Cluster-Orchestrierung

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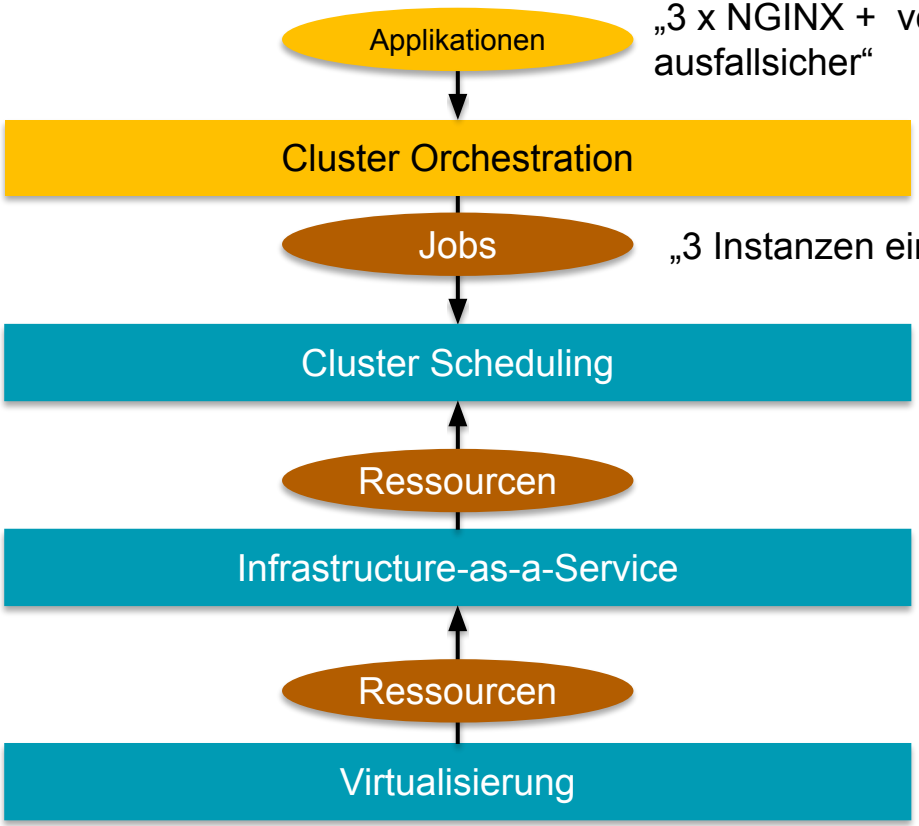
Kubernetes engineers when they don't have a kitchen towel

QA|WARE

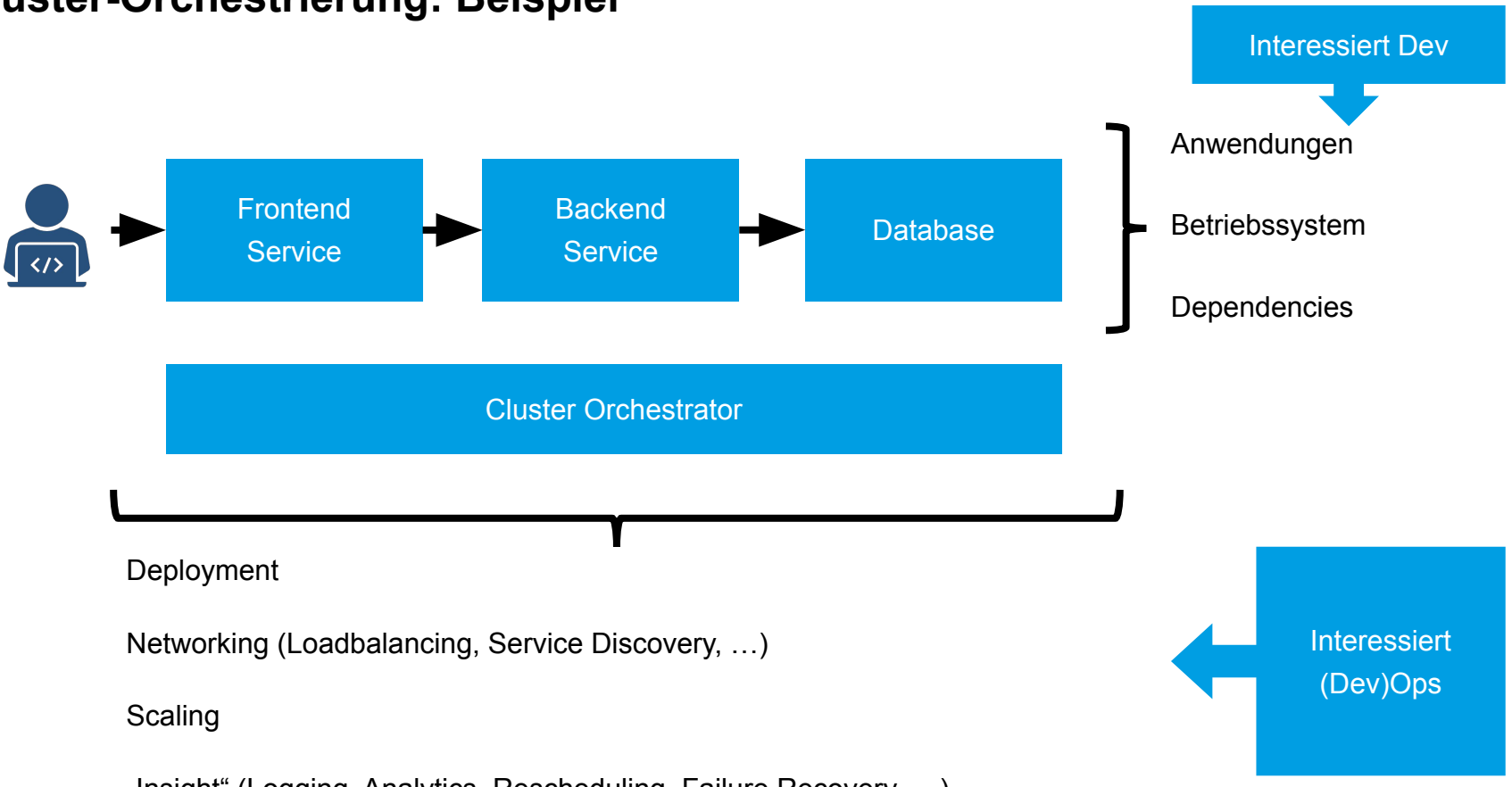
Das Big Picture: Wir sind nun auf Applikationsebene.



„3 x NGINX + vorgelagerter HAproxy - ausfallsicher“

„3 Instanzen eines NGINX Containers“

Cluster-Orchestrierung: Beispiel



Cluster-Orchestrierung

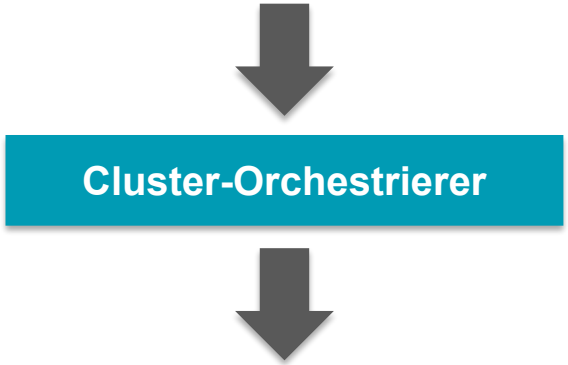
Ziel: Eine Anwendung, die in mehrere Betriebskomponenten (Container) aufgeteilt ist, auf mehreren Knoten laufen lassen.

Führt Abstraktionen zur Ausführung von Anwendungen mit ihren Services in einem großen Cluster ein.

Orchestrierung ist keine statische, einmalige Aktivität wie die Provisionierung, sondern eine dynamische, kontinuierliche Aktivität.

Orchestrierung hat den Anspruch, alle Standard-Betriebsprozeduren einer Anwendung zu automatisieren.

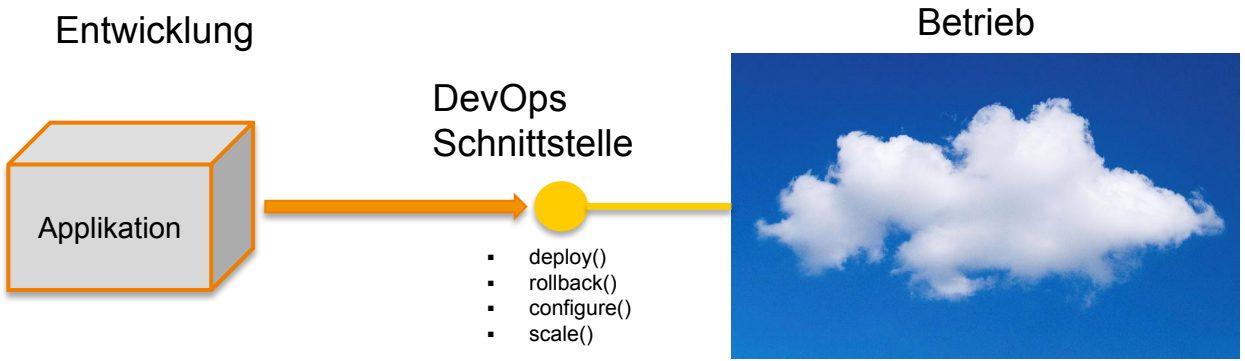
Blaupause der Anwendung, die den gewünschten Betriebszustand der Anwendung beschreibt: Betriebskomponenten (Container), deren Betriebsanforderungen sowie die angebotenen und benötigten Schnittstellen.



