Nuvolaris Trainings

Nuvolaris Operator

Part 1: Introducting Kubernetes Operators

https://www.nuvolaris.io

Agenda (Part 1)

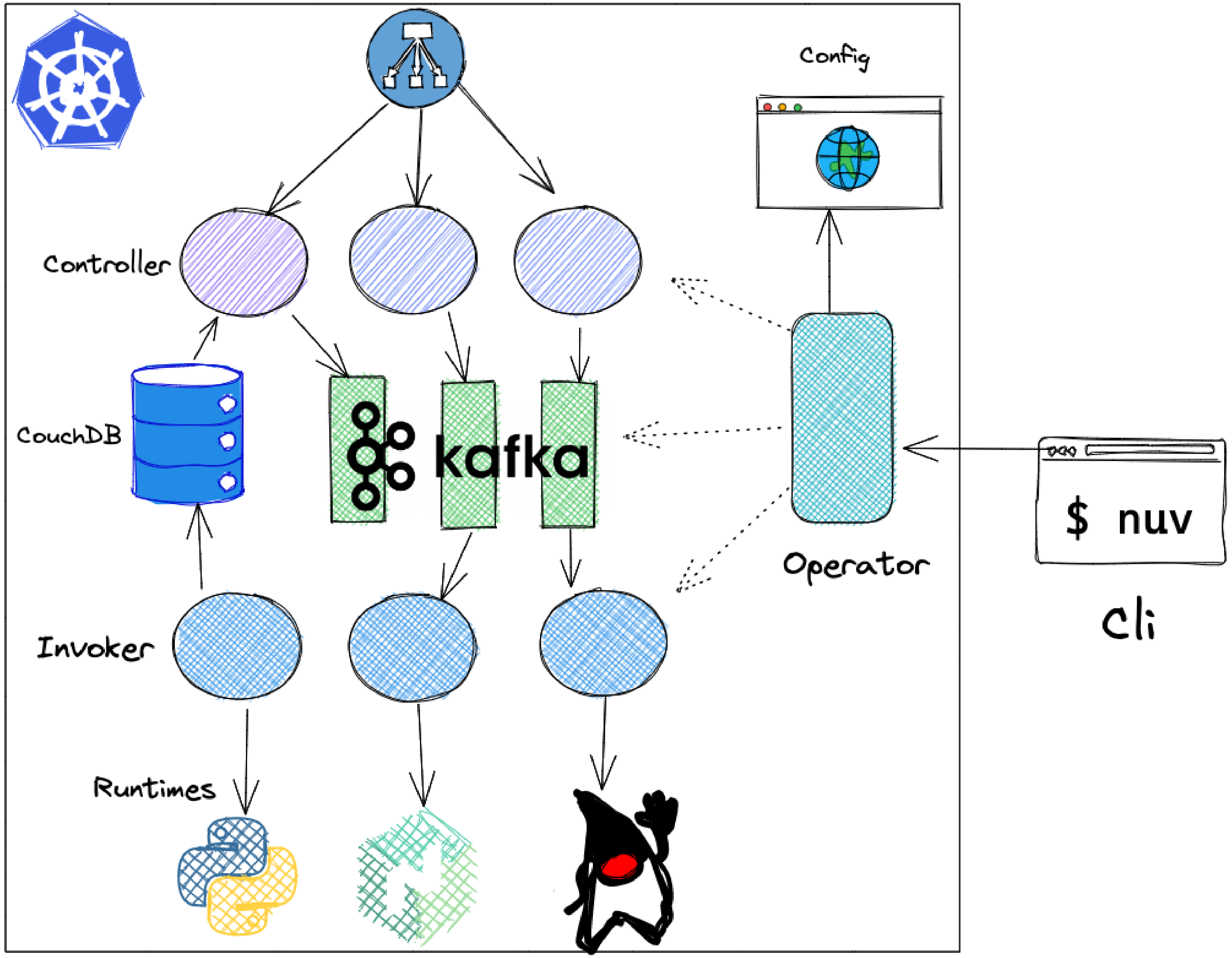
- The Nuvolaris Project
- Development Environment
- Kubernetes 101
- Custom Resource Definitions
- Kustomize

What is Kubernetes ?

- In theory, an **orchestrator**
  - also Windows, originally, was just a **GUI** on top of DOS
- In practice, an **Operating System** for the cloud

What is Nuvolaris?

