Join us for KubeCon + CloudNativeCon Virtual

Event dates: August 17-20, 2020
Schedule: Now available!
Cost: $75
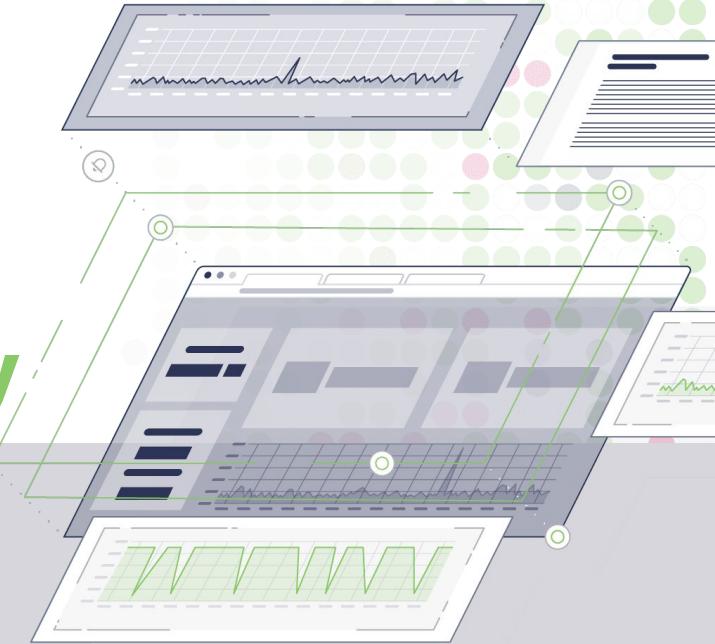
Register now!

Overview

- Introduction
- Sensu 💚 the CNCF
- The CNCF Cloud Native Trail Map
- Top 7 K8s APIs
- Getting to the "Why?" for observability

Kubernetes APIs
**Introductions**

What is Sensu?

Unified infrastructure and application monitoring at scale. Gain deep visibility into servers, containers, services, applications, functions, and connected devices across any public or private cloud.
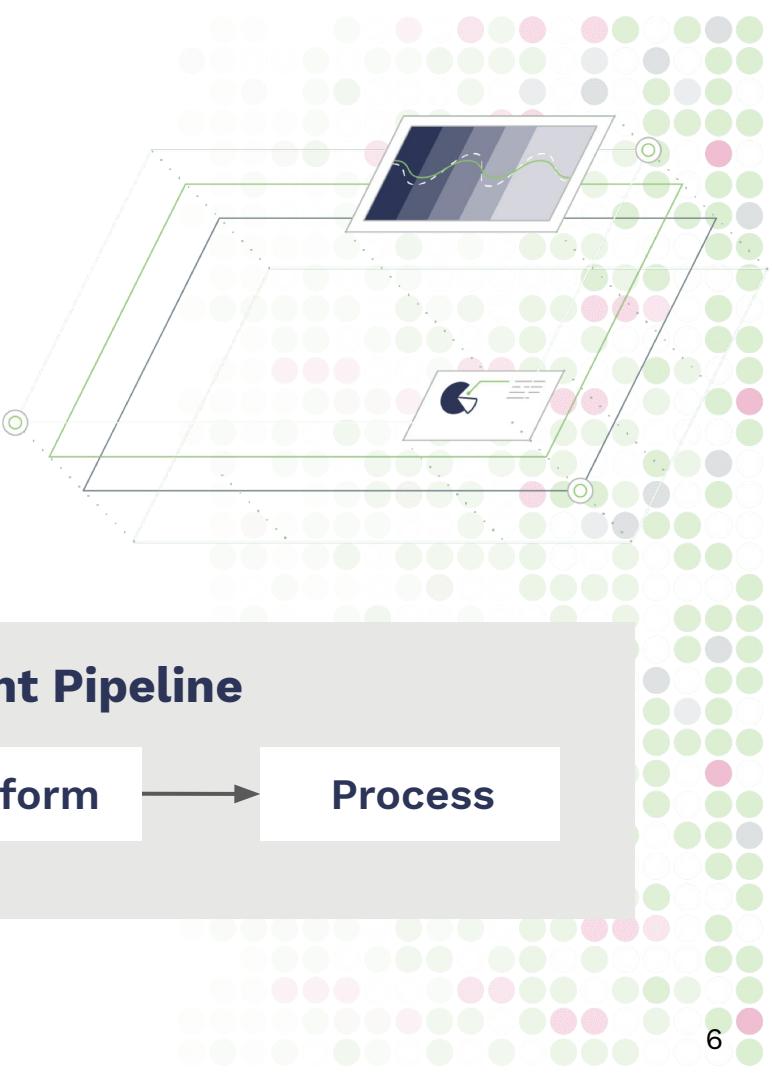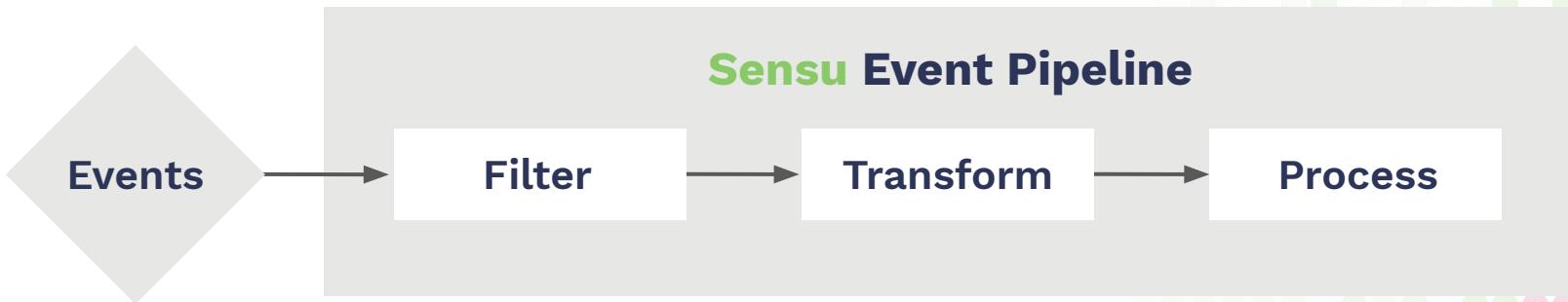
sensu.io | @sensu

How does Sensu work?

