# ДОДАТОК А

Графічний матеріал кваліфікаційної роботи

Кафедра ЕОМ

Комп'ютерна інженерія та управління

# Розгортання та управління Kubernetes-кластерами за допомогою Infrastructure as Code (IaC)

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2025

## Мета та завдання роботи

**Мета :**
Автоматизувати процес розгортання Kubernetes-кластера в хмарному середовищі OpenStack з використанням підходу Infrastructure as Code, забезпечити керованість, повторюваність та розширюваність розгортання.

**Завдання:**

- Розробити шаблони Terraform для створення інфраструктури
- Інтегрувати Ansible для конфігурації кластеру
- Встановити Kubernetes-кластер через Kubespray
- Реалізувати GitOps-підхід із використанням FluxCD

# Що таке Terraform?

Terraform — це інструмент для опису інфраструктури у вигляді коду.

Ключові особливості:

- Декларативний підхід
- Підтримка різних провайдерів (AWS, GCP, OpenStack)
- Планування змін (terraform plan)
- Управління станом (terraform.tfstate)

**Об'єкти:**

- Pods — найменші одиниці розгортання
- Services — мережеві абстракції
- Deployments — управління реплікацією
- Ingress — маршрутизація трафіку

# Що таке Kubernetes?

Kubernetes — це система оркестрації контейнерів, яка автоматизує розгортання, масштабування та управління застосунками.

