CONTINO

Programmable Infrastructure with Kubernetes

Hibri Marzook and Talieson Sisson

Whoami

Hibri Marzook

hibri.marzook@contino.io

@hibri

http://github.com/hibri

Taliesin Sisson

talieson.sisson@contino.io

http://github.com/taliesins

Agenda

1. Complexity in distributed systems (5 min)
2. The Reconciliation Loop (5 min)
3. Extensibility in K8S (5 min)
4. Building a Custom Controller with Go (15 min)
5. What have others done (5 min)
6. A Service Mesh - Istio (5 min)
7. Q&A (10 min)

Something is always *brokn*

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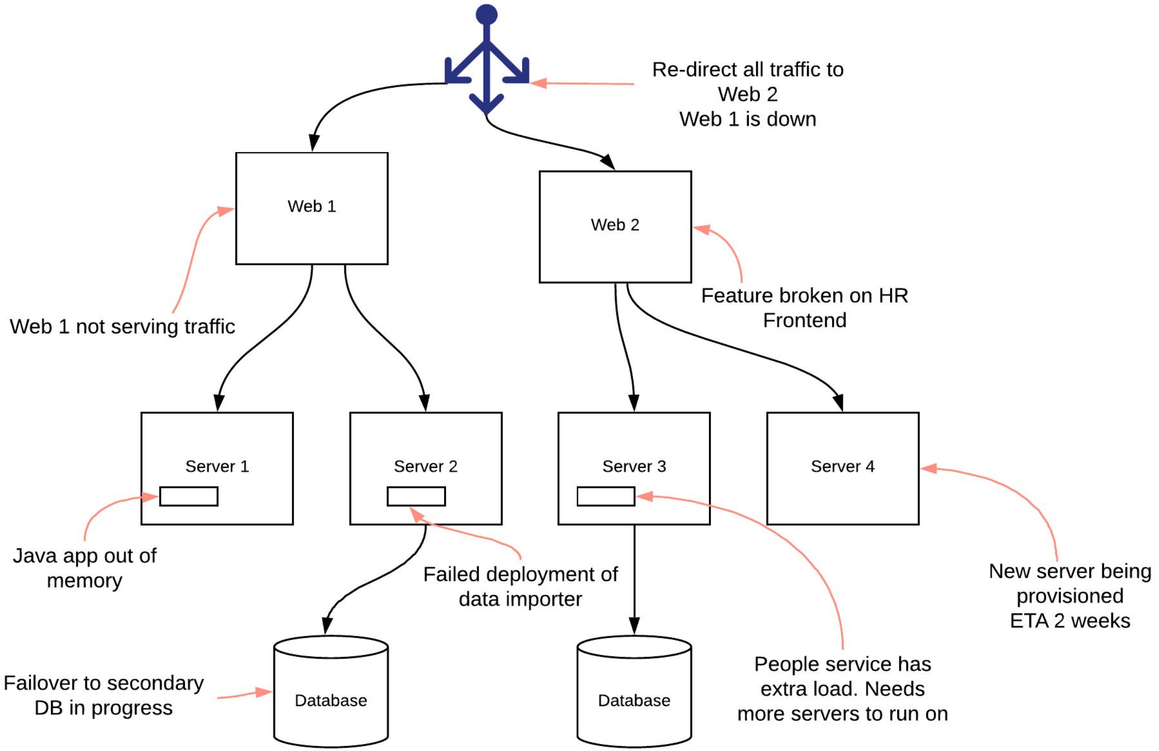
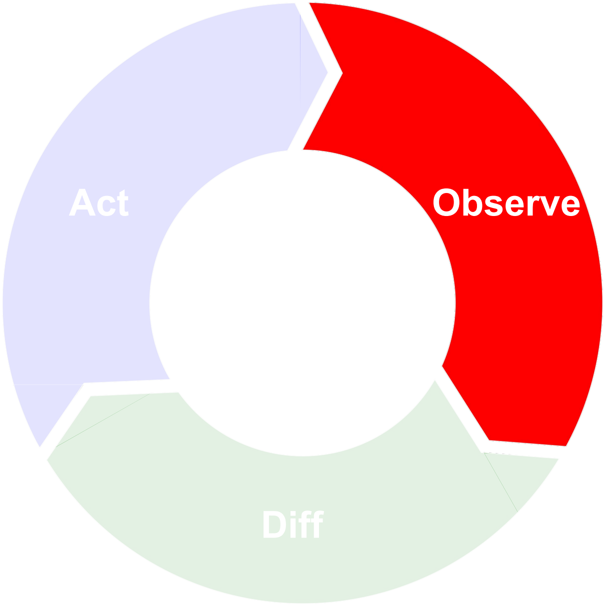
Something is always broken



The Human Reconciliation Loop



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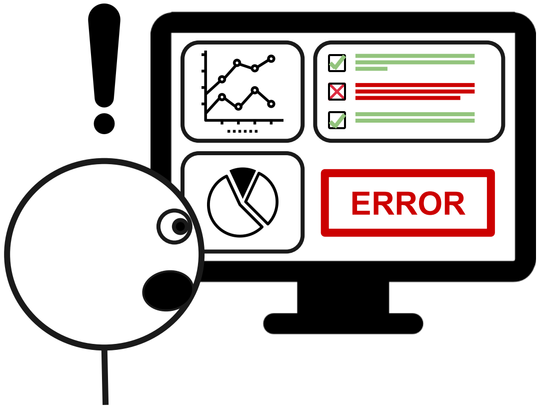