Sensu is a flexible observability pipeline.

Sensu Event Pipeline

Events → Filter → Transform → Process
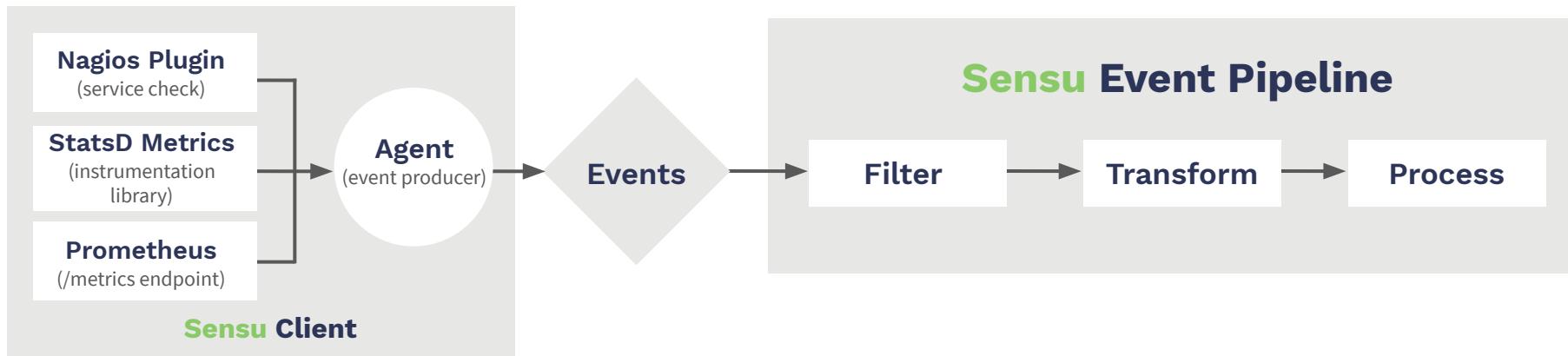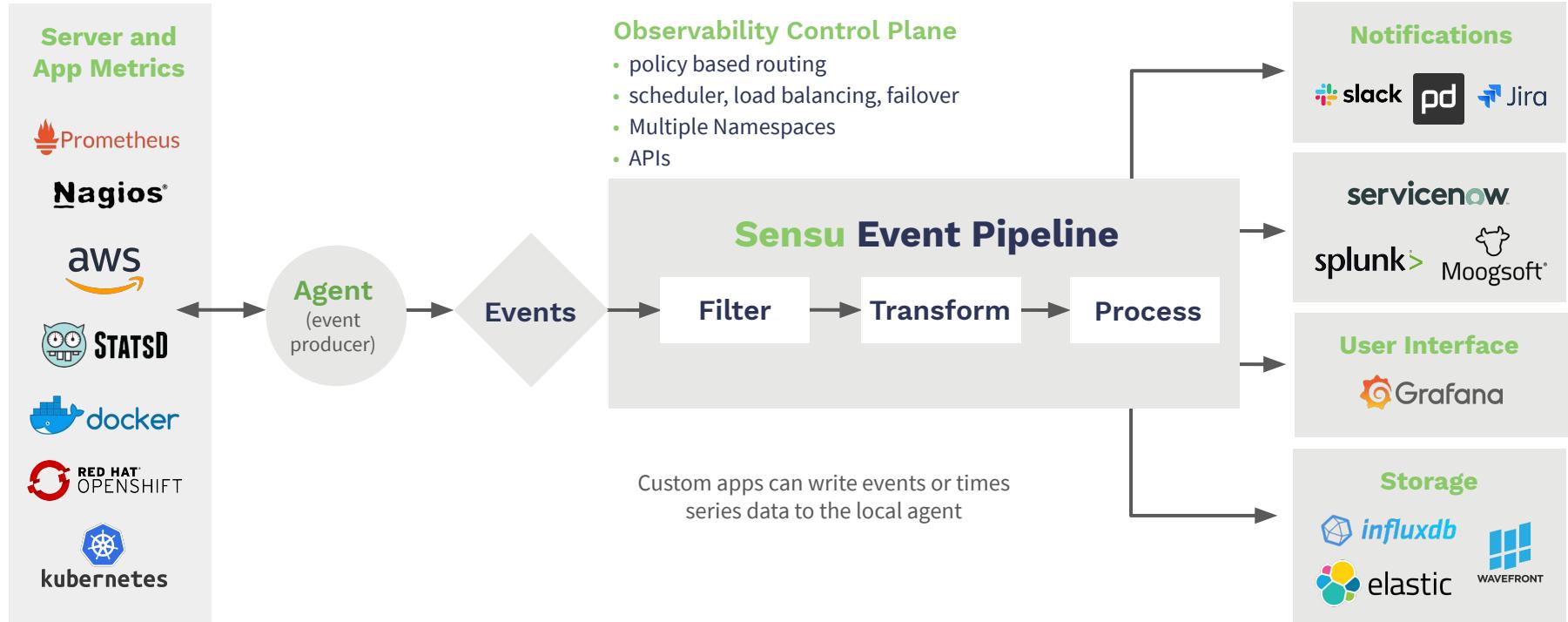
Sensu Go
The observability pipeline
The Sensu Go agent is a powerful cross-platform event producer.