**Основні компоненти:**

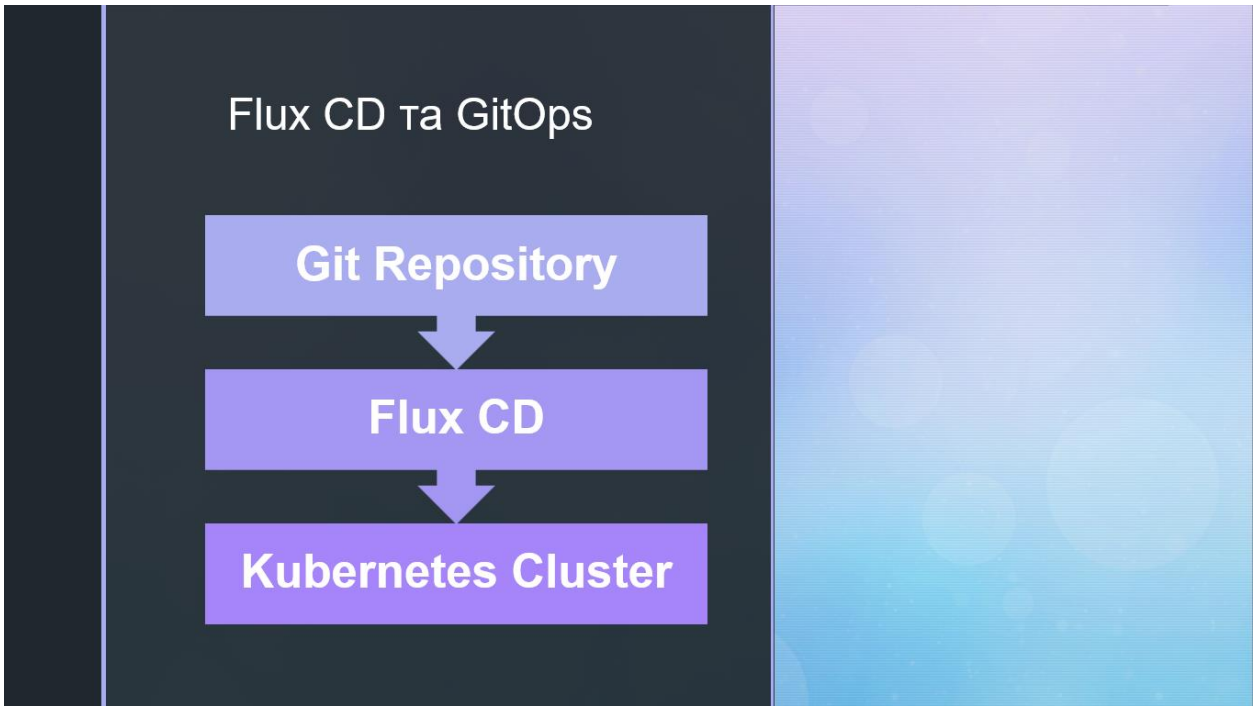
**Control Plane**

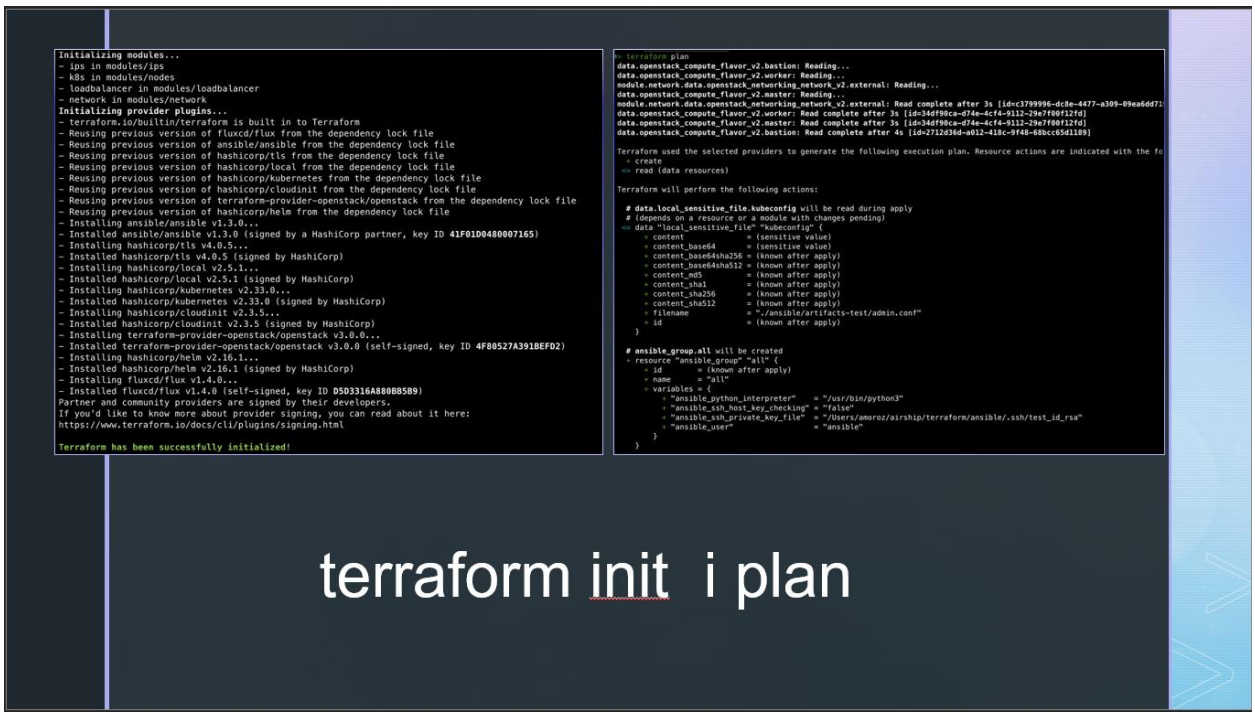
API Server, etcd, scheduler

**Worker Nodes**

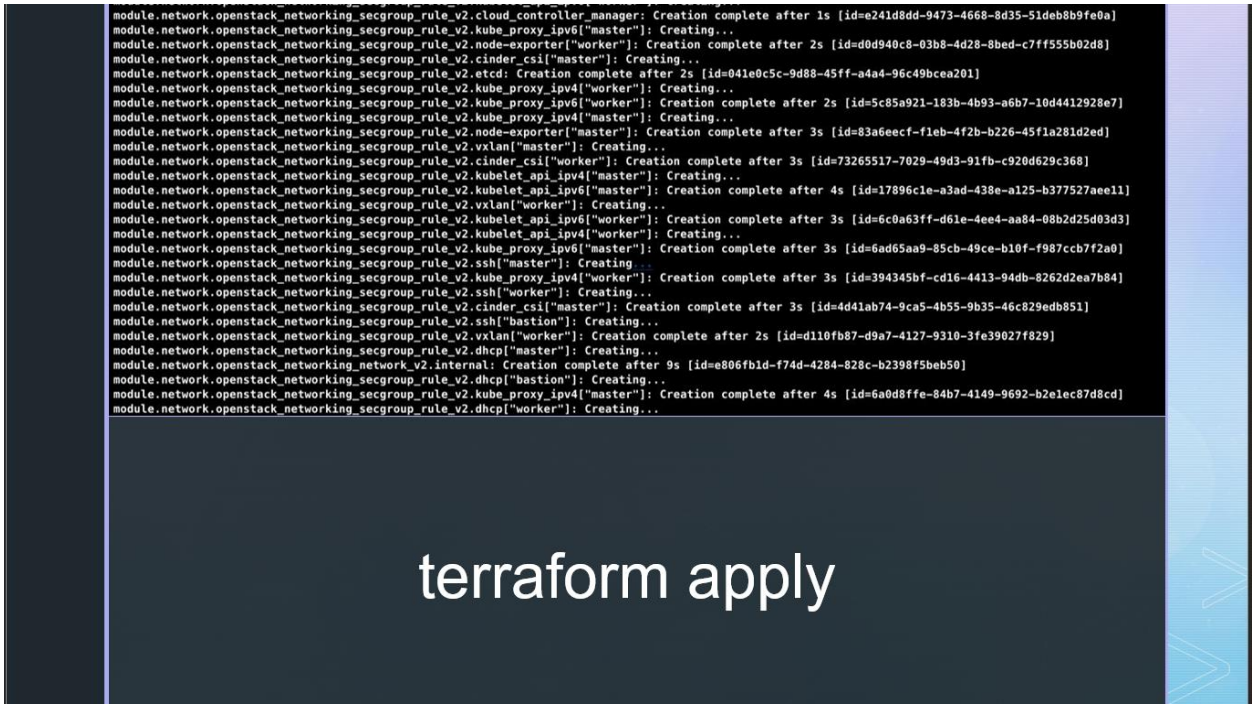
kubelet, container runtime


Архітектура рішення
1. Terraform
2. Ansible
3. Kubespray
4. Helm


Flux CD та GitOps
Git Repository
Flux CD
Kubernetes Cluster




terraform init i plan




terraform apply

- Ansible + Kubespray

```
terraform_data.kubespray (local-exec): TASK [kubernetes_sigs.kubespray.kubernetes/preinstall : Remove kubespray specific config from dhclient config] ***
terraform_data.kubespray (local-exec): skipping: [test-master-0] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}
terraform_data.kubespray (local-exec): skipping: [test-master-1] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}
terraform_data.kubespray (local-exec): skipping: [test-master-2] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}
terraform_data.kubespray (local-exec): skipping: [test-worker-0] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}
terraform_data.kubespray (local-exec): skipping: [test-worker-1] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}

