Kubernetes Advanced

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16. Kubernetes - RBAC

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19. Kubernetes - Backups

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20. Kubernetes - Tipps & Tricks

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21. Kubernetes - Documentation

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    - Helpful to learn - Kubernetes
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22. Kubernetes - Shared Volumes

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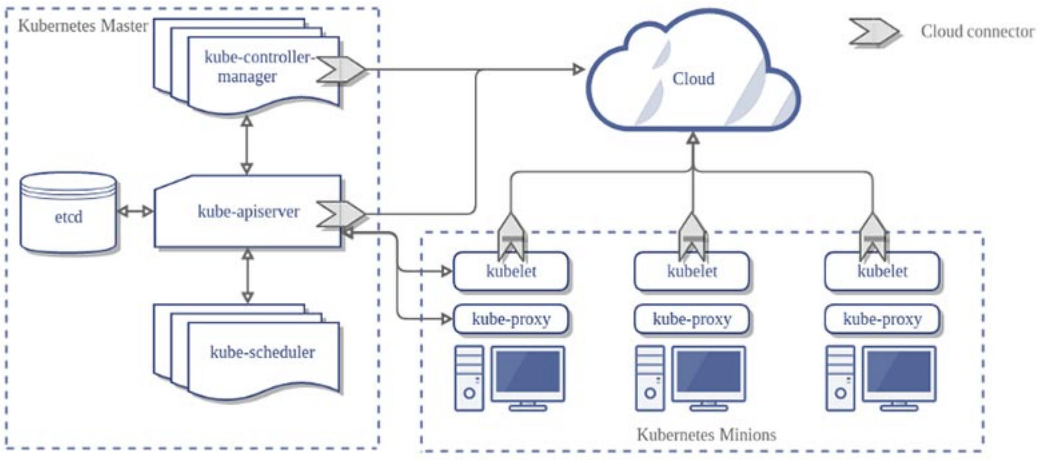
23. Kubernetes - Hardening

    - Kubernetes Tipps Hardening

Kubernetes - Überblick

Aufbau Allgemein

Schaubild



Komponenten / Grundbegriffe

Master (Control Plane)

Aufgaben

- Der Master koordiniert den Cluster
- Der Master koordiniert alle Aktivitäten in Ihrem Cluster
  - Planen von Anwendungen
  - Verwalten des gewünschten Status der Anwendungen
  - Skalieren von Anwendungen
  - Rollout neuer Updates.

Komponenten des Masters

ETCD

- Verwalten der Konfiguration des Clusters (key/value - pairs)

KUBE-CONTROLLER-MANAGER

- Zuständig für die Überwachung der Stati im Cluster mit Hilfe von endlos loops.
- kommuniziert mit dem Cluster über die kubernetes-api (bereitgestellt vom kube-api-server)

KUBE-API-SERVER

- provides api-frontend for administration (no gui)
- Exposes an HTTP API (users, parts of the cluster and external components communicate with it)
- REST API

KUBE-SCHEDULER

- assigns Pods to Nodes.
- scheduler determines which Nodes are valid placements for each Pod in the scheduling queue (according to constraints and available resources)
- The scheduler then ranks each valid Node and binds the Pod to a suitable Node.
- Reference implementation (other schedulers can be used)

Nodes

- Nodes (Knoten) sind die Arbeiter (Maschinen), die Anwendungen ausführen
- Ref: https://kubernetes.io/de/docs/concepts/architecture/nodes/

Pod/Pods

- Pods sind die kleinsten einsetzbaren Einheiten, die in Kubernetes erstellt und verwaltet werden können.
- Ein Pod (übersetzt Gruppe) ist eine Gruppe von einem oder mehreren Containern
  - gemeinsam genutzter Speicher- und Netzwerkressourcen
  - Befinden sich immer auf dem gleich virtuellen Server

Control Plane Node (former: master) - components

Node (Minion) - components

General

- On the nodes we will rollout the applications

kubelet

```
Node Agent that runs on every node (worker)
Er stellt sicher, dass Container in einem Pod ausgeführt werden.
```

Kube-proxy

- Läuft auf jedem Node
- = Netzwerk-Proxy für die Kubernetes-Netzwerk-Services.
- Kube-proxy verwaltet die Netzwerkkommunikation innerhalb oder außerhalb Ihres Clusters.

Referenzen

- https://www.redhat.com/de/topics/containers/kubernetes-architecture

Structure Kubernetes Deep Dive

- https://github.com/jmetzger/training-kubernetes-advanced/assets/1933318/1ca0d174-f354-43b2-81cc-67af8498b56c

Ports und Protokolle

- https://kubernetes.io/docs/reference/networking/ports-and-protocols/

kubelet garbage collection

What is do ?

- Deletes unused containers after 1 minutes
- and unused images after 5 minutes

Reference:

- https://kubernetes.io/docs/concepts/architecture/garbage-collection/#containers-images

list images with ctr

- ctr is the cli tool for containerd

```
## from client
kubectl run nginx --image nginx

## on worker - node
ctr images list | grep nginx
```

Installation

Kubernetes mit der Cluster API aufsetzen

Prerequisites

- You need to have a Kubernetes Cluster running (this will be the management cluster)
  - Within that you will you have cluster api
  - This could be something like kind, rancherdesktop.io
  - And of course also a cluster on premise

Step 1: Create Management Cluster

Step 1a: Install clusterctl

```
## Install rancherdesktop.io
## You are able to use it on windows (that's what we do now, and install

## Install clusterctl in wsl -> Ubuntu
sudo su -
cd /usr/src
curl -L https://github.com/kubernetes-sigs/cluster-api/releases/download/v1.4.2/clusterctl-linux-amd64 -o clusterctl
sudo install -o root -g root -m 0755 clusterctl /usr/local/bin/clusterctl
clusterctl version
```

- Reference gist: https://gist.github.com/vfarcic/d8113b6f149583e1cf1614d76f2a4182
- https://cluster-api.sigs.k8s.io/user/quick-start.html#install-clusterctl

Step 1b: Set env variables for digitalocean

```
export DIGITALOCEAN_ACCESS_TOKEN=[...] # Replace with your token here
```

Step 1c: Create kubernetes snapshot to be used for Kubernetes Control Plane and workers

```
## can be done as unprivileged user !!!
export PATH=$PATH:~/.local/bin
sudo apt update
apt install -y jq zip
sudo git clone https://github.com/kubernetes-sigs/image-builder
cd image-builder/images/capi
cat Makefile
```

```
## Size of machine will always be 1gb and 1vcpu created in NYC1
make build-do-ubuntu-2004
```

Step 1d: Add Snapshot to Region FRA1

```
-> Add to Region FRA1 -> under Manage -> Images -> Snapshots
Please do this through the web-interface of DigitalOcean
## IF YOU DO NOT DO THIS... Droplets cannot be created because they are in NYC1
```

Step 1e: Install doctl (optional)

```
## works in most cases on wsl, but only if snap is working properly
## snap install doctl
## if not do -> this

cd ~
wget https://github.com/digitalocean/doctl/releases/download/v1.94.0/doctl-1.94.0-linux-amd64.tar.gz
tar xf ~/doctl-1.94.0-linux-amd64.tar.gz
sudo mv ~/doctl /usr/local/bin

## now authenticate
doctl auth init --access-token ${DIGITALOCEAN_ACCESS_TOKEN}
```

Step 1f: Set env for to create worker cluster with controlplane and workers

```
## control the datacenter - default nyc1
export DO_REGION=fra1
## control size of machines
## default 1vcpu-1gb
export DO_CONTROL_PLANE_MACHINE_TYPE=s-2vcpu-2gb
export DO_NODE_MACHINE_TYPE=s-2vcpu-2gb
## needed to set up the api provider
export DO_B64ENCODED_CREDENTIALS="$(\
    echo -n "$DIGITALOCEAN_ACCESS_TOKEN" \
    | base64 \
    | tr -d '\n')"

## get the snapshot id / get the right id
doctl compute image list-user
## e.g.
## 132627725

export DO_CONTROL_PLANE_MACHINE_IMAGE=132627725
export DO_NODE_MACHINE_IMAGE=132627725
```

Step 1g: Setup cluster and api-provider

```
### In our case it sets up the management cluster on rancher
### to be used for kubernetes
cd ../../../

clusterctl init \
    --infrastructure digitalocean
```

Step 1h: Generate the yaml scripts for both control plane and workers

```
## it looks there will be a fingerprint to be used, which chooses the ssh-key to be used
## to connect to the machines
## look for all the ssh-key like so:
doctl compute ssh-key list

## So we choose one from the list
export DO_SSH_KEY_FINGERPRINT=[...]

## Check the variables
## Show use the necessary env-variables.
clusterctl generate cluster devops-toolkit \
    --infrastructure digitalocean \
    --target-namespace infra \
    --kubernetes-version v1.24.11 \
    --control-plane-machine-count 3 \
    --worker-machine-count 3 \
    --list-variables


## Kuberentes must be the same version as you created the snapshots for do
## to be used for digitalocean -> creating a cluster there
clusterctl generate cluster devops-toolkit \
    --infrastructure digitalocean \
    --target-namespace infra \
    --kubernetes-version v1.24.11 \
    --control-plane-machine-count 3 \
    --worker-machine-count 3 \
    | tee cluster.yaml

kubectl create namespace infra

kubectl apply --filename cluster.yaml
```

Step 1i: Wait till the control plane is initialized + install calico

```
kubectl get kubeadmcontrolplane

## When initialized get kubeconfig and install calicao
clusterctl --namespace infra2 \
    get kubeconfig devops-toolkit \
    | tee kubeconfig.yaml


kubectl --kubeconfig kubeconfig.yaml get ns
## you will see control plane is not ready because of network missing
kubectl --kubeconfig kubeconfig.yaml get nodes

kubectl --kubeconfig kubeconfig.yaml apply -f https://docs.projectcalico.org/v3.25/manifests/calico.yaml
```

Step 1j: READY it is (says Yoda)

```
## Wait a while, now you will see, the nodes are ready
kubectl --kubeconfig kubeconfig.yaml get nodes
```

Kubernetes Praxis API-Objekte

Das Tool kubectl (Devs/Ops) - Spickzettel

Allgemein

```
## Zeige Information über das Cluster
kubectl cluster-info

## Welche api-resources gibt es ?
kubectl api-resources

## Hilfe zu object und eigenschaften bekommen
kubectl explain pod
kubectl explain pod.metadata
kubectl explain pod.metadata.name
```

Arbeiten mit manifesten

```
kubectl apply -f nginx-replicaset.yml
## Wie ist aktuell die hinterlegte config im system
kubectl get -o yaml -f nginx-replicaset.yml

## Änderung in nginx-replicaset.yml z.B. replicas: 4
## dry-run - was wird geändert
kubectl diff -f nginx-replicaset.yml

## anwenden
kubectl apply -f nginx-replicaset.yml

## Alle Objekte aus manifest löschen
kubectl delete -f nginx-replicaset.yml

```

Ausgabeformate

```
## Ausgabe kann in verschiedenen Formaten erfolgen
kubectl get pods -o wide # weitere informationen
## im json format
kubectl get pods -o json

## gilt natürluch auch für andere kommandos
```

```
kubectl get deploy -o json
kubectl get deploy -o yaml

## get a specific value from the complete json - tree
kubectl get node k8s-nue-jo-ff1p1 -o=jsonpath='{.metadata.labels}'
```

Zu den Pods

```
## Start einen pod // BESSER: direkt manifest verwenden
## kubectl run podname image=imagename
kubectl run nginx image=nginx

## Pods anzeigen
kubectl get pods
kubectl get pod
## Format weitere Information
kubectl get pod -o wide
## Zeige labels der Pods
kubectl get pods --show-labels

## Zeige pods mit einem bestimmten label
kubectl get pods -l app=nginx

## Status eines Pods anzeigen
kubectl describe pod nginx

## Pod löschen
kubectl delete pod nginx

## Kommando in pod ausführen
kubectl exec -it nginx -- bash
```

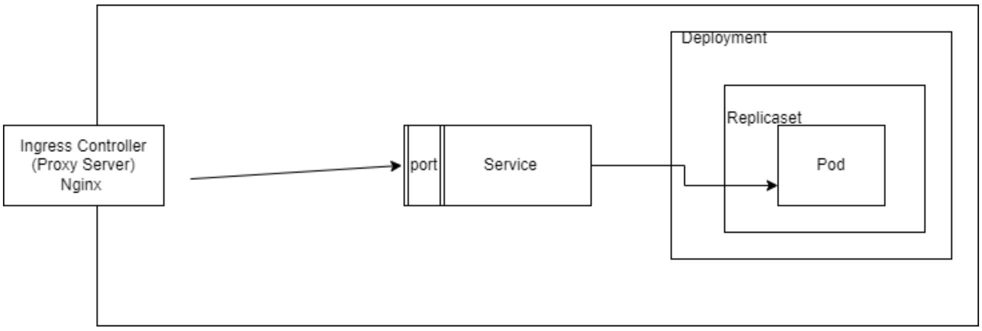
Arbeiten mit namespaces

```
## Welche namespaces auf dem System
kubectl get ns
kubectl get namespaces
## Standardmäßig wird immer der default namespace verwendet
## wenn man kommandos aufruft
kubectl get deployments

## Möchte ich z.B. deployment vom kube-system (installation) aufrufen,
## kann ich den namespace angeben
kubectl get deployments --namespace=kube-system
kubectl get deployments -n kube-system

## wir wollen unseren default namespace ändern
kubectl config set-context --current --namespace <dein-namespace>
```

Referenz

- https://kubernetes.io/de/docs/reference/kubectl/cheatsheet/

Bauen einer Applikation mit Resource Objekten



kubectl/manifest/deployments

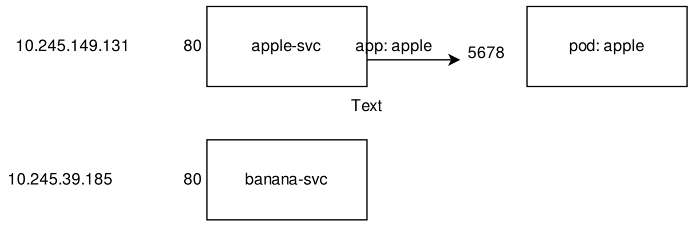
```
cd
mkdir -p manifests
cd manifests
mkdir 03-deploy
```

```
cd 03-deploy
nano deploy.yml
```

```
## vi deploy.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 8 # tells deployment to run 2 pods matching the template
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.21
        ports:
        - containerPort: 80
```

```
kubectl apply -f deploy.yml
```

Services - Aufbau



kubectl/manifest/service

Schritt 1: Deployment

```
cd
mkdir -p manifests
cd manifests
mkdir 04-service
cd 04-service
```

```
## 01-deploy.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: my-nginx
spec:
  selector:
    matchLabels:
      run: my-nginx
  replicas: 3
  template:
    metadata:
      labels:
        run: my-nginx
    spec:
      containers:
      - name: my-nginx
        image: nginx
        ports:
        - containerPort: 80
```

```
kubectl apply -f .
```

Schritt 2:

```
## 02-svc.yml
apiVersion: v1
kind: Service
metadata:
  name: my-nginx
  labels:
    svc: nginx
spec:
  ports:
  - port: 80
    protocol: TCP
  selector:
    run: my-nginx
```

```
kubectl apply -f .
```

Ref.