- a Serverless **distribution** for Kubernetes
- *Linux* : **RedHat** = *Kubernetes* : **Nuvolaris**



Nuvolaris Architecture

Kubernetes Operators

- It is a **pattern** that is becoming commonplace
  - There is *NOT* a specific API that you implement
  - You have to use the *Kubernetes API* anyway
- You define your own Resource
  - Defining new resources as **CRD** `Custom Resource Definitions`
  - Creating instances conforming to the CRD
    - that describes the *desidered state*
  - **Writing code that brings the system to this state**

Operator Frameworks

- **Operator Framework**: ansible/helm/go
- **Kudo**: a declarative, yaml based framework
- **Metacontroller**: generic, with hooks in any languages
- **Shell-operator**: write operators in bash
- **Kubebuilder**: Go based operator
- **Kopf**: Python based Operator

also exists Java, Rust, Elixir, Javascript based operator frameworks

Dev Environment

VSCode-based Development Environment

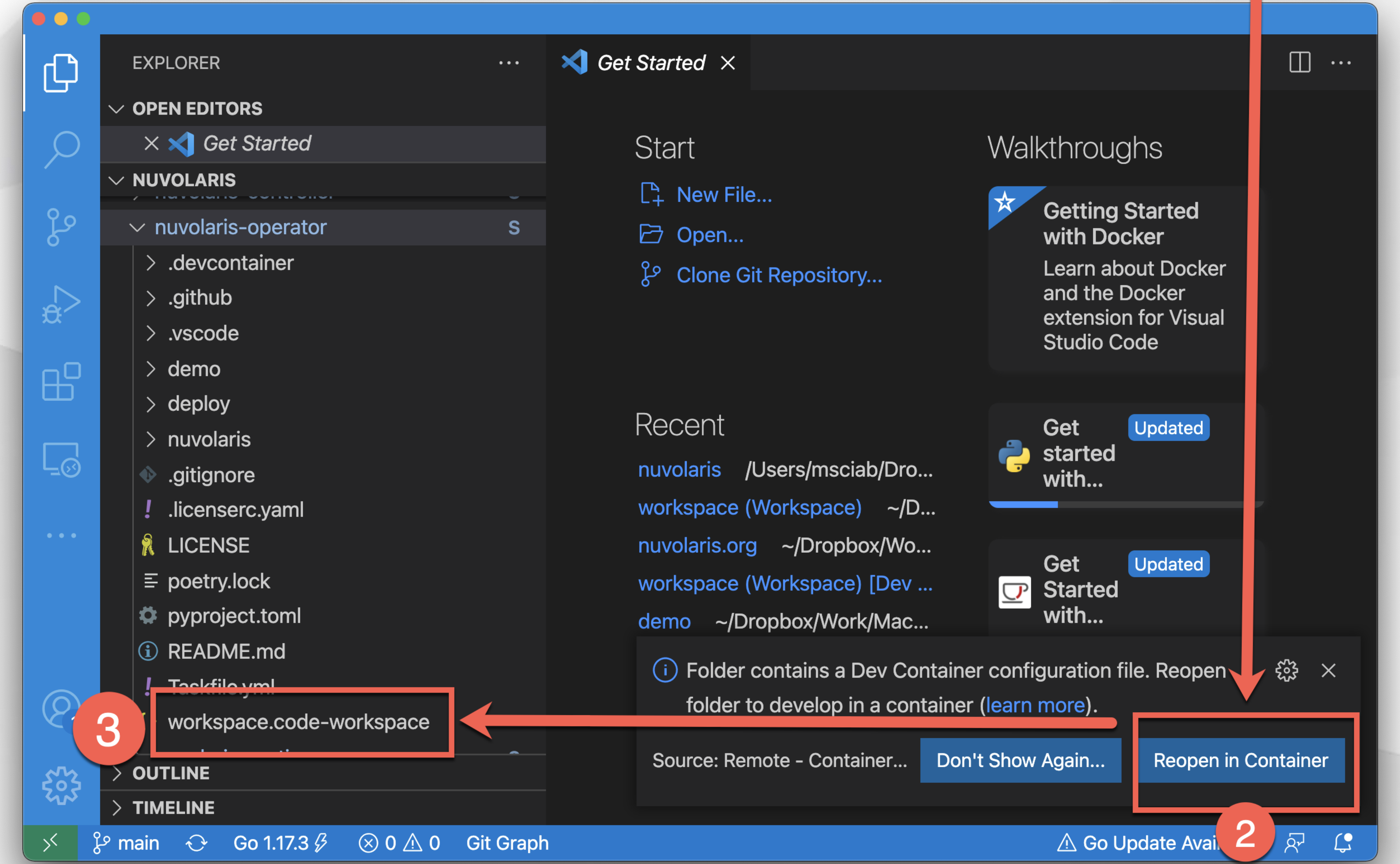
- Clone the repositories (multiple and linked)

```
git clone https://github.com/nuvolaris/nuvolaris
--recurse-submodules
```