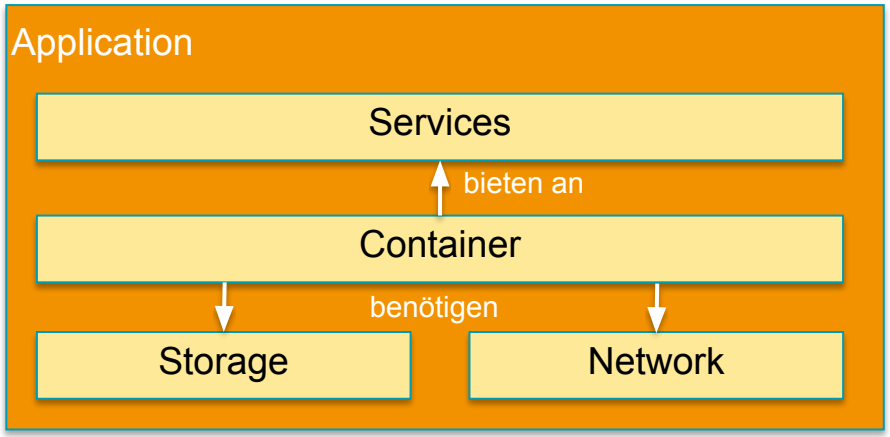
Steuerungsaktivitäten im Cluster:

- Start von Containern auf Knoten (Scheduler)
- Verknüpfung von Containern
- …

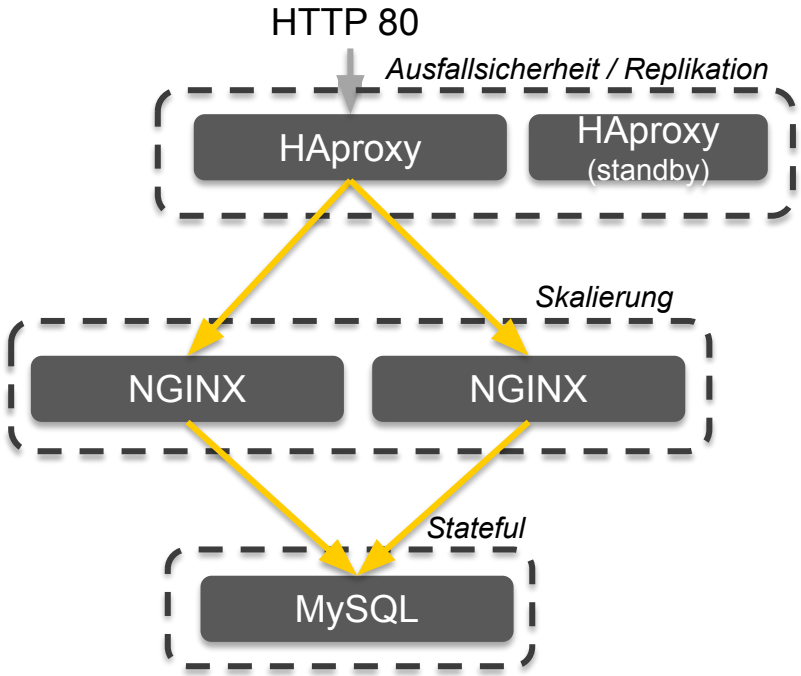
Ein Cluster-Orchestrierer bietet eine Schnittstelle zwischen Betrieb und Entwicklung für ein Cluster an.



Blaupause einer Anwendung (vereinfacht)



Metamodell

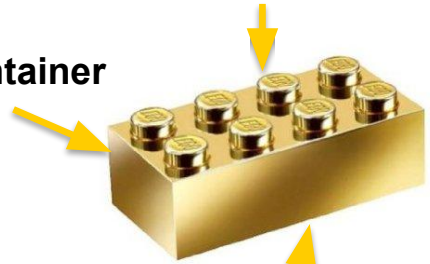


Modell

Analogie 1: Lego Star Wars

Services (angeboten)

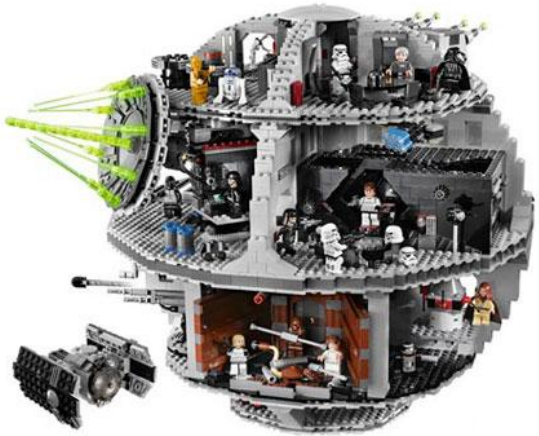
Container



Quelle: Lego

Services (benötigt)

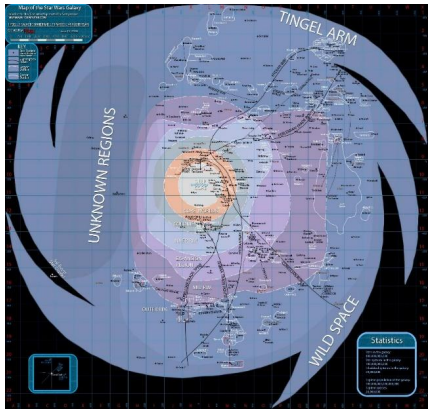
Cluster-Orchestrierer



Quelle: Lego

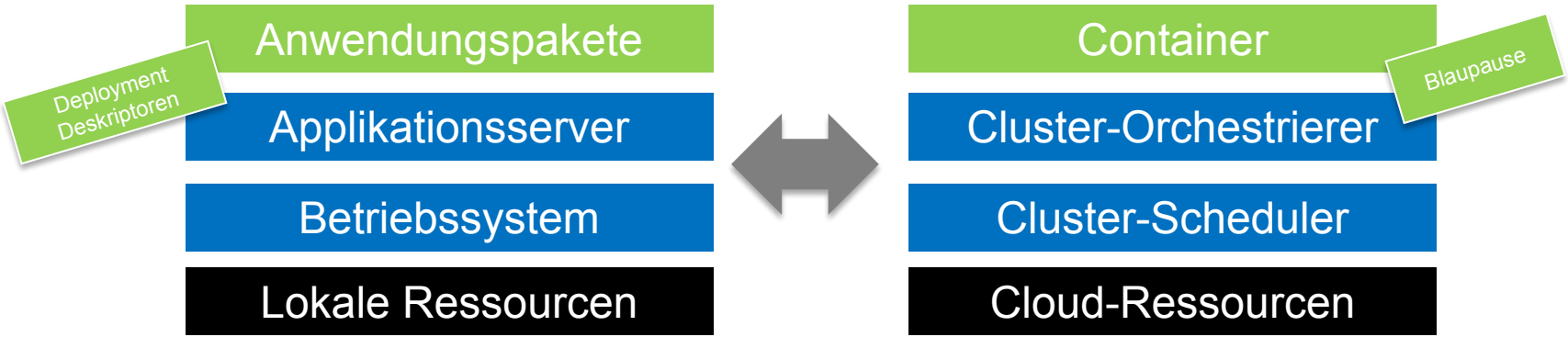
Blaupause

Cluster-Scheduler

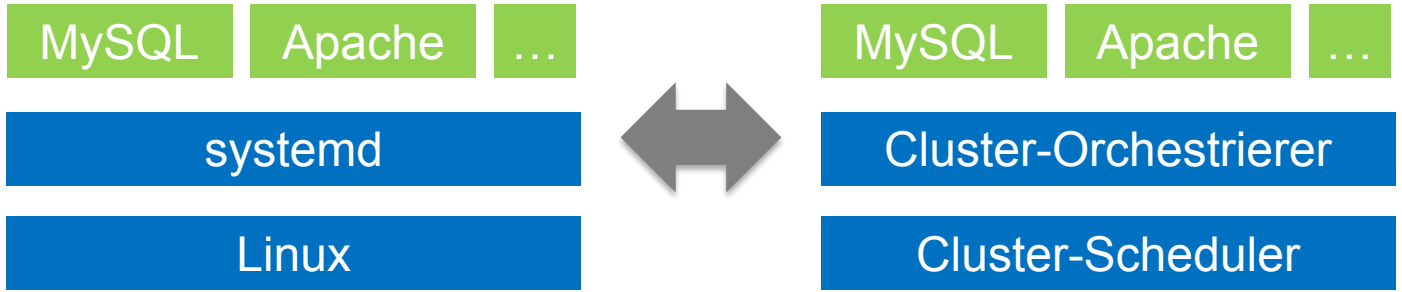


Quelle: wikipedia.de

Analogie 1: Applikationsserver



Analogie 2: Betriebssystem



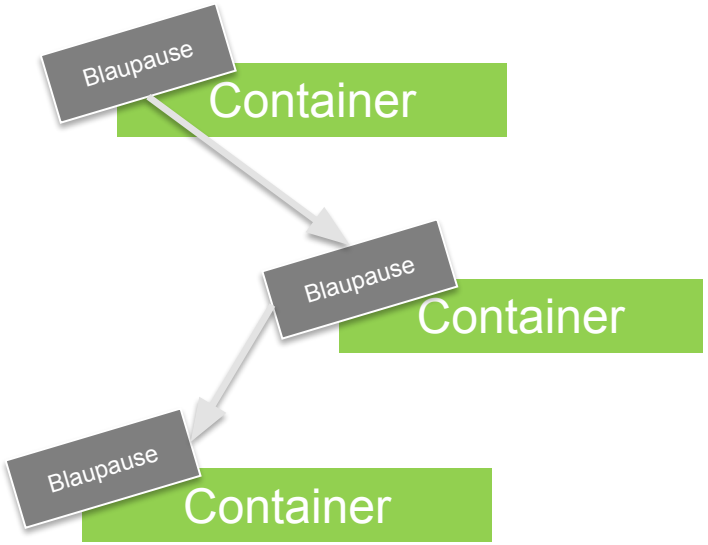
Ein Cluster-Orchestrierer automatisiert vielerlei Betriebsaufgaben für Anwendung auf einem Cluster (1 / 2):

- Scheduling von Containern mit applikationsspezifischen Constraints (z.B. Deployment- und Start-Reihenfolgen, Gruppierung, …)
- Aufbau von notwendigen Netzwerk-Verbindungen zwischen Containern.
- Bereitstellung von persistenten Speichern für zustandsbehaftete Container.
- (Auto-)Skalierung von Containern.
- Re-Scheduling von Containern im Fehlerfall (Auto-Healing) oder zur Performance-Optimierung.
- Container-Logistik: Verwaltung und Bereitstellung von Containern.

