Kappa–Serverless IoT

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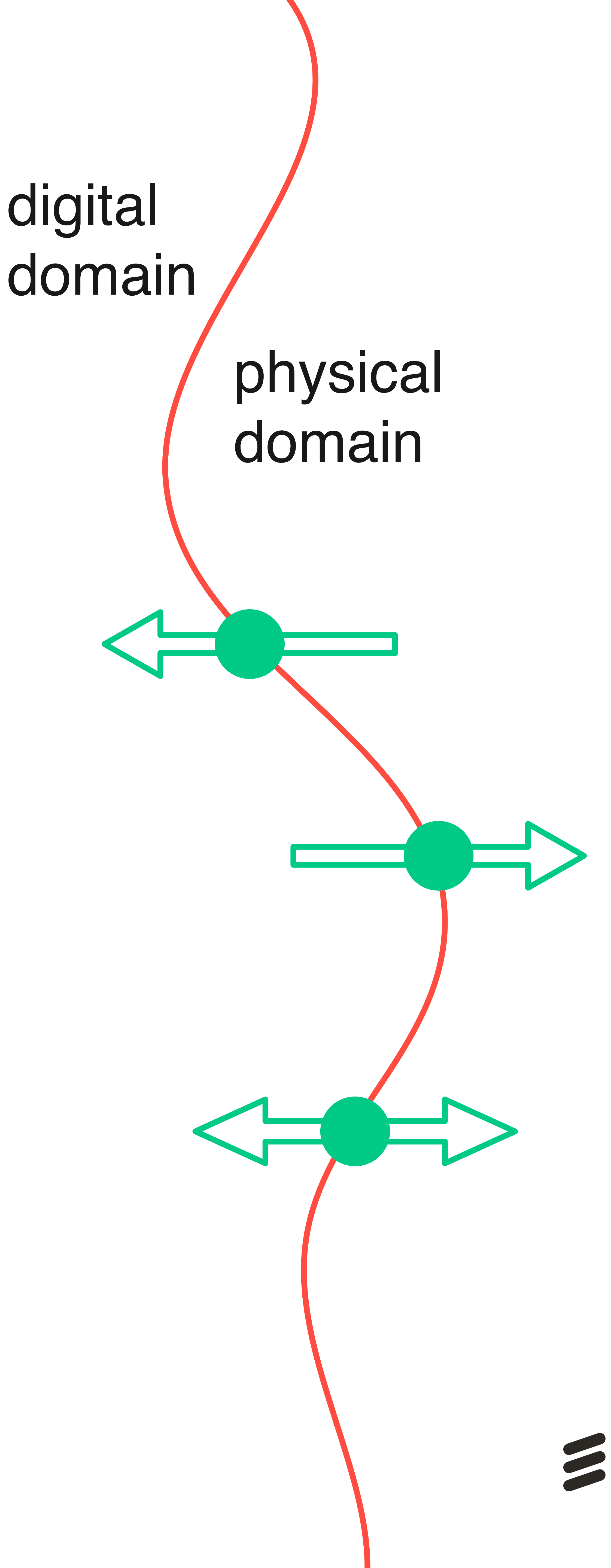
Serverless IoT

Does it even make sense?

- IoT is about
  - capturing, digitally representing, and manipulating the physical world
  - devices forming the interface between the domains
  - long-running, stateful applications
- Things IoT should adopt from cloud and serverless
  - simplicity
  - resource sharing, multi-tenancy
  - fine-grained metrics



digital domain

physical domain

Serverless IoT

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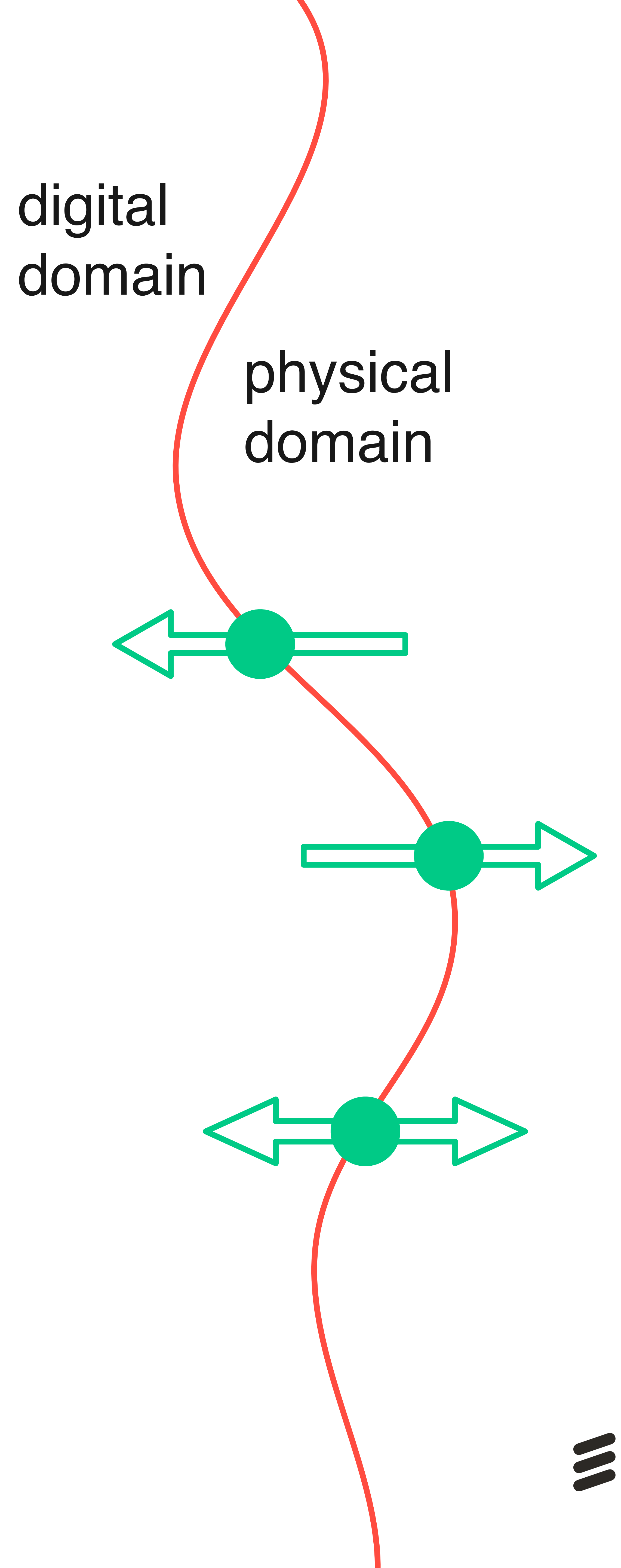
Serverless computing	Serverless IoT
transparent provisioning	semantics
stateless	local state
short lived	long lived, but mostly sleeping
use your favourite language/paradigm	restricted programming model



IoT-programming with Calvin

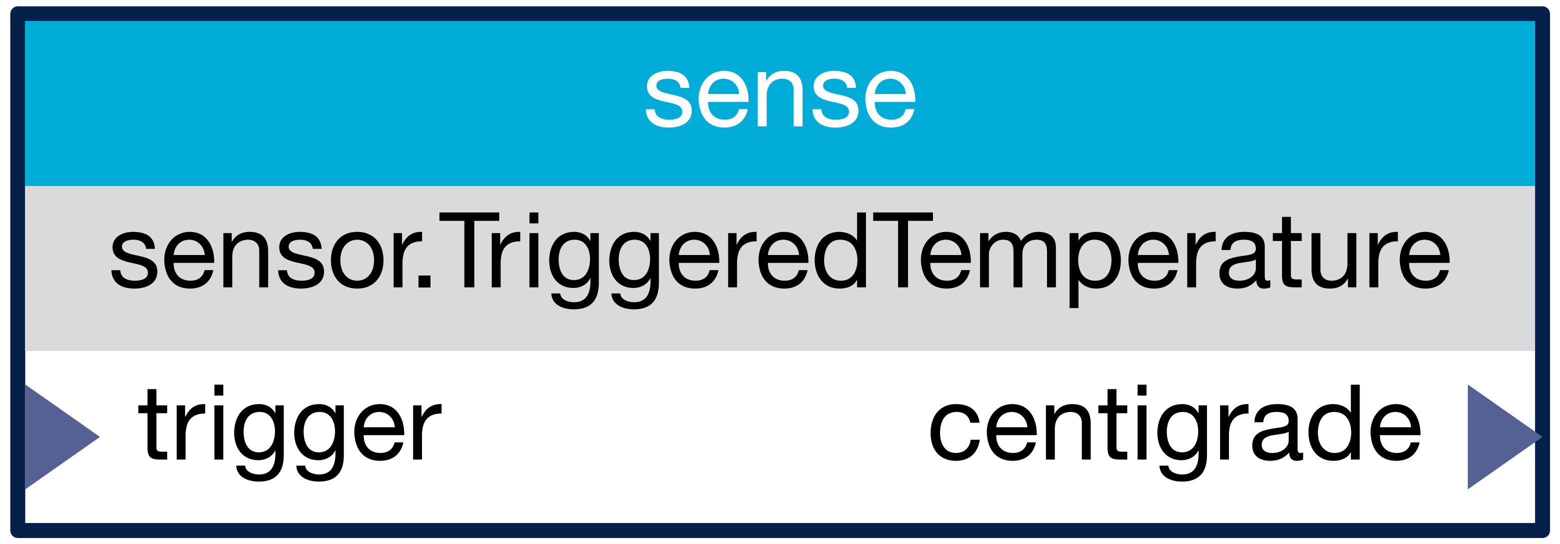
Separating the what from the where and how

Runtimes and Actors

capabilities:
sense.temp
math.fft

attributes:
location="kitchen"
owner="me"