  - do not forget **`--recurse-submodules`**
- Open the folder `nuvolaris` with VSCode:
  - Command Line: `code nuvolaris`
- Open the workspaces in subfolders: `workspace.code-workspace`

1

```
$ git clone https://github.com/nuvolaris/nuvolaris --recurse-submodules
$ code nuvolaris
```



Folder contains a Dev Container configuration file. Reopen folder to develop in a container (learn more).

Test Nuvolaris Operator

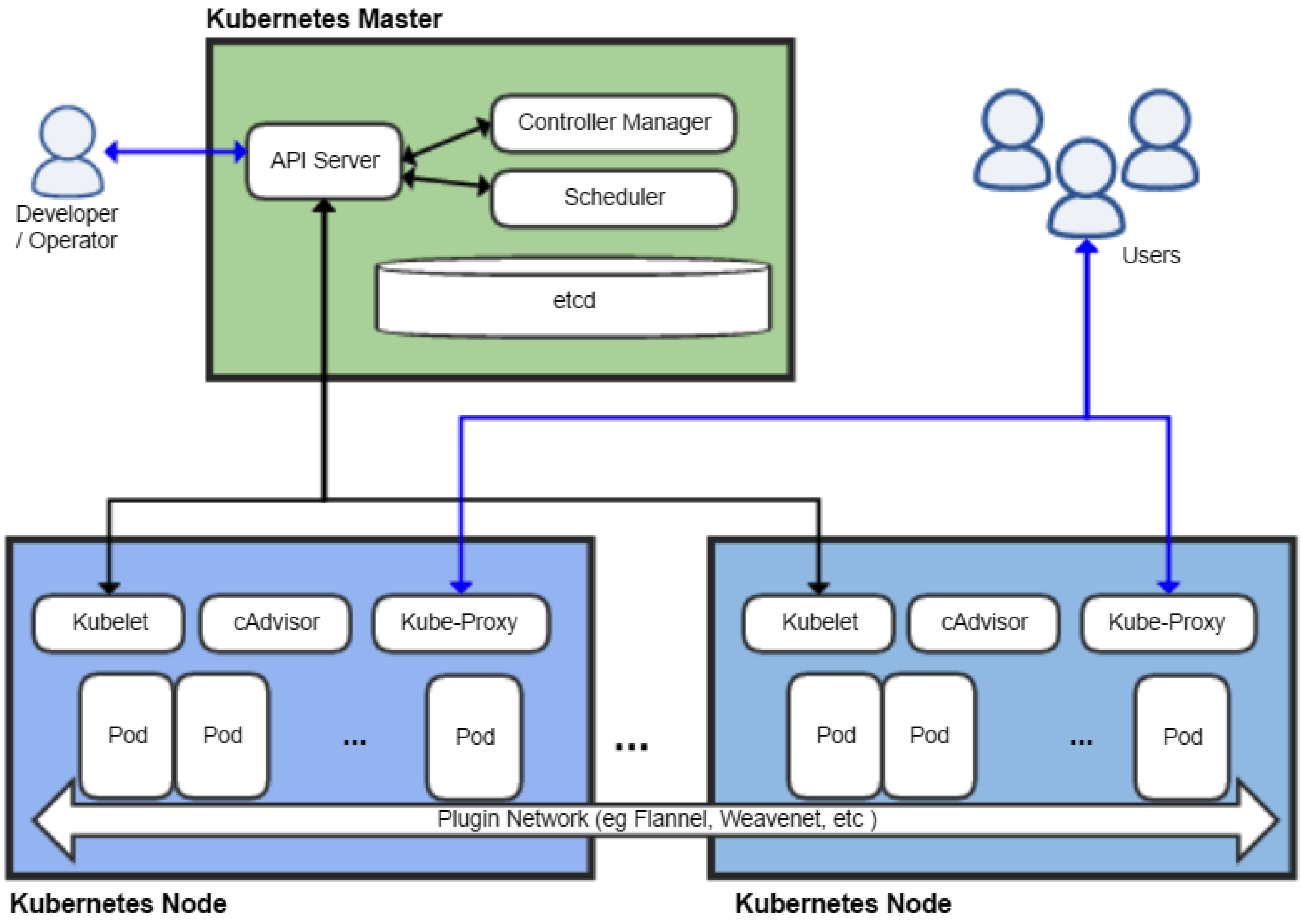
- Open `nuvolaris-operator/workspace.code-workspace`
- `kubectl get nodes`

```
NAME                         STATUS   ROLES                  AGE   VERSION
nuvolaris-control-plane      Ready    control-plane,master   41m   v1.21.1
nuvolaris-worker             Ready    <none>                 41m   v1.21.1
```