terraform_data.kubespray (local-exec): TASK [kubernetes_sigs.kubespray.kubernetes/preinstall : Remove kubespray specific dhclient hook] ***
terraform_data.kubespray (local-exec): skipping: [test-master-0] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}
terraform_data.kubespray (local-exec): skipping: [test-master-1] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
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terraform_data.kubespray (local-exec): skipping: [test-master-2] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}
terraform_data.kubespray (local-exec): skipping: [test-worker-0] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}
terraform_data.kubespray (local-exec): skipping: [test-worker-1] => {"changed": false, "false_condition": "resolvconf_mode != 'host_resolvconf'", "skip_reason": "Conditional result was Fa
lse"}

terraform_data.kubespray (local-exec): TASK [kubernetes_sigs.kubespray.kubernetes/preinstall : Flush handlers] ********

terraform_data.kubespray (local-exec): TASK [kubernetes_sigs.kubespray.kubernetes/preinstall : Flush handlers] ********

terraform_data.kubespray (local-exec): TASK [kubernetes_sigs.kubespray.kubernetes/preinstall : Flush handlers] ********

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terraform_data.kubespray (local-exec): TASK [kubernetes_sigs.kubespray.kubernetes/preinstall : Flush handlers] ********

terraform_data.kubespray (local-exec): RUNNING HANDLER [kubernetes_sigs.kubespray.kubernetes/preinstall : Preinstall | reload kubelet] ***
terraform_data.kubespray (local-exec): skipping: [test-master-0] => {"changed": false, "false_condition": "not dns_early | bool", "skip_reason": "Conditional result was False"}
terraform_data.kubespray (local-exec): skipping: [test-master-1] => {"changed": false, "false_condition": "not dns_early | bool", "skip_reason": "Conditional result was False"}
terraform_data.kubespray (local-exec): skipping: [test-master-2] => {"changed": false, "false_condition": "not dns_early | bool", "skip_reason": "Conditional result was False"}
terraform_data.kubespray (local-exec): skipping: [test-worker-0] => {"changed": false, "false_condition": "not dns_early | bool", "skip_reason": "Conditional result was False"}
terraform_data.kubespray (local-exec): skipping: [test-worker-1] => {"changed": false, "false_condition": "not dns_early | bool", "skip_reason": "Conditional result was False"}