Runtime

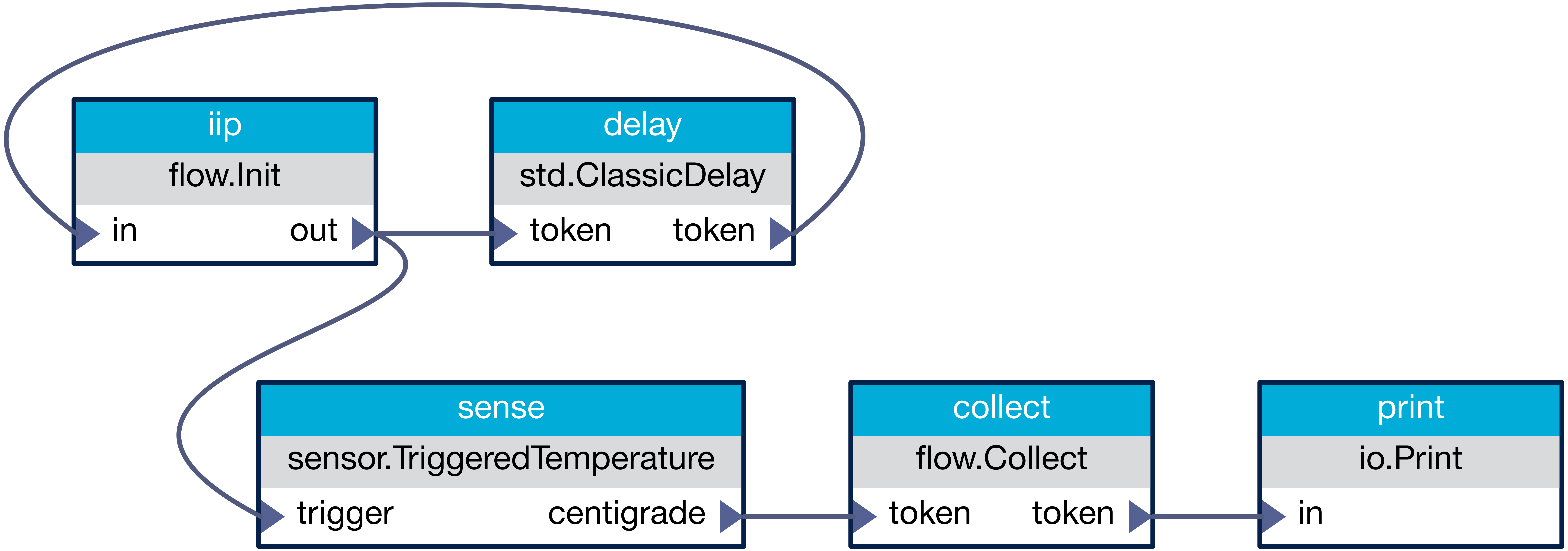


Actor

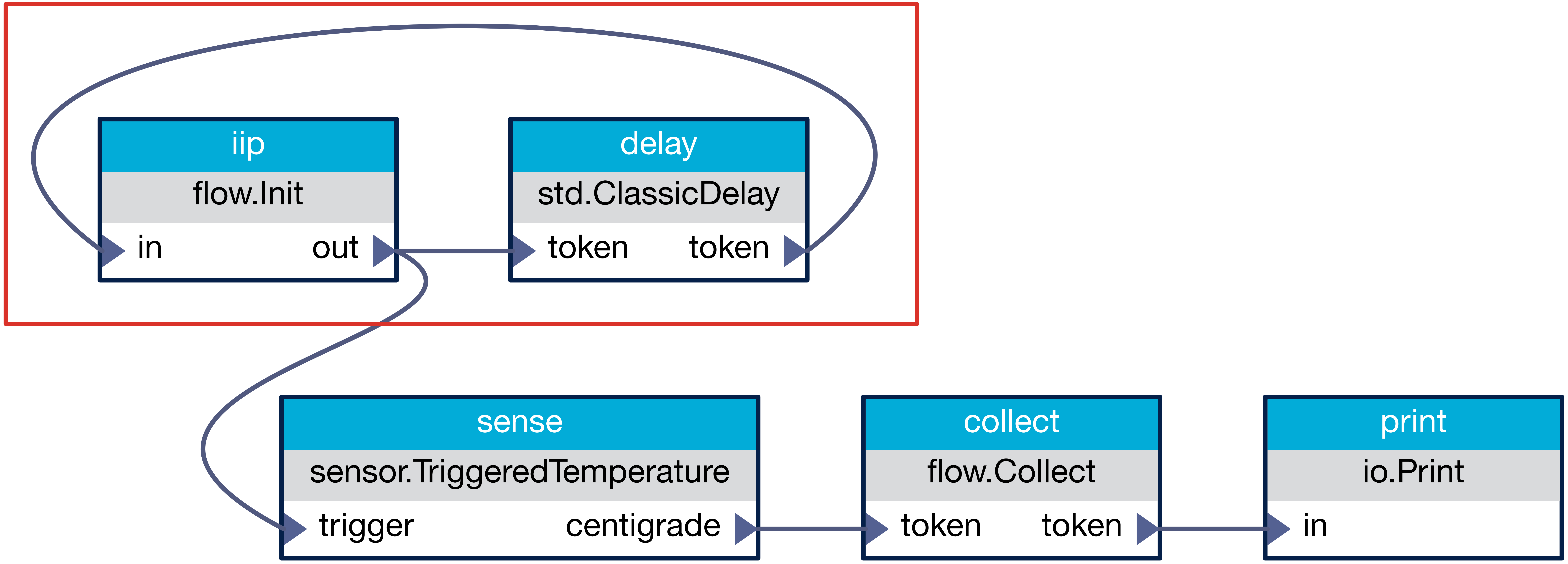
- Portable platform abstraction layer
  - ARM CortexM (constrained)
  - ARM CortexA and up to DC (base)
- Tracks capabilities and attributes
- Handles message passing and security
- Mesh of runtimes create **single machine illusion**

- Unit of isolation and execution
- Responds to events and incoming messages
- Atomic operations
- Local state only
- Moves to runtime to access its resources
- Common code across all runtimes

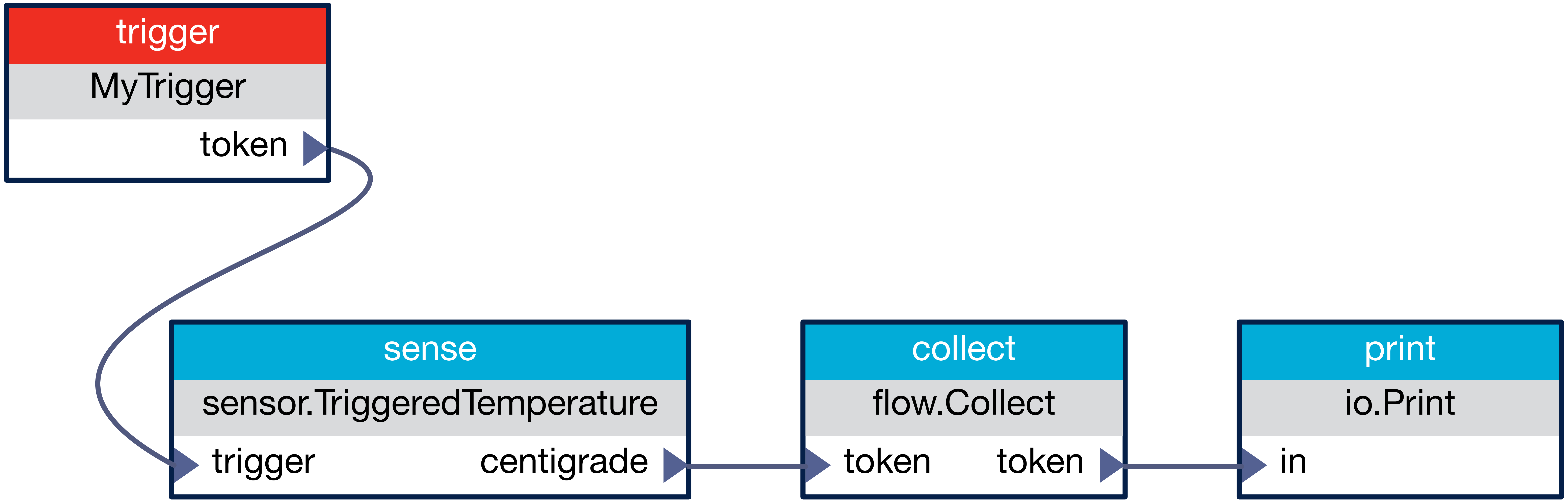
Applications



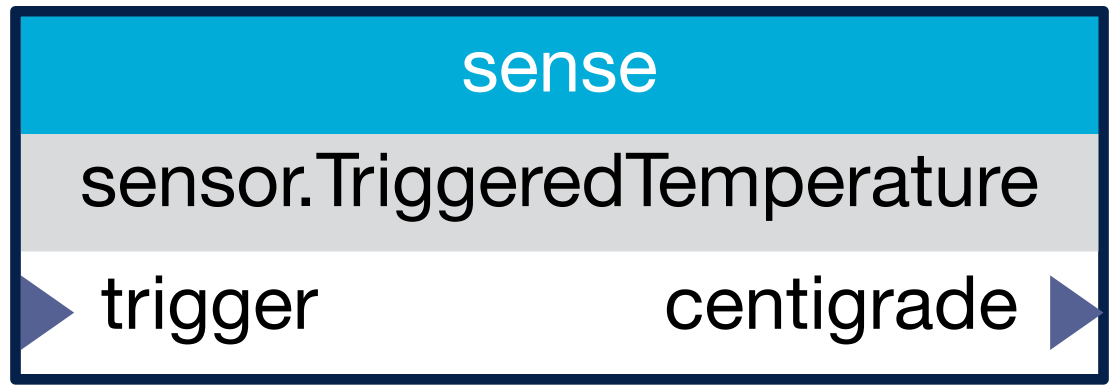
Applications



Applications



Finding Resources



sense

sensor.TriggeredTemperature

trigger

centigrade

capabilities:
sense.temp

attributes:
country="us"

capabilities:
sense.temp

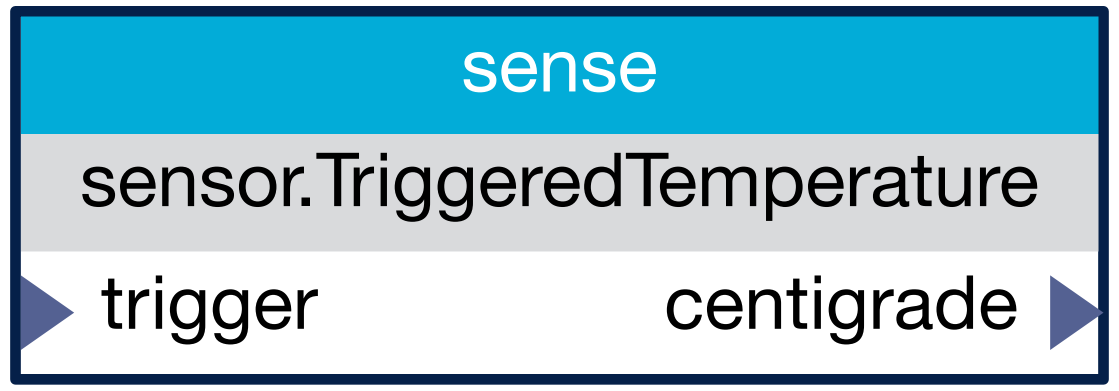
attributes:
country="sweden"

capabilities:
sense.humidity

attributes:
name="us"