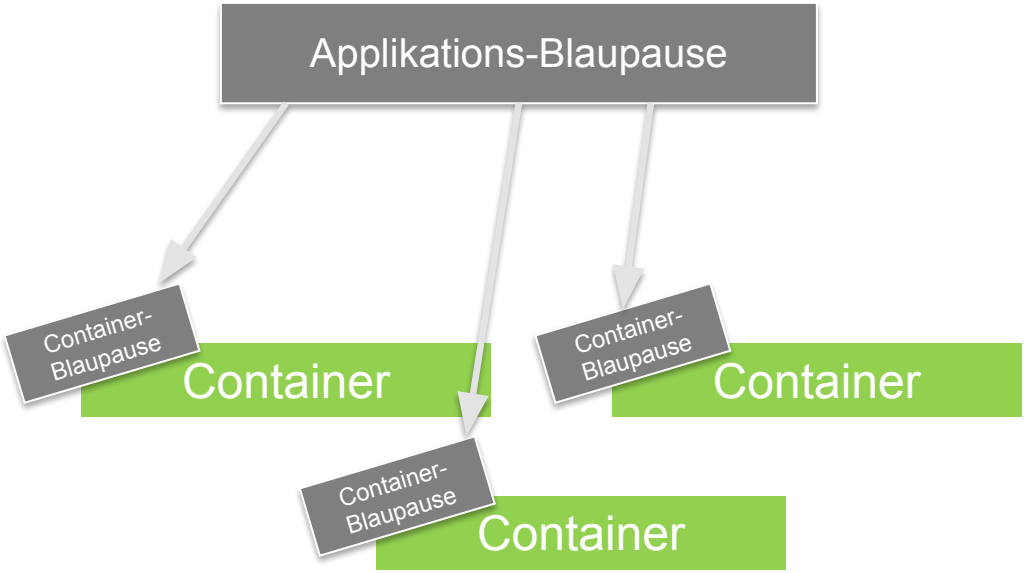
Ein Cluster-Orchestrierer automatisiert vielerlei Betriebsaufgaben für Anwendung auf einem Cluster (2 / 2):

- Package-Management: Verwaltung und Bereitstellung von Applikationen.
- Bereitstellung von Administrationsschnittstellen (Remote-API, Kommandozeile).
- Management von Services: Service Discovery, Naming, Load Balancing.
- Automatismen für Rollout-Workflows wie z.B. Canary Rollout.
- Monitoring und Diagnose von Containern und Services.

1-Level- vs. 2-Level-Orchestrierung



1-Level-Orchestrierung
(Container-Graph)



2-Level-Orchestrierung
(Container-Repository mit zentraler Bauanleitung)

1-Level- vs. 2-Level-Orchestrierung

Plain Docker

```
FROM ubuntu
ENTRYPOINT nginx
EXPOSE 80

docker run -d --link
nginx:nginx
```

1-Level-Orchestrierung
(Container-Graph)

https://docs.docker.com/compose/compose-file

Docker Compose

```
weba:
  image: qaware/nginx
  expose:
     - 80

webb:
  image: qaware/nginx
  expose:
     - 80

haproxy:
   image: qaware/haproxy
   links:
      - weba
      - webb
   ports:
      - „80:80“
   expose:
      - 80
```

```
FROM ubuntu
ENTRYPOINT nginx
EXPOSE 80
```

```
FROM ubuntu
ENTRYPOINT haproxy
EXPOSE 80
```

2-Level-Orchestrierung
(Container-Repository mit zentraler Bauanleitung)

Kubernetes

kubernetes by Google

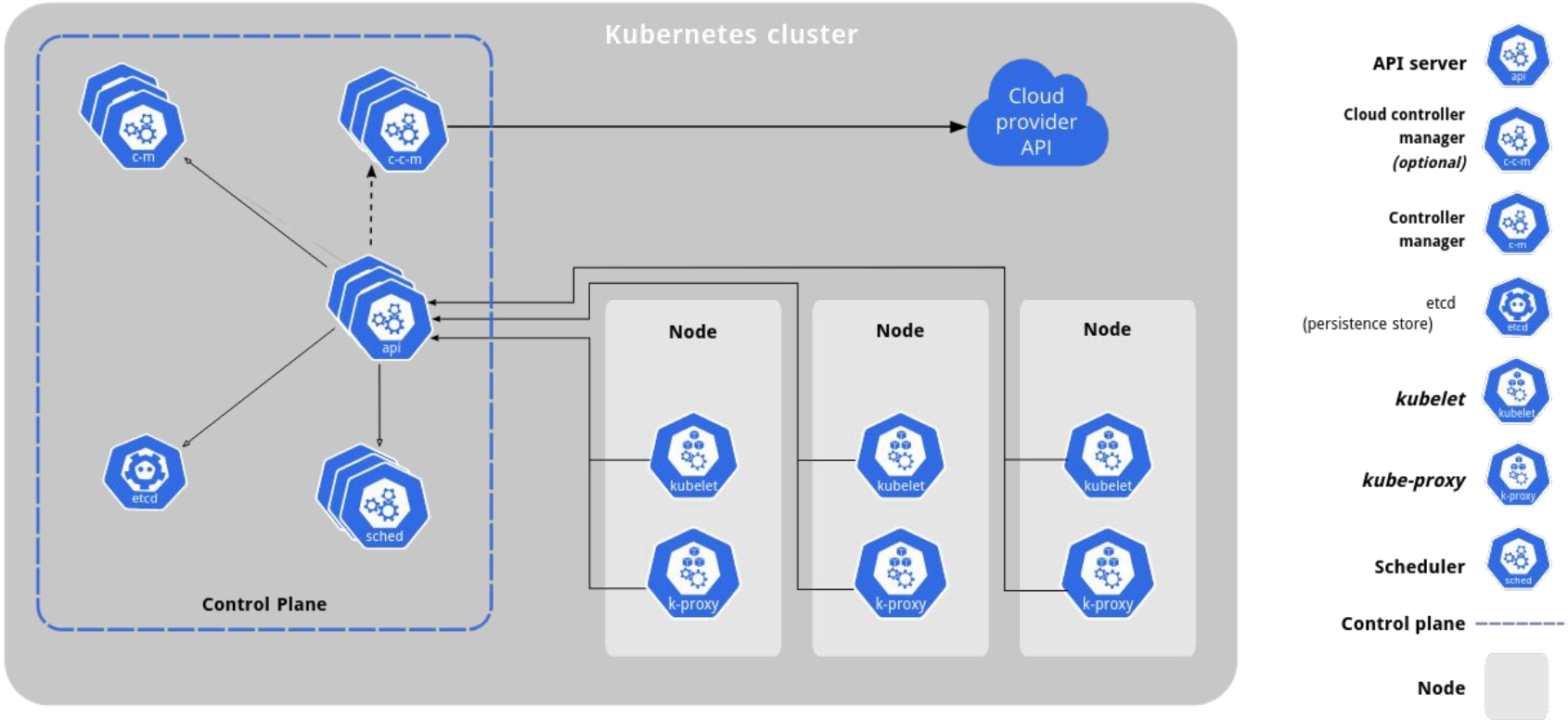
Manage a cluster of Linux containers as a single system to accelerate Dev and simplify Ops.

http://kubernetes.io

Kubernetes

- Cluster-Orchestrierer auf Basis von Docker-Containern, der eine Reihe an Kern-Abstraktionen für den Betrieb von Anwendungen in einem großen Cluster einführt. Die Blaupause wird über YAML-Dateien definiert.
- Open-Source-Projekt, das von Google initiiert wurde. Google will damit die jahrelange Erfahrung im Betrieb großer Cluster der Öffentlichkeit zugänglich machen und damit auch Synergien mit dem eigenen Cloud-Geschäft heben.
- Seit Juli 2015 in der Version 1.0 verfügbar und damit produktionsreif. Skaliert aktuell nachweislich auf 1000 Nodes großen Clustern.
- Bei vielen Firmen im Einsatz wie z.B. Google im Rahmen der Google Container Engine, Wikipedia, ebay. Beiträge an der Codebasis aus vielen Firmen neben Google – u.A. Mesosphere, Microsoft, Pivotal, RedHat.
- Setzt den Standard im Bereich Cluster-Orchestrierung. Dafür wurde auch eigens die Cloud Native Computing Foundation gegründet (https://cncf.io).

Architektur von Kubernetes



Pods & Deployments

Wichtige Kubernetes-Konzepte

Der Grundbaustein ist eure **Anwendung**.

App

Wichtige Kubernetes-Konzepte

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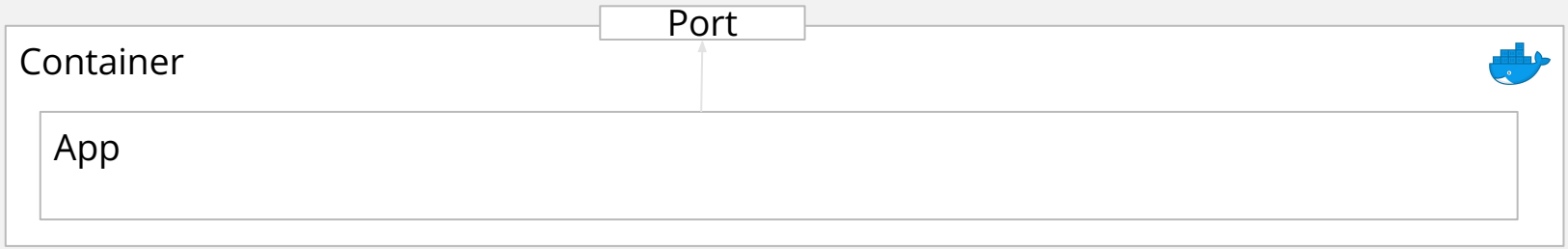
Der Grundbaustein ist eure **Anwendung**.