Sensu Event Pipeline

Nagios Plugin
(service check)

StatsD Metrics
(instrumentation library)

Prometheus
(/metrics endpoint)

Agent
(event producer)

Events

Filter → Transform → Process

Sensu Client

Observability Pipeline Architecture

Server and App Metrics

Agent
(event producer)

Events

Observability Control Plane
- policy based routing
- scheduler, load balancing, failover
- Multiple Namespaces
- APIs

Sensu Event Pipeline

| Filter | → | Transform | → | Process |

Custom apps can write events or times series data to the local agent

Notifications
slack pd Jira

servicenow
splunk> Moogsoft

User Interface
Grafana

Storage
influxdb WAVEFRONT
elastic

8

Sensu 💚 the CNCF

- "Monitoring Kubernetes" (blog post) https://www.cncf.io/blog/2019/01/09/monitoring-kubernetes-part-1-the-challenges-data-sources
- "Monitoring Kubernetes Workloads: the Sidecar Pattern" https://youtu.be/X14nPCoNUg0
- "How Kubernetes works" (blog post) https://www.cncf.io/blog/2019/08/19/how-kubernetes-works
- KubeCon 2018-19 Sponsors

Cloud Native Journey

"You can't perform any operation without proper observability."
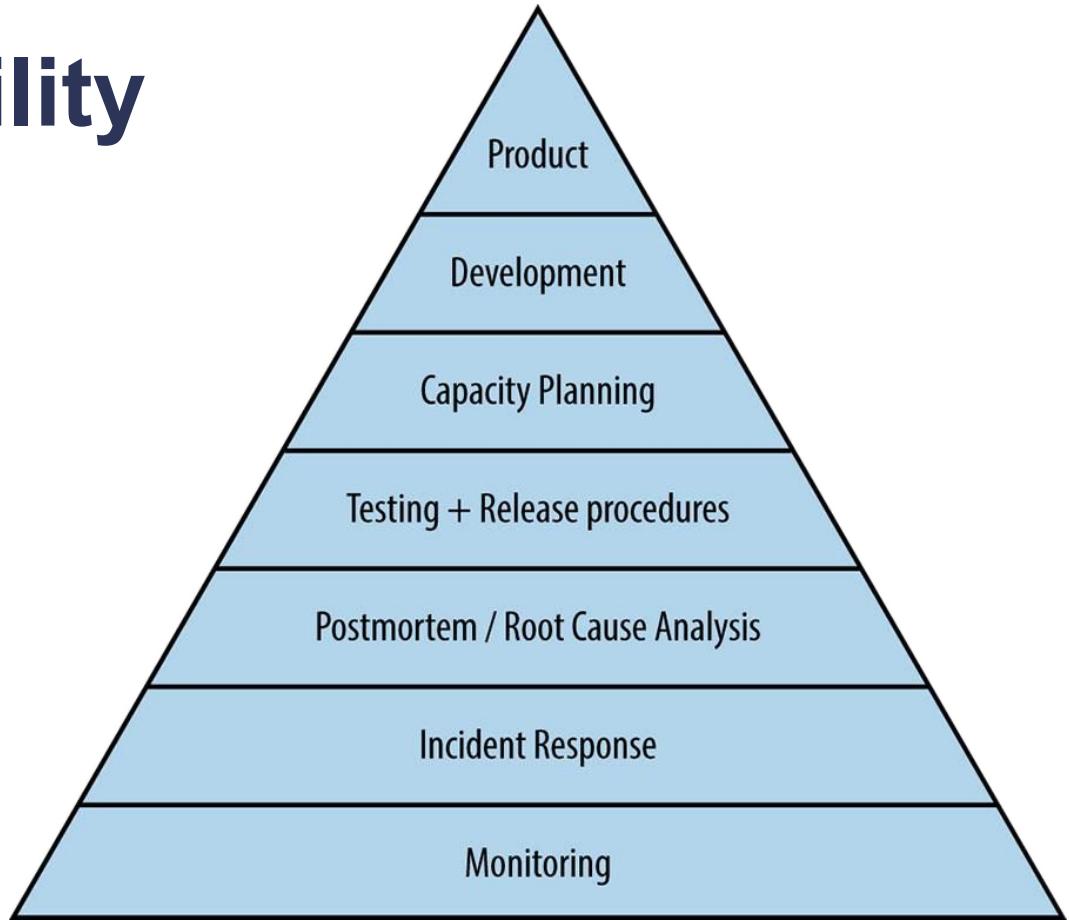
– Gene Kim