Finding Resources

```
apply sense : attr_match(country="us")
```



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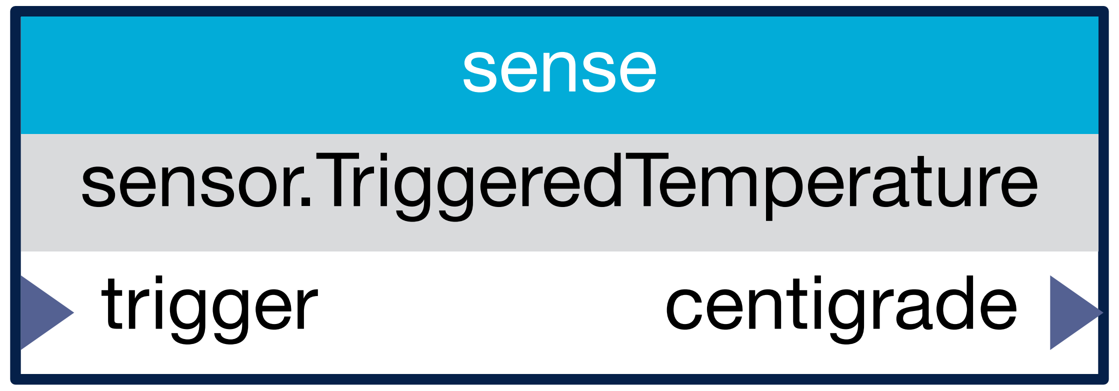

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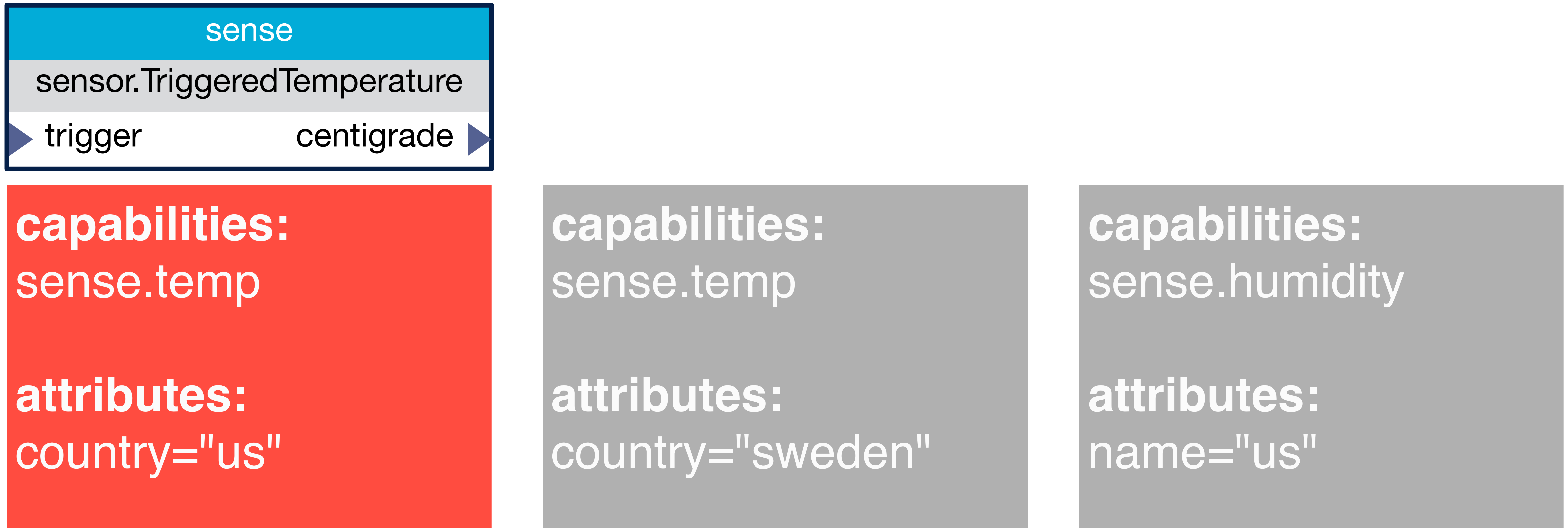

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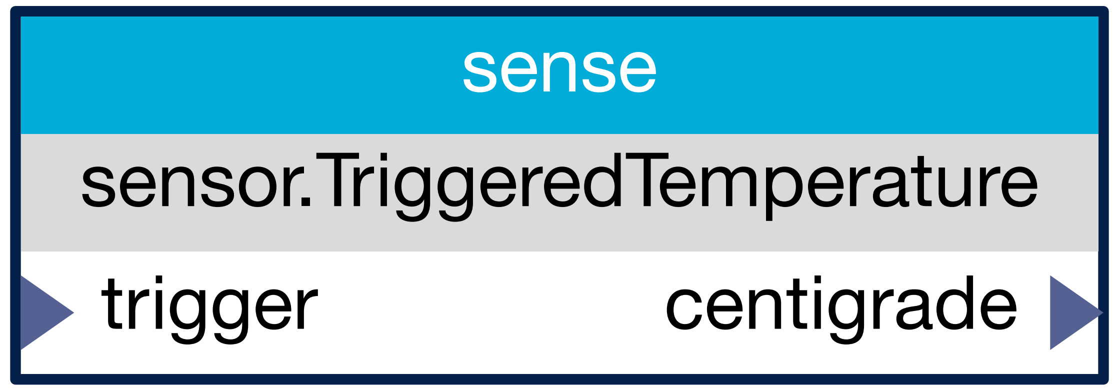
Replication and Scaling



capabilities:
sense.temp

attributes:
name="s1"
owner="me"

capabilities:
sense.temp

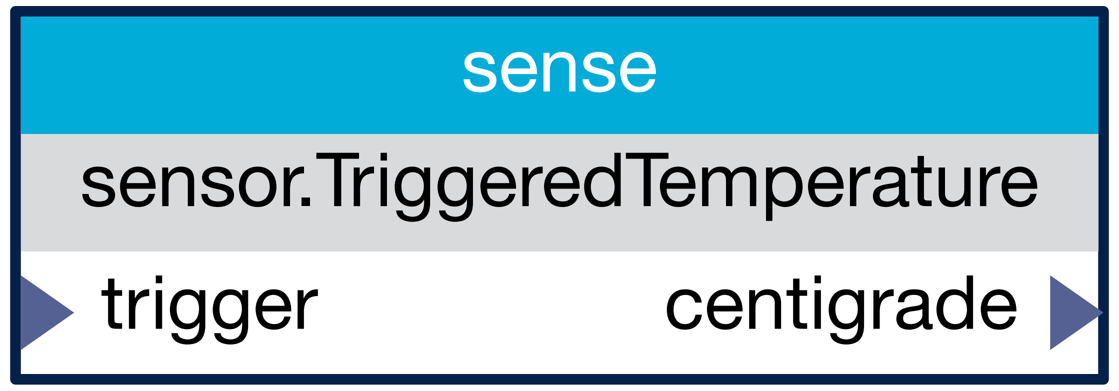
attributes:
name="s2"
owner="me"

capabilities:
sense.temp

attributes:
name="s3"
owner="me"

Replication and Scaling

```
apply sense : device_scaling() & attr_match(owner="me")
```



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capabilities:
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Replication and Scaling

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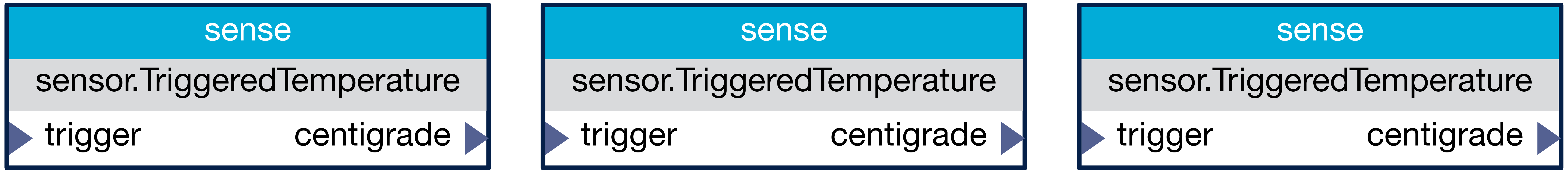