Die **Anwendung** steckt in einem **Container** (siehe Vorlesung “Virtualisierung”). **Container** öffnen **Ports** nach außen.



Wichtige Kubernetes-Konzepte

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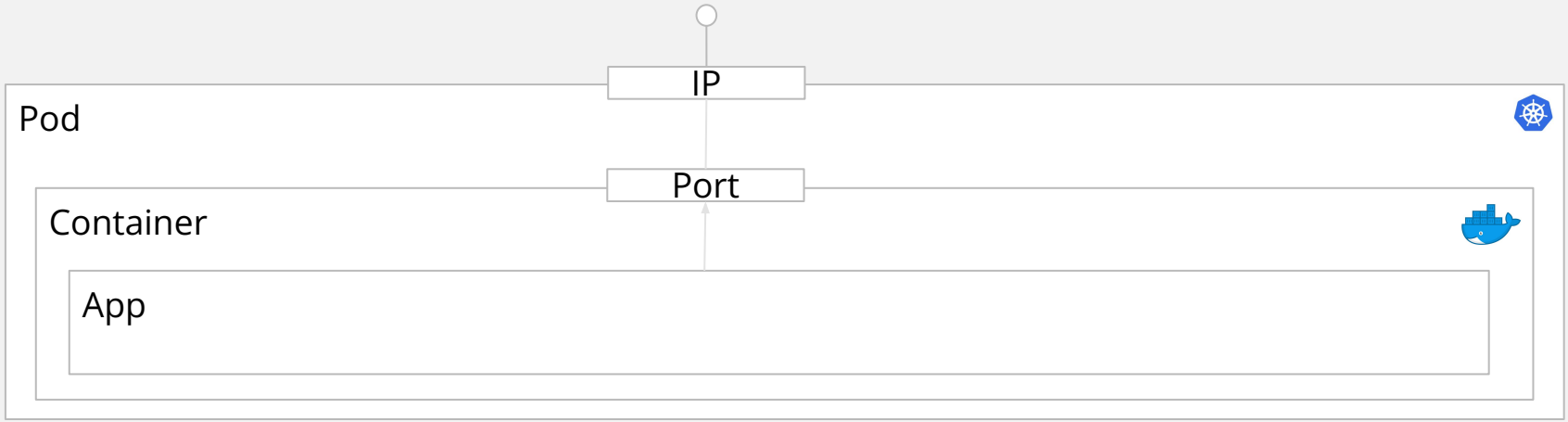
Der Grundbaustein ist eure **Anwendung**.

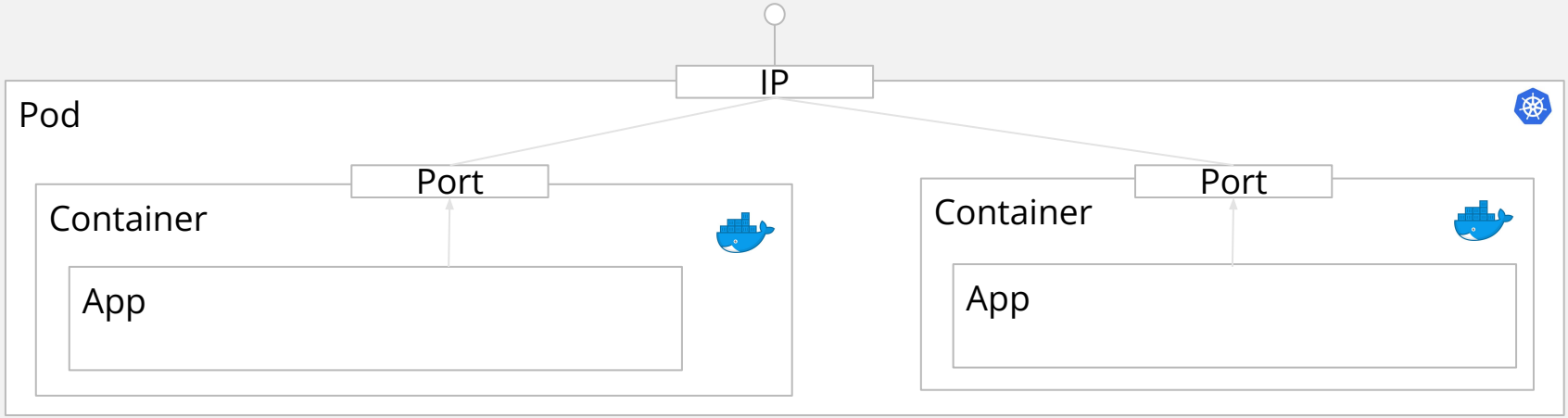
Die **Anwendung** steckt in einem **Container** (siehe Vorlesung “Virtualisierung”). **Container** öffnen **Ports** nach außen.

Container werden in Kubernetes zu **Pods** zusammengefasst. **Pods** haben nach außen hin eine I**P-Adresse**.

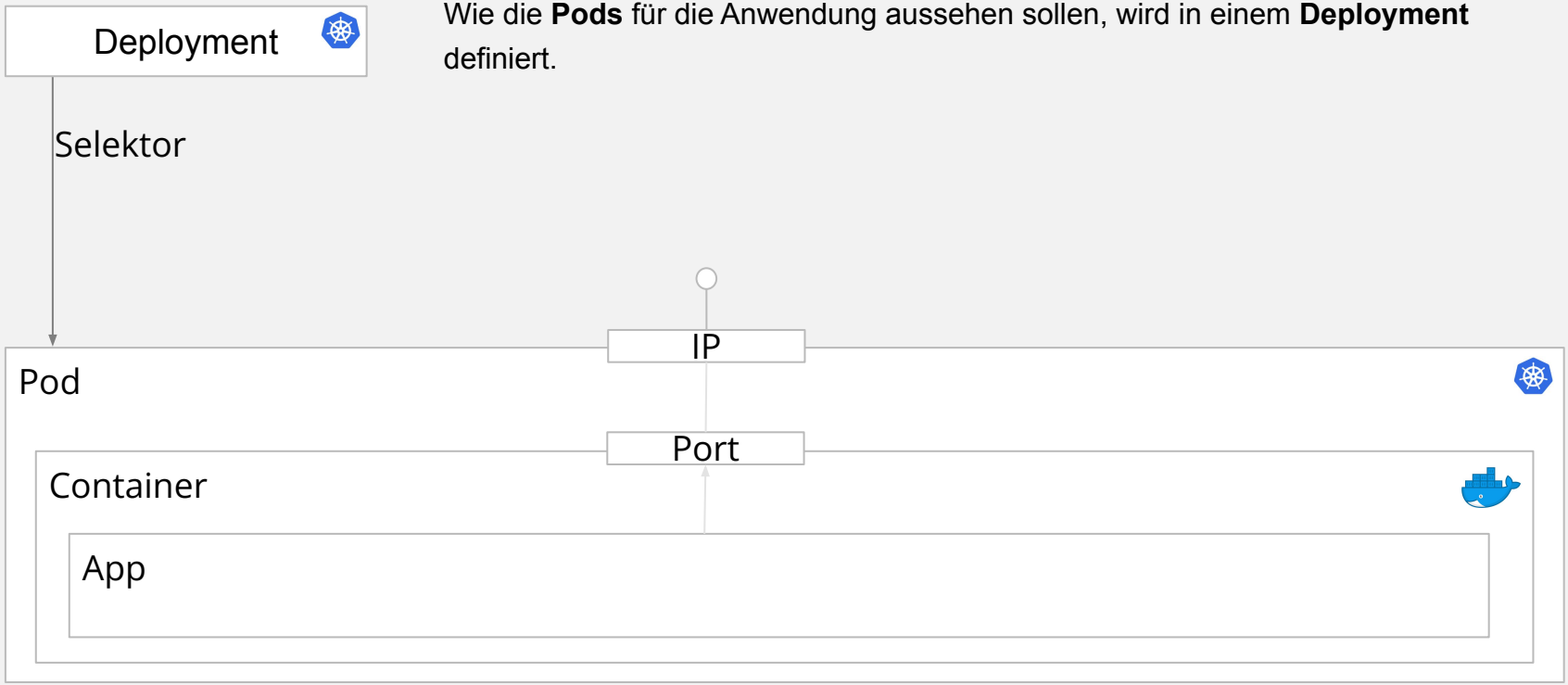


Wichtige Kubernetes-Konzepte

In einem **Pod** können auch mehrere **Container** laufen.



Wichtige Kubernetes-Konzepte



Wie die **Pods** für die Anwendung aussehen sollen, wird in einem **Deployment** definiert.