- https://kubernetes.io/docs/concepts/services-networking/connect-applications-service/

DNS - Resolution - Services

How does it work

```
3 Variants:

svc-name
or:
svc-name.<namespace>
or:
svc-name.<namespace>.svc.cluster.local
```

Example

```
kubectl run podtest --rm -ti --image busybox
If you don't see a command prompt, try pressing enter.
/ # wget -O - http://apple-service.jochen
Connecting to apple-service.jochen (10.245.39.214:80)
writing to stdout
apple-tln1
-                    100%
|***************************************************************************************************************|    11  0:00:00
ETA
written to stdout
/ # wget -O - http://apple-service.jochen.svc.cluster.local
Connecting to apple-service.jochen.svc.cluster.local (10.245.39.214:80)
writing to stdout
apple-tln1
-                    100%
|***************************************************************************************************************|    11  0:00:00
ETA
written to stdout
/ # wget -O - http://apple-service
Connecting to apple-service (10.245.39.214:80)
writing to stdout
apple-tln1
-                    100%
|***************************************************************************************************************|    11  0:00:00
ETA
written to stdout
```

Hintergrund Ingress

Ref. / Dokumentation

- https://matthewpalmer.net/kubernetes-app-developer/articles/kubernetes-ingress-guide-nginx-example.html

Beispiel mit Hostnamen

Prerequisits

```
## Ingress Controller muss aktiviert sein
### Nur der Fall wenn man microk8s zum Einrichten verwendet
### Ubuntu
microk8s enable ingress
```

Walkthrough

Step 1: pods and services

```
cd
mkdir -p manifests
cd manifests
mkdir abi
cd abi
```

```
## apple.yml
## vi apple.yml
kind: Pod
apiVersion: v1
metadata:
  name: apple-app
  labels:
    app: apple
spec:
  containers:
    - name: apple-app
      image: hashicorp/http-echo
      args:
        - "-text=apple-<dein-name>"
---

kind: Service
apiVersion: v1
metadata:
  name: apple-service
spec:
  selector:
    app: apple
  ports:
    - protocol: TCP
      port: 80
      targetPort: 5678 # Default port for image
```

```
kubectl apply -f apple.yml
```

```
## banana
## vi banana.yml
kind: Pod
apiVersion: v1
metadata:
  name: banana-app
  labels:
    app: banana
spec:
  containers:
    - name: banana-app
      image: hashicorp/http-echo
      args:
        - "-text=banana-<dein-name>"

---

kind: Service
apiVersion: v1
metadata:
  name: banana-service
spec:
  selector:
    app: banana
  ports:
    - port: 80
      targetPort: 5678 # Default port for image
```

```
kubectl apply -f banana.yml
```

Step 2: Ingress

```
## Ingress
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: example-ingress
  annotations:
    ingress.kubernetes.io/rewrite-target: /
    # with the ingress controller from helm, you need to set an annotation
    # otherwice it does not know, which controller to use
    # old version... use ingressClassName instead
    # kubernetes.io/ingress.class: nginx
spec:
  ingressClassName: nginx
  rules:
  - host: "<euername>.lab<nr>.t3isp.de"
    http:
      paths:
        - path: /apple
          backend:
            serviceName: apple-service
            servicePort: 80
        - path: /banana
          backend:
            serviceName: banana-service
            servicePort: 80
```

```
## ingress
kubectl apply -f ingress.yml
kubectl get ing
```

Reference

- https://matthewpalmer.net/kubernetes-app-developer/articles/kubernetes-ingress-guide-nginx-example.html

Find the problem

```
## Hints

## 1. Which resources does our version of kubectl support
## Can we find Ingress as "Kind" here.
kubectl api-ressources

## 2. Let's see, how the configuration works
kubectl explain --api-version=networking.k8s.io/v1 ingress.spec.rules.http.paths.backend.service

## now we can adjust our config
```

Solution

```
## in kubernetes 1.22.2 - ingress.yml needs to be modified like so.
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: example-ingress
  annotations:
    ingress.kubernetes.io/rewrite-target: /
    # with the ingress controller from helm, you need to set an annotation
    # old version useClassName instead
    # otherwice it does not know, which controller to use
    # kubernetes.io/ingress.class: nginx
spec:
  ingressClassName: nginx
  rules:
  - host: "app12.lab.t3isp.de"
    http:
      paths:
        - path: /apple
          pathType: Prefix
          backend:
            service:
              name: apple-service
              port:
                number: 80
        - path: /banana
          pathType: Prefix
          backend:
            service:
              name: banana-service
              port:
                number: 80
```

Configmap MariaDB - Example

Schritt 1: configmap

```
cd
mkdir -p manifests
cd manifests
mkdir cftest
cd cftest
nano 01-configmap.yml
```

```
### 01-configmap.yml
kind: ConfigMap
apiVersion: v1
metadata:
  name: mariadb-configmap
data:
  # als Wertepaare
  MARIADB_ROOT_PASSWORD: 11abc432
```

```
kubectl apply -f .
kubectl get cm
kubectl get cm mariadb-configmap -o yaml
```

Schritt 2: Deployment

```
nano 02-deploy.yml
```

```
##deploy.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: mariadb-deployment
spec:
  selector:
    matchLabels:
      app: mariadb
  replicas: 1
  template:
    metadata:
      labels:
        app: mariadb
    spec:
      containers:
      - name: mariadb-cont
        image: mariadb:latest
        envFrom:
        - configMapRef:
            name: mariadb-configmap
```

```
kubectl apply -f .
```

Important Sidenode

- If configmap changes, deployment does not know
- So kubectl apply -f deploy.yml will not have any effect
- to fix, use stakater/reloader: https://github.com/stakater/Reloader

Kubernetes - Wartung / Debugging

Netzwerkverbindung zu pod testen

Situation

```
Managed Cluster und ich kann nicht auf einzelne Nodes per ssh zugreifen
```

Behelf: Eigenen Pod starten mit busybox

```
## laengere Version
kubectl run podtest --rm -ti --image busybox -- /bin/sh
```

```
## kuerzere Version
kubectl run podtest --rm -ti --image busybox
```

Example test connection

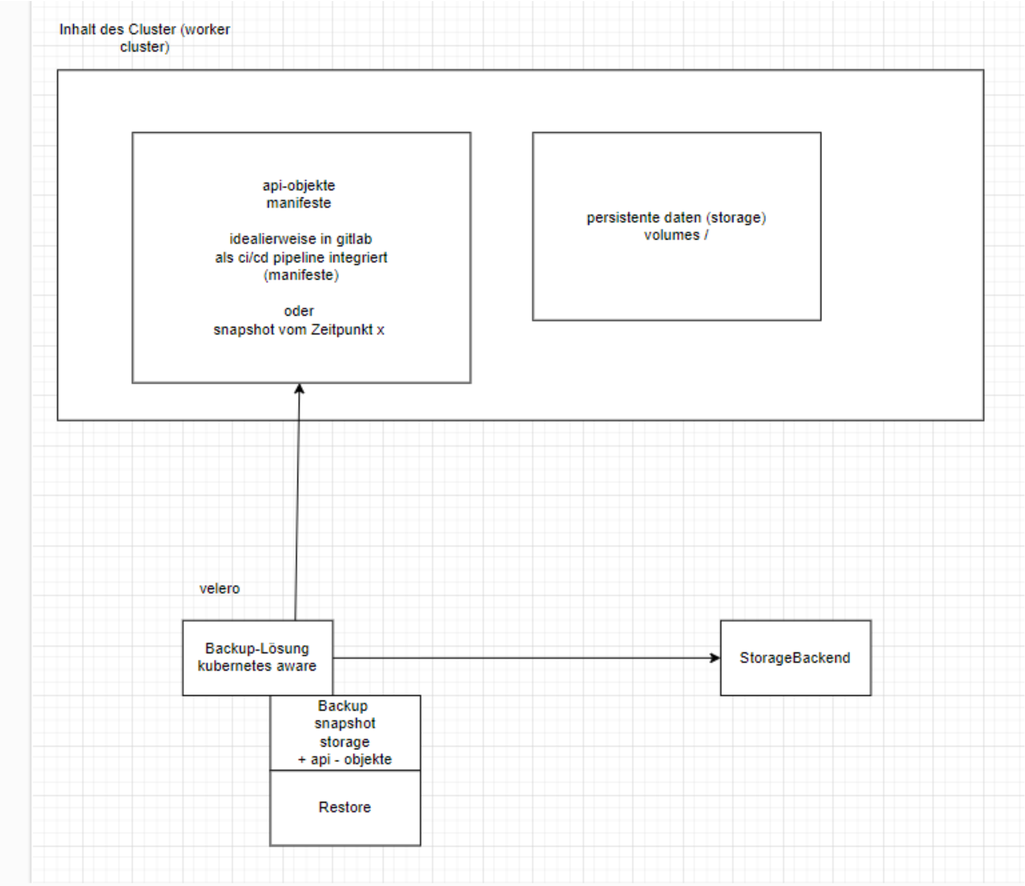
```
## wget befehl zum Kopieren
wget -O - http://10.244.0.99
```

```
## -O -> Output (grosses O (buchstabe))
kubectl run podtest --rm -ti --image busybox -- /bin/sh
/ # wget -O - http://10.244.0.99
/ # exit
```

Kubernetes Backup

Backups mit Velero

Schaubild



Walkthrough in digitalocean

- https://www.digitalocean.com/community/tutorials/how-to-back-up-and-restore-a-kubernetes-cluster-on-digitalocean-using-velero

Kubernetes Upgrade

Upgrade von tanzu (Cluster API)

Step 1: Upgrade Tanzu Kubernetes Grid (Cluster Api)

- https://docs.vmware.com/en/VMware-Tanzu-Kubernetes-Grid/1.6/vmware-tanzu-kubernetes-grid-16/GUID-upgrade-tkg-index.html

Step 2: Upgrade Management Cluster

- https://docs.vmware.com/en/VMware-Tanzu-Kubernetes-Grid/1.6/vmware-tanzu-kubernetes-grid-16/GUID-upgrade-tkg-management-cluster.html

Step 3: Variante 1: Workload Cluster aktualisieren.

- https://docs.vmware.com/en/VMware-Tanzu-Kubernetes-Grid/1.6/vmware-tanzu-kubernetes-grid-16/GUID-upgrade-tkg-workload-clusters.html

Step 3: Variante 2: Neues Cluster hochziehen, ausrollen und altes abschalten

- https://docs.vmware.com/en/VMware-Tanzu-Kubernetes-Grid/1.6/vmware-tanzu-kubernetes-grid-16/GUID-tanzu-k8s-clusters-index.html

Monitoring with Prometheus / Grafana

Overview

What does it do ?

- It monitors your system by collecting data
- Data is pulled from your system by defined endpoints (http) from your cluster
- To provide data on your system, a lot of exporters are available, that
  - collect the data and provide it in Prometheus

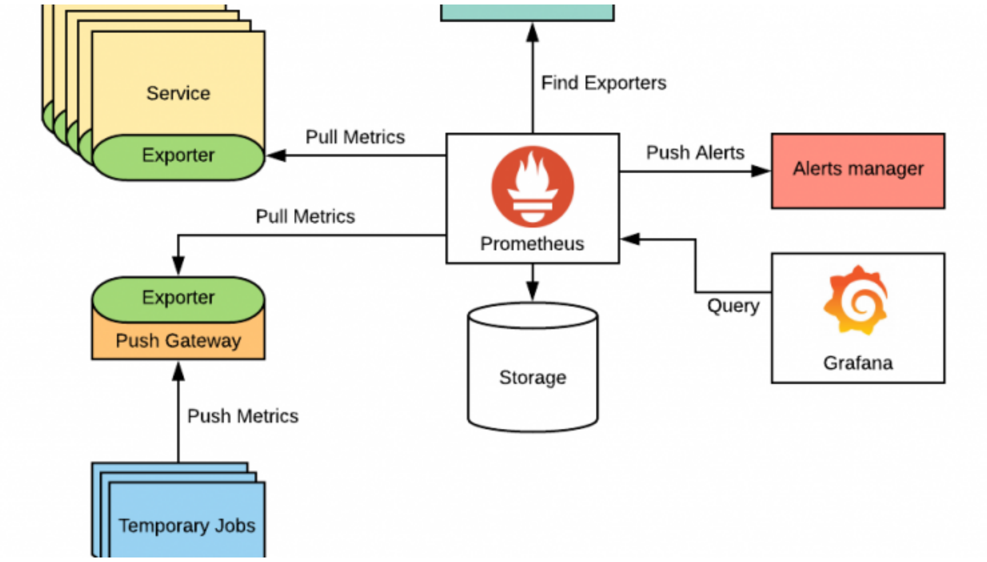
Technical

- Prometheus has a TDB (Time Series Database) and is good as storing time series with data
- Prometheus includes a local on-disk time series database, but also optionally integrates with remote storage systems.
- Prometheus's local time series database stores data in a custom, highly efficient format on local storage.
- Ref: https://prometheus.io/docs/prometheus/latest/storage/

What are time series ?

- A time series is a sequence of data points that occur in successive order over some period of time.
- Beispiel:
  - Du willst die täglichen Schlusspreise für eine Aktie für ein Jahr dokumentieren
  - Damit willst Du weitere Analysen machen
  - Du würdest das Paar Datum/Preis dann in der Datumsreihenfolge sortieren und so ausgeben
  - Dies wäre eine "time series"

Kompenenten von Prometheus



Quelle: https://www.devopsschool.com/

Prometheus Server

1. Retrieval (Sammeln)
   - Data Retrieval Worker
     - pull metrics data
2. Storage
   - Time Series Database (TDB)
     - stores metrics data
3. HTTP Server
   - Accepts PromQL - Queries (e.g. from Grafana)
     - accept queries

Grafana ?

- Grafana wird meist verwendet um die grafische Auswertung zu machen.
- Mit Grafana kann ich einfach Dashboards verwenden
- Ich kann sehr leicht festlegen (Durch Data Sources), so meine Daten herkommen

Setup prometheus/Grafana with helm

Prerequisites

- Ubuntu 20.04 with running microk8s single cluster
- Works on any other cluster, but installing helm is different

Prepare

```
## Be sure helm is installed on your client
## In our walkthrough, we will do it directly on 1 node,
## which is not recommended for Production
```

Walkthrough

Step 1: install helm, if not there yet

```
snap install --classic helm
```

Step 2: Rollout prometheus/grafana stack in namespace prometheus

```
## add prometheus repo
helm repo add prometheus-community https://prometheus-community.github.io/helm-charts
helm repo update

## install stack into new prometheus namespace
helm install -n prometheus --create-namespace prometheus prometheus-community/kube-prometheus-stack

## After installation look at the pods
## You should see 3 pods
kubectl --namespace prometheus get pods -l "release=prometheus"

## After a while it should be more pods
kubectl get all -n prometheus
```

Step 3a Let's explain (der Prometheus - Server)

```
## 2 Stateful sets
kubectl get statefulsets  -n prometheus
## output
## alertmanager-prometheus-kube-prometheus-alertmanager   1/1     5m14s
## prometheus-prometheus-kube-prometheus-prometheus.      1/1.    5m23s
```

```
## Moving part 1:
## prometheus-prometheus-kube-prometheus-prometheus
## That is the core prometheus server based on the main image

## Let's validate
## schauen wir mal in das File
kubectl get statefulset -n prometheus -o yaml > sts-prometheus-server.yml

## Und vereinfacht (jetzt sehen wir direkt die beiden verwendeten images)
## 1) prometheus - server
## 2) der dazugehörige config-reloader als Side-Car
kubectl get sts -n prometheus prometheus-prometheus-kube-prometheus-prometheus -o
jsonpath='{.spec.template.spec.containers[*].image}'

## Aber wer managed den server -> managed-by -> kubernetes-operator
kubectl get sts -n prometheus prometheus-prometheus-kube-prometheus-prometheus -o jsonpath="{.spec.template.metadata.labels}" | jq
.

## Wir der sts von helm erstellt ?
## NEIN ;o)
## show us all the template that helm generate to apply them to kube-api-server
helm template prometheus prometheus-community/kube-prometheus-stack > all-prometheus.yml
## NOPE -> none
cat all-prometheus.yaml | grep -i kind: | grep -i stateful

## secrets -> configuration von prometheus
## wenn ein eigenschaft Punkte hat, z.B. prometheus.yaml.gz
##
## {"prometheus.yaml.gz":"H4s
## dann muss man escapen, um darauf zuzugreifen -> aus . wird \.
kubectl get -n prometheus secrets prometheus-prometheus-kube-prometheus-prometheus -o jsonpath='{.data.prometheus\.yaml\.gz}' |
base64 -d | gzip -d -
```

Step 3b: Prometheus Operator und Admission Controller -> Hook

```
## The Prometheus Operator for Kubernetes
## provides easy monitoring definitions
## for Kubernetes services and deployment and management of Prometheus instances.
## But how are they created
## After installation new resource-type are introduced
cat all-prometheus.yaml | grep ^kind: | grep -e 'Prometheus' -e 'ServiceM' | uniq
kind: Prometheus
kind: PrometheusRule
kind: ServiceMonitor
```

Step 3c: How are the StatefulSets created

```
## New custom resource definitions are created
## The Prometheus custom resource definition (CRD) declaratively defines a desired Prometheus setup to run in a Kubernetes
cluster. It provides options to # configure replication, persistent storage, and Alertmanagers to which the deployed Prometheus
instances send alerts to.

## For each Prometheus resource, the Operator deploys a properly configured StatefulSet in the same namespace. The Prometheus Pods
are configured to mount # ca Secret called <prometheus-name> containing the configuration for Prometheus.
## https://github.com/prometheus-community/helm-charts/blob/main/charts/kube-prometheus-stack/crds/crd-prometheuses.yaml
```

Step 3d: How are PrometheusRules created

```
## PrometheusRule are manipulated by the MutationHook when they enter the AdmissionController
## The AdmissionController is used after proper authentication in the kube-api-server

cat all-prometheus.yml | grep 'Mutating' -B1 -A32
```

```
## Output
## Ref: https://kubernetes.io/docs/reference/access-authn-authz/extensible-admission-controllers/
apiVersion: admissionregistration.k8s.io/v1
kind: MutatingWebhookConfiguration
metadata:
  name:  prometheus-kube-prometheus-admission
  labels:
    app: kube-prometheus-stack-admission
    app.kubernetes.io/managed-by: Helm
    app.kubernetes.io/instance: prometheus
    app.kubernetes.io/version: "35.4.2"
    app.kubernetes.io/part-of: kube-prometheus-stack
    chart: kube-prometheus-stack-35.4.2
    release: "prometheus"
    heritage: "Helm"
webhooks:
  - name: prometheusrulemutate.monitoring.coreos.com
    failurePolicy: Ignore
    rules:
      - apiGroups:
          - monitoring.coreos.com
        apiVersions:
          - "*"
        resources:
          - prometheusrules
        operations:
          - CREATE
          - UPDATE
    clientConfig:
      service:
        namespace: prometheus
        name: prometheus-kube-prometheus-operator
        path: /admission-prometheusrules/mutate
    admissionReviewVersions: ["v1", "v1beta1"]
    sideEffects: None
```