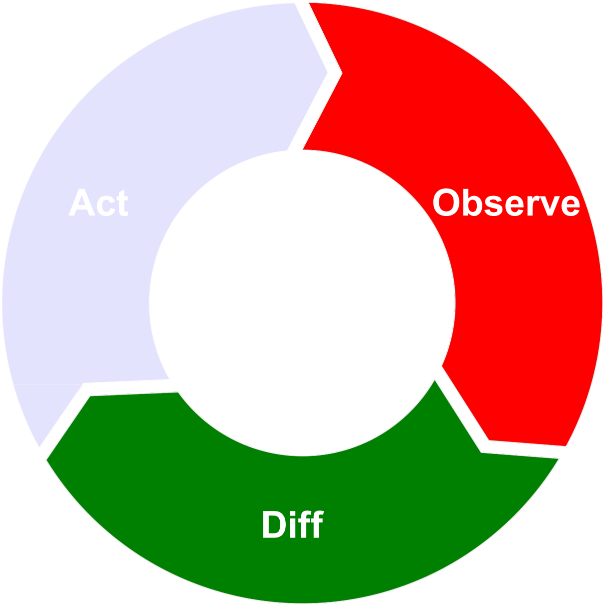

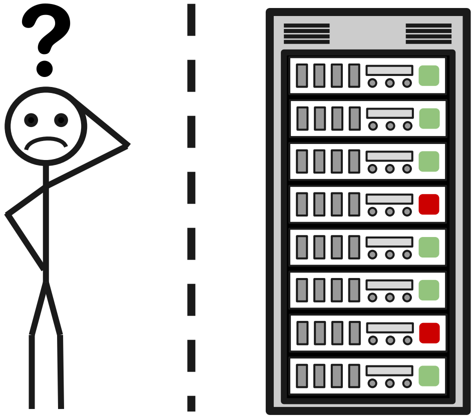

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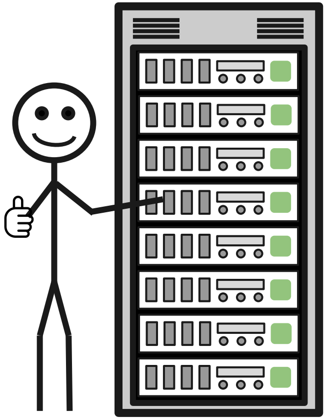
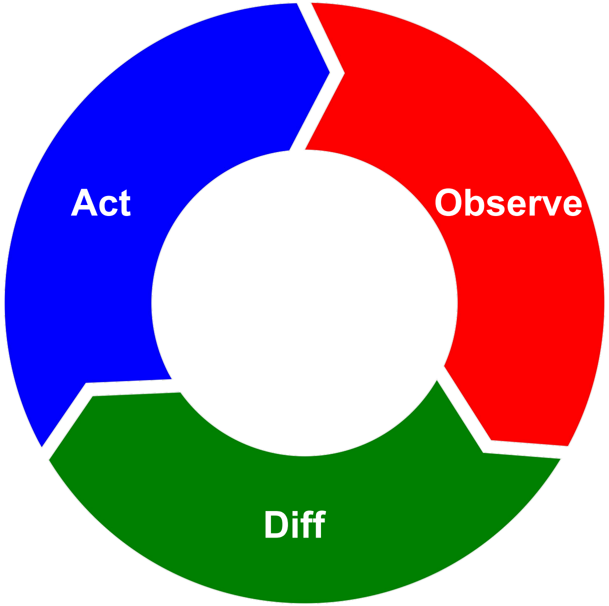
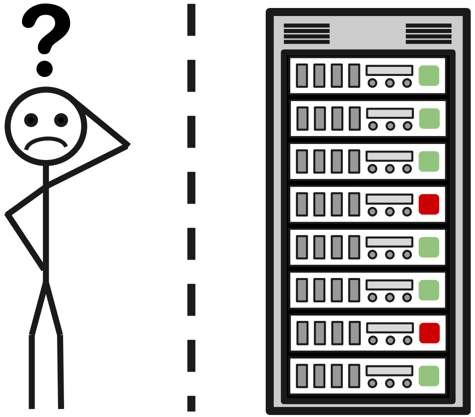






Automated Reconciliation Loop

Start Loop

Event

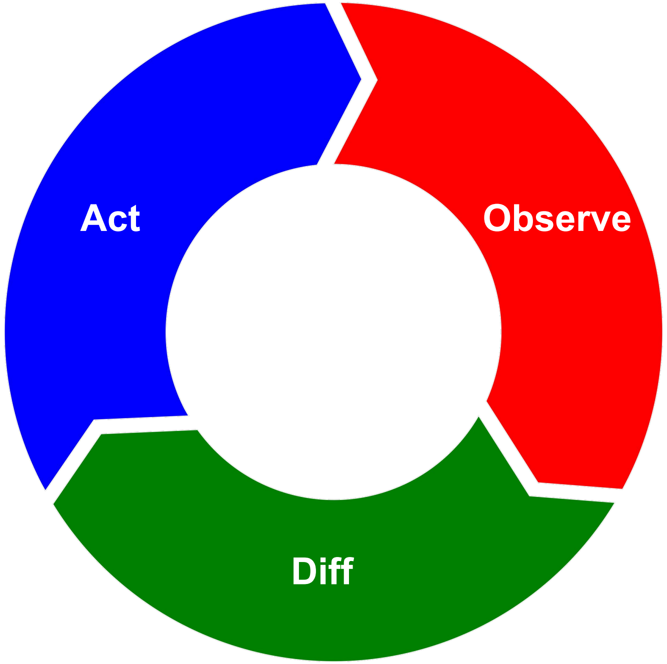
Observe - What happened

Event Handler

Diff - Decide what actions to take

Act - Take action

Repeat Loop



Reconciliation in Kubernetes

There are three states of the world;

An Idealized desired state which is a declarative statement of what the world should be like

An actual state the actual state of the system.

A current state which approximates the actual state, and might be noisy, incomplete, or out of date.