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Replication and Scaling

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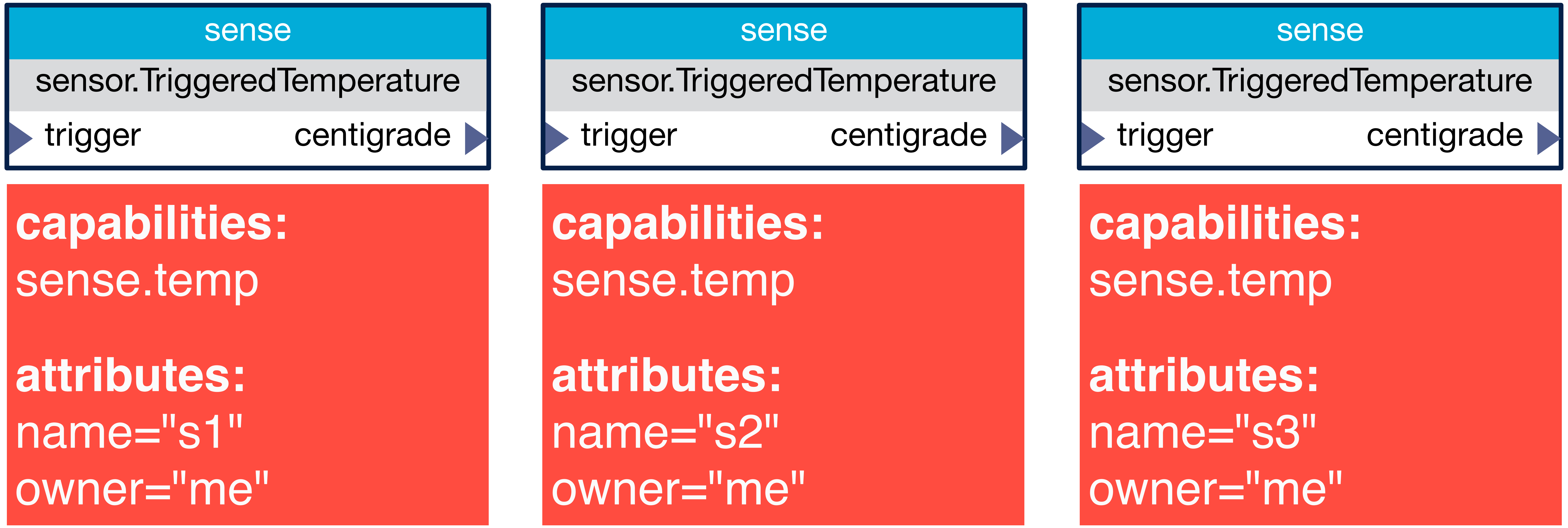

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owner="me"

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sense

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capabilities:
sense.temp

attributes:
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owner="me"

Replication and Scaling

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owner="me"

sense

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owner="me"

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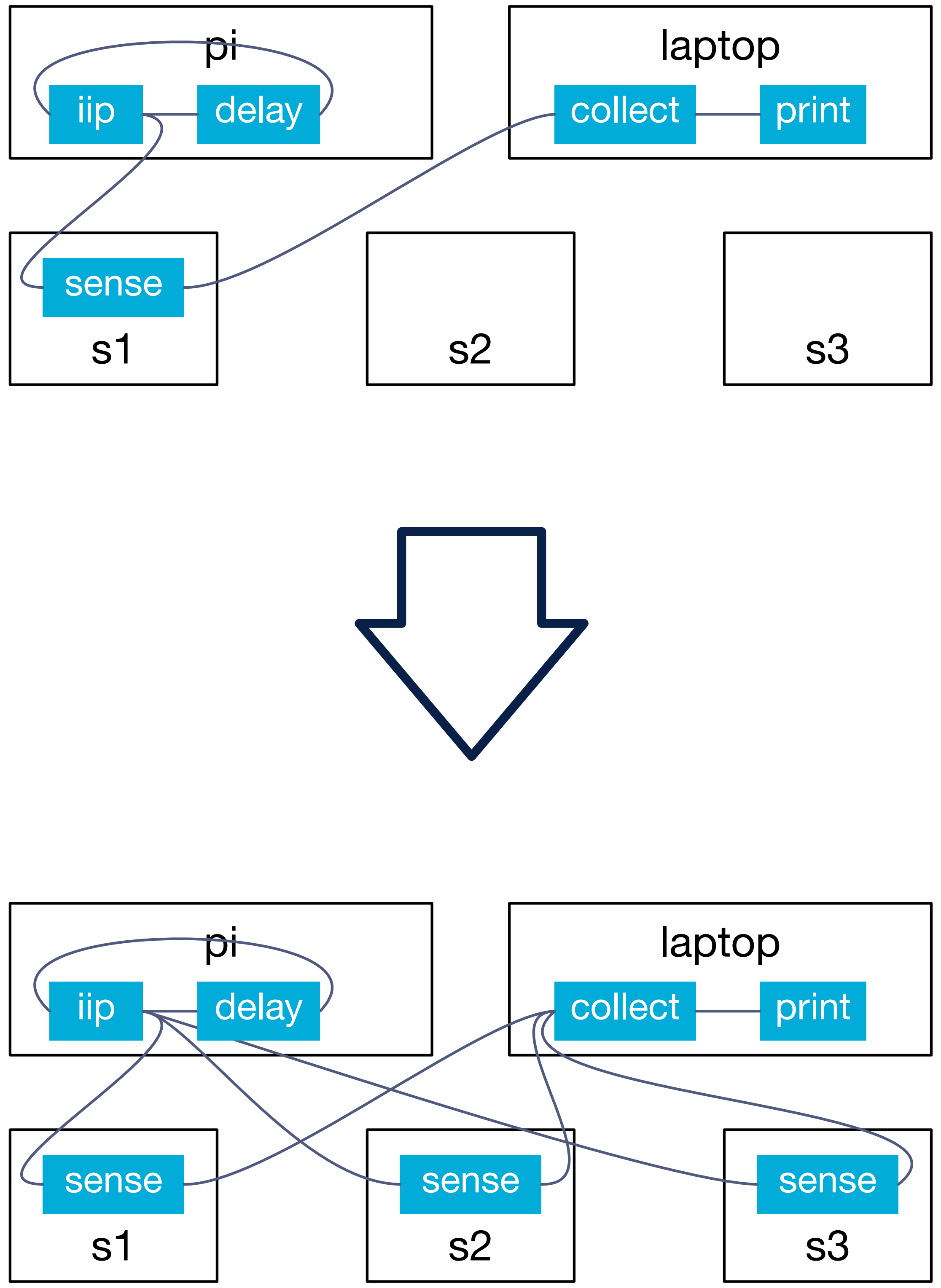
attributes:
name="s3"
owner="me"



Replication and Scaling

```
apply sense : device_scaling() & attr_match(owner="me")
apply sense : performance_scaling() & attr_match(owner="me")
```

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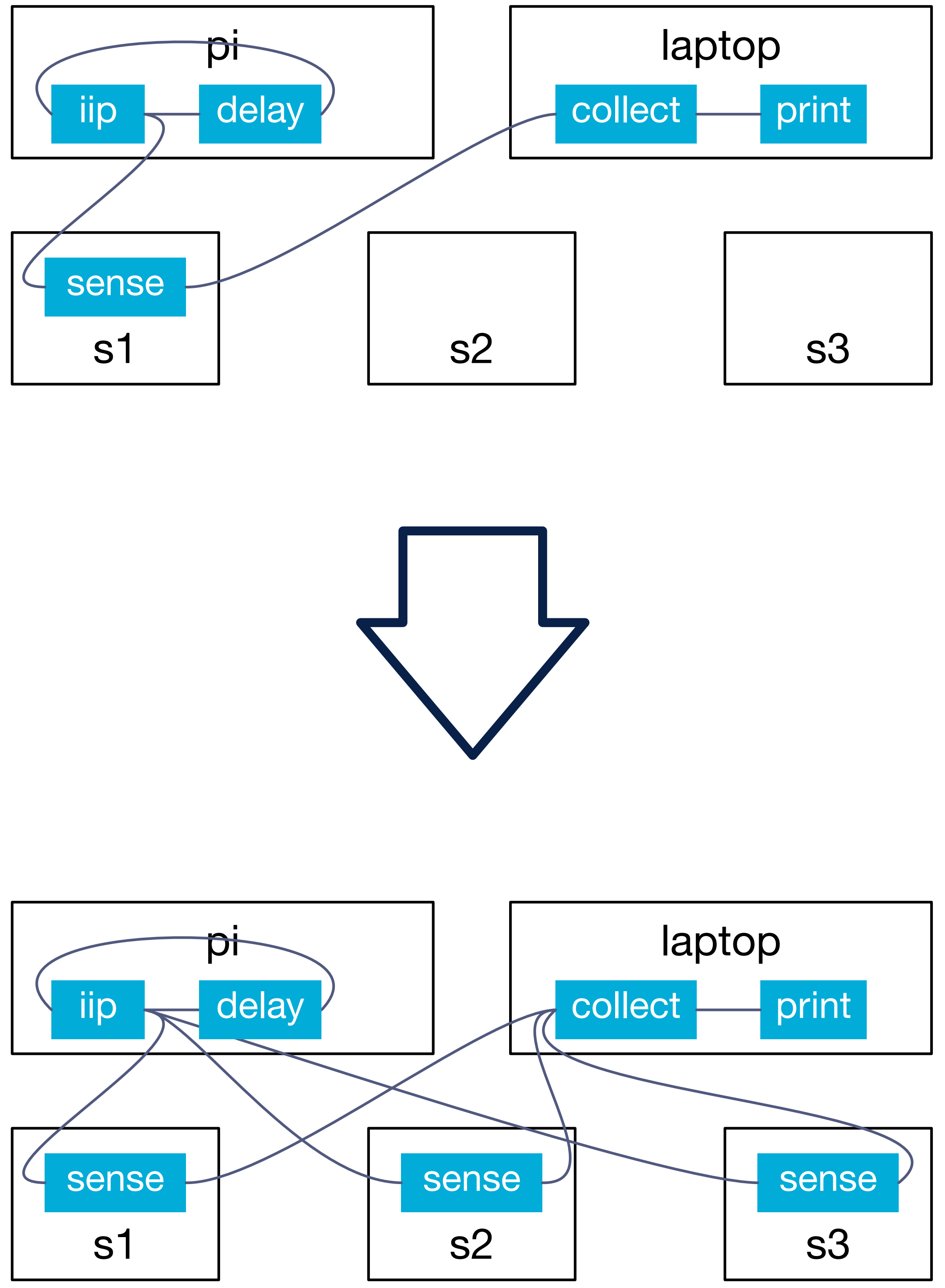
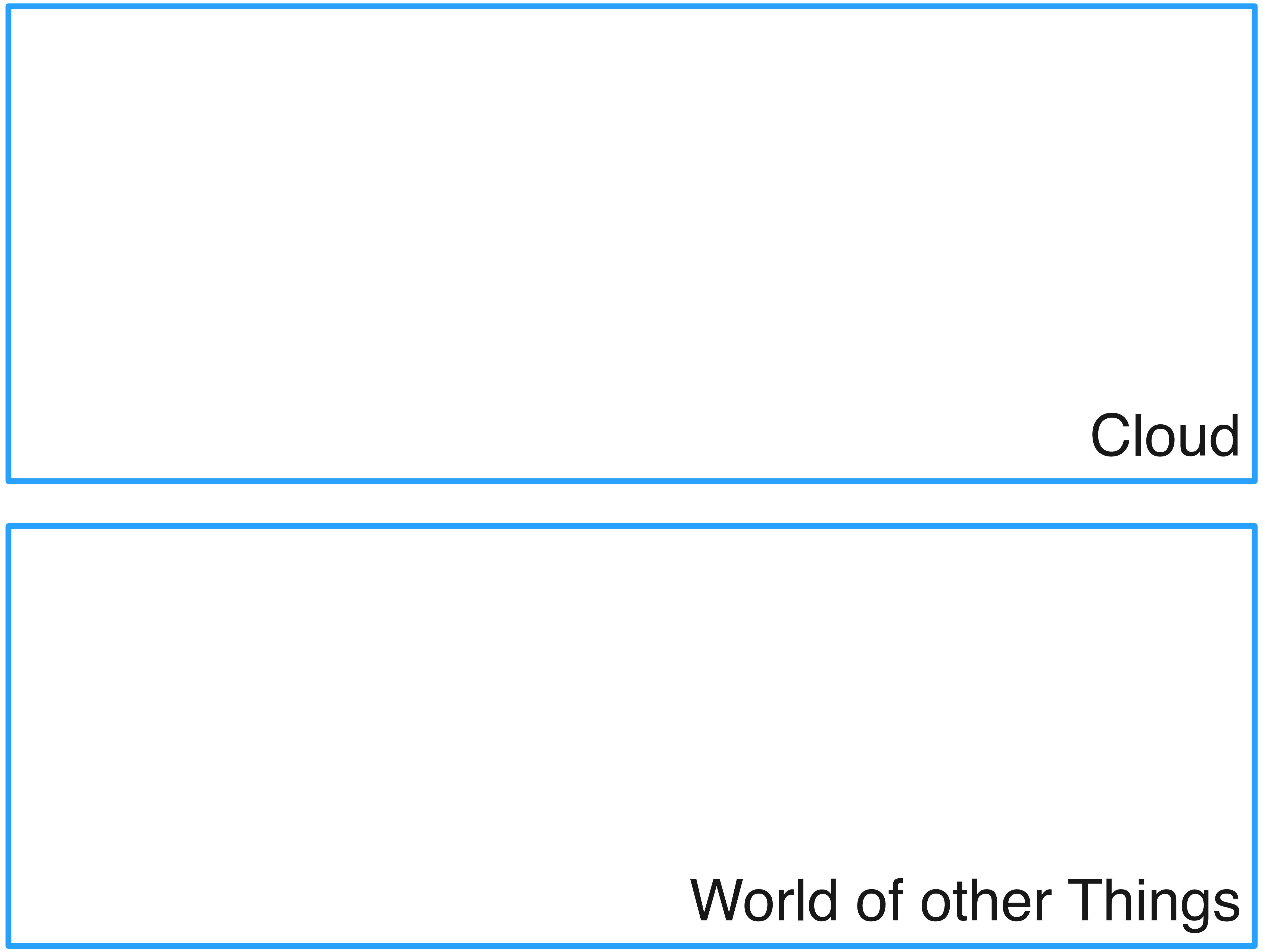


