Kubernetes Networking

Agenda

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    - Ports und Protokolle
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    - kubectl verbindung mit namespace einrichten
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    - Beispiel mit Hostnamen
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    - Kubernetes Load Balancer
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Backlog

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    - Beispiele Ingress Egress NetworkPolicy
    - Mesh / istio
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2. Calico NetworkPolicy
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3. Kubernetes calico (CNI-Plugin)
    - Welcher Routing-Mode wird im aktuellen Cluster verwendet
    - Wird eBPF verwendet ?
    - Install calicoctl in pod
    - Wann calicoctl (Stand 2024/01 calico 3.27)
    - Install calico-api-server to use kubectl instead of calicoctl

- Calico Default Routing Mode BGP & vxlancrossnet
- Internals - Pod to Pod - Communication on Worker3 (node))
- Internals - Inter-Pod - Communication (worker 3 -> worker 1

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    - Bauen einer Applikation mit Resource Objekten
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    - Replicasets
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    - Hintergrund Ingress
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    - Configmap MariaDB my.cnf
5. Kubernetes multus (Meta-CNI - Plugin)
    - Multus Überblick
    - sr-iov mit multus
6. Kubernetes coil (egress - gateway)
    - coil
7. Kubernetes antrea (CNI-Plugin)
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    - Overview Kubernetes Antrea CNI-Plugin
    - Antctl
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8. Kubernetes - Wartung / Debugging
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    - Alte manifeste konvertieren mit convert plugin
    - Curl from pod api-server
9. Kubernetes Deployment Scenarios
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    - Praxis-Übung A/B Deployment
10. Helm (Kubernetes Paketmanager)
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    - Nutzer einrichten microk8s ab kubernetes 1.25
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    - Quality of Service - evict pods
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14. Kubernetes - Tipps & Tricks
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    - Curl api-server kubernetes aus pod heraus
16. Kubernetes - Documentation
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17. Kubernetes - Hardening

- Kubernetes Tipps Hardening
- Kubernetes Security Admission Controller Example
- Was muss ich bei der Netzwerk-Sicherheit beachten ?

18. Kubernetes Interna / Misc.
    - OCI,Container,Images Standards
    - Geolocation Kubernetes Cluster
    - statische IP für Pod in calico
    - yaml linting
    - ssl terminierung über proxy nginx
    - LoadBalancer / Cluster Controller Manager
19. Kubernetes - Ingress
    - Ingress controller in microk8s aktivieren
    - ingress mit ssl absichern
20. Kubernetes Documentation
    - Well-Known Annotations

Backlog

1. Kubernetes - Überblick
    - Installation - Welche Komponenten from scratch
2. Kubernetes - microk8s (Installation und Management)
    - kubectl unter windows - Remote-Verbindung zu Kuberenets (microk8s) einrichten
    - Arbeiten mit der Registry
    - Installation Kubernetes Dashboard
3. Kubernetes - RBAC
    - Nutzer einrichten - kubernetes bis 1.24
4. kubectl
    - Tipps&Tricks zu Deploymnent - Rollout
5. Kubernetes - Monitoring (microk8s und vanilla)
    - metrics-server aktivieren (microk8s und vanilla)
6. Kubernetes - Backups
    - Kubernetes Aware Cloud Backup - kasten.io
7. Kubernetes - Tipps & Tricks
    - Assigning Pods to Nodes
8. Kubernetes - Documentation
    - LDAP-Anbindung
    - Helpful to learn - Kubernetes
    - Environment to learn
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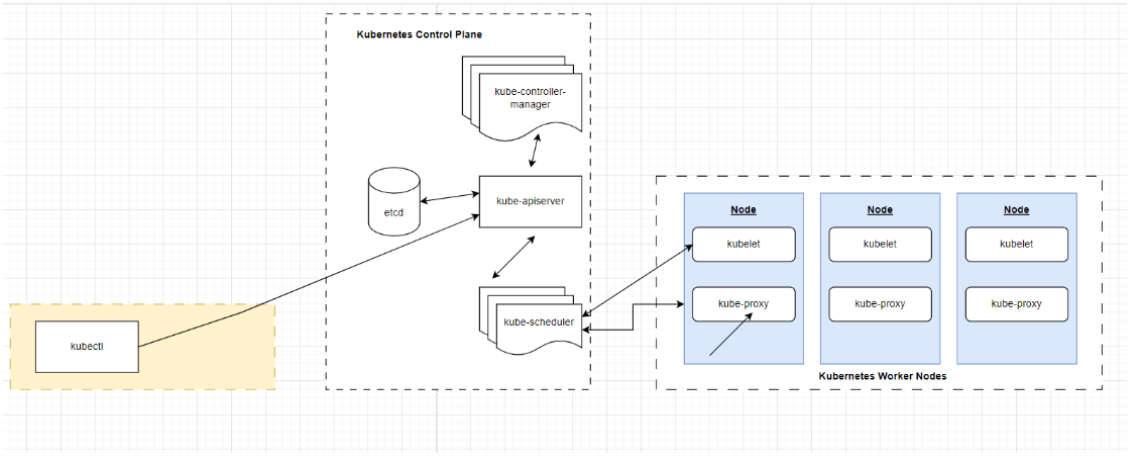
    - Youtube Channel
9. Kubernetes - Shared Volumes
    - Shared Volumes with nfs
10. Kubernetes - Hardening
    - Kubernetes Tipps Hardening
11. Kubernetes Probes (Liveness and Readiness)
    - Übung Liveness-Probe
    - Funktionsweise Readiness-Probe vs. Liveness-Probe

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 (former: master node) - components

Worker Node - 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

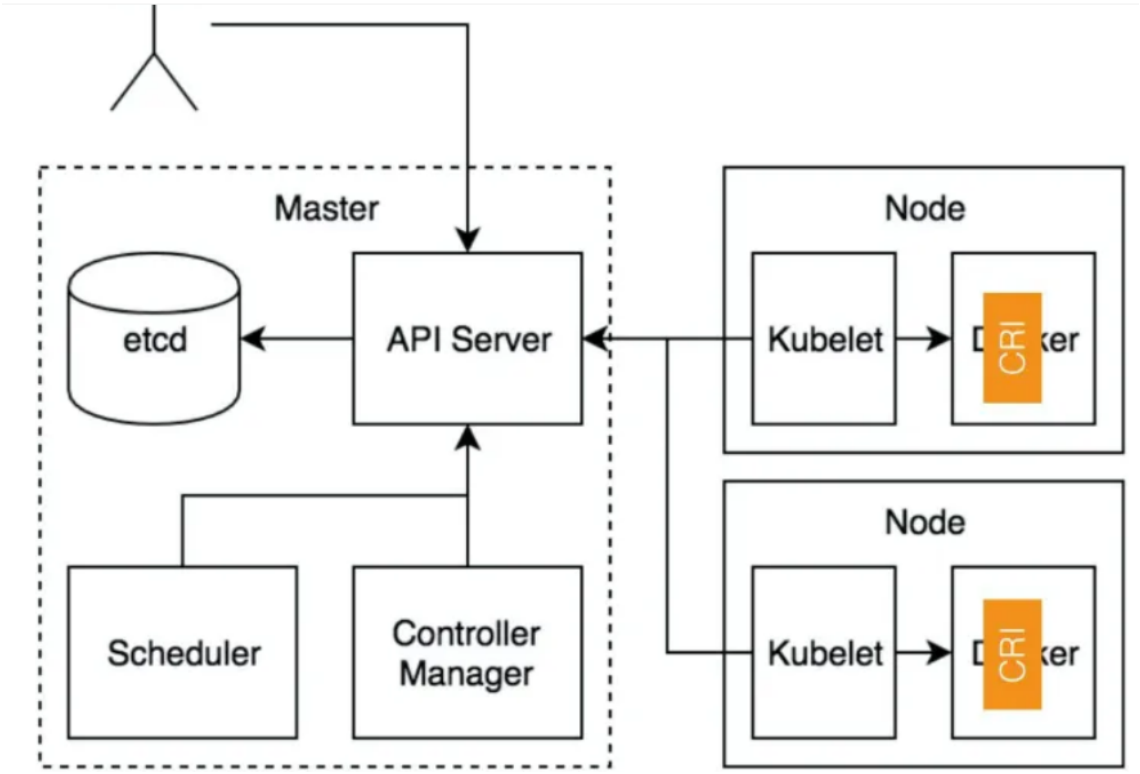
- https://www.redhat.com/de/topics/containers/kubernetes-architecture

Structure Kubernetes Deep Dive

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

CRI - Container Runtime interface

Where is it embedded



What is it for ?

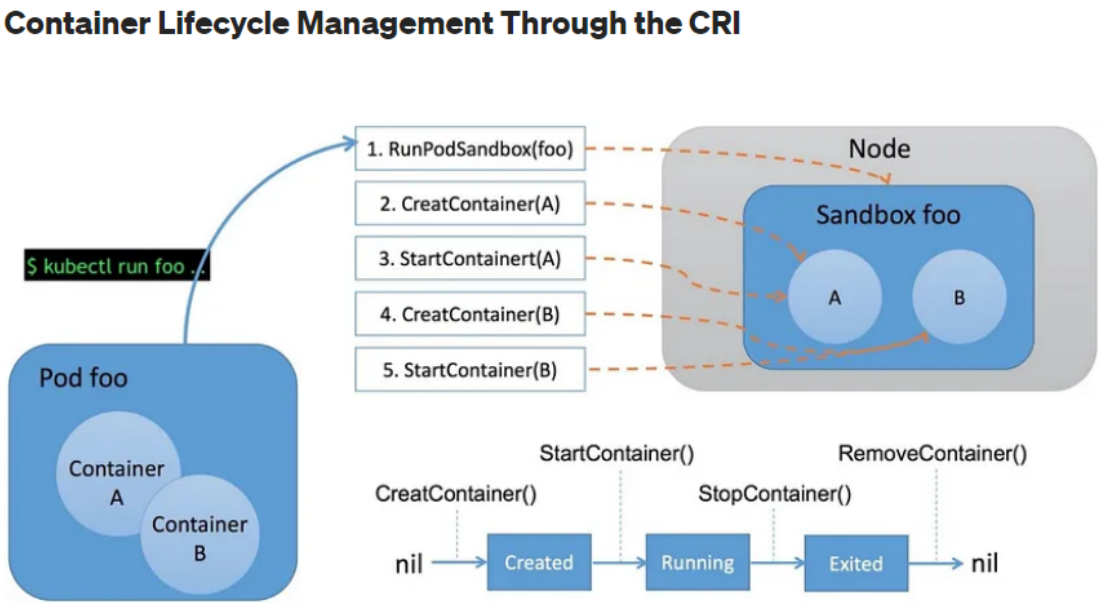
- Abstraction layer called by kubelet to make it possible to use other container runtimes
- The CRI uses gRPC as its communication protocol.

kubelet calls the CRI with its subcommands

- Expected commands are

```
Sandbox:
  Delete
  Create
  List
Image:
  Pull
  List
Container.
  Create
  Start
  Exec
```

Steps in the CRI



Ports und Protokolle

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

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:1.23

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/

kubectl verbindung mit namespace einrichten

config einrichten

```
cd
mkdir .kube
cd .kube
cp -a /tmp/config config
ls -la
## nano config befüllen
## das bekommt ihr aus Eurem Cluster Management Tool
```

```
kubectl cluster-info
```

Arbeitsbereich konfigurieren

```
kubectl create ns jochen
kubectl get ns
kubectl config set-context --current --namespace jochen
kubectl get pods
```

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

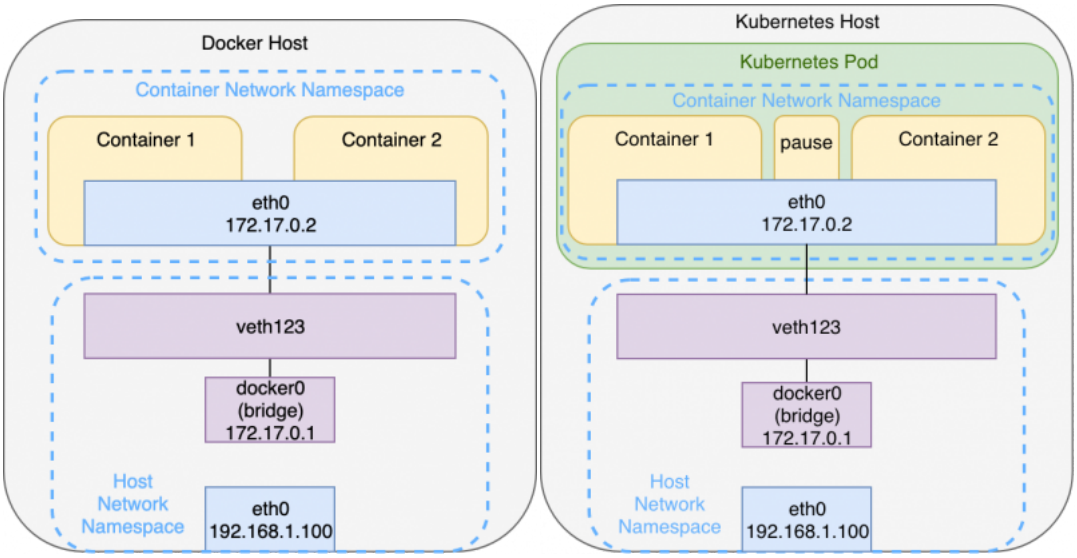
```
vim test.yml
Eigenschaft: <return> # springt eingerückt in die nächste Zeile um 2 spaces eingerückt

## 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)

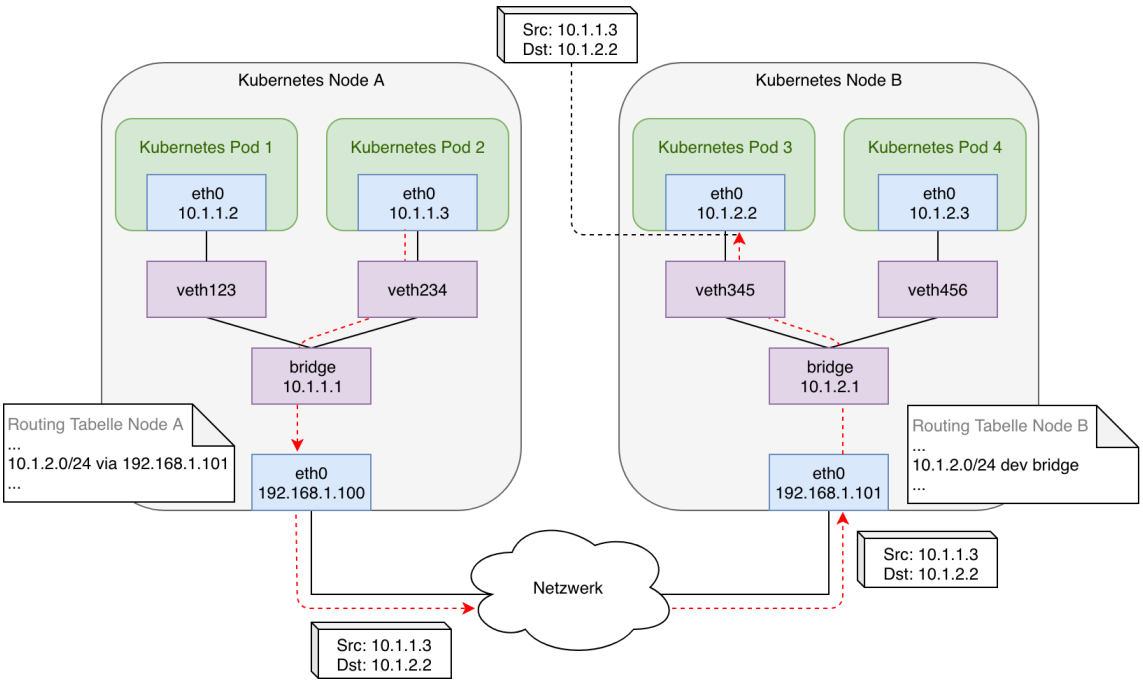
Prerequisites

- 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 done 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 Communication (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 .
## als root auf dem worker node
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/

Wirkweise cni

Ablauf

- Containerd ruft CNI plugin über subcommandos: ADD, DEL, CHECK, VERSION auf (mehr subcommandos gibt es nicht)
- Was gemacht werden soll wird über JSON-Objekt übergeben
- Die Antwort kommt auch wieder als JSON zurück

Plugins die Standardmäßig schon da sind

- https://www.cni.dev/plugins/current/

CNI-Provider

- Ein Kubernetes-Cluster braucht immer ein CNI-Provider, sonst funktioniert die Kmmunikation nicht und die Nodes im Cluster stehen auf NotReady
- Beispiele: Calico, WeaveNet, Antrea, Cilium, Flannel

IPAM - IP Address Management

- Ziel ist, dass Adressen nicht mehrmals vergeben werden.
- Dazu wird ein Pool bereitgestellt.
- Es gibt 3 CNI IPAM - Module:
  - host-local
  - dhcp
  - static

```
* IPAM: IP address allocation
dhcp : Runs a daemon on the host to make DHCP requests on behalf of a container
host-local : Maintains a local database of allocated IPs
static : Allocates static IPv4/IPv6 addresses to containers
```

Beispiel json für antrea (wird verwendet beim Aufruf von CNI)

```
root@worker1:/etc/cni/net.d# cat 10-antrea.conflist
{
    "cniVersion":"0.3.0",
    "name": "antrea",
    "plugins": [
        {
            "type": "antrea",
            "ipam": {
                "type": "host-local"
            }
        }
        ,
        {
            "type": "portmap",
            "capabilities": {"portMappings": true}
        }
        ,
        {
            "type": "bandwidth",
            "capabilities": {"bandwidth": true}
        }
    ]
}
```

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 ?

- Flannel
- Canal
- Calico
- Cilium
- Antrea (vmware)
- Weave Net

Flannel

Generell

- Flannel is a CNI which gives a subnet to each host for use with container runtimes.

Overlay - Netzwerk

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

Vorteile

- Guter einfacher Einstieg
- reduziert auf eine Binary flanneld

Nachteile

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

Guter Einstieg in flannel

- https://mvallim.github.io/kubernetes-under-the-hood/documentation/kube-flannel.html

Canal

General

- Auch ein Overlay - Netzwerk
- Unterstützt auch policies
- Kombination aus Flannel (Overlay) und den NetworkPolicies aus Calico

Calico

Komponenten

Calico API server

- Lets you manage Calico resources directly with kubectl.

Felix

```
Main task: Programs routes and ACLs, and anything else required on the host to provide desired connectivity for the endpoints on
that host. Runs on each machine that hosts endpoints. Runs as an agent daemon.
```

BIRD

- Gets routes from Felix and distributes to BGP peers on the network for inter-host routing. Runs on each node that hosts a Felix agent. Open source, internet routing daemon.

confd

```
Monitors Calico datastore for changes to BGP configuration and global defaults such as AS number, logging levels, and IPAM
information. Open source, lightweight configuration management tool.