The role of the reconciliation loop is to repeatedly compare the **current state** against the **desired state**, and take action to drive the **actual state** to match the **desired state**

Brendan Burns - How Kubernetes Changes Operations, Login Magazine, October 2015

Extensibility in K8S

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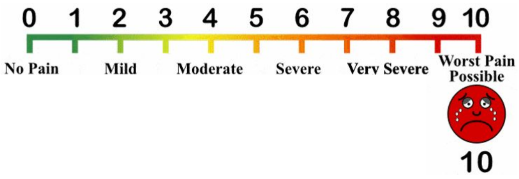
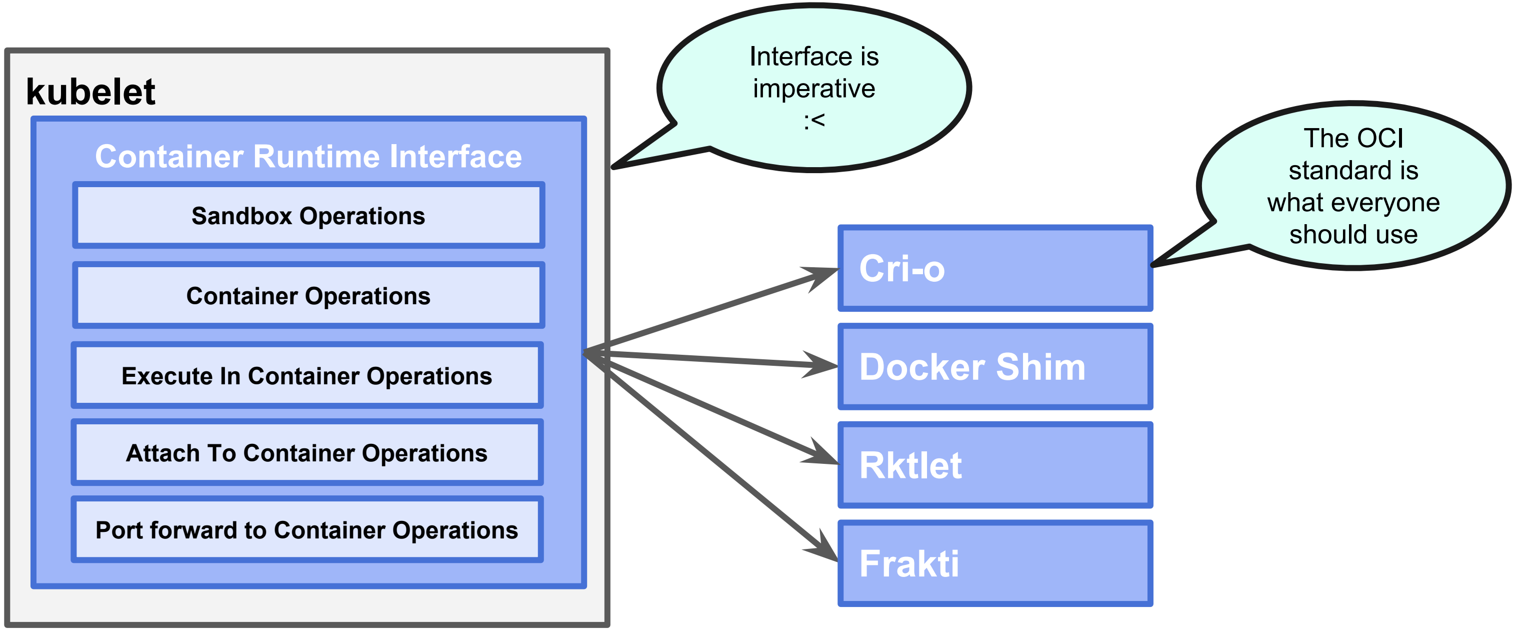
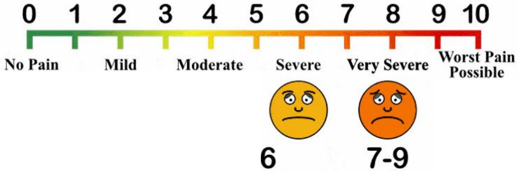
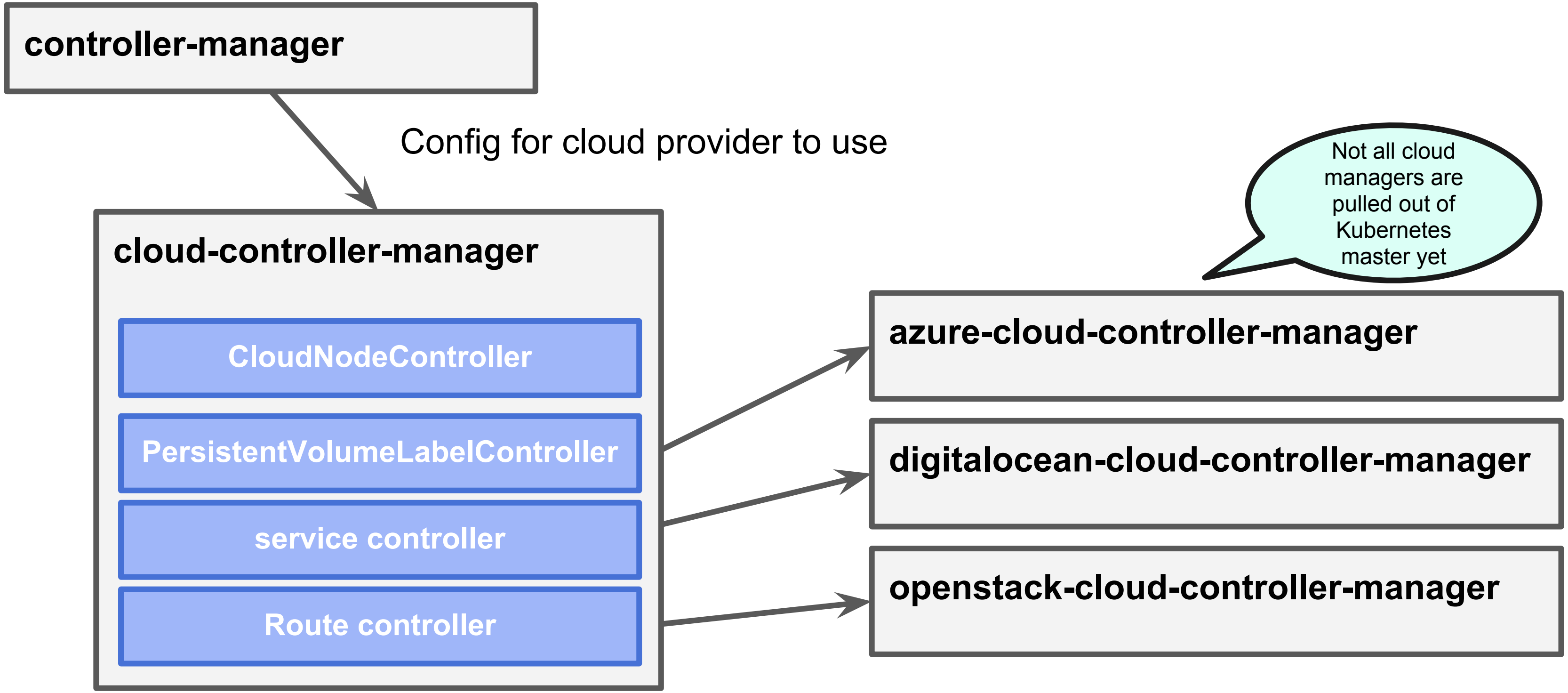


