CloudARK

KubePlus

Multi-tenant application stacks on Kubernetes

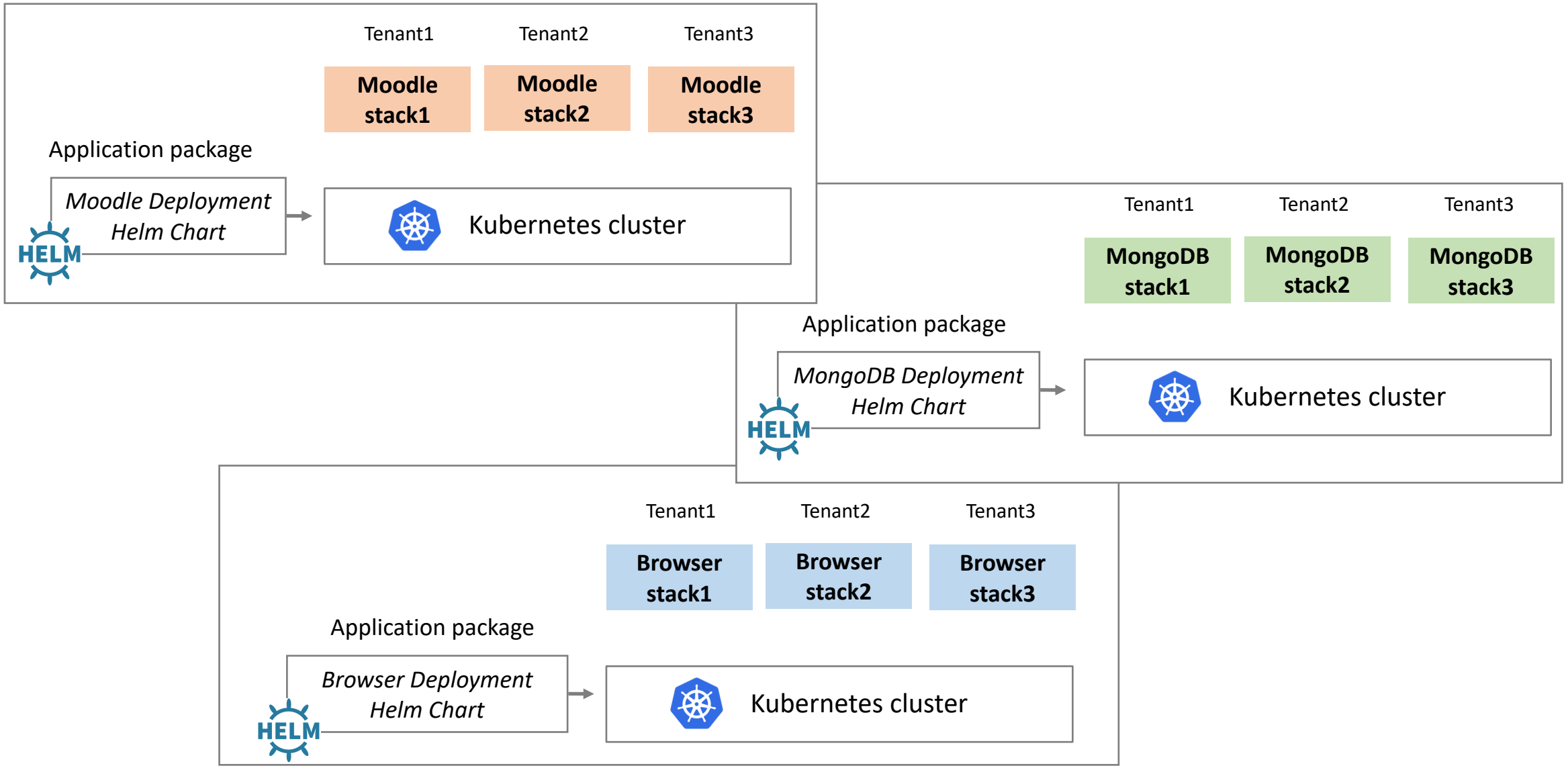
https://github.com/cloud-ark/kubeplus

Devdatta Kulkarni
Founder, CloudARK
https://www.linkedin.com/in/devdatta-kulkarni-192ab46/

Application as-a-Service on K8s

CloudARK

Separate application stack per tenant



Challenge

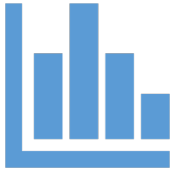
CloudARK

Multi-tenancy management

How to isolate and manage per-tenant Kubernetes resources?