Wichtige Kubernetes-Konzepte

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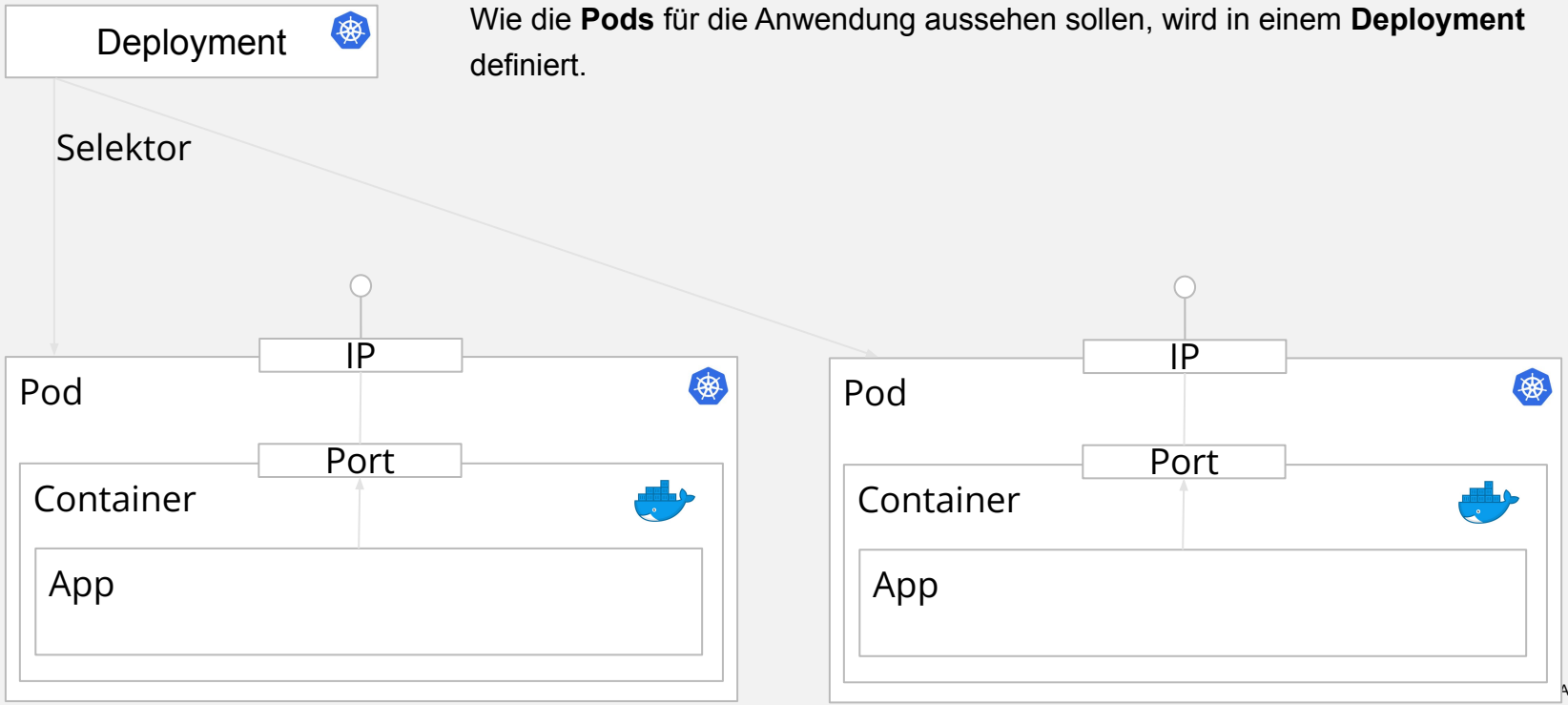
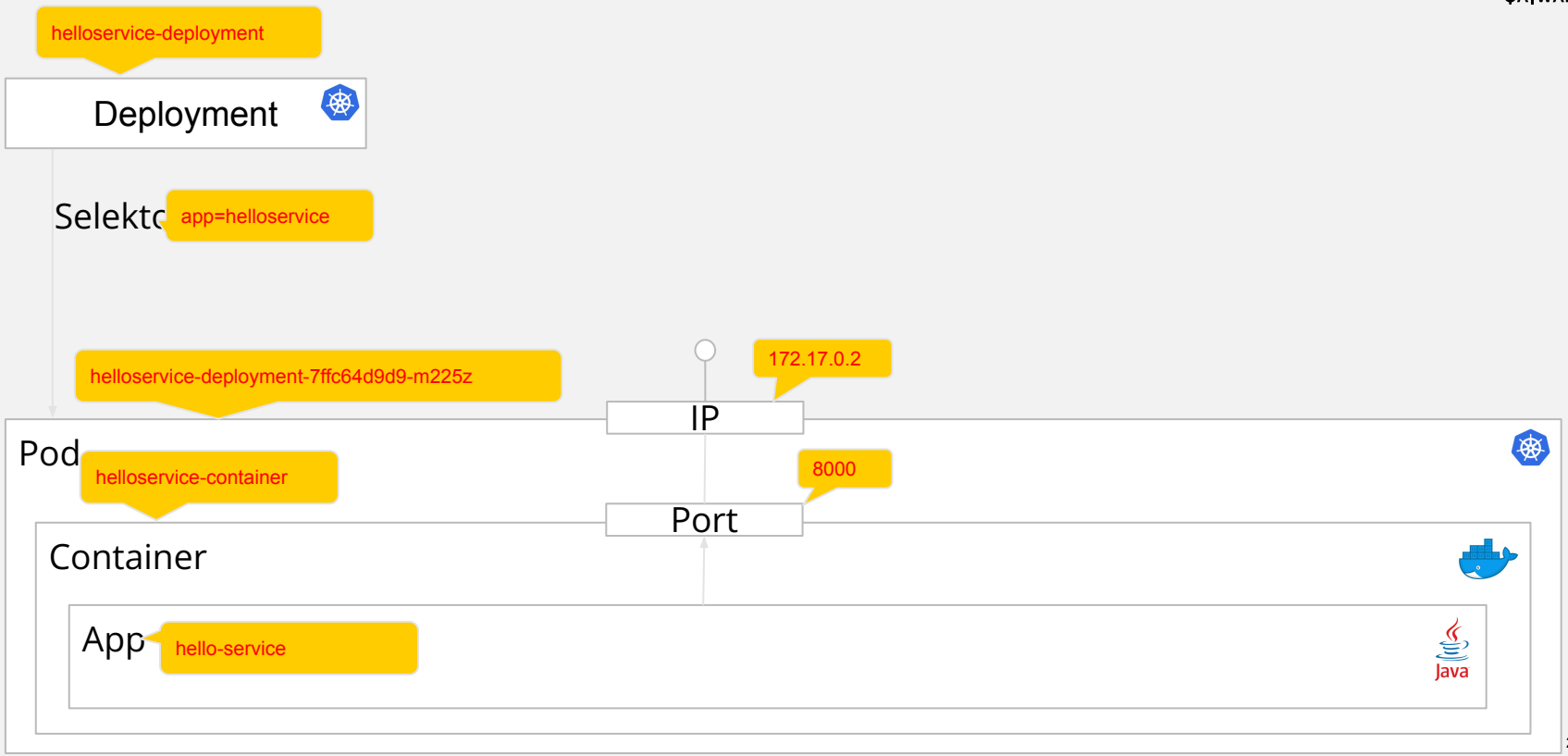


Wie die **Pods** für die Anwendung aussehen sollen, wird in einem **Deployment** definiert.

Deployment: Definition


```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: hello-service
spec:
  replicas: 3
  template:
    metadata:
      labels:
        app: helloservice
    spec:
      containers:
      - name: hello-service
        image: "hitchhikersguide/zwitscher-service:1.0.1"
        ports:
        - containerPort: 8000
        env:
        - name:
          value: zwitscher-consul
```

Big Picture: Hello-Service



Probes & Resources

Resource Constraints


```
resources:
  # Define resources to help K8S scheduler

  # CPU is specified in units of cores
  # Memory is specified in units of bytes

  # required resources for a Pod to be started
  requests:
    memory: "128M"
    cpu: “0.25"

  # the Pod will be restarted if limits are exceeded
  limits:
    memory: "192M"
    cpu: “0.5"
```

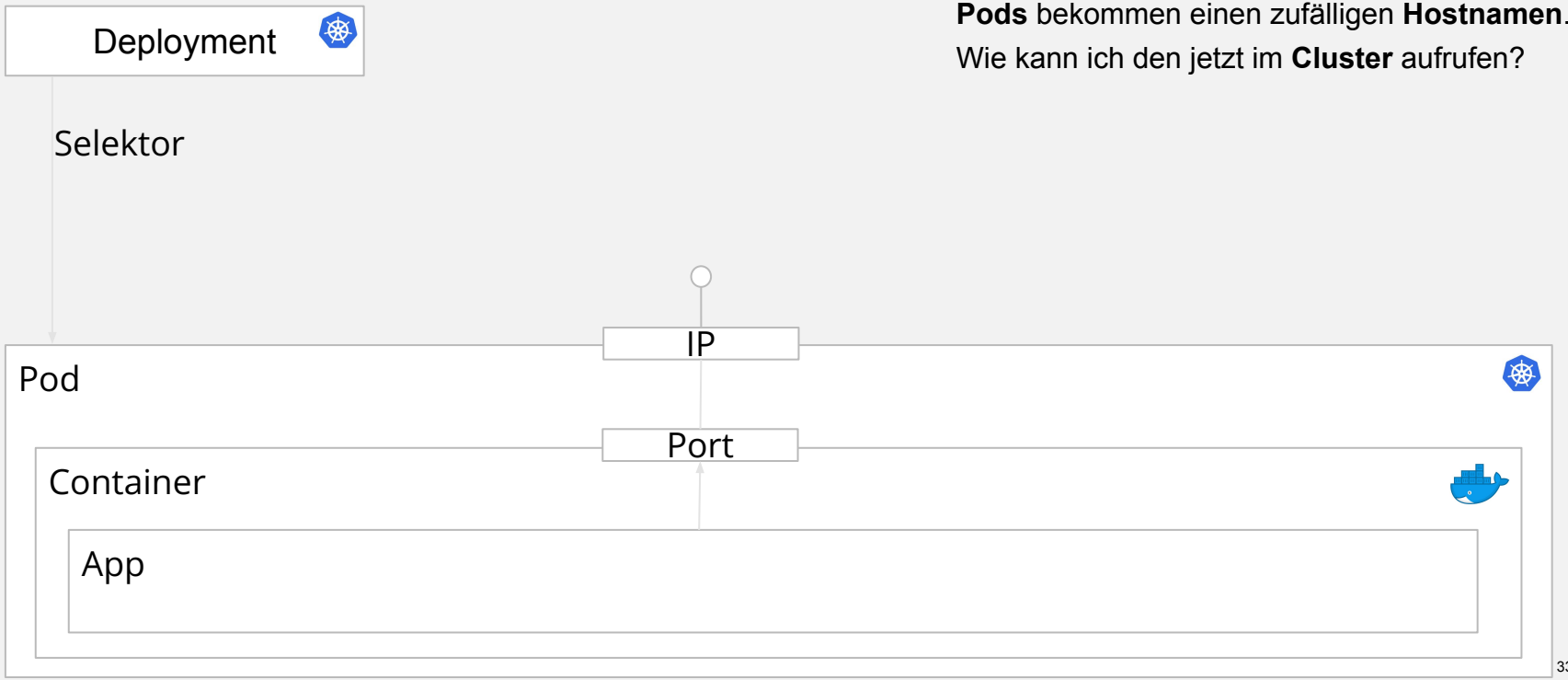
Liveness und Readiness Probes


```
# container will receive requests if probe succeeds
readinessProbe:
  httpGet:
    path: /admin/info
    port: 8080
  initialDelaySeconds: 30
  timeoutSeconds: 5

# container will be killed if probe fails
livenessProbe:
  httpGet:
    path: /admin/health
    port: 8080
  initialDelaySeconds: 90
  timeoutSeconds: 10
```