Confd dynamically generates BIRD configuration files based on the updates to data in the datastore. When the configuration file
changes, confd triggers BIRD to load the new files
```

Dikastes

```
Enforces NetworkPolicy for istio service mesh
```

CNI plugin

Datastore plugin

IPAM plugin

kube-controllers

```
Main task: Monitors the Kubernetes API and performs actions based on cluster state. kube-controllers.

The tigera/kube-controllers container includes the following controllers:

Policy controller
Namespace controller
Serviceaccount controller
```

```
Workloadendpoint controller
Node controller
```

Typha

```
Typha maintains a single datastore connection on behalf of all of its clients like Felix and confd. It caches the datastore state
and deduplicates events so that they can be fanned out to many listeners.
```

calicoctl

- Wird heute selten gebraucht, da das meiste heute mit kubectl über den Calico API Server realisiert werden kann
- Früher haben die neuesten NetworkPolicies/v3 nur über calioctl funktioniert

Generell

- klassische Netzwerk (BGP) - kein Overlay
- klassische Netzwerk-Tools können verwendet werden.
- eBPF ist implementiert, aber muss aktiviert

Vorteile gegenüber Flannel

- Policy über Kubernetes Object (NetworkPolicies)

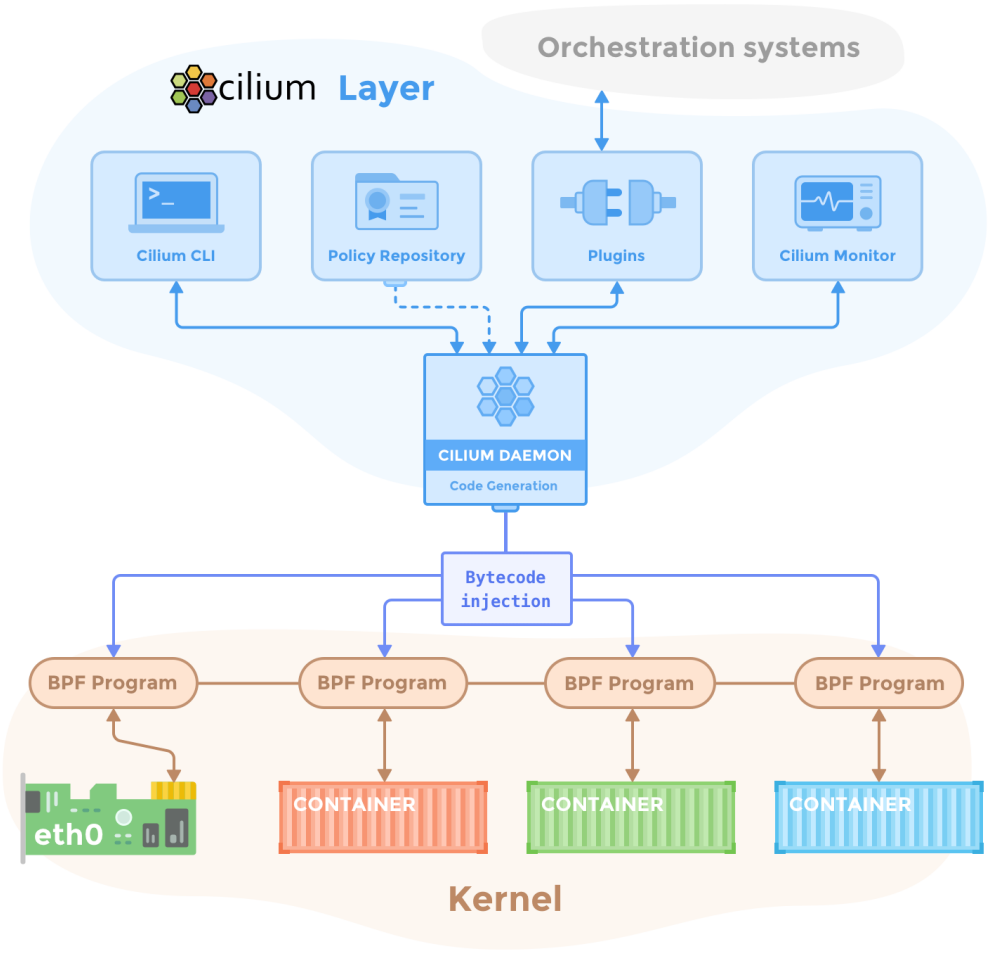
Vorteile

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

Referenz

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

Cilium



Komponenten:

Cilium Agent

- Läuft auf jeder Node im Cluster
- Lauscht auf events from Orchestrierer (z.B. container gestoppt und gestartet)
- Managed die eBPF - Programme, die Linux kernel verwendet um den Netzwerkzugriff aus und in die Container zu kontrollieren

Client (CLI)

- Wird im Agent mit installiert (interagiert mit dem agent auf dem gleichen Node)
- Kann aber auch auf dem Client installiert werden auf dem kubectl läuft.

Cilium Operator

- Zuständig dafür, dass die Agents auf den einzelnen Nodes ausgerollt werden
- Es gibt ihn nur 1x im Cluster
- Ist unkritisch, sobald alles ausgerollt ist.
  - wenn dieser nicht läuft funktioniert das Networking trotzdem

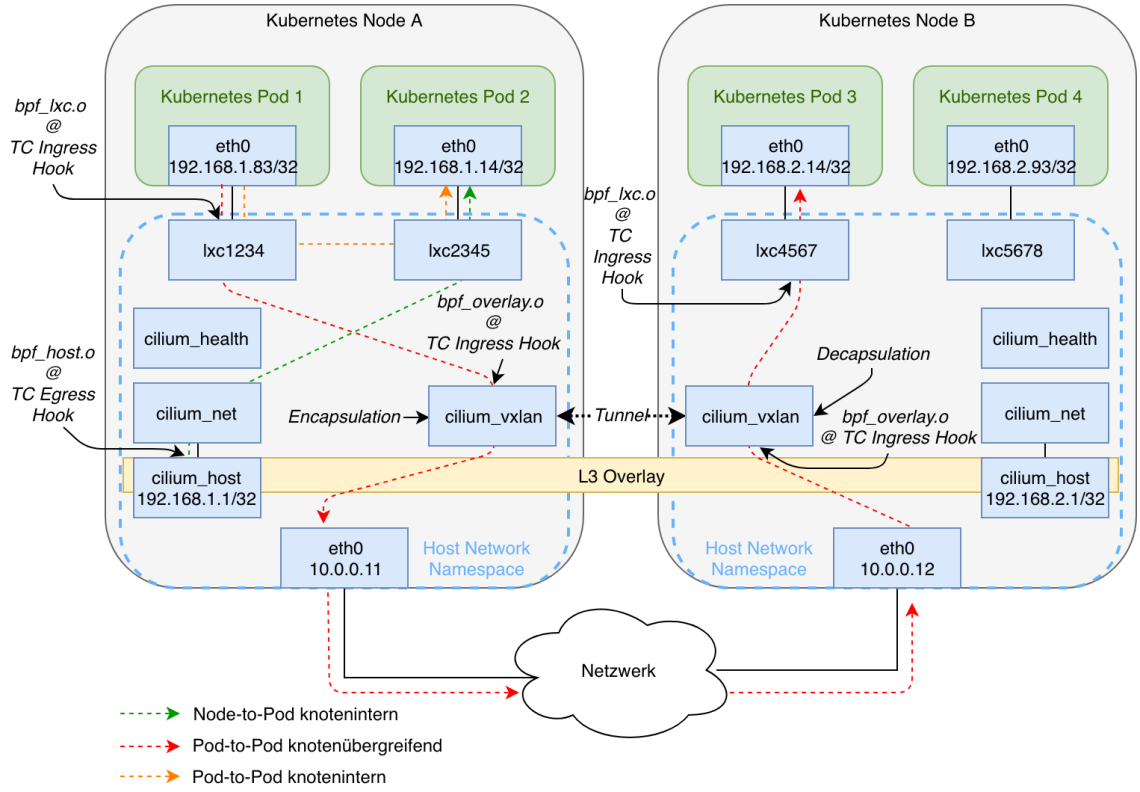
cilium CNI - Plugin

- Ist ein binary auf dem server (worker)
- wird durch die Container Runtime ausgeführt.
- cilium cni plugin interagiert mit der Cilium API auf dem Node

Datastore

- Daten werden per Default in CRD (Custom Resource Defintions) gespeichert
- Diese Resource Objekte werden von Cilium definiert und angelegt.
  - Wenn Sie angelegt sind, sind die Daten dadurch automatisch im etc - Speicher
  - Mit der weiteren Möglichkeit den Status zu speichern.
- Alternative: Speichern der Daten direkt in etcd

Generell



- Quelle: https://www.inovex.de/de/blog/kubernetes-networking-2-calico-cilium-weavenet/
- Verwendet keine Bridge sondern Hooks im Kernel, die mit eBPF aufgesetzt werden
  - Bessere Performance
- eBPF wird auch für NetworkPolicies unter der Haube eingesetzt
- Mit Ciliums Cluster Mesh lassen sich mehrere Cluster miteinander verbinden:

Vorteile

- Höhere Leistung mit eBPF-Ansatz. (extended Berkely Packet Filter)
  - JIT - Just in time compiled -
  - Bytecode wird zu MaschineCode kompiliert (Miniprogramme im Kernel)
- Ersatz für iptables (wesentlich schneller und keine Degredation wie iptables ab 5000 Services)
- Gut geeignet für größere Cluster

Weave Net

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

DNS - Resolution - Services

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

Kubernetes NetworkPolicy

Einfache Übung Network Policy

Schritt 1: Deployment und Service erstellen

```
KURZ=jm
kubectl create ns policy-demo-$KURZ
```

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

```
## nano 01-deployment.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 1
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.23
        ports:
        - containerPort: 80
```

```
kubectl -n policy-demo-$KURZ apply -f .
```

```
## nano 02-service.yaml
apiVersion: v1
kind: Service
metadata:
  name: nginx
spec:
  type: ClusterIP # Default Wert
  ports:
  - port: 80
    protocol: TCP
  selector:
    app: nginx
```

```
kubectl -n policy-demo-$KURZ apply -f .
```

Schritt 2: Zugriff testen ohne Regeln

```
## lassen einen 2. pod laufen mit dem auf den nginx zugreifen
kubectl run --namespace=policy-demo-$KURZ access --rm -ti --image busybox
```

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

```
## Optional: Pod anzeigen in 2. ssh-session zu jump-host
kubectl -n policy-demo-$KURZ get pods --show-labels
```

Schritt 3: Policy festlegen, dass kein Zugriff erlaubt ist.

```
## nano 03-default-deny.yaml
## Schritt 2: Policy festlegen, dass kein Ingress-Traffic erlaubt
## in diesem namespace: policy-demo-$KURZ
kind: NetworkPolicy
apiVersion: networking.k8s.io/v1
metadata:
  name: default-deny
spec:
  podSelector:
    matchLabels: {}
```

```
kubectl -n policy-demo-$KURZ apply -f .
```

Schritt 3.5: Verbindung mit deny all Regeln testen

```
kubectl run --namespace=policy-demo-$KURZ access --rm -ti --image busybox
```

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

Schritt 4: Zugriff erlauben von pods mit dem Label run=access (alle mit run gestarteten pods mit namen access haben dieses label per default)

```
## nano 04-access-nginx.yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: access-nginx
spec:
  podSelector:
    matchLabels:
      app: nginx
  ingress:
    - from:
      - podSelector:
          matchLabels:
            run: access
```

```
kubectl -n policy-demo-$KURZ apply -f .
```

Schritt 5: Testen (zugriff sollte funktionieren)

```
## 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-$KURZ access --rm -ti --image busybox
```

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

Schritt 6: Pod mit label run=no-access - da sollte es nicht gehen

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

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

Schritt 7: Aufräumen

```
kubectl delete ns policy-demo-$KURZ
```

Ref:

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

NetworkPolicy from IPBlock

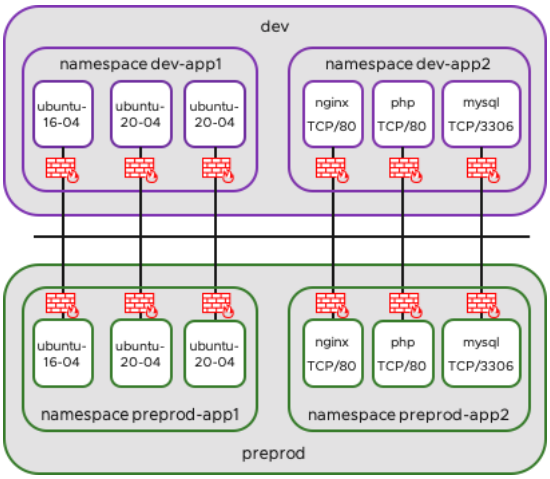
```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 1
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: traefik/whoami
        ports:
        - containerPort: 80
---
## nano 02-service.yaml
apiVersion: v1
kind: Service
metadata:
  name: nginx
spec:
  type: NodePort # Default Wert
  ports:
  - port: 80
    protocol: TCP
  selector:
    app: nginx
---
## nano 03-default-deny.yaml
## Schritt 2: Policy festlegen, dass kein Ingress-Traffic erlaubt
## in diesem namespace: policy-demo-$KURZ
kind: NetworkPolicy
apiVersion: networking.k8s.io/v1
metadata:
  name: default-deny
spec:
  podSelector:
    matchLabels: {}
---
## nano 05-from-access.yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: access-nginx
spec:
  podSelector:
    matchLabels:
      app: nginx
  ingress:
    - from:
      - ipBlock:
```

```
          cidr: 138.197.181.70/32
```

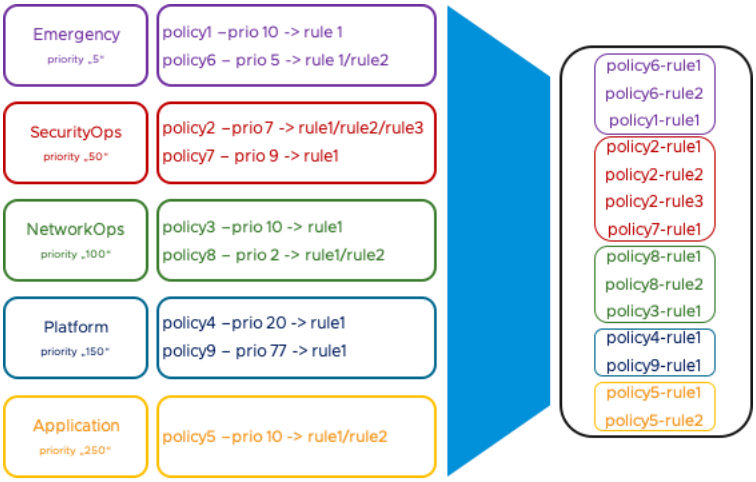
Kubernetes (Antrea-)NetworkPolicy

Antrea NetworkPolicy Exercise - Each trainee has its own cluster

Our Goal

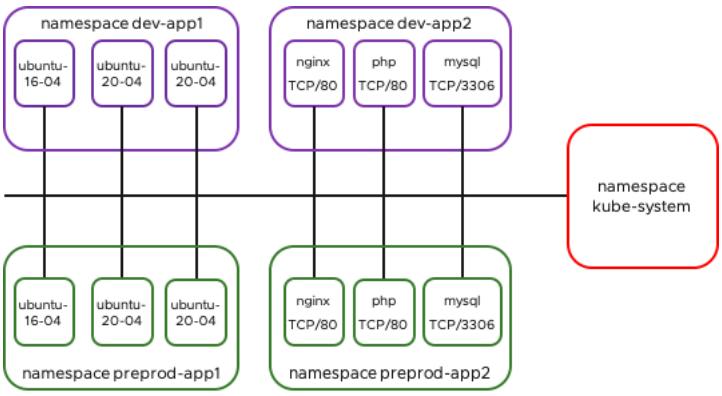


How the order of priorities work



Our Setup

```
In app1 are some Ubuntu Servers for Testing: dev-app1 / preprod-app1

1x Ubuntu Server 16.04
2x Ubuntu Server 20.04
In app2 is a simple 3 Tier-App (WEB-APP-DB): dev-app2 / preprod-app2 (3tier-app)

1x nginx TCP/80 (NodePort)
1x php TCP/80 (ClusterIP)
1x mysql TCP/3306 (ClusterIP)
```



Step 1: Rollout the pods (dev-app1/dev-app2)

```
cd
mkdir -p manifests
cd manifests
mkdir 10-antrea
cd 10-antrea
nano 01-pods-dev-app1-app2.yaml
```

```
apiVersion: v1
kind: Namespace
metadata:
  name: dev-app1
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ubuntu-16-04
  labels:
    app: ubuntu-16-04
  namespace: dev-app1
spec:
  replicas: 1
  selector:
    matchLabels:
      app: ubuntu-16-04
  template:
    metadata:
      labels:
        app: ubuntu-16-04
    spec:
      containers:
      - name: ubuntu-16-04
        image: ubuntu:16.04
        imagePullPolicy: IfNotPresent
        command: [ "/bin/bash", "-c" ]
        args:
          - apt-get update;
            apt-get install iputils-ping -y;
            apt-get install net-tools;
            apt-get install curl -y;
            sleep infinity;
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ubuntu-20-04
  labels:
    app: ubuntu-20-04
  namespace: dev-app1
spec:
  replicas: 2
  selector:
    matchLabels:
      app: ubuntu-20-04
  template:
    metadata:
      labels:
```

```
        app: ubuntu-20-04
    spec:
      containers:
      - name: ubuntu-20-04
        image: ubuntu:20.04
        imagePullPolicy: IfNotPresent
        command: [ "/bin/bash", "-c" ]
        args:
          - apt-get update;
            apt-get install tcpdump -y;
            apt-get install telnet -y;
            apt-get install iputils-ping -y;
            apt-get install nmap -y;
            apt-get install net-tools;
            apt-get install netdiscover -y;
            apt-get install mysql-client -y;
            apt-get install curl -y;
            apt-get install dsniff -y;
            sleep infinity;
---
apiVersion: v1
kind: Namespace
metadata:
  name: dev-app2
---
apiVersion: v1
kind: ConfigMap
metadata:
  name: default-conf
  namespace: dev-app2
data:
  default.conf: |
    server {
    listen 80 default_server;

    location / {
      proxy_pass http://app-service;
      proxy_http_version 1.1;
    }

    error_page   500 502 503 504  /50x.html;
    location = /50x.html {
        root   /usr/share/nginx/html;
    }