Container Runtime Interface

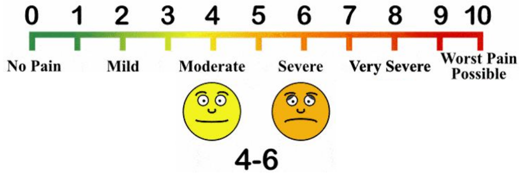

kubelet
Container Runtime Interface
Sandbox Operations
Container Operations
Execute In Container Operations
Attach To Container Operations
Port forward to Container Operations
Interface is imperative :<
Cri-o
Docker Shim
Rktlet
Frakti
The OCI standard is what everyone should use

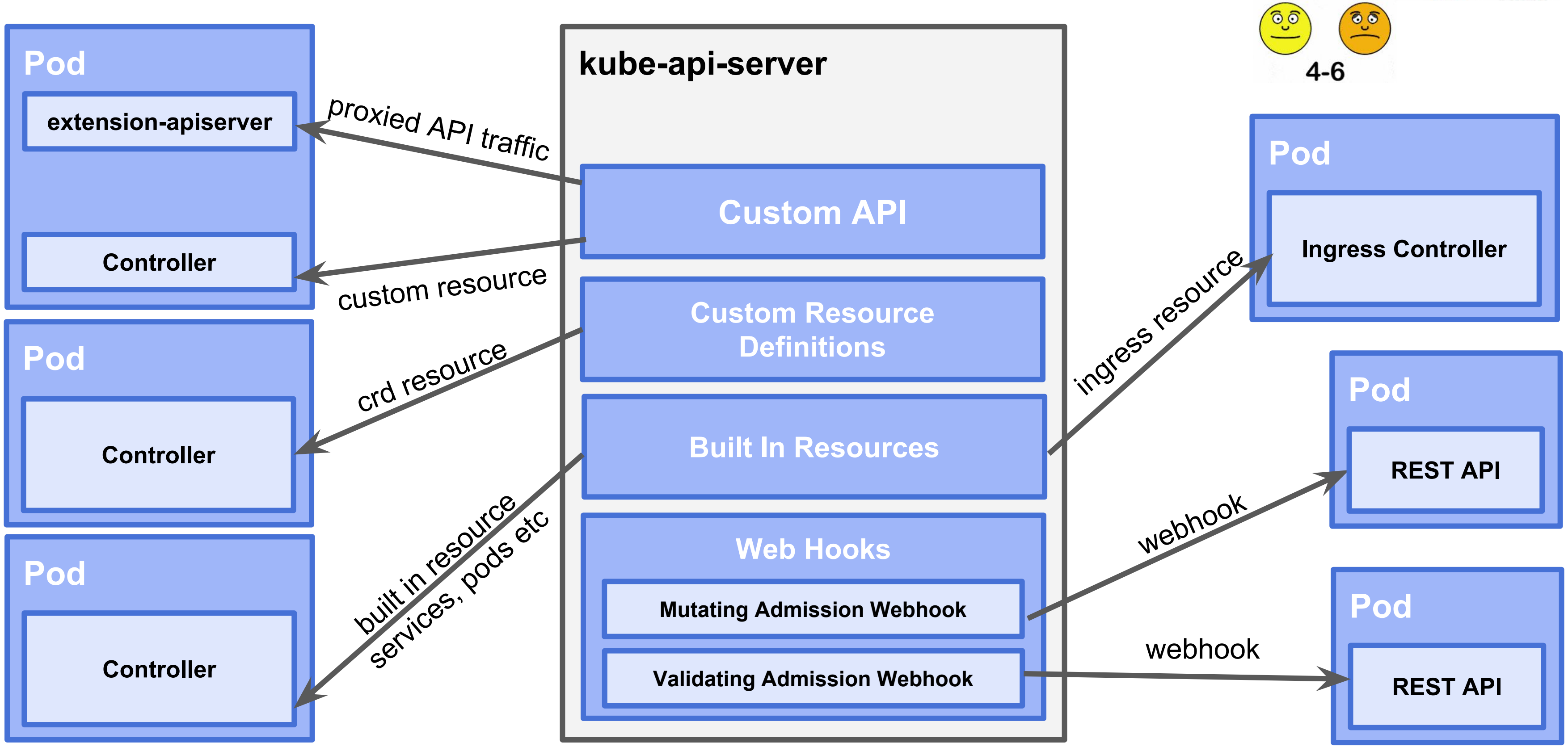
Cloud controllers




controller-manager
Config for cloud provider to use
cloud-controller-manager
CloudNodeController
PersistentVolumeLabelController
service controller
Route controller
Not all cloud managers are pulled out of Kubernetes master yet
azure-cloud-controller-manager
digitalocean-cloud-controller-manager
openstack-cloud-controller-manager