Service Reliability Hierarchy
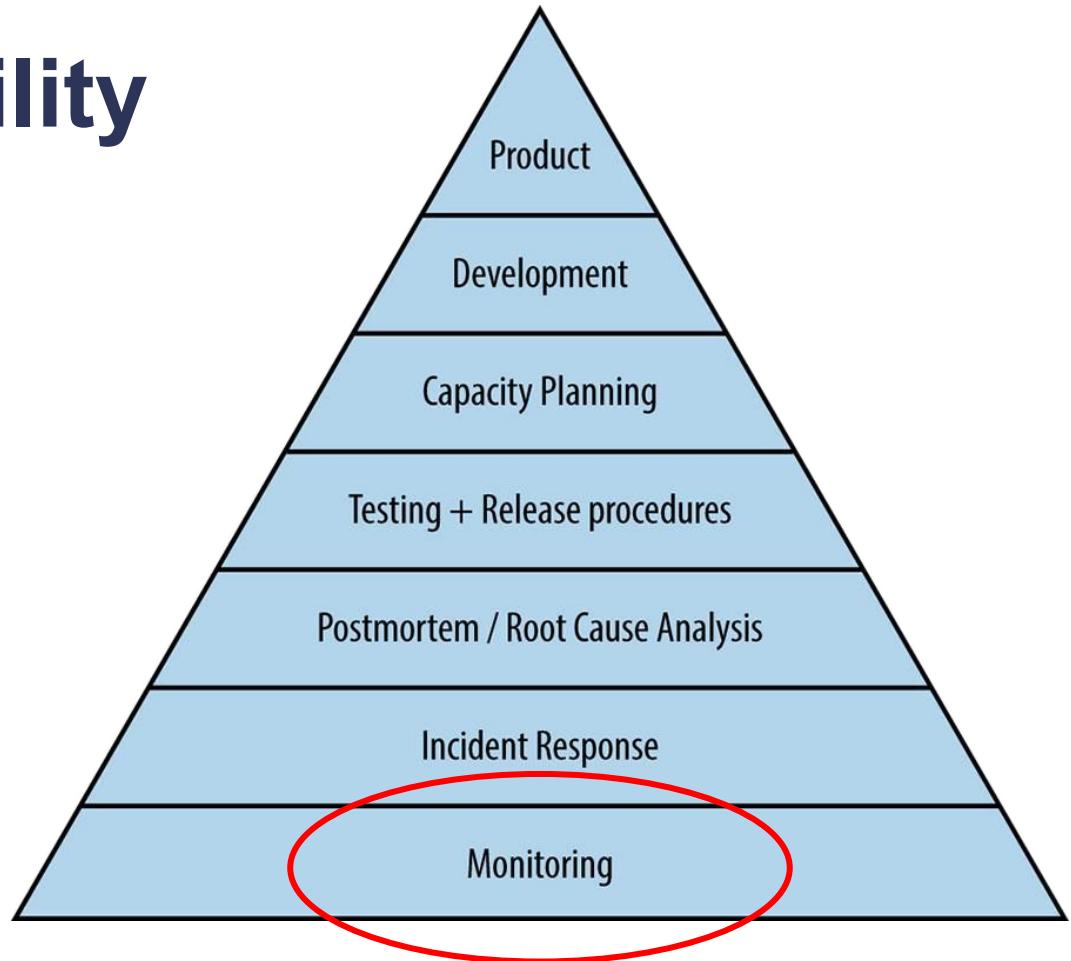
Part I. Introduction

Part II. Principles

Part III. **Practices**

Service Reliability Hierarchy

Product

Development

Capacity Planning

Testing + Release procedures

Postmortem / Root Cause Analysis

Incident Response

Monitoring

The CNCF Trail Map

1. CONTAINERIZATION
- Commonly done with Docker containers
- Any size application and dependencies (even PDP-11 code running on an emulator) can be containerized
- Over time, you should aspire towards splitting suitable applications and writing future functionality as microservices

2. CI/CD
- Setup Continuous Integration/Continuous Delivery (CI/CD) so that changes to your source code automatically result in a new container being built, tested, and deployed to staging and eventually, perhaps, to production
- Setup automated rollouts, roll backs and testing
- Argo is a set of Kubernetes-native tools for deploying and running jobs, applications, workflows, and events using GitOps paradigms such as continuous and progressive delivery and MLops

argo
CNCF Incubating

3. ORCHESTRATION & APPLICATION DEFINITION
- Kubernetes is the market-leading orchestration solution
- You should select a Certified Kubernetes Distribution, Hosted Platform, or Installer: cncf.io/ck
- Helm Charts help you define, install, and upgrade even the most complex Kubernetes application

kubernetes
CNCF Graduated

HELM
CNCF Graduated

4. OBSERVABILITY & ANALYSIS
- Pick solutions for monitoring, logging and tracing
- Consider CNCF projects Prometheus for monitoring, Fluentd for logging and Jaeger for Tracing
- For tracing, look for an OpenTracing-compatible implementation like Jaeger

Prometheus
CNCF Graduated

fluentd
CNCF Graduated

JAEGER
CNCF Graduated

OPENTRACING
CNCF Incubating

5. SERVICE PROXY, DISCOVERY, & MESH
- CoreDNS is a fast and flexible tool that is useful for service discovery
- Envoy and Linkerd each enable service mesh architectures
- They offer health checking, routing, and load balancing

https://github.com/cncf/trailmap

The CNCF Trail Map

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argo
CNCF Incubating

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CNCF Incubating

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CNCF's Cloud Native Trail Map

"This Cloud Native Trail Map is a recommended process for leveraging open source, cloud native technologies. At each step, you can choose a vendor-supported offering or do it yourself, and **everything after step #3 is optional <u>based on your circumstances.</u>**"

Top 7 K8s APIs for O11y

7: K8s Metrics APIs

- Most well-known APIs for monitoring

- Built-in Prometheus exporters

- kubelet-metrics (including cadvisor)

- kube-state-metrics (cluster level)

- **Consumable by most o11y tools**

6: Service APIs

- Ingress, Endpoint, and Service resources

- Service **metadata**, **spec**, and **status**

- Service ports, internal and external IP addresses, load balancing, and label selector configuration details

- `kubectl describe service <service>`

5: Container API

- **Pod API resource**

- Information about running containers

- Container **status** and **details** including image source, commands, networking, execution environment, and resource requirements