Step 4: Let's look into Deployments

```
kubectl -n prometheus get deploy
```

- What do they do

Step 5: Let's look into DaemonSets

```
kubectl -n prometheus get ds
## node-exporter runs on every node
## connects to server, collects data and exports it
## so it is available for prometheus at the endpoint
```

Helm -> prometheus stack -> What does it do

- Sets up Monitoring Stack
- Configuration for your K8s cluster

  - Worker Nodes monitored
  - K8s components (pods a.s.o) are monitored

Where does configuration come from ?

```
## roundabout 31 configmaps
kubectl -n prometheus get configmaps

## also you have secrets (Grafana, Prometheus, Operator)
kubectl -n prometheus get secrets
```

CRD's were created

```
## custom resource definitions
kubectl -n prometheus crd
## Sehr lang !
kubectl -n prometheus get crd/prometheuses.monitoring.coreos.com -o yaml
```

Look into the pods to see the image used, how configuration is mounted

```
kubectl -n prometheus get sts
kubectl -n prometheus describe sts/prometheus-prometheus-kube-prometheus-prometheus > prom.yml
kubectl -n prometheus describe sts/alertmanager-prometheus-kube-prometheus-alertmanager > alert.yml

kubectl -n prometheus get deploy
kubectl -n prometheus describe deploy/prometheus-kube-prometheus-operator > operator.yml

## ---> das SECRET erstellt der Kubernetes Operator für uns !
## First prom.yml
##. Mounts:
##      /etc/prometheus/config from config (rw)
##   -> What endpoints to scrape
## comes from:
kubectl get -n prometheus secrets prometheus-prometheus-kube-prometheus-prometheus -o jsonpath='{.data.prometheus\.yaml\.gz}' |
base64 -d | gunzip > config-prom.yml
## vi config-prom.yml
## Look into the scrape_configs
```

Connect to grafana

```
## wie ist der port 3000
kubectl logs prometheus-grafana-776fb976f7-w9nrp grafana
## hier nochmal port und auch, wie das secret heisst
kubectl describe pods prometheus-grafana-776fb976f7-w9nrp | less

## user / pass ?
kubectl get -n prometheus secrets prometheus-grafana -o jsonpath='{.data.admin-password}' | base64 -d
kubectl get -n prometheus secrets prometheus-grafana -o jsonpath='{.data.admin-user}' | base64 -d

## localhost:3000 erreichbarkeit starten -- im Vordergrund
kubectl port-forward deploy/prometheus-grafana 3000
## if on remote - system do a ssh-tunnel
## ssh -L 3000:127.0.0.1:3000 user@remote-ip


## letzte Schritt: browser aufrufen: http://localhost:3000
```

Reference:

- Techworld with Nana: https://www.youtube.com/watch?v=QoDqxm7ybLc

exporters mongodb

prometheus - export

- https://github.com/prometheus-community/helm-charts/tree/main/charts/prometheus-mongodb-exporter

Step 1: mongodb - deployment in mongodb namespace

```
## vi mongo-db-deploy.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: mongodb-deployment
  labels:
    app: mongodb
spec:
  replicas: 1
  selector:
    matchLabels:
      app: mongodb
  template:
    metadata:
      labels:
        app: mongodb
    spec:
      containers:
      - name: mongodb
        image: mongo
        ports:
        - containerPort: 27017
---
apiVersion: v1
kind: Service
metadata:
  name: mongodb-service
spec:
  selector:
    app: mongodb
  ports:
    - protocol: TCP
      port: 27017
      targetPort: 27017
```

```
kubectl apply -f mongo-db-deploy.yml
```

Step 2: Install prometheus - mongodb - export

```
helm repo add prometheus-community https://prometheus-community.github.io/helm-charts
helm repo update
helm show values prometheus-community/prometheus-mongodb-exporter > values.yml

## adjust so it looks like so:
vi values.yml
## [mongodb[+srv]://][user:pass@]host1[:port1][,host2[:port2],...][/database][?options]
## mongodb-service is the service name
mongodb:
  uri: "mongodb://mongodb-service:27017"

serviceMonitor:
  additionalLabels:
    release: prometheus
```

```
helm install mongodb-exporter prometheus-community/prometheus-mongodb-exporter -f values.yml
```

Step 3: Helm -> template -> What does it do ?

```
helm template mongodb-exporter prometheus-community/prometheus-mongodb-exporter -f values.yml
```

Good Kubernetes Board for Grafana

- https://github.com/dotdc/grafana-dashboards-kubernetes
- https://medium.com/@dotdc/a-set-of-modern-grafana-dashboards-for-kubernetes-4b989c72a4b2

Kubernetes Tipps & Tricks

kubectl kubeconfig mergen

So funktioniert es auch bereits:

```
## hier werden mehrere kubeconfigs durchsucht
export KUBECONFIG=~/.kube/config:/path/cluster1:/path/cluster2
```

Jetzt alles in eine Datei

```
cd ~/.kube
kubectl config view --flatten > all-in-one-kubeconfig.yaml
mv config config.old
mv all-in-one-kubeconfig.yaml config
```

Contexts jeweils anzeigen

```
kubectl config
kubectl config use-context mycontext
```

Kubernetes Certificates (Control Plane) / Security

vmware - cluster api

- https://docs.vmware.com/en/VMware-Tanzu-Kubernetes-Grid/1.6/vmware-tanzu-kubernetes-grid-16/GUID-cluster-lifecycle-secrets.html

Pod Security Admission (PSA)

Seit: 1.2.22 Pod Security Admission

- 1.2.22 - ALpha - D.h. ist noch nicht aktiviert und muss als Feature Gate aktiviert (Kind)
- 1.2.23 - Beta -> d.h. evtl. aktiviert

Vorgefertigte Regelwerke

- privileges - keinerlei Einschränkungen
- baseline - einige Einschränkungen
- restricted - sehr streng
- Reference: https://kubernetes.io/docs/concepts/security/pod-security-standards/

Praktisches Beispiel für Version ab 1.2.23 - Problemstellung

```
mkdir -p manifests
cd manifests
mkdir psa
cd psa
nano 01-ns.yml
```

```
## Schritt 1: Namespace anlegen
## vi 01-ns.yml

apiVersion: v1
kind: Namespace
metadata:
  name: test-ns1
  labels:
    # soft version - running but showing complaints
    # pod-security.kubernetes.io/enforce: baseline
    pod-security.kubernetes.io/enforce: restricted
    pod-security.kubernetes.io/audit: restricted
    pod-security.kubernetes.io/warn: restricted
```

```
kubectl apply -f 01-ns.yml
```

```
## Schritt 2: Testen mit nginx - pod
## vi 02-nginx.yml

apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: test-ns1
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
```

```
## a lot of warnings will come up
## because this image runs as root !! (by default)
kubectl apply -f 02-nginx.yml
```

```
## Schritt 3:
## Anpassen der Sicherheitseinstellung (Phase1) im Container

## vi 02-nginx.yml

apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: test-ns1
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
      securityContext:
        seccompProfile:
          type: RuntimeDefault
```

```
kubectl delete -f 02-nginx.yml
kubectl apply -f 02-nginx.yml
kubectl -n test-ns1 get pods
```

```
## Schritt 4:
## Weitere Anpassung runAsNotRoot
## vi 02-nginx.yml
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: test-ns<tln>
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
      securityContext:
        seccompProfile:
          type: RuntimeDefault
        runAsNonRoot: true
```

```
## pod kann erstellt werden, wird aber nicht gestartet
kubectl delete -f 02-nginx.yml
kubectl apply -f 02-nginx.yml
kubectl -n test-ns1 get pods
kubectl -n test-ns1 describe pods nginx
```

```
## Schritt 4:
## Anpassen der Sicherheitseinstellung (Phase1) im Container
```

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: test-ns1
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
      securityContext:
        seccompProfile:
          type: RuntimeDefault
        runAsNonRoot: true
        allowPrivilegeEscalation: false
        capabilities:
          drop: ["ALL"]
```

```
kubectl delete -f 02-nginx.yml
kubectl apply -f 02-nginx.yml
kubectl -n test-ns1 get pods
```

Praktisches Beispiel für Version ab 1.2.23 -Lösung - Container als NICHT-Root laufen lassen

- Wir müssen ein image, dass auch als NICHT-Root laufen kann
- .. oder selbst eines bauen (;o)) o bei nginx ist das bitnami/nginx

```
## vi 03-nginx-bitnami.yml
apiVersion: v1
kind: Pod
metadata:
  name: bitnami-nginx
  namespace: test-ns1
spec:
  containers:
    - image: bitnami/nginx
      name: bitnami-nginx
      ports:
        - containerPort: 80
      securityContext:
        seccompProfile:
          type: RuntimeDefault
        runAsNonRoot: true
```

```
## und er läuft als nicht root
kubectl apply -f 03_pod-bitnami.yml
kubectl -n test-ns1 get pods
```

Pod Security Policy (PSP)

General

- PodSecurity is an eine Rolle gebunden (clusterrole)
- Deprecated in 1.21 removed in 1.25
- From 1.25 on please use PSA (Pod Security Admission) instead

Prerequisites

- We should have a running Cluster of 1.22/1.23

Walkthrough

Step 1: Create Digitalocean microk8s 1-node - cluster, with this cloud-init-script

- cloud-init (ubuntu 20.04 LTS, 8 GB Ram)

```
##!/bin/bash

groupadd sshadmin
USERS="11trainingdo"
echo $USERS
for USER in $USERS
do
  echo "Adding user $USER"
  useradd -s /bin/bash --create-home $USER
  usermod -aG sshadmin $USER
  echo "$USER:deinsehrgeheimespasswort" | chpasswd
done

## We can sudo with 11trainingdo
usermod -aG sudo 11trainingdo

## 20.04 and 22.04 this will be in the subfolder
if [ -f /etc/ssh/sshd_config.d/50-cloud-init.conf ]
then
  sed -i "s/PasswordAuthentication no/PasswordAuthentication yes/g" /etc/ssh/sshd_config.d/50-cloud-init.conf
fi

### both is needed
sed -i "s/PasswordAuthentication no/PasswordAuthentication yes/g" /etc/ssh/sshd_config

usermod -aG sshadmin root

## TBD - Delete AllowUsers Entries with sed
## otherwice we cannot login by group

echo "AllowGroups sshadmin" >> /etc/ssh/sshd_config
systemctl reload sshd

echo "Installing microk8s"
snap install --classic --channel=1.23/stable microk8s
microk8s enable dns rbac
echo "alias kubectl='microk8s kubectl'" >> /root/.bashrc
source ~/.bashrc
alias kubectl='microk8s kubectl'

## now we need to modify the setting of kube-api-server
## currently in 1.23 no other admission-plugins are activated
echo "--enable-admission-plugins=PodSecurityPolicy" >> /var/snap/microk8s/current/args/kube-apiserver
microk8s stop
microk8s start
```

Step 2:

```
## Setup .kube/config from content
microk8s config
```

Step 3

```
## rbac.yaml
## vi service-account.yml
apiVersion: v1
kind: ServiceAccount
metadata:
  name: training
  namespace: default
---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: pods-clusterrole
rules:
- apiGroups: [""] # "" indicates the core API group
  resources: ["pods"]
  verbs: ["get", "watch", "list", "create"]
- apiGroups: [""] # "" indicates the core API group
  resources: ["events"]
  verbs: ["get", "list"]
---
## vi rb-training-ns-default-pods.yml
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: rolebinding-ns-default-pods
  namespace: default
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: pods-clusterrole
subjects:
- kind: ServiceAccount
  name: training
  namespace: default
```

Step 4: Secret aus secrets rauskopiert

```
kubectl get secrets | grep training-token
TOKEN=$(kubectl get secrets training-token-<xyz> -o jsonpath='{.data.token}' |  base64 -d)
## z.B. TOKEN=$(kubectl get secrets training-token-kjl5m -o jsonpath='{.data.token}' |  base64 -d)
```

```
echo $TOKEN
kubectl config set-context training-ctx --cluster microk8s-cluster --user training
kubectl config set-credentials training --token=$TOKEN
```

Step 5: Apply yaml-manifests for psp - stuff (as admin)

```
## vi setup.yaml
apiVersion: policy/v1beta1
kind: PodSecurityPolicy
metadata:
  name: norootcontainers
spec:
  allowPrivilegeEscalation: false
  allowedHostPaths:
  - pathPrefix: /dev/null
    readOnly: true
  fsGroup:
    rule: RunAsAny
  hostPorts:
  - max: 65535
    min: 0
  runAsUser:
    rule: MustRunAsNonRoot
  seLinux:
    rule: RunAsAny
  supplementalGroups:
    rule: RunAsAny
  volumes:
  - '*'
---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: norootcontainers-psp-role
rules:
- apiGroups:
  - policy
  resourceNames:
  - norootcontainers
  resources:
  - podsecuritypolicies
  verbs:
  - use
---
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: norootcontainers-psp-role:training
  namespace: default
roleRef:
  kind: ClusterRole
  name: norootcontainers-psp-role
  apiGroup: rbac.authorization.k8s.io
subjects:
- kind: ServiceAccount
  name: training
  namespace: default
```

Step 5: Change to training-ctx and apply

```
kubectl config use-context training-ctx
```

```
## vi demopod.yaml
apiVersion: v1
kind: Pod
metadata:
  name: demopod
spec:
  containers:
    - name:  demopod
      image: nginx
```

```
kubectl apply -f demopod.yaml
kubectl get pods ## expecting
kubectl describe pods demopod
```

Reference

- https://docs.mirantis.com/mke/3.4/ops/deploy-apps-k8s/pod-security-policies/psp-examples.html

Kubernetes Network / Firewall

Calico/Cilium - nginx example NetworkPolicy

```
## Schritt 1:
kubectl create ns policy-demo
kubectl create deployment --namespace=policy-demo nginx --image=nginx:1.21
kubectl expose --namespace=policy-demo deployment nginx --port=80
## lassen einen 2. pod laufen mit dem auf den nginx zugreifen
kubectl run --namespace=policy-demo access --rm -it --image busybox
```

```
## innerhalb der shell
## Verbindung möglich
wget -q nginx -O -
```

```
## Schritt 2: Policy festlegen, dass kein Ingress-Traffic erlaubt
## in diesem namespace: policy-demo
kubectl create -f - <<EOF
kind: NetworkPolicy
apiVersion: networking.k8s.io/v1
metadata:
  name: default-deny
  namespace: policy-demo
```

```
spec:
  podSelector:
    matchLabels: {}
EOF
## lassen einen 2. pod laufen mit dem auf den nginx zugreifen
kubectl run --namespace=policy-demo access --rm -ti --image busybox
```

```
## innerhalb der shell
## keine Verbindung mehr möglich, weil policy greift
wget -q nginx -O -
```

```
## Schritt 3: Zugriff erlauben von pods mit dem Label run=access
kubectl create -f - <<EOF
kind: NetworkPolicy
apiVersion: networking.k8s.io/v1
metadata:
  name: access-nginx
  namespace: policy-demo
spec:
  podSelector:
    matchLabels:
      app: nginx
  ingress:
    - from:
      - podSelector:
          matchLabels:
            run: access
EOF

## lassen einen 2. pod laufen mit dem auf den nginx zugreifen
## pod hat durch run -> access automatisch das label run:access zugewiesen
kubectl run --namespace=policy-demo access --rm -ti --image busybox
```

```
## innerhalb der shell
wget -q nginx -O -
```

```
kubectl run --namespace=policy-demo no-access --rm -ti --image busybox
```

```
## in der shell
wget -q nginx -O -
```

```

kubectl delete ns policy-demo
```

Ref:

- https://projectcalico.docs.tigera.io/security/tutorials/kubernetes-policy-basic

Egress / Ingress Examples with Exercise

Links

- https://github.com/ahmetb/kubernetes-network-policy-recipes
- https://k8s-examples.container-solutions.com/examples/NetworkPolicy/NetworkPolicy.html

Example with http (Cilium !!)