Custom controllers





kube-api-server

Custom API

Custom Resource Definitions

Built In Resources

Web Hooks

Mutating Admission Webhook

Validating Admission Webhook

Pod

extension-apiserver

Controller

proxied API traffic

custom resource

Pod

Controller

crd resource

Pod

Controller

built in resource

services, pods etc

ingress resource

Pod

Ingress Controller

webhook

Pod

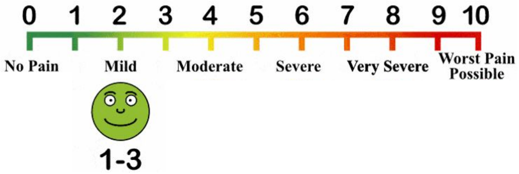
REST API

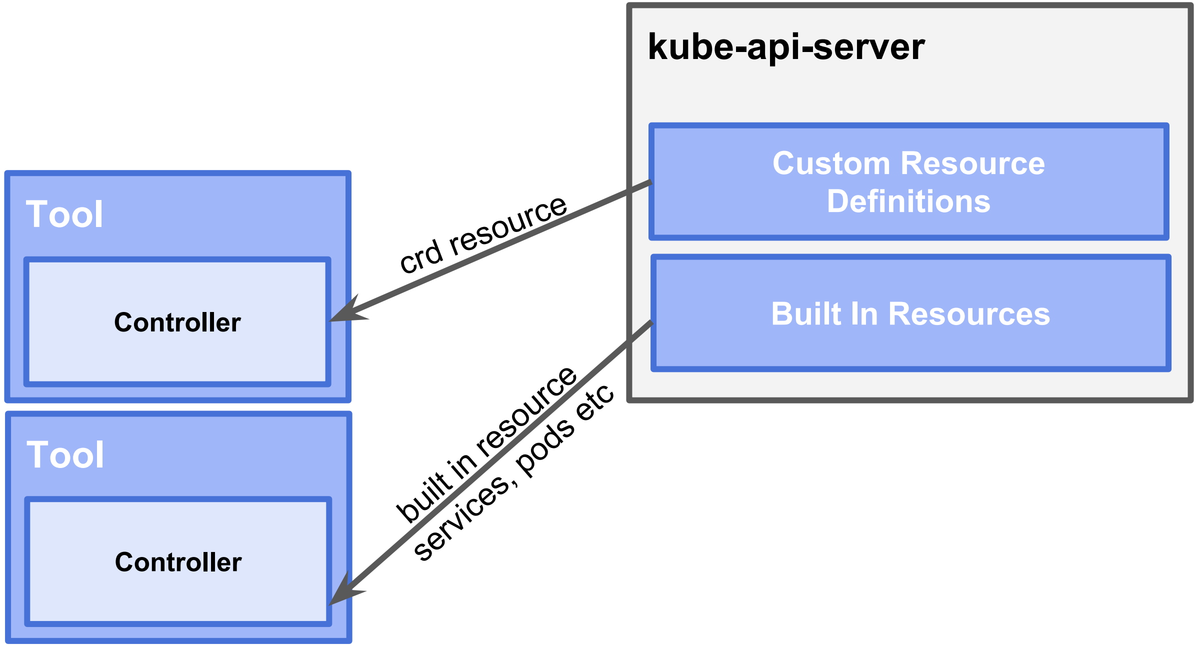
webhook

Pod

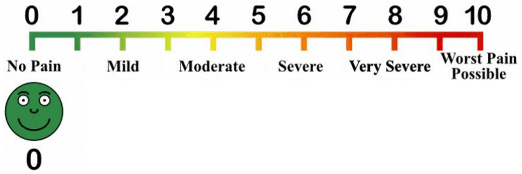
REST API

Command line tool





Labels & Annotations



Labels

- Identifying information
- Can be used for queries
- Each key must be unique for the object
- Restricted size (63 chars)

```
"metadata": {
 "labels": {
   "cd" : "blue",
   "owner" : "Team Fox"
 }
}
```

Annotations

- Non-identifying information
- Can be used for queries
- Duplicates keys are allowed for the object
- Unrestricted size

```
"metadata": {
 "annotations": {
   "releaseNotes" : "Fixed ie 6 compatability",
   "qaTests" : '{"results": {"passed": "99", "failed":”1" }}'
 }
}
```