4: Pod API

- Primary/core workload API resource
- `kubectl describe pod <pod name>`
- Pod **metadata**, **spec**, and **status**
- Controller references
- Read log API (misc operation)

```
[homelab $ kubectl --namespace cncf-webinar logs nginx-example-5bd95679c8-bxqbh -c nginx --tail 10
10.24.1.1 - - [06/Jul/2020:18:21:34 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.24.1.1 - - [06/Jul/2020:18:21:35 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.223 - - [06/Jul/2020:18:21:38 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.223 - - [06/Jul/2020:18:21:48 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.24.1.1 - - [06/Jul/2020:18:23:33 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.223 - - [06/Jul/2020:18:23:33 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.223 - - [06/Jul/2020:18:23:34 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.225 - - [06/Jul/2020:18:23:35 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.24.1.1 - - [06/Jul/2020:18:23:38 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.225 - - [06/Jul/2020:18:23:39 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
[homelab $ curl -s "http://127.0.0.1:8888/api/v1/namespaces/cncf-webinar/pods/nginx-example-5bd95679c8-bxqbh/log?fol
low=false&tailLines=10&container=nginx"
10.24.1.1 - - [06/Jul/2020:18:21:34 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.24.1.1 - - [06/Jul/2020:18:21:35 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.223 - - [06/Jul/2020:18:21:38 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.223 - - [06/Jul/2020:18:21:48 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.24.1.1 - - [06/Jul/2020:18:23:33 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
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10.138.15.223 - - [06/Jul/2020:18:23:34 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.225 - - [06/Jul/2020:18:23:35 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.24.1.1 - - [06/Jul/2020:18:23:38 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
10.138.15.225 - - [06/Jul/2020:18:23:39 +0000] "HEAD / HTTP/1.1" 200 0 "-" "curl/7.64.0" "-"
homelab $
```

3: Kubernetes Downward API

The Downward API enables Pods to expose information about themselves to Containers running in the Pod via files or environment variables.

3: Kubernetes Downward API

Motivation for the Downward API

It is sometimes useful for a Container to have information about itself, without being overly coupled to Kubernetes. The Downward API allows containers to consume information about themselves or the cluster without using the Kubernetes client or API server.

An example is an existing application that assumes a particular well-known environment variable holds a unique identifier. One possibility is to wrap the application, but that is tedious and error prone, and it violates the goal of low coupling. A better option would be to use the Pod's name as an identifier, and inject the Pod's name into the well-known environment variable.

https://kubernetes.io/docs/~/downward-api-volume-expose-pod-information/

3: Kubernetes Downward API

- Pod configuration directive
- Expose pod information via files or env vars
- **Alternative/complement to serviceAccount**
- Useful w/ monitoring & observability tools
- Enrich observations w/ rich context

3: Kubernetes Downward API
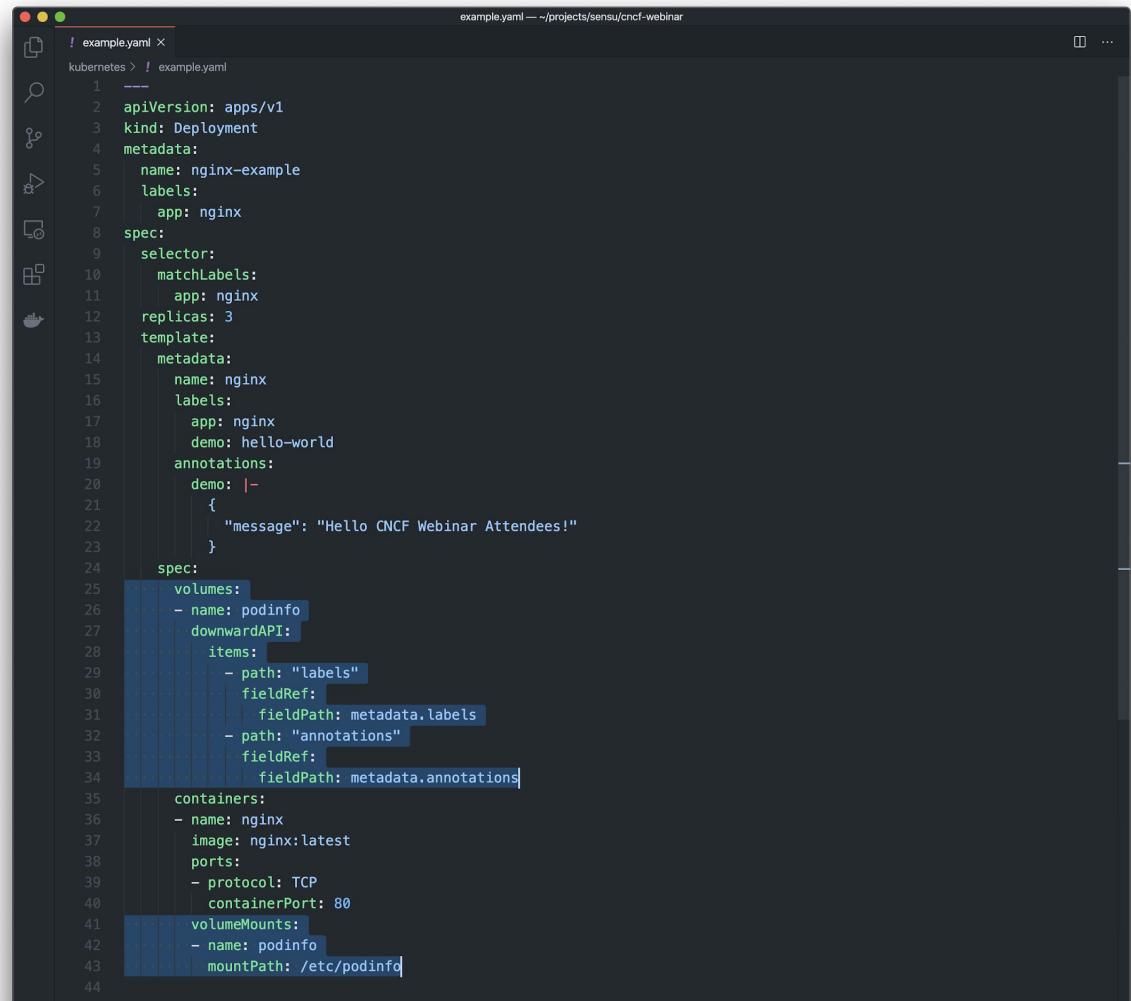
- Selectors: **fieldRef** & **resourceFieldRef**
- Available fields:
  - **metadata** (labels & annotations)
  - **spec** (nodeName, serviceAccountName)
  - **status** (status.podIP, status.hostIP)