Tenant level policies on Helm charts

E.g., Separate node per tenant



Tenant level consumption metrics

E.g., CPU, Memory, Storage, Network consumption per tenant

Tenant level resource topologies

Kubernetes resource relationship graph with relations between resources like Pod, Service, Custom Resource etc.

DIY approach : Labels limiting

There is no easy way to apply labels on all Kubernetes resources in an application stack, especially if the stack contains Custom Resources for which finding all the sub-resources is not easy.

Our solution – KubePlus

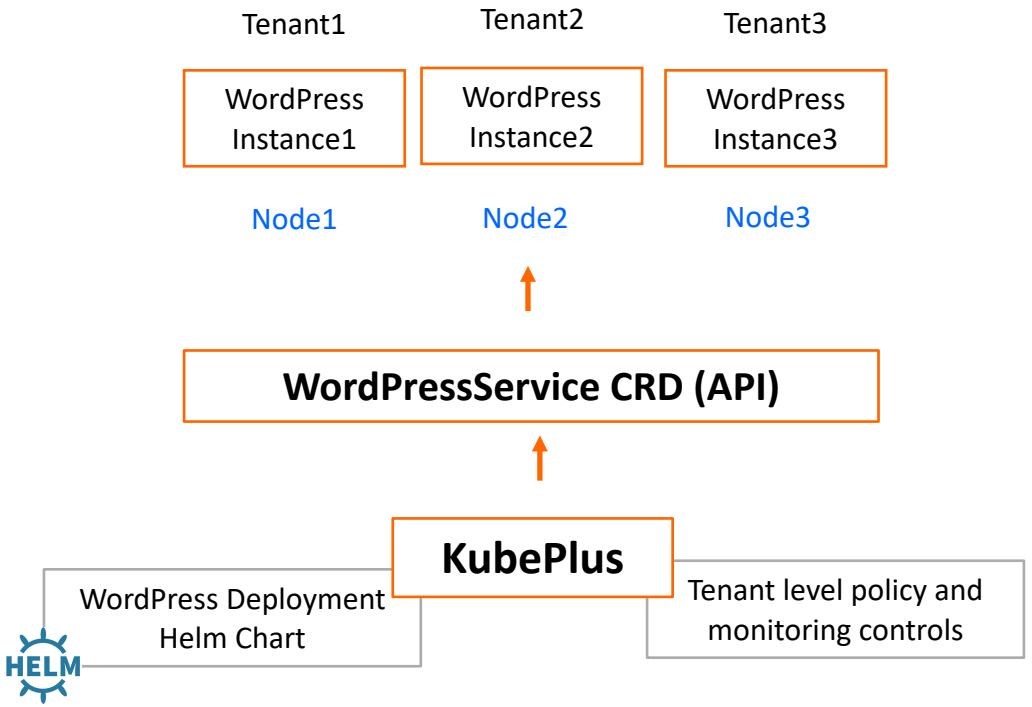
CloudARK

Basic Idea: Wrap a Kubernetes-native API around Helm chart

Packaged application
Helm chart

KubePlus →

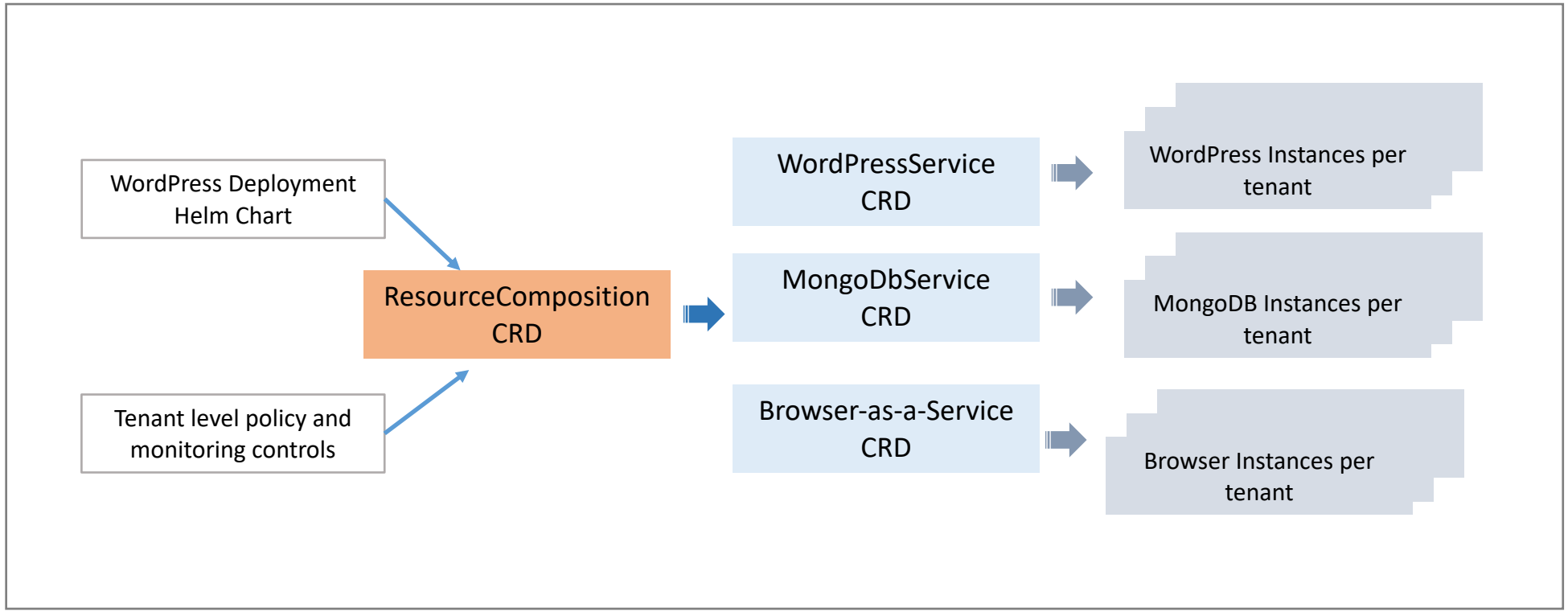
Application as-a-Service
New Kubernetes CRD (API)



KubePlus

CloudARK

Open-source framework to create platform APIs declaratively



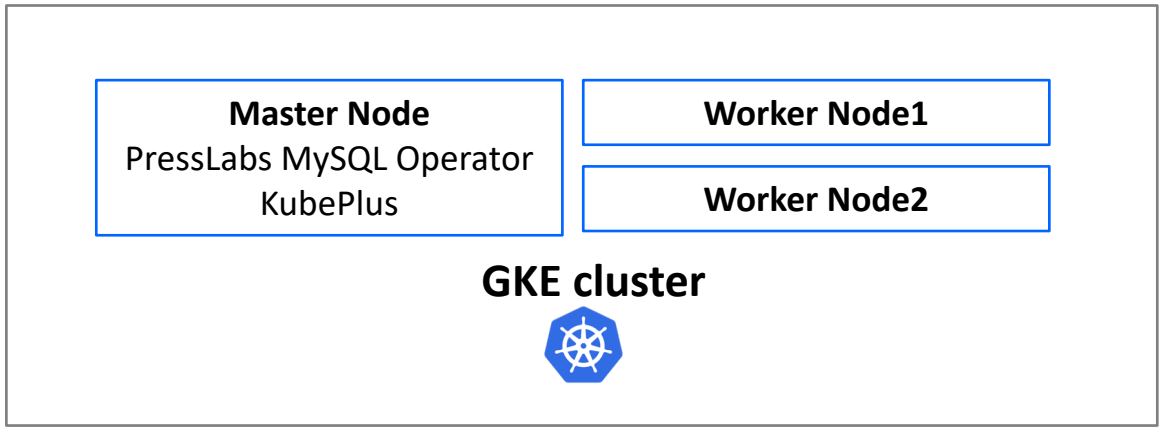
CRD for CRDs

Demo scenario

CloudARK

Build a WordPress-as-a-service

- Wordpress Pod
- MysqlCluster CR



Tenant-level policies that we want to enforce in this setup.

