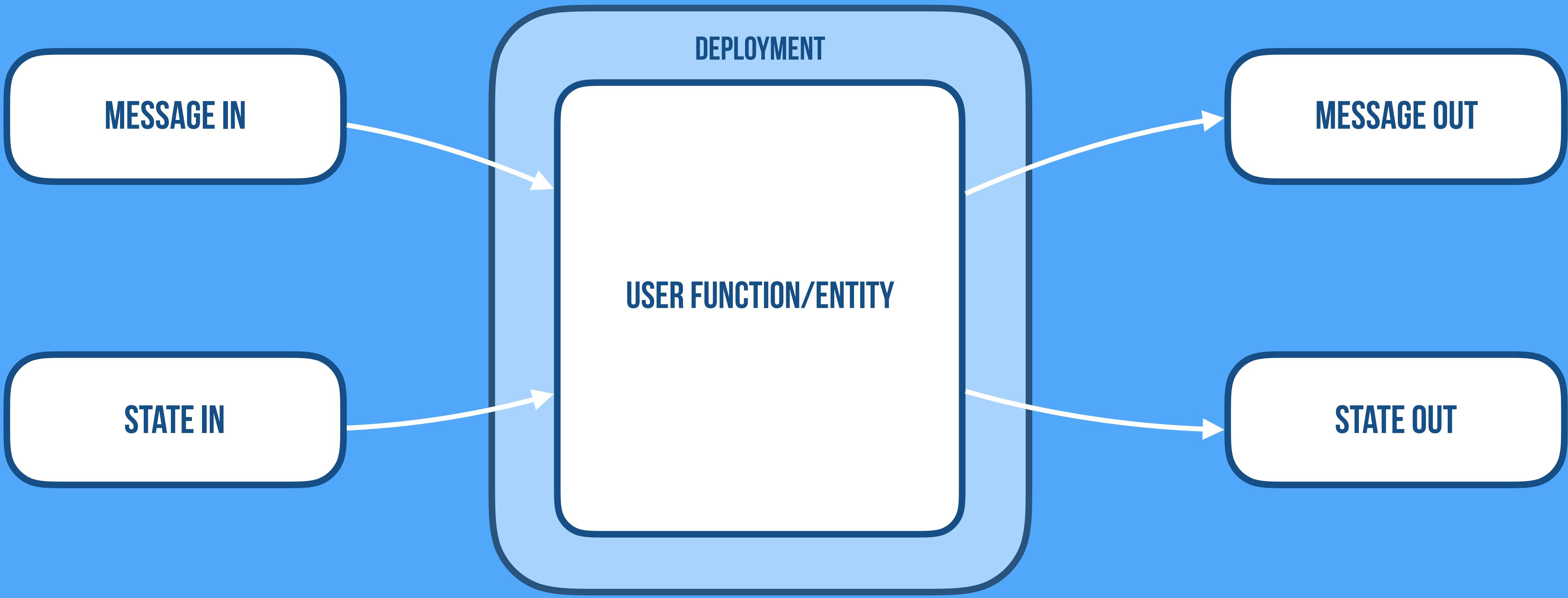

Let Us Use Better Models
For Distributed State

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A FEW BATTLE-TESTED, YET CONSTRAINED, MODELS ARE:

Let Us Use Better Models For Distributed State

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Event Sourcing

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Key Value

Event Sourced Services

HAPPY PATH

Event
Sourced
Services

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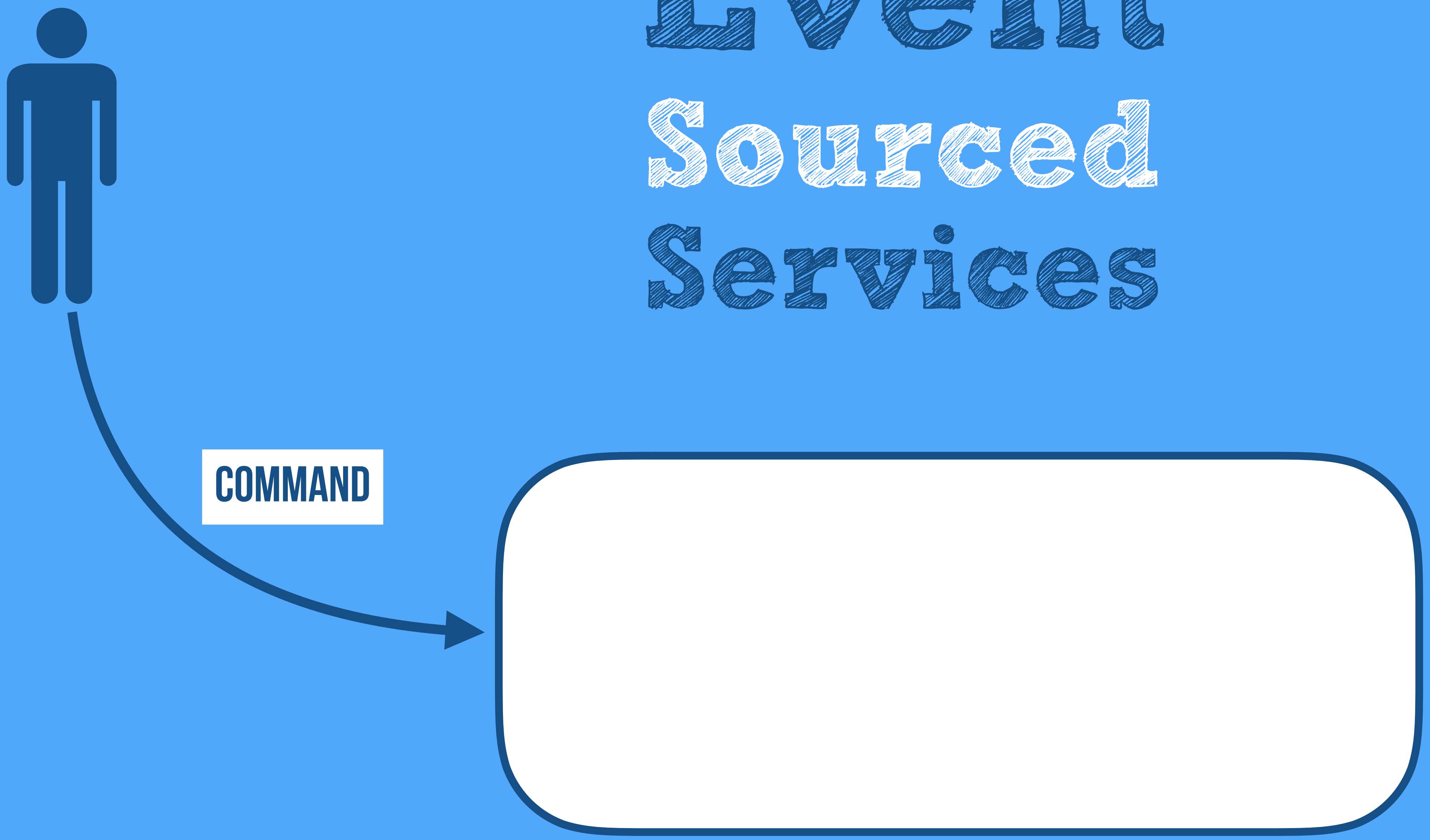
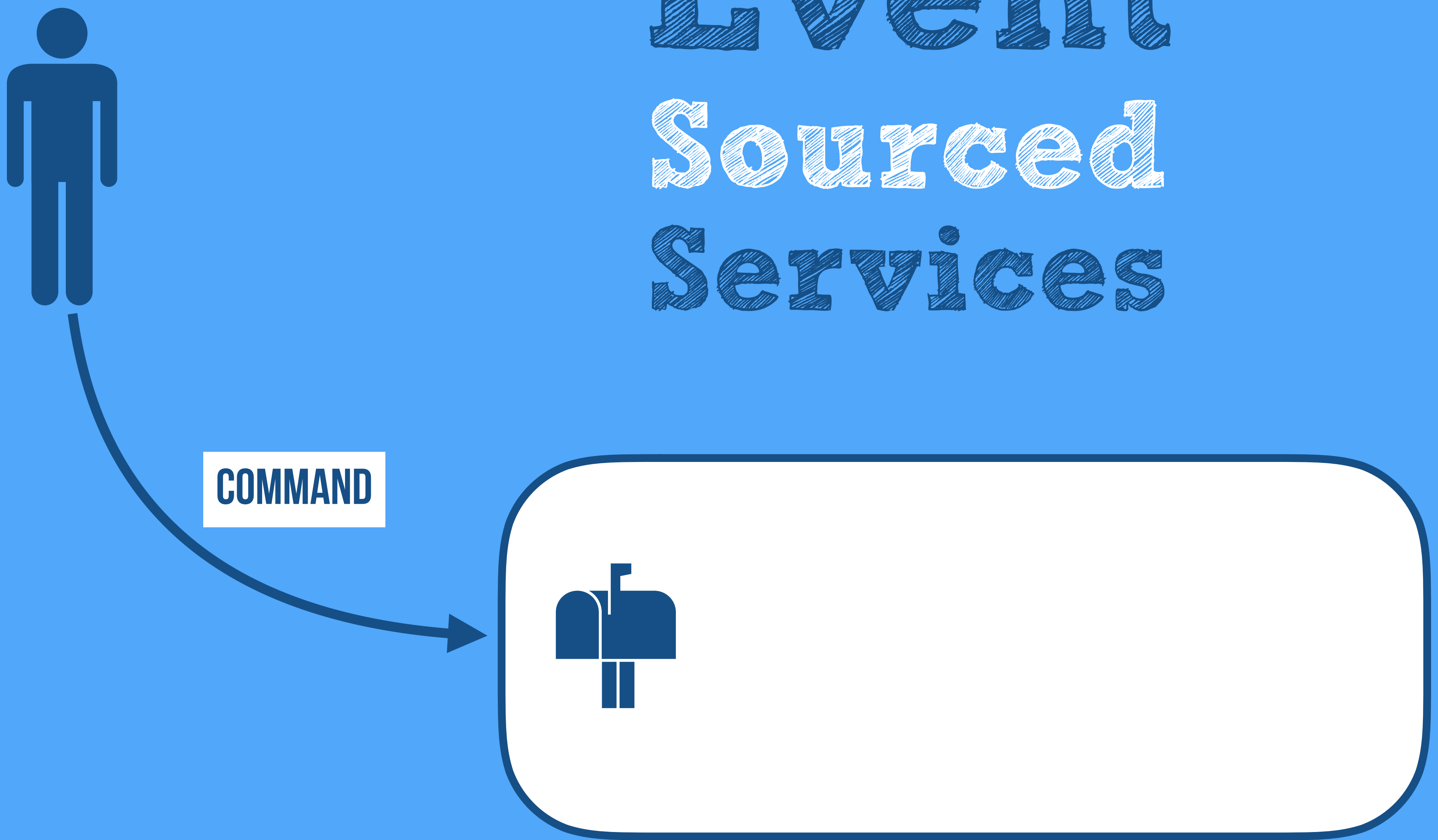


HAPPY PATH

Event Sourced Services



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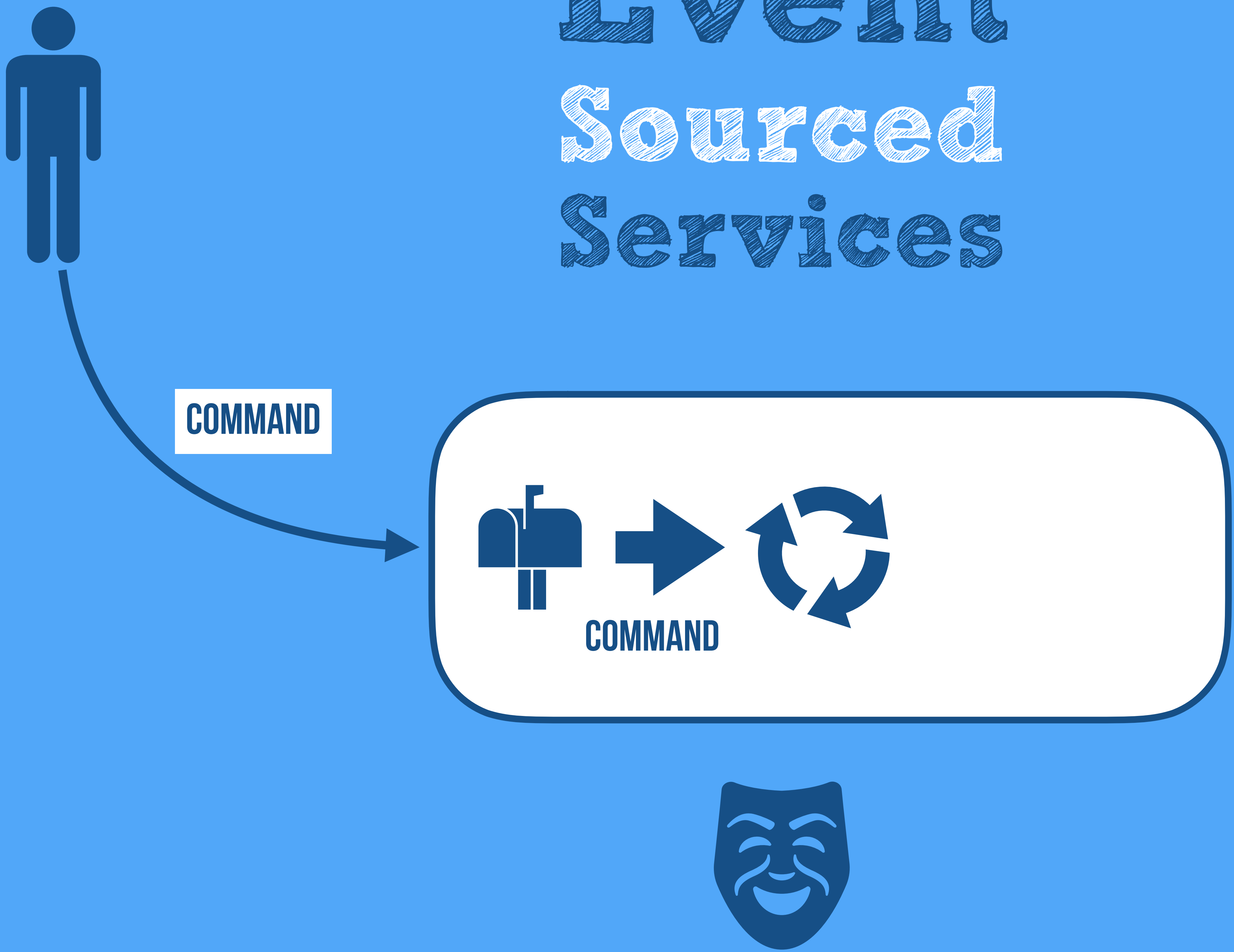

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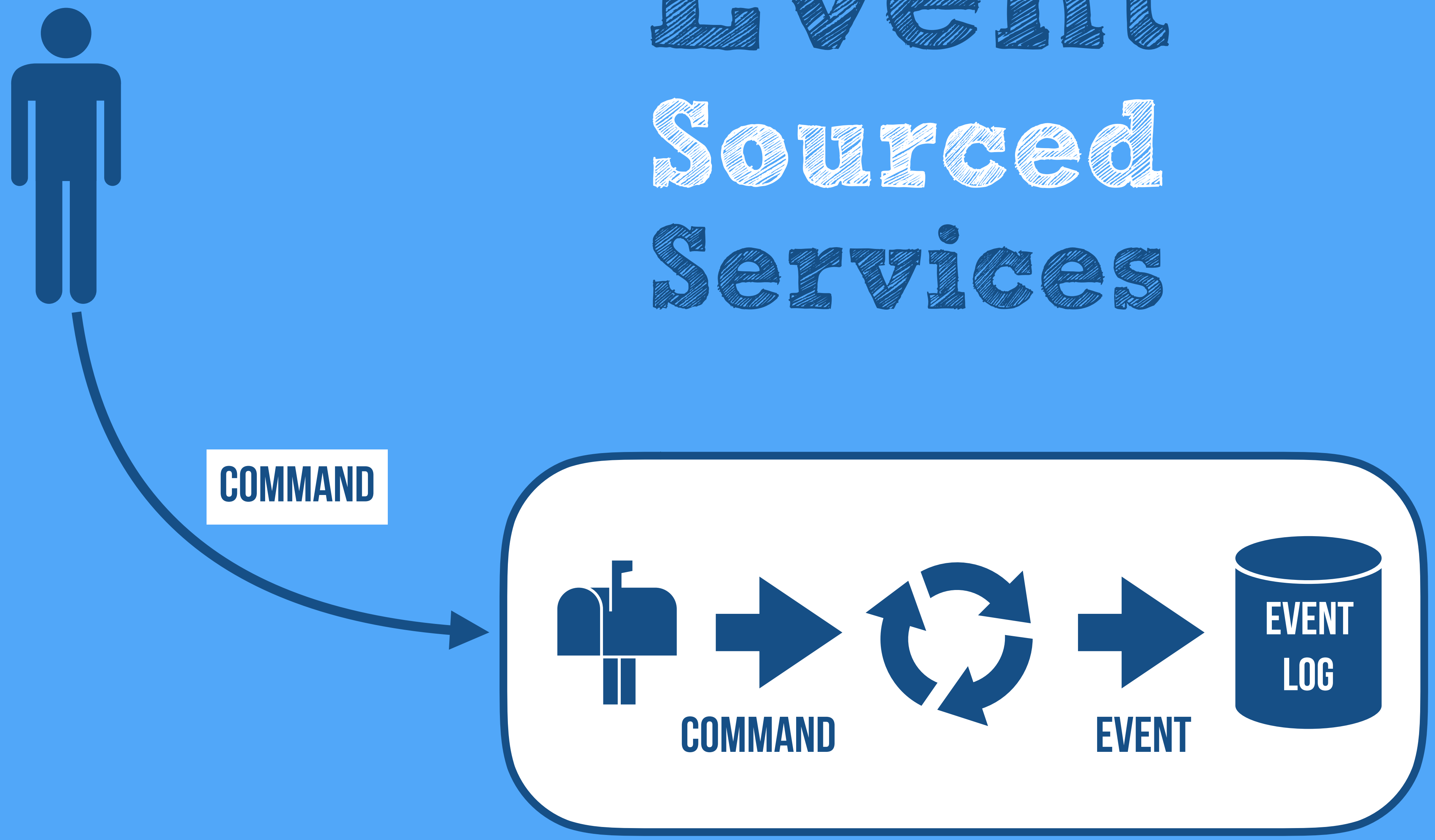