    }
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx
  namespace: dev-app2
spec:
  replicas: 1
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
        service: web
        kind: dev
        type: internal
    spec:
      containers:
      - name: nginx
        image: nginx
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 80
        volumeMounts:
        - mountPath: /etc/nginx/conf.d # mount nginx-conf volumn to /etc/nginx
          readOnly: true
          name: default-conf
        - mountPath: /var/log/nginx
          name: log
      volumes:
```

```
      - name: default-conf
        configMap:
          name: default-conf # place ConfigMap `nginx-conf` on /etc/nginx
          items:
            - key: default.conf
              path: default.conf
      - name: log
        emptyDir: {}
---
apiVersion: v1
kind: Service
metadata:
  name: nginx
  namespace: dev-app2
spec:
  type: NodePort
  ports:
  - port: 80
    targetPort: 80
  selector:
    app: nginx
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: appserver
  labels:
    app: app
  namespace: dev-app2
spec:
  replicas: 1
  selector:
    matchLabels:
      app: app
  template:
    metadata:
      labels:
        app: app
        kind: dev
        type: internal
    spec:
      containers:
      - name: php-apache
        image: derstich/miserver:006
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 80
---
apiVersion: v1
kind: Service
metadata:
  name: app-service
  labels:
    app: app
  namespace: dev-app2
spec:
  ports:
  - port: 80
    protocol: TCP
  selector:
    app: app
---
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: mysql
  namespace: dev-app2
spec:
  selector:
    matchLabels:
      app: mysql8
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql8
        service: db
```

```
        kind: dev
        type: internal
    spec:
      containers:
      - image: mysql:5.6
        name: mysql
        imagePullPolicy: IfNotPresent
        env:
        - name: MYSQL_ROOT_PASSWORD
          value: .sweetpwd.
        - name: MYSQL_DATABASE
          value: my_db
        - name: MYSQL_USER
          value: db_user
        - name: MYSQL_PASSWORD
          value: .mypwd
        args: ["--default-authentication-plugin=mysql_native_password"]
        ports:
        - containerPort: 3306
          name: mysql8
---
apiVersion: v1
kind: Service
metadata:
  name: mysql8-service
  labels:
    app: mysql8
  namespace: dev-app2
spec:
  type: ClusterIP
  ports:
  - port: 3306
    protocol: TCP
  selector:
    app: mysql8
```

```
kubectl apply -f .
kubectl -n dev-app1 get all
kubectl -n dev-app2 get all
```

Schritt 2: rollout preprod-app1/preprod-app2

```
nano 02-deployment-preprod-app1-app2.yaml
```

```
apiVersion: v1
kind: Namespace
metadata:
  name: preprod-app1
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ubuntu-16-04
  labels:
    app: ubuntu-16-04
  namespace: preprod-app1
spec:
  replicas: 1
  selector:
    matchLabels:
      app: ubuntu-16-04
  template:
    metadata:
      labels:
        app: ubuntu-16-04
    spec:
      containers:
      - name: ubuntu-16-04
        image: ubuntu:16.04
        imagePullPolicy: IfNotPresent
        command: [ "/bin/bash", "-c" ]
        args:
          - apt-get update;
            apt-get install iputils-ping -y;
            apt-get install net-tools;
            apt-get install curl -y;
            sleep infinity;
```

```
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ubuntu-20-04
  labels:
    app: ubuntu-20-04
  namespace: preprod-app1
spec:
  replicas: 2
  selector:
    matchLabels:
      app: ubuntu-20-04
  template:
    metadata:
      labels:
        app: ubuntu-20-04
    spec:
      containers:
      - name: ubuntu-20-04
        image: ubuntu:20.04
        imagePullPolicy: IfNotPresent
        command: [ "/bin/bash", "-c" ]
        args:
          - apt-get update;
            apt-get install tcpdump -y;
            apt-get install telnet -y;
            apt-get install iputils-ping -y;
            apt-get install nmap -y;
            apt-get install net-tools;
            apt-get install netdiscover -y;
            apt-get install mysql-client -y;
            apt-get install curl -y;
            apt-get install dsniff -y;
            sleep infinity;
---
apiVersion: v1
kind: Namespace
metadata:
  name: preprod-app2
---
apiVersion: v1
kind: ConfigMap
metadata:
  name: default-conf
  namespace: preprod-app2
data:
  default.conf: |
    server {
    listen 80 default_server;

    location / {
      proxy_pass http://app-service;
      proxy_http_version 1.1;
    }

    error_page   500 502 503 504  /50x.html;
    location = /50x.html {
        root   /usr/share/nginx/html;
    }

    }
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx
  namespace: preprod-app2
spec:
  replicas: 1
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
        service: web
```

```
        kind: dev
        type: internal
    spec:
      containers:
      - name: nginx
        image: nginx
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 80
        volumeMounts:
        - mountPath: /etc/nginx/conf.d # mount nginx-conf volumn to /etc/nginx
          readOnly: true
          name: default-conf
        - mountPath: /var/log/nginx
          name: log
      volumes:
      - name: default-conf
        configMap:
          name: default-conf # place ConfigMap `nginx-conf` on /etc/nginx
          items:
            - key: default.conf
              path: default.conf
      - name: log
        emptyDir: {}
---
apiVersion: v1
kind: Service
metadata:
  name: nginx
  namespace: preprod-app2
spec:
  type: NodePort
  ports:
  - port: 80
    targetPort: 80
  selector:
    app: nginx
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: appserver
  labels:
    app: app
  namespace: preprod-app2
spec:
  replicas: 1
  selector:
    matchLabels:
      app: app
  template:
    metadata:
      labels:
        app: app
        kind: dev
        type: internal
    spec:
      containers:
      - name: php-apache
        image: derstich/miserver:005
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 80
---
apiVersion: v1
kind: Service
metadata:
  name: app-service
  labels:
    app: app
  namespace: preprod-app2
spec:
  ports:
  - port: 80
    protocol: TCP
  selector:
    app: app
---
```

```
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: mysql
  namespace: preprod-app2
spec:
  selector:
    matchLabels:
      app: mysql8
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql8
        service: db
        kind: dev
        type: internal
    spec:
      containers:
      - image: mysql:5.6
        name: mysql
        imagePullPolicy: IfNotPresent
        env:
        - name: MYSQL_ROOT_PASSWORD
          value: .sweetpwd.
        - name: MYSQL_DATABASE
          value: my_db
        - name: MYSQL_USER
          value: db_user
        - name: MYSQL_PASSWORD
          value: .mypwd
        args: ["--default-authentication-plugin=mysql_native_password"]
        ports:
        - containerPort: 3306
          name: mysql8
---
apiVersion: v1
kind: Service
metadata:
  name: mysql8-service
  labels:
    app: mysql8
  namespace: preprod-app2
spec:
  type: ClusterIP
  ports:
  - port: 3306
    protocol: TCP
  selector:
    app: mysql8
```

```
kubectl apply -f .
```

Schritt 3: Daten auslesen

```
## dev-app1
kubectl -n dev-app1 get pods -o=custom-
columns=NAMESPACE:.metadata.namespace,NAME:.metadata.name,STATUS:.status.phase,IP:.status.podIP,NODE:.spec.nodeName

## dev-app2
kubectl -n dev-app2 get pods -o=custom-
columns=NAMESPACE:.metadata.namespace,NAME:.metadata.name,STATUS:.status.phase,IP:.status.podIP,NODE:.spec.nodeName

## preprod-app1
kubectl -n preprod-app1 get pods -o=custom-
columns=NAMESPACE:.metadata.namespace,NAME:.metadata.name,STATUS:.status.phase,IP:.status.podIP,NODE:.spec.nodeName

## preprod-app2
kubectl -n preprod-app2 get pods -o=custom-
columns=NAMESPACE:.metadata.namespace,NAME:.metadata.name,STATUS:.status.phase,IP:.status.podIP,NODE:.spec.nodeName
```

```
## BITTE die Infos zwischen speichern oder Screenshot machen
```

Schritt 4: Zugriffe auf dev-app2/prepod-app2 klären

```
## nodeip rausbekommen
kubectl get nodes -o wide
```

```
kubectl get svc -n dev-app2 nginx
```

```
tln1@k8s-client:~/manifests/10-antrea$ kubectl get svc -n dev-app2-$KURZ nginx
NAME    TYPE       CLUSTER-IP      EXTERNAL-IP   PORT(S)        AGE
nginx   NodePort   10.101.253.56   <none>        80:32767/TCP   25m
```

```
curl -i http://10.135.0.5:32767
## oder im Browser mit Public - IP
```

```
kubectl get svc -n preprod-app2 nginx
```

```
NAME    TYPE       CLUSTER-IP       EXTERNAL-IP   PORT(S)        AGE
nginx   NodePort   10.106.173.151   <none>        80:31836/TCP   14m
```

```
curl -i http://10.135.0.5:31836
```

Schritt 5: Zugriff ohne antrea policy testen

```
kubectl exec -it -n dev-app1 deployment/ubuntu-20-04 -- /bin/bash
```

```
## scannen des netzes
## !!! Achtung Netz kann anders sein !!!
nmap 10.244.0.0/22
```

```
Nmap scan report for 10.244.3.18
Host is up (0.0038s latency).
All 1000 scanned ports on 10.244.3.18 are closed

Nmap scan report for 10-244-3-19.nginx.preprod-app2-jm.svc.cluster.local (10.244.3.19)
Host is up (0.0032s latency).
Not shown: 999 closed ports
PORT   STATE SERVICE
80/tcp open  http

Nmap scan report for 10-244-3-20.mysql8-service.preprod-app2-jm.svc.cluster.local (10.244.3.20)
Host is up (0.0031s latency).
Not shown: 999 closed ports
PORT     STATE SERVICE
3306/tcp open  mysql

Nmap done: 1024 IP addresses (44 hosts up) scanned in 15.46 seconds
```

- Namen werden aufgelöst (rückwärtig)
- alle ports sind einsehbar
- Verbindung funktioniert nach überall

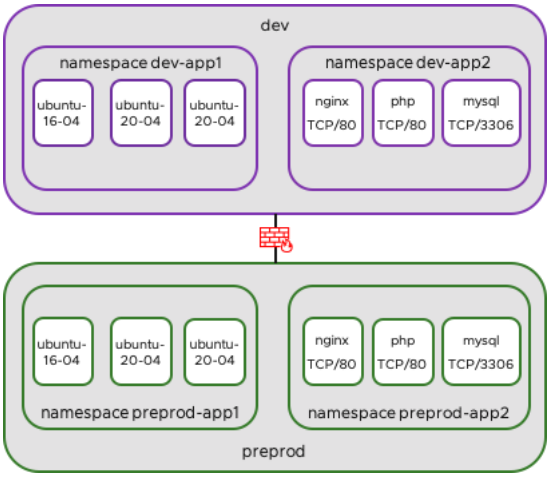
```
## mysql preprod herausfinden
## !!! Achtung Netz ändern
nmap 10.244.0.0/22 | grep mysql | grep preprod
```

```
root@ubuntu-20-04-66598645fd-4gsjg:/# nmap 10.244.0.0/22 | grep mysql | grep preprod
Nmap scan report for 10-244-3-20.mysql8-service.preprod-app2-jm.svc.cluster.local (10.244.3.20)
```

```
## Oh, wir haben das Passwort herausgefunden (Social Engineering ;o))
.sweetpwd.
```

```
mysql -h 10-244-3-20.mysql8-service.preprod-app2.svc.cluster.local -p
```

Schritt 6: Isolieren von dev und preprod




```
## Namspaces labeln
kubectl label ns dev-app1 env=dev ns=dev-app1
kubectl label ns dev-app2 env=dev ns=dev-app2
kubectl label ns preprod-app1 env=preprod ns=preprod-app1
kubectl label ns preprod-app2 env=preprod ns=preprod-app2

kubectl describe ns dev-app1
```

```
## now create the policy
## nano 10-deny-dev-to-preprod.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: deny-dev-to-preprod
spec:
    priority: 100
    tier: SecurityOps
    appliedTo:
      - namespaceSelector:
          matchLabels:
            env: preprod
    ingress:
      - action: Drop
        from:
          - namespaceSelector:
              matchLabels:
                env: dev
```

```
## Test ob ping von preprod nach dev funktioniert
## Hier ein POD-IP raussuchen
kubectl -n dev-app1 get pods -o wide
kubectl -n preprod-app1 exec deployments/ubuntu-20-04 -- ping 10.244.3.15

## Test ob ping von dev nach preprod funktioniert - der sollte nicht funktionieren
## Hier eine POD-IP rausschen
kubectl -n preprod-app1 get pods -o wide
kubectl -n dev-app1 exec deployments/ubuntu-20-04 -- ping 10.244.2.25
```

```
## ClusterNetworkPolicy anwenden
kubectl apply -f .
```

```
## Jetzt nochmal die Pings testen von oben
## ---> Ping ist immer noch möglich --> da keine Firewall - Regel
kubectl -n preprod-app1 exec deployments/ubuntu-20-04 -- ping 10.244.3.15

## in die andere Richtung geht es aber nicht !!
kubectl -n dev-app1 exec deployments/ubuntu-20-04 -- ping 10.244.2.25
```

```
## ok jetzt in die andere richtung
## nano 15-deny-preprod-to-dev.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
```

```
  name: deny-preprod-to-dev
spec:
    priority: 101
    tier: SecurityOps
    appliedTo:
      - namespaceSelector:
          matchLabels:
            env: dev
    ingress:
      - action: Drop
        from:
          - namespaceSelector:
              matchLabels:
                env: preprod
```

```
kubectl apply -f .
kubectl get clusternetworkpolicies
```

```
## Only output
NAME                     TIER          PRIORITY   DESIRED NODES   CURRENT NODES   AGE
deny-dev-to-preprod-jm   SecurityOps   100        2               2               16m
deny-preprod-to-dev      SecurityOps   101        2               2               3m15s
```

```
## und jetzt geht pingen in die andere Richtung auch nicht mehr
kubectl -n preprod-app1 exec deployments/ubuntu-20-04 -- ping 10.244.3.15
```

Schritt 7: Isolate Pods (allow only traffic within the namespaces)

- Aktuell ist das ping vom preprod-app1 zum preprod-app2 namespace noch möglich
- Das wollen wir einschränken
- Ausserdem von dev-app1 zu dev-app2

```
## So sehen unsere Namespace - Labels aus
kubectl describe namespace dev-app1
```

```
## Ausgabe, z.B.
Name:         dev-app1-jm
Labels:       env=dev-jm
              ns=dev-app1-jm
```

```
## nano 20-allow-ns-dev-app1-dev-app1.yaml
## Traffic innerhalb des Namespaces erlaubt

apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 20-allow-ns-dev-app1-dev-app1
spec:
    priority: 100
    tier: application
    appliedTo:
      - namespaceSelector:
          matchLabels:
            ns: dev-app1
    ingress:
      - action: Allow
        from:
          - namespaceSelector:
              matchLabels:
                ns: dev-app1
```

```
kubectl apply -f .
```

```
## nano 25-drop-any-ns-dev-app1.yaml
## allen anderen Traffic zum namespace app2 hin verbieten aus anderen namespaces
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 25-drop-any-ns-dev-app1
spec:
    priority: 110
    tier: application
    appliedTo:
      - namespaceSelector:
          matchLabels:
            ns: dev-app1
```

```
    ingress:
      - action: Drop
        from:
          - namespaceSelector: {}
```

```
kubectl apply -f .
```

```
## nano 30-allow-ns-preprod-app1-preprod-app1.yaml
## Same for preprod-app1
## Allow all traffic within namespace
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 30-allow-ns-preprod-app1-preprod-app1
spec:
    priority: 120
    tier: application
    appliedTo:
      - namespaceSelector:
          matchLabels:
            ns: preprod-app1
    ingress:
      - action: Allow
        from:
          - namespaceSelector:
              matchLabels:
                ns: preprod-app1
```

```
kubectl apply -f .
```

```
## disallow all traffic from other namespaces to prepr
## nano 35-drop-any-ns-preprod-app1.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 35-drop-any-ns-preprod-app1
spec:
    priority: 130
    tier: application
    appliedTo:
      - namespaceSelector:
          matchLabels:
            ns: preprod-app1
    ingress:
      - action: Drop
        from:
          - namespaceSelector: {}
```

```
kubectl apply -f .
```

```
## TESTEN
## Pod ausfinding machen, und ip vom 2. Pod finden in preprod-app1
kubectl -n preprod-app1 get pods -o wide
kubectl -n preprod-app1 exec -it ubuntu-16-04-b7d656f5b-f55rs -- ping 192.168.1.12
## ping aus anderem Namespace sollte nicht gehen
kubectl -n preprod-app2 get pods -o wide
kubectl -n preprod-app2 exec -it appserver-98bc7fd55-bjv94 -- ping 192.168.1.12
```

Schritt 8: Isolate traffic within app2 - namespaces (3-Tier-app)

```
## For dev-app2 we want
web->app (80)
app->db (3306)
drop everything else
```

```
kubectl -n dev-app2 describe pods | head -n 20
kubectl -n preprod-app2 describe pods | head -n 20
```

```
Name:             appserver-8596ff696-14bpm
Namespace:        dev-app2-jm
Priority:         0
Service Account:  default
Node:             worker3/10.135.0.8
Start Time:       Wed, 29 Nov 2023 04:44:37 +0000
Labels:           app=app
                  kind=dev
                  pod-template-hash=8596ff696
```

- we are using the label app=xxx

```
## nano 40-allow-web-app.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 40-allow-web-app
spec:
    priority: 10
    tier: application
    appliedTo:
      - podSelector:
          matchLabels:
            app: app
    ingress:
      - action: Allow
        from:
          - podSelector:
              matchLabels:
                app: nginx
        ports:
          - protocol: TCP
            port: 80
```

```
kubectl apply -f  .
```

```
## nano 45-allow-app-db.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 02-allow-app-db
spec:
    priority: 20
    tier: application
    appliedTo:
      - podSelector:
          matchLabels:
            app: mysql8
    ingress:
      - action: Allow
        from:
          - podSelector:
              matchLabels:
                app: app
        ports:
          - protocol: TCP
            port: 3306
```

```
kubectl apply -f .
```

```
## nano 50-deny-any-to-app2.yaml
## Deny everything else
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 50-deny-any-to-app2
spec:
    priority: 30
    tier: application
    appliedTo:
      - namespaceSelector:
```

```
          matchLabels:
                  ns: dev-app2
      - namespaceSelector:
          matchLabels:
                  ns: preprod-app2
    ingress:
      - action: Drop
        from:
          - namespaceSelector: {}
```

```
kubectl apply -f .
```

```
## TESTEN -> das sollte gehen // VOM web->app
kubectl -n dev-app2 get pods -l app=app -o wide
kubectl -n dev-app2 exec -it nginx-655cc89789-cjfmh -- curl -i http://192.168.1.9

## TESTEN -> geht nicht // VOM app->web
kubectl -n dev-app2 get pods -l app=nginx -o wide
kubectl -n dev-app2 exec -it appserver-8596ff696-jd9k4 -- wget -O - 192.168.2.8
```

Schritt 9: Usage of the Emergency Tier - e.g. Attack

- We have problems with Ubuntu 16.04. an we want to isolate it.