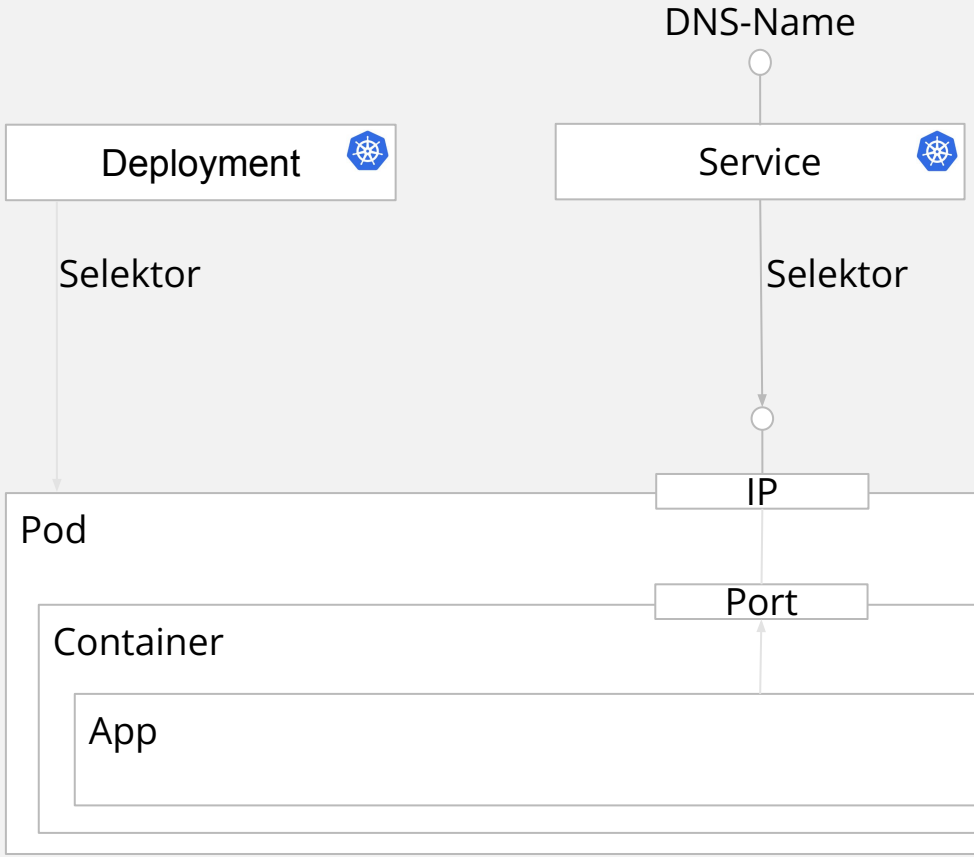
Services

Wichtige Kubernetes Konzepte



Pods bekommen einen zufälligen **Hostnamen**.
Wie kann ich den jetzt im **Cluster** aufrufen?

Wichtige Kubernetes Konzepte



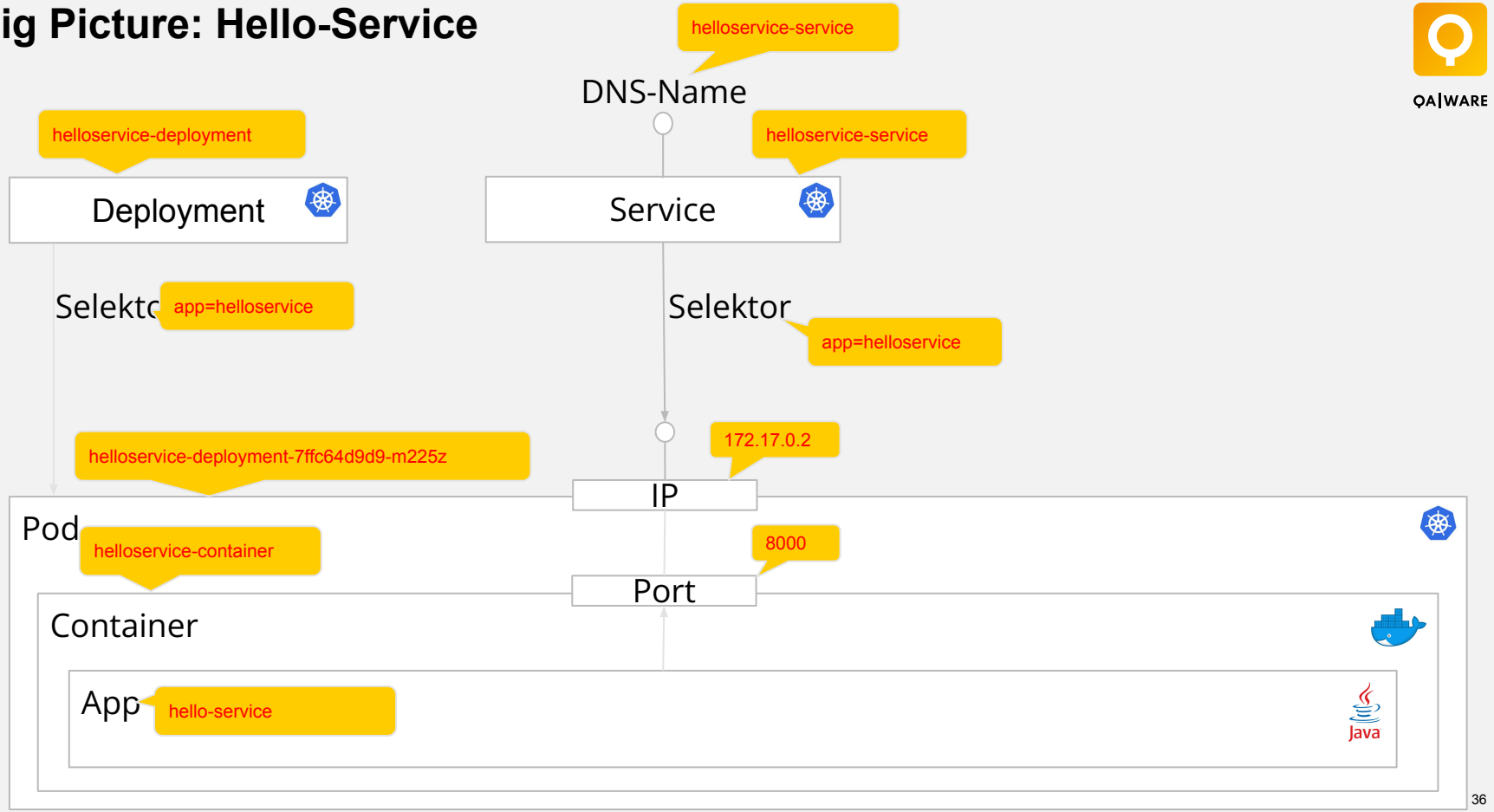
Pods bekommen einen zufälligen **Hostnamen**. Wie kann ich den jetzt im **Cluster** aufrufen?

Ein **Service** vergibt einen **DNS-Namen** für ein Set von **Pods**.