Make your own automated reconciliation loop

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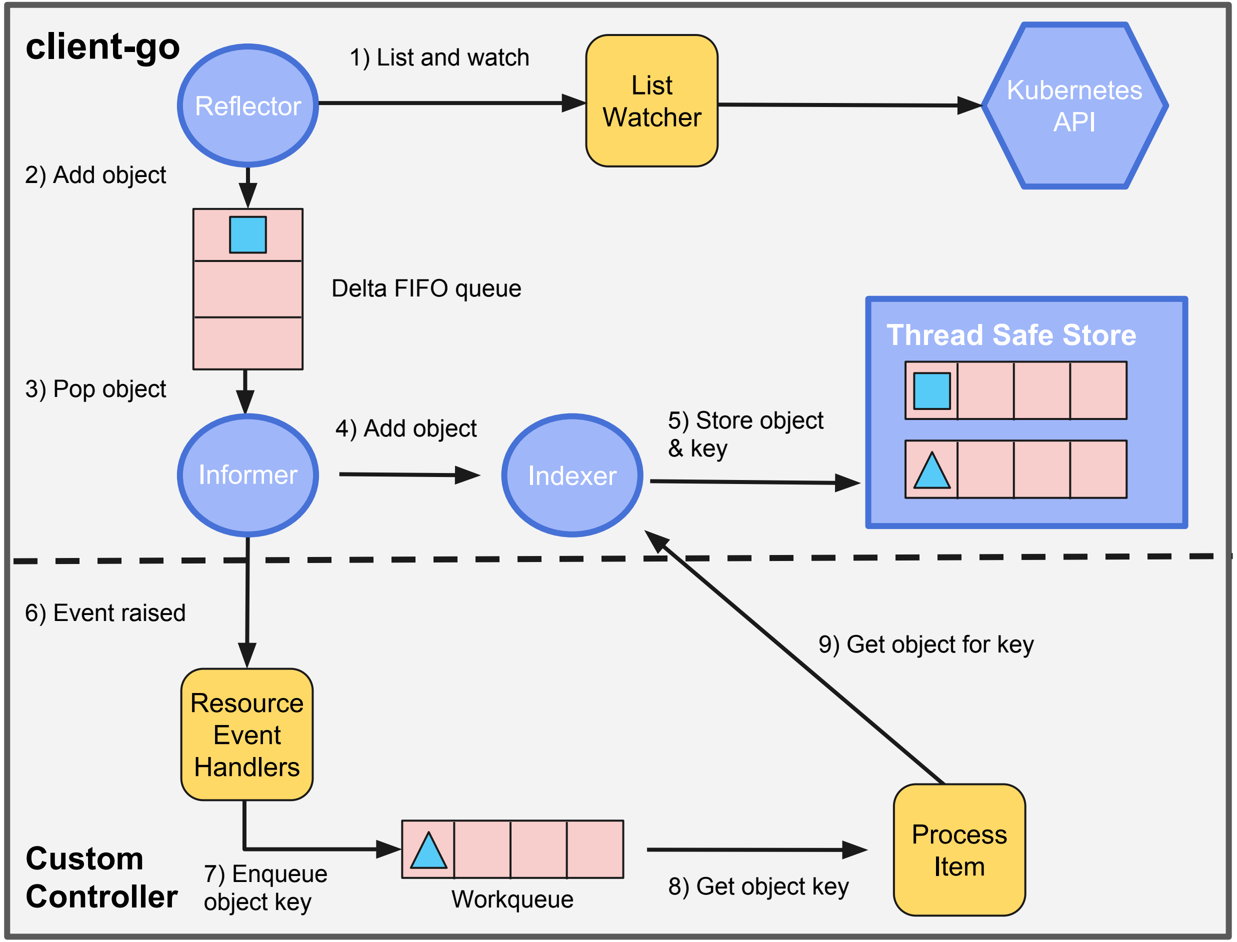
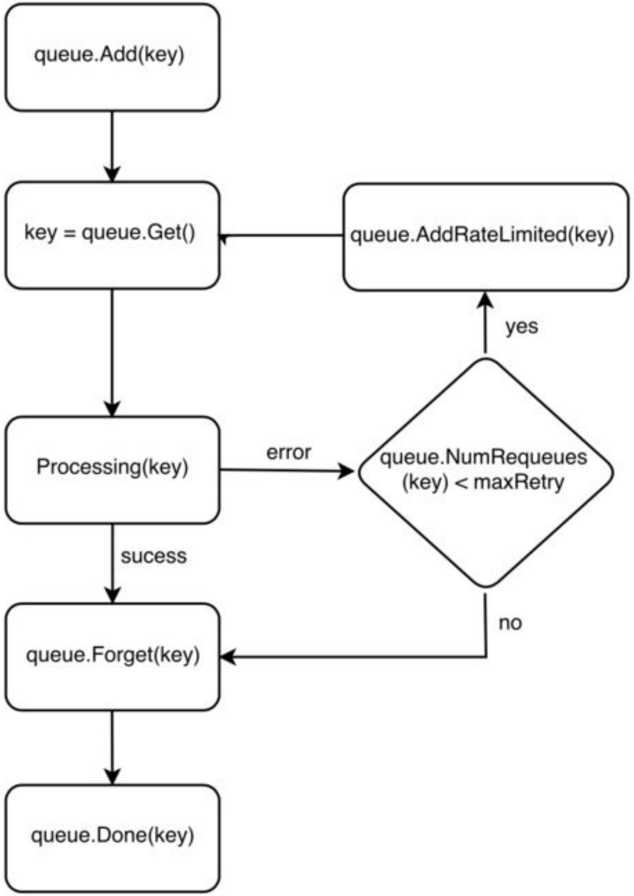
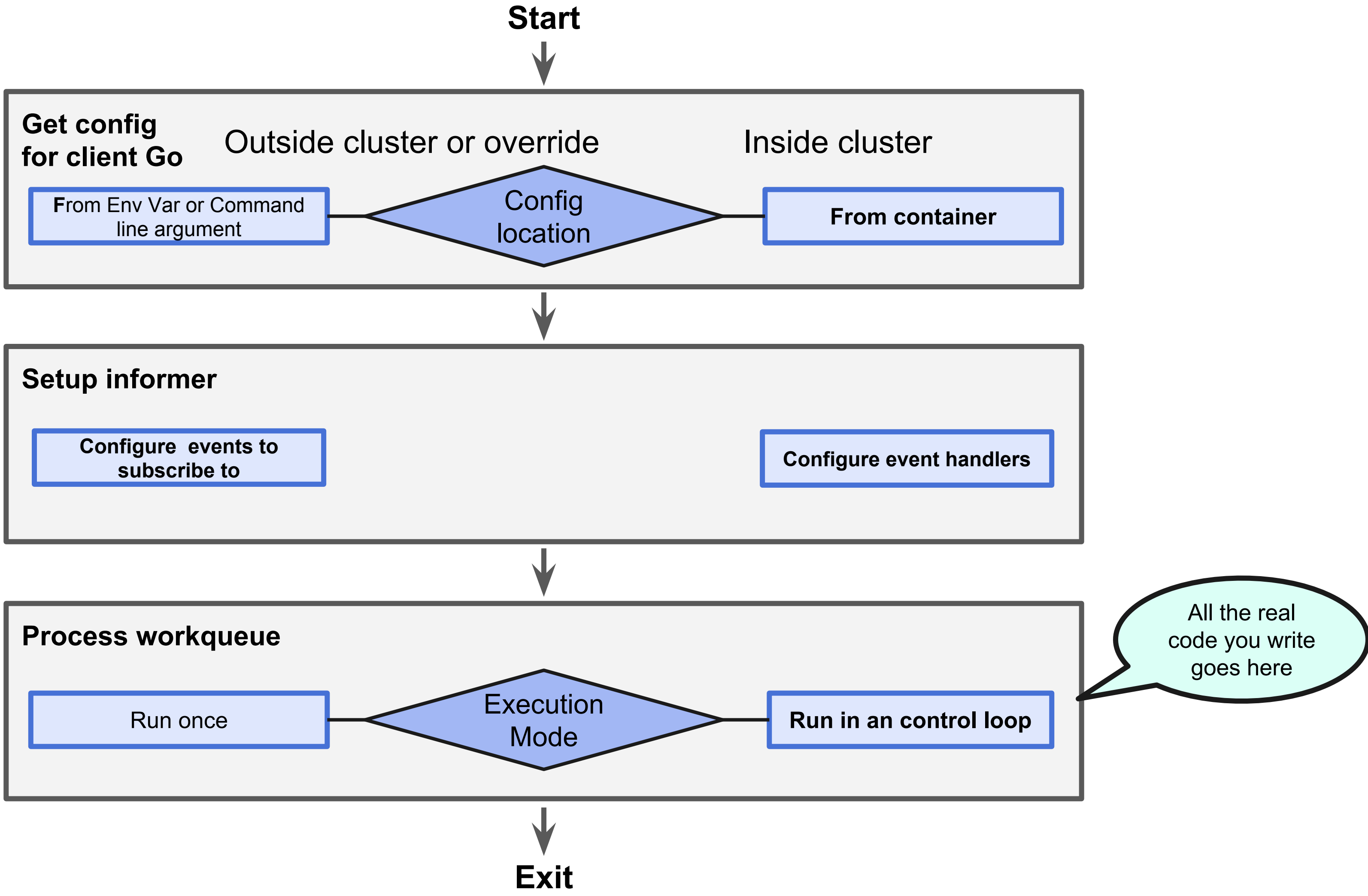