- Test

```
cd tests
task deploy
task wsk
```

Kubernetes 101



Kubernetes Architecture

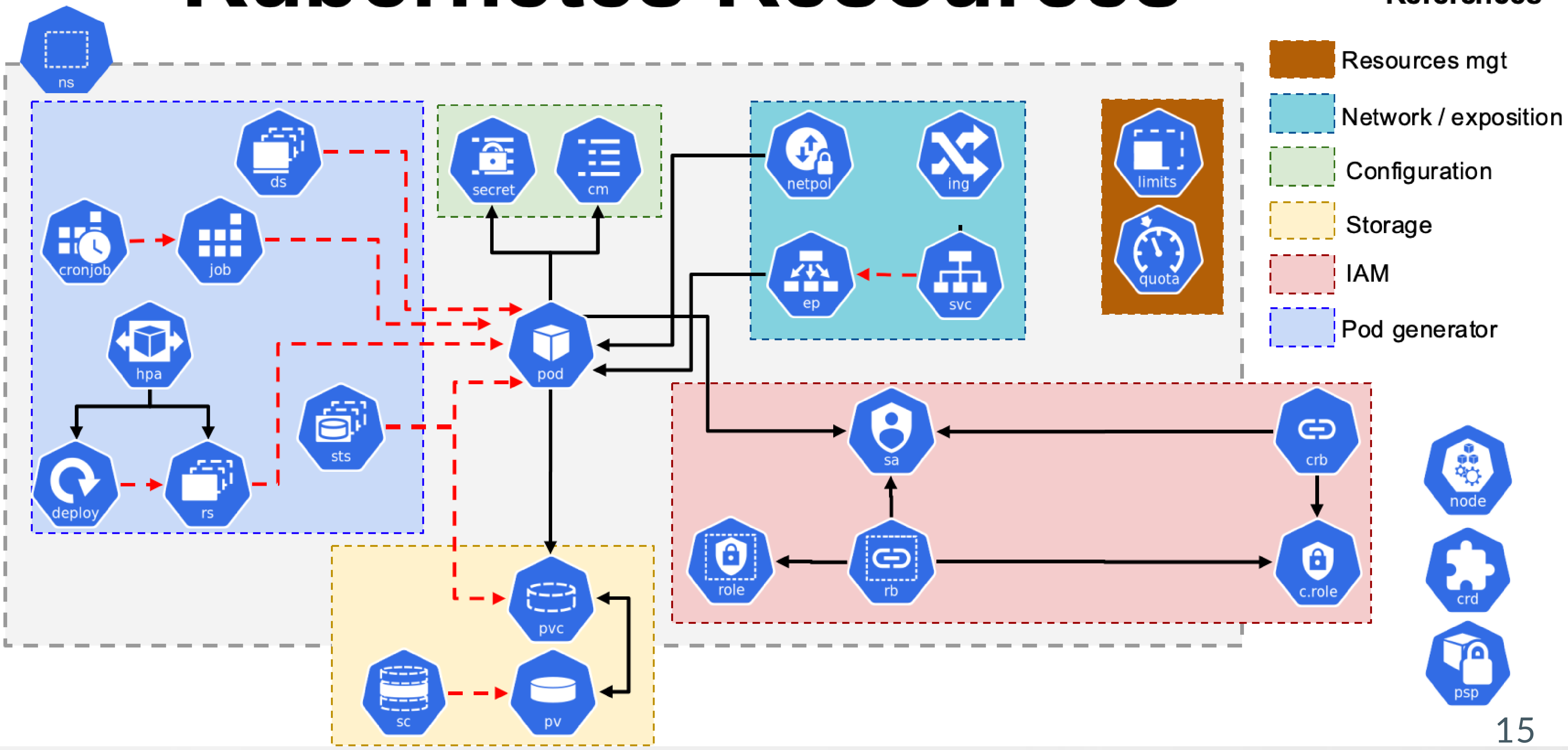
Kubernetes `kubectl` Commands

```
# checking nodes and namespaces
kubectl get nodes
kubectl get ns
kubectl create ns demo
kubectl get ns
# default namespace
kubectl config set-context --current --namespace demo
# various resourcs
kubectl get pod
kubectl get deploy
kubectl get svc
```