Kappa–Serverless IoT

Architecture



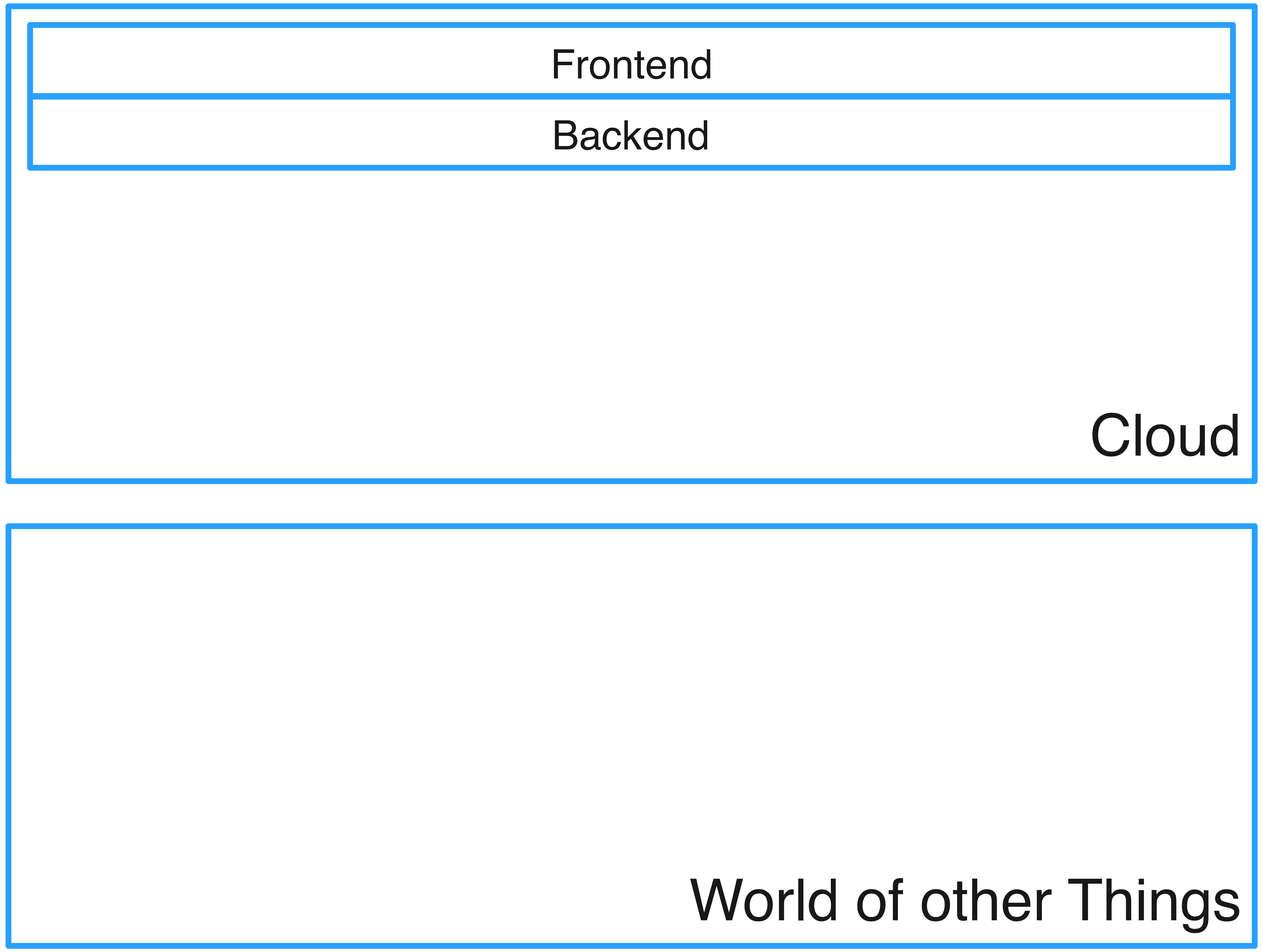
Cloud

World of other Things

Architecture

- Web service with REST API

Command	Meaning
PUT /kappa	Deploy script in body, return reference
POST /kappa/ref	Send JSON data to kappa inport
GET /kappa/ref	Read JSON data from kappa outport
DELETE /kappa/ref	Delete a kappa
GET /kappa	List all kappas