client-go
Reflector
1) List and watch
List Watcher
Kubernetes API
2) Add object
Delta FIFO queue
Thread Safe Store
3) Pop object
Informer
4) Add object
Indexer
5) Store object & key
6) Event raised
9) Get object for key
Resource Event Handlers
Custom Controller
7) Enqueue object key
Workqueue
8) Get object key
Process Item

Workqueue


queue.Add(key)
key = queue.Get()
queue.AddRateLimited(key)
yes
Processing(key)
error
queue.NumRequeues
(key) < maxRetry
sucess
no
queue.Forget(key)
queue.Done(key)



Start

Get config for client Go

Outside cluster or override

Inside cluster

From Env Var or Command line argument

Config location

From container

Setup informer

Configure events to subscribe to

Configure event handlers

Process workqueue

Run once

Execution Mode

Run in an control loop

All the real code you write goes here

Exit

Building a Custom Controller that uses CRDs

```
Get-Config -> main.go 45 getKubernetesConfig
Setup informers -> controller.go 88 NewController
    Events to listen to -> main.go 95 main
    Events to listen to -> main.go 96 main
    Handlers for events -> controller.go 117 NewController
    Handlers for events -> controller.go 129 NewController
Run informers -> 101 main.go main
    Start x number of consumers in parallel -> controller.go 166 Run
        "Observe" Get item off workqueue -> controller.go 188 processNextWorkItem
            "Diff" retrieve desired state -> controller.go 250 syncHandler
            "Diff" retrieve current state -> controller.go 272 syncHandler
            "Act" create resource -> controller.go 275
            "Act" update resource -> controller.go 298
            "Act" does not have delete resource in this example (often handled by event handler)
        Repeat Until Exit Program
    Until Exit Program
Until Exit Program
```

What have others done

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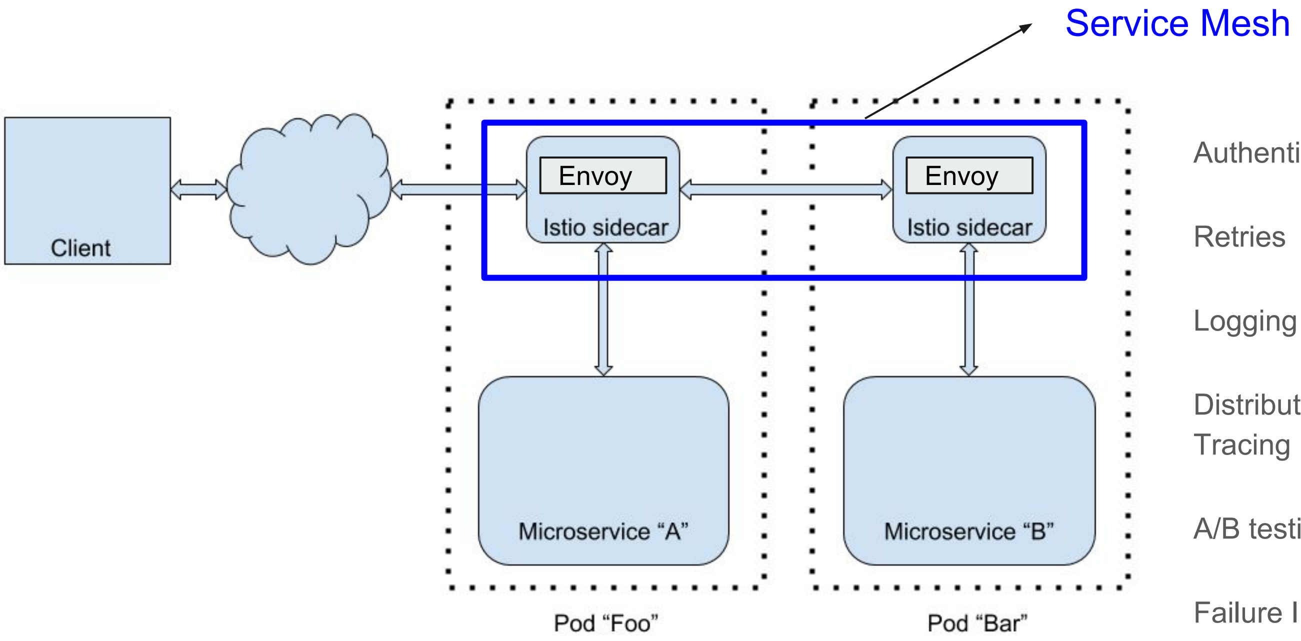
Leveraging the extensibility in K8S

K8S provides abstractions over the underlying infrastructure, we can use these abstractions to build more interesting things. Some of these are