Kubernetes Descriptors Concepts

- Kubernetes is declarative:
  - You **describe** what you want to get by the system
  - Kubernetes will bring the system to the desidered state
- You declare what you want with *descriptors* in YAML
  - those descriptors are in YAML format
    - actually, they are internally JSON files
    - YAML is really syntax sugar for JSON
- Kubernetes brings the system to what you asked
  - ... **if it is possible** ...

Kubernetes Resources



Structure of a Kubernetes resource

- Common: Header and Metadata

```
apiVersion: v1                  # resources are versioned AND grouped
kind: Pod                       # each resource has a `kind`
metadata:
  name: demo-pod                # name of the resources
  namespace: demo               # grouped in a namespace
  labels:                       # used to locate resources
     app: demo                  # formact key=value
```

- `spec` : changes according to the kind
- `status` : maintained by the system

Simple Descriptor: a Pod

- A pod is a *set* of containers
  - the closest thing to `docker run`

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: demo-pod
  namespace: demo
spec:
  containers:
    - name: nginx
      image: nginx
      ports:
      - containerPort: 80
```

Deploy Pod

```
cat demo-pod.yaml
kubectl apply -f demo-pod.yaml
kubectl get pod
kubectl delete pod demo-pod
```

Nested Descriptor: a Deployment

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: demo-deploy
```

Templatized, repeat the template using labels

```yaml
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
```

Deployment template

It creates `replica` times the pods specified in the template

```yaml
template:
  metadata:
    labels:
      app: nginx
  spec:
    containers:
    - name: nginx
      image: nginx
      ports:
      - containerPort: 80
```

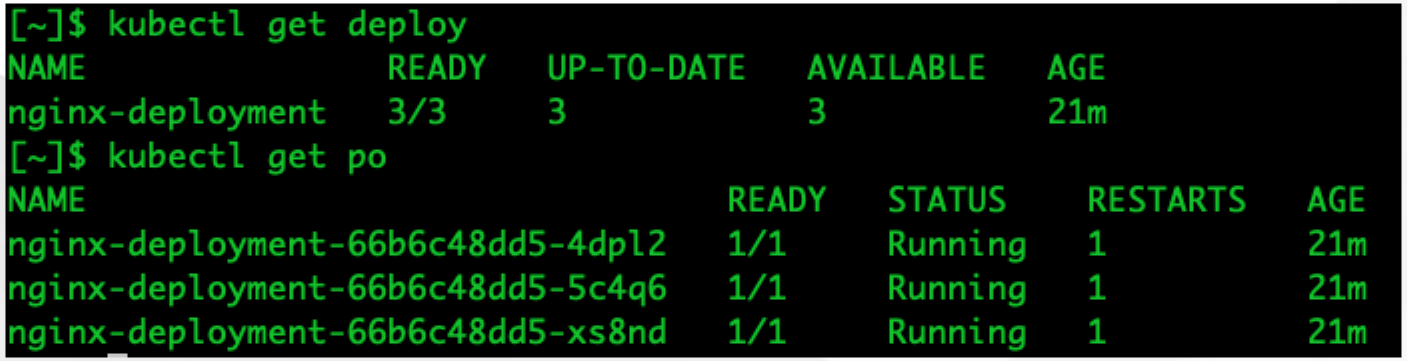
Deploy a Deployment

```
cat demo-deployment.yaml
kubectl apply -f demo-deployment.yaml
kubectl get deploy
kubectl get pod
kubectl delete -f demo-deployment.yaml
kubectl get deploy
kubectl get pod
```