- Every Pod in Wordpress Helm chart should be defined with specific requests and limits for cpu and memory resources
- Wordpress stacks for different tenants should be deployed on different Worker nodes

In Kubernetes these are achieved by setting following attributes in the Pod Spec:

- resource requests/limits
- nodeSelector

CRD for CRD - Create WordpressService

CloudARK

Create a sample WordPress Service

```
apiVersion: workflows.kubeplus/v1alpha1
kind: ResourceComposition
metadata:
  name: wordpress-service-composition
spec:
  # newResource defines the new CRD to be installed define a workflow.
  newResource:
    resource:
      kind: WordpressService
      group: platformapi.kubeplus
      version: v1alpha1
      plural: wordpressservices
    # URL of the Helm chart that contains Kubernetes resources that represent a workflow.
    chartURL: https://github.com/cloud-ark/kubeplus/blob/master/examples/multitenancy/wordpress-mysqlcluster-stack/wordpress-mysqlcluster-chart-0.0.1.tgz?raw=true
    chartName: wordpress-mysqlcluster-chart
  respolicy:
    apiVersion: workflows.kubeplus/v1alpha1
    kind: ResourcePolicy
    metadata:
      name: wordpress-service-policy
    spec:
      resource:
        kind: WordpressService
        group: platformapi.kubeplus
        version: v1alpha1
      policy:
        # Add following requests and limits for the first container of all the Pods that are related via
        # owner reference relationship to instances of resources specified above.
        podconfig:
          limits:
            cpu: 200m
            memory: 2Gi
          requests:
            cpu: 100m
            memory: 1Gi
          nodeSelector: values.nodeName
```

Creating instance of WordPress Service

CloudARK

Create a WordPress Service instance – wp-service-tenant1

```
apiVersion: platformapi.kubeplus/v1alpha1
kind: WordpressService
metadata:
  name: wp-service-tenant1
  namespace: wp-stack-ns1
spec:
  namespace: wp-stack-ns1
  tenantName: tenant1
  nodeName: gke-cluster-4-default-pool-dacc3ab3-1x4v
```