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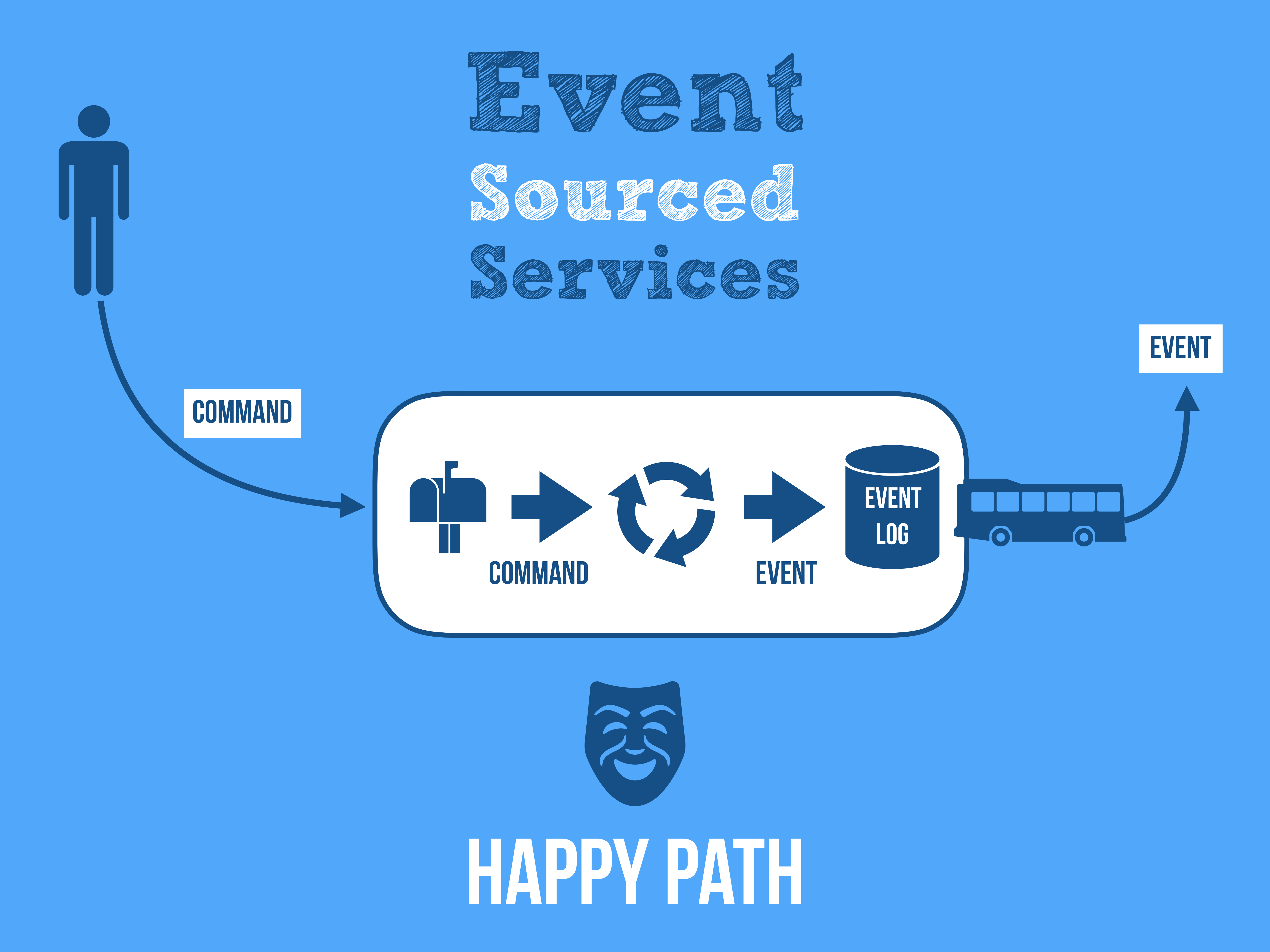
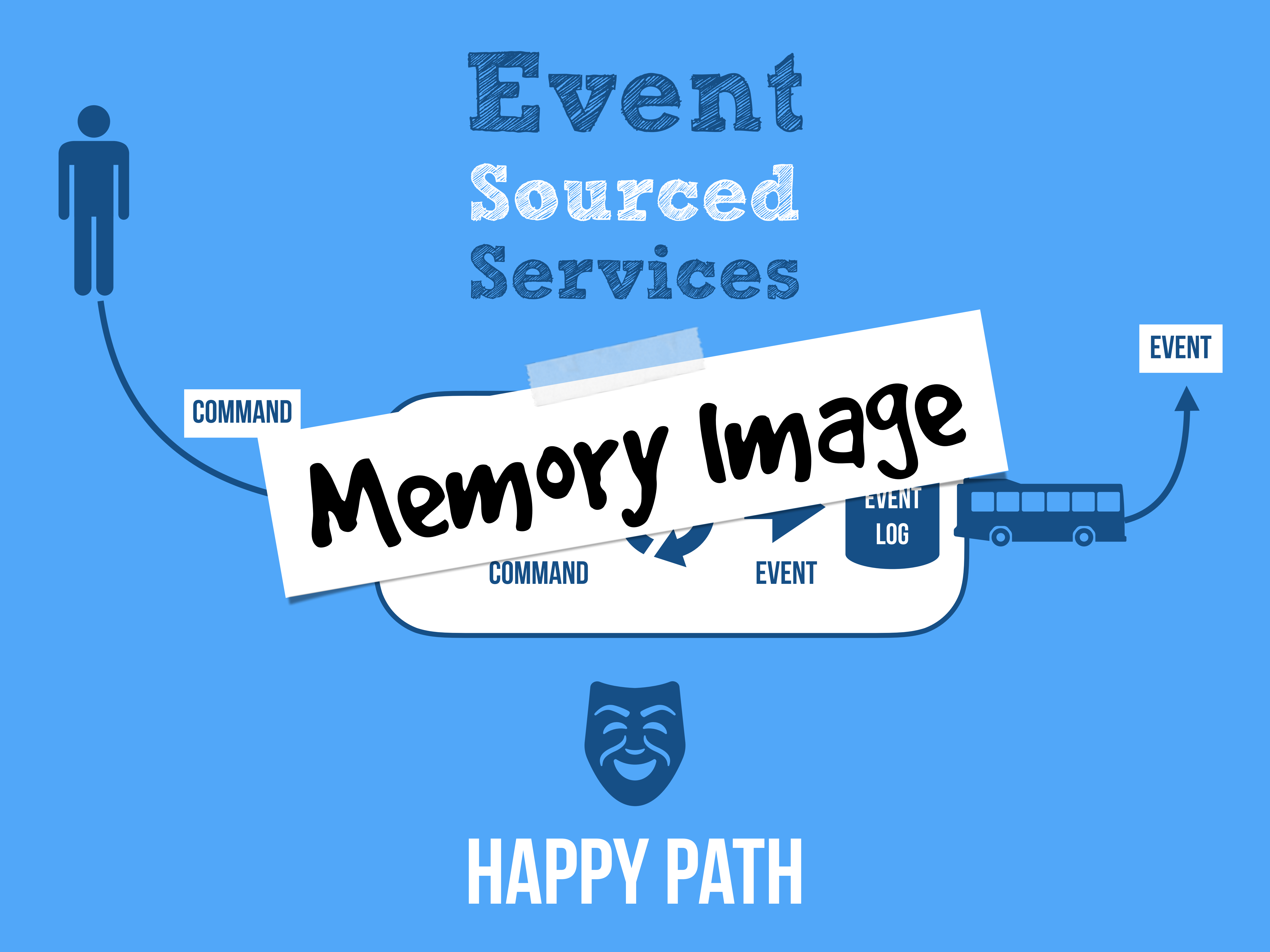

Event
Sourced
Services
COMMAND
EVENT
COMMAND
EVENT
EVENT
LOG
HAPPY PATH


Event
Sourced
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Memory Image
EVENT
EVENT
LOG
COMMAND
EVENT
HAPPY PATH

Event Sourced Services

HAPPY PATH

Event
Sourced
Services

SAD PATH, RECOVER FROM FAILURE

Event
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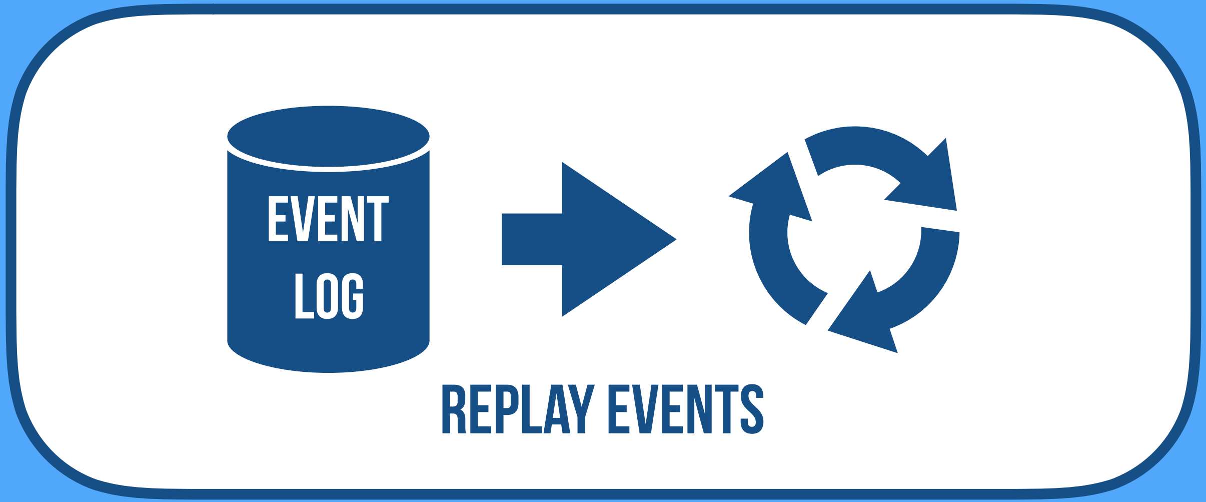

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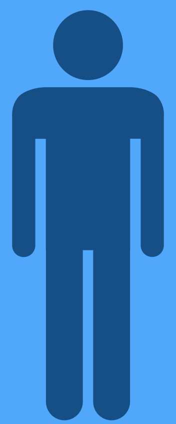
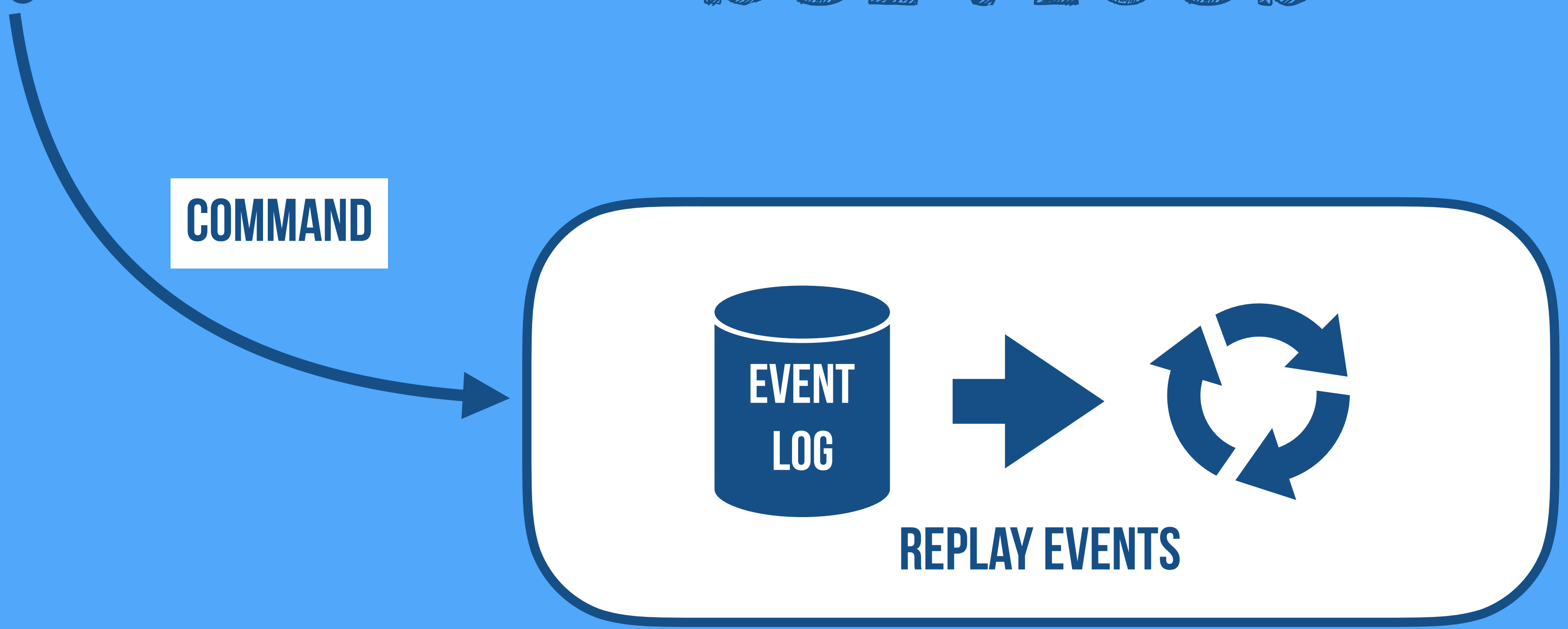




SAD PATH, RECOVER FROM FAILURE

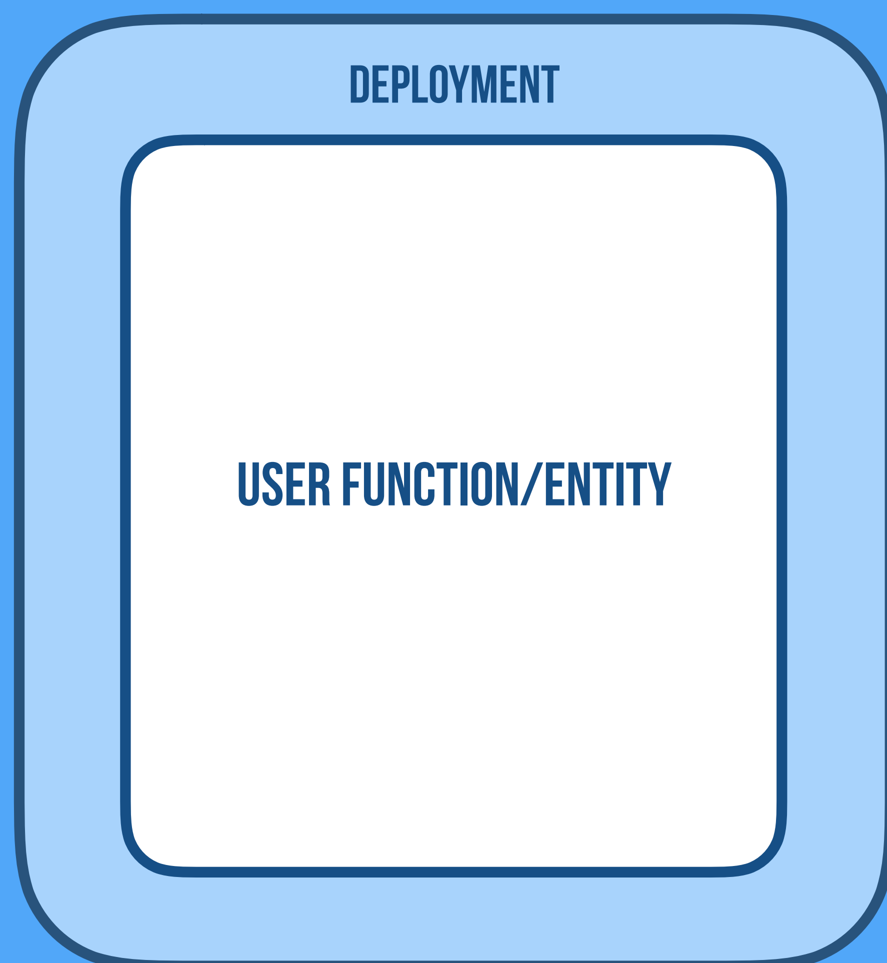
Serverless

Event Sourcing

DEPLOYMENT

Serverless

Event Sourcing



Serverless
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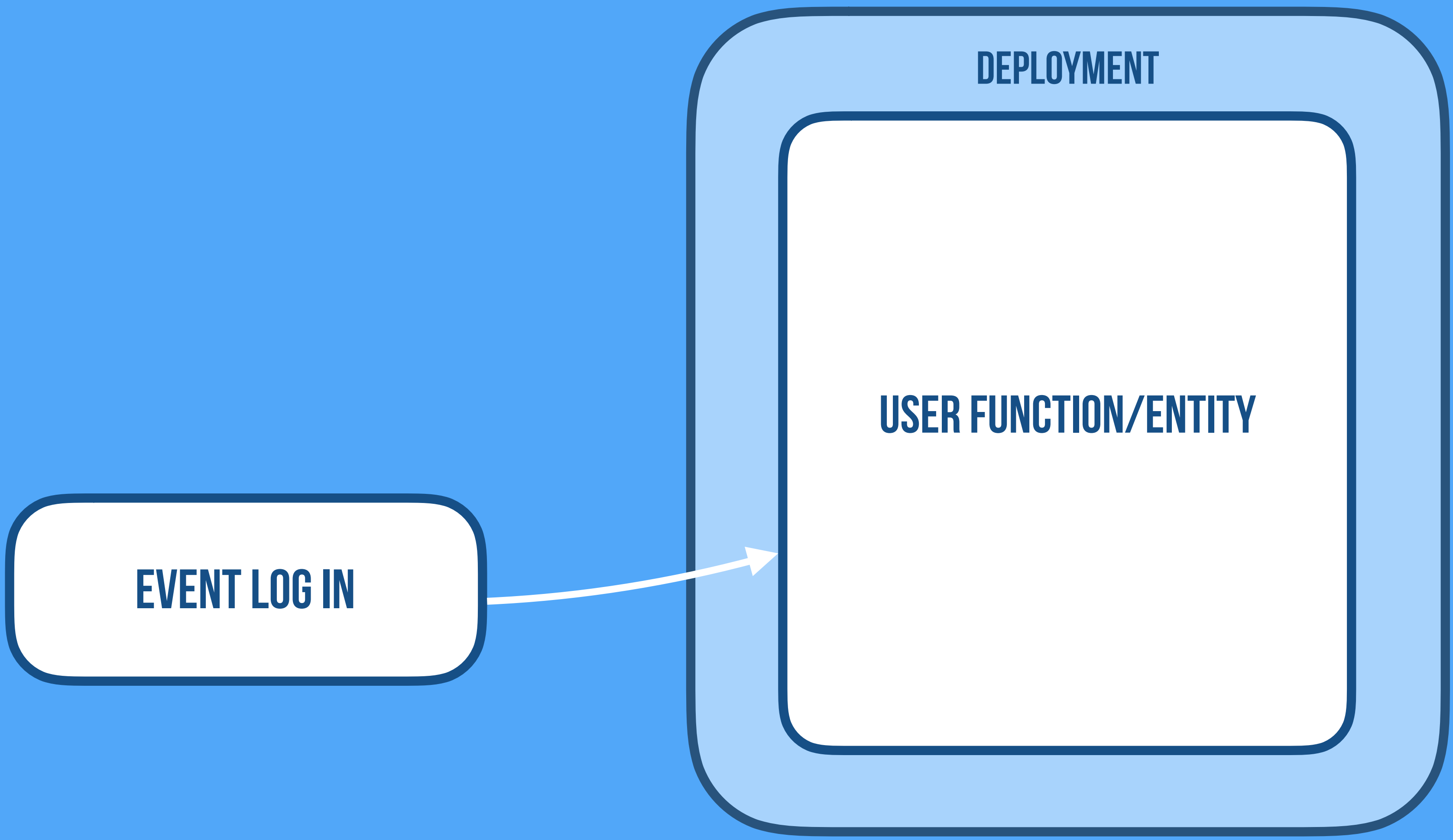