Kubernetes CRD

Kubernetes Controllers

- Deployment, DaemonSet, StatefulSet



```
[~]$ kubectl get deploy
NAME               READY   UP-TO-DATE   AVAILABLE   AGE
nginx-deployment   3/3     3            3           21m
[~]$ kubectl get po
NAME                                READY   STATUS    RESTARTS   AGE
nginx-deployment-66b6c48dd5-4dpl2   1/1     Running   1          21m
nginx-deployment-66b6c48dd5-5c4q6   1/1     Running   1          21m
nginx-deployment-66b6c48dd5-xs8nd   1/1     Running   1          21m
```

What they do?

- create a set of resources, then control them as an unit
- **Operators** are an extension of the concept

Custom Resources Definitions

- Define your own Kubernetes Resources
  - create new Kinds of resources
  - Handled as other resources

Resource Handlers

- You need to write your own resource handler!
  - It responds to Kubernetes events
  - It interacts with Kubernetes APIs to perform operations

Components of a CRD

- Group, Kind and short names:
  - Example: `nuvolaris.org`, `Sample`, `sam`
- Spec and Status
  - Versioned
  - defined as an OpenApi Schema:

```yaml
type: object
properties:
  spec:
    type: object
```

Defining a CRD (1/2)

```yaml
apiVersion: apiextensions.k8s.io/v1
kind: CustomResourceDefinition
metadata:
  name: samples.nuvolaris.org
spec:
  scope: Namespaced              # Namespaced or Cluster wide
  group: nuvolaris.org           # Group (resources are grouped)
  names:
    kind: Sample                 # Kind (and its names)
    plural: samples
    singular: sample
    shortNames:
      - sam
```

Defining a CRD (2/2)

```yaml
versions:
  - name: v1
    served: true
    storage: true
    subresources: { status: { } }
    schema:
      openAPIV3Schema:
        type: object
        properties:
          spec:
            type: object
            x-kubernetes-preserve-unknown-fields: true
          status:
            type: object
            x-kubernetes-preserve-unknown-fields: true
```

Instance

```yaml
apiVersion: nuvolaris.org/v1
kind: Sample
metadata:
  name: obj
spec:
  count: 2
```

Demo

```
cat demo-crd.yaml
kubectl apply -f demo-crd.yaml
kubectl get crd
cat demo-obj.yaml
kubectl apply -f demo-obj.yaml
kubectl get samples
kubectl delete sample obj
```

Kustomize

Interacting with Kubernetes

- Resources needs to be adapted to various cases
  - there are literally tens of solutions for this problem
  - `helm` is very used, but...
    - templating YAML is not a great idea!
    - lot of code just to manage whitespaces!
- We are goingo to use `kustomize`
  - part of `kubectl`
  - much easier development and debug

About `kustomize`

- Originally a separate tool, now part of `kubectl`
  - It works "customizing" sets of descriptors with rules
  - support many ways of *patching* the JSON/YAML
  - **NO TEMPLATING** (huge win over `helm`!)
- You simply do `kubectl apply -k <folder>`
  - It will search for `kustomization.yaml`
  - It will produce the output sent to Kubernetes
- Debug the output without applying with: `kubectl kustomize <folder>`

Simple `kustomizationl.yaml` with patch

```yaml
apiVersion: kustomize.config.k8s.io/v1beta1
kind: Kustomization
resources:
- demo-deployment.yaml
patches:
 - path: patch.yaml
```