```
apiVersion: "cilium.io/v2"
kind: CiliumNetworkPolicy
description: "L7 policy to restrict access to specific HTTP call"
metadata:
  name: "rule1"
spec:
  endpointSelector:
    matchLabels:
      type: l7-test
  ingress:
  - fromEndpoints:
    - matchLabels:
        org: client-pod
    toPorts:
    - ports:
      - port: "8080"
        protocol: TCP
      rules:
        http:
        - method: "GET"
          path: "/discount"
```

Downside egress (NetworkPolicy - not ciliumnetworkpolicy)

- No valid api for anything other than IP's and/or Ports
- If you want more, you have to use CNI-Plugin specific, e.g.

Example egress with ip's

```
## Allow traffic of all pods having the label role:app
## egress only to a specific ip and port
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: test-network-policy
  namespace: default
spec:
  podSelector:
    matchLabels:
      role: app
  policyTypes:
  - Egress
  egress:
  - to:
    - ipBlock:
        cidr: 10.10.0.0/16
    ports:
    - protocol: TCP
      port: 5432
```

Example Advanced Egress (cni-plugin specific)

Cilium (Exercise)

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx-static-web
  labels:
    webserver: nginx
spec:
  containers:
  - name: web
    image: nginx
```

```
apiVersion: cilium.io/v2
kind: CiliumNetworkPolicy
metadata:
  name: "fqdn-pprof"
  # namespace: msp
spec:
  endpointSelector:
    matchLabels:
      webserver: nginx
  egress:
  - toFQDNs:
    - matchPattern: '*.google.com'
  - toPorts:
    - ports:
      - port: "53"
        protocol: ANY
      rules:
        dns:
        - matchPattern: '*'
```

```
kubectl apply -f .
kubectl exec -it nginx-static-web -- bash
```

```
## im pod
## does work
curl -I https://www.google.com
## does not work
curl -I https://www.google.de
## does not work
curl -I https://www.heise.de
```

Calico

- Only Calico enterprise

- Calico Enterprise extends Calico's policy model so that domain names (FQDN / DNS) can be used to allow access from a pod or set of pods (via label selector) to external resources outside of your cluster.
- https://projectcalico.docs.tigera.io/security/calico-enterprise/egress-access-controls

Using isitio as mesh (e.g. with cilium/calico)

Installation of sidecar in calico

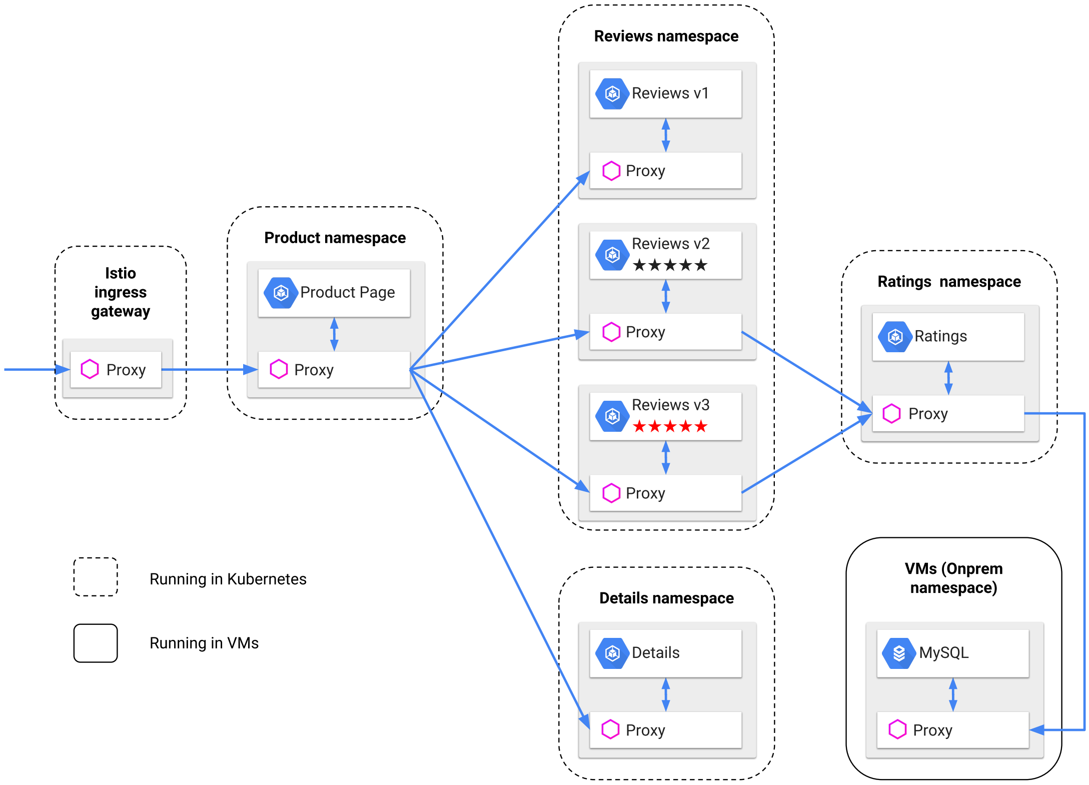
- https://projectcalico.docs.tigera.io/getting-started/kubernetes/hardway/istio-integration

Example

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: test-network-policy
  namespace: default
spec:
  podSelector:
    matchLabels:
      role: app
  policyTypes:
  - Egress
  egress:
  - to:
    - ipBlock:
        cidr: 10.10.0.0/16
    ports:
    - protocol: TCP
      port: 5432
```

Mesh / istio

Schaubild



Istio

```
## Visualization
## with kiali (included in istio)
https://istio.io/latest/docs/tasks/observability/kiali/kiali-graph.png

## Example
## https://istio.io/latest/docs/examples/bookinfo/
```

```
The sidecars are injected in all pods within the namespace by labeling the namespace like so:
kubectl label namespace default istio-injection=enabled

## Gateway (like Ingress in vanilla Kubernetes)
kubectl label namespace default istio-injection=enabled
```

istio tls

- https://istio.io/latest/docs/ops/configuration/traffic-management/tls-configuration/

istio - the next generation without sidecar

- https://istio.io/latest/blog/2022/introducing-ambient-mesh/

Kubernetes Probes (Liveness and Readiness)

Übung Liveness-Probe

Übung 1: Liveness (command)

```
What does it do ?

* At the beginning pod is ready (first 30 seconds)
* Check will be done after 5 seconds of pod being startet
* Check will be done periodically every 5 minutes and will check
  * for /tmp/healthy
  * if file is there will return: 0
  * if file is not there will return: 1
* After 30 seconds container will be killed
* After 35 seconds container will be restarted
```

```
## cd
## mkdir -p manifests/probes
## cd manifests/probes
## vi 01-pod-liveness-command.yml

apiVersion: v1
kind: Pod
metadata:
  labels:
    test: liveness
  name: liveness-exec
spec:
  containers:
  - name: liveness
    image: busybox
    args:
    - /bin/sh
    - -c
    - touch /tmp/healthy; sleep 30; rm -f /tmp/healthy; sleep 600
    livenessProbe:
      exec:
        command:
        - cat
        - /tmp/healthy
      initialDelaySeconds: 5
      periodSeconds: 5
```

```
## apply and test
kubectl apply -f 01-pod-liveness-command.yml
kubectl describe -l test=liveness pods
sleep 30
kubectl describe -l test=liveness pods
sleep 5
kubectl describe -l test=liveness pods
```

```
## cleanup
kubectl delete -f 01-pod-liveness-command.yml

```

Übung 2: Liveness Probe (HTTP)

```
## Step 0: Understanding Prerequisite:
This is how this image works:
## after 10 seconds it returns code 500
http.HandleFunc("/healthz", func(w http.ResponseWriter, r *http.Request) {
    duration := time.Now().Sub(started)
    if duration.Seconds() > 10 {
        w.WriteHeader(500)
        w.Write([]byte(fmt.Sprintf("error: %v", duration.Seconds())))
    } else {
        w.WriteHeader(200)
        w.Write([]byte("ok"))
    }
})
```

```
## Step 1: Pod  - manifest
## vi 02-pod-liveness-http.yml
## status-code >=200 and < 400 o.k.
## else failure
apiVersion: v1
kind: Pod
metadata:
  labels:
    test: liveness
  name: liveness-http
spec:
  containers:
  - name: liveness
    image: k8s.gcr.io/liveness
    args:
    - /server
    livenessProbe:
      httpGet:
        path: /healthz
        port: 8080
        httpHeaders:
        - name: Custom-Header
          value: Awesome
      initialDelaySeconds: 3
      periodSeconds: 3
```

```
## Step 2: apply and test
kubectl apply -f 02-pod-liveness-http.yml
## after 10 seconds port should have been started
sleep 10
kubectl describe pod liveness-http
```

Reference:

- https://kubernetes.io/docs/tasks/configure-pod-container/configure-liveness-readiness-startup-probes/

Übung Liveness http aus nginx

Funktionsweise Readiness-Probe vs. Liveness-Probe

Why / Howto /

- Readiness checks, if container is ready and if it's not READY
  - SENDS NO TRAFFIC to the container

Difference to LiveNess

- They are configured exactly the same, but use another keyword
  - readinessProbe instead of livenessProbe

Example

```
readinessProbe:
  exec:
    command:
    - cat
    - /tmp/healthy
  initialDelaySeconds: 5
  periodSeconds: 5
```

Reference

- https://kubernetes.io/docs/tasks/configure-pod-container/configure-liveness-readiness-startup-probes/#define-readiness-probes

Manueller Check readyz endpoint kubernetes api server aus pod

Walkthrough

```
kubectl run -it --rm podtester --image=busybox
## im pod
## um zu sehen mit welchem Port wir uns verbinden können
env | grep -i kubernetes
```

```
## kubernetes liegt als service vor
wget -O - https://kubernetes:443/readyz?verbose
```

Reference:

- https://kubernetes.io/docs/reference/using-api/health-checks/

Kubernetes QoS / Limits / Requests

Quality of Service - evict pods

Die Class wird auf Basis der Limits und Requests der Container vergeben

Request

```
Request: Definiert wieviel ein Container mindestens braucht (CPU,memory)
```

Limit

```
Limit: Definiert, was ein Container maximal braucht.
```

Wo ?

```
in spec.containers.resources
kubectl explain pod.spec.containers.resources
```

Art der Typen:

- Guaranteed
- Burstable
- BestEffort

Guaranteed

```
Type: Guaranteed:
https://kubernetes.io/docs/tasks/configure-pod-container/quality-service-pod/#create-a-pod-that-gets-assigned-a-qos-class-of-
guaranteed

set when limit equals request
(request: das braucht er,
limit: das braucht er maximal)

Garantied ist die höchste Stufe und diese werden bei fehlenden Ressourcen
als letztes "evicted"

apiVersion: v1

kind: Pod
metadata:
  name: qos-demo
  namespace: qos-example
spec:
  containers:
  - name: qos-demo-ctr
    image: nginx
    resources:
      limits:
        memory: "200Mi"
        cpu: "700m"

      requests:
        memory: "200Mi"
        cpu: "700m"
```

Referenz

- https://home.robusta.dev/blog/kubernetes-memory-limit

Tools to identify LimitRange and Requests

VPA (Vertical Pod Autoscaler) / goldilocks

```
## Please only repo updateMode: "off" will do this
## Do not use automatic adjustment
Example VPA configuration
apiVersion: autoscaling.k8s.io/v1
kind: VerticalPodAutoscaler
metadata:
  name: my-app-vpa
```

```
spec:
  targetRef:
    apiVersion: "apps/v1"
    kind:       Deployment
    name:       my-app
  updatePolicy:
    updateMode: "off"
```

- goldilocks will now make visible instead of kubectl describe vpa
- https://github.com/FairwindsOps/goldilocks
- als Basis: https://github.com/kubernetes/autoscaler/
- https://www.fairwinds.com/goldilocks

Kubernetes Autoscaling

Autoscaling Pods/Deployments

Example: newest version with autoscaling/v2 used to be hpa/v1

Prerequisites

- Metrics-Server needs to be running

```
## Test with
kubectl top pods
```

```
## Install
kubectl apply -f https://github.com/kubernetes-sigs/metrics-server/releases/latest/download/components.yaml
## after that at will be available in kube-system namespace as pod
kubectl -n kube-system get pods | grep -i metrics
```

Step 1: deploy app

```
cd
mkdir -p manifests
cd manifests
mkdir hpa
cd hpa
vi 01-deploy.yaml
```

```
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: hello
spec:
  replicas: 3
  selector:
    matchLabels:
      app: hello
  template:
    metadata:
      labels:
        app: hello
    spec:
      containers:
      - name: hello
        image: k8s.gcr.io/hpa-example
        resources:
          requests:
            cpu: 100m
---
kind: Service
apiVersion: v1
metadata:
  name: hello
spec:
  selector:
    app: hello
  ports:
    - port: 80
      targetPort: 80
---
apiVersion: autoscaling/v2
kind: HorizontalPodAutoscaler
metadata:
  name: hello
spec:
  scaleTargetRef:
    apiVersion: apps/v1
    kind: Deployment
    name: hello
  minReplicas: 2
  maxReplicas: 20
  metrics:
  - type: Resource
    resource:
      name: cpu
      target:
        type: Utilization
        averageUtilization: 80
```

Step 2: Load Generator

```
vi 02-loadgenerator.yml
```

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: load-generator
  labels:
    app: load-generator
spec:
  replicas: 100
  selector:
    matchLabels:
      app: load-generator
  template:
    metadata:
      name: load-generator
      labels:
        app: load-generator
    spec:
      containers:
      - name: load-generator
        image: busybox
        command:
        - /bin/sh
        - -c
        - "while true; do wget -q -O- http://hello.default.svc.cluster.local; done"
```

Downscaling

- Downscalinng will happen after 5 minutes o

```
## Adjust down to 1 minute
behavior:
  scaleDown:
    stabilizationWindowSeconds: 60
```

```
For scaling down the stabilization window is 300 seconds (or the value of the --horizontal-pod-autoscaler-downscale-stabilization
flag if provided)
```

Reference

- https://docs.digitalocean.com/tutorials/cluster-autoscaling-ca-hpa/
- https://kubernetes.io/docs/tasks/run-application/horizontal-pod-autoscale-walkthrough/#autoscaling-on-more-specific-metrics
- https://medium.com/expedia-group-tech/autoscaling-in-kubernetes-why-doesnt-the-horizontal-pod-autoscaler-work-for-me-5f0094694054

Kubernetes Deployment Scenarios

Deployment green/blue,canary,rolling update

Canary Deployment

```
A small group of the user base will see the new application
(e.g. 1000 out of 100.000), all the others will still see the old version

From: a canary was used to test if the air was good in the mine
(like a test balloon)
```

Blue / Green Deployment

```
The current version is the Blue one
The new version is the Green one
```

```
New Version (GREEN) will be tested and if it works
the traffic will be switch completey to the new version (GREEN)

Old version can either be deleted or will function as fallback
```

A/B Deployment/Testing

```
2 Different versions are online, e.g. to test a new design / new feature
You can configure the weight (how much traffic to one or the other)
by the number of pods
```

Example Calculation

```
e.g. Deployment1: 10 pods
Deployment2: 5 pods

Both have a common label,
The service will access them through this label
```

Service Blue/Green

Step 1: Deployment + Service

```
## vi blue.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-version-blue
spec:
  selector:
    matchLabels:
      version: blue
  replicas: 10 # tells deployment to run 2 pods matching the template
  template:
    metadata:
      labels:
        app: nginx
        version: blue
    spec:
      containers:
      - name: nginx
        image: nginx:1.21
        ports:
        - containerPort: 80
```

```
## vi green.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-version-green
spec:
  selector:
    matchLabels:
      version: green
  replicas: 1 # tells deployment to run 2 pods matching the template
  template:
    metadata:
      labels:
        app: nginx
        version: green
    spec:
      containers:
      - name: nginx
        image: nginx:1.22
        ports:
        - containerPort: 80
```

```
## svc.yml
apiVersion: v1
kind: Service
metadata:
  name: svc-nginx
spec:
  ports:
  - port: 80
```

```
    protocol: TCP
  selector:
    app: nginx
```

Step 2: Ingress

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: ingress-config
  annotations:
    ingress.kubernetes.io/rewrite-target: /
    # with the ingress controller from helm, you need to set an annotation
    # old version useClassName instead
    # otherwice it does not know, which controller to use
    # kubernetes.io/ingress.class: nginx
spec:
  ingressClassName: nginx
  rules:
  - host: "app.lab1.t3isp.de"
    http:
      paths:
        - path: /
          pathType: Prefix
          backend:
            service:
              name: svc-nginx
              port:
                number: 80
```

```
kubectl apply -f .
```

Praxis-Übung A/B Deployment

Walkthrough

```
cd
cd manifests
mkdir ab
cd ab
```

```
## vi 01-cm-version1.yml
apiVersion: v1
kind: ConfigMap
metadata:
  name: nginx-version-1
data:
  index.html: |
    <html>
    <h1>Welcome to Version 1</h1>
    </br>
    <h1>Hi! This is a configmap Index file Version 1 </h1>
    </html>
```

```
## vi 02-deployment-v1.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deploy-v1
spec:
  selector:
    matchLabels:
      version: v1
  replicas: 2
  template:
    metadata:
      labels:
        app: nginx
        version: v1
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
        volumeMounts:
            - name: nginx-index-file
              mountPath: /usr/share/nginx/html/
      volumes:
      - name: nginx-index-file
        configMap:
          name: nginx-version-1
```