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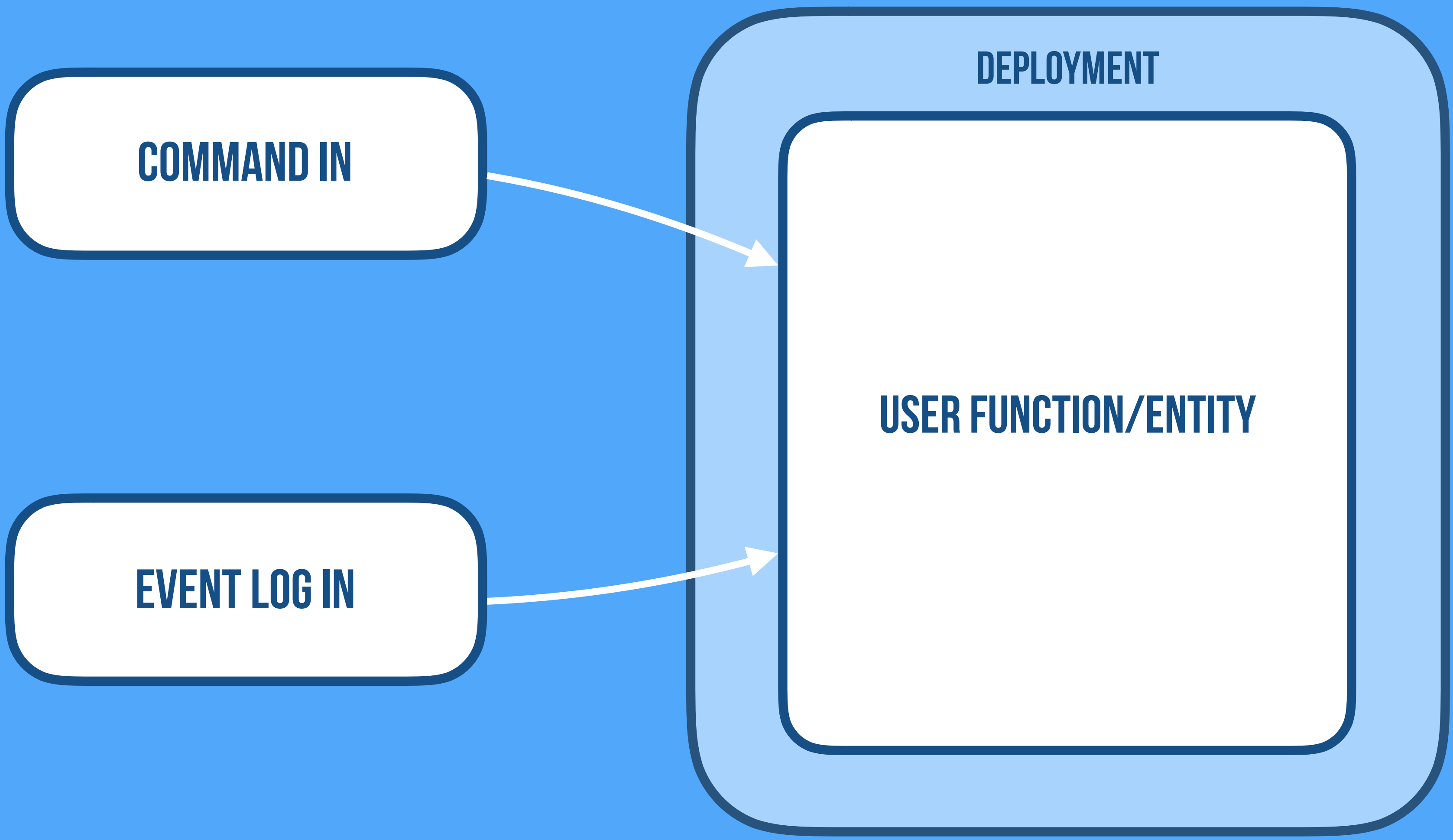

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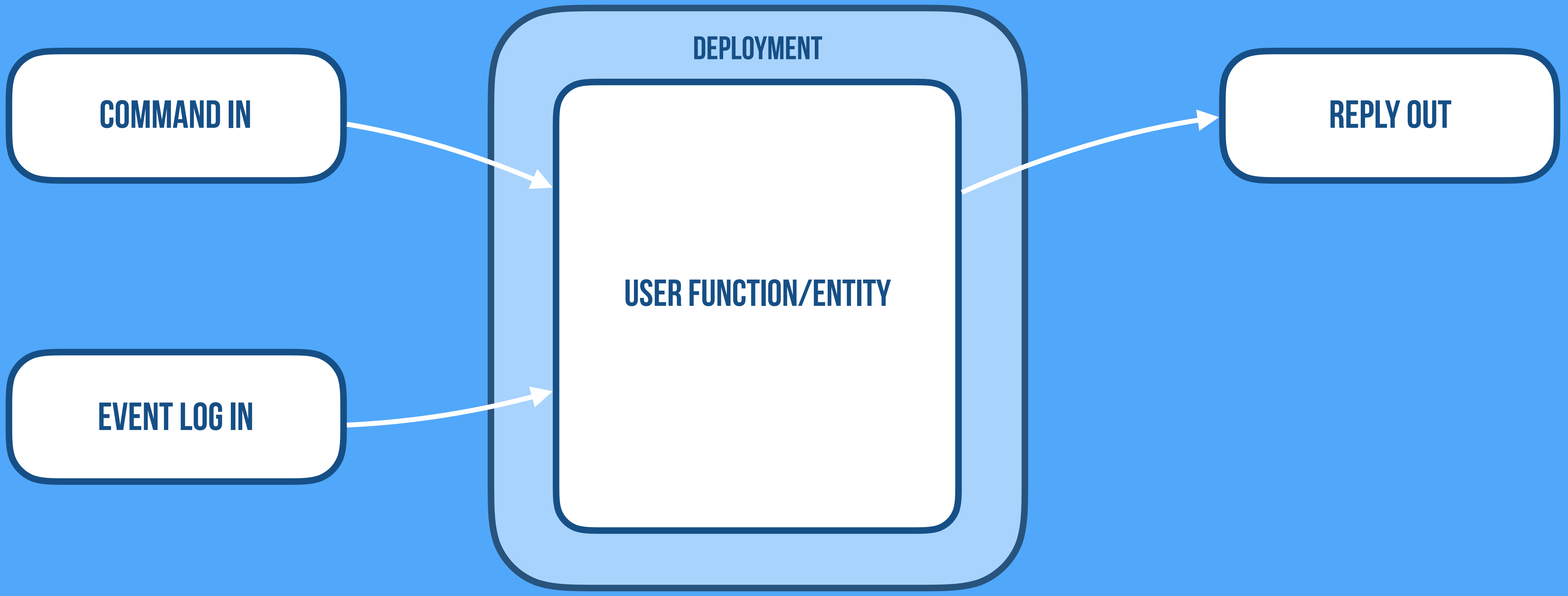

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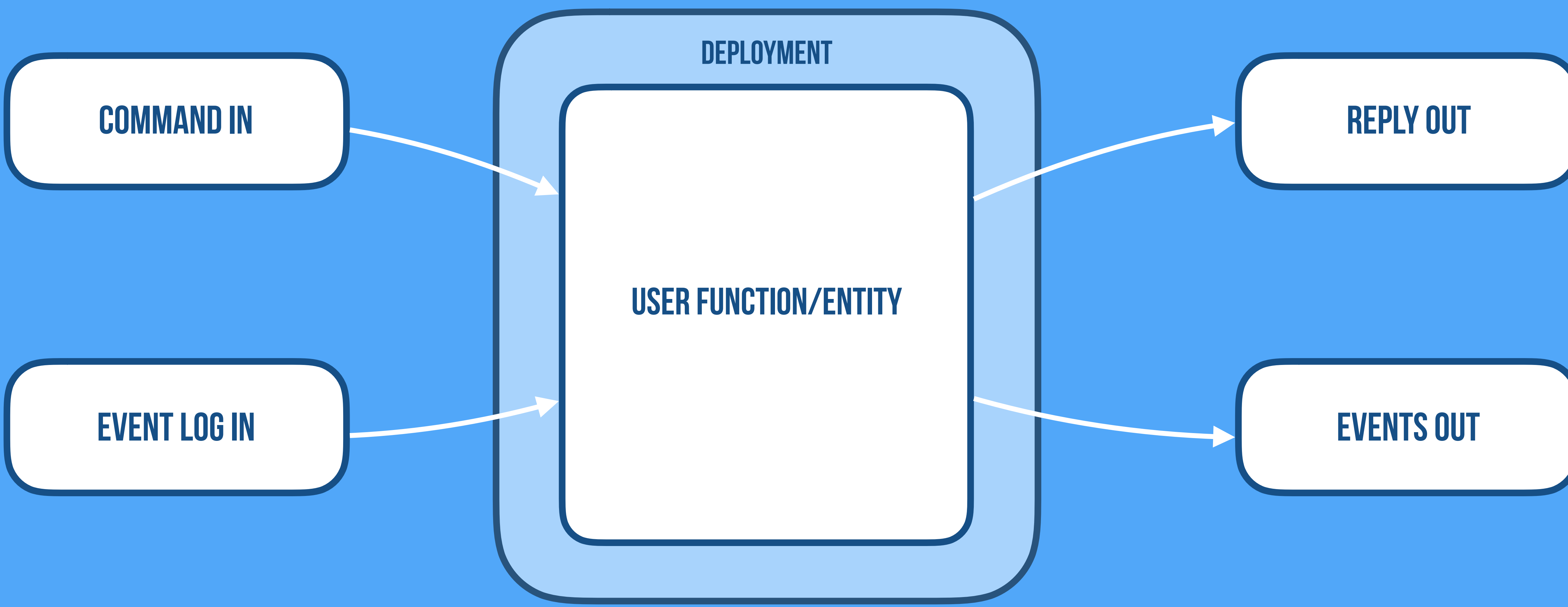

ACID 2.0

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Associative

Batch-insensitive

(grouping doesn't matter)

$$a+(b+c)=(a+b)+c$$

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Commutative

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Idempotent

Retransmission-insensitive

(duplication does not matter)

$a+a=a$

CONFLICT-FREE REPLICATED DATA TYPES

Convergent & Commutative Replicated Data Types - Shapiro et. al. 2011

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CRDT

ACID 2.0

Strong Eventual Consistency

Replicated & Decentralized

Always Converge Correctly

Monotonic Merge Function

Highly Available & Scalable

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DATA TYPES

Counters
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Sets
Maps
Graphs
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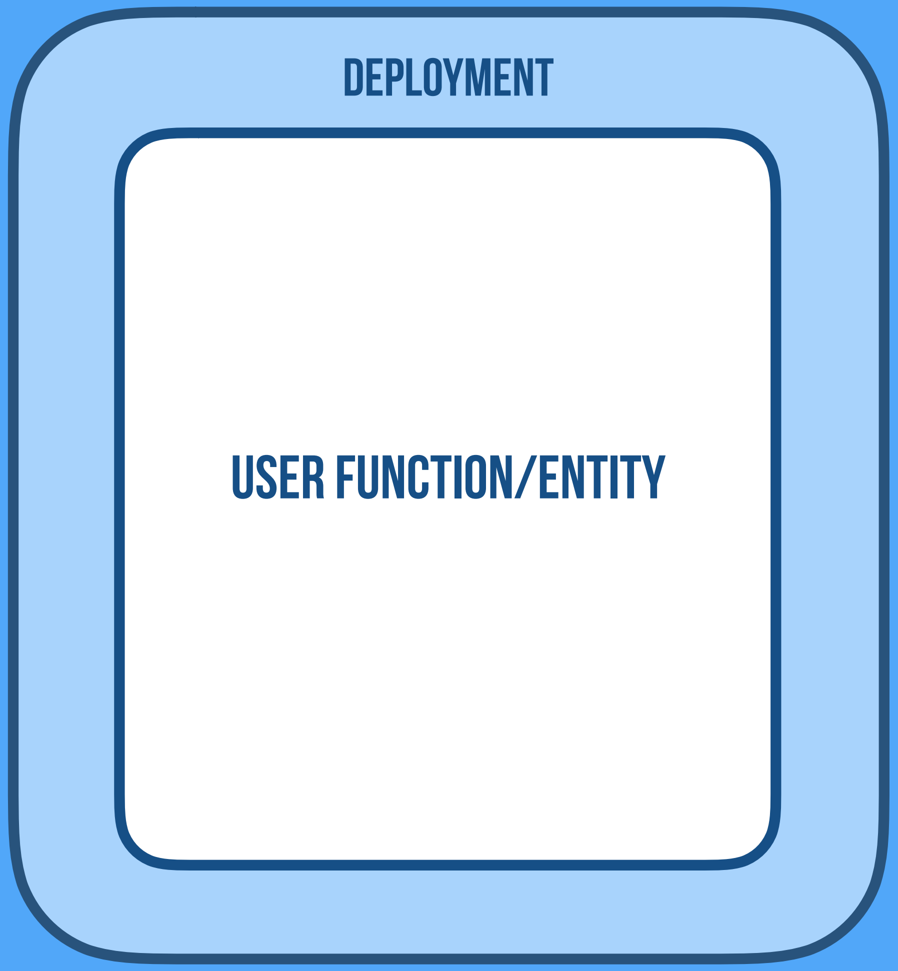
Serverless CRDTs

DEPLOYMENT

Serverless CRDTs



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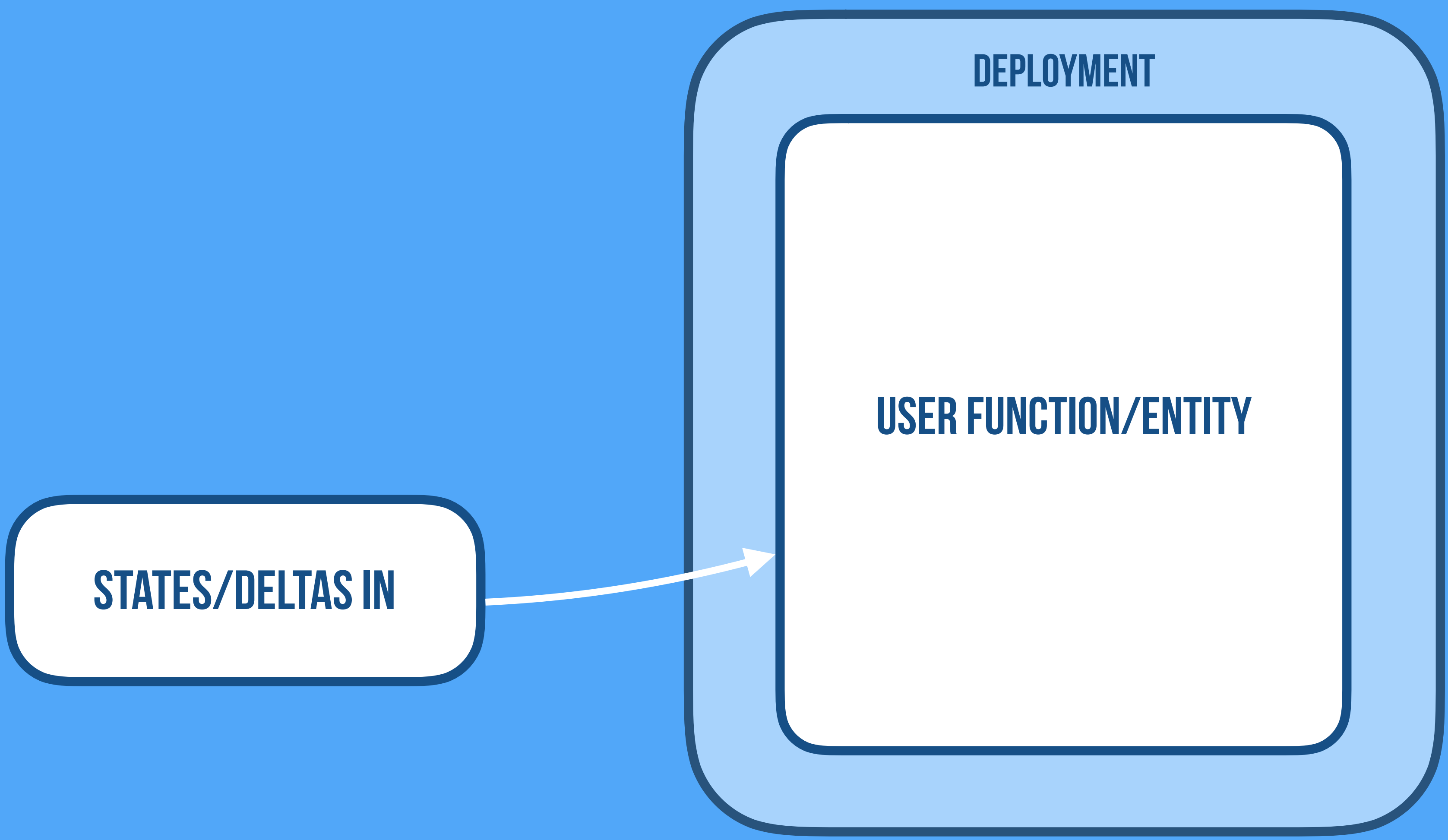

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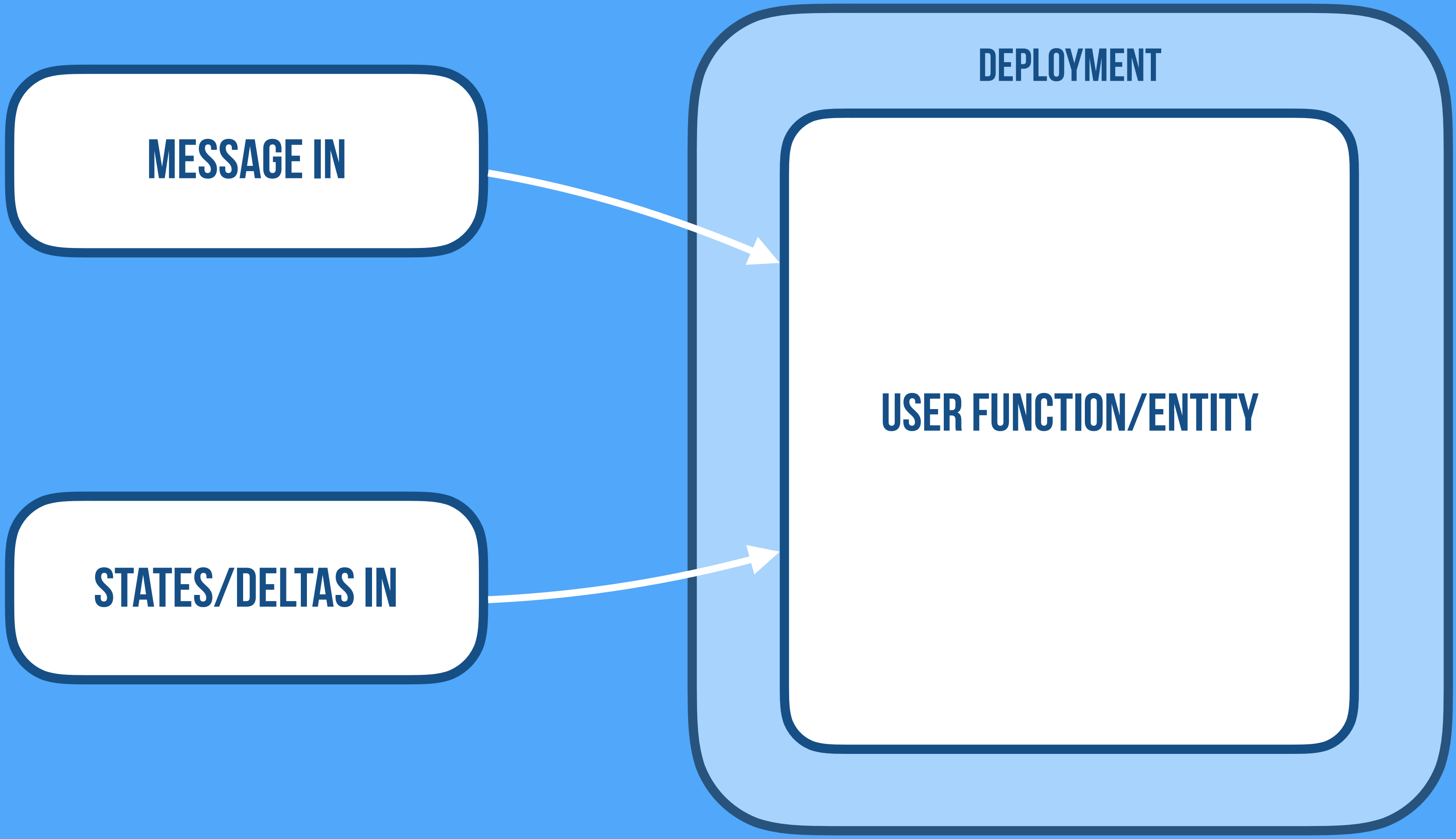