Frontend

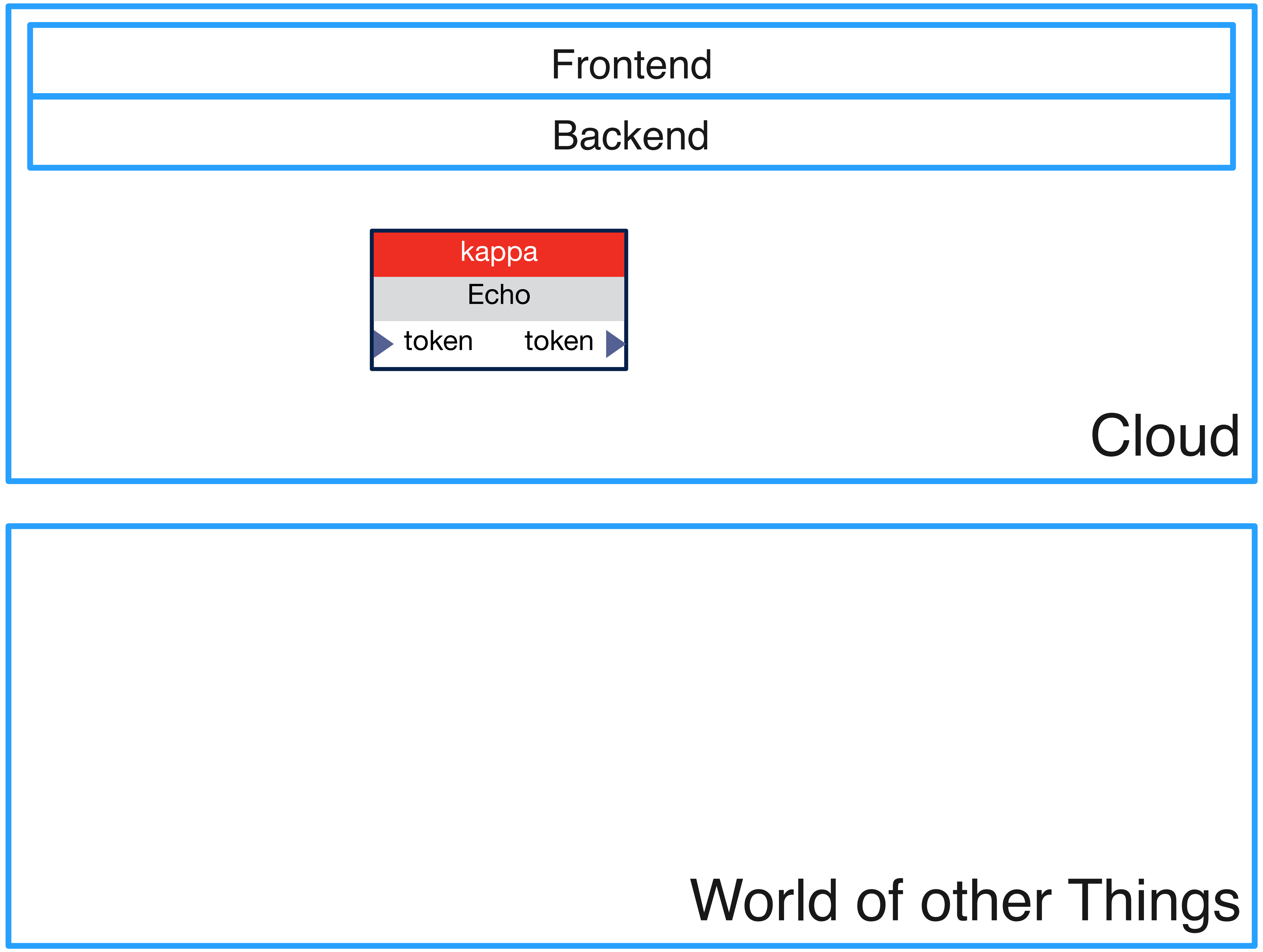
Backend

Cloud

World of other Things

Architecture

- Web service with REST API
- FaaS script defined as a component



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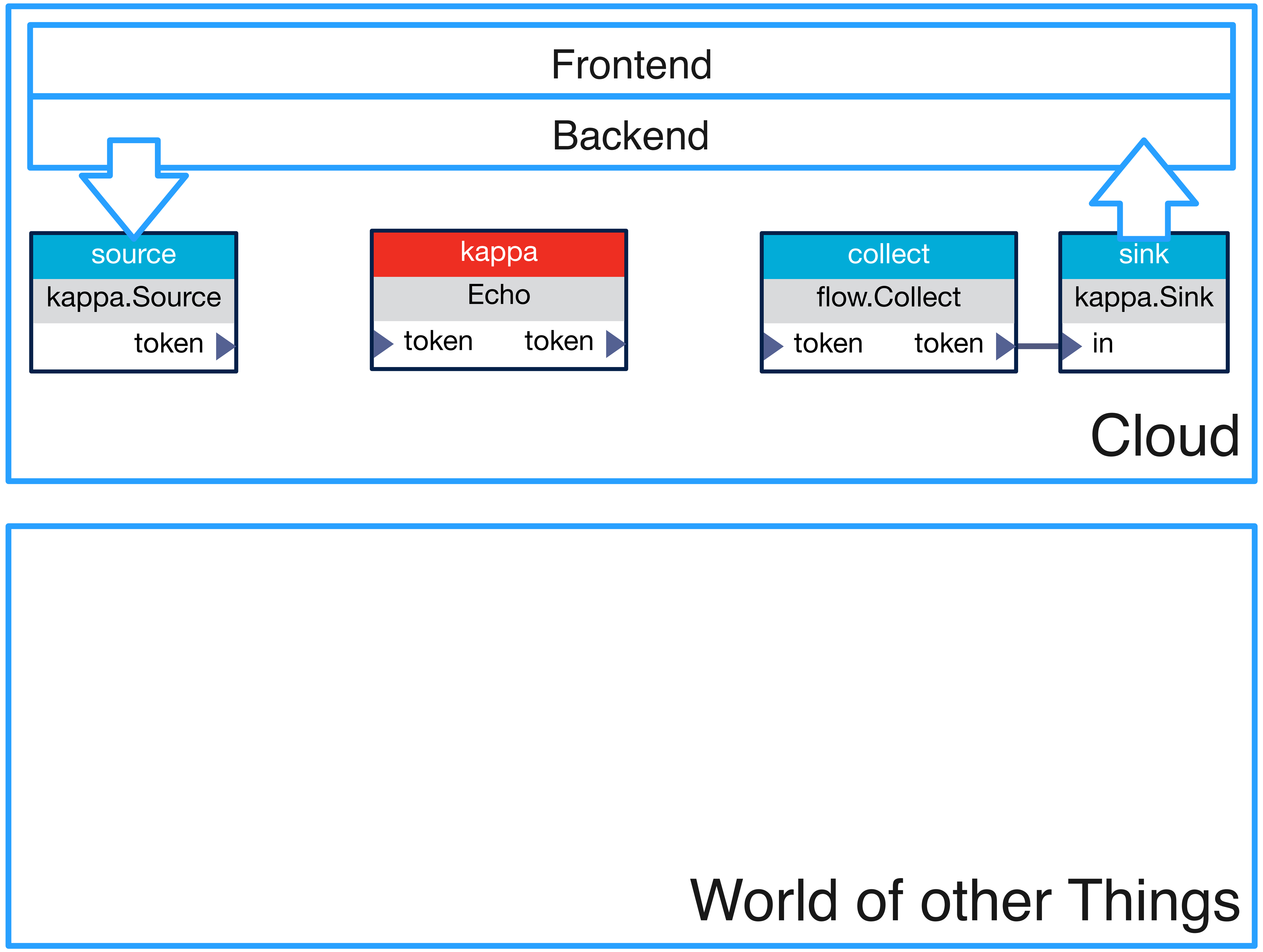
- Web service with REST API
- FaaS script defined as a component
- Runtime with two special actors as bridge to API
  - kappa.Source
  - kappa.Sink



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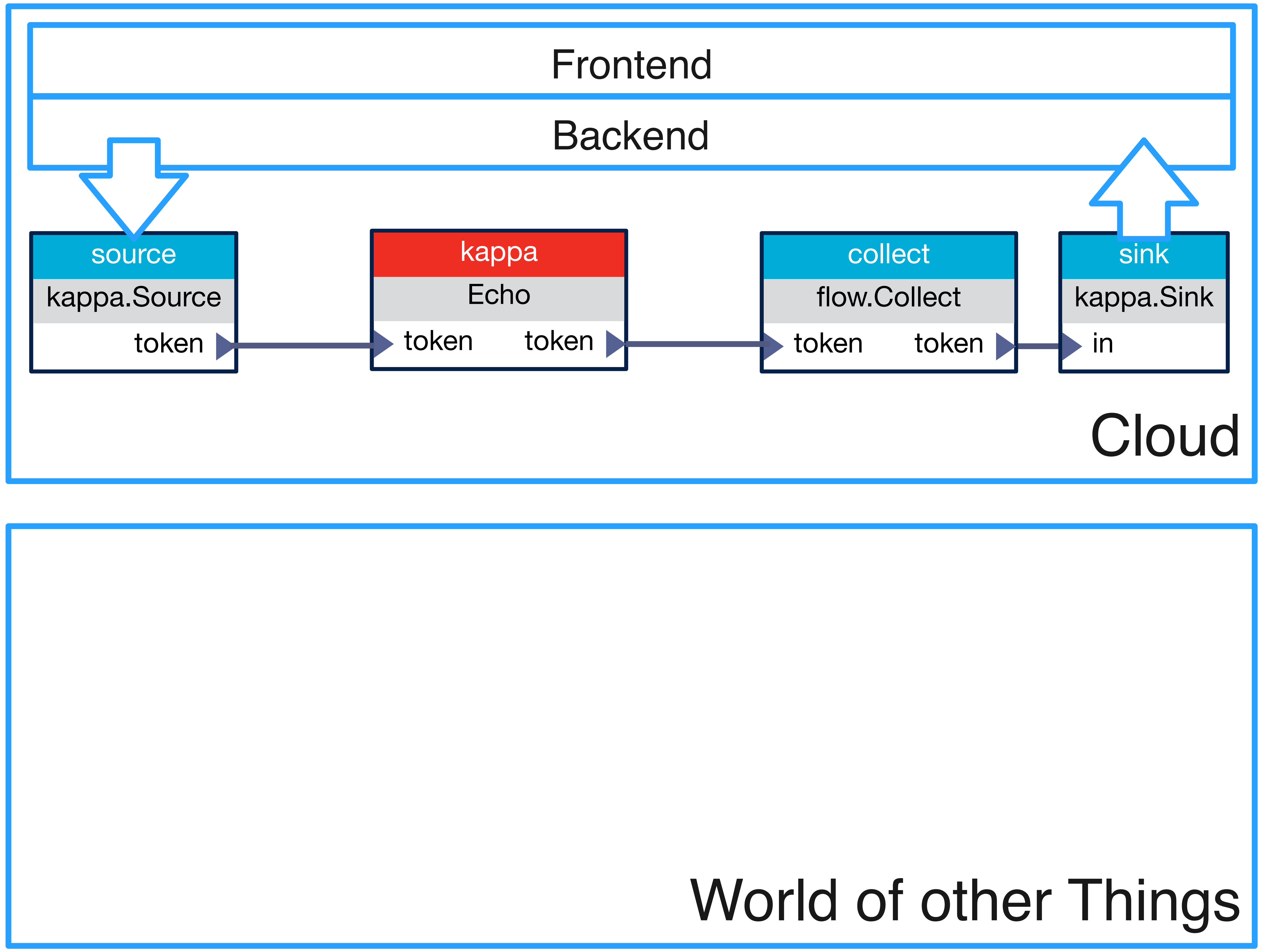

Architecture

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- Wrap component in source, collect, and sink
- Deploy, communicate with, and destroy kappa