- Service Mesh - An infrastructure layer for inter-service communication
- Ingress Controllers - Do smart things with Layer 7 traffic
- Serverless - If you can orchestrate containers, why not extend it to orchestrate code?
- Operators - Write applications to manage other applications
- Service catalog - Use Kubernetes to deploy non-K8S infrastructure
- Policy as Code - Validate your infrastructure, do code reviews before changes are applied.
- Vulnerability Management & Runtime defense - Build tools to continuously monitor threats and deal with them

A Service Mesh - Istio



Authentication

Retries

Logging

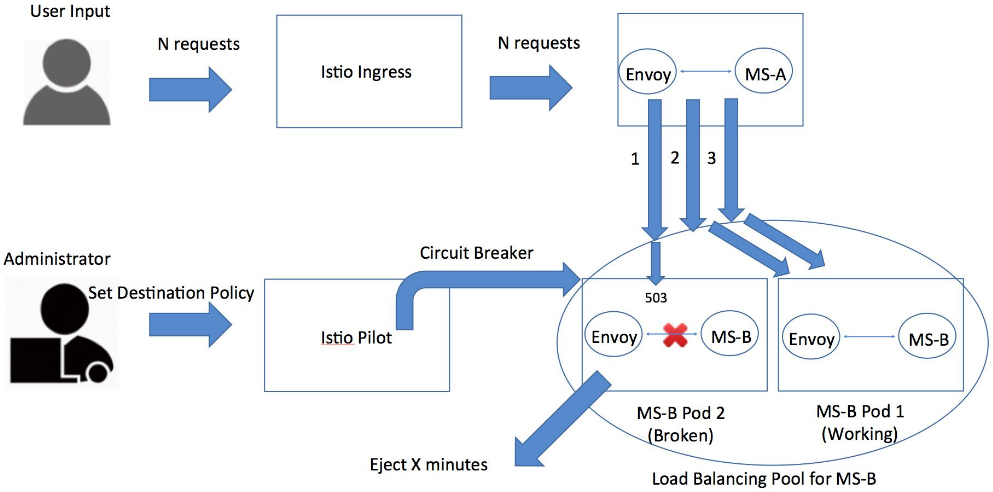
Distributed Tracing

A/B testing

Failure Injection

Circuit Breaking with Istio

```
apiVersion: networking.istio.io/v1alpha3
kind: DestinationRule
metadata:
  name: httpbin
spec:
  host: httpbin
  trafficPolicy:
    connectionPool:
      tcp:
        maxConnections: 1
      http:
        http1MaxPendingRequests: 1
        maxRequestsPerConnection: 1
```



Resources

- https://github.com/kubernetes/community/blob/master/contributors/devel/controllers.md
- https://github.com/kubernetes/community/blob/master/contributors/design-proposals/architecture/principles.md
- https://docs.openstack.org/kuryr-kubernetes/latest/devref/kuryr_kubernetes_ingress_design.html
- Template to create custom controller - https://blog.openshift.com/kubernetes-deep-dive-code-generation-customresources/
- Building controller from scratch (code looks good) - https://medium.com/@trstringer/create-kubernetes-controllers-for-core-and-custom-resources-62fc35ad64a3
- Build controller from scratch - https://www.youtube.com/watch?v=QIMz4V9WxVc
- Walk through kubernetes code - https://www.youtube.com/watch?v=ryeINNfVOi8
- Programming Kubernetes with the Go SDK - https://www.youtube.com/watch?v=qiB4RxCDC8o
- Istio - https://istio.io/

QUESTIONS?

London

1 Fore Street,
Moorgate,
London,
EC2Y 9DT,
UK

—
london@contino.io

New York

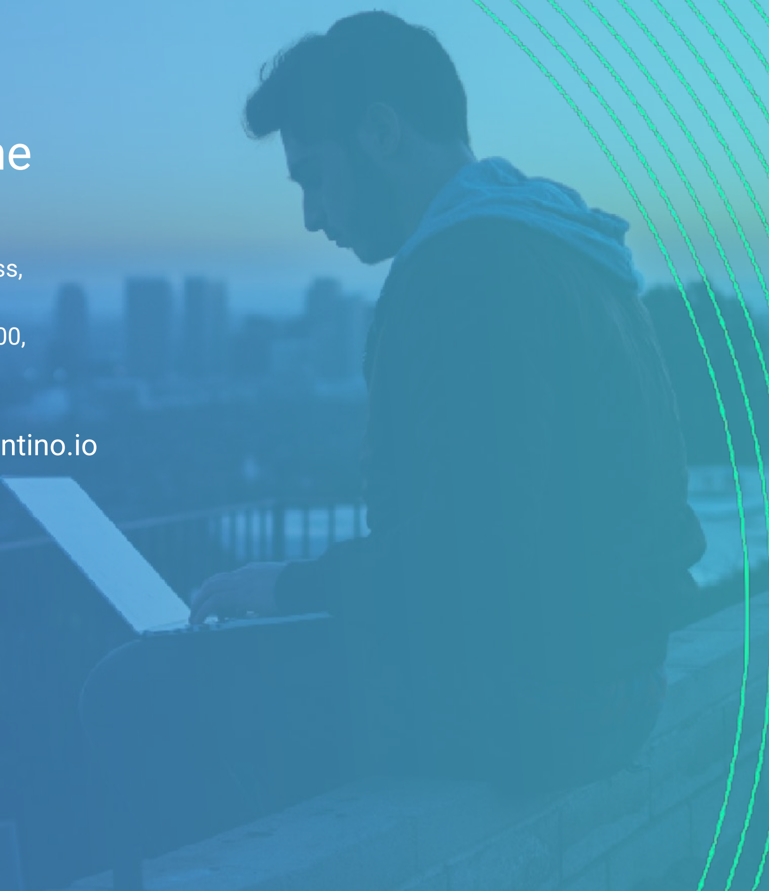
404 5th Avenue,
New York, NY,
10018EC2Y 9DT,
UK

—
newyork@contino.io

Melbourne

Level 2,
Hub Southern Cross,
696 Bourke St,
Melbourne VIC 3000,
Australia

—
melbourne@contino.io



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contino.io

info@contino.io