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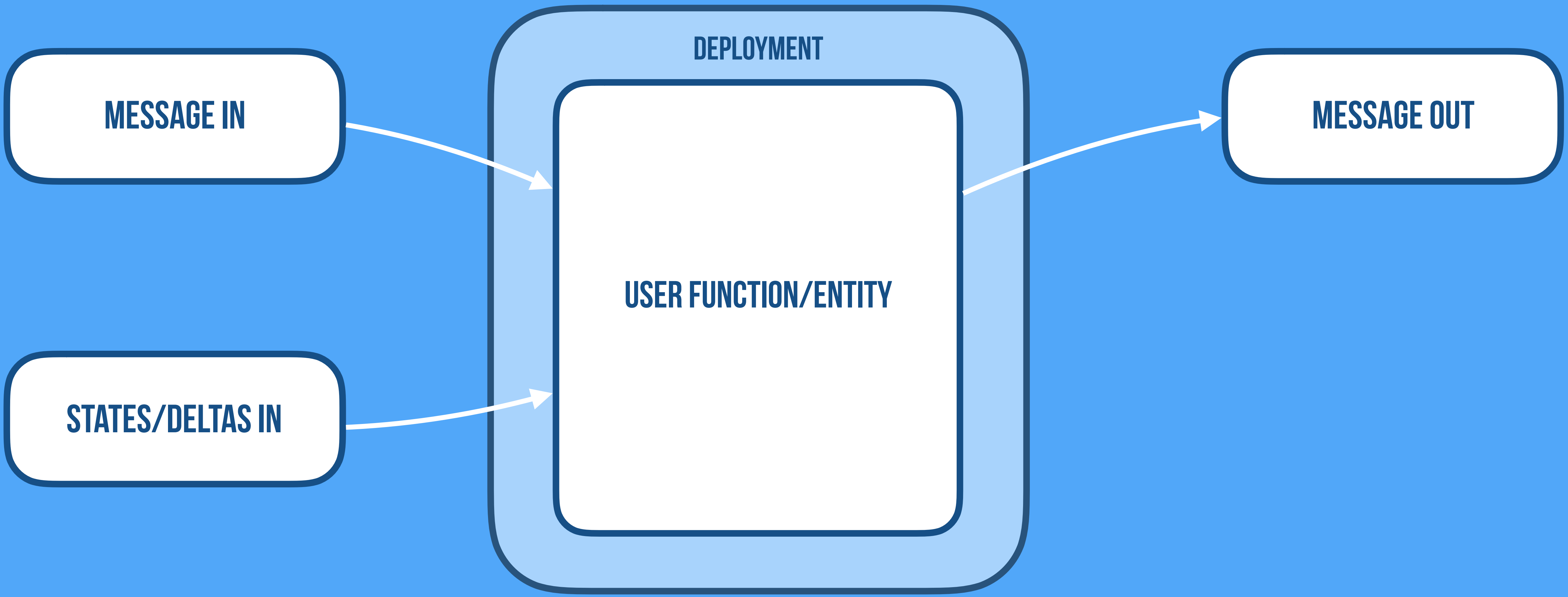

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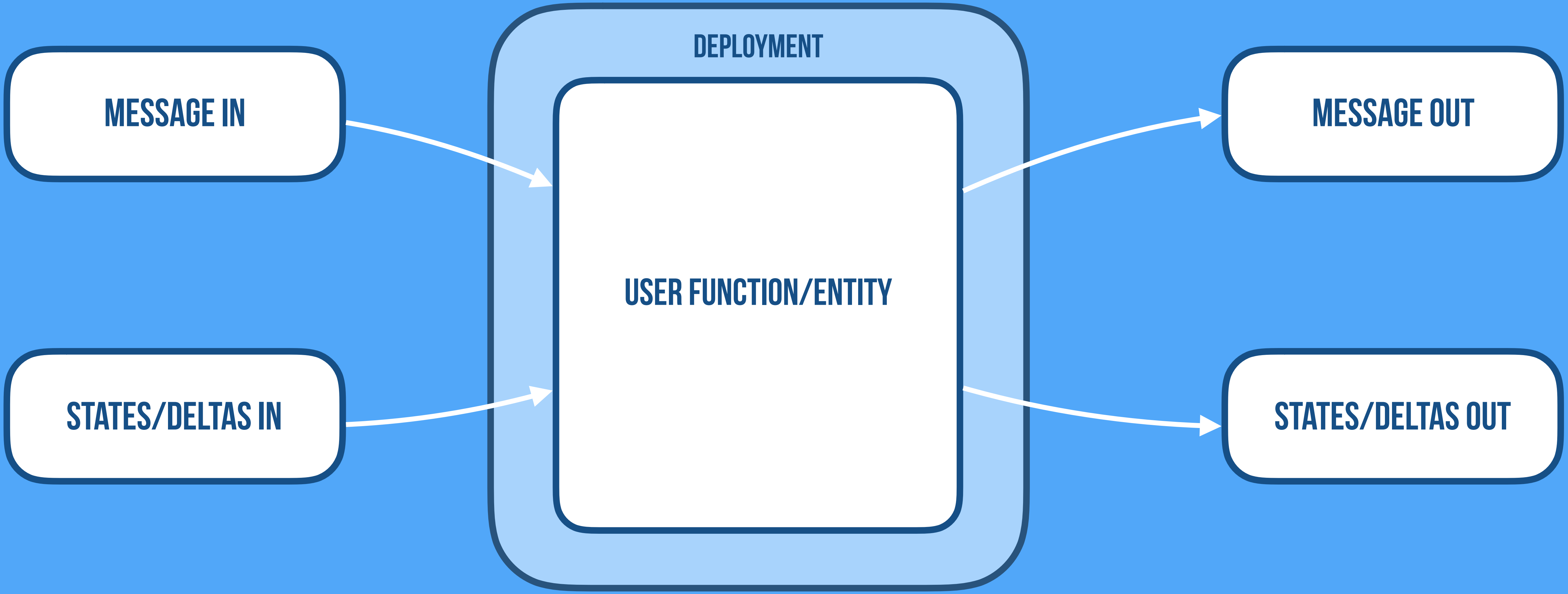

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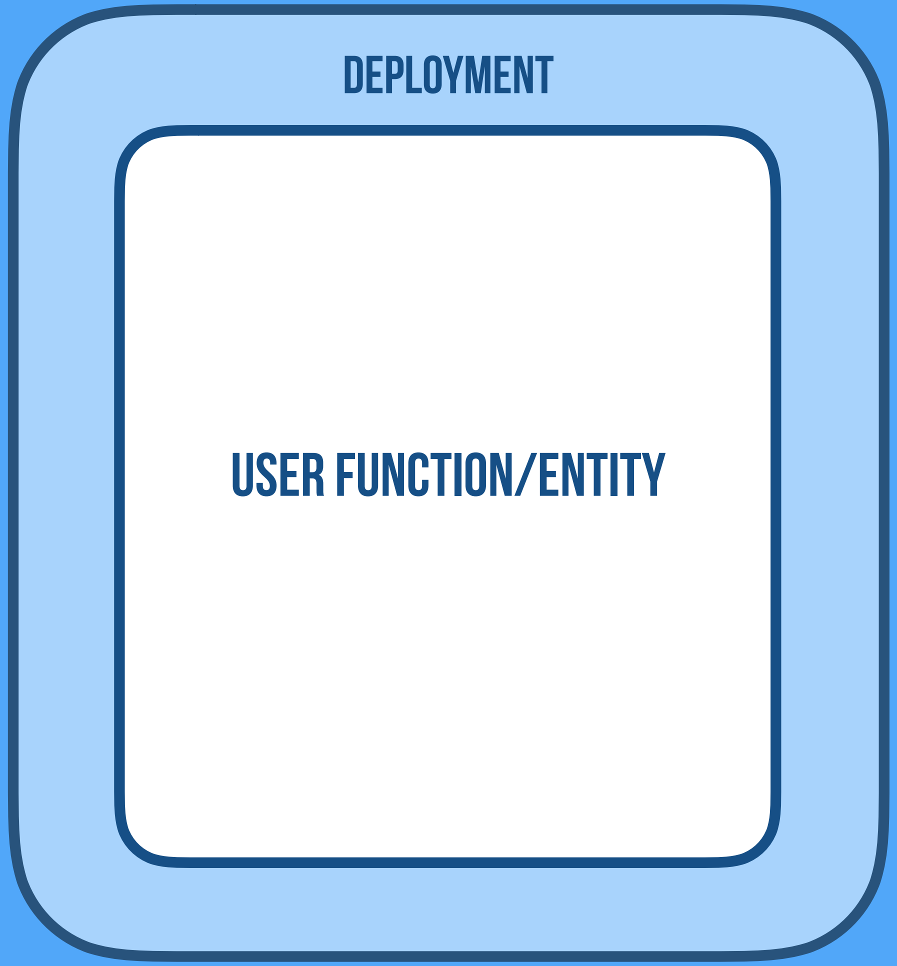

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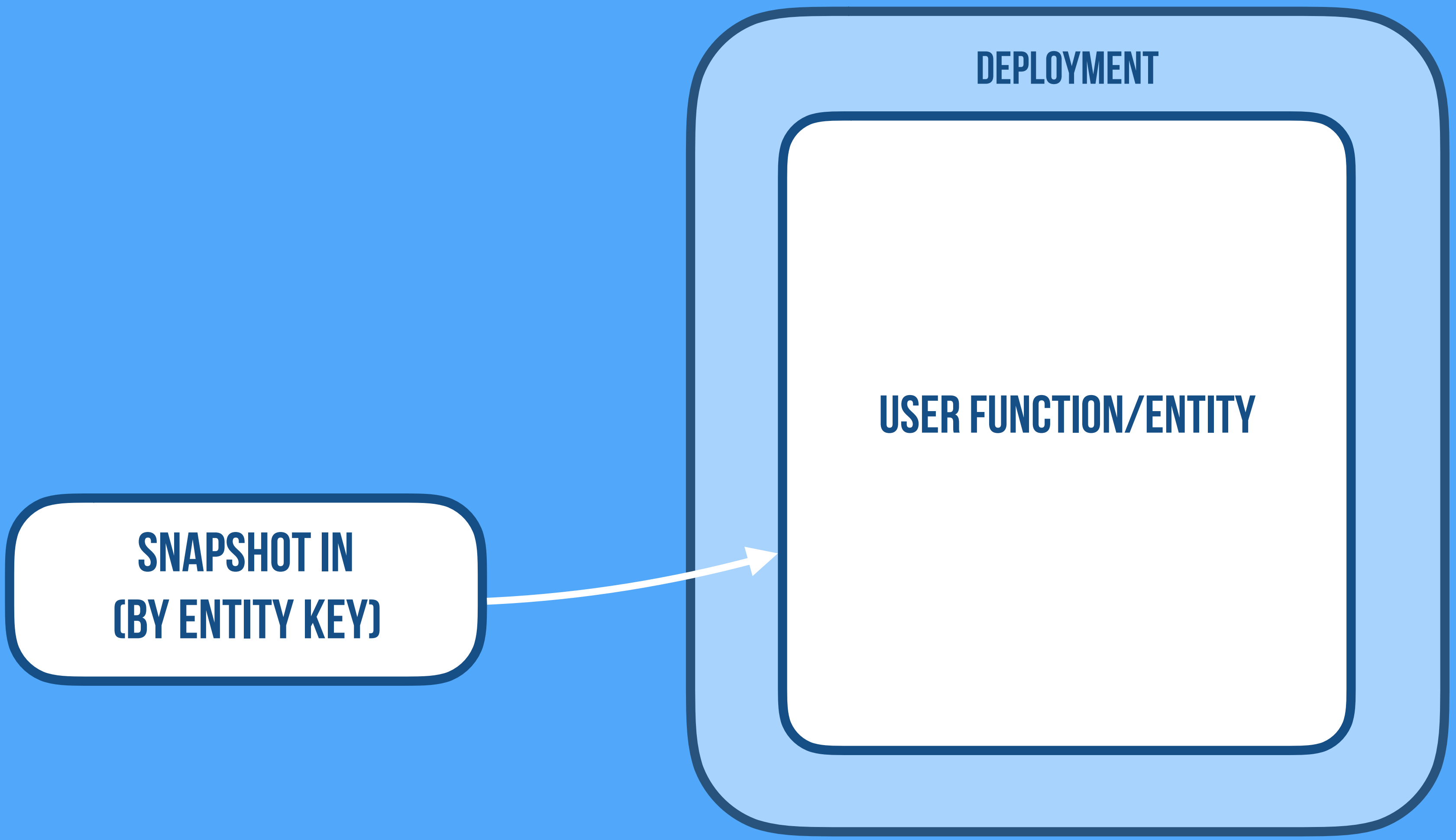

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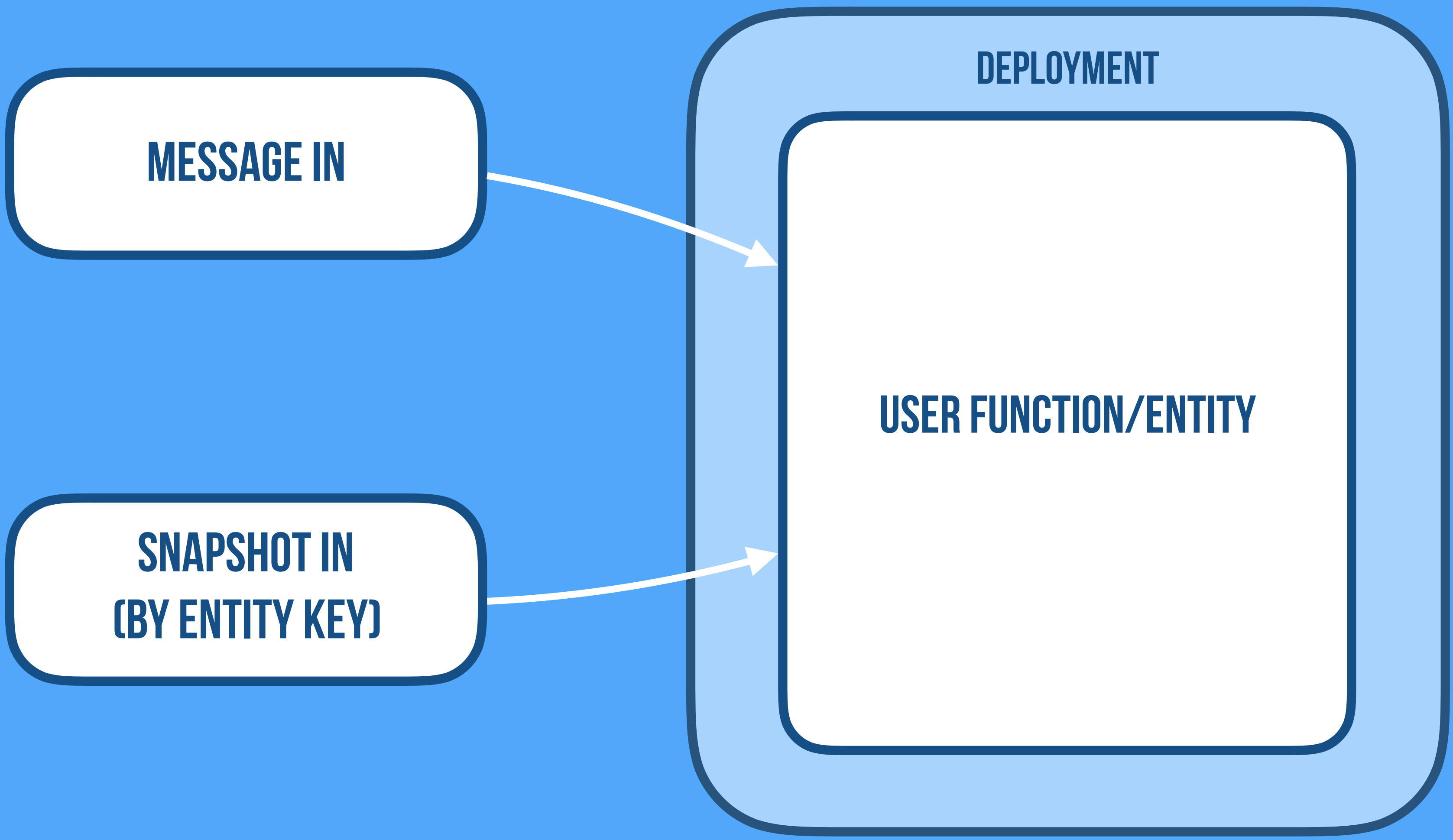

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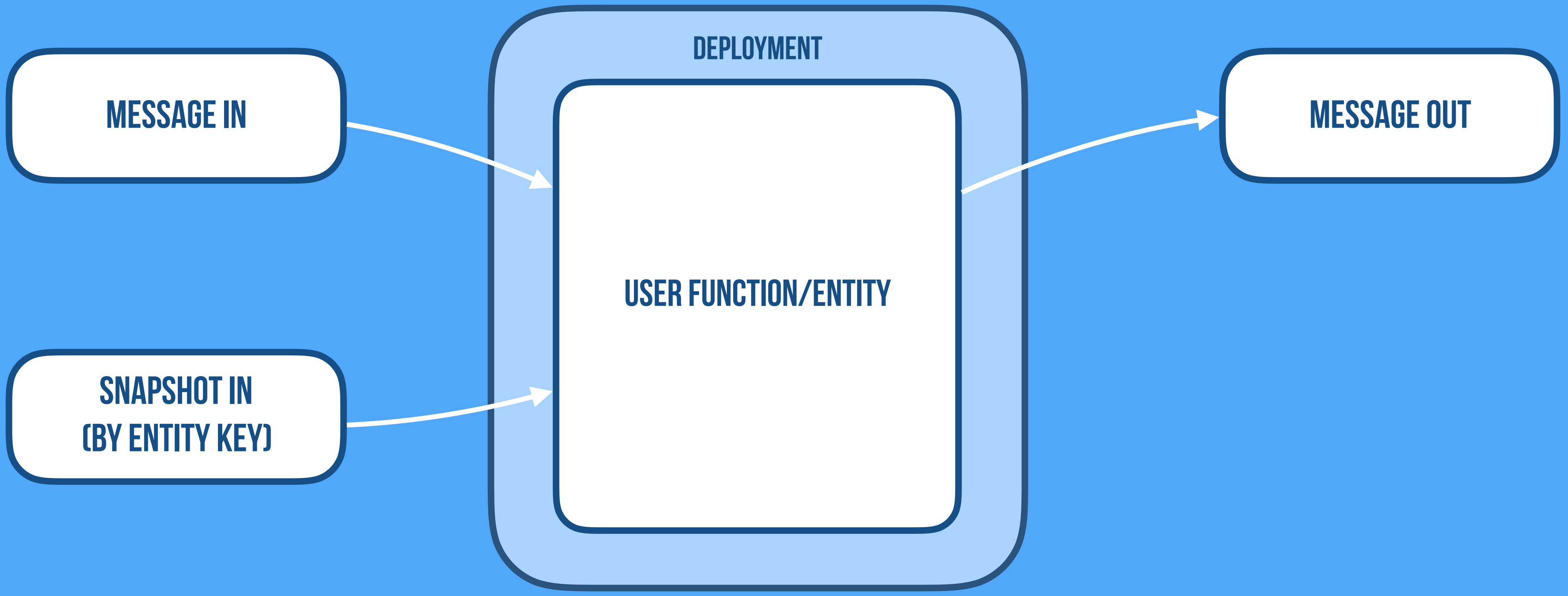