```
kubectl get tiers
```

```
## nano 80-emergency.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 50-deny-any-pod-ubuntu16
spec:
    priority: 50
    tier: emergency
    appliedTo:
      - podSelector:
          matchLabels:
                  app: ubuntu-16-04
    ingress:
      - action: Drop
        from:
          - namespaceSelector: {}
```

```
kubectl apply -f .
```

- Because Emergency has the highest priority, the policy in application (allow any in ns-app1) has no Impact anymore.

```
## TESTEN
## GET IP
kubectl -n dev-app1 get pods -l app=ubuntu-16-04 -o wide
## Use that IP for testing, e.g. 192.168.1.8
kubectl -n dev-app1 exec -it ubuntu-20-04-66598645fd-dfx7f -- ping 192.168.1.8
```

Reference:

- https://www.vrealize.it/2020/09/28/securing-you-k8s-network-with-antrea-clusternetworkpolicy/

Kubernetes calico (CNI-Plugin)

Find corresponding networks

Walkthrough

```
## Step 1: create pod
kubectl run nginx-master --image=nginx
## Find out on which node it runs
kubectl get pods -o wide
## create a debug container
kubectl debug -it nginx-master --image=busybox
```

```
## now within debug pod found out interface
 ip a | grep @
3: eth0@if22: <BROADCAST,MULTICAST,UP,LOWER_UP,M-DOWN> mtu 1500 qdisc noqueue
```

```
## Log in to worker node  where pod runs and check interfaces
kubectl debug -it node/worker1 --image=busybox
```

```
## on worker node
## show matched line starting with 22 and then another 4 lines
ip a | grep -A 5 ^22
## e.g.
##
ip a | grep -A 5 ^22
22: cali42c2aab93f3@if3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group default
    link/ether ee:ee:ee:ee:ee:ee brd ff:ff:ff:ff:ff:ff link-netns cni-5adf994b-3a7e-c344-5d82-ef1f7a293d88
    inet6 fe80::ecee:eeff:feee:eeee/64 scope link
       valid_lft forever preferred_lft forever
```

```
## Now you are able to determine the firewall rules
## you will find fw and tw rules (fw - from workload and tw - to workload)
iptables -L -v | grep  cali42c2aab93f3
```

```
## ... That is what you see as an example
Chain cali-tw-cali42c2aab93f3 (1 references)
 pkts bytes target     prot opt in     out     source               destination
   10  1384 ACCEPT     all  --  any    any     anywhere             anywhere             /* cali:WKA8EzdUNM0rVty1 */ ctstate
RELATED,ESTABLISHED
    0     0 DROP       all  --  any    any     anywhere             anywhere             /* cali:wr_OqGXKIN_LWnX0 */ ctstate
INVALID
    0     0 MARK       all  --  any    any     anywhere             anywhere             /* cali:kOUMqNj8np60A3Bi */ MARK and
0xfffeffff
```

Calico Logging Firewall Rules

General

- NetworkPolicy of Kubernetes does not provide possibility to track

Solutions

- Use NetworkPolicy from calico (to apply it with kubectl - the calico api server needs to be installed) / or use calicoctl
- Enable Tracing
- Use: https://kubernetes.io/blog/2019/04/19/introducing-kube-iptables-tailer/

Solution 1: NetworkPolicy calico

- https://github.com/projectcalico/calico/issues/4344

Logs

```
## Normally you should see it with (on the right kubernetes node)
cat /var/log/syslog | grep calico-packet

## This is how a syslog entry looks like
Here is a example (default) Log:
Apr  3 10:12:30 aks-workerpool1-13987120-vmss000000 kernel: [10821.860593] calico-packet: IN=calic440f455693 OUT=eth0
MAC=ee:ee:ee:ee:ee:ee:f2:f8:09:3d:97:03:08:00 SRC=10.244.2.7 DST=8.8.8.8 LEN=84 TOS=0x00 PREC=0x00 TTL=63 ID=33536 DF PROTO=ICMP
TYPE=8 CODE=0 ID=32113 SEQ=43
```

Walkthrough

```
cd
mkdir -p manifests
cd manifests
mkdir pol2
cd pol2
vi 01-pod.yaml
```

```
apiVersion: v1
kind: Pod
metadata:
  name: static-web
  labels:
    app: web
spec:
  containers:
    - name: web
      image: nginx
      ports:
        - name: web
          containerPort: 80
          protocol: TCP
```

```
vi 02-pol.yaml
```

```
apiVersion: projectcalico.org/v3
kind: NetworkPolicy
metadata:
  name: log
spec:
  selector: app == 'web'
  types:
  - Ingress
  - Egress
  ingress:
  - action: Log
  egress:
  - action: Log
  - action: Deny
```

```
kubectl apply -f .
## find the node, where it runs on
kubectl get pods -o wide
```

```
## login to that node with ssh (kubernetes node)
## e.g. ssh user@node
## switch to root: sudo su -
tail -f /var/log/syslog | grep calico-packet
## or
journalctl -f | grep calico-packet
```

```
## now open a debug pod
kubectl debug -it static-web --image=busybox
## in pod ping - this will not work, because we cannot retrieve dns
ping www.google.de
```

```
## watch output from other node in the meanwhile
```

Reference

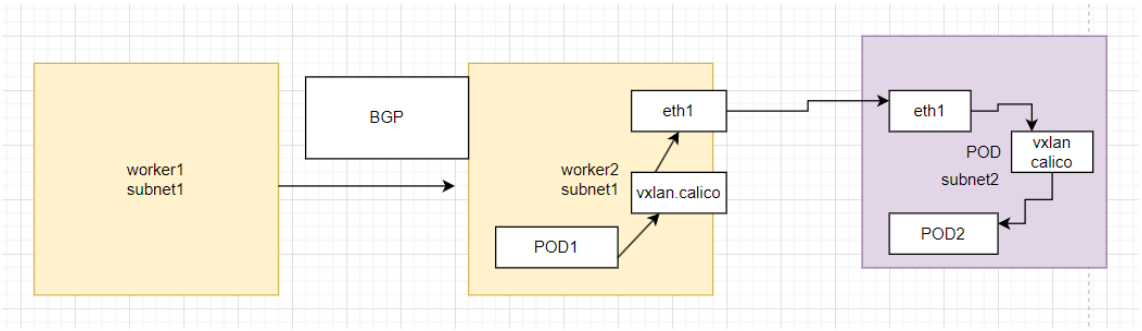
- Eventually set a prefix for logging:
- https://docs.tigera.io/calico-cloud/visibility/iptables

Calico Default Routing Mode BGP & vxlancrossnet

What does it do ?

- BGP is used, when other node is on same subnet
- vxlan is used, when worker node to reach is in other subnet

Grafics

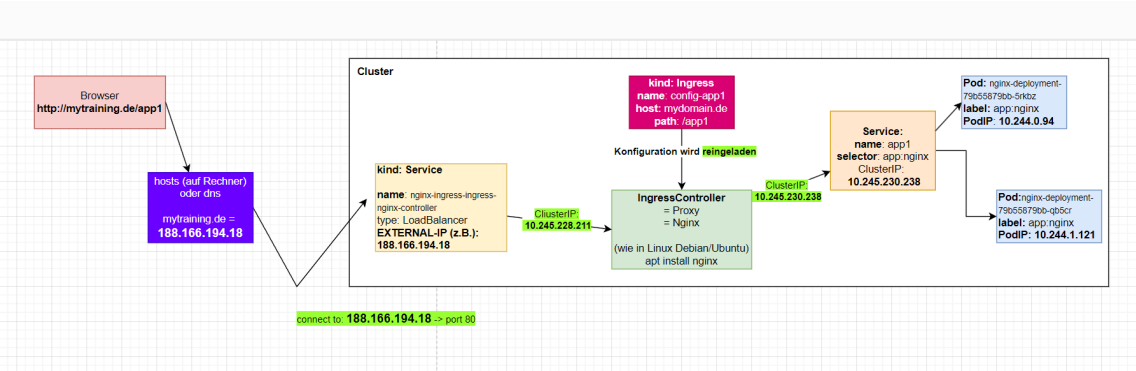


How to find out, if this node is used

```
kubectl -n calico-system get ippool -o yaml | grep vxlan
```

Kubernetes - Ingress

Vom Browser über den Ingress bis zum Pod - Schaubild



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
```

Arbeiten mit tcpdump in pods / ingress controller

Prerequisites: Project abi is up and running

Debug traffic to pod

```
## IP des pod apple-app rausfiltern
kubectl get pods -o wide

kubectl debug apple-app -it --image nicolaka/netshoot
## Show processes of other container first
kubectl debug apple-app -it --image nicolaka/netshoot --target=apple-app
```

in pod

```
ps aux
tcpdump -n port 5678
```

in 2. Session (kubectl)

```
kubectl run -it --rm podtester --image=busybox
```

```
wget -O - <ip-des-apple-pods>:5678
```

Debug traffic to ingress controller

mit netshoot connecten

Variante 1: Direkt

```
kubectl -n ingress debug nginx-ingress-ingress-nginx-controller-7bc7c7776d-jpj5h -it --image nicolaka/netshoot
```

```
## in der shell
tcpdump -n port 80
## write to file in pcap format
Older versions of tcpdump truncate packets to 68 or 96 bytes. If this is the case, use -s to capture full-sized packets:
tcpdump -i <interface> -s 65535 -w <file>
```

Variante 2: Im Hintergrund laufen lassen und connecten

```
kubectl -n ingress debug nginx-ingress-ingress-nginx-controller-7bc7c7776d-jpj5h --image nicolaka/netshoot -- sleep infinite
kubectl -n ingress exec -it nginx-ingress-ingress-nginx-controller-7bc7c7776d-jpj5h -c debugger-gwvsr -- zsh
```

```
## in der shell
tcpdump -n port 80
## write to file in pcap format
Older versions of tcpdump truncate packets to 68 or 96 bytes. If this is the case, use -s to capture full-sized packets:
tcpdump -i <interface> -s 65535 -w <file>
```

Testen

```
## Im browser url aufrufen
## z.B.
http://jochen.lab1.t3isp.de
```

Kubernetes Cheatsheet/Spickzettel

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
## direkt in den 1. Pod des Deployments wechseln
kubectl exec -it deployment/name-des-deployments -- bash
```

Logs ausgeben

```
kubectl logs podname
## -n = namespace
## | less -> seitenweise Ausgabe
kubectl -n ingress logs nginx-ingress-ingress-nginx-controller-7bc7c7776d-jpj5h | less
```

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/

Kubernetes Praxis (zum Verständnis von Netzwerk)

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:1.23

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

Example (that does not work)

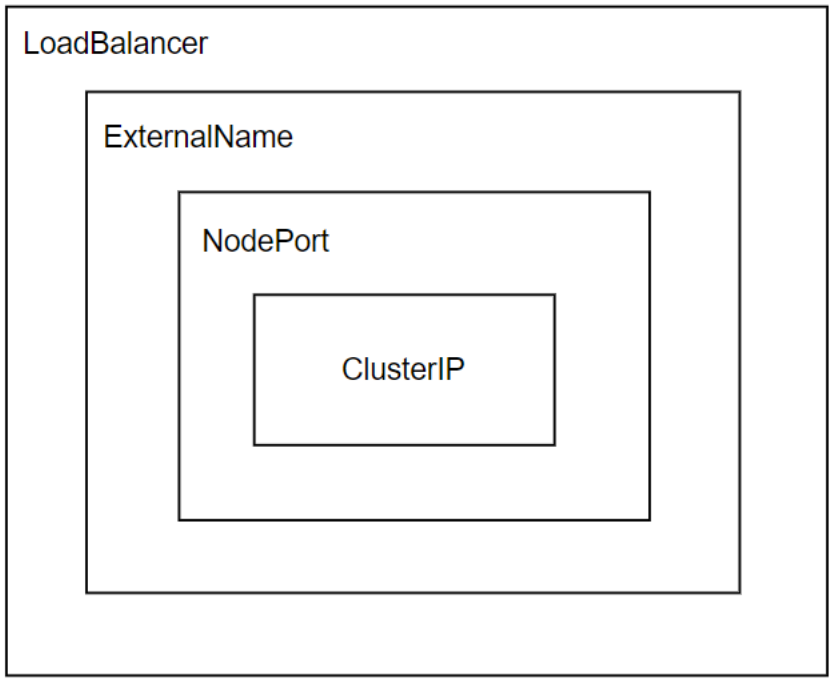
```
kubectl run foo2 --image=foo2
## ImageErrPull - Image konnte nicht geladen werden
```

```
kubectl get pods
## Weitere status - info
kubectl describe pods foo2
```

Ref:

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

Service Typen / Ebenen - Schaubild



kubectl/manifest/service

Schritt 1: Deployment

```
cd
mkdir -p manifests
cd manifests
mkdir 04-service
cd 04-service
##vi 01-deploy.yml
```

```
## 01-deploy.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: my-nginx
spec:
  selector:
    matchLabels:
      app: my-nginx
  replicas: 3
  template:
    metadata:
      labels:
        app: 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:
    app: my-nginx
```

```
kubectl apply -f .
```

Ref.

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

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
```

Beispiel mit Hostnamen

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

```
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
```

Kubernetes Load Balancer

Kubernetes Load Balancer

Attention

- On digitalocean, we will probably run into problems, that it is not working properly

General

- Supports bgp and arp
- Divided into controller, speaker

Installation Ways

- helm
- manifests

Walkthrough Digitalocean

```
## Just to show some basics
## Page from metallb says that digitalocean is not really supported well
## So we will not install the speaker .

helm repo add metallb https://metallb.github.io/metallb
```

```
## Eventually disabling speaker
## vi values.yml
```

```
helm install metallb metallb/metallb --namespace=metallb-system --create-namespace
```

```
cd
mkdir -p manifests
cd manifests
mkdir mb
cd mb
vi 01-cm.yml
```

```
apiVersion: v1
kind: ConfigMap
metadata:
  namespace: metallb-system
  name: config
data:
  config: |
    address-pools:
    - name: default
      protocol: layer2
      addresses:
      # Take the single address in case of digitalocean here.
      # External ip
      # - 192.168.1.240-192.168.1.250
      - 61.46.56.21
```

```
vi 02-svc.yml
```

```
apiVersion: v1
kind: Service
metadata:
  name: nginx-svc
spec:
  selector:

## Adjust -> selector -> according to nginx below
    app: nginx
  ports:
  - name: http
    port: 80
    targetPort: 80
  type: LoadBalancer
  # uncomment to try, if you get it automatically
  loadBalancerIP: 61.46.56.21
```

```
kubectl apply -f .
kubectl -n metallb-system get svc my-service
```

```
kubectl create deployment nginx --image nginx:alpine --port 80 --replicas=1
kubectl get svc nginx-svc
## You can open 80 port on Firewall using Console and open http://167.99.99.99 for a test.
```

Trafic Policy

- https://metallb.universe.tf/usage/

Kubernetes Load Balancer new version for IpAdresses - object

Installatiion

- Refs: https://metallb.universe.tf/installation/

Step 1: Installation:

```
kubectl apply -f https://raw.githubusercontent.com/metallb/metallb/v0.13.9/config/manifests/metallb-native.yaml
```

Step 2: Konfiguration

```
mkdir -p manifests
cd manifests
mkdir metallb
vi 01-pool.yaml
```

```
apiVersion: metallb.io/v1beta1
kind: IPAddressPool
metadata:
  name: first-pool
  namespace: metallb-system
spec:
  addresses:
  - 192.168.1.240-192.168.1.250
```

```
vi 02-l2.yaml
```

```
## now we need to propagate
apiVersion: metallb.io/v1beta1
kind: L2Advertisement
metadata:
  name: example
  namespace: metallb-system
```

References

- https://microk8s.io/docs/addon-metallb
- https://metallb.universe.tf/
- Calico Issues: https://metallb.universe.tf/configuration/calico/

Kubernetes - Netzwerk (CNI's) / Mesh

Calico/Cilium - nginx example NetworkPolicy

Schritt 1: Deployment und Service erstellen

```
KURZ=jm
kubectl create ns policy-demo-$KURZ
```

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

```
## nano 01-deployment.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 1
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.23
        ports:
        - containerPort: 80
```

```
kubectl -n policy-demo-$KURZ apply -f .
```

```
## nano 02-service.yaml
apiVersion: v1
kind: Service
metadata:
  name: nginx
spec:
  type: ClusterIP # Default Wert
  ports:
  - port: 80
```

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

```
kubectl -n policy-demo-$KURZ apply -f .
```

Schritt 2: Zugriff testen ohne Regeln

```
## lassen einen 2. pod laufen mit dem auf den nginx zugreifen
kubectl run --namespace=policy-demo-$KURZ access --rm -ti --image busybox
```

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

```
## Optional: Pod anzeigen in 2. ssh-session zu jump-host
kubectl -n policy-demo-$KURZ get pods --show-labels
```

Schritt 3: Policy festlegen, dass kein Zugriff erlaubt ist.

```
## nano 03-default-deny.yaml
## Schritt 2: Policy festlegen, dass kein Ingress-Traffic erlaubt
## in diesem namespace: policy-demo-$KURZ
kind: NetworkPolicy
apiVersion: networking.k8s.io/v1
metadata:
  name: default-deny
spec:
  podSelector:
    matchLabels: {}
```

```
kubectl -n policy-demo-$KURZ apply -f .
```

Schritt 3.5: Verbindung mit deny all Regeln testen

```
kubectl run --namespace=policy-demo-$KURZ access --rm -ti --image busybox
```

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

Schritt 4: Zugriff erlauben von pods mit dem Label run=access (alle mit run gestarteten pods mit namen access haben dieses label per default)

```
## nano 04-access-nginx.yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: access-nginx
spec:
  podSelector:
    matchLabels:
      app: nginx
  ingress:
    - from:
      - podSelector:
          matchLabels:
            run: access
```

```
kubectl -n policy-demo-$KURZ apply -f .
```

Schritt 5: Testen (zugriff sollte funktionieren)

```
## 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-$KURZ access --rm -ti --image busybox
```