Spec attributes from values.yaml

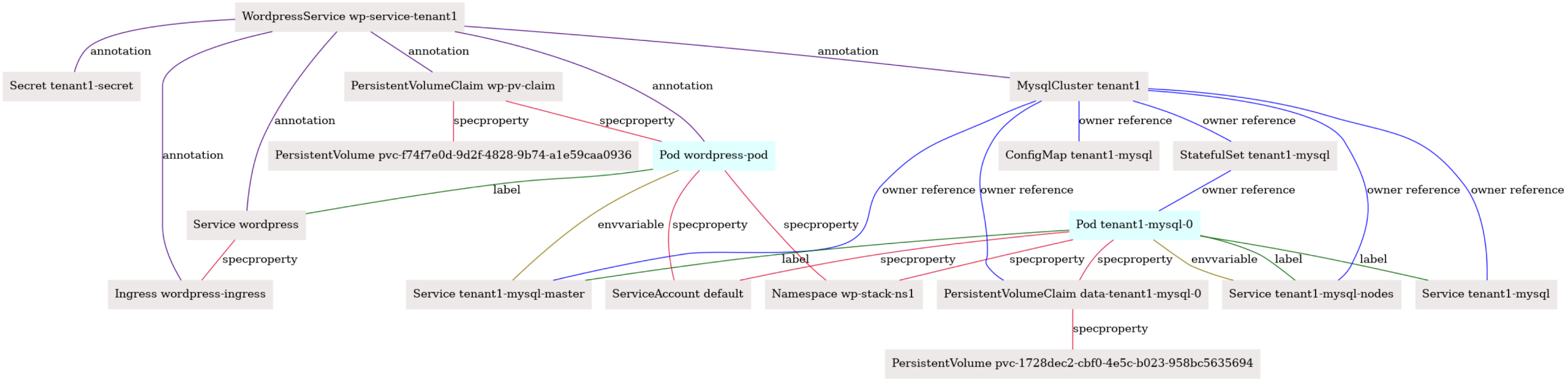
HELM

Tenant1 resource topology

CloudARK

Resource relationship graph

kubectl connections WordpressService wp-service-tenant1 wp-stack-ns1



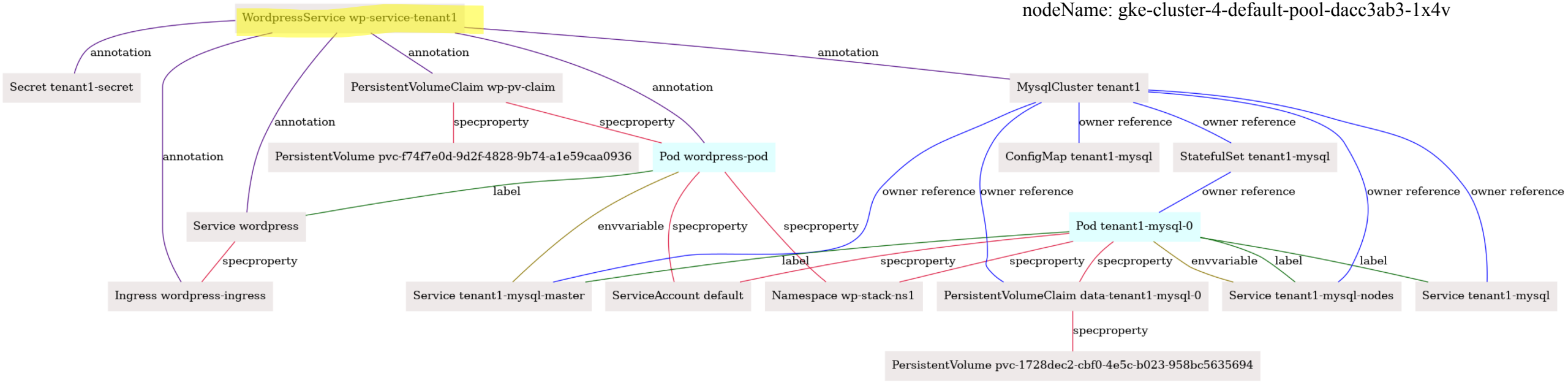
KubePlus discovers Kubernetes resource relationships based on ownerReferences, labels, annotations and spec properties