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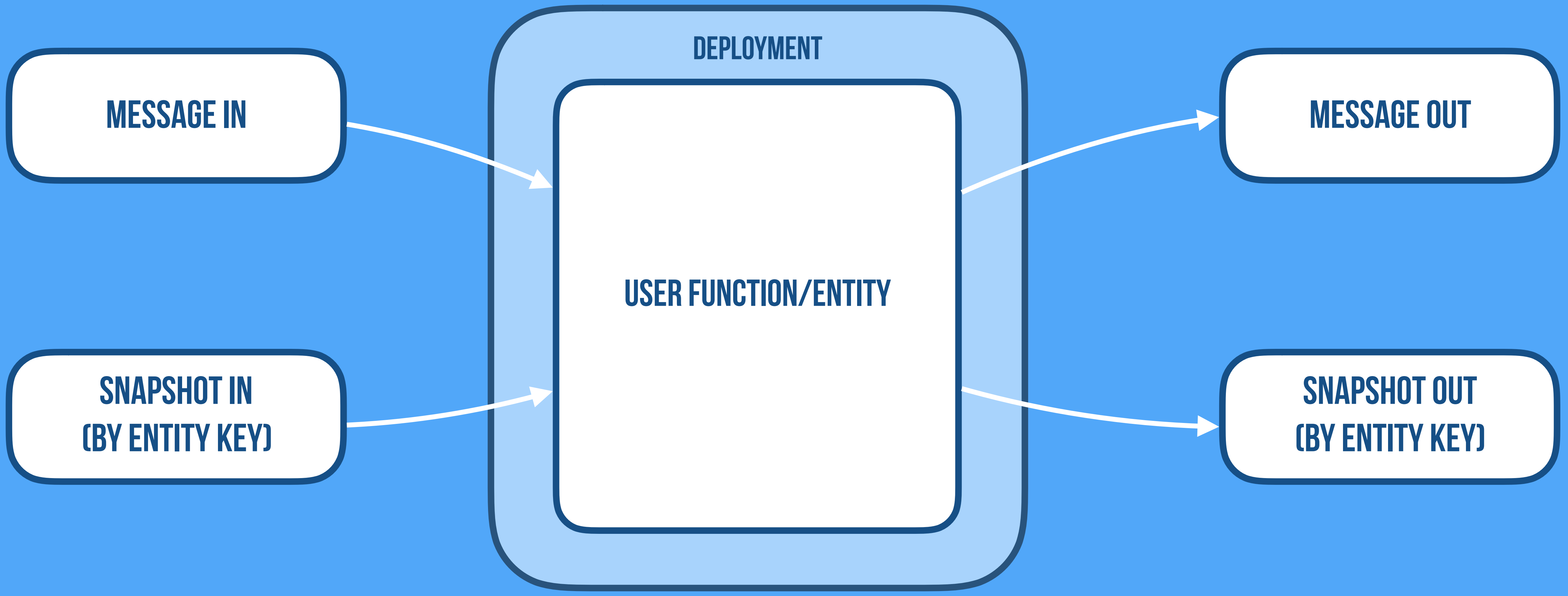

Introducing

cloudstate

WHAT IS CLOUDSTATE?

https://cloudstate.io

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Two things:

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Two things:

1. Standards Project—defining a specification, protocol, and TCK

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Highlights:

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- Open Source leveraging Akka, gRPC, Knative, GraalVM, running on Kubernetes

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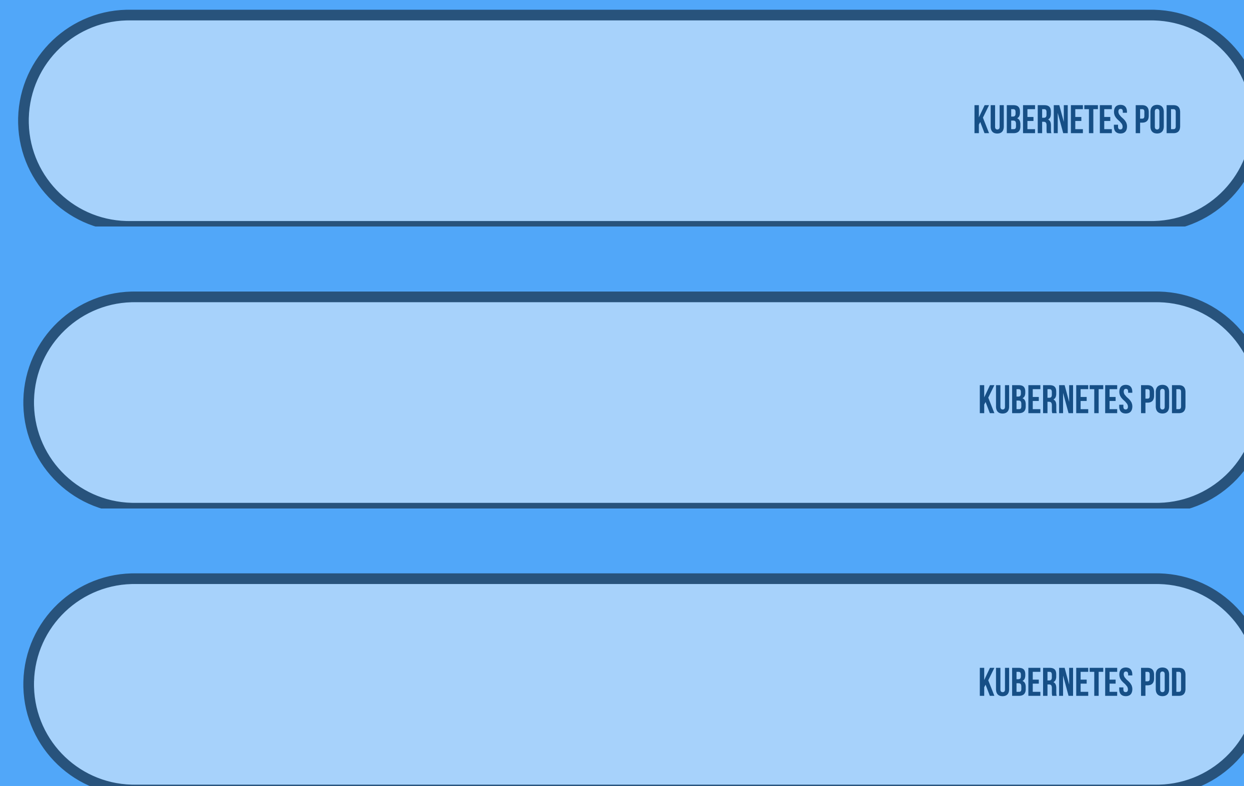

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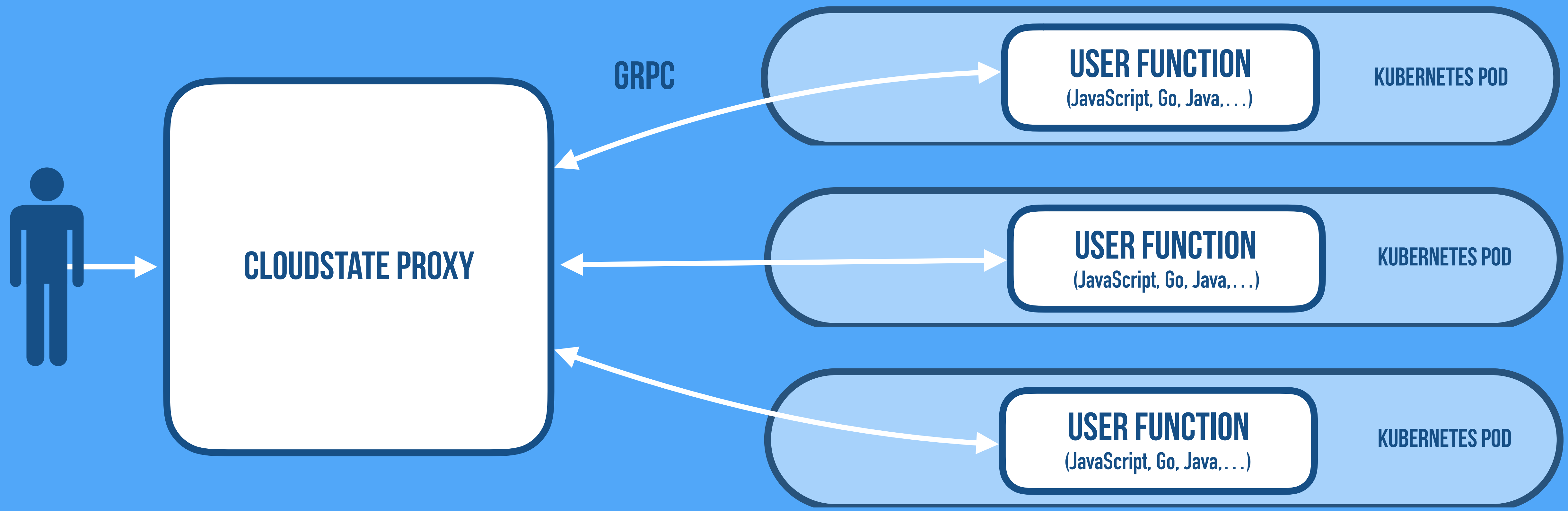

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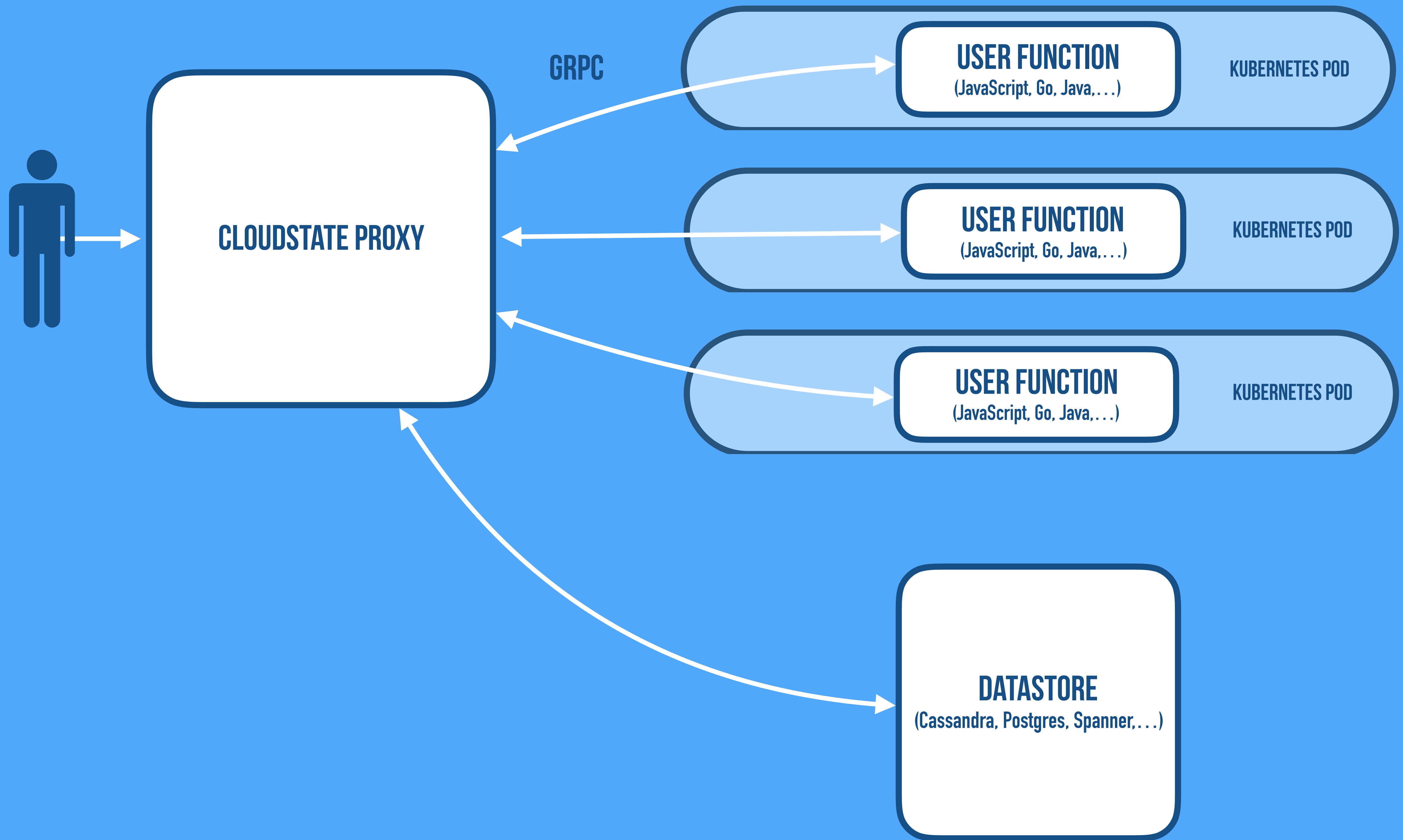
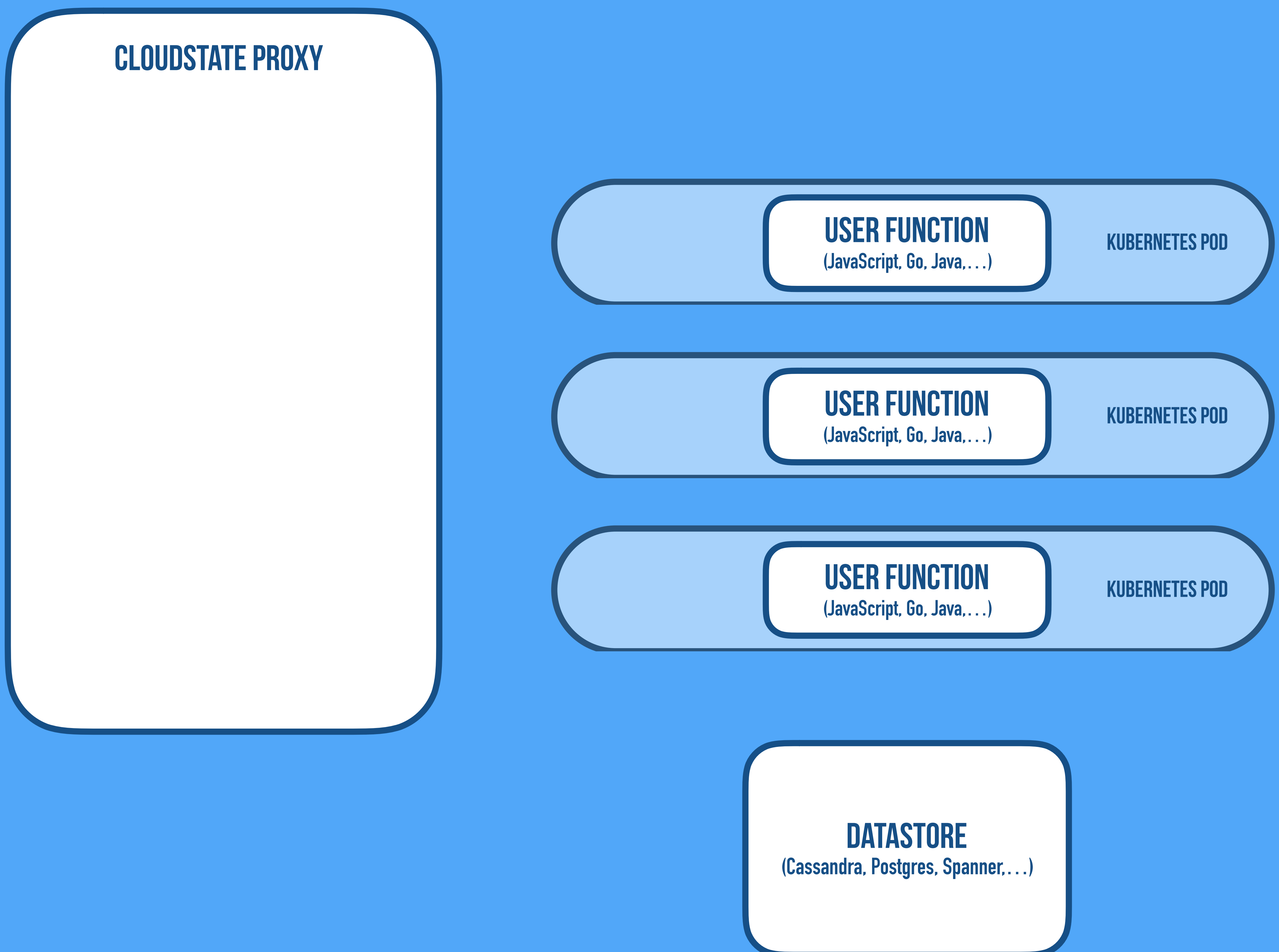


POWERED BY AKKA CLUSTER SIDECARS



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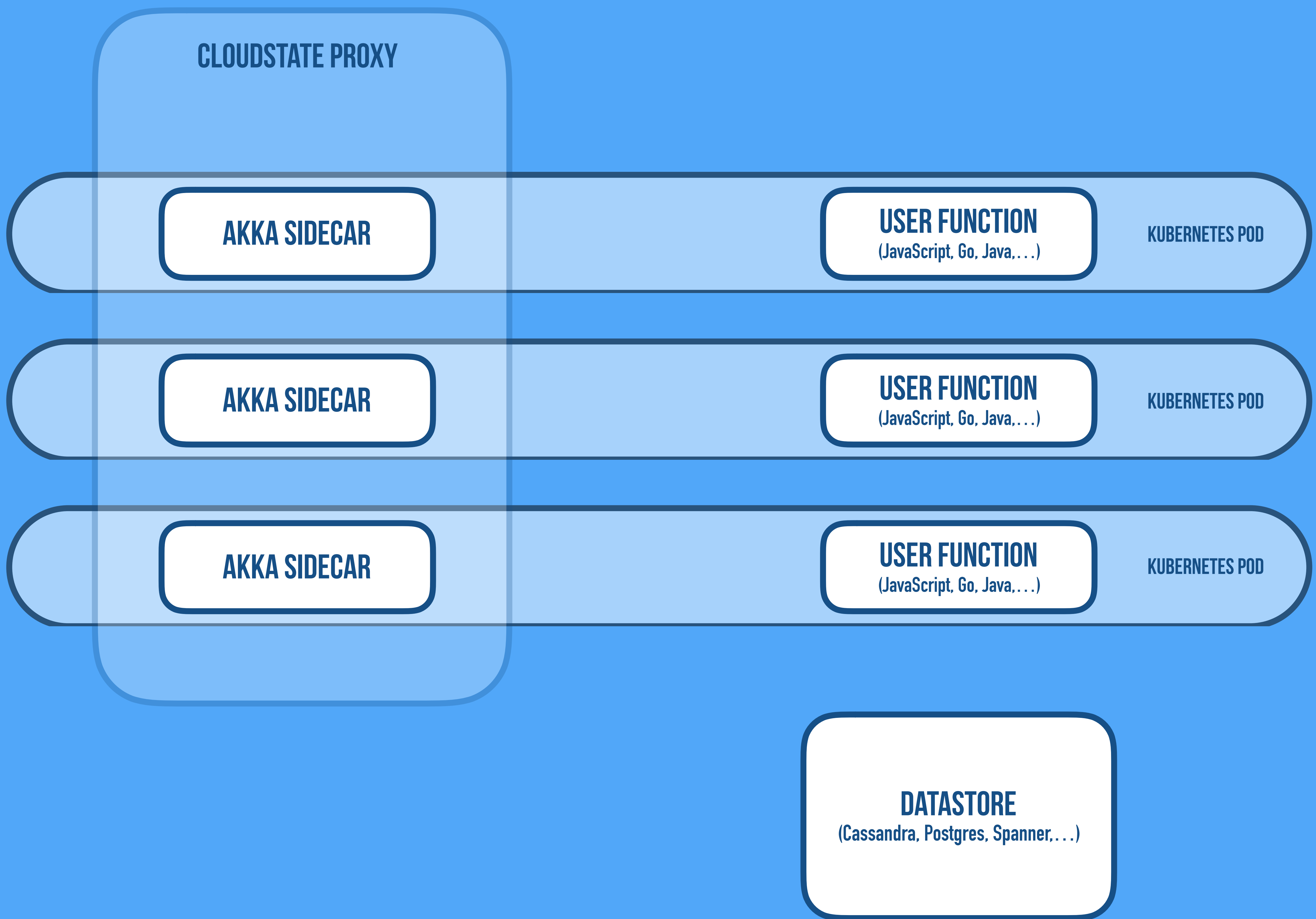