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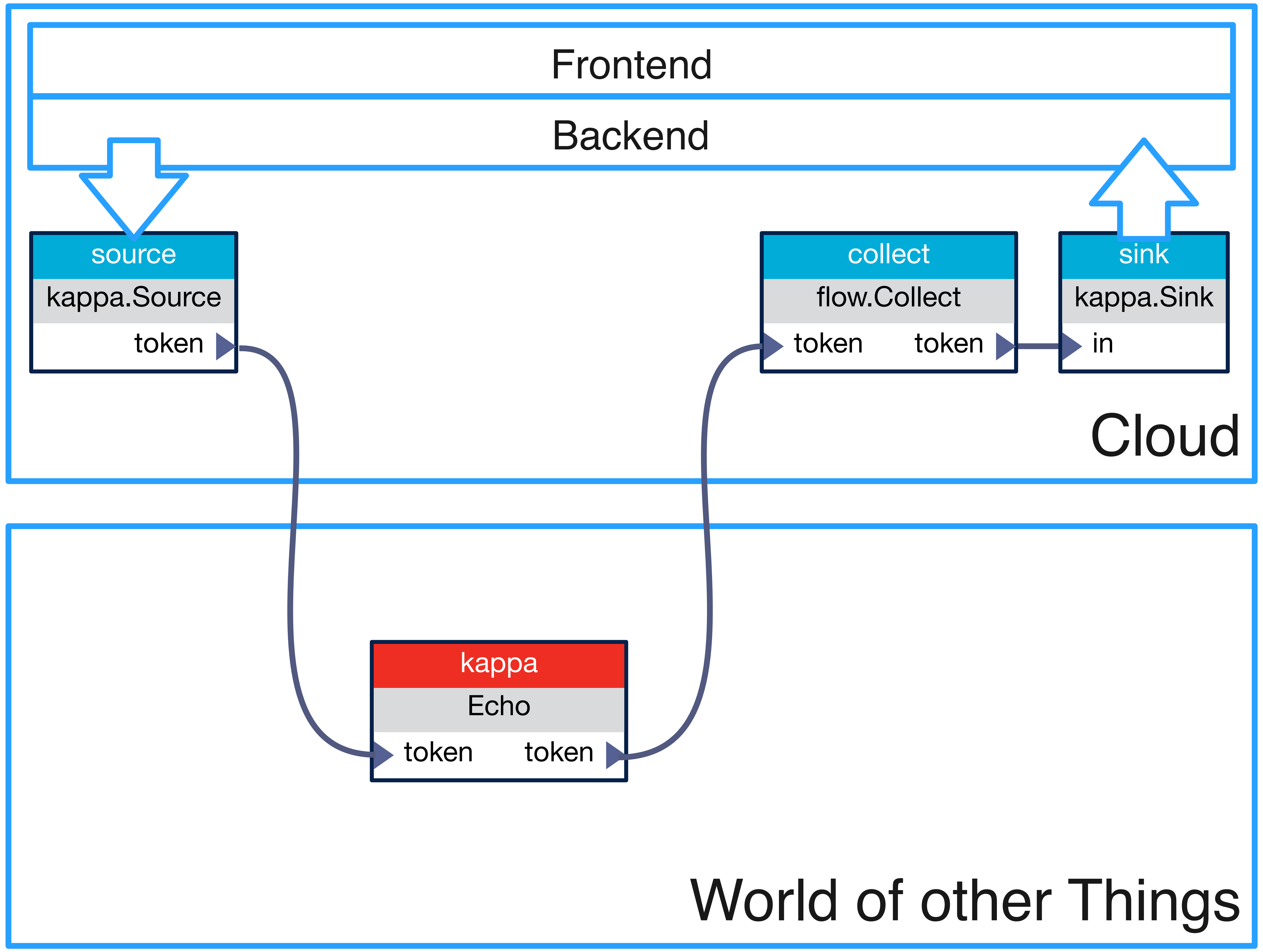
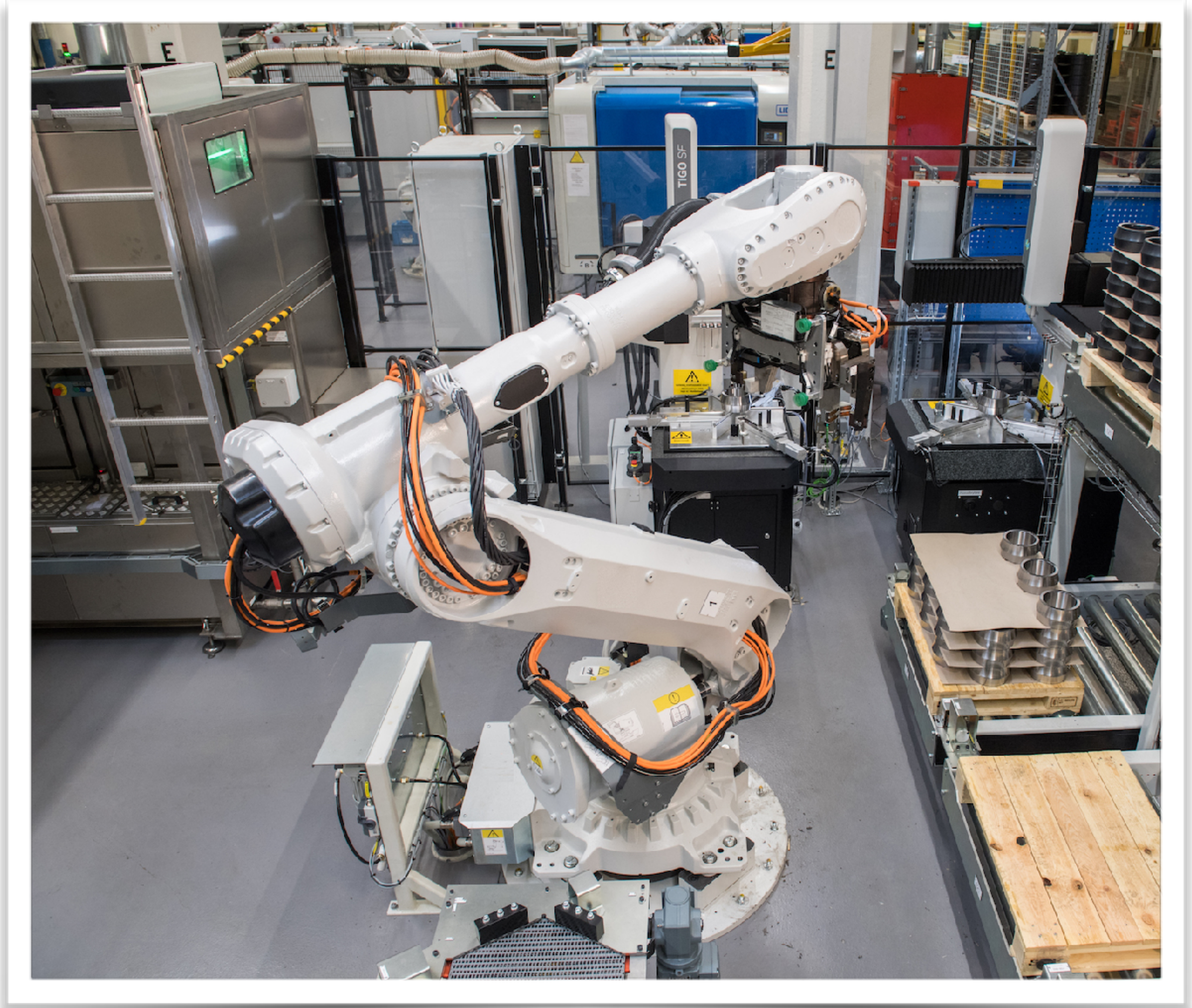


Example Use Cases



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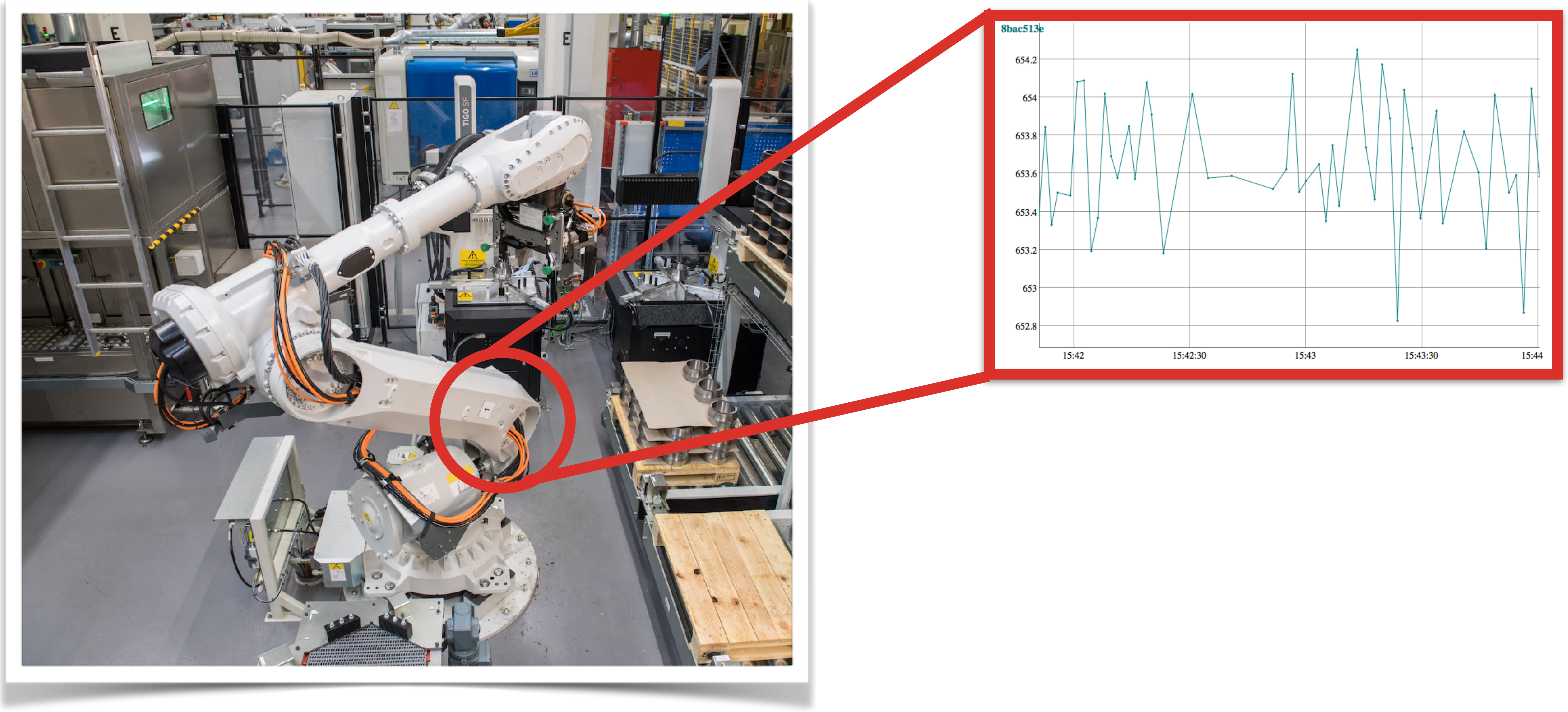

Introspection
Visualize running system, log-on-condition, etc.