```
## vi 03-cm-version2.yml
apiVersion: v1
kind: ConfigMap
metadata:
  name: nginx-version-2
data:
  index.html: |
    <html>
    <h1>Welcome to Version 2</h1>
    </br>
    <h1>Hi! This is a configmap Index file Version 2 </h1>
    </html>
```

```
## vi 04-deployment-v2.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deploy-v2
spec:
  selector:
    matchLabels:
      version: v2
  replicas: 2
  template:
    metadata:
      labels:
        app: nginx
        version: v2
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
        volumeMounts:
            - name: nginx-index-file
              mountPath: /usr/share/nginx/html/
      volumes:
      - name: nginx-index-file
        configMap:
          name: nginx-version-2
```

```
## vi 05-svc.yml
apiVersion: v1
kind: Service
metadata:
  name: my-nginx
  labels:
    svc: nginx
spec:
  type: NodePort
  ports:
  - port: 80
    protocol: TCP
  selector:
    app: nginx
```

```
kubectl apply -f .
## get external ip
kubectl get nodes -o wide
## get port
kubectl get svc my-nginx -o wide
## test it with curl apply it multiple time (at least ten times)
curl <external-ip>:<node-port>
```

Kubernetes - Misc

Wann wird podIP vergeben ?

Example (that does work)

```
## Show the pods that are running
kubectl get pods

## Synopsis (most simplistic example
## kubectl run NAME --image=IMAGE_EG_FROM_DOCKER
## example
kubectl run nginx --image=nginx

kubectl get pods
## on which node does it run ?
kubectl get pods -o wide
```

Example (that does not work)

```
kubectl run foo2 --image=foo2
## ImageErrPull - Image konnte nicht geladen werden
kubectl get pods
## Weitere status - info
kubectl describe pods foo2
```

Ref:

- https://kubernetes.io/docs/reference/generated/kubectl/kubectl-commands#run

Bash completion installieren

Walkthrough

```
## Eventuell, wenn bash-completion nicht installiert ist.
apt install bash-completion
source /usr/share/bash-completion/bash_completion
## is it installed properly
type _init_completion
```

```
## activate for all users
kubectl completion bash | sudo tee /etc/bash_completion.d/kubectl > /dev/null

## verifizieren - neue login shell
su -

## zum Testen
kubectl g<TAB>
kubectl get
```

Alternative für k als alias für kubectl

```
source <(kubectl completion bash)
complete -F __start_kubectl k
```

Reference

- https://kubernetes.io/docs/tasks/tools/included/optional-kubectl-configs-bash-linux/

Remote-Verbindung zu Kubernetes (microk8s) einrichten

```
## on CLIENT install kubectl
sudo snap install kubectl --classic

## On MASTER -server get config
## als root
cd
microk8s config > /home/kurs/remote_config

## Download (scp config file) and store in .kube - folder
cd ~
mkdir .kube
cd .kube  # Wichtig: config muss nachher im verzeichnis .kube liegen
## scp kurs@master_server:/path/to/remote_config config
## z.B.
scp kurs@192.168.56.102:/home/kurs/remote_config config
## oder benutzer 11trainingdo
scp 11trainingdo@192.168.56.102:/home/11trainingdo/remote_config config

##### Evtl. IP-Adresse in config zum Server aendern
```

```
## Ultimative 1. Test auf CLIENT
kubectl cluster-info

## or if using kubectl or alias
kubectl get pods

## if you want to use a different kube config file, you can do like so
kubectl --kubeconfig /home/myuser/.kube/myconfig
```

vim support for yaml

Ubuntu (im Unterverzeichnis /etc/vim/vimrc.local - systemweit)

```
hi CursorColumn cterm=NONE ctermbg=lightred ctermfg=white
autocmd FileType y?ml setlocal ts=2 sts=2 sw=2 ai number expandtab cursorline cursorcolumn
```

Testen

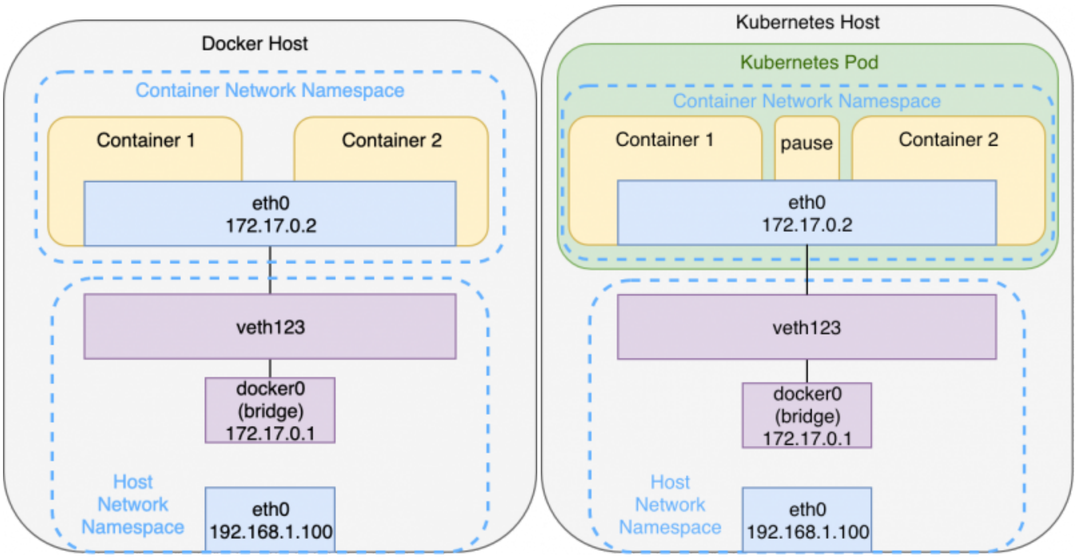
```
vim test.yml
Eigenschaft: <return> # springt eingerückt in die nächste Zeile um 2 spaces eingerückt

## evtl funktioniert vi test.yml auf manchen Systemen nicht, weil kein vim (vi improved)
```

Kubernetes - Netzwerk (CNI's) / Mesh

Netzwerk Interna

Network Namespace for each pod

Overview



General

- Each pod will have its own network namespace
  - with routing, networkdevices
- Connection to default namespace to host is done through veth - Link to bridge on host network
  - similar like on docker to docker0

```
 Each container is connected to the bridge via a veth-pair. This interface pair functions like a virtual point-to-point ethernet
connection and connects the network namespaces of the containers with the network namespace of the host
```

- Every container is in the same Network Namespace, so they can communicate through localhost
  - Example with hashicorp/http-echo container 1 and busybox container 2 ?

Pod-To-Pod Communication (across nodes)

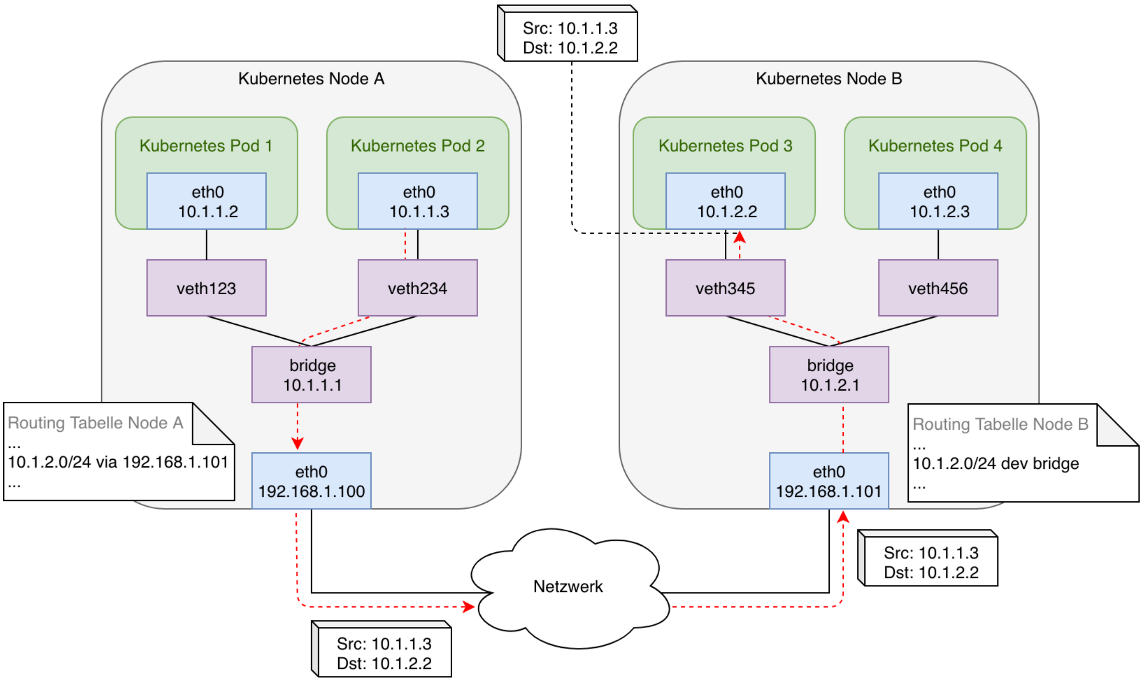
Prerequisites

- pods on a single node as well as pods on a topological remote can establish communication at all times
- Each pod receives a unique IP address, valid anywhere in the cluster. Kubernetes requires this address to not be subject to network address translation (NAT)
- Pods on the same node through virtual bridge (see image above)

General (what needs to be done) - and could be doen manually

- local bridge networks of all nodes need to be connected
- there needs to be an IPAM (IP-Address Managemenet) so addresses are only used once
- The need to be routes so, that each bridge can communicate with the bridge on the other network
- Plus: There needs to be a rule for incoming network
- Also: A tunnel needs to be set up to the outside world.

General - Pod-to-Pod Communiation (across nodes) - what would need to be done



General - Pod-to-Pod Communication (side-note)

- This could of cause be done manually, but it is too complex
- So Kubernetes has created an Interface, which is well defined
  - The interface is called CNI (common network interface)
  - Funtionally is achieved through Network Plugin (which use this interface)
    - e.g. calico / cilium / weave net / flannel

CNI

- CNI only handles network connectivity of container and the cleanup of allocated resources (i.e. IP addresses) after containers have been deleted (garbage collection) and therefore is lightweight and quite easy to implement.
- There are some basic libraries within CNI which do some basic stuff.

Hidden Pause Container

What is for ?

- Holds the network - namespace for the pod
- Gets started first and falls asleep later
- Will still be there, when the other containers die

```
cd
mkdir -p manifests
cd manifests
mkdir pausetest
cd pausetest
nano 01-nginx.yml
```

```
## vi nginx-static.yml

apiVersion: v1
kind: Pod
metadata:
  name: nginx-pausetest
  labels:
    webserver: nginx:1.21
spec:
  containers:
```

```
  - name: web
    image: nginx
```

```
kubectl apply -f .

ctr -n k8s.io c list | grep pause
```

References

- https://www.inovex.de/de/blog/kubernetes-networking-part-1-en/
- https://www.inovex.de/de/blog/kubernetes-networking-2-calico-cilium-weavenet/

Übersicht Netzwerke

CNI

- Common Network Interface
- Feste Definition, wie Container mit Netzwerk-Bibliotheken kommunizieren

Docker - Container oder andere

- Container wird hochgefahren -> über CNI -> zieht Netzwerk - IP hoch.
- Container witd runtergahren -> uber CNI -> Netzwerk - IP wird released

Welche gibt es ?

- Flanel
- Canal
- Calico
- Cilium
- Weave Net

Flannel

Overlay - Netzwerk

- virtuelles Netzwerk was sich oben drüber und eigentlich auf Netzwerkebene nicht existiert
- VXLAN

Vorteile

- Guter einfacher Einstieg
- redziert auf eine Binary flanneld

Nachteile

- keine Firewall - Policies möglich
- keine klassichen Netzwerk-Tools zum Debuggen möglich.

Canal

General

- Auch ein Overlay - Netzwerk
- Unterstüzt auch policies

Calico

Generell

- klassische Netzwerk (BGP)

Vorteile gegenüber Flannel

- Policy über Kubernetes Object (NetworkPolicies)

Vorteile

- ISTIO integrierbar (Mesh - Netz)
- Performance etwas besser als Flannel (weil keine Encapsulation)

Referenz

- https://projectcalico.docs.tigera.io/security/calico-network-policy

Cilium

Weave Net

- Ähnlich calico
- Verwendet overlay netzwerk
- Sehr stabil bzgl IPV4/IPV6 (Dual Stack)
- Sehr grosses Feature-Set
- mit das älteste Plugin

microk8s Vergleich

- https://microk8s.io/compare

```
snap.microk8s.daemon-flanneld
Flannel is a CNI which gives a subnet to each host for use with container runtimes.
```

```
Flanneld runs if ha-cluster is not enabled. If ha-cluster is enabled, calico is run instead.

The flannel daemon is started using the arguments in ${SNAP_DATA}/args/flanneld. For more information on the configuration, see
the flannel documentation.
```

IPV4/IPV6 Dualstack

- https://kubernetes.io/docs/concepts/services-networking/dual-stack/

Ingress controller in microk8s aktivieren

Aktivieren

```
microk8s enable ingress
```

Referenz

- https://microk8s.io/docs/addon-ingress

Kubernetes - Ingress

ingress mit ssl absichern

Kubernetes - Wartung / Debugging

kubectl drain/uncordon

```
## Achtung, bitte keine pods verwenden, dies können "ge"-drained (ausgetrocknet) werden
kubectl drain <node-name>
z.B.
## Daemonsets ignorieren, da diese nicht gelöscht werden
kubectl drain n17 --ignore-daemonsets

## Alle pods von replicasets werden jetzt auf andere nodes verschoben
## Ich kann jetzt wartungsarbeiten durchführen

## Wenn fertig bin:
kubectl uncordon n17

## Achtung: deployments werden nicht neu ausgerollt, dass muss ich anstossen.
## z.B.
kubectl rollout restart deploy/webserver
```

Alte manifeste konvertieren mit convert plugin

What is about?

- Plugins needs to be installed seperately on Client (or where you have your manifests)

Walkthrough

```
curl -LO "https://dl.k8s.io/release/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl-convert"
## Validate the checksum
curl -LO "https://dl.k8s.io/$(curl -L -s https://dl.k8s.io/release/stable.txt)/bin/linux/amd64/kubectl-convert.sha256"
echo "$(<kubectl-convert.sha256) kubectl-convert" | sha256sum --check
## install
sudo install -o root -g root -m 0755 kubectl-convert /usr/local/bin/kubectl-convert

## Does it work
kubectl convert --help

## Works like so
## Convert to the newest version
## kubectl convert -f pod.yaml
```

Reference

- https://kubernetes.io/docs/tasks/tools/install-kubectl-linux/#install-kubectl-convert-plugin

Curl from pod api-server

https://nieldw.medium.com/curling-the-kubernetes-api-server-d7675cfc398c

Kubernetes Praxis API-Objekte

kubectl example with run

Example (that does work)

```
## Show the pods that are running
kubectl get pods

## Synopsis (most simplistic example
## kubectl run NAME --image=IMAGE_EG_FROM_DOCKER
## example
kubectl run nginx --image=nginx

kubectl get pods
## on which node does it run ?
kubectl get pods -o wide
```

Example (that does not work)

```
kubectl run foo2 --image=foo2
## ImageErrPull - Image konnte nicht geladen werden
kubectl get pods
## Weitere status - info
kubectl describe pods foo2
```

Ref:

- https://kubernetes.io/docs/reference/generated/kubectl/kubectl-commands#run

Ingress Controller auf Digitalocean (doks) mit helm installieren

Basics

- Das Verfahren funktioniert auch so auf anderen Plattformen, wenn helm verwendet wird und noch kein IngressController vorhanden
- Ist kein IngressController vorhanden, werden die Ingress-Objekte zwar angelegt, es funktioniert aber nicht.

Prerequisites

- kubectl muss eingerichtet sein

Walkthrough (Setup Ingress Controller)

```
helm repo add ingress-nginx https://kubernetes.github.io/ingress-nginx
helm repo update
helm show values ingress-nginx/ingress-nginx

## It will be setup with type loadbalancer - so waiting to retrieve an ip from the external loadbalancer
## This will take a little.
helm install nginx-ingress ingress-nginx/ingress-nginx --namespace ingress --create-namespace --set
controller.publishService.enabled=true

## See when the external ip comes available
kubectl -n ingress get all
kubectl --namespace ingress get services -o wide -w nginx-ingress-ingress-nginx-controller

## Output
NAME                                     TYPE           CLUSTER-IP     EXTERNAL-IP      PORT(S)                      AGE
SELECTOR
nginx-ingress-ingress-nginx-controller   LoadBalancer   10.245.78.34   157.245.20.222   80:31588/TCP,443:30704/TCP   4m39s
app.kubernetes.io/component=controller,app.kubernetes.io/instance=nginx-ingress,app.kubernetes.io/name=ingress-nginx