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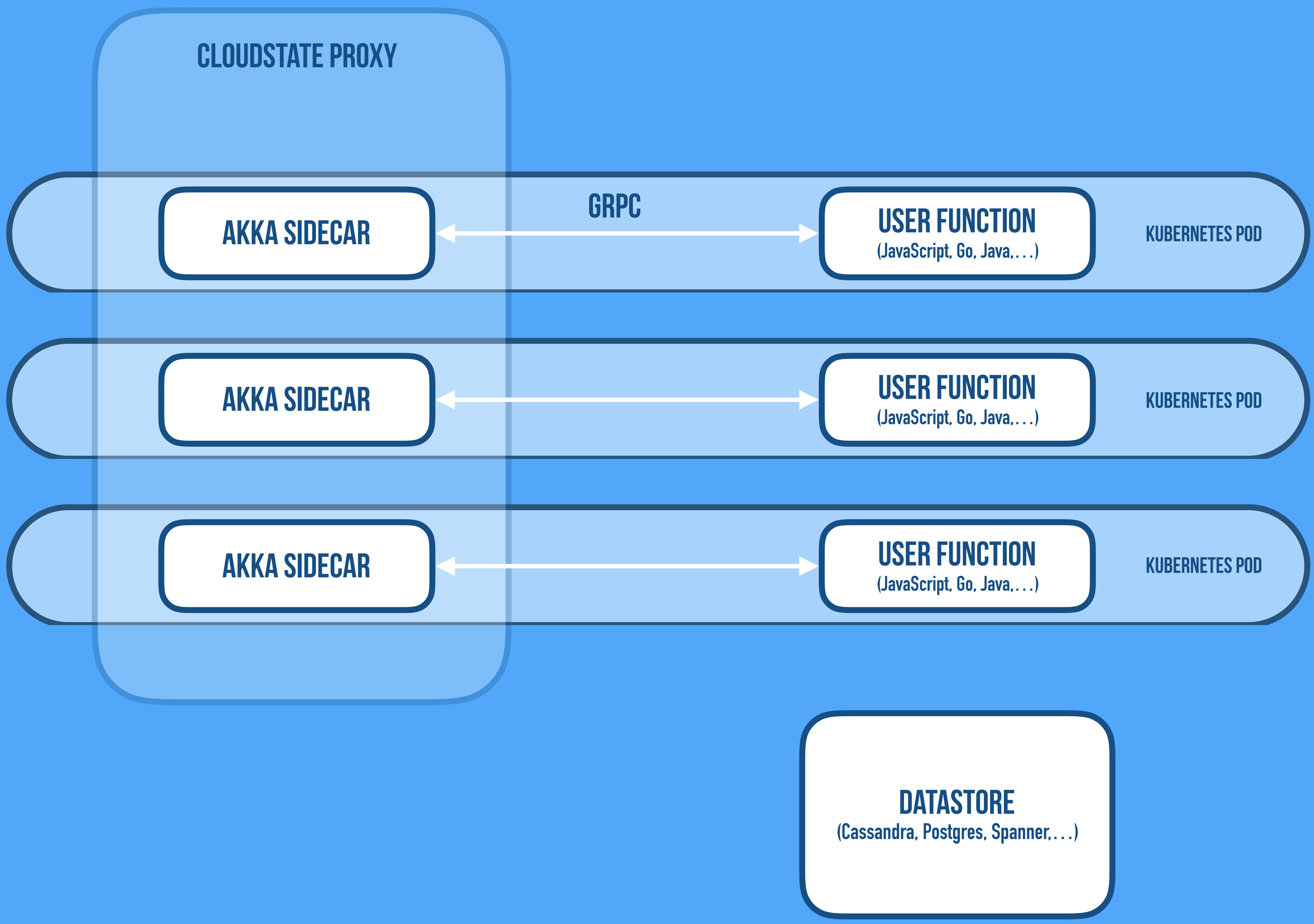

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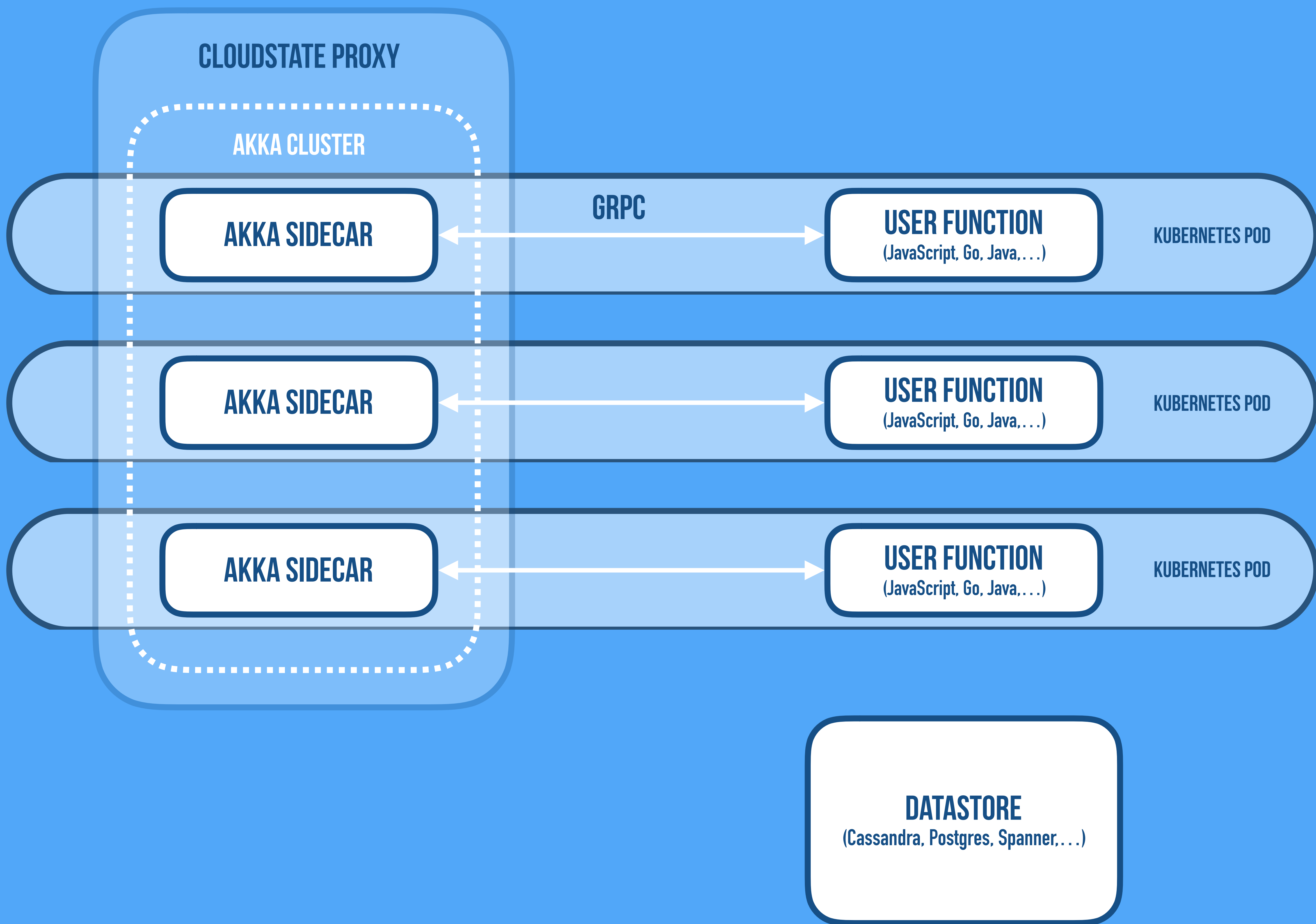

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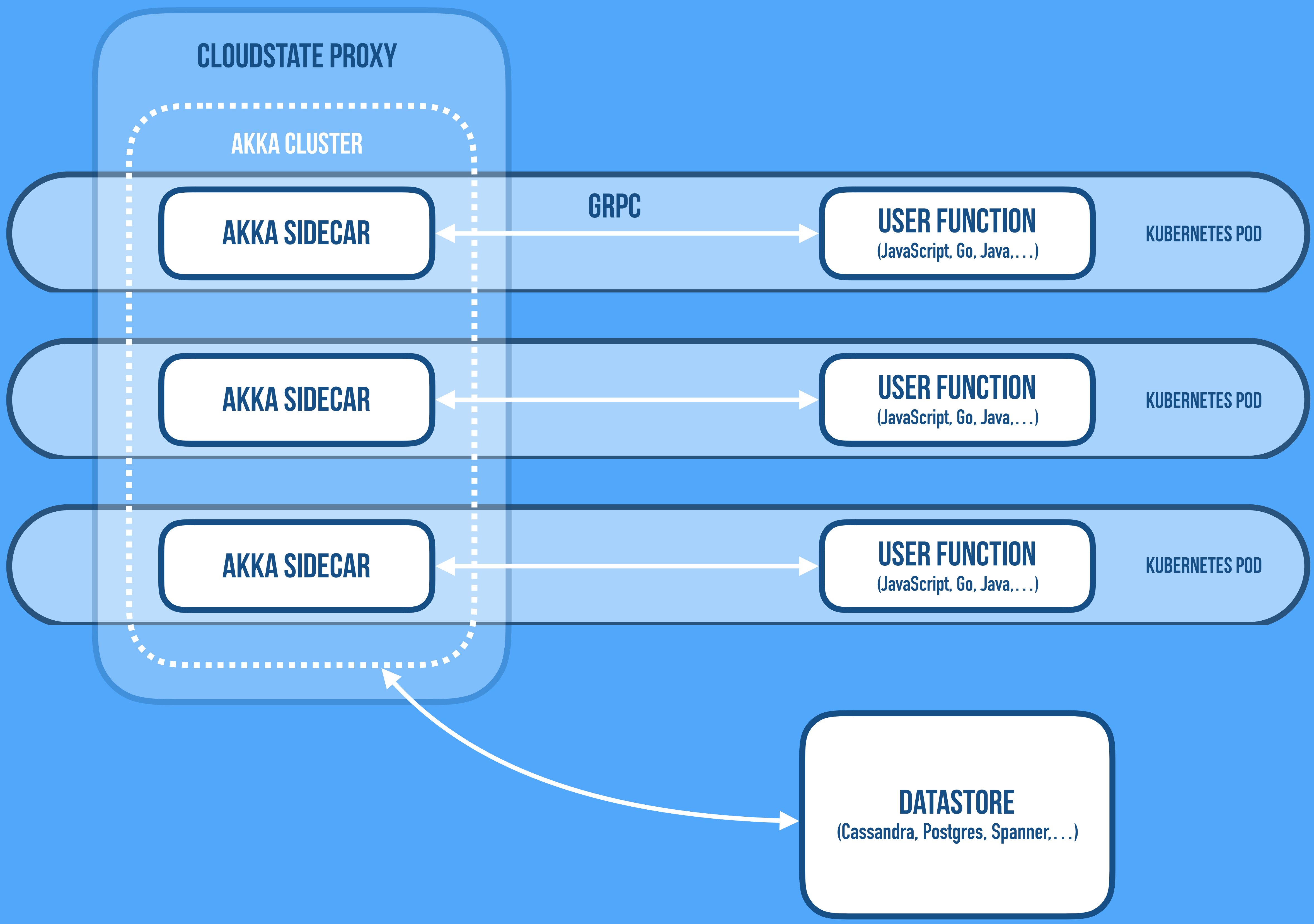

AKKA CLUSTER STATE MANAGEMENT

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- Actor-based Distributed Runtime

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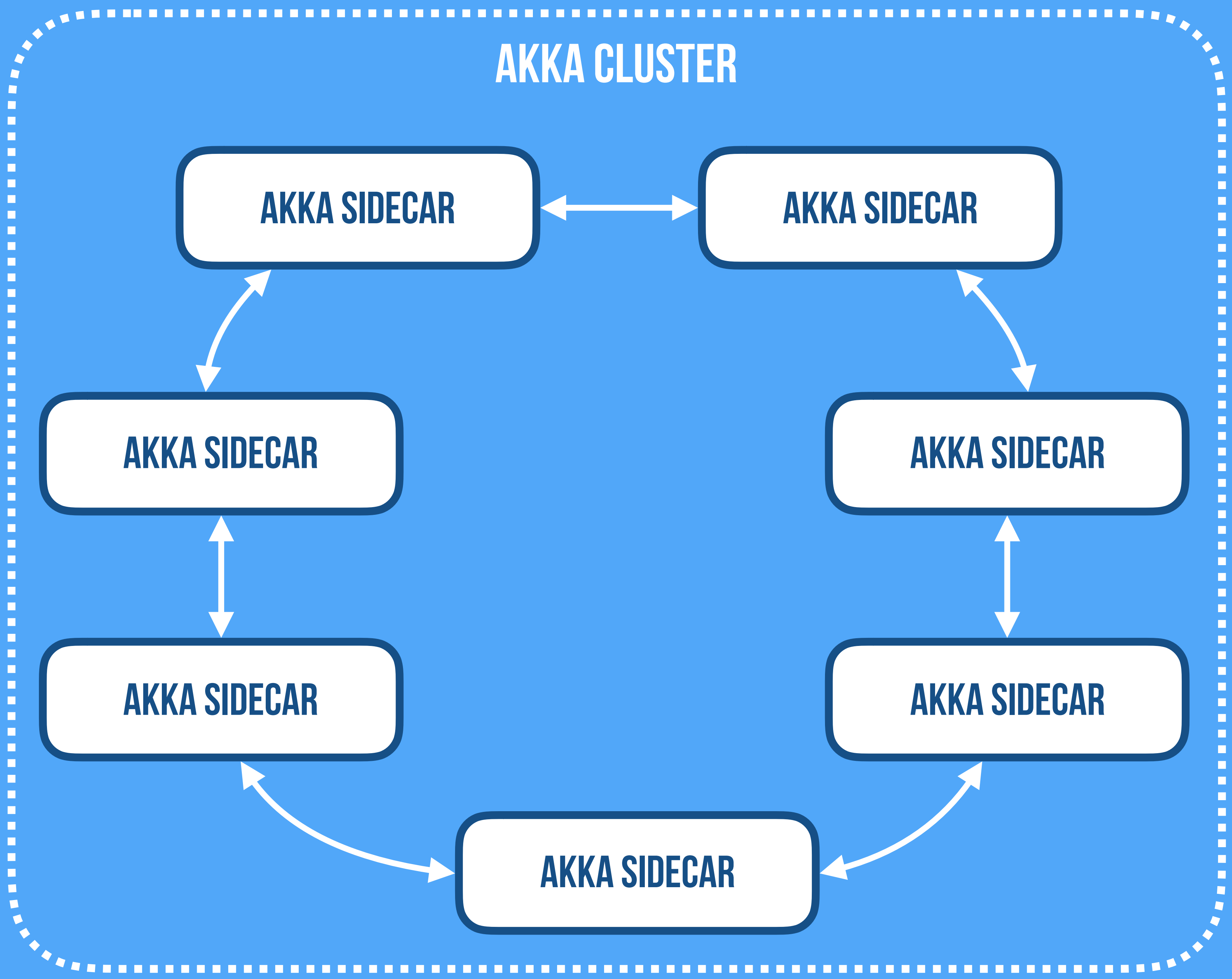

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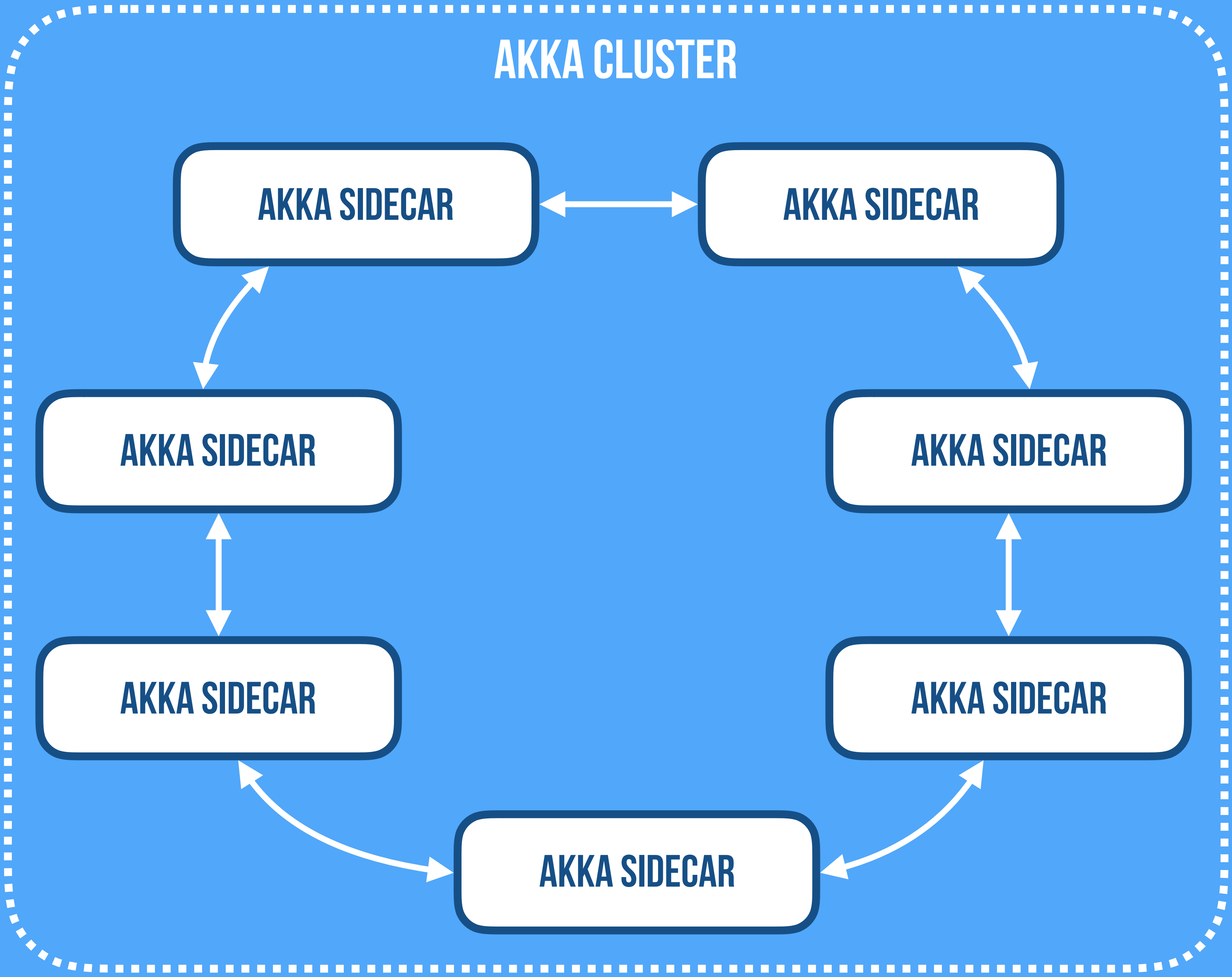