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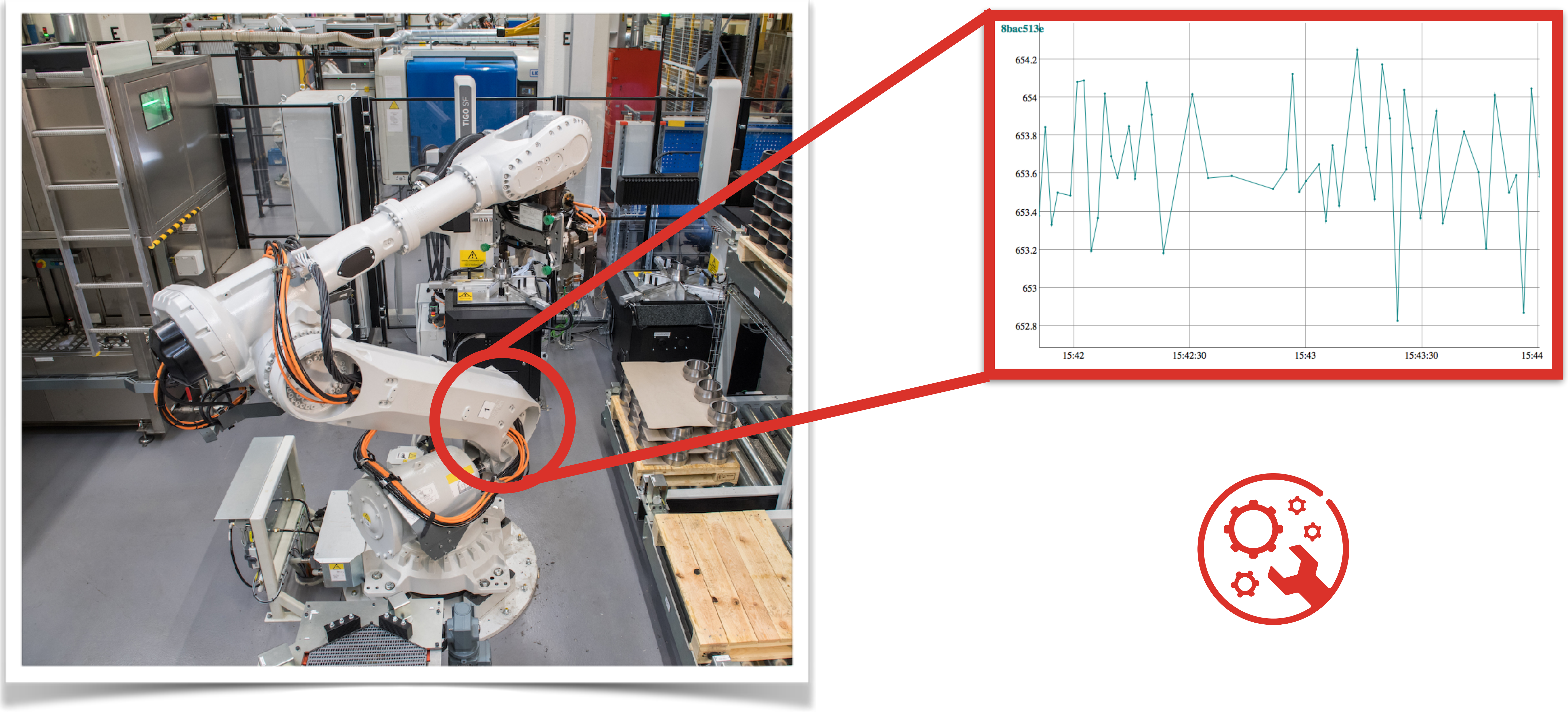

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Deploy local control loops, use API to set desired state

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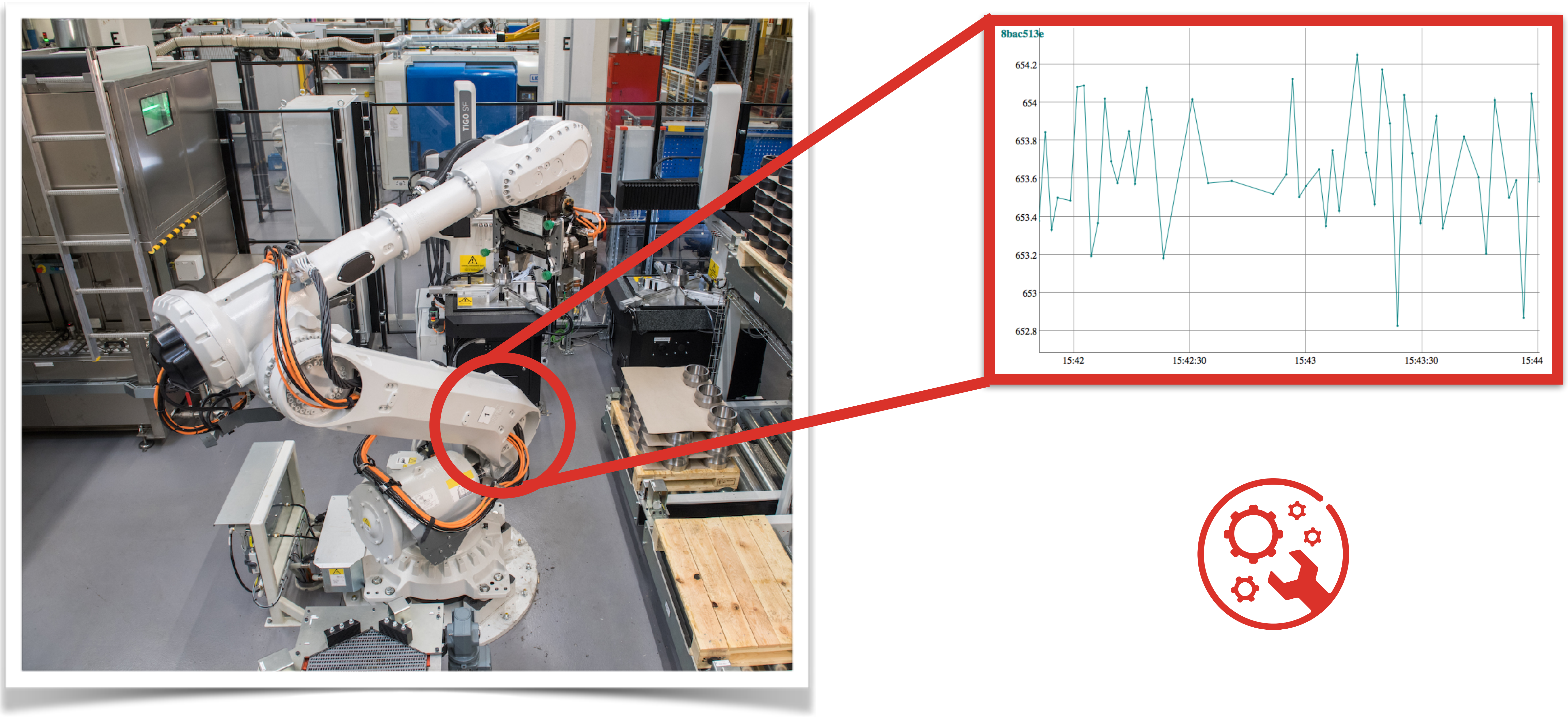

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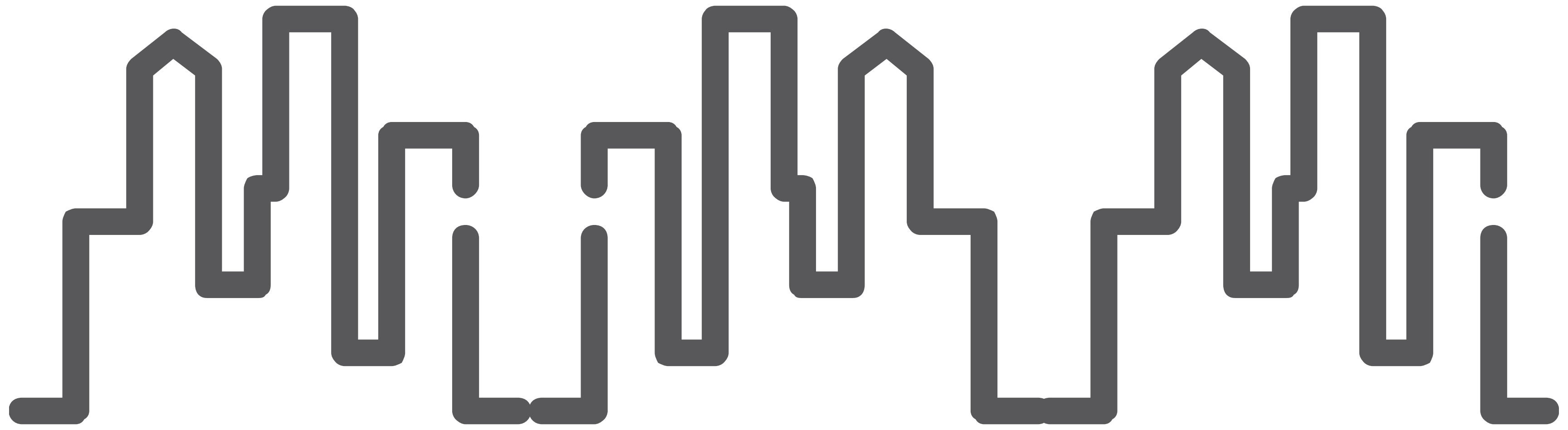

Large area sampling
Statistically sound sampling of data without violating privacy (e.g. indoor temp)

Serverless IoT Revisited

If you can't be a first class cloud citizen,
at least be a first class neighbour