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

Schritt 6: Pod mit label run=no-access - da sollte es nicht gehen

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

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

Schritt 7: Aufräumen

```
kubectl delete ns policy-demo-$KURZ
```

Ref:

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

Beispiele Ingress Egress NetworkPolicy

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

- 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

```
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 .
```

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

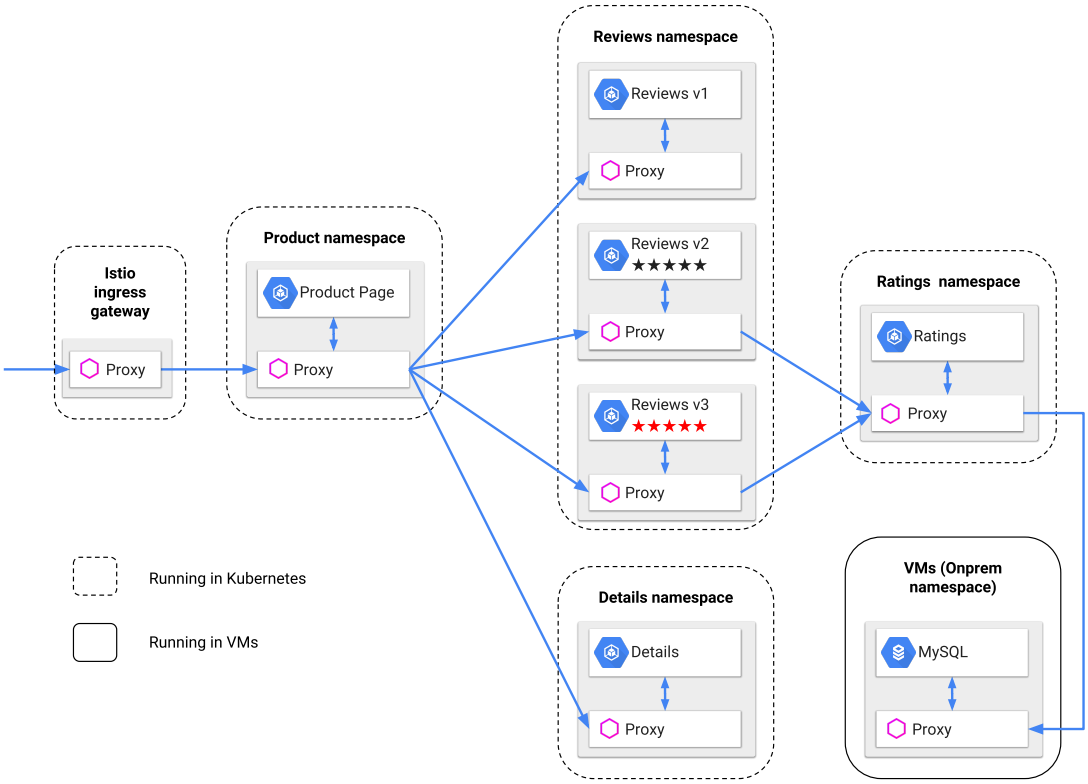
- https://projectcalico.docs.tigera.io/getting-started/kubernetes/hardway/istio-integration

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/

DNS - Resolution - Services

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

Calico NetworkPolicy

Protecting Services

Example

```
apiVersion: projectcalico.org/v3
kind: GlobalNetworkPolicy
metadata:
  name: allow-cluster-ips
spec:
  selector: k8s-role == 'node'
  types:
  - Ingress
  applyOnForward: true
  preDNAT: true
  ingress:
   # Allow 50.60.0.0/16 to access Cluster IP A
  - action: Allow
    source:
      nets:
      - 50.60.0.0/16
    destination:
      nets:
      - 10.20.30.40/32  Cluster IP A
   # Allow 70.80.90.0/24 to access Cluster IP B
  - action: Allow
    source:
      nets:
      - 70.80.90.0/24
    destination:
      nets:
      - 10.20.30.41/32  Cluster IP B
```

Referenz

- https://docs.tigera.io/calico/latest/network-policy/services/services-cluster-ips

Exercise calico Network Policy

Step 1: Set global policy

```
apiVersion: crd.projectcalico.org/v1
kind: GlobalNetworkPolicy
metadata:
  name: default-deny
spec:
  namespaceSelector: kubernetes.io/metadata.name != "kube-system"
  types:
  - Ingress
  - Egress
  egress:
   # allow all namespaces to communicate to DNS pods
  - action: Allow
    protocol: UDP
    destination:
      selector: 'k8s-app == "kube-dns"'
      ports:
      - 53
  - action: Allow
    protocol: TCP
    destination:
      selector: 'k8s-app == "kube-dns"'
      ports:
      - 53
```

```
kubectl apply -f .
```

Step 2: nginx ausrollen aus manifests/04-service und testen

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

```
nano deploy.yml
```

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: web-nginx
spec:
  selector:
    matchLabels:
      web: my-nginx
  replicas: 2
  template:
    metadata:
      labels:
        web: my-nginx
    spec:
      containers:
      - name: cont-nginx
        image: nginx
        ports:
        - containerPort: 80
```

```
nano service.yml
```

```
apiVersion: v1
kind: Service
metadata:
  name: svc-nginx
  labels:
    run: svc-my-nginx
spec:
  type: ClusterIP
  ports:
  - port: 80
    protocol: TCP
  selector:
    web: my-nginx
```

```
kubectl apply -f .
```

```
kubectl run -it --rm access --image=busybox
```

```
## In der Bbusybox
wget -O - http://svc-nginx
```

Step 3: Traffic erlauben egress von busybox

```
cd
cd manifests
mkdir cnp
cd cnp
```

```
## vi 02-egress-allow-busybox.yml
apiVersion: crd.projectcalico.org/v1
kind: NetworkPolicy
metadata:
  name: allow-busybox-egress
spec:
  selector: run == 'access'
  types:
  - Egress
  egress:
  - action: Allow
```

```
kubectl apply -f .
```

```
kubectl run -it --rm access --image=busybox
```

```
## sollte gehen
wget -O - http://www.google.de

## sollte nicht funktionieren
wget -O - http://my-nginx
```

Step 4: Traffic erlauben für nginx

```
## 03-allow-ingress-my-nginx.yml
apiVersion: crd.projectcalico.org/v1
kind: NetworkPolicy
metadata:
  name: allow-nginx-ingress
spec:
  selector: run == 'my-nginx'
  types:
  - Ingress
  ingress:
  - action: Allow
    source:
      selector: run == 'access'
```

```
kubectl apply -f .
```

```
kubectl run -it --rm access --image=busybox
```

```
## In der Bbusybox
wget -O - http://my-nginx
```

Kubernetes calico (CNI-Plugin)

Welcher Routing-Mode wird im aktuellen Cluster verwendet

```
kubectl -n calico-system describe ds calico-node | grep -A 35  calico-node
## or specific
kubectl -n calico-system describe ds calico-node | egrep -i -e vxlan  -e cluster_type
```

```
Environment:
      DATASTORE_TYPE:                     kubernetes
      WAIT_FOR_DATASTORE:                 true
      CLUSTER_TYPE:                       k8s,operator,bgp
      CALICO_DISABLE_FILE_LOGGING:        false
      FELIX_DEFAULTENDPOINTTOHOSTACTION:  ACCEPT
      FELIX_HEALTHENABLED:                true
      FELIX_HEALTHPORT:                   9099
      NODENAME:                            (v1:spec.nodeName)
      NAMESPACE:                           (v1:metadata.namespace)
      FELIX_TYPHAK8SNAMESPACE:            calico-system
      FELIX_TYPHAK8SSERVICENAME:          calico-typha
      FELIX_TYPHACAFILE:                  /etc/pki/tls/certs/tigera-ca-bundle.crt
      FELIX_TYPHACERTFILE:                /node-certs/tls.crt
      FELIX_TYPHAKEYFILE:                 /node-certs/tls.key
      FIPS_MODE_ENABLED:                  false
      FELIX_TYPHACN:                      typha-server
      CALICO_MANAGE_CNI:                  true
      CALICO_IPV4POOL_CIDR:               192.168.0.0/16
      CALICO_IPV4POOL_VXLAN:              CrossSubnet
      CALICO_IPV4POOL_BLOCK_SIZE:         26
      CALICO_IPV4POOL_NODE_SELECTOR:      all()
      CALICO_IPV4POOL_DISABLE_BGP_EXPORT: false
      CALICO_NETWORKING_BACKEND:          bird
      IP:                                 autodetect
      IP_AUTODETECTION_METHOD:            first-found
      IP6:                                none
      FELIX_IPV6SUPPORT:                  false
      KUBERNETES_SERVICE_HOST:            10.96.0.1
      KUBERNETES_SERVICE_PORT:            443
    Mounts:
```

Wird eBPF verwendet ?

- Hint: By default this should not be activated

Version microk8s

```
kubectl -n kube-system logs calico-node-78s8q | grep -i bpfenabled
```

Version installed on your own in cluster, e.g. kubeadm

```
## Is in different namespace in this case
kubectl -n calico-system logs calico-node-78s8q | grep -i bpfenabled
```

Install calicoctl in pod

General

It was like that ....

- calicoctl used to do validation locally in calicoctl for your manifests in the projectcalico/v3 api-version
- This version was not available in kube-api-server

Now ....

- Validation takes place on server side.
- For this to work the kube-api-server needs to be configured with calico
- Now the preferred method is to use kubectl (without dependencies to calicoctl) but not for.....
  - calicoctl node
  - calicoctl ipam
  - calicoctl convert
  - calicoctl version

Reference:

- https://docs.tigera.io/calico/latest/operations/calicoctl/configure/kdd

calicoctl Installation walkthrough (running in pod)

Find out version

```
## welche version von calico setzen wir aktuell auf dem server ein
kubectl -n kube-system get ds calico-node -o=jsonpath='{.spec.template.spec.containers[0].image}'
## docker.io/calico/node:v3.23.5
```

Pod erstellen für calicoctl auf Basis von

```
cd
mkdir -p manifests
cd manifests
mkdir calicoctl
cd calicoctl
vi calicoctl.yaml
```

```
### https://raw.githubusercontent.com/projectcalico/calico/v3.25.1/manifests/calicoctl.yaml
### Calico Version master
## https://projectcalico.docs.tigera.io/releases#master
## This manifest includes the following component versions:
##   calico/ctl:v3.25.1



apiVersion: v1
kind: ServiceAccount
metadata:
  name: calicoctl
  namespace: kube-system

---

apiVersion: v1
kind: Pod
metadata:
  name: calicoctl
  namespace: kube-system
spec:
  nodeSelector:
    kubernetes.io/os: linux
  hostNetwork: true
  serviceAccountName: calicoctl
  containers:
  - name: calicoctl
    image: calico/ctl:v3.23.5
```

```
    command:
      - /calicoctl
    args:
      - version
      - --poll=1m
    env:
    - name: DATASTORE_TYPE
      value: kubernetes

---

kind: ClusterRole
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: calicoctl
rules:
  - apiGroups: [""]
    resources:
      - namespaces
      - nodes
    verbs:
      - get
      - list
      - update
  - apiGroups: [""]
    resources:
      - nodes/status
    verbs:
      - update
  - apiGroups: [""]
    resources:
      - pods
      - serviceaccounts
    verbs:
      - get
      - list
  - apiGroups: [""]
    resources:
      - pods/status
    verbs:
      - update
  - apiGroups: ["crd.projectcalico.org"]
    resources:
      - bgppeers
      - bgpconfigurations
      - clusterinformations
      - felixconfigurations
      - globalnetworkpolicies
      - globalnetworksets
      - ippools
      - ipreservations
      - kubecontrollersconfigurations
      - networkpolicies
      - networksets
      - hostendpoints
      - ipamblocks
      - blockaffinities
      - ipamhandles
      - ipamconfigs
    verbs:
      - create
      - get
      - list
      - update
      - delete
  - apiGroups: ["networking.k8s.io"]
    resources:
      - networkpolicies
    verbs:
      - get
      - list

---

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: calicoctl
```

```
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: calicoctl
subjects:
- kind: ServiceAccount
  name: calicoctl
  namespace: kube-system
```

calicoctl verwenden

```
## this will always work, no matter what version
kubectl -n kube-system exec calicoctl -- /calicoctl version

## this will only work without flags, if we have the same version
## on both sides
```

Wann calicoctl (Stand 2024/01 calico 3.27)

Für Informationen über die Nodes (z.B. BGP) - direkt auf Node ausführen

- calicoctl get nodes

Um Zusatzinformationen abzufragen, die nur in calicoctl zur Verfügung stehen

```
## namespace in command needs to be written at then end
calicoctl get wep -n namespace-der-application

## get version
calicoctl version

## show cidr / the ippool
calicoctl ipam show
calicoctl ipam check
```

Calico - only on one of nodes (e.g. controlplane - need to login with ssh)

```
## .kube/config does not need to be configured
calicoctl node status
calicoctl ipam status
```

Install calico-api-server to use kubectl instead of calicoctl

prepare kube-api-server for to be use for calico calls.

- Possible from calico 3.20+ (GA)
- https://docs.tigera.io/calico/latest/operations/install-apiserver

Step 1: Apply manifests for api server

```
cd
mkdir -p manifests
cd manifests
## calico api server
mkdir cas
cd cas
vi cas.yaml
```

```
## taken from https://raw.githubusercontent.com/projectcalico/calico/v3.25.1/manifests/apiserver.yaml
## but adjusted images version to corresponding installation
## kubectl -n kube-system get ds calico-node -o=jsonpath='{.spec.template.spec.containers[0].image}'
## This is a tech-preview manifest which installs the Calico API server. Note that this manifest is liable to change
## or be removed in future releases without further warning.
##
## Namespace and namespace-scoped resources.
apiVersion: v1
kind: Namespace
metadata:
  labels:
    name: calico-apiserver
  name: calico-apiserver
spec:

---

## Policy to ensure the API server isn't cut off. Can be modified, but ensure
```

```
## that the main API server is always able to reach the Calico API server.
kind: NetworkPolicy
apiVersion: networking.k8s.io/v1
metadata:
  name: allow-apiserver
  namespace: calico-apiserver
spec:
  podSelector:
    matchLabels:
      apiserver: "true"
  ingress:
  - ports:
    - protocol: TCP
      port: 5443

---

apiVersion: v1
kind: Service
metadata:
  name: calico-api
  namespace: calico-apiserver
spec:
  ports:
  - name: apiserver
    port: 443
    protocol: TCP
    targetPort: 5443
  selector:
    apiserver: "true"
  type: ClusterIP

---

apiVersion: apps/v1
kind: Deployment
metadata:
  labels:
    apiserver: "true"
    k8s-app: calico-apiserver
  name: calico-apiserver
  namespace: calico-apiserver
spec:
  replicas: 1
  selector:
    matchLabels:
      apiserver: "true"
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        apiserver: "true"
        k8s-app: calico-apiserver
      name: calico-apiserver
      namespace: calico-apiserver
    spec:
      containers:
      - args:
        - --secure-port=5443
        # - -v=5 # not working in v3.23.5 not available as flag there
        env:
        - name: DATASTORE_TYPE
          value: kubernetes
        image: calico/apiserver:v3.23.5
        livenessProbe:
          httpGet:
            path: /version
            port: 5443
            scheme: HTTPS
          initialDelaySeconds: 90
          periodSeconds: 10
        name: calico-apiserver
        readinessProbe:
          exec:
            command:
            - /code/filecheck
          failureThreshold: 5
```

```
          initialDelaySeconds: 5
          periodSeconds: 10
        securityContext:
          privileged: false
          runAsUser: 0
        volumeMounts:
        - mountPath: /code/apiserver.local.config/certificates
          name: calico-apiserver-certs
      dnsPolicy: ClusterFirst
      nodeSelector:
        kubernetes.io/os: linux
      restartPolicy: Always
      serviceAccount: calico-apiserver
      serviceAccountName: calico-apiserver
      tolerations:
      - effect: NoSchedule
        key: node-role.kubernetes.io/master
      - effect: NoSchedule
        key: node-role.kubernetes.io/control-plane
      volumes:
      - name: calico-apiserver-certs
        secret:
          secretName: calico-apiserver-certs

---

apiVersion: v1
kind: ServiceAccount
metadata:
  name: calico-apiserver
  namespace: calico-apiserver

---

## Cluster-scoped resources below here.
apiVersion: apiregistration.k8s.io/v1
kind: APIService
metadata:
  name: v3.projectcalico.org
spec:
  group: projectcalico.org
  groupPriorityMinimum: 1500
  service:
    name: calico-api
    namespace: calico-apiserver
    port: 443
  version: v3
  versionPriority: 200

---

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: calico-crds
rules:
- apiGroups:
  - extensions
  - networking.k8s.io
  - ""
  resources:
  - networkpolicies
  - nodes
  - namespaces
  - pods
  - serviceaccounts
  verbs:
  - get
  - list
  - watch
- apiGroups:
  - crd.projectcalico.org
  resources:
  - globalnetworkpolicies
  - networkpolicies
  - clusterinformations
  - hostendpoints
  - globalnetworksets
```

```
  - networksets
  - bgpconfigurations
  - bgppeers
  - felixconfigurations
  - kubecontrollersconfigurations
  - ippools
  - ipreservations
  - ipamblocks
  - blockaffinities
  - caliconodestatuses
  - ipamconfigs
  verbs:
  - get
  - list
  - watch
  - create
  - update
  - delete
- apiGroups:
  - policy
  resourceNames:
  - calico-apiserver
  resources:
  - podsecuritypolicies
  verbs:
  - use

---

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: calico-extension-apiserver-auth-access
rules:
- apiGroups:
  - ""
  resourceNames:
  - extension-apiserver-authentication
  resources:
  - configmaps
  verbs:
  - list
  - watch
  - get
- apiGroups:
  - rbac.authorization.k8s.io
  resources:
  - clusterroles
  - clusterrolebindings
  - roles
  - rolebindings
  verbs:
  - get
  - list
  - watch

---

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: calico-webhook-reader
rules:
- apiGroups:
  - admissionregistration.k8s.io
  resources:
  - mutatingwebhookconfigurations
  - validatingwebhookconfigurations
  verbs:
  - get
  - list
  - watch

---

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
```

```
  name: calico-apiserver-access-crds
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: calico-crds
subjects:
- kind: ServiceAccount
  name: calico-apiserver
  namespace: calico-apiserver

---

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: calico-apiserver-delegate-auth
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: system:auth-delegator
subjects:
- kind: ServiceAccount
  name: calico-apiserver
  namespace: calico-apiserver

---

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: calico-apiserver-webhook-reader
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: calico-webhook-reader
subjects:
- kind: ServiceAccount
  name: calico-apiserver
  namespace: calico-apiserver