- put it in a folder `deploy` and `apply -k deploy`

Sample patch of a `Deployment`

- We want to change the replica count

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: demo-deploy
spec:
  replicas: 2
```

- Intuitively, provide enough context to locate the descriptor
- Provide the replaced fields

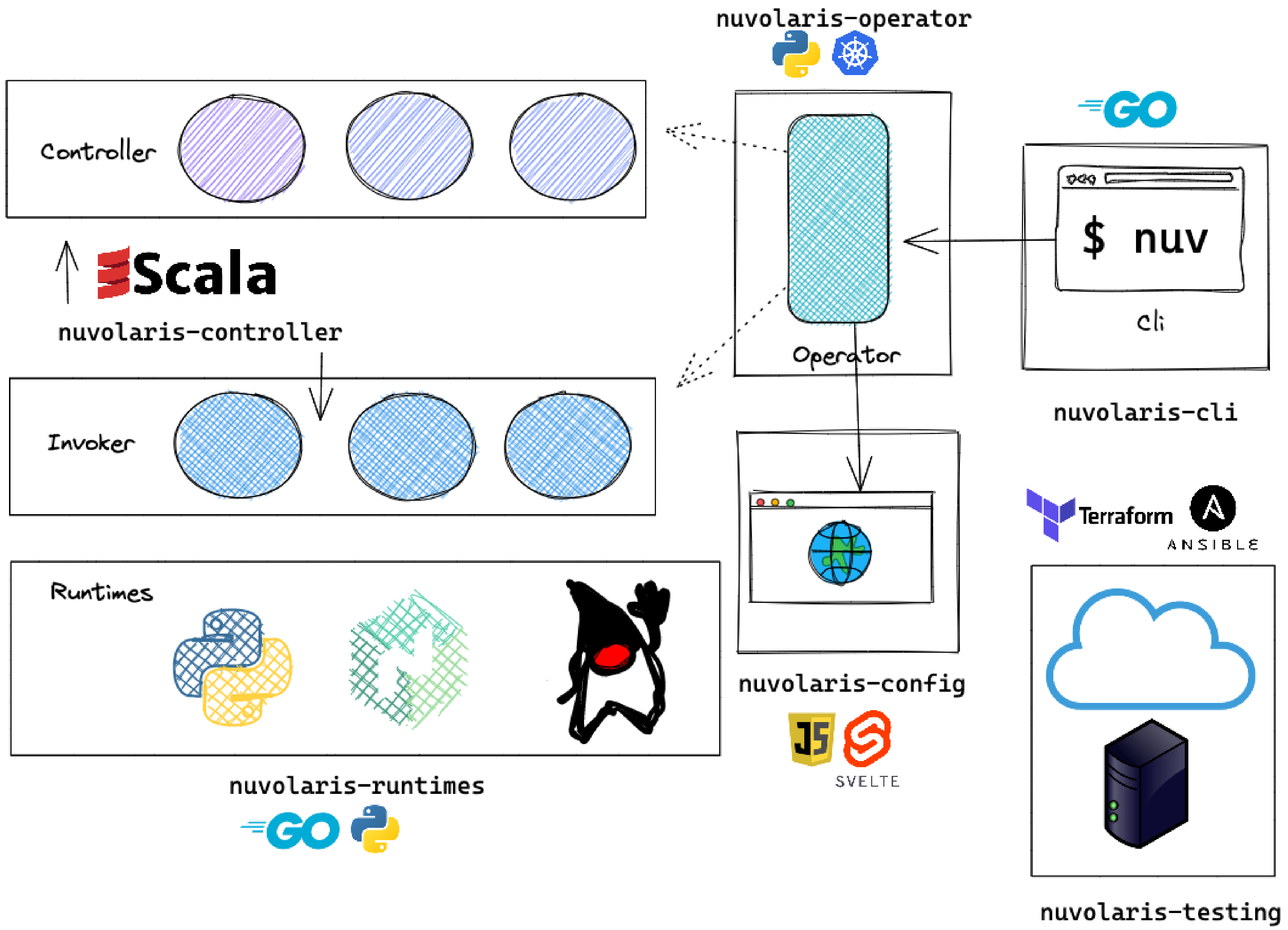
Kustomize example

```
cat demo-deployment.yaml | grep replica
# create a customization
mkdir deploy
cp demo-deployment.yaml deploy
cp patch.yaml deploy
cp kustomization.yaml deploy
# kustomization deploy
kubectl kustomize deploy | grep replica
kubectl apply -k deploy
kubectl get po
```

Conclusion

What is next?

- Setup Pyhon and Kopf
- Authentication
- Reacting to Events
- Invoking Kubectl and Kustomnize
- Implementing the Operator



Nuvolaris Components and Technologies

Contributing to Nuvolaris

Before sending a Pull Request you need:

- Add **Apache License** headers to each file:
- The simplest way:

```
license-eye header fix
```

- There is a check for each Pull Request

Regular contributors need to sign the Apache ICLA