Service: Definition

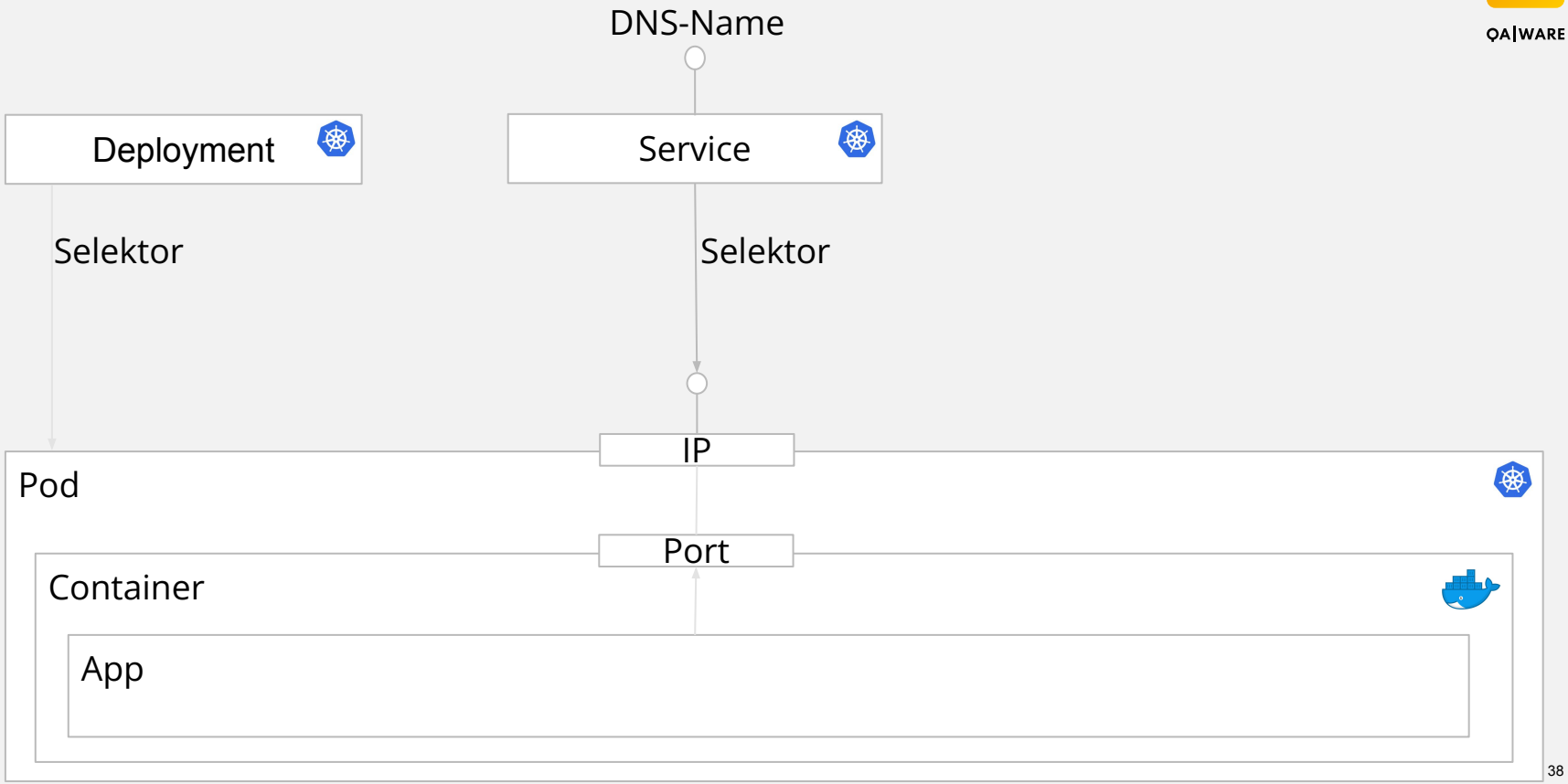

```yaml
apiVersion: v1
kind: Service
metadata:
  name: hello-service
  labels:
    app: helloservice
spec:
  # use NodePort here to be able to access the port on each node
  # use LoadBalancer for external load-balanced IP if supported
  type: NodePort
  ports:
  - port: 8080
  selector:
    app: helloservice
```

Big Picture: Hello-Service

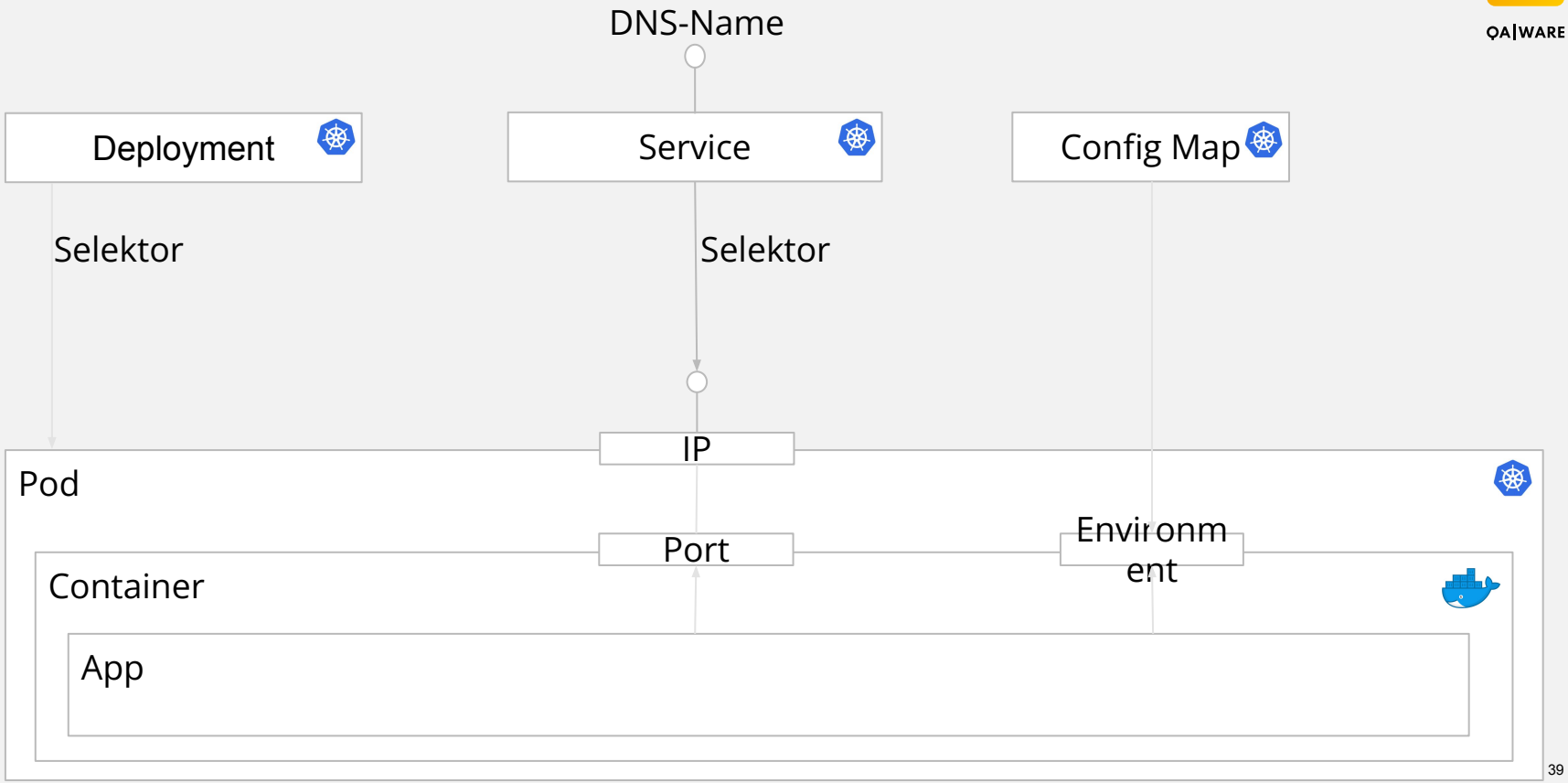


Config Maps

Wichtige Kubernetes Konzepte



Wichtige Kubernetes Konzepte



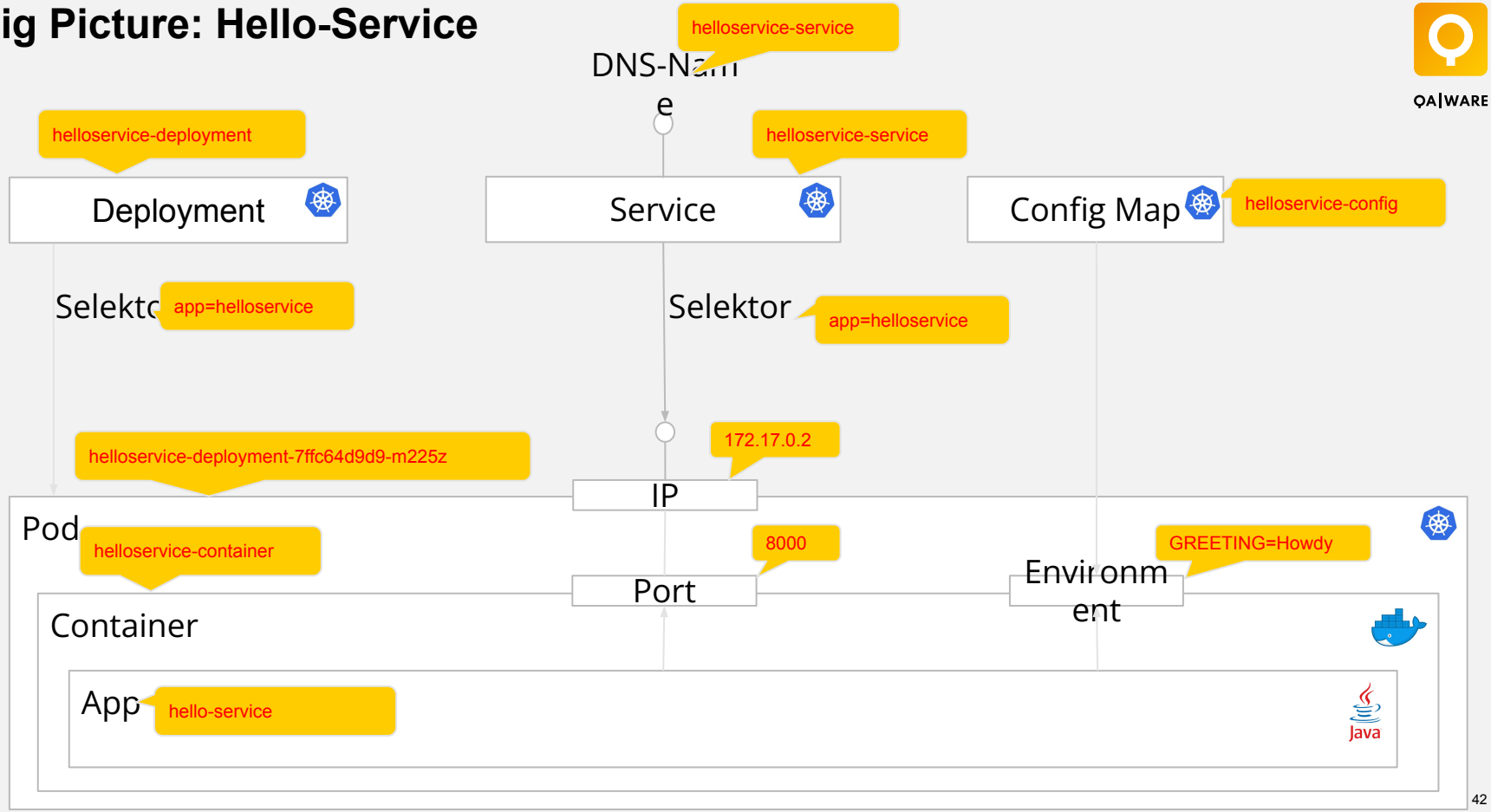
Konfiguration: Config Maps (1)

```yaml
apiVersion: v1
kind: ConfigMap
metadata:
  name: game-demo
data:
  # property-like keys; each key maps to a simple value
  player_initial_lives: "3"
  ui_properties_file_name: "user-interface.properties"
```