K8s Downward API

Configured as volume mount

–OR–

Configured as environment variable

```yaml
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-example
  labels:
    app: nginx
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 3
  template:
    metadata:
      name: nginx
      labels:
        app: nginx
        demo: hello-world
      annotations:
        demo: |-
          {
            "message": "Hello CNCF Webinar Attendees!"
          }
    spec:
      volumes:
      - name: podinfo
        downwardAPI:
          items:
            - path: "labels"
              fieldRef:
                fieldPath: metadata.labels
            - path: "annotations"
              fieldRef:
                fieldPath: metadata.annotations
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - protocol: TCP
          containerPort: 80
        volumeMounts:
        - name: podinfo
          mountPath: /etc/podinfo
```

K8s Downward API

Configured as volume mount

–OR–

Configured as environment variable

```yaml
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-example
  labels:
    app: nginx
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 3
  template:
    metadata:
      name: nginx
      labels:
        app: nginx
        demo: hello-world
      annotations:
        demo: |-
          {
            "message": "Hello CNCF Webinar Attendees!"
          }
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - protocol: TCP
          containerPort: 80
        env:
        - name: APP_EXAMPLE
          value: hello world
        - name: APP_NAMESPACE
          valueFrom:
            fieldRef:
              fieldPath: metadata.namespace
```

```
[root@nginx-example-5bd95679c8-bxqbh:/# export | grep APP_
declare -x APP_EXAMPLE="hello world"
declare -x APP_NAMESPACE="cncf-webinar"
[root@nginx-example-5bd95679c8-bxqbh:/# ls /etc/podinfo
annotations  labels
[root@nginx-example-5bd95679c8-bxqbh:/# cat /etc/podinfo/labels && echo
app="nginx"
demo="hello-world"
pod-template-hash="5bd95679c8"
root@nginx-example-5bd95679c8-bxqbh:/# cat /etc/podinfo/
```

Terminal — bash — 80×24

```
sensu $ kubectl exec -it nginx-6b8cb45687-crsgw -c sensu-agent /bin/ash
/ # echo $KUBE_KUBELET
gke-kubernetes-sensu-go-default-pool-33524e02-tq5r
/ # echo $SENSU_NAME
nginx-6b8cb45687-crsgw
/ # echo $SENSU_NAMESPACE
cncf-webinar
/ # echo $SENSU_LABELS | jq .
{
  "foo": "bar",
  "namespace": "cncf-webinar",
  "kubelet": "gke-kubernetes-sensu-go-default-pool-33524e02-tq5r"
}
/ #
```

nginx.yaml — ~/projects/sensu/cncf-webinar

nginx.yaml

kubernetes > nginx.yaml

```yaml
103
104        - name: sensu-agent
105          image: sensu/sensu:5.21.0
106          command: [
107            "/opt/sensu/bin/sensu-agent", "start",
108            "--config-file", "/etc/sensu/agent/agent.yaml",
109            "--log-level", "debug"
110          ]
111          env:
112          - name: KUBE_KUBELET
113            valueFrom:
114              fieldRef:
115                fieldPath: spec.nodeName
116          - name: SENSU_NAME
117            valueFrom:
118              fieldRef:
119                fieldPath: metadata.name
120          - name: SENSU_NAMESPACE
121            valueFrom:
122              fieldRef:
123                fieldPath: metadata.namespace
124          - name: SENSU_LABELS
125            value: >-
126              {
127                "foo": "bar",
128                "kube_namespace": "$(SENSU_NAMESPACE)",
129                "kubelet": "$(KUBE_KUBELET)"
130              }
131          - name: SENSU_BACKEND_URL
132            value: wss://sensu-backend-0.sensu.sensu-system.svc.cluster.
133          - name: SENSU_SUBSCRIPTIONS
134            value: kubernetes linux nginx
135          - name: SENSU_KEEPALIVE_INTERVAL
136            value: "5"
137          - name: SENSU_KEEPALIVE_WARNING_TIMEOUT
```

```
sensu $ kubectl get pods --namespace cncf-webinar
NAME                         READY   STATUS    RESTARTS   AGE
nginx-6b8cb45687-crsgw       2/2     Running   0          51m
nginx-6b8cb45687-dsjbm       2/2     Running   0          51m
nginx-6b8cb45687-krwd8       2/2     Running   0          52m
sensu $ sensuctl entity list --namespace cncf-webinar --format json | jq '.[] |
>     name: .metadata.name,
>     namespace: .metadata.namespace,
>     labels: .metadata.labels
> }'
{
    "name": "nginx-6b8cb45687-crsgw",
    "namespace": "cncf-webinar",
    "labels": {
        "foo": "bar",
        "kubelet": "gke-kubernetes-sensu-go-default-pool-33524e02-tq5r",
        "namespace": "cncf-webinar"
    }
}
{
    "name": "nginx-6b8cb45687-dsjbm",
    "namespace": "cncf-webinar",
    "labels": {
        "foo": "bar",
        "kubelet": "gke-kubernetes-sensu-go-default-pool-33524e02-mrk9",
        "namespace": "cncf-webinar"
    }
}
{
    "name": "nginx-6b8cb45687-krwd8",
    "namespace": "cncf-webinar",
    "labels": {
        "foo": "bar",
        "kubelet": "gke-kubernetes-sensu-go-default-pool-33524e02-64tz",
        "namespace": "cncf-webinar"
    }
}
sensu $
```

demo.sensu.io/c/~/n/cncf-webinar/entities/nginx-6b8cb45687-crsgw

Sensu

local-cluster › cncf-webinar › entities › nginx-6b8cb45687-crsgw

- Dashboard
- cncf-webinar
- Events
- Entities
- Silences
- Configuration

Entity: nginx-6b8cb45687-crsgw

Status	✓ success (0)
Last Seen	just now
Subscriptions	kubernetes
	linux
	nginx
	entity:nginx-6b8cb45687-crsgw

		User	
		Deregister	
		Deregistration	
		Redacted Keys	

Class	agent
Hostname	nginx-6b8cb45687-crsgw
Cloud Provider	—
VM System	—
VM Role	guest

OS	
Platform	
Architecture	
ARM Version	
libc Implement...	