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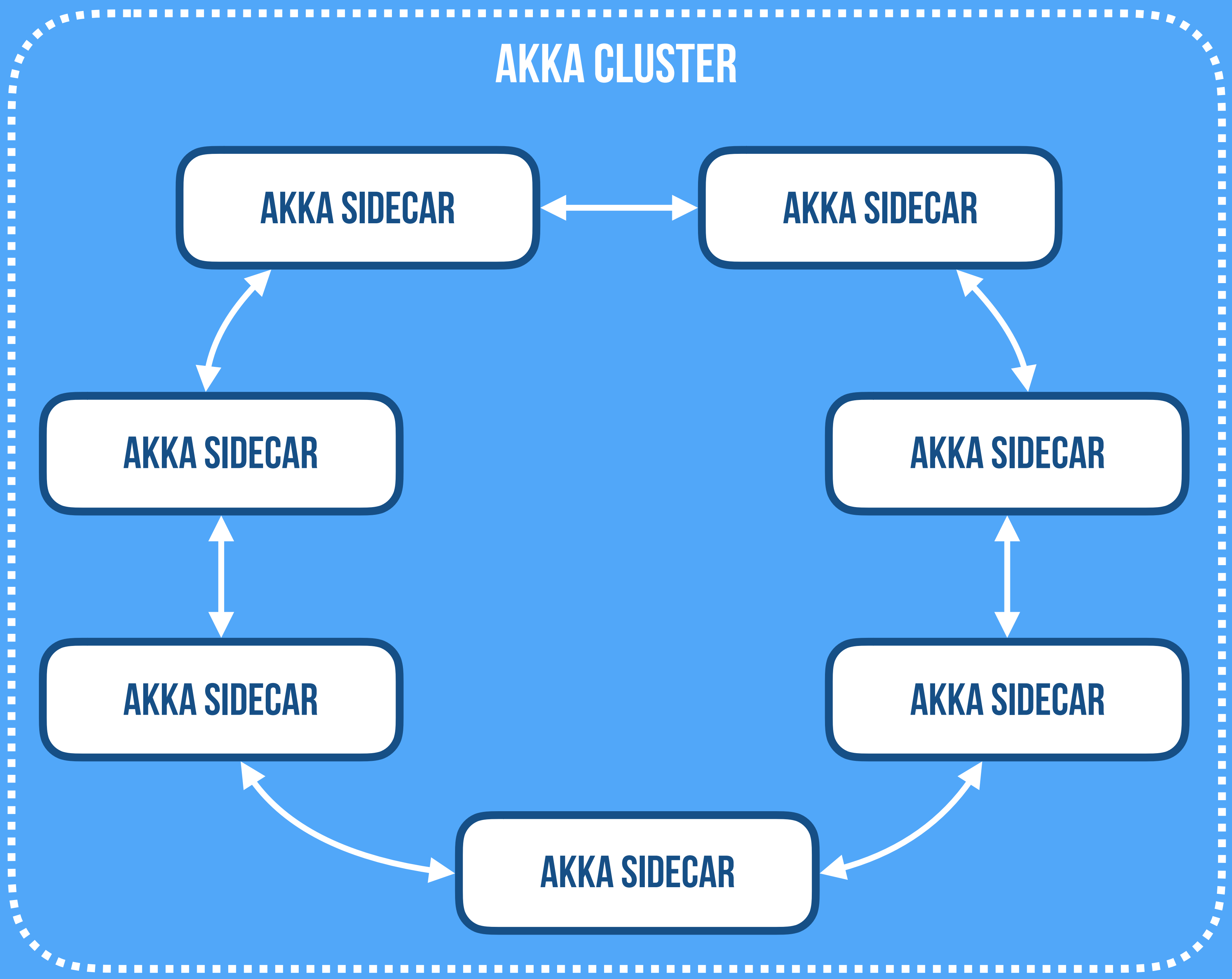

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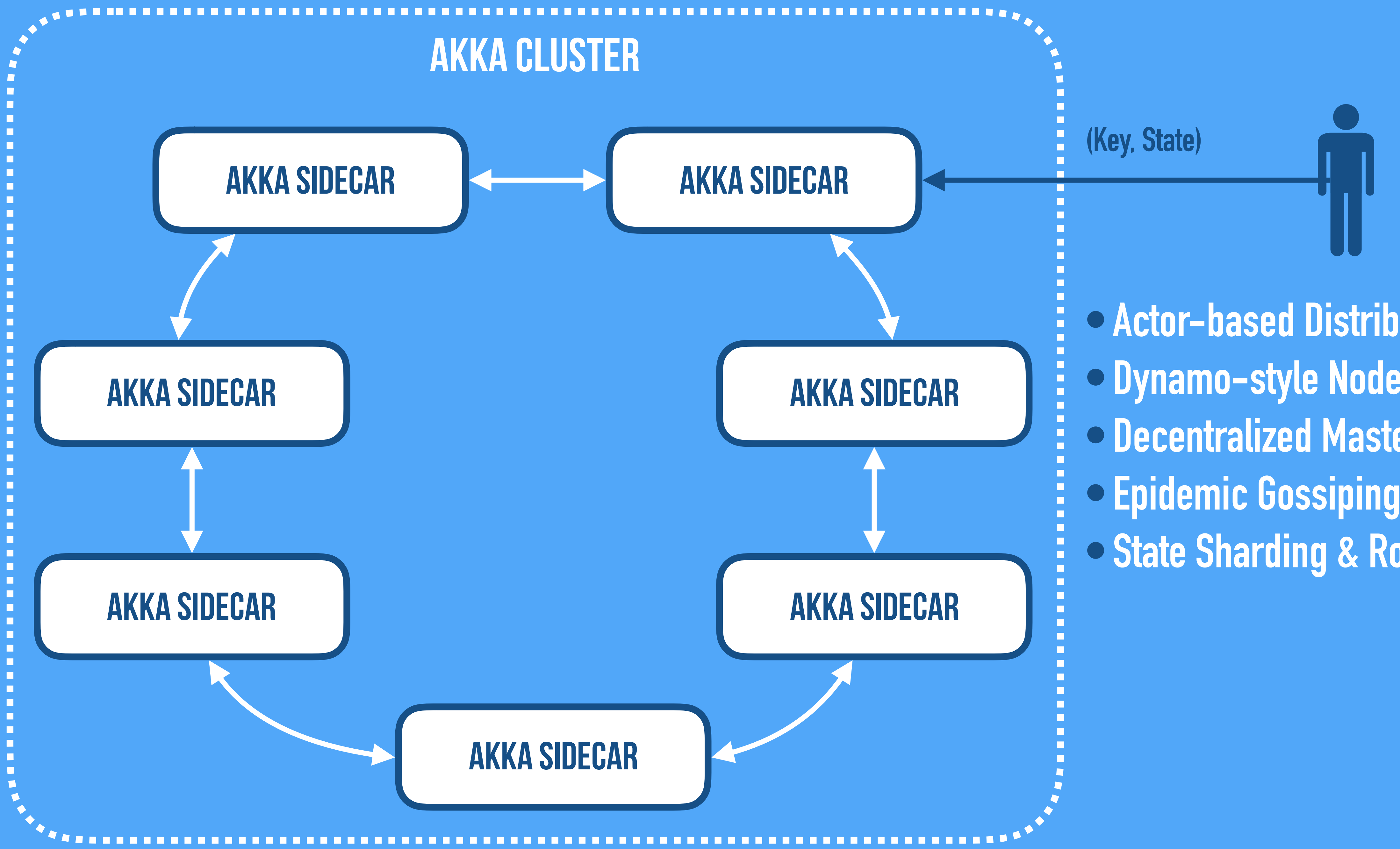

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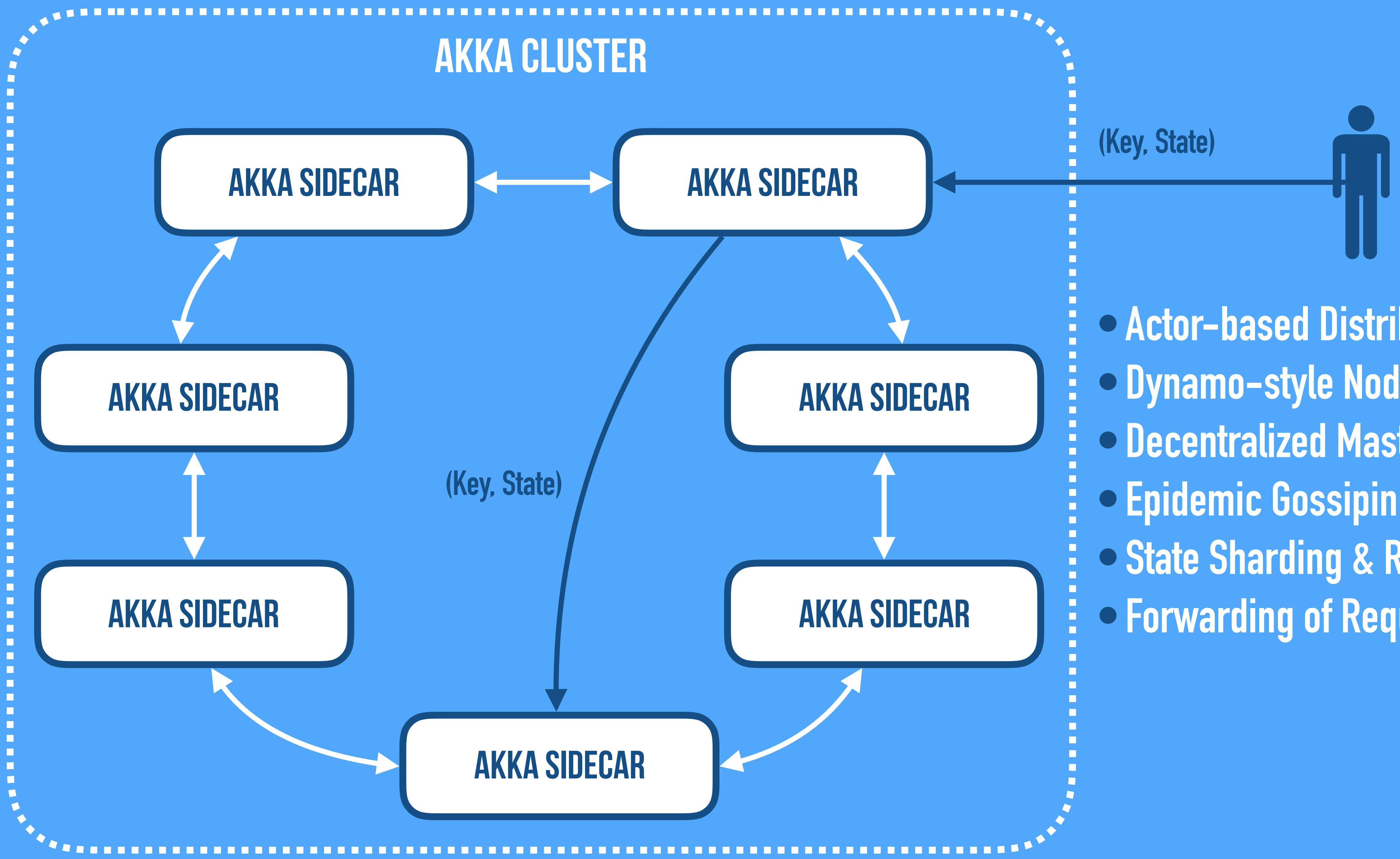

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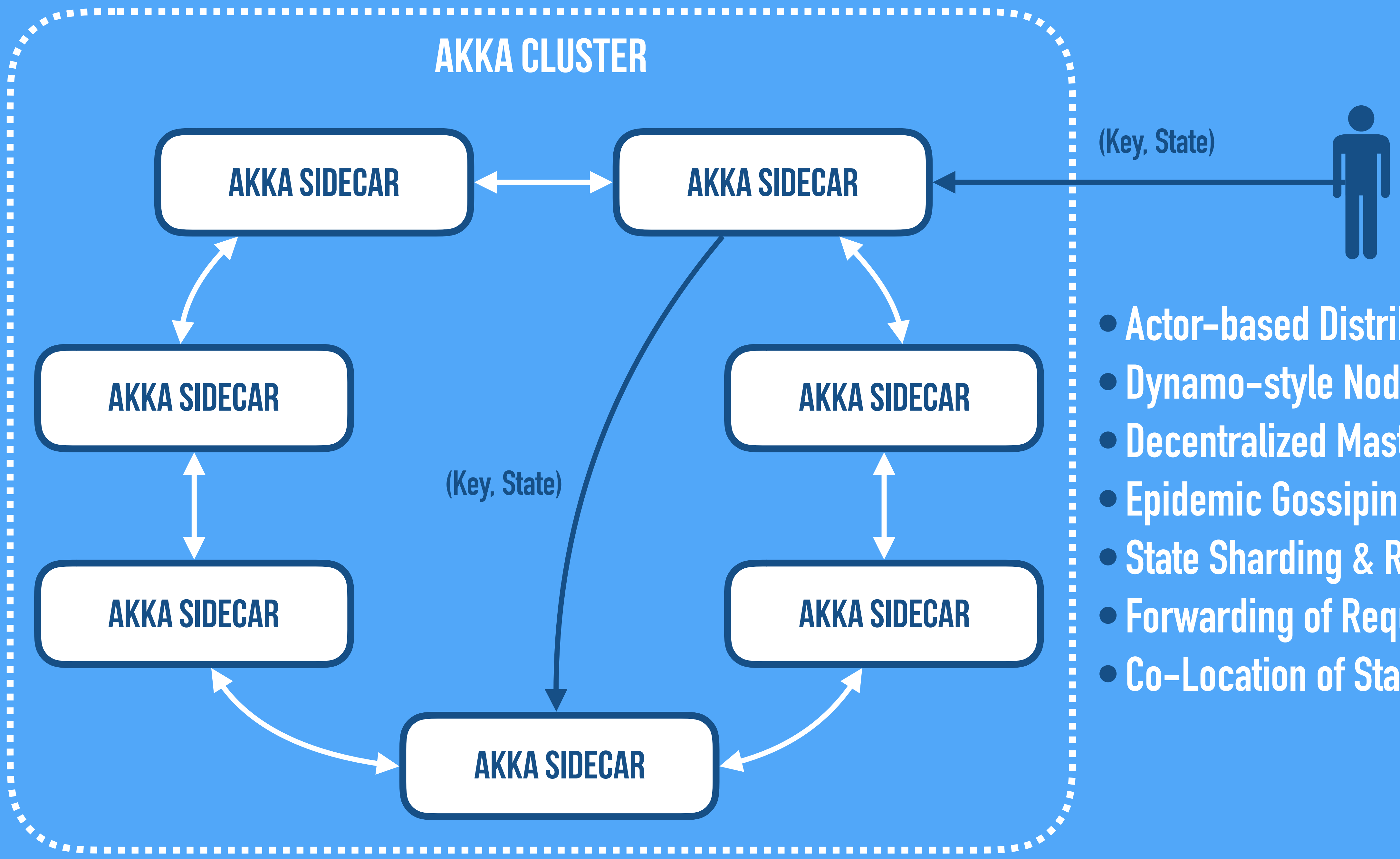

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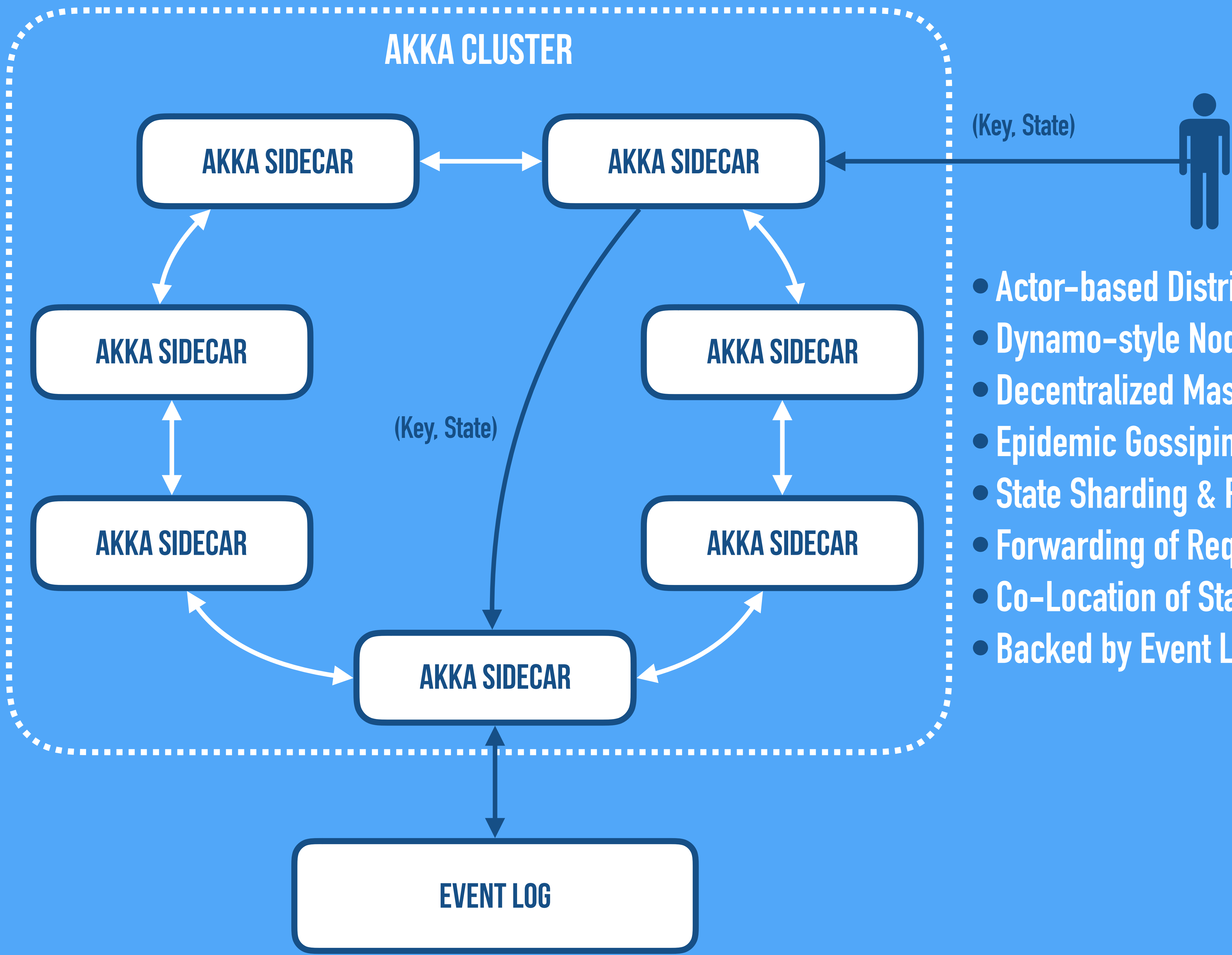