---

apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: calico-extension-apiserver-auth-access
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: calico-extension-apiserver-auth-access
subjects:
- kind: ServiceAccount
  name: calico-apiserver
  namespace: calico-apiserver
```

Step 2: create certificates

```
openssl req -x509 -nodes -newkey rsa:4096 -keyout apiserver.key -out apiserver.crt -days 365 -subj "/" -addext "subjectAltName =
DNS:calico-api.calico-apiserver.svc"
kubectl create secret -n calico-apiserver generic calico-apiserver-certs --from-file=apiserver.key --from-file=apiserver.crt
## configure server with ca-bundle
kubectl patch apiservice v3.projectcalico.org -p \
    "{\"spec\": {\"caBundle\": \"$(kubectl get secret -n calico-apiserver calico-apiserver-certs -o go-template='{{ index .data
"apiserver.crt" }}')\"}}"
```

Step 3: check if it is working

```
## pod should run
kubectl -n calico-apiserver get pods
## if not delete it
## e.g.
kubectl -n calico-apiserver delete po calico-apiserver-6f64fdcc5c-kz45t
## it will get recreated because of deployment
```

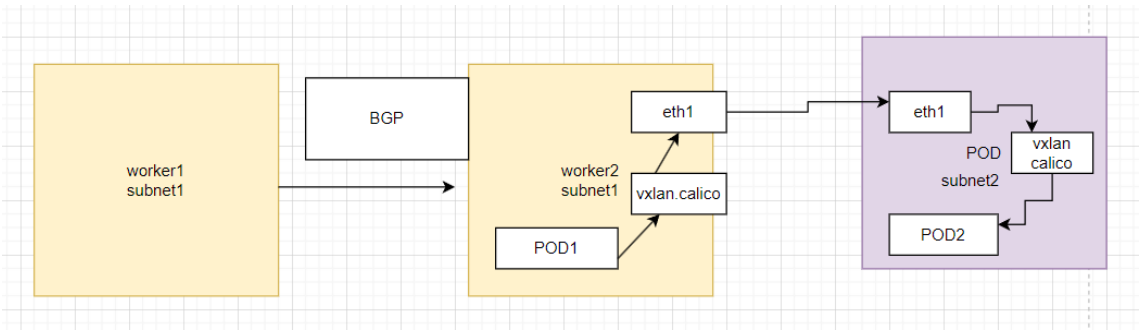
```
kubectl api-resources | grep '\sprojectcalico.org'
## only available in v3
kubectl get clusterinfo
```

Calico Default Routing Mode BGP & vxlancrossnet

What does it do ?

- BGP is used, when other node is on same subnet
- vxlan is used, when worker node to reach is in other subnet

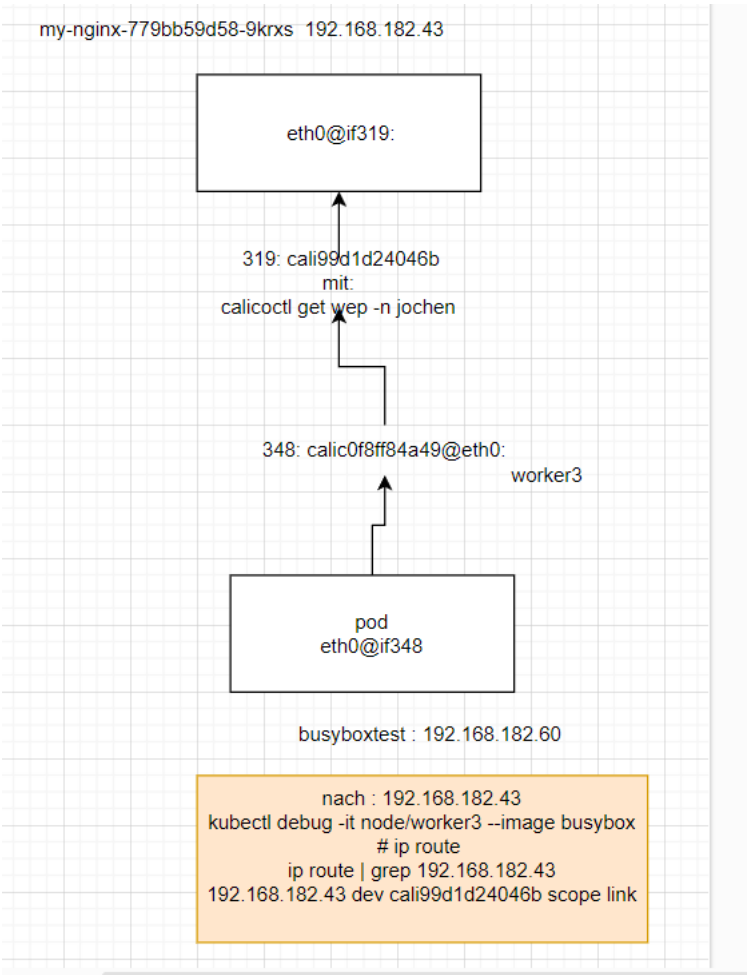
Grafics



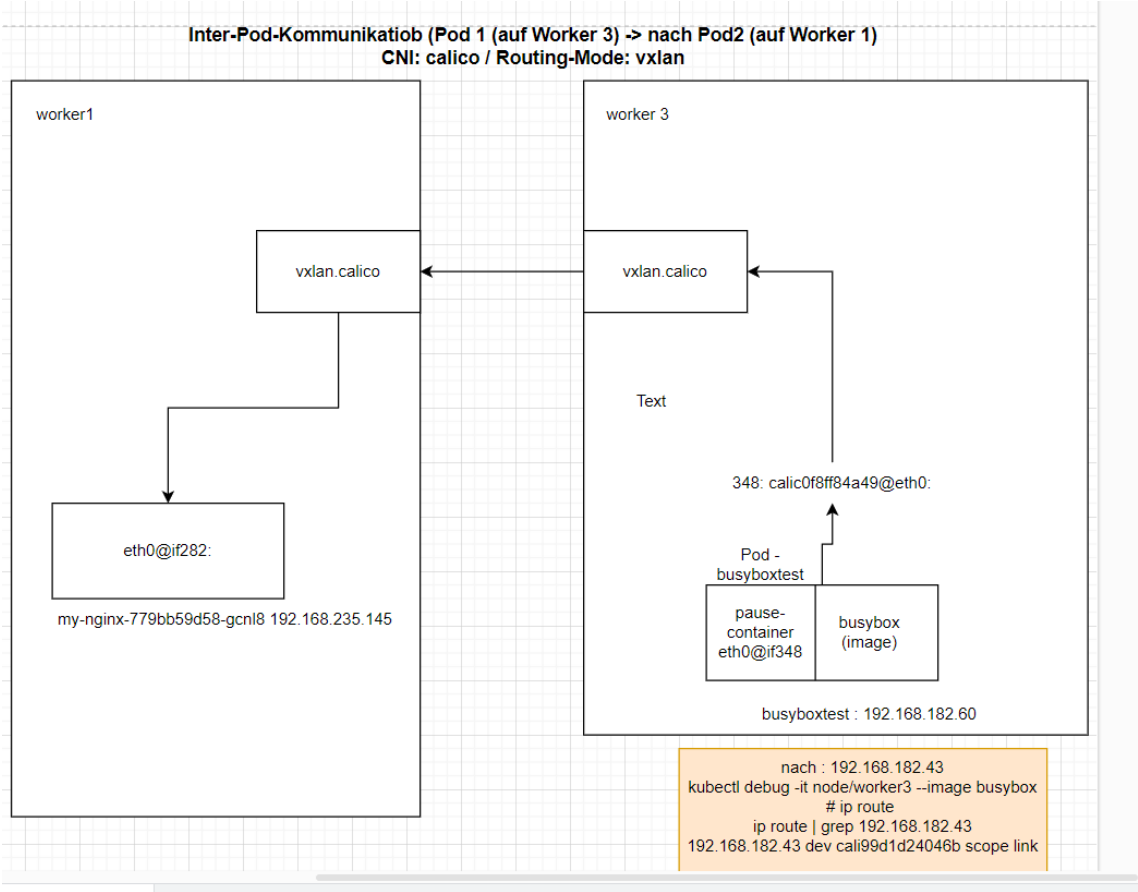
How to find out, if this node is used

```
kubectl -n calico-system get ippool -o yaml | grep vxlan
```

Internals - Pod to Pod - Communication on Worker3 (node))

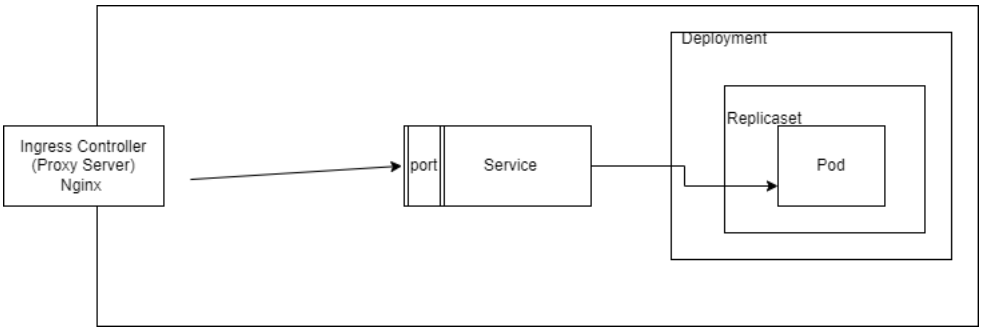


Internals - Inter-Pod - Communication (worker 3 -> worker 1



Kubernetes Praxis API-Objekte

Bauen einer Applikation mit Resource Objekten



Pod manifest

Walkthrough

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

```
## vi nginx-static.yml

apiVersion: v1
kind: Pod
metadata:
```

```
  name: nginx-static-web
  labels:
    webserver: nginx
spec:
  containers:
  - name: web
    image: nginx
```

```
kubectl apply -f nginx-static.yml
kubectl describe pod nginx-static-web
## show config
kubectl get pod/nginx-static-web -o yaml
kubectl get pod/nginx-static-web -o wide
```

Replicasets

```
cd
mkdir -p manifests
cd manifests
mkdir 02-rs
cd 02-rs
## vi rs.yml
```

```
apiVersion: apps/v1
kind: ReplicaSet
metadata:
  name: nginx-replica-set
spec:
  replicas: 2
  selector:
    matchLabels:
      tier: frontend
  template:
    metadata:
      name: template-nginx-replica-set
      labels:
        tier: frontend
    spec:
      containers:
        - name: nginx
          image: nginx:1.21
          ports:
            - containerPort: 80
```

```
kubectl apply -f rs.yml
```

kubectl/manifest/deployments

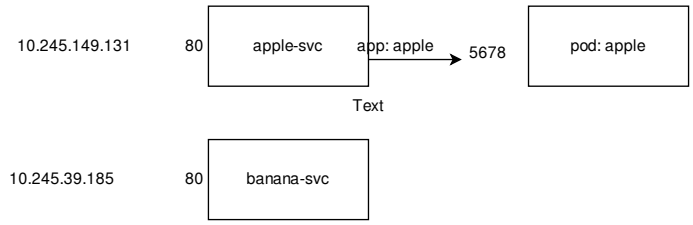
```
cd
mkdir -p manifests
cd manifests
mkdir 03-deploy
cd 03-deploy
nano deploy.yml
```

```
## vi deploy.yml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  selector:
    matchLabels:
      app: nginx
  replicas: 8 # tells deployment to run 8 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



Hintergrund Ingress

Ref. / Dokumentation

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

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
```

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 - 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

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 .
```

Kubernetes multus (Meta-CNI - Plugin)

Multus Überblick

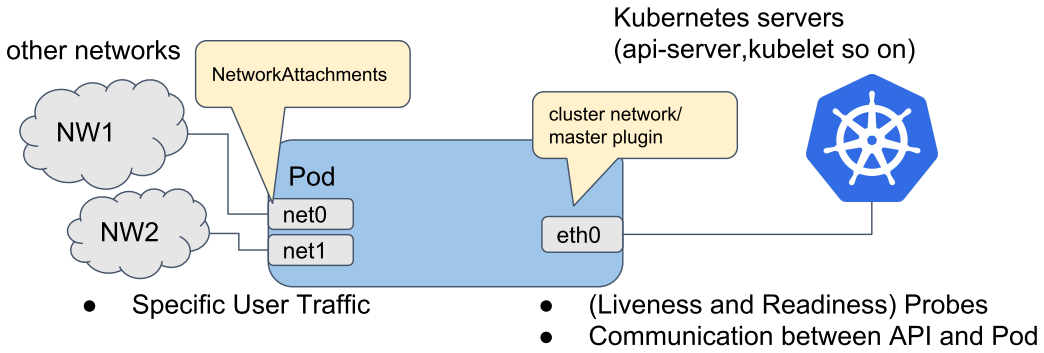
Problem, Warum multus ?

- Aktuell kann seitens kubernetes nur ein Interface verwaltet werden, weil der CNI-Call nur 1x ausgeführt wird. (eigentlich 2x wenn man localhost mit einbezieht)

Prerequisites

- a CNI, that manages the network needs to be installed before hand, like Calico, Cilium

Graphics



General

- Multus is a meta-plugin, which makes it possible to attach additional networks to your pod (multi - homing)

macvlan plugin

Example macvlan

- https://github.com/k8snetworkplumbingwg/multus-cni/blob/master/examples/macvlan-pod.yml

```
---
## This net-attach-def defines macvlan-conf with
##   + ips capabilities to specify ip in pod annotation and
##   + mac capabilities to specify mac address in pod annotation
## default gateway is defined as well
apiVersion: "k8s.cni.cncf.io/v1"
kind: NetworkAttachmentDefinition
metadata:
  name: macvlan-conf
spec:
  config: '{
      "cniVersion": "0.3.1",
      "plugins": [
        {
          "type": "macvlan",
          "capabilities": { "ips": true },
          "master": "eth0",
          "mode": "bridge",
          "ipam": {
            "type": "static",
            "routes": [
              {
                "dst": "0.0.0.0/0",
                "gw": "10.1.1.1"
              }
            ]
          }
        }, {
          "capabilities": { "mac": true },
          "type": "tuning"
        }
      ]
    }'
---
## Define a pod with macvlan-conf, defined above, with ip address and mac, and
## "gateway" overrides default gateway to use macvlan-conf's one.
## without "gateway" in k8s.v1.cni.cncf.io/networks, default route will be cluster
## network interface, eth0, even tough macvlan-conf has default gateway config.
apiVersion: v1
kind: Pod
metadata:
  name: samplepod
  annotations:
    k8s.v1.cni.cncf.io/networks: '[
            { "name": "macvlan-conf",
              "ips": [ "10.1.1.101/24" ],
              "mac": "c2:b0:57:49:47:f1",
              "gateway": [ "10.1.1.1" ]
            }]'
```

```
spec:
  containers:
  - name: samplepod
    command: ["/bin/bash", "-c", "trap : TERM INT; sleep infinity & wait"]
    image: dougbtv/centos-network
    ports:
    - containerPort: 80
```

sr-iov mit multus

Voraussetzung: Multus:

Konzept SR-IOV

- Direkte Hardwareanbindung der Netzwerkkarte
- Offload wird auf Netzwerkkarte gemacht (nicht im Kernel)
- bessere Performance

Generell

- Erweiterung des PCI-Express Standarads
- Eine Netzwerkkarte wird mehrmals angeboten und Kommunikation erfolgt direkt und nicht über den Umweg Kernel

Vorbereitung

- https://github.com/k8snetworkplumbingwg/sriov-network-device-plugin
- https://github.com/k8snetworkplumbingwg/sriov-network-device-plugin/tree/db98d96cc0d6ad3fff917ba238bd1cc5cc3f7e82#config-parameters

Einbindung

- https://github.com/k8snetworkplumbingwg/sriov-network-device-plugin#example-deployments
- https://github.com/k8snetworkplumbingwg/multus-cni/blob/master/examples/sriov-pod.yml

Kubernetes coil (egress - gateway)

coil

Opt-In egress-gateway (NAT-Service)

```
apiVersion: coil.cybozu.com/v2
kind: Egress
metadata:
  namespace: internet-egress
  name: nat
spec:
  replicas: 2
  destinations:
  - 0.0.0.0/0
  - ::/0
```

- Not all Pods become the client of Egress. To become a client, Pods need to have special annotations like this:

```
apiVersion: v1
kind: Pod
metadata:
  namespace: default
  name: nat-client
  annotations:
    egress.coil.cybozu.com/internet-egress: nat
spec:
```

Reference

- Refs: https://blog.kintone.io/entry/coilv2
- https://github.com/cybozu-go/coil

Kubernetes antrea (CNI-Plugin)

Unterschiede Dokus vmware (antrea mit nsx-t) und OpenSource Antrea

- OpenSource - Version has less features than closed version

Antrea (OpenSource) - Version

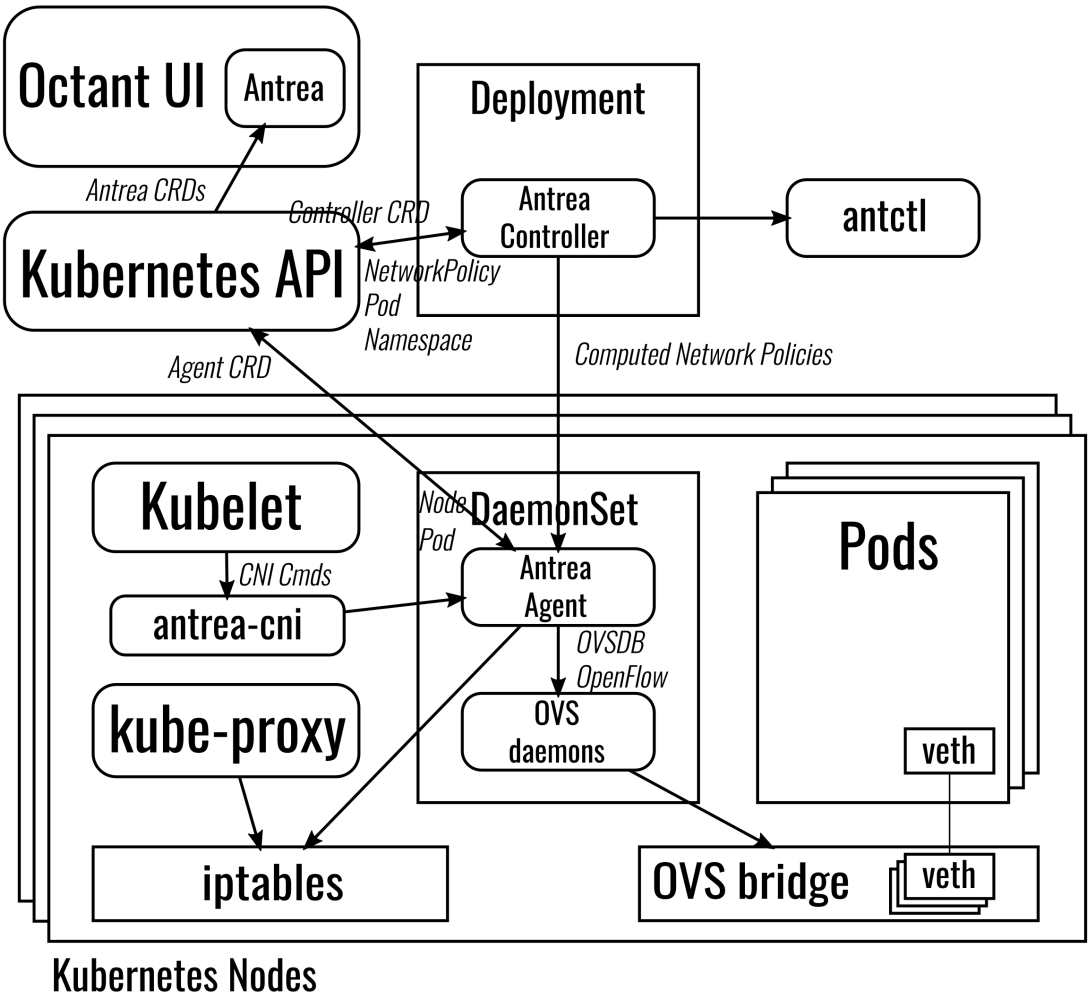
- https://antrea.io/docs/v1.13.2/

vmware - spread across tanzu (AFAIK)