Tenant1 resource topology

CloudARK

Resource relationship graph

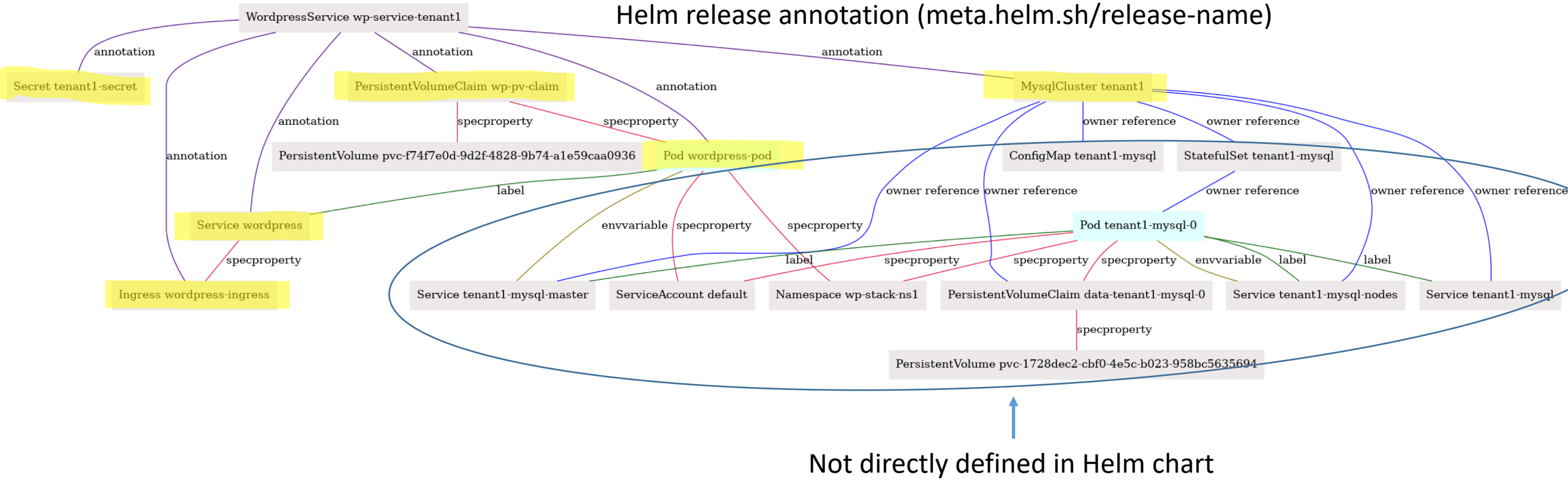
```
apiVersion: platformapi.kubeplus/v1alpha1
kind: WordpressService
metadata:
  name: wp-service-tenant1
  namespace: wp-stack-ns1
spec:
  namespace: wp-stack-ns1
  tenantName: tenant1
  nodeName: gke-cluster-4-default-pool-dacc3ab3-1x4v
```



Tenant1 resource topology

CloudARK

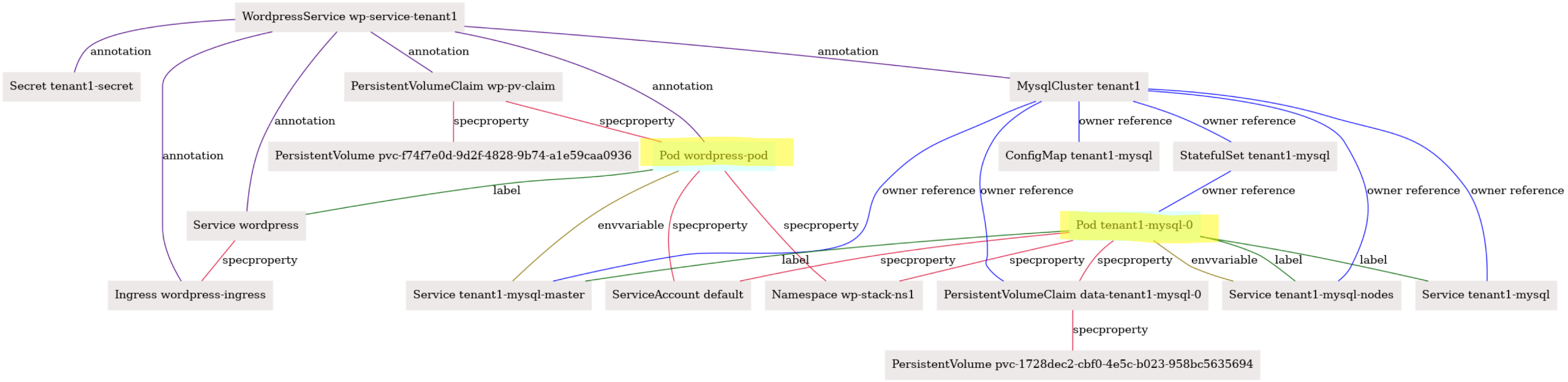
Resource relationship graph



Tenant1 resource topology

CloudARK

Resource relationship graph



Verify policies – cpu/memory

CloudARK

Policy Input

```
policy:
podconfig:
    limits:
       cpu: 200m
       memory: 2Gi
    requests:
       cpu: 100m
        memory: 1Gi
    nodeSelector: values.nodeName
```