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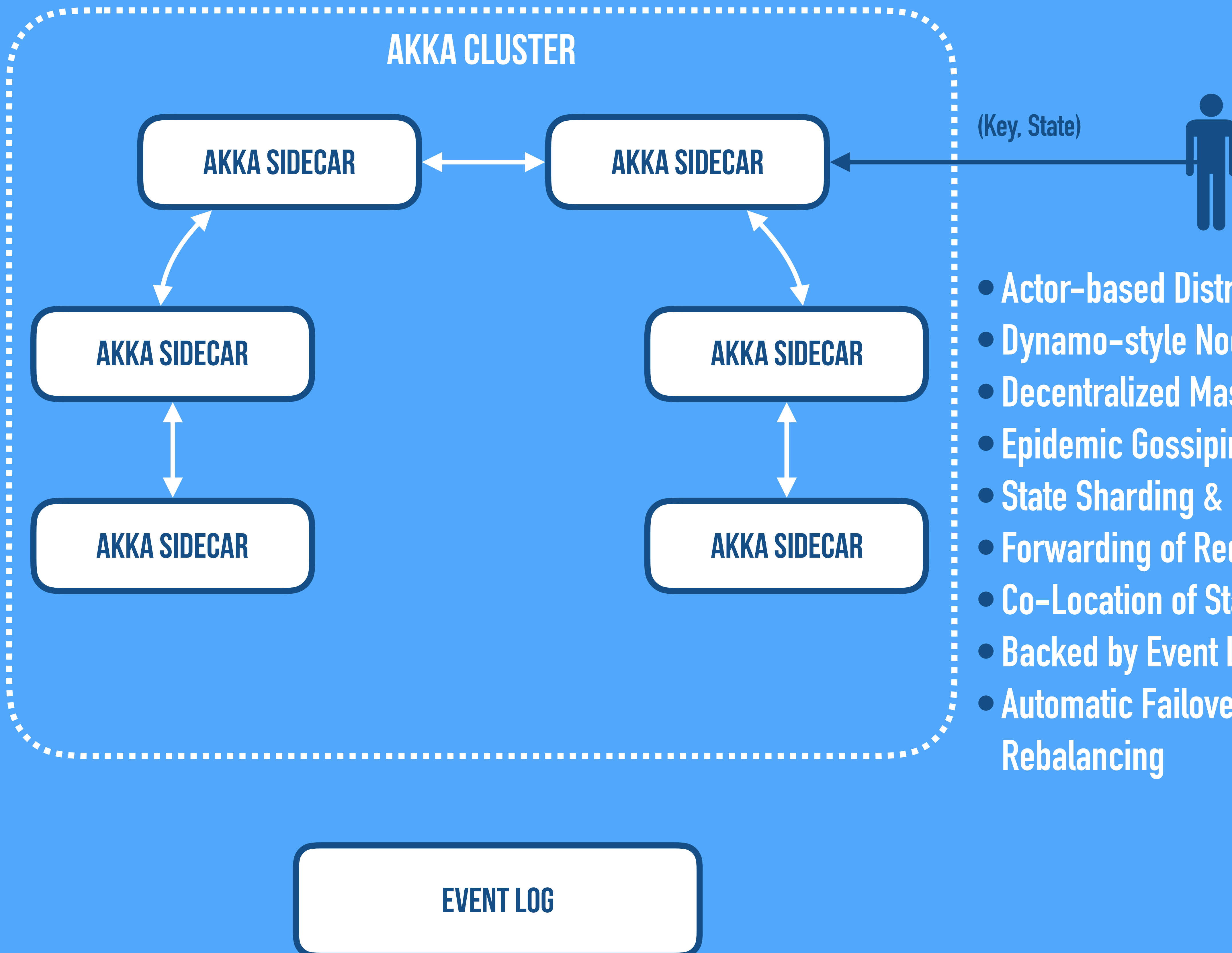

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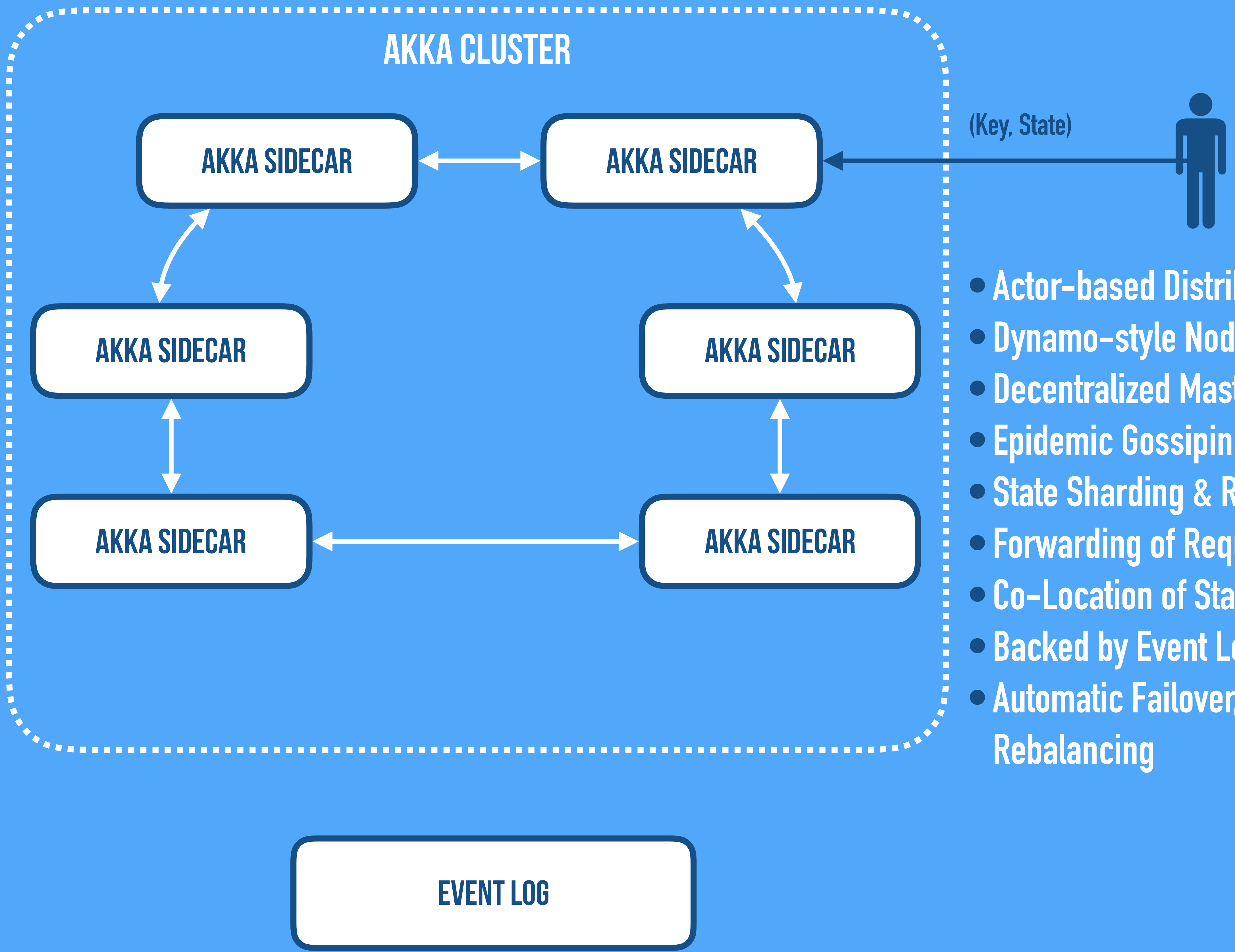

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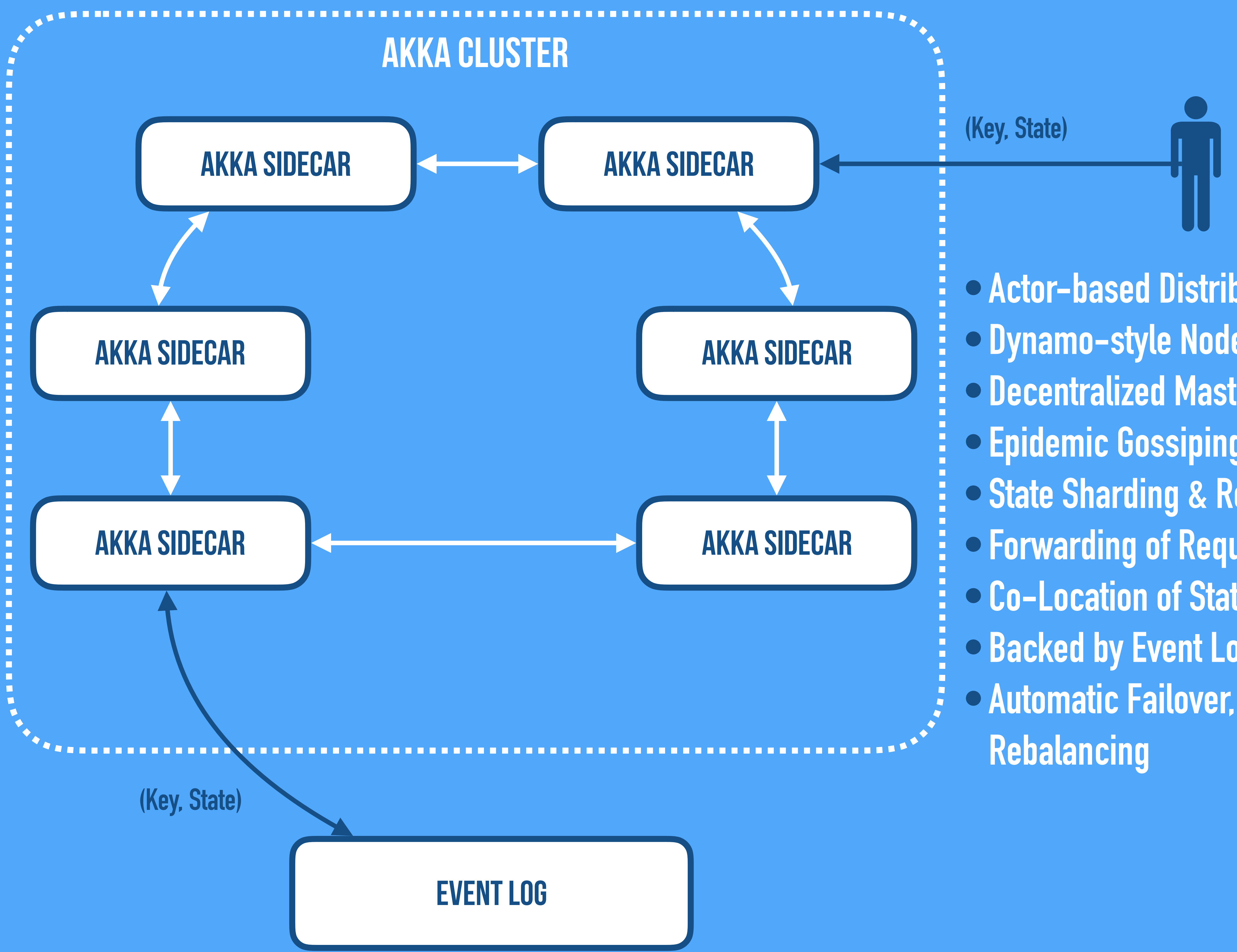

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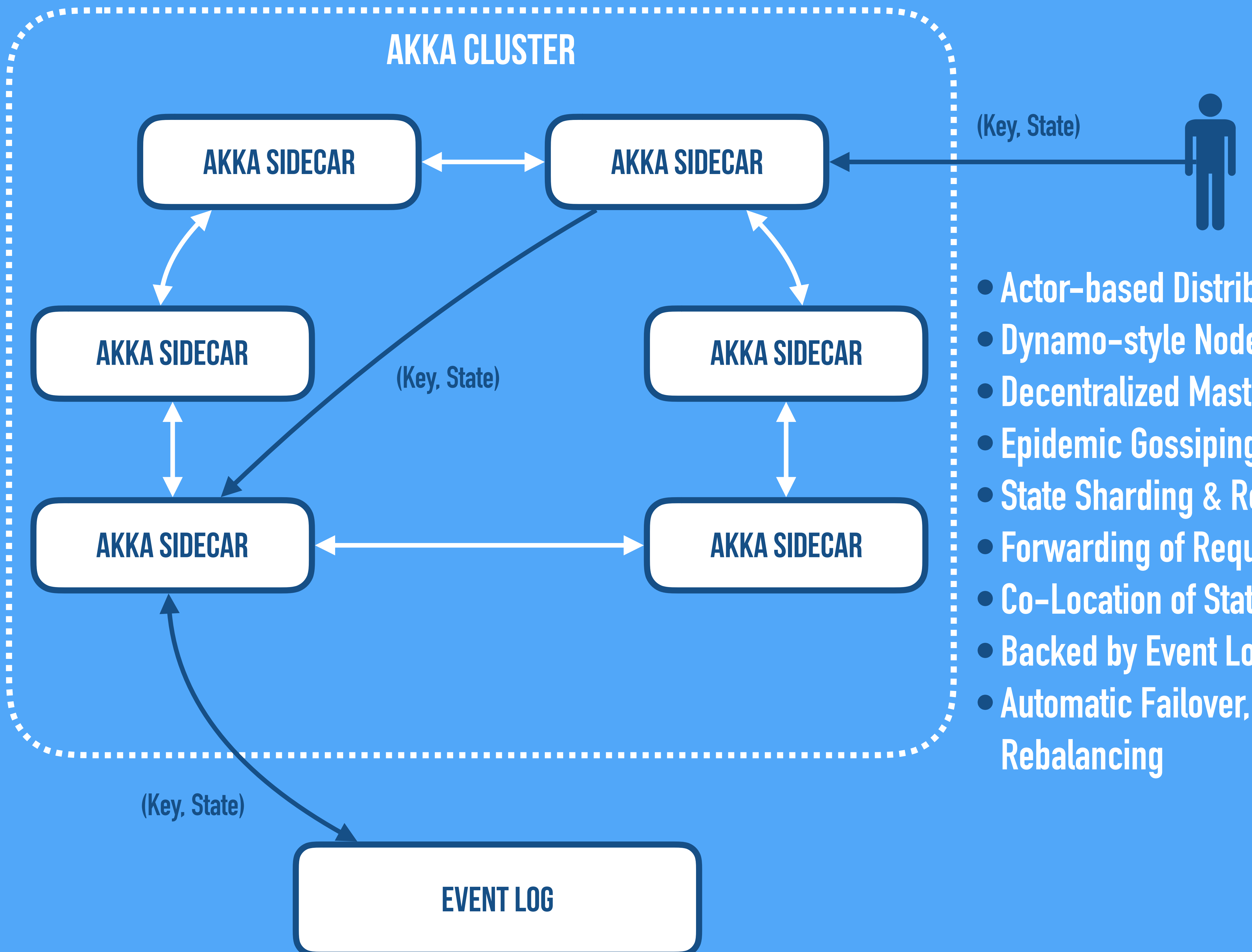

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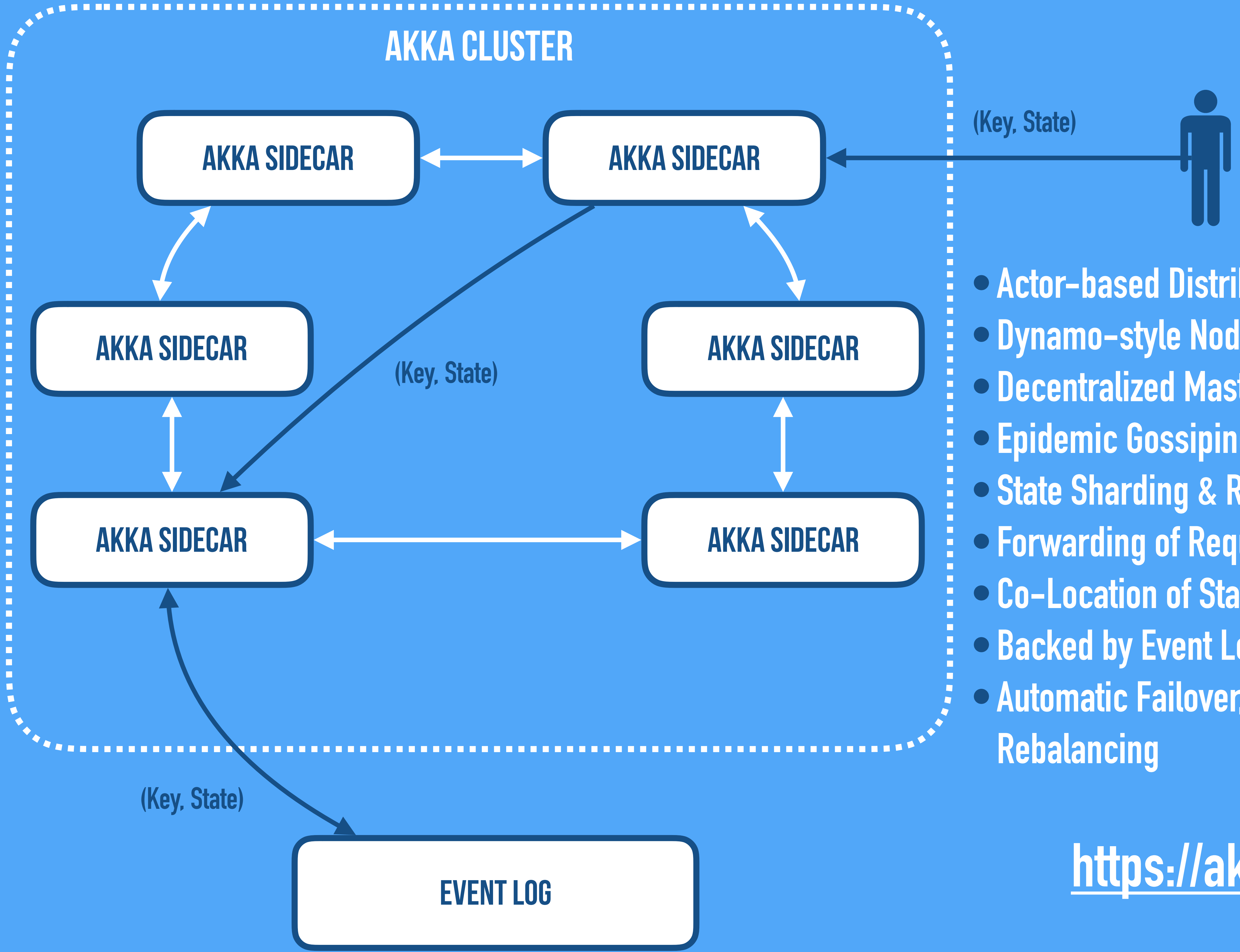

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https://akka.io

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4. We can't ignore/delegate the hardest thing: State
5. We think that Cloudstate shows the way