Adapter	eth0
MAC	da:69:0e:07:a8:12
IP Address	10.24.2.31/24

Labels   foo bar   kubelet   gke-kubernetes-sensu-go-d...

admin

2: Kubernetes Events API

- First-class K8s resource

- Resource **state changes**, **errors**, and other **system messages**

- As seen in "kubectl describe" output

- Examples: image pull failures, volume mount failures, scheduling events, etc.

$ kubectl get events

```
                                    Terminal — bash — 140×40
sensu $ kubectl -n default scale deployment nginx-example --replicas 2

_____
Every 2.0s: kubectl -n default get pods                              homelab: Wed Jul  8 21:35:29 2020

NAME                              READY   STATUS    RESTARTS   AGE
nginx-example-6d5bbbc7d7-nl6rq    1/1     Running   0          61s
nginx-example-6d5bbbc7d7-phz6t    1/1     Running   0          9m15s
nginx-example-6d5bbbc7d7-ps49p    1/1     Running   0          61s
nginx-example-6d5bbbc7d7-x59tx    1/1     Running   0          9m13s
nginx-example-6d5bbbc7d7-zrs77    1/1     Running   0          61s




_____
Every 2.0s: kubectl -n default get events                            homelab: Wed Jul  8 21:35:29 2020

No resources found.




[0] 0:kube-proxy- 1:webinar*                                         "homelab" 21:35 08-Jul-20
```

$ kubectl get events --field-selector involvedObject.kind!=Pod

```
Terminal — bash — 140×40
sensu $ kubectl -n default apply -f kubernetes/example-events-api.yaml

_____

Every 2.0s: kubectl -n default get pods                          homelab: Wed Jul  8 21:45:02 2020

No resources found.




_____

Every 2.0s: kubectl -n default get events --field-selector involvedObject.kind!=Pod    homelab: Wed Jul  8 21:45:01 2020

No resources found.




[0] 0:kube-proxy- 1:webinar*                                      "homelab" 21:44 08-Jul-20
```

$ kubectl get events --field-selector type!=Normal

$ /api/v1/namespaces/cncf-webinar/events?fieldSelector%21%3DNormal


```
sensu $ kubectl get events --field-selector type!=Normal
LAST SEEN    TYPE       REASON    OBJECT                        MESSAGE
28s          Warning    Failed    pod/nginx-6c8997c749-88gj8    Failed to pull image "enginex:latest": rpc error: code = Unknown desc = Error re
sponse from daemon: pull access denied for enginex, repository does not exist or may require 'docker login'
28s          Warning    Failed    pod/nginx-6c8997c749-88gj8    Error: ErrImagePull
44s          Warning    Failed    pod/nginx-6c8997c749-88gj8    Error: ImagePullBackOff
sensu $

sensu $ curl -XGET -s "http://127.0.0.1:8888/api/v1/namespaces/cncf-webinar/events?fieldSelector=type%21%3DNormal" | jq '.items[] | {
>         type: .type,
>         message: .message,
>         reason: .reason,
>         kind: .involvedObject.kind,
>         name: .involvedObject.name
>      }'
{
  "type": "Warning",
  "message": "Failed to pull image \"enginex:latest\": rpc error: code = Unknown desc = Error response from daemon: pull access denied for e
nginex, repository does not exist or may require 'docker login'",
  "reason": "Failed",
  "kind": "Pod",
  "name": "nginx-6c8997c749-88gj8"
}
{
  "type": "Warning",
  "message": "Error: ErrImagePull",
  "reason": "Failed",
  "kind": "Pod",
  "name": "nginx-6c8997c749-88gj8"
}
{
  "type": "Warning",
  "message": "Error: ImagePullBackOff",
  "reason": "Failed",
  "kind": "Pod",
  "name": "nginx-6c8997c749-88gj8"
}
sensu $
```