Provided when WordpressService was registered

CPU/Memory requests and limits on two pods in the tenant1 stack

1

```
$ kubectl get pods tenant1-mysql-0 -n wp-stack-ns1 -o json | jq -r '.spec.containers[0].resources'
{
  "limits": {
    "cpu": "200m",
    "memory": "2Gi"
  },
  "requests": {
    "cpu": "100m",
    "memory": "1Gi"
  }
}
```

2

```
$ kubectl get pods wordpress-pod -n wp-stack-ns1 -o json | jq -r '.spec.containers[0].resources'
{
  "limits": {
    "cpu": "200m",
    "memory": "2Gi"
  },
  "requests": {
    "cpu": "100m",
    "memory": "1Gi"
  }
}
```

Verify policies - nodeName

CloudARK

```
apiVersion: platformapi.kubeplus/v1alpha1
kind: WordpressService
metadata:
  name: wp-service-tenant1
  namespace: wp-stack-ns1
spec:
  namespace: wp-stack-ns1
  tenantName: tenant1
  nodeName: gke-cluster-4-default-pool-dacc3ab3-1x4v
```

Pods running on the specified node

3

```
$ kubectl get pods tenant1-mysql-0  -n wp-stack-ns1 -o json | jq -r '.spec.nodeName'
gke-cluster-4-default-pool-dacc3ab3-1x4v
```

4

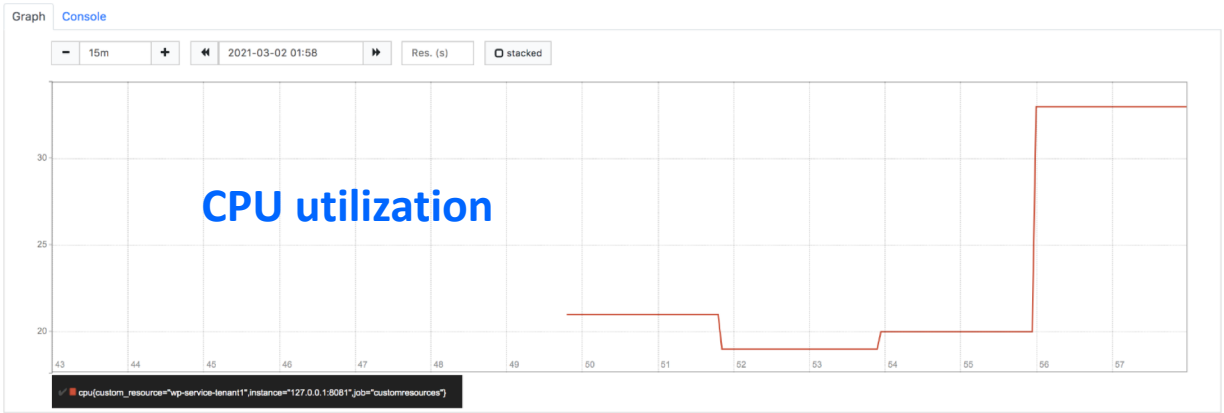
```
$ kubectl get pods wordpress-pod  -n wp-stack-ns1 -o json | jq -r '.spec.nodeName'
gke-cluster-4-default-pool-dacc3ab3-1x4v
```