- https://docs.vmware.com/en/VMware-Tanzu-Kubernetes-Grid/2.4/tkg-deploy-mc/mgmt-reqs-network-antrea-tiering.html

Overview Kubernetes Antrea CNI-Plugin

Overview



Basics

- Created by vmware
- Uses Open VShift (virtuell Switches)
- Kernel-Modul openswitch.ko takes care of traffic (performant)

Components

antrea-controller (+api)

- Watches kube-api-server for changes on
  - pod
  - namespaces
  - NetworkPolicy
- Implementation of Controller - API-Server
- Reachable over kube-api-server by implementation https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/apiserver-aggregation/
- Currently only 1 replica is supported
- computes NetworkPolicies and distributes them to the Antrea agents

antrea controller api - part (how authentication works)

- The Controller API server delegates authentication and authorization to the Kubernetes API
- the Antrea Agent uses a Kubernetes ServiceAccount token to authenticate to the Controller,
- the Controller API server validates the token and whether the ServiceAccount is authorized for the API request with the Kubernetes API.

antrea-agent

- Runs on every pod, deployed by Daemonset
- has an endpoint running gRPC which the controller connects to
- Agents connect to controller api by ClusterIP - wit a service Account
- Authentication is done through the kubernetes api server

antctl

- cli for some debugging
- controller-mode on controller (accessing from within controller pod)
- agent-mode on agent (accessing from within agent-pod)
- external also possible - uses kubeconfig to connect
    - Connection is done through kube-api-server

Important antctl commands

```
## on kube-system
kubectl -n kube-system get üpods

antctl get featuregates
```

Reference

- https://antrea.io/docs/v1.3.0/docs/design/architecture/

Antctl

Install (externally as tool (not in pod)): uses .kube/config (Done by trainer)

```
## as root
cd /usr/local/sbin
curl -Lo ./antctl "https://github.com/antrea-io/antrea/releases/download/v1.13.2/antctl-$(uname)-x86_64"
chmod +x ./antctl
```

```
## run as unprivileged user having a .kube/config in homedir
antctl version
```

Shows feature-gates for controller and agent (using antctl client externally)

- Shows both (for controller and for agent), when you do it externally as client-tool from outside pod

```
antctl get featuregates
```

```
Antrea Agent Feature Gates
FEATUREGATE              STATUS         VERSION
Egress                   Enabled        BETA
EndpointSlice            Enabled        BETA
NetworkPolicyStats       Enabled        BETA
NodePortLocal            Enabled        BETA
Traceflow                Enabled        BETA
AntreaIPAM               Disabled       ALPHA
ServiceExternalIP        Disabled       ALPHA
AntreaProxy              Enabled        BETA
FlowExporter             Disabled       ALPHA
Multicluster             Disabled       ALPHA
AntreaPolicy             Enabled        BETA
Multicast                Enabled        BETA

Antrea Controller Feature Gates
FEATUREGATE              STATUS         VERSION
Multicluster             Disabled       ALPHA
AntreaPolicy             Enabled        BETA
Multicast                Enabled        BETA
Egress                   Enabled        BETA
NetworkPolicyStats       Enabled        BETA
ServiceExternalIP        Disabled       ALPHA
Traceflow                Enabled        BETA
NodeIPAM                 Enabled        BETA
```

Use antctl from within agent

```
kubectl -n kube-system exec -it ANTREA-AGENT_POD_NAME -n kube-system -c antrea-agent -- bash
```

- or

```
kubectl -n kube-system exec -it daemonset/antrea-agent -n kube-system -c antrea-agent -- bash
```

```
antctl help
antctl log-level
antctl get featuregates
```

Antrea view bridge and config

Finding the bridge

- ovs-vsctl - utility for querying and configuring ovs-vswitchd

```
## How to see the bridge
kubectl -n kube-system exec -it antrea-agent-79bx2 -c antrea-agent -- ovs-vsctl show

## or: always shows the first pod it finds
kubectl -n kube-system exec -it daemonset/antrea-agent -c antrea-agent -- ovs-vsctl show
```

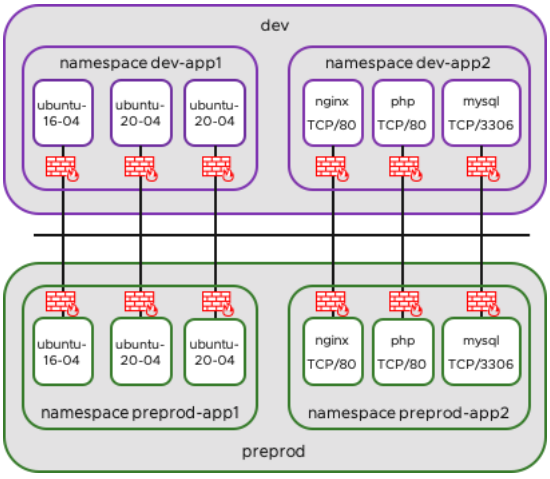
```
708fb906-48b3-4b9e-8508-b4b862389d58
    Bridge br-int
        datapath_type: system
        Port antrea-tun0
            Interface antrea-tun0
                type: geneve
                options: {key=flow, remote_ip=flow}
        Port antrea-gw0
            Interface antrea-gw0
                type: internal
    ovs version: "2.17.7"
```

Show the configuraton settings of antrea (configmap)

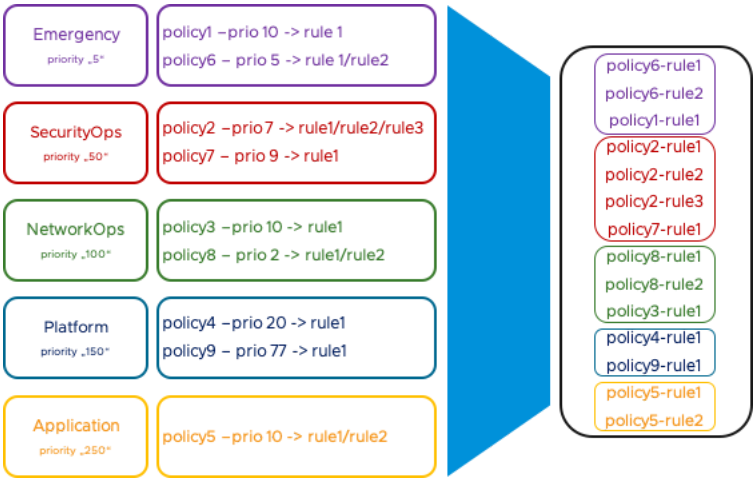
```
kubectl -n kube-system get cm antrea-config -o yaml
```

Antrea NetworkPolicy Exercise - 1 Cluster in Group

Our Goal

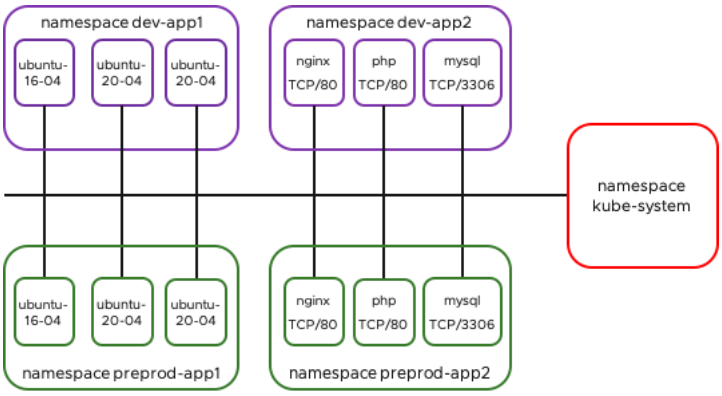


How the order of priorities work



Our Setup

```
In app1 are some Ubuntu Servers for Testing: dev-app1 / preprod-app1

1x Ubuntu Server 16.04
2x Ubuntu Server 20.04
In app2 is a simple 3 Tier-App (WEB-APP-DB): dev-app2 / preprod-app2 (3tier-app)

1x nginx TCP/80 (NodePort)
1x php TCP/80 (ClusterIP)
1x mysql TCP/3306 (ClusterIP)
```



Step 1: Rollout the pods (dev-app1)

- Important - you need to adjust the namespaces as follows:
  - dev-app1- -> z.B. dev-app1-jjm (Deine Initialien)

```
cd
mkdir -p manifests
cd manifests
mkdir 10-antrea
cd 10-antrea
```

```
## nano 01-deployment-dev-app1.yaml
apiVersion: v1
kind: Namespace
metadata:
  name: dev-app1-<name-kurz>
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ubuntu-16-04
  labels:
    app: ubuntu-16-04
```

```
  namespace: dev-app1-<name-kurz>
spec:
  replicas: 1
  selector:
    matchLabels:
      app: ubuntu-16-04
  template:
    metadata:
      labels:
        app: ubuntu-16-04
    spec:
      containers:
      - name: ubuntu-16-04
        image: ubuntu:16.04
        imagePullPolicy: IfNotPresent
        command: [ "/bin/bash", "-c" ]
        args:
          - apt-get update;
            apt-get install iputils-ping -y;
            apt-get install net-tools;
            apt-get install curl -y;
            sleep infinity;
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ubuntu-20-04
  labels:
    app: ubuntu-20-04
  namespace: dev-app1-<name-kurz>
spec:
  replicas: 2
  selector:
    matchLabels:
      app: ubuntu-20-04
  template:
    metadata:
      labels:
        app: ubuntu-20-04
    spec:
      containers:
      - name: ubuntu-20-04
        image: ubuntu:20.04
        imagePullPolicy: IfNotPresent
        command: [ "/bin/bash", "-c" ]
        args:
          - apt-get update;
            apt-get install tcpdump -y;
            apt-get install telnet -y;
            apt-get install iputils-ping -y;
            apt-get install nmap -y;
            apt-get install net-tools;
            apt-get install netdiscover -y;
            apt-get install mysql-client -y;
            apt-get install curl -y;
            apt-get install dsniff -y;
            sleep infinity;
```

```
## check if we have replaced all the kurz entries
cat 01-deployment-dev-app1.yaml | grep kurz

kubectl apply -f .
## kubectl -n dev-app1-<name-kurz> get pods
## z.B. kubectl -n dev-app1-jjm get pods
```

Step 2: Rollout the pods (dev-app2)

```
## nano 02-deployment-dev-app2.yaml
apiVersion: v1
kind: Namespace
metadata:
  name: dev-app2-<name-kurz>
---
apiVersion: v1
kind: ConfigMap
metadata:
  name: default-conf
```

```
  namespace: dev-app2-<name-kurz>
data:
  default.conf: |
    server {
    listen 80 default_server;

    location / {
      proxy_pass http://app-service;
      proxy_http_version 1.1;
    }

    error_page   500 502 503 504  /50x.html;
    location = /50x.html {
        root   /usr/share/nginx/html;
    }

    }
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx
  namespace: dev-app2-<name-kurz>
spec:
  replicas: 1
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
        service: web
        kind: dev
        type: internal
    spec:
      containers:
      - name: nginx
        image: nginx
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 80
        volumeMounts:
        - mountPath: /etc/nginx/conf.d # mount nginx-conf volumn to /etc/nginx
          readOnly: true
          name: default-conf
        - mountPath: /var/log/nginx
          name: log
      volumes:
      - name: default-conf
        configMap:
          name: default-conf # place ConfigMap `nginx-conf` on /etc/nginx
          items:
            - key: default.conf
              path: default.conf
      - name: log
        emptyDir: {}
---
apiVersion: v1
kind: Service
metadata:
  name: nginx
  namespace: dev-app2-<name-kurz>
spec:
  type: NodePort
  ports:
  - port: 80
    targetPort: 80
  selector:
    app: nginx
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: appserver
  labels:
    app: app
  namespace: dev-app2-<name-kurz>
```

```
spec:
  replicas: 1
  selector:
    matchLabels:
      app: app
  template:
    metadata:
      labels:
        app: app
        kind: dev
        type: internal
    spec:
      containers:
      - name: php-apache
        image: derstich/miserver:006
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 80
---
apiVersion: v1
kind: Service
metadata:
  name: app-service
  labels:
    app: app
  namespace: dev-app2-<name-kurz>
spec:
  ports:
  - port: 80
    protocol: TCP
  selector:
    app: app
---
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: mysql
  namespace: dev-app2-<name-kurz>
spec:
  selector:
    matchLabels:
      app: mysql8
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql8
        service: db
        kind: dev
        type: internal
    spec:
      containers:
      - image: mysql:5.6
        name: mysql
        imagePullPolicy: IfNotPresent
        env:
        - name: MYSQL_ROOT_PASSWORD
          value: .sweetpwd.
        - name: MYSQL_DATABASE
          value: my_db
        - name: MYSQL_USER
          value: db_user
        - name: MYSQL_PASSWORD
          value: .mypwd
        args: ["--default-authentication-plugin=mysql_native_password"]
        ports:
        - containerPort: 3306
          name: mysql8
---
apiVersion: v1
kind: Service
metadata:
  name: mysql8-service
  labels:
    app: mysql8
  namespace: dev-app2-<name-kurz>
spec:
```

```
  type: ClusterIP
  ports:
  - port: 3306
    protocol: TCP
  selector:
    app: mysql8
```

```
kubectl apply -f .
kubectl -n dev-app2-<name-kurz> get all
```

Schritt 3: rollout preprod-app1

```
## nano 03-deployment-preprod-app1.yaml
apiVersion: v1
kind: Namespace
metadata:
  name: preprod-app1-<name-kurz>
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ubuntu-16-04
  labels:
    app: ubuntu-16-04
  namespace: preprod-app1-<name-kurz>
spec:
  replicas: 1
  selector:
    matchLabels:
      app: ubuntu-16-04
  template:
    metadata:
      labels:
        app: ubuntu-16-04
    spec:
      containers:
      - name: ubuntu-16-04
        image: ubuntu:16.04
        imagePullPolicy: IfNotPresent
        command: [ "/bin/bash", "-c" ]
        args:
          - apt-get update;
            apt-get install iputils-ping -y;
            apt-get install net-tools;
            apt-get install curl -y;
            sleep infinity;
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: ubuntu-20-04
  labels:
    app: ubuntu-20-04
  namespace: preprod-app1-<name-kurz>
spec:
  replicas: 2
  selector:
    matchLabels:
      app: ubuntu-20-04
  template:
    metadata:
      labels:
        app: ubuntu-20-04
    spec:
      containers:
      - name: ubuntu-20-04
        image: ubuntu:20.04
        imagePullPolicy: IfNotPresent
        command: [ "/bin/bash", "-c" ]
        args:
          - apt-get update;
            apt-get install tcpdump -y;
            apt-get install telnet -y;
            apt-get install iputils-ping -y;
            apt-get install nmap -y;
            apt-get install net-tools;
            apt-get install netdiscover -y;
```

```
            apt-get install mysql-client -y;
            apt-get install curl -y;
            apt-get install dsniff -y;
            sleep infinity;
```

```
kubectl apply -f .
```

Schritt 4: Deploy preprod-app2

```
## nano 04-deployment-preprod-app2.yaml
apiVersion: v1
kind: Namespace
metadata:
  name: preprod-app2-<name-kurz>
---
apiVersion: v1
kind: ConfigMap
metadata:
  name: default-conf
  namespace: preprod-app2-<name-kurz>
data:
  default.conf: |
    server {
    listen 80 default_server;

    location / {
      proxy_pass http://app-service;
      proxy_http_version 1.1;
    }

    error_page   500 502 503 504  /50x.html;
    location = /50x.html {
        root   /usr/share/nginx/html;
    }

    }
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx
  namespace: preprod-app2-<name-kurz>
spec:
  replicas: 1
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
        service: web
        kind: dev
        type: internal
    spec:
      containers:
      - name: nginx
        image: nginx
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 80
        volumeMounts:
        - mountPath: /etc/nginx/conf.d # mount nginx-conf volumn to /etc/nginx
          readOnly: true
          name: default-conf
        - mountPath: /var/log/nginx
          name: log
      volumes:
      - name: default-conf
        configMap:
          name: default-conf # place ConfigMap `nginx-conf` on /etc/nginx
          items:
            - key: default.conf
              path: default.conf
      - name: log
        emptyDir: {}
---
```

```
apiVersion: v1
kind: Service
metadata:
  name: nginx
  namespace: preprod-app2-<name-kurz>
spec:
  type: NodePort
  ports:
  - port: 80
    targetPort: 80
  selector:
    app: nginx
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: appserver
  labels:
    app: app
  namespace: preprod-app2-<name-kurz>
spec:
  replicas: 1
  selector:
    matchLabels:
      app: app
  template:
    metadata:
      labels:
        app: app
        kind: dev
        type: internal
    spec:
      containers:
      - name: php-apache
        image: derstich/miserver:005
        imagePullPolicy: IfNotPresent
        ports:
        - containerPort: 80
---
apiVersion: v1
kind: Service
metadata:
  name: app-service
  labels:
    app: app
  namespace: preprod-app2-<name-kurz>
spec:
  ports:
  - port: 80
    protocol: TCP
  selector:
    app: app
---
apiVersion: apps/v1 # for versions before 1.9.0 use apps/v1beta2
kind: Deployment
metadata:
  name: mysql
  namespace: preprod-app2-<name-kurz>
spec:
  selector:
    matchLabels:
      app: mysql8
  strategy:
    type: Recreate
  template:
    metadata:
      labels:
        app: mysql8
        service: db
        kind: dev
        type: internal
    spec:
      containers:
      - image: mysql:5.6
        name: mysql
        imagePullPolicy: IfNotPresent
        env:
        - name: MYSQL_ROOT_PASSWORD
```

```
          value: .sweetpwd.
        - name: MYSQL_DATABASE
          value: my_db
        - name: MYSQL_USER
          value: db_user
        - name: MYSQL_PASSWORD
          value: .mypwd
        args: ["--default-authentication-plugin=mysql_native_password"]
        ports:
        - containerPort: 3306
          name: mysql8
---
apiVersion: v1
kind: Service
metadata:
  name: mysql8-service
  labels:
    app: mysql8
  namespace: preprod-app2-<name-kurz>
spec:
  type: ClusterIP
  ports:
  - port: 3306
    protocol: TCP
  selector:
    app: mysql8
```

```
kubectl apply -f .
```