terraform_data.kubespray (local-exec): RUNNING HANDLER [kubernetes_sigs.kubespray.kubernetes/preinstall : Preinstall | kube-apiserver configured] ***
terraform_data.kubespray (local-exec): skipping: [test-worker-0] => {"changed": false, "false_condition": "inventory_hostname in groups['kube_control_plane'] and dns_mode != 'none' and re
solvconf_mode == 'host_resolvconf'", "skip_reason": "Conditional result was False"}
terraform_data.kubespray (local-exec): skipping: [test-worker-1] => {"changed": false, "false_condition": "inventory_hostname in groups['kube_control_plane'] and dns_mode != 'none' and re
solvconf_mode == 'host_resolvconf'", "skip_reason": "Conditional result was False"}
terraform_data.kubespray (local-exec): ok: [test-master-2] => {"changed": false, "stat": {"exists": false}}
terraform_data.kubespray (local-exec): ok: [test-master-0] => {"changed": false, "stat": {"exists": false}}
terraform_data.kubespray (local-exec): ok: [test-master-1] => {"changed": false, "stat": {"exists": false}}

terraform_data.kubespray (local-exec): RUNNING HANDLER [kubernetes_sigs.kubespray.kubernetes/preinstall : Preinstall | kube-controller configured] ***
```
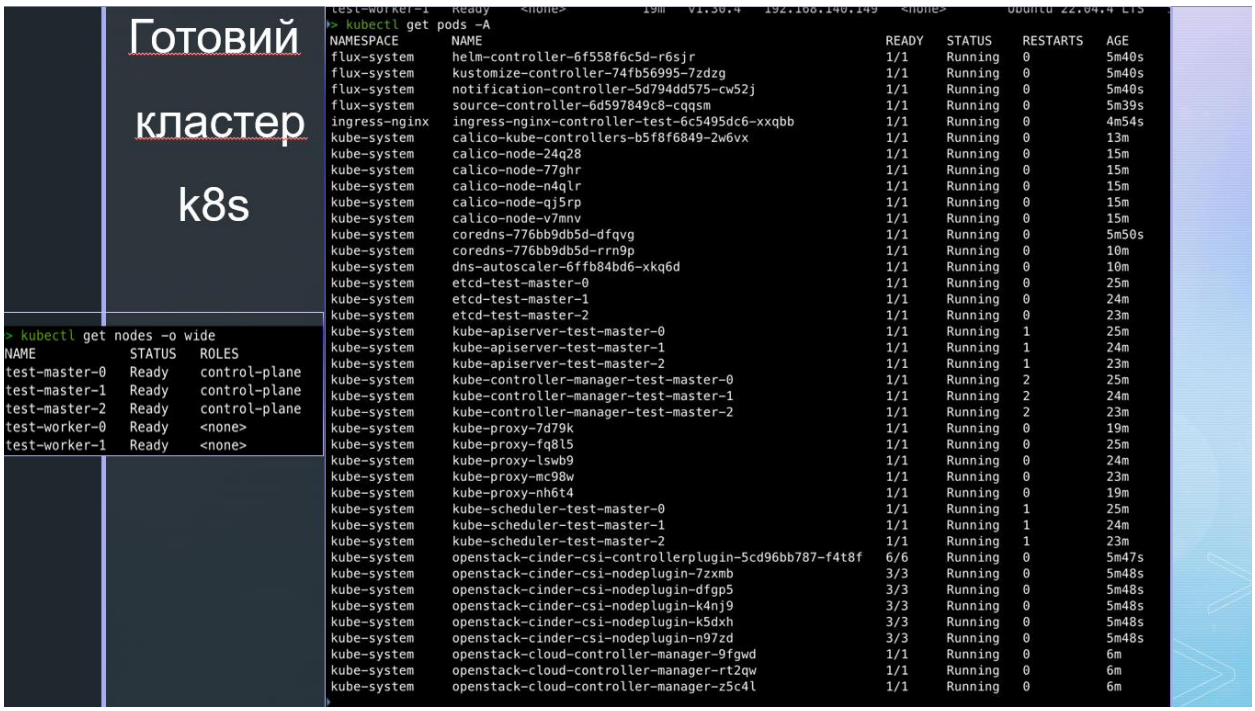
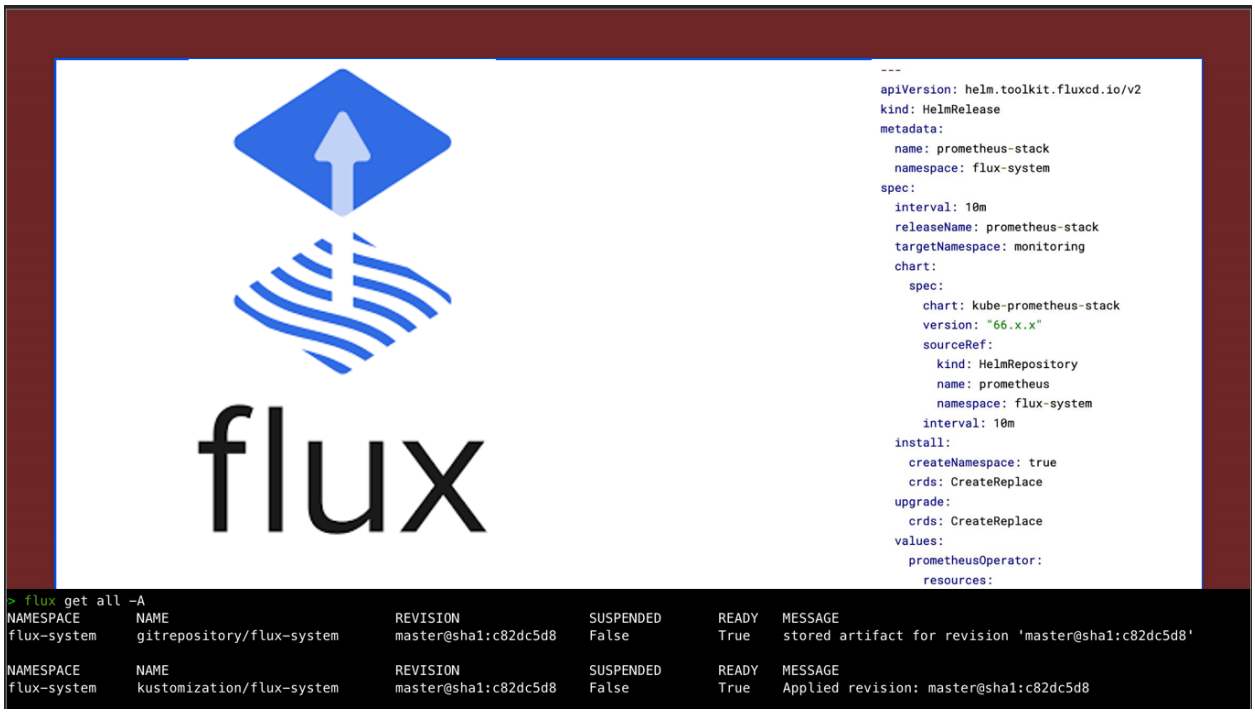