Tenant1 consumption metrics

CloudARK

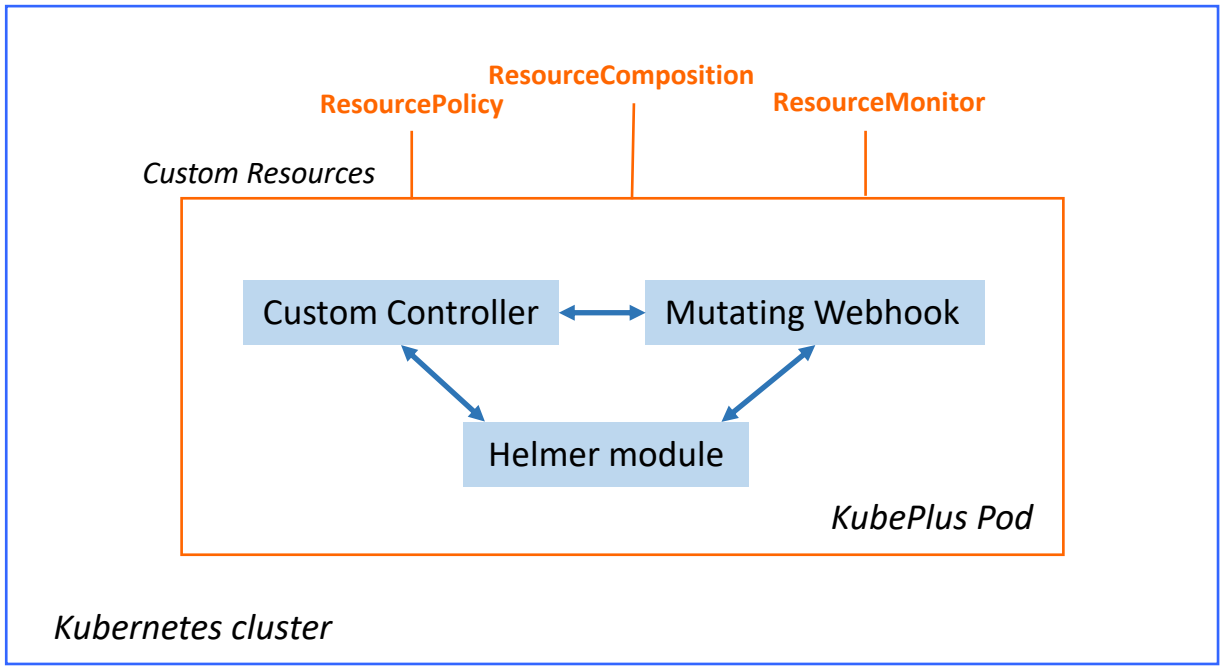
Prometheus metrics for CPU utilization and network bytes received

```
$ kubectl metrics cr WordpressService wp-service-tenant1 wp-stack-ns1 -o pretty --follow-connections
------------------------------------------------------------
Kubernetes Resources created:
    Number of Sub-resources: -
    Number of Pods: 2
        Number of Containers: 8
        Number of Nodes: 1
Underlying Physical Resoures consumed:
    Total CPU(cores): 23m
    Total MEMORY(bytes): 422Mi
    Total Storage(bytes): 2Gi
    Total Network bytes received: 90728729.0
    Total Network bytes transferred: 129797673.0
------------------------------------------------------------
```



KubePlus – Under the hood

CloudARK



KubePlus
kubectl plugins

Visualize Kubernetes resource relationships

- CRUD Operations on ResourceComposition: Custom Controller
- CRUD Operations on new Custom API: Mutating Webhook + Helmer
- Policy Enforcement: Mutating Webhook
- Metrics:
  - CPU/Memory/Storage: Pod-level specs
  - Network: cadvisor
- Resource relationship graphs: ownerReferences, labels, annotations, spec properties

Comparison

CloudARK

KubePlus CRD for CRD & helm-operator from Operator framework

CRD for CRD approach allows us to have a single Operator for managing multiple APIs from different Helm charts. With helm-operator a new Operator is created for every Helm chart.

KubePlus CRD for CRD & OAM

KubePlus is designed with tenant-centric approach and OAM is designed with app-centric approach. KubePlus currently takes Helm chart as the application input and can evolve later to take more complex application definition inputs such as OAM.

Conclusion

CloudARK

KubePlus allows creating multi-tenant platform services **declaratively.**

Hence, we refer to it as **Platform-as-Code** tool.

We are looking for feedback from the community.

Resources:

- KubePlus GitHub: https://github.com/cloud-ark/kubeplus
- KubePlus Documentation: https://cloud-ark.github.io/kubeplus/docs/html/html/index.html
- Platform-as-Code: https://cloudark.io/platform-as-code

Questions?

CRD for CRD - Create WordpressService

CloudARK

Create a sample WordPress Service