Schritt 5: Daten auslesen

```
## Das bitte anpassen
KURZ=jm
```

```
## dev-app1
kubectl -n dev-app1-$KURZ get pods -o=custom-
columns=NAMESPACE:.metadata.namespace,NAME:.metadata.name,STATUS:.status.phase,IP:.status.podIP,NODE:.spec.nodeName

## dev-app2
kubectl -n dev-app2-$KURZ get pods -o=custom-
columns=NAMESPACE:.metadata.namespace,NAME:.metadata.name,STATUS:.status.phase,IP:.status.podIP,NODE:.spec.nodeName

## preprod-app1
kubectl -n preprod-app1-$KURZ get pods -o=custom-
columns=NAMESPACE:.metadata.namespace,NAME:.metadata.name,STATUS:.status.phase,IP:.status.podIP,NODE:.spec.nodeName

## preprod-app2
kubectl -n preprod-app2-$KURZ get pods -o=custom-
columns=NAMESPACE:.metadata.namespace,NAME:.metadata.name,STATUS:.status.phase,IP:.status.podIP,NODE:.spec.nodeName
```

```
## BITTE die Infos zwischen speichern oder Screenshot machen
```

Schritt 6: Zugriff auf dev-app2 klären

```
## Das ändern
KURZ=jm
```

```
kubectl get svc -n dev-app2-$KURZ nginx
```

```
tln1@k8s-client:~/manifests/10-antrea$ kubectl get svc -n dev-app2-$KURZ nginx
NAME    TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)        AGE
nginx   NodePort    10.101.253.56   <none>        80:32767/TCP   25m
```

```
curl -i http://10.135.0.5:32767
## oder im Browser mit Public - IP
```

Schritt 7: Zugriff auf preprod-app klären

```
## Das ändern
KURZ=jm
```

```
kubectl get svc -n preprod-app2-$KURZ nginx
```

```
NAME    TYPE        CLUSTER-IP       EXTERNAL-IP   PORT(S)        AGE
nginx   NodePort    10.106.173.151   <none>        80:31836/TCP   14m
```

```
curl -i http://10.135.0.5:31836
```

Schritt 8: Zugriff ohne antrea policy testen

```
KURZ=jm
kubectl exec -it -n dev-app1-$KURZ deployment/ubuntu-20-04 -- /bin/bash
```

```
## scannen des netzes
nmap 10.244.0.0/22
```

```
Nmap scan report for 10.244.3.18
Host is up (0.0038s latency).
All 1000 scanned ports on 10.244.3.18 are closed

Nmap scan report for 10-244-3-19.nginx.preprod-app2-jm.svc.cluster.local (10.244.3.19)
Host is up (0.0032s latency).
Not shown: 999 closed ports
PORT   STATE SERVICE
80/tcp open  http

Nmap scan report for 10-244-3-20.mysql8-service.preprod-app2-jm.svc.cluster.local (10.244.3.20)
Host is up (0.0031s latency).
Not shown: 999 closed ports
PORT     STATE SERVICE
3306/tcp open  mysql

Nmap done: 1024 IP addresses (44 hosts up) scanned in 15.46 seconds
```

- Namen werden aufgelöst (rückwärtig)
- alle ports sind einsehbar
- Verbindung funktioniert nach überall

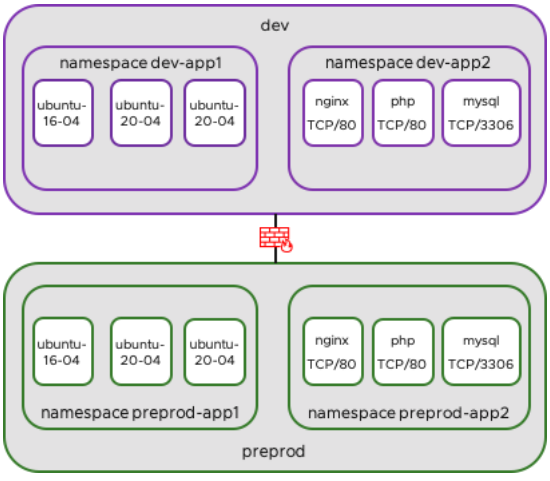
```
## mysql preprod herausfinden
nmap 10.244.0.0/22 | grep mysql | grep preprod
```

```
root@ubuntu-20-04-66598645fd-4gsjg:/# nmap 10.244.0.0/22 | grep mysql | grep preprod
Nmap scan report for 10-244-3-20.mysql8-service.preprod-app2-jm.svc.cluster.local (10.244.3.20)
```

```
## Oh, wir haben das Passwort herausgefunden (Social Engineering ;o))
.sweetpwd.
```

```
mysql -h 10-244-3-20.mysql8-service.preprod-app2-jm.svc.cluster.local -p
```

Schritt 9: Isolate dev and preprod




```
## entsprechend anpassen
KURZ=jm
```

```
## Namspaces labeln
kubectl label ns dev-app1-$KURZ env=dev-$KURZ ns=dev-app1-$KURZ
kubectl label ns dev-app2-$KURZ env=dev-$KURZ ns=dev-app2-$KURZ
kubectl label ns preprod-app1-$KURZ env=preprod-$KURZ ns=preprod-app1-$KURZ
kubectl label ns preprod-app2-$KURZ env=preprod-$KURZ ns=preprod-app2-$KURZ

kubectl describe ns dev-app1-$KURZ
```

```
## now create the policy
## nano 10-deny-dev-to-preprod.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: deny-dev-to-preprod-<name-kurz>
spec:
    priority: 100
    tier: SecurityOps
    appliedTo:
      - namespaceSelector:
          matchLabels:
            env: preprod-<name-kurz>
    ingress:
      - action: Drop
        from:
          - namespaceSelector:
              matchLabels:
                env: dev-<name-kurz>
```

```
KURZ=jm
## Test ob ping von preprod nach dev funktioniert
## Hier ein POD-IP raussuchen
kubectl -n dev-app1-$KURZ get pods -o wide
kubectl -n preprod-app1-$KURZ exec deployments/ubuntu-20-04 -- ping 10.244.3.15

## Test ob ping von dev nach preprod funktioniert - der sollte nicht funktionieren
## Hier eine POD-IP rausschen
kubectl -n preprod-app1-$KURZ get pods -o wide
kubectl -n dev-app1-$KURZ exec deployments/ubuntu-20-04 -- ping 10.244.2.25
```

```
## ClusterNetworkPolicy anwenden
kubectl apply -f .
```

```
## Jetzt nochmal die Pings testen von oben
## ---> Ping ist immer noch möglich --> da keine Firewall - Regel
kubectl -n preprod-app1-$KURZ exec deployments/ubuntu-20-04 -- ping 10.244.3.15

## in die andere Richtung geht es aber nicht !!
kubectl -n dev-app1-$KURZ exec deployments/ubuntu-20-04 -- ping 10.244.2.25
```

```
## ok jetzt in die andere richtung
## nano 15-deny-preprod-to-dev.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: deny-preprod-to-dev-<kurz-name>
spec:
    priority: 101
    tier: SecurityOps
    appliedTo:
      - namespaceSelector:
          matchLabels:
            env: dev-<name-kurz>
    ingress:
      - action: Drop
        from:
          - namespaceSelector:
              matchLabels:
                env: preprod-<name-kurz>
```

```
kubectl apply -f .
kubectl get clusternetworkpolicies
```

```
## Only output
NAME                     TIER          PRIORITY   DESIRED NODES   CURRENT NODES   AGE
```

```
deny-dev-to-preprod-jm   SecurityOps   100        2               2               16m
deny-preprod-to-dev      SecurityOps   101        2               2               3m15s
```

```
## und jetzt geht pingen in die andere Richtung auch nicht mehr
kubectl -n preprod-app1-$KURZ exec deployments/ubuntu-20-04 -- ping 10.244.3.15
```

Schritt 11: Isolate Pods (only within the namespaces)

- Aktuell ist das ping vom preprod-app1- zum preprod-app2- namespace noch möglich
- Das wollen wir einschränken
- Ausserdem von dev-app1- zu dev-app2-

```
## bei dir anpassen
KURZ=jm
```

```
## So sehen unsere Namespace - Labels aus
kubectl describe namespace dev-app1-$KURZ
```

```
## Ausgabe, z.B.
Name:         dev-app1-jm
Labels:       env=dev-jm
              ns=dev-app1-jm
```

```
## nano 20-allow-ns-dev-app1-dev-app1.yaml
## Traffic innerhalb des Namespaces erlaubt

apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 20-allow-ns-dev-app1-dev-app1-<name-kurz>
spec:
    priority: 100
    tier: application
    appliedTo:
      - namespaceSelector:
          matchLabels:
            ns: dev-app1-<name-kurz>
    ingress:
      - action: Allow
        from:
          - namespaceSelector:
              matchLabels:
                ns: dev-app1-<name-kurz>
```

```
kubectl apply -f .
```

```
## nano 25-drop-any-ns-dev-app2.yaml
## allen anderen Traffic zum namespace app2 hin verbieten aus anderen namespaces
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 25-drop-any-ns-dev-app2-<name-kurz>
spec:
    priority: 110
    tier: application
    appliedTo:
      - namespaceSelector:
          matchLabels:
            ns: dev-app2-<name-kurz>
    ingress:
      - action: Drop
        from:
          - namespaceSelector: {}
```

```
kubectl apply -f .
```

```
## nano 30-allow-ns-preprod-app1-preprod-app1.yaml
## Same for preprod-app1
## Allow all traffic within namespace
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 30-allow-ns-preprod-app1-preprod-app1-<name-kurz>
spec:
    priority: 120
    tier: application
```

```
    appliedTo:
      - namespaceSelector:
          matchLabels:
            ns: preprod-app1-<name-kurz>
    ingress:
      - action: Allow
        from:
          - namespaceSelector:
              matchLabels:
                ns: preprod-app1-<name-kurz>
```

```
kubectl apply -f .
```

```
## disallow all traffic from other namespaces to prepr
## nano 35-drop-any-ns-preprod-app2.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 21-drop-any-ns-preprod-app2<name-kurz>
spec:
    priority: 130
    tier: application
    appliedTo:
      - namespaceSelector:
          matchLabels:
            ns: preprod-app2-<name-kurz>
    ingress:
      - action: Drop
        from:
          - namespaceSelector: {}
```

```
kubectl apply -f .
```

Schritt 12: Isolate traffic within app2 - namespaces (3-Tier-app) (Das kann leider nur er Trainer machen ;o() - wg der Labels

```
## For dev-app2-<name-kurz> we want
web->app (80)
app->db (3306)
drop everything else
```

```
KURZ=jm;
```

```
kubectl -n dev-app2-$KURZ describe pods | head -n 20
kubectl -n preprod-app2-$KURZ describe pods | head -n 20
```

```
Name:             appserver-8596ff696-14bpm
Namespace:        dev-app2-jm
Priority:         0
Service Account:  default
Node:             worker3/10.135.0.8
Start Time:       Wed, 29 Nov 2023 04:44:37 +0000
Labels:           app=app
                  kind=dev
                  pod-template-hash=8596ff696
```

- we are using the label app=xxx

```
## nano 40-allow-web-app.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 40-allow-web-app-<name-kurz>
spec:
    priority: 10
    tier: application
    appliedTo:
      - podSelector:
          matchLabels:
            app: app
    ingress:
      - action: Allow
```

```
        from:
          - podSelector:
              matchLabels:
                app: nginx
        ports:
          - protocol: TCP
            port: 80
```

```
kubectl apply -f  .
```

```
## nano 45-allow-app-db.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 02-allow-app-db-<name-kurz>
spec:
    priority: 20
    tier: application
    appliedTo:
      - podSelector:
          matchLabels:
            app: mysql8
    ingress:
      - action: Allow
        from:
          - podSelector:
              matchLabels:
                app: app
        ports:
          - protocol: TCP
            port: 3306
```

```
kubectl apply -f .
```

```
## nano 50-deny-any-to-app2.yaml
## Deny everything else
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 03-deny-any-to-app2-<name-kurz>
spec:
    priority: 30
    tier: application
    appliedTo:
      - namespaceSelector:
          matchLabels:
                  ns: dev-app2-<name-kurz>
      - namespaceSelector:
          matchLabels:
                  ns: preprod-app2-<name-kurz>
    ingress:
      - action: Drop
        from:
          - namespaceSelector: {}
```

```
kubectl apply -f .
```

Schritt 13: Usage of the Emergency Tier - e.g. Attack (only Trainer)

- We have problems with Ubuntu 16.04. an we want to isolate it.

```
kubectl get tiers
```

```
## nano 80-emergency.yaml
apiVersion: crd.antrea.io/v1beta1
kind: ClusterNetworkPolicy
metadata:
  name: 50-deny-any-pod-ubuntu16-<name-kurz>
spec:
    priority: 50
    tier: emergency
    appliedTo:
      - podSelector:
          matchLabels:
                  app: ubuntu-16-04
    ingress:
```

```
    - action: Drop
      from:
        - namespaceSelector: {}
```

```
kubectl apply -f .
```

- Because Emergency has the highest priority, the policy in application (allow any in ns-app1) has no Impact anymore.

Reference:

- https://www.vrealize.it/2020/09/28/securing-you-k8s-network-with-antrea-clusternetworkpolicy/

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 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>
```

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
## do this on one of the nodes
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 01-service-account.yml
apiVersion: v1
kind: ServiceAccount
metadata:
  name: training
  namespace: default
```

```
kubectl apply -f .
```

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 02-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: 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 03-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 03-pods-clusterrole.yml
```

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

```
## vi 04-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 .
```

Mini-Schritt 4: Testen (klappt der Zugang)

```
kubectl auth can-i get pods -n default --as system:serviceaccount:default:training
## yes
kubectl auth can-i get deployment -n default --as system:serviceaccount:default:training
## no
```

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
```

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
```

Kubernetes QoS

Quality of Service - evict pods

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

```
Request: Definiert wieviel ein Container mindestens braucht (CPU,memory)
Limit: Definiert, was ein Container maximal braucht.

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"
```

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/

Autoscaling Pods/Deployments

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

```
---
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
```

- https://docs.digitalocean.com/tutorials/cluster-autoscaling-ca-hpa/

Reference

- 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

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. aktiviert

Vorgefertigte Regelwerke

- privileges - keinerlei Einschränkungen
- baseline - einige Einschränkungen
- restricted - sehr streng

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:
    pod-security.kubernetes.io/enforce: baseline
    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
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
```

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)

ä 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

### statische IP für Pod in calico

  * https://docs.tigera.io/calico/latest/networking/ipam/use-specific-ip

### yaml linting

  * https://www.kubeval.com/installation/

### ssl terminierung über proxy nginx


### mit ssl

  * https://jackiechen.blog/2019/01/24/nginx-sample-config-of-http-and-ldaps-reverse-proxy/

### Ohne ssl

  * https://kubernetes.github.io/ingress-nginx/user-guide/exposing-tcp-udp-services/

### LoadBalancer / Cluster Controller Manager


### Keypart: Cluster Controller Manager (CCM)

  * was decoupled from Kube Controller Manager
    * to make it easier for cloud providers to implement their specific environment/workings (e.g. LoadBalancer)
  * To do this a skeleton was provided.

![CCM](https://kubernetes.io/images/docs/post-ccm-arch.png)

### Control Loops in the CCM

  * Der CCM erbt seine Funktionen von Komponenten des Kubernetes, die von einem Cloud Provider abhängig sind.
  * Die meisten Funktionen des CCM stammen aus dem KCM. Wie im vorherigen Abschnitt erwähnt, führt das CCM die folgenden
Steuerschleifen durch:
```

Node Controller Route Controller Service Controller

```
### Service Controller
```

Der Service Controller ist verantwortlich für das Abhören von Ereignissen zum Erstellen, Aktualisieren und Löschen von Diensten. Basierend auf dem aktuellen Stand der Services in Kubernetes konfiguriert es Cloud Load Balancer (wie ELB, Google LB oder Oracle Cloud Infrastructure LB), um den Zustand der Services in Kubernetes abzubilden. Darüber hinaus wird sichergestellt, dass die Service Backends für Cloud Loadbalancer auf dem neuesten Stand sind.

```
### Load Balancer Implementation in DigitalOcean (DO)


  * https://github.com/digitalocean/digitalocean-cloud-controller-manager/tree/master
  * https://github.com/digitalocean/digitalocean-cloud-controller-manager/blob/master/cloud-controller-manager/do/loadbalancers.go

#### api - domain is hardcoded in cloud controller manager for digitalocean

![image](https://github.com/jmetzger/training-kubernetes-networking/assets/1933318/d3b2d698-9fcb-4a46-981e-6bb38067aadc)

### References:

  * [Good explanation](https://medium.com/@m.json/the-kubernetes-cloud-controller-manager-d440af0d2be5)
  * [Zugrundeliegende Konzepte](https://kubernetes.io/de/docs/concepts/architecture/cloud-controller/)

## Kubernetes - Ingress

### Ingress controller in microk8s aktivieren


### Aktivieren
```

microk8s enable ingress

```
### Referenz

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

### ingress mit ssl absichern

## Kubernetes Documentation

### Well-Known Annotations

  * https://kubernetes.io/docs/reference/labels-annotations-taints/

## 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:6HeLUJW3a$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:6HeLUJW3a$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 labels: volume: nfs-data-volume-tln 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/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 spec: storageClassName: "" volumeName: pv-nfs-tln 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://

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://

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://

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

```
## 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/

### 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
```