## Helm-чарти

**NGINX Ingress**

**Metrics Server**

**OpenStack CCM**


Готовий
кластер
k8s
> kubectl get nodes -o wide
NAME STATUS ROLES
test-master-0 Ready control-plane
test-master-1 Ready control-plane
test-master-2 Ready control-plane
test-worker-0 Ready <none>
test-worker-1 Ready <none>
> kubectl get pods -A
NAMESPACE NAME READY STATUS RESTARTS AGE
flux-system helm-controller-6f558f6c5d-r6sjr 1/1 Running 0 5m40s
flux-system kustomize-controller-74fb56995-7zdzg 1/1 Running 0 5m40s
flux-system notification-controller-5d794dd575-cw52j 1/1 Running 0 5m40s
flux-system source-controller-6d597849c8-cqqsm 1/1 Running 0 5m39s
ingress-nginx ingress-nginx-controller-test-6c5495dc6-xxqbb 1/1 Running 0 4m54s
kube-system calico-kube-controllers-b5f8f6849-2w6vx 1/1 Running 0 13m
kube-system calico-node-24q28 1/1 Running 0 15m
kube-system calico-node-77ghr 1/1 Running 0 15m
kube-system calico-node-n4qlr 1/1 Running 0 15m
kube-system calico-node-qj5rp 1/1 Running 0 15m
kube-system calico-node-v7mnv 1/1 Running 0 15m
kube-system coredns-776bb9db5d-dfqvg 1/1 Running 0 5m50s
kube-system coredns-776bb9db5d-rrn9p 1/1 Running 0 10m
kube-system dns-autoscaler-6ffb84bd6-xkq6d 1/1 Running 0 10m
kube-system etcd-test-master-0 1/1 Running 0 25m
kube-system etcd-test-master-1 1/1 Running 0 24m
kube-system etcd-test-master-2 1/1 Running 0 23m
kube-system kube-apiserver-test-master-0 1/1 Running 1 25m
kube-system kube-apiserver-test-master-1 1/1 Running 1 24m
kube-system kube-apiserver-test-master-2 1/1 Running 1 23m
kube-system kube-controller-manager-test-master-0 1/1 Running 2 25m
kube-system kube-controller-manager-test-master-1 1/1 Running 2 24m
kube-system kube-controller-manager-test-master-2 1/1 Running 2 23m
kube-system kube-proxy-7d79k 1/1 Running 0 19m
kube-system kube-proxy-fq8l5 1/1 Running 0 25m
kube-system kube-proxy-lswb9 1/1 Running 0 24m
kube-system kube-proxy-mc98w 1/1 Running 0 23m
kube-system kube-proxy-nh6t4 1/1 Running 0 19m
kube-system kube-scheduler-test-master-0 1/1 Running 1 25m
kube-system kube-scheduler-test-master-1 1/1 Running 1 24m
kube-system kube-scheduler-test-master-2 1/1 Running 1 23m
kube-system openstack-cinder-csi-controllerplugin-5cd96bb787-f4t8f 6/6 Running 0 5m47s
kube-system openstack-cinder-csi-nodeplugin-7zxmb 3/3 Running 0 5m48s
kube-system openstack-cinder-csi-nodeplugin-dfgp5 3/3 Running 0 5m48s
kube-system openstack-cinder-csi-nodeplugin-k4nj9 3/3 Running 0 5m48s
kube-system openstack-cinder-csi-nodeplugin-k5dxh 3/3 Running 0 5m48s
kube-system openstack-cinder-csi-nodeplugin-n97zd 3/3 Running 0 5m48s
kube-system openstack-cloud-controller-manager-9fgwd 1/1 Running 0 6m
kube-system openstack-cloud-controller-manager-rt2qw 1/1 Running 0 6m
kube-system openstack-cloud-controller-manager-z5c4l 1/1 Running 0 6m


flux
---
apiVersion: helm.toolkit.fluxcd.io/v2
kind: HelmRelease
metadata:
name: prometheus-stack
namespace: flux-system
spec:
interval: 10m
releaseName: prometheus-stack
targetNamespace: monitoring
chart:
spec:
chart: kube-prometheus-stack
version: "66.x.x"
sourceRef:
kind: HelmRepository
name: prometheus
namespace: flux-system
interval: 10m
install:
createNamespace: true
crds: CreateReplace
upgrade:
crds: CreateReplace
values:
prometheusOperator:
resources:
> flux get all -A
NAMESPACE NAME REVISION SUSPENDED READY MESSAGE
flux-system gitrepository/flux-system master@sha1:c82dc5d8 False True stored artifact for revision 'master@sha1:c82dc5d8'
NAMESPACE NAME REVISION SUSPENDED READY MESSAGE
flux-system kustomization/flux-system master@sha1:c82dc5d8 False True Applied revision: master@sha1:c82dc5d8