## Now setup wildcard - domain for training purpose
## inwx.com
*.lab1.t3isp.de A 157.245.20.222
```

Documentation for default ingress nginx

- https://kubernetes.github.io/ingress-nginx/user-guide/nginx-configuration/configmap/

Beispiel Ingress

Prerequisits

```
## Ingress Controller muss aktiviert sein
microk8s enable ingress
```

Walkthrough

Schritt 1:

```
cd
mkdir -p manifests
cd manifests
```

```
mkdir abi
cd abi
```

```
## apple.yml
## vi apple.yml
kind: Pod
apiVersion: v1
metadata:
  name: apple-app
  labels:
    app: apple
spec:
  containers:
    - name: apple-app
      image: hashicorp/http-echo
      args:
        - "-text=apple"
---

kind: Service
apiVersion: v1
metadata:
  name: apple-service
spec:
  selector:
    app: apple
  ports:
    - protocol: TCP
      port: 80
      targetPort: 5678 # Default port for image
```

```
kubectl apply -f apple.yml
```

```
## banana
## vi banana.yml
kind: Pod
apiVersion: v1
metadata:
  name: banana-app
  labels:
    app: banana
spec:
  containers:
    - name: banana-app
      image: hashicorp/http-echo
      args:
        - "-text=banana"

---

kind: Service
apiVersion: v1
metadata:
  name: banana-service
spec:
  selector:
    app: banana
  ports:
    - port: 80
      targetPort: 5678 # Default port for image
```

```
kubectl apply -f banana.yml
```

Schritt 2:

```
## Ingress
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: example-ingress
  annotations:
    ingress.kubernetes.io/rewrite-target: /
spec:
  ingressClassName: nginx
  rules:
  - http:
      paths:
        - path: /apple
          backend:
            serviceName: apple-service
            servicePort: 80
        - path: /banana
          backend:
            serviceName: banana-service
            servicePort: 80
```

```
## ingress
kubectl apply -f ingress.yml
kubectl get ing
```

Reference

- https://matthewpalmer.net/kubernetes-app-developer/articles/kubernetes-ingress-guide-nginx-example.html

Find the problem

```
## Hints

## 1. Which resources does our version of kubectl support
## Can we find Ingress as "Kind" here.
kubectl api-ressources

## 2. Let's see, how the configuration works
kubectl explain --api-version=networking.k8s.io/v1 ingress.spec.rules.http.paths.backend.service

## now we can adjust our config
```

Solution

```
## in kubernetes 1.22.2 - ingress.yml needs to be modified like so.
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: example-ingress
  annotations:
    ingress.kubernetes.io/rewrite-target: /
spec:
  ingressClassName: nginx
  rules:
  - http:
      paths:
        - path: /apple
          pathType: Prefix
          backend:
            service:
              name: apple-service
              port:
                number: 80
        - path: /banana
          pathType: Prefix
          backend:
            service:
              name: banana-service
              port:
                number: 80
```

Install Ingress On Digitalocean DOKS

Achtung: Ingress mit Helm - annotations

Permanente Weiterleitung mit Ingress

Example

```
## redirect.yml
apiVersion: v1
kind: Namespace
metadata:
  name: my-namespace

---

apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  annotations:
    nginx.ingress.kubernetes.io/permanent-redirect: https://www.google.de
    nginx.ingress.kubernetes.io/permanent-redirect-code: "308"
  creationTimestamp: null
  name: destination-home
  namespace: my-namespace
spec:
  rules:
  - host: web.training.local
    http:
      paths:
      - backend:
          service:
            name: http-svc
            port:
              number: 80
        path: /source
        pathType: ImplementationSpecific
```

```
Achtung: host-eintrag auf Rechner machen, von dem aus man zugreift

/etc/hosts
45.23.12.12 web.training.local
```

```
curl -I  http://web.training.local/source
HTTP/1.1 308
Permanent Redirect
```

Umbauen zu google ;o)

```
This annotation allows to return a permanent redirect instead of sending data to the upstream. For example
nginx.ingress.kubernetes.io/permanent-redirect: https://www.google.com would redirect everything to Google.
```

Refs:

- https://github.com/kubernetes/ingress-nginx/blob/main/docs/user-guide/nginx-configuration/annotations.md#permanent-redirect
-

ConfigMap Example

Schritt 1: configmap vorbereiten

```
cd
mkdir -p manifests
cd manifests
mkdir configmaptests
cd configmaptests
nano 01-configmap.yml
```

```
### 01-configmap.yml
kind: ConfigMap
apiVersion: v1
metadata:
  name: example-configmap
data:
  # als Wertepaare
  database: mongodb
  database_uri: mongodb://localhost:27017
```

```
kubectl apply -f 01-configmap.yml
kubectl get cm
kubectl get cm -o yaml
```

Schrit 2: Beispiel als Datei

```
nano 02-pod.yml
```

```
kind: Pod
apiVersion: v1
metadata:
  name: pod-mit-configmap

spec:
  # Add the ConfigMap as a volume to the Pod
  volumes:
    # `name` here must match the name
    # specified in the volume mount
    - name: example-configmap-volume
      # Populate the volume with config map data
      configMap:
        # `name` here must match the name
        # specified in the ConfigMap's YAML
        name: example-configmap

  containers:
    - name: container-configmap
      image: nginx:latest
      # Mount the volume that contains the configuration data
      # into your container filesystem
      volumeMounts:
        # `name` here must match the name
        # from the volumes section of this pod
        - name: example-configmap-volume
          mountPath: /etc/config
```

```
kubectl apply -f 02-pod.yml
```

```
##Jetzt schauen wir uns den Container/Pod mal an
kubectl exec pod-mit-configmap -- ls -la /etc/config
kubectl exec -it pod-mit-configmap --  bash
## ls -la /etc/config
```

Schritt 3: Beispiel. ConfigMap als env-variablen

```
nano 03-pod-mit-env.yml
```

```
## 03-pod-mit-env.yml
kind: Pod
apiVersion: v1
metadata:
  name: pod-env-var
spec:
  containers:
    - name: env-var-configmap
      image: nginx:latest
      envFrom:
        - configMapRef:
            name: example-configmap
```

```
kubectl apply -f 03-pod-mit-env.yml
```

```
## und wir schauen uns das an
##Jetzt schauen wir uns den Container/Pod mal an
kubectl exec pod-env-var -- env
kubectl exec -it pod-env-var --  bash
## env
```

Reference:

- https://matthewpalmer.net/kubernetes-app-developer/articles/ultimate-configmap-guide-kubernetes.html

Configmap MariaDB my.cnf

configmap zu fuss

```
vi mariadb-config2.yml
```

```
kind: ConfigMap
apiVersion: v1
metadata:
  name: example-configmap
data:
  # als Wertepaare
  database: mongodb
  my.cnf: |
 [mysqld]
 slow_query_log = 1
 innodb_buffer_pool_size = 1G
```

```
kubectl apply -f .
```

```
##deploy.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: mariadb-deployment
spec:
  selector:
    matchLabels:
      app: mariadb
  replicas: 1
  template:
    metadata:
      labels:
        app: mariadb
    spec:
      containers:
      - name: mariadb-cont
        image: mariadb:latest
        envFrom:
        - configMapRef:
            name: mariadb-configmap

        volumeMounts:
          - name: example-configmap-volume
            mountPath: /etc/my

      volumes:
      - name: example-configmap-volume
        configMap:
          name: example-configmap
```

```
kubectl apply -f .
```

Helm (Kubernetes Paketmanager)

Helm Grundlagen

Wo ?

```
artifacts helm
```

- https://artifacthub.io/

Komponenten

```
Chart - beeinhaltet Beschreibung und Komponenten
tar.gz - Format
oder Verzeichnis

Wenn wir ein Chart ausführen wird eine Release erstellen
(parallel: image -> container, analog: chart -> release)
```

Installation

```
## Beispiel ubuntu
## snap install --classic helm

## Cluster muss vorhanden, aber nicht notwendig wo helm installiert

## Voraussetzung auf dem Client-Rechner (helm ist nichts als anderes als ein Client-Programm)
Ein lauffähiges kubectl auf dem lokalen System (welches sich mit dem Cluster verbinden kann).
-> saubere -> .kube/config

## Test
kubectl cluster-info
```

Helm Warum ?

```
Ein Paket für alle Komponenten
Einfaches Installieren, Updaten und deinstallieren
Feststehende Struktur
```

Helm Example

Prerequisites

- kubectl needs to be installed and configured to access cluster
- Good: helm works as unprivileged user as well - Good for our setup
- install helm on ubuntu (client) as root: snap install --classic helm
  - this installs helm3
- Please only use: helm3. No server-side components needed (in cluster)
  - Get away from examples using helm2 (hint: helm init) - uses tiller

Simple Walkthrough (Example 0)

```
## Repo hinzufpgen
helm repo add bitnami https://charts.bitnami.com/bitnami
## gecachte Informationen aktualieren
helm repo update

helm search repo bitnami
## helm install release-name bitnami/mysql
helm install my-mysql bitnami/mysql
## Chart runterziehen ohne installieren
## helm pull bitnami/mysql

## Release anzeigen zu lassen
helm list

## Status einer Release / Achtung, heisst nicht unbedingt nicht, dass pod läuft
helm status my-mysql

## weitere release installieren
## helm install neuer-release-name  bitnami/mysql
```

Under the hood

```
## Helm speichert Informationen über die Releases in den Secrets
kubectl get secrets | grep helm
```

Example 1: - To get know the structure

```
helm repo add bitnami https://charts.bitnami.com/bitnami
helm search repo bitnami
helm repo update
helm pull bitnami/mysql
tar xzvf mysql-9.0.0.tgz
```

Example 2: We will setup mysql without persistent storage (not helpful in production ;o()

```
helm repo add bitnami https://charts.bitnami.com/bitnami
helm search repo bitnami
helm repo update

helm install my-mysql bitnami/mysql
```

Example 2 - continue - fehlerbehebung

```
helm uninstall my-mysql
## Install with persistentStorage disabled - Setting a specific value
helm install my-mysql --set primary.persistence.enabled=false bitnami/mysql

## just as notice
## helm uninstall my-mysql
```

Example 2b: using a values file

```
## mkdir helm-mysql
## cd helm-mysql
## vi values.yml
primary:
  persistence:
    enabled: false
```

```
helm uninstall my-mysql
helm install my-mysql bitnami/mysql -f values.yml
```

Example 3: Install wordpress

```
helm repo add bitnami https://charts.bitnami.com/bitnami
helm install my-wordpress \
  --set wordpressUsername=admin \
  --set wordpressPassword=password \
  --set mariadb.auth.rootPassword=secretpassword \
    bitnami/wordpress
```

Example 4: Install Wordpress with values and auth

```

## mkdir helm-mysql
## cd helm-mysql
## vi values.yml
persistence:
  enabled: false



wordpressUsername: admin
wordpressPassword: password
mariadb:
  primary:
    persistence:
      enabled: false

  auth:
    rootPassword: secretpassword

```

```
helm uninstall my-wordpress
helm install my-wordpress bitnami/wordpress -f values
```

Referenced

- https://github.com/bitnami/charts/tree/master/bitnami/mysql/#installing-the-chart
- https://helm.sh/docs/intro/quickstart/

Kubernetes - RBAC

Nutzer einrichten microk8s ab kubernetes 1.25

Enable RBAC in microk8s

```
## This is important, if not enable every user on the system is allowed to do everything
microk8s enable rbac
```

Schritt 1: Nutzer-Account auf Server anlegen und secret anlegen / in Client

```
cd
mkdir -p manifests/rbac
cd manifests/rbac
```

Mini-Schritt 1: Definition für Nutzer

```
## vi service-account.yml
apiVersion: v1
kind: ServiceAccount
metadata:
  name: training
  namespace: default
```

```
kubectl apply -f service-account.yml
```

Mini-Schritt 1.5: Secret erstellen

- From Kubernetes 1.25 tokens are not created automatically when creating a service account (sa)
- You have to create them manually with annotation attached
- https://kubernetes.io/docs/reference/access-authn-authz/service-accounts-admin/#create-token

```
## vi secret.yml
apiVersion: v1
kind: Secret
type: kubernetes.io/service-account-token
metadata:
  name: trainingtoken
  annotations:
    kubernetes.io/service-account.name: training
```

```
kubectl apply -f .
```

Mini-Schritt 2: ClusterRole festlegen - Dies gilt für alle namespaces, muss aber noch zugewiesen werden

```
### Bevor sie zugewiesen ist, funktioniert sie nicht - da sie keinem Nutzer zugewiesen ist

## vi pods-clusterrole.yml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: pods-clusterrole
rules:
- apiGroups: [""] # "" indicates the core API group
  resources: ["pods"]
  verbs: ["get", "watch", "list", "create"]
```

```
kubectl apply -f pods-clusterrole.yml
```

Mini-Schritt 3: Die ClusterRolle den entsprechenden Nutzern über RoleBinding zu ordnen

```
## vi rb-training-ns-default-pods.yml
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: rolebinding-ns-default-pods
  namespace: default
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: pods-clusterrole
subjects:
- kind: ServiceAccount
  name: training
  namespace: default
```

```
kubectl apply -f rb-training-ns-default-pods.yml
```

Mini-Schritt 4: Testen (klappt der Zugang)

```
kubectl auth can-i get pods -n default --as system:serviceaccount:default:training
```

Schritt 2: Context anlegen / Credentials auslesen und in kubeconfig hinterlegen (ab Kubernetes-Version 1.25.)

Mini-Schritt 1: kubeconfig setzen

```
kubectl config set-context training-ctx --cluster microk8s-cluster --user training

## extract name of the token from here

TOKEN=`kubectl get secret trainingtoken -o jsonpath='{.data.token}' | base64 --decode`
echo $TOKEN
kubectl config set-credentials training --token=$TOKEN
kubectl config use-context training-ctx

## Hier reichen die Rechte nicht aus
kubectl get deploy
## Error from server (Forbidden): pods is forbidden: User "system:serviceaccount:kube-system:training" cannot list # resource
"pods" in API group "" in the namespace "default"
```

Mini-Schritt 2:

```
kubectl config use-context training-ctx
kubectl get pods
```

Mini-Schritt 3: Zurück zum alten Default-Context

```
kubectl config get-contexts
```

```
CURRENT   NAME           CLUSTER            AUTHINFO    NAMESPACE
          microk8s       microk8s-cluster   admin2
*         training-ctx   microk8s-cluster   training2
```

```
kubectl config use-context microk8s
```

Refs:

- https://docs.oracle.com/en-us/iaas/Content/ContEng/Tasks/contengaddingserviceaccttoken.htm
- https://microk8s.io/docs/multi-user
- https://faun.pub/kubernetes-rbac-use-one-role-in-multiple-namespaces-d1d08bb08286

Ref: Create Service Account Token

- https://kubernetes.io/docs/reference/access-authn-authz/service-accounts-admin/#create-token

Tipps&Tricks zu Deploymnent - Rollout

Warum

```
Rückgängig machen von deploys, Deploys neu unstossen.
(Das sind die wichtigsten Fähigkeiten
```

Beispiele

```
## Deployment nochmal durchführen
## z.B. nach kubectl uncordon n12.training.local
kubectl rollout restart deploy nginx-deployment

## Rollout rückgängig machen
kubectl rollout undo deploy nginx-deployment
```

Kustomize

Kustomize Overlay Beispiel

Konzept Overlay

- Base + Overlay = Gepatchtes manifest
- Sachen patchen.
- Die werden drübergelegt.

Example 1: Walkthrough

```
## Step 1:
## Create the structure
## kustomize-example1
## L base
## | - kustomization.yml
## L overlays
##.    L dev
##       - kustomization.yml
##.    L prod
##.      - kustomization.yml
cd; mkdir -p manifests/kustomize-example1/base; mkdir -p manifests/kustomize-example1/overlays/prod; cd manifests/kustomize-
example1
```

```
## Step 2: base dir with files
## now create the base kustomization file
## vi base/kustomization.yml
resources:
- service.yml
```

```
## Step 3: Create the service - file
## vi base/service.yml
kind: Service
apiVersion: v1
metadata:
  name: service-app
spec:
  type: ClusterIP
  selector:
    app: simple-app
  ports:
  - name: http
    port: 80
```

```
## See how it looks like
kubectl kustomize ./base
```

```
## Step 4: create the customization file accordingly
##vi overlays/prod/kustomization.yaml
```

```
bases:
- ../../base
patches:
- service-ports.yaml
```

```
## Step 5: create overlay (patch files)
## vi overlays/prod/service-ports.yaml
kind: Service
apiVersion: v1
metadata:
  #Name der zu patchenden Ressource
  name: service-app
spec:
  # Changed to Nodeport
  type: NodePort
  ports: #Die Porteinstellungen werden überschrieben
  - name: https
    port: 443
```

```
## Step 6:
kubectl kustomize overlays/prod

## or apply it directly
kubectl apply -k overlays/prod/
```

```
## Step 7:
## mkdir -p overlays/dev
## vi overlays/dev/kustomization
bases:
- ../../base
```