[0] 0:kube-proxy- 1:webinar*   "homelab" 09:27 09-Jul-20

1: Kubernetes API Watchers
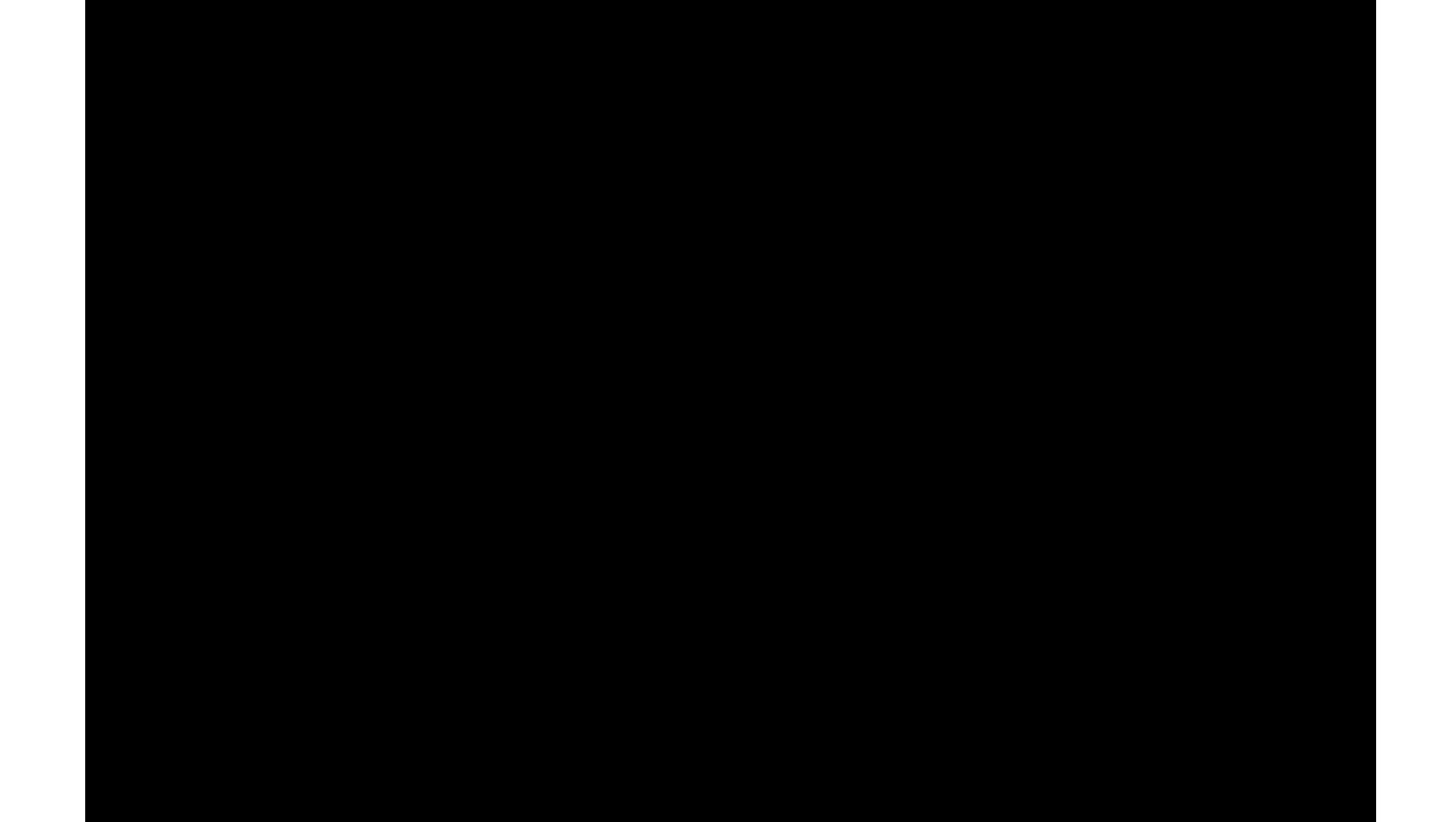
- Change notifications for **all K8s resources**

- Supports resource **instances** & **collections**

```
GET /api/v1/namespaces/{namespace}/pods
GET /api/v1/watch/namespaces/{namespace}/pods?resourceVersion=123456789
GET /api/v1/watch/namespaces/{namespace}/pods/{name}?resourceVersion=123
```
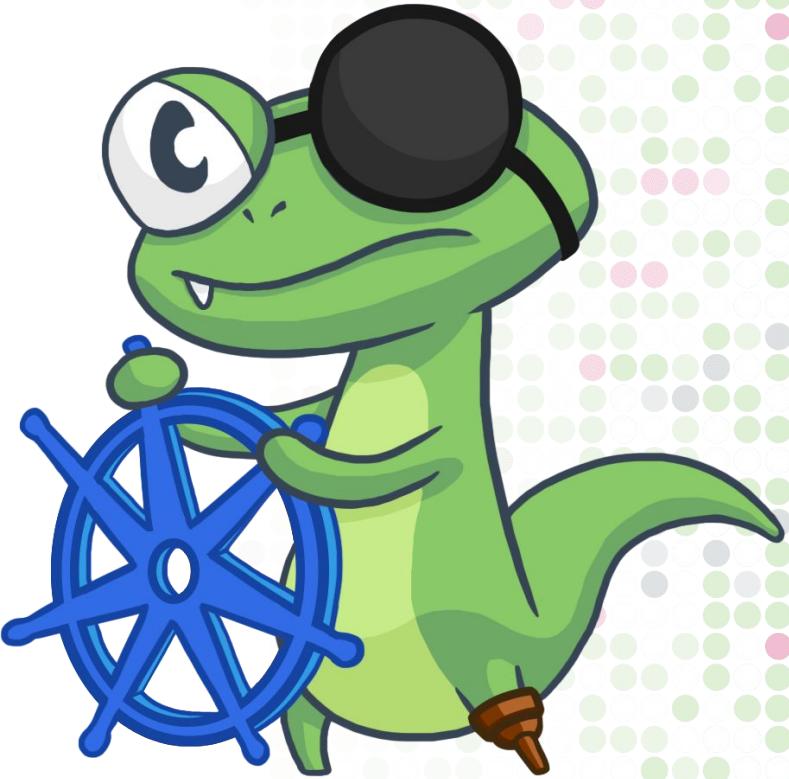
- Returns **ADDED**, **MODIFIED**, and **DELETED** change notifications

Top 7 Kubernetes APIs:

7. Kubernetes Metrics APIs
6. Service API
5. Container API
4. Pod API
3. Kubernetes Downward API
2. Kubernetes Events API
1. Kubernetes API Watchers

Closing remarks:
Getting to the why

- Holistic view of K8s health

- Richer observations

- Additional context needed to complement metrics

- **Observability should tell the whole story**

Going further: join our webinar!

- Filling gaps in K8s observability

- Getting richer context with an o11y pipeline

- New K8s integrations for Sensu

- Live webinar: **August 20, 2020 @ 10:30 AM PT**

- RSVP: **bit.ly/k8s-o11y**

Thank you!

Learn more:
sensu.io

Join our community:
discourse.sensu.io

Join our webinar next month!
bit.ly/k8s-o11y