```
## Step 8:
## statt mit der base zu arbeiten
kubectl kustomize overlays/dev
```

Example 2: Advanced Patching with patchesJson6902 (You need to have done example 1 firstly)

```
## Schritt 1:
## Replace overlays/prod/kustomization.yml with the following syntax
bases:
- ../../base
patchesJson6902:
- target:
    version: v1
    kind: Service
    name: service-app
  path: service-patch.yaml
```

```
## Schritt 2:
## vi overlays/prod/service-patch.yaml
- op: remove
  path: /spec/ports
  value:
  - name: http
    port: 80
- op: add
  path: /spec/ports
  value:
  - name: https
    port: 443
```

```
## Schritt 3:
kubectl kustomize overlays/prod
```

Special Use Case: Change the metadata.name

```
## Same as Example 2, but patch-file is a bit different
## vi overlays/prod/service-patch.yaml
- op: remove
  path: /spec/ports
  value:
  - name: http
    port: 80

- op: add
```

```
  path: /spec/ports
  value:
  - name: https
    port: 443

- op: replace
  path: /metadata/name
  value: svc-app-test
```

```
kubectl kustomize overlays/prod
```

Ref:

- https://blog.ordix.de/kubernetes-anwendungen-mit-kustomize

Helm mit kustomize verheiraten

Kubernetes - Tipps & Tricks

Kubernetes Debuggen ClusterIP/PodIP

Situation

- Kein Zugriff auf die Nodes, zum Testen von Verbindungen zu Pods und Services über die PodIP/ClusterIP

Lösung

```
## Wir starten eine Busybox und fragen per wget und port ab
## busytester ist der name
## long version
kubectl run -it --rm --image=busybox busytester
## wget <pod-ip-des-ziels>
## exit


## quick and dirty
kubectl run -it --rm --image=busybox busytester -- wget <pod-ip-des-ziels>
```

Debugging pods

How ?

1. Which pod is in charge
2. Problems when starting: kubectl describe po mypod
3. Problems while running: kubectl logs mypod

Taints und Tolerations

Taints

```
Taints schliessen auf einer Node alle Pods aus, die nicht bestimmte taints haben:

Möglichkeiten:

o Sie werden nicht gescheduled - NoSchedule
o Sie werden nicht executed - NoExecute
o Sie werden möglichst nicht gescheduled. - PreferNoSchedule
```

Tolerations

```
Tolerations werden auf Pod-Ebene vergeben:
tolerations:

Ein Pod kann (wenn es auf einem Node taints gibt), nur
gescheduled bzw. ausgeführt werden, wenn er die
Labels hat, die auch als
Taints auf dem Node vergeben sind.
```

Walkthrough

Step 1: Cordon the other nodes - scheduling will not be possible there

```
## Cordon nodes n11 and n111
## You will see a taint here
kubectl cordon n11
kubectl cordon n111
kubectl describe n111 | grep -i taint
```

Step 2: Set taint on first node

```
kubectl taint nodes n1 gpu=true:NoSchedule
```

Step 3

```
cd
mkdir -p manifests
cd manifests
mkdir tainttest
cd tainttest
nano 01-no-tolerations.yml
```

```
##vi 01-no-tolerations.yml
apiVersion: v1
kind: Pod
metadata:
  name: nginx-test-no-tol
  labels:
    env: test-env
spec:
  containers:
  - name: nginx
    image: nginx:1.21
```

```
kubectl apply -f .
kubectl get po nginx-test-no-tol
kubectl get describe nginx-test-no-tol
```

Step 4:

```
## vi 02-nginx-test-wrong-tol.yml
apiVersion: v1
kind: Pod
metadata:
  name: nginx-test-wrong-tol
  labels:
    env: test-env
spec:
  containers:
  - name: nginx
    image: nginx:latest
  tolerations:
  - key: "cpu"
    operator: "Equal"
    value: "true"
    effect: "NoSchedule"
```

```
kubectl apply -f .
kubectl get po nginx-test-wrong-tol
kubectl describe po nginx-test-wrong-tol
```

Step 5:

```
## vi 03-good-tolerations.yml
apiVersion: v1
kind: Pod
metadata:
  name: nginx-test-good-tol
  labels:
    env: test-env
spec:
  containers:
  - name: nginx
    image: nginx:latest
  tolerations:
  - key: "gpu"
    operator: "Equal"
    value: "true"
    effect: "NoSchedule"
```

```
kubectl apply -f .
kubectl get po nginx-test-good-tol
kubectl describe po nginx-test-good-tol
```

Taints rausnehmen

```
kubectl taint nodes n1 gpu:true:NoSchedule-
```

uncordon other nodes

```
kubectl uncordon n11
kubectl uncordon n111
```

References

- Doku Kubernetes Taints and Tolerations
- https://blog.kubecost.com/blog/kubernetes-taints/

pod aus deployment bei config - Änderung neu ausrollen

- https://github.com/stakater/Reloader

Kubernetes Advanced

Curl api-server kubernetes aus pod heraus

https://nieldw.medium.com/curling-the-kubernetes-api-server-d7675cfc398c

Kubernetes - Documentation

Documentation zu microk8s plugins/addons

- https://microk8s.io/docs/addons

Shared Volumes - Welche gibt es ?

- https://kubernetes.io/docs/concepts/storage/volumes/

Kubernetes - Hardening

Kubernetes Tipps Hardening

PSA (Pod Security Admission)

```
Policies defined by namespace.
e.g. not allowed to run container as root.

Will complain/deny when creating such a pod with that container type
```

Möglichkeiten in Pods und Containern

```
## für die Pods
kubectl explain pod.spec.securityContext
kubectl explain pod.spec.containers.securityContext
```

Example (seccomp / security context)

```
A. seccomp - profile
https://github.com/docker/docker/blob/master/profiles/seccomp/default.json
```

```
apiVersion: v1
kind: Pod
metadata:
  name: audit-pod
  labels:
    app: audit-pod
spec:
  securityContext:
    seccompProfile:
      type: Localhost
      localhostProfile: profiles/audit.json

  containers:

  - name: test-container
    image: hashicorp/http-echo:0.2.3
    args:
    - "-text=just made some syscalls!"
    securityContext:
      allowPrivilegeEscalation: false
```

SecurityContext (auf Pod Ebene)

```
kubectl explain pod.spec.containers.securityContext
```

NetworkPolicy

```
## Firewall Kubernetes
```

Kubernetes Security Admission Controller Example

Seit: 1.2.22 Pod Security Admission

- 1.2.22 - ALpha - D.h. ist noch nicht aktiviert und muss als Feature Gate aktiviert (Kind)
- 1.2.23 - Beta -> d.h. evtl. aktiviert

Vorgefertigte Regelwerke

- privileges - keinerlei Einschränkungen
- baseline - einige Einschränkungen
- restricted - sehr streng
- Reference: https://kubernetes.io/docs/concepts/security/pod-security-standards/

Praktisches Beispiel für Version ab 1.2.23 - Problemstellung

```
mkdir -p manifests
cd manifests
mkdir psa
cd psa
nano 01-ns.yml
```

```
## Schritt 1: Namespace anlegen
## vi 01-ns.yml

apiVersion: v1
kind: Namespace
metadata:
  name: test-ns1
  labels:
    # soft version - running but showing complaints
    # pod-security.kubernetes.io/enforce: baseline
    pod-security.kubernetes.io/enforce: restricted
    pod-security.kubernetes.io/audit: restricted
    pod-security.kubernetes.io/warn: restricted
```

```
kubectl apply -f 01-ns.yml
```

```
## Schritt 2: Testen mit nginx - pod
## vi 02-nginx.yml

apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: test-ns1
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
```

```
## a lot of warnings will come up
## because this image runs as root !! (by default)
kubectl apply -f 02-nginx.yml
```

```
## Schritt 3:
## Anpassen der Sicherheitseinstellung (Phase1) im Container

## vi 02-nginx.yml

apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: test-ns1
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
      securityContext:
        seccompProfile:
          type: RuntimeDefault
```

```
kubectl delete -f 02-nginx.yml
kubectl apply -f 02-nginx.yml
kubectl -n test-ns1 get pods
```

```
## Schritt 4:
## Weitere Anpassung runAsNotRoot
## vi 02-nginx.yml
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: test-ns<tln>
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
      securityContext:
        seccompProfile:
          type: RuntimeDefault
        runAsNonRoot: true
```

```
## pod kann erstellt werden, wird aber nicht gestartet
kubectl delete -f 02-nginx.yml
kubectl apply -f 02-nginx.yml
kubectl -n test-ns1 get pods
kubectl -n test-ns1 describe pods nginx
```

```
## Schritt 4:
## Anpassen der Sicherheitseinstellung (Phase1) im Container
```

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  namespace: test-ns1
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
      securityContext:
        seccompProfile:
          type: RuntimeDefault
        runAsNonRoot: true
        allowPrivilegeEscalation: false
        capabilities:
          drop: ["ALL"]
```

```
kubectl delete -f 02-nginx.yml
kubectl apply -f 02-nginx.yml
kubectl -n test-ns1 get pods
```

Praktisches Beispiel für Version ab 1.2.23 -Lösung - Container als NICHT-Root laufen lassen

- Wir müssen ein image, dass auch als NICHT-Root laufen kann
- .. oder selbst eines bauen (;o)) o bei nginx ist das bitnami/nginx

```
## vi 03-nginx-bitnami.yml
apiVersion: v1
kind: Pod
metadata:
  name: bitnami-nginx
  namespace: test-ns1
spec:
  containers:
    - image: bitnami/nginx
      name: bitnami-nginx
      ports:
        - containerPort: 80
      securityContext:
        seccompProfile:
          type: RuntimeDefault
        runAsNonRoot: true
```

```
## und er läuft als nicht root
kubectl apply -f 03_pod-bitnami.yml
kubectl -n test-ns1 get pods
```

Was muss ich bei der Netzwerk-Sicherheit beachten ?

Bereich 1: Kubernetes (Cluster)

```
1. Welche Ports sollten wirklich geöffnet sein ?

für Kubernetes

2. Wer muss den von wo den Kube-Api-Server zugreifen

- den Traffic einschränken
```

Bereich 2: Nodes

```
Alle nicht benötigten fremden Ports sollten geschlossen sein
Wenn offen, nur über vordefinierte Zugangswege (und auch nur bestimmte Nutzer)
```

Pods (Container / Image)

```
## Ingress (NetworkPolicy) - engmaschig stricken
## 1. Wer soll von wo auf welche Pod zugreifen können

## 2. Welche Pod auf welchen anderen Pod (Service)

Egress
## Welche Pods dürfen wohin nach draussen
```

Einschränking der Fähigkeien eines Pods

```
kein PrivilegeEscalation
nur notwendige Capabilities
unter einem nicht-root Benutzer laufen lassen
```

Patching

```
## pods -> neuestes images bei security vulnerablities
## nodes -> auch neues patches (apt upgrade)
## kubernetes cluster -> auf dem neuesten Stand
  # -> wie ist der Prozess ClusterUpdate, update der manifeste zu neuen API-Versionen
```

RBAC

```
## Nutzer (kubectl, systemnutzer -> pods)

## 1. Zugriff von den pods



## 2. Zugriff über helm / kubectl
## Wer darf was ? Was muss der Nutzer können
```

Compliance

```
PSP's / PSA
PodSecurityPolicy was deprecated in Kubernetes v1.21, and removed from Kubernetes in v1.25

PSA - Pode Security Admission
```

Kubernetes Interna / Misc.

OCI,Container,Images Standards

Schritt 1:

```
cd
mkdir bautest
cd bautest
```

Schritt 2:

```
## nano docker-compose.yml
version: "3.8"

services:
  myubuntu:
    build: ./myubuntu
    restart: always
```

Schritt 3:

```
mkdir myubuntu
cd myubuntu
```

```
nano hello.sh
```

```
##!/bin/bash
let i=0

while true
do
  let i=i+1
  echo $i:hello-docker
  sleep 5
done
```

```
## nano Dockerfile
FROM ubuntu:latest
RUN apt-get update; apt-get install -y inetutils-ping
COPY hello.sh .
RUN chmod u+x hello.sh
CMD ["/hello.sh"]
```

Schritt 4:

```
cd ../
## wichtig, im docker-compose - Ordner seiend
##pwd
##~/bautest
docker-compose up -d
## wird image gebaut und container gestartet

## Bei Veränderung vom Dockerfile, muss man den Parameter --build mitangeben
docker-compose up -d --build
```

Geolocation Kubernetes Cluster

- https://learnk8s.io/bite-sized/connecting-multiple-kubernetes-clusters

Kubernetes - Überblick

Installation - Welche Komponenten from scratch

Step 1: Server 1 (manuell installiert -> microk8s)

```
## Installation Ubuntu - Server

## cloud-init script
## s.u. BASIS (keine Voraussetzung - nur zum Einrichten des Nutzers 11trainingdo per ssh)

## Server 1 - manuell
## Ubuntu 20.04 LTS - Grundinstallation

## minimal Netzwerk - öffentlichen IP
## nichts besonderes eingerichtet - Standard Digitalocean

## Standard vo Installation microk8s
lo                UNKNOWN        127.0.0.1/8 ::1/128
## public ip / interne
eth0              UP             164.92.255.234/20 10.19.0.6/16 fe80::c:66ff:fec4:cbce/64
```

```
## private ip
eth1             UP             10.135.0.3/16 fe80::8081:aaff:feaa:780/64

snap install microk8s --classic
## namensaufloesung fuer pods
microk8s enable dns
```

```
## Funktioniert microk8s
microk8s status
```

Steps 2: Server 2+3 (automatische Installation -> microk8s)

```
## Was macht das ?
## 1. Basisnutzer (11trainingdo) - keine Voraussetzung für microk8s
## 2. Installation von microk8s
##.>>>>>>> microk8s installiert <<<<<<<<
## - snap install --classic microk8s
## >>>>>>> Zuordnung zur Gruppe microk8s - notwendig für bestimmte plugins (z.B. helm)
## usermod -a -G microk8s root
## >>>>>>> Setzen des .kube - Verzeichnisses auf den Nutzer microk8s -> nicht zwingend erforderlich
## chown -r -R microk8s ~/.kube
## >>>>>>> REQUIRED .. DNS aktivieren, wichtig für Namensauflösungen innerhalb der PODS
## >>>>>>> sonst funktioniert das nicht !!!
## microk8s enable dns
## >>>>>>> kubectl alias gesetzt, damit man nicht immer microk8s kubectl eingeben muss
## - echo "alias kubectl='microk8s kubectl'" >> /root/.bashrc

## cloud-init script
## s.u. MITMICROK8S (keine Voraussetzung - nur zum Einrichten des Nutzers 11trainingdo per ssh)
##cloud-config
users:
  - name: 11trainingdo
    shell: /bin/bash

runcmd:
  - sed -i "s/PasswordAuthentication no/PasswordAuthentication yes/g" /etc/ssh/sshd_config
  - echo " " >> /etc/ssh/sshd_config
  - echo "AllowUsers 11trainingdo" >> /etc/ssh/sshd_config
  - echo "AllowUsers root" >> /etc/ssh/sshd_config
  - systemctl reload sshd
  - sed -i '/11trainingdo/c
11trainingdo:$6$HeLUJW3a$4xSfDFQjKWfAoGkZF3LFAxM4hgl3d6ATbr2kEu9zMOFwLxkYMO.AJF526mZONwdmsm9sg0tCBKl.SYbhS52u70:17476:0:99999:7:::'
 /etc/shadow
  - echo "11trainingdo ALL=(ALL) ALL" > /etc/sudoers.d/11trainingdo
  - chmod 0440 /etc/sudoers.d/11trainingdo

  - echo "Installing microk8s"
  - snap install --classic microk8s
  - usermod -a -G microk8s root
  - chown -f -R microk8s ~/.kube
  - microk8s enable dns
  - echo "alias kubectl='microk8s kubectl'" >> /root/.bashrc
```

```
## Prüfen ob microk8s - wird automatisch nach Installation gestartet
## kann eine Weile dauern
microk8s status
```

Step 3: Client - Maschine (wir sollten nicht auf control-plane oder cluster - node arbeiten

```
Weiteren Server hochgezogen.
Vanilla + BASIS

## Installation Ubuntu - Server

## cloud-init script
## s.u. BASIS (keine Voraussetzung - nur zum Einrichten des Nutzers 11trainingdo per ssh)

## Server 1 - manuell
## Ubuntu 20.04 LTS - Grundinstallation

## minimal Netzwerk - öffentlichen IP
## nichts besonderes eingerichtet - Standard Digitalocean

## Standard vo Installation microk8s
lo               UNKNOWN        127.0.0.1/8 ::1/128
## public ip / interne
```

```
eth0             UP             164.92.255.232/20 10.19.0.6/16 fe80::c:66ff:fec4:cbce/64
## private ip
eth1             UP             10.135.0.5/16 fe80::8081:aaff:feaa:780/64
```

```
##### Installation von kubectl aus dem snap
## NICHT .. keine microk8s - keine control-plane / worker-node
## NUR Client zum Arbeiten
snap install kubectl --classic

##### .kube/config
## Damit ein Zugriff auf die kube-server-api möglich
## d.h. REST-API Interface, um das Cluster verwalten.
## Hier haben uns für den ersten Control-Node entschieden
## Alternativ wäre round-robin per dns möglich

## Mini-Schritt 1:
## Auf dem Server 1: kubeconfig ausspielen
microk8s config > /root/kube-config
## auf das Zielsystem gebracht (client 1)
scp /root/kubeconfig 11trainingdo@10.135.0.5:/home/11trainingdo

## Mini-Schritt 2:
## Auf dem Client 1 (diese Maschine) kubeconfig an die richtige Stelle bringen
## Standardmäßig der Client nach eine Konfigurationsdatei sucht in ~/.kube/config
sudo su -
cd
mkdir .kube
cd .kube
mv /home/11trainingdo/kube-config config

## Verbindungstest gemacht
## Damit feststellen ob das funktioniert.
kubectl cluster-info
```

Schritt 4: Auf allen Servern IP's hinterlegen und richtigen Hostnamen überprüfen

```
## Auf jedem Server
hostnamectl
## evtl. hostname setzen
## z.B. - auf jedem Server eindeutig
hostnamectl set-hostname n1.training.local

## Gleiche hosts auf allen server einrichten.
## Wichtig, um Traffic zu minimieren verwenden, die interne (private) IP

/etc/hosts
10.135.0.3 n1.training.local n1
10.135.0.4 n2.training.local n2
10.135.0.5 n3.training.local n3
```

Schritt 5: Cluster aufbauen

```
## Mini-Schritt 1:
## Server 1: connection - string (token)
microk8s add-node
## Zeigt Liste und wir nehmen den Eintrag mit der lokalen / öffentlichen ip
## Dieser Token kann nur 1x verwendet werden und wir auf dem ANDEREN node ausgeführt
## microk8s join 10.135.0.3:25000/e9cdaa11b5d6d24461c8643cdf107837/bcad1949221a

## Mini-Schritt 2:
## Dauert eine Weile, bis das durch ist.
## Server 2: Den Node hinzufügen durch den JOIN - Befehl
microk8s join 10.135.0.3:25000/e9cdaa11b5d6d24461c8643cdf107837/bcad1949221a

## Mini-Schritt 3:
## Server 1: token besorgen für node 3
microk8s add-node

## Mini-Schritt 4:
## Server 3: Den Node hinzufügen durch den JOIN-Befehl
microk8s join 10.135.0.3:25000/09c96e57ec12af45b2752fb45450530c/bcad1949221a

## Mini-Schritt 5: Überprüfen ob HA-Cluster läuft
Server 1: (es kann auf jedem der 3 Server überprüft werden, auf einem reicht
microk8s status | grep high-availability
high-availability: yes
```

Ergänzend nicht notwendige Scripte

```
## cloud-init script
## s.u. BASIS (keine Voraussetzung - nur zum Einrichten des Nutzers 11trainingdo per ssh)

## Digitalocean - unter user_data reingepastet beim Einrichten

##cloud-config
users:
  - name: 11trainingdo
    shell: /bin/bash

runcmd:
  - sed -i "s/PasswordAuthentication no/PasswordAuthentication yes/g" /etc/ssh/sshd_config
  - echo " " >> /etc/ssh/sshd_config
  - echo "AllowUsers 11trainingdo" >> /etc/ssh/sshd_config
  - echo "AllowUsers root" >> /etc/ssh/sshd_config
  - systemctl reload sshd
  - sed -i '/11trainingdo/c
11trainingdo:$6$HeLUJW3a$4xSfDFQjKWfAoGkZF3LFAxM4hgl3d6ATbr2kEu9zMOFwLxkYMO.AJF526mZONwdmsm9sg0tCBKl.SYbhS52u70:17476:0:99999:7:::'
 /etc/shadow
  - echo "11trainingdo ALL=(ALL) ALL" > /etc/sudoers.d/11trainingdo
  - chmod 0440 /etc/sudoers.d/11trainingdo
```

Kubernetes - microk8s (Installation und Management)

kubectl unter windows - Remote-Verbindung zu Kuberenets (microk8s) einrichten

Walkthrough (Installation)

```
## Step 1
chocolatry installiert.
(powershell als Administrator ausführen)
## https://docs.chocolatey.org/en-us/choco/setup
Set-ExecutionPolicy Bypass -Scope Process -Force; [System.Net.ServicePointManager]::SecurityProtocol =
[System.Net.ServicePointManager]::SecurityProtocol -bor 3072; iex ((New-Object
System.Net.WebClient).DownloadString('https://community.chocolatey.org/install.ps1'))

## Step 2
choco install kubernetes-cli

## Step 3
testen:
kubectl version --client

## Step 4:
## powershell als normaler benutzer öffnen
```

Walkthrough (autocompletion)

```
in powershell (normaler Benutzer)
kubectl completion powershell | Out-String | Invoke-Expression
```

kubectl - config - Struktur vorbereiten

```
## in powershell im heimatordner des Benutzers .kube - ordnern anlegen
## C:\Users\<dein-name>\
mkdir .kube
cd .kube
```

IP von Cluster-Node bekommen

```
## auf virtualbox - maschine per ssh einloggen
## öffentliche ip herausfinden - z.B. enp0s8 bei HostOnly - Adapter
ip -br a
```

config für kubectl aus Cluster-Node auslesen (microk8s)

```
## auf virtualbox - maschine per ssh einloggen / zum root wechseln
## abfragen
microk8s config

## Alle Zeilen ins clipboard kopieren
## und mit notepad++ in die Datei \Users\<dein-name>\.kube\config
## schreiben
## Wichtig: Zeile cluster -> clusters / server
## Hier ip von letztem Schritt eintragen:
## z.B.
Server: https://192.168.56.106/......
```

Testen

```
## in powershell
## kann ich eine Verbindung zum Cluster aufbauen ?
kubectl cluster-info
```

- https://kubernetes.io/docs/tasks/tools/install-kubectl-windows/

Arbeiten mit der Registry

Installation Kubernetes Dashboard

Reference:

- https://blog.tippybits.com/installing-kubernetes-in-virtualbox-3d49f666b4d6

Kubernetes - RBAC

Nutzer einrichten - kubernetes bis 1.24

Enable RBAC in microk8s

```
## This is important, if not enable every user on the system is allowed to do everything
microk8s enable rbac
```

Schritt 1: Nutzer-Account auf Server anlegen / in Client

```
cd
mkdir -p manifests/rbac
cd manifests/rbac
```

Mini-Schritt 1: Definition für Nutzer

```
## vi service-account.yml
apiVersion: v1
kind: ServiceAccount
metadata:
  name: training
  namespace: default
```

```
kubectl apply -f service-account.yml
```

Mini-Schritt 2: ClusterRolle festlegen - Dies gilt für alle namespaces, muss aber noch zugewiesen werden

```
### Bevor sie zugewiesen ist, funktioniert sie nicht - da sie keinem Nutzer zugewiesen ist

## vi pods-clusterrole.yml
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: pods-clusterrole
rules:
- apiGroups: [""] # "" indicates the core API group
  resources: ["pods"]
  verbs: ["get", "watch", "list"]
```

```
kubectl apply -f pods-clusterrole.yml
```

Mini-Schritt 3: Die ClusterRolle den entsprechenden Nutzern über RoleBinding zu ordnen

```
## vi rb-training-ns-default-pods.yml
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: rolebinding-ns-default-pods
  namespace: default
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: pods-clusterrole
subjects:
```

```
- kind: ServiceAccount
  name: training
  namespace: default
```

```
kubectl apply -f rb-training-ns-default-pods.yml
```

Mini-Schritt 4: Testen (klappt der Zugang)

```
kubectl auth can-i get pods -n default --as system:serviceaccount:default:training
```

Schritt 2: Context anlegen / Credentials auslesen und in kubeconfig hinterlegen (bis Version 1.25.)

Mini-Schritt 1: kubeconfig setzen

```
kubectl config set-context training-ctx --cluster microk8s-cluster --user training

## extract name of the token from here

TOKEN=`kubectl get secret trainingtoken -o jsonpath='{.data.token}' | base64 --decode`
echo $TOKEN
kubectl config set-credentials training --token=$TOKEN
kubectl config use-context training-ctx

## Hier reichen die Rechte nicht aus
kubectl get deploy
## Error from server (Forbidden): pods is forbidden: User "system:serviceaccount:kube-system:training" cannot list # resource
"pods" in API group "" in the namespace "default"
```

Mini-Schritt 2:

```
kubectl config use-context training-ctx
kubectl get pods
```

Refs:

- https://docs.oracle.com/en-us/iaas/Content/ContEng/Tasks/contengaddingserviceaccttoken.htm
- https://microk8s.io/docs/multi-user
- https://faun.pub/kubernetes-rbac-use-one-role-in-multiple-namespaces-d1d08bb08286

Ref: Create Service Account Token

- https://kubernetes.io/docs/reference/access-authn-authz/service-accounts-admin/#create-token

kubectl

Tipps&Tricks zu Deploymnent - Rollout

Warum

```
Rückgängig machen von deploys, Deploys neu unstossen.
(Das sind die wichtigsten Fähigkeiten
```

Beispiele

```
## Deployment nochmal durchführen
## z.B. nach kubectl uncordon n12.training.local
kubectl rollout restart deploy nginx-deployment

## Rollout rückgängig machen
kubectl rollout undo deploy nginx-deployment
```

Kubernetes - Monitoring (microk8s und vanilla)

metrics-server aktivieren (microk8s und vanilla)

Warum ? Was macht er ?

```
Der Metrics-Server sammelt Informationen von den einzelnen Nodes und Pods
Er bietet mit

kubectl top pods
kubectl top nodes

ein einfaches Interface, um einen ersten Eindruck über die Auslastung zu bekommen.
```

Walktrough

```
## Auf einem der Nodes im Cluster (HA-Cluster)
microk8s enable metrics-server

## Es dauert jetzt einen Moment bis dieser aktiv ist auch nach der Installation
## Auf dem Client
kubectl top nodes
kubectl top pods
```

Kubernetes

- https://kubernetes-sigs.github.io/metrics-server/
- kubectl apply -f https://github.com/kubernetes-sigs/metrics-server/releases/latest/download/components.yaml

Kubernetes - Backups

Kubernetes - Tipps & Tricks

Assigning Pods to Nodes

Walkthrough

```
## leave n3 as is
kubectl label nodes n7 rechenzentrum=rz1
kubectl label nodes n17 rechenzentrum=rz2
kubectl label nodes n27 rechenzentrum=rz2

kubectl get nodes --show-labels
```

```
## nginx-deployment
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 9 # tells deployment to run 2 pods matching the template
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80
      nodeSelector:
        rechenzentrum: rz2

## Let's rewrite that to deployment
apiVersion: v1
kind: Pod
metadata:
  name: nginx
  labels:
    env: test
spec:
  containers:
  - name: nginx
    image: nginx
    imagePullPolicy: IfNotPresent
  nodeSelector:
    rechenzentrum=rz2
```

Ref:

- https://kubernetes.io/docs/concepts/scheduling-eviction/assign-pod-node/

Kubernetes - Documentation

LDAP-Anbindung

- https://github.com/apprenda-kismatic/kubernetes-ldap

Helpful to learn - Kubernetes

- https://kubernetes.io/docs/tasks/

Environment to learn

- https://killercoda.com/killer-shell-cks

Environment to learn II

- https://killercoda.com/

Youtube Channel

- https://www.youtube.com/watch?v=01qcYSck1c4

Kubernetes - Shared Volumes

Shared Volumes with nfs

Create new server and install nfs-server

```
## on Ubuntu 20.04LTS
apt install nfs-kernel-server
systemctl status nfs-server

vi /etc/exports
## adjust ip's of kubernetes master and nodes
## kmaster
/var/nfs/ 192.168.56.101(rw,sync,no_root_squash,no_subtree_check)
## knode1
/var/nfs/ 192.168.56.103(rw,sync,no_root_squash,no_subtree_check)
## knode 2
/var/nfs/ 192.168.56.105(rw,sync,no_root_squash,no_subtree_check)

exportfs -av
```

On all nodes (needed for production)

```
##
apt install nfs-common
```

On all nodes (only for testing)

```
#### Please do this on all servers (if you have access by ssh)
### find out, if connection to nfs works !

## for testing
mkdir /mnt/nfs
## 10.135.0.18 is our nfs-server
mount -t nfs 10.135.0.18:/var/nfs /mnt/nfs
ls -la /mnt/nfs
umount /mnt/nfs
```

Persistent Storage-Step 1: Setup PersistentVolume in cluster

```
cd
cd manifests
mkdir -p nfs
cd nfs
nano 01-pv.yml
```

```
apiVersion: v1
kind: PersistentVolume
metadata:
  # any PV name
  name: pv-nfs-tln<nr>
  labels:
    volume: nfs-data-volume-tln<nr>
spec:
  capacity:
    # storage size
    storage: 1Gi
  accessModes:
    # ReadWriteMany(RW from multi nodes), ReadWriteOnce(RW from a node), ReadOnlyMany(R from multi nodes)
    - ReadWriteMany
  persistentVolumeReclaimPolicy:
    # retain even if pods terminate
    Retain
  nfs:
    # NFS server's definition
    path: /var/nfs/tln<nr>/nginx
    server: 10.135.0.18
    readOnly: false
  storageClassName: ""
```

```
kubectl apply -f 01-pv.yml
kubectl get pv
```

Persistent Storage-Step 2: Create Persistent Volume Claim

```
nano 02-pvc.yml
```

```
## vi 02-pvc.yml
## now we want to claim space
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: pv-nfs-claim-tln<nr>
spec:
  storageClassName: ""
  volumeName: pv-nfs-tln<nr>
  accessModes:
  - ReadWriteMany
  resources:
     requests:
       storage: 1Gi
```

```
kubectl apply -f 02-pvc.yml
kubectl get pvc
```

Persistent Storage-Step 3: Deployment

```
## deployment including mount
## vi 03-deploy.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 4 # tells deployment to run 4 pods matching the template
  template:
    metadata:
      labels:
        app: nginx
    spec:

      containers:
      - name: nginx
        image: nginx:latest
        ports:
        - containerPort: 80

        volumeMounts:
          - name: nfsvol
            mountPath: "/usr/share/nginx/html"

      volumes:
      - name: nfsvol
        persistentVolumeClaim:
          claimName: pv-nfs-claim-tln<tln>

```

```
kubectl apply -f 03-deploy.yml
```

Persistent Storage Step 4: service

```
## now testing it with a service
## cat 04-service.yml
apiVersion: v1
kind: Service
```

```
metadata:
  name: service-nginx
  labels:
    run: svc-my-nginx
spec:
  type: NodePort
  ports:
  - port: 80
    protocol: TCP
  selector:
    app: nginx
```

```
kubectl apply -f 04-service.yml
```

Persistent Storage Step 5: write data and test

```
## connect to the container and add index.html - data
kubectl exec -it deploy/nginx-deployment -- bash
## in container
echo "hello dear friend" > /usr/share/nginx/html/index.html
exit

## now try to connect
kubectl get svc

## connect with ip and port
kubectl run -it --rm curly --image=curlimages/curl -- /bin/sh
## curl http://<cluster-ip>
## exit

## now destroy deployment
kubectl delete -f 03-deploy.yml

## Try again - no connection
kubectl run -it --rm curly --image=curlimages/curl -- /bin/sh
## curl http://<cluster-ip>
## exit
```

Persistent Storage Step 6: retest after redeployment

```
## now start deployment again
kubectl apply -f 03-deploy.yml

## and try connection again
kubectl run -it --rm curly --image=curlimages/curl -- /bin/sh
## curl http://<cluster-ip>
## exit
```

Kubernetes - Hardening

Kubernetes Tipps Hardening

PSA (Pod Security Admission)

```
Policies defined by namespace.
e.g. not allowed to run container as root.

Will complain/deny when creating such a pod with that container type
```

Möglichkeiten in Pods und Containern

```
## für die Pods
kubectl explain pod.spec.securityContext
kubectl explain pod.spec.containers.securityContext
```

Example (seccomp / security context)

```
A. seccomp - profile
https://github.com/docker/docker/blob/master/profiles/seccomp/default.json
```

```
apiVersion: v1
kind: Pod
metadata:
  name: audit-pod
  labels:
    app: audit-pod
spec:
  securityContext:
    seccompProfile:
      type: Localhost
      localhostProfile: profiles/audit.json

  containers:

  - name: test-container
    image: hashicorp/http-echo:0.2.3
    args:
    - "-text=just made some syscalls!"
    securityContext:
      allowPrivilegeEscalation: false
```

SecurityContext (auf Pod Ebene)

```
kubectl explain pod.spec.containers.securityContext
```

NetworkPolicy

```
## Firewall Kubernetes
```