Konfiguration: Config Maps (2)

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: configmap-demo-pod
spec:
  containers:
    - name: demo
      image: alpine
      command: ["sleep", "3600"]
      env:
        # Define the environment variable
        - name: PLAYER_INITIAL_LIVES # Notice that the case is different here
                                     # from the key name in the ConfigMap.
          valueFrom:
            configMapKeyRef:
              name: game-demo           # The ConfigMap this value comes from.
              key: player_initial_lives # The key to fetch.
        - name: UI_PROPERTIES_FILE_NAME
          valueFrom:
            configMapKeyRef:
              name: game-demo
              key: ui_properties_file_name
```

Big Picture: Hello-Service



Weitere Konzepte von Kubernetes

Anwendungen:

- StatefulSet: Wenn eine Anwendung doch einen Zustand braucht
- Persistent Volumes: Zugriff auf persistenten Speicher

Global:

- DaemonSet: Wenn ein Dienst auf jedem Node im Cluster laufen muss
- Job: Wenn eine Aufgabe regelmäßig ausgeführt werden muss

Security:

- Network Policies: Wer darf mit wem kommunizieren?

Helm: Verwaltung von Applikationspaketen für Kubernetes.

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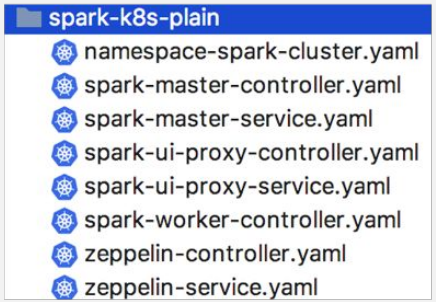
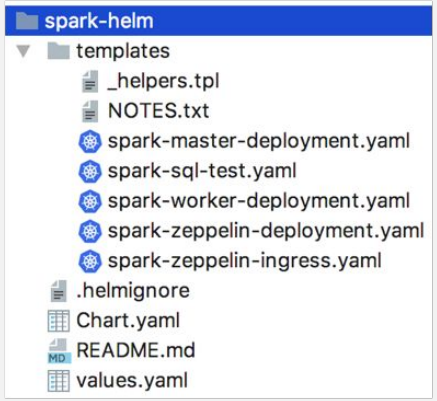
HELM https://helm.sh



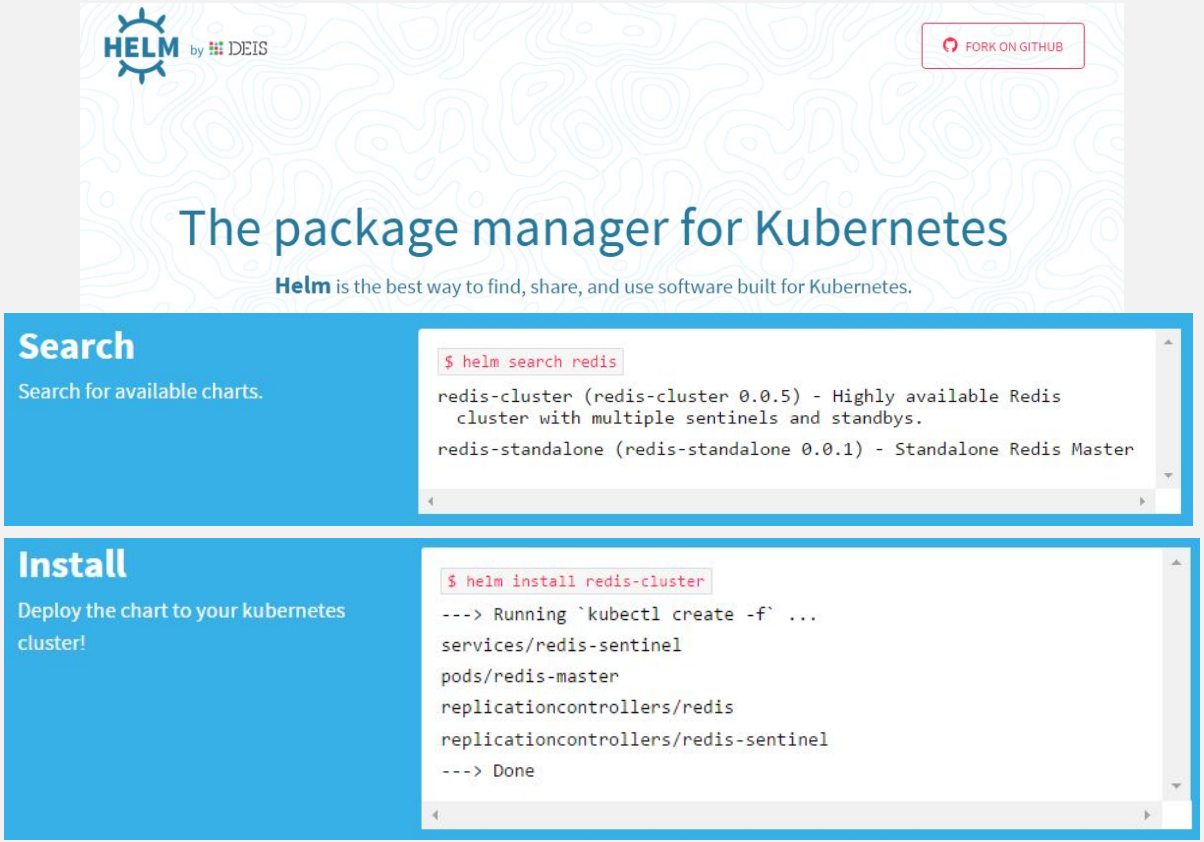
- `kubectl, kubectl, kubectl, ...`
- Konfiguration?
- Endpunkte?



- Chart suchen auf https://hub.kubeapps.com
- Doku dort lesen (README.md)
- Konfigurationsparameter lesen:
  `helm inspect stable/spark`
- Chart starten mit überschriebener Konfiguration:

```
helm install --name my-release
     -f values.yaml stable/spark
```

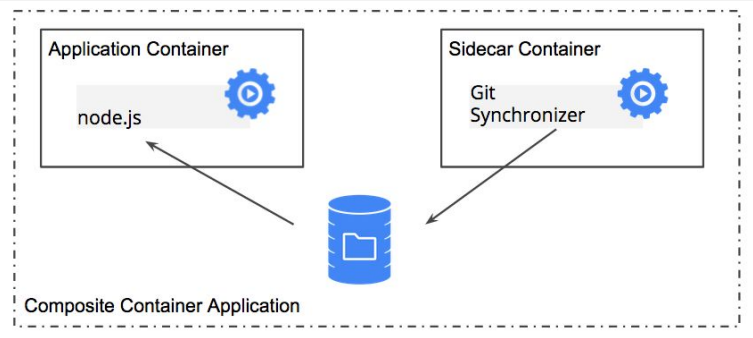
Helm: Verwaltung von Applikationspaketen für Kubernetes.



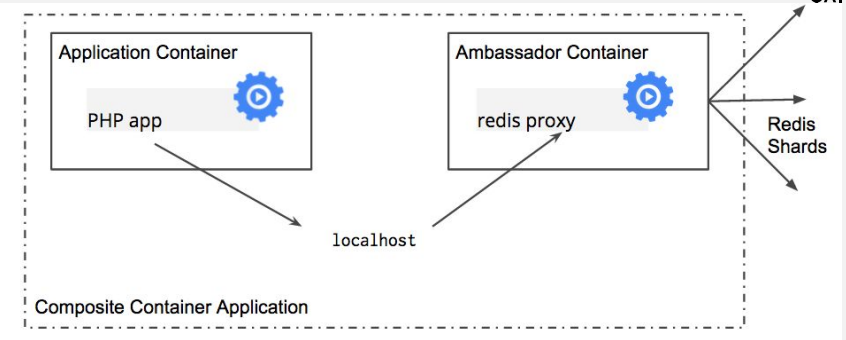
Quelle: https://github.com/helm/helm

Orchestrierungsmuster

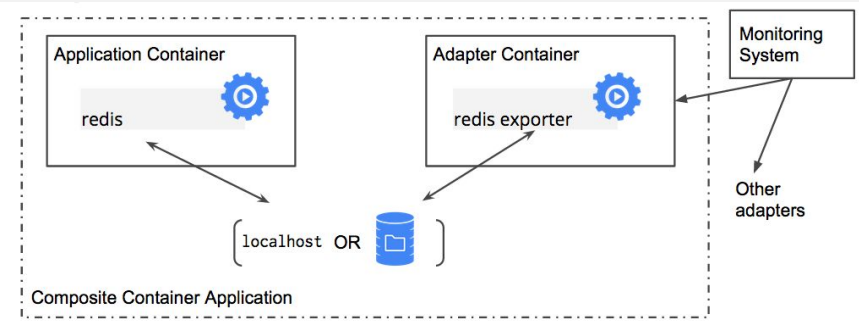
Orchestrierungsmuster – Separation of Concerns mit modularen Containern



Sidecar Container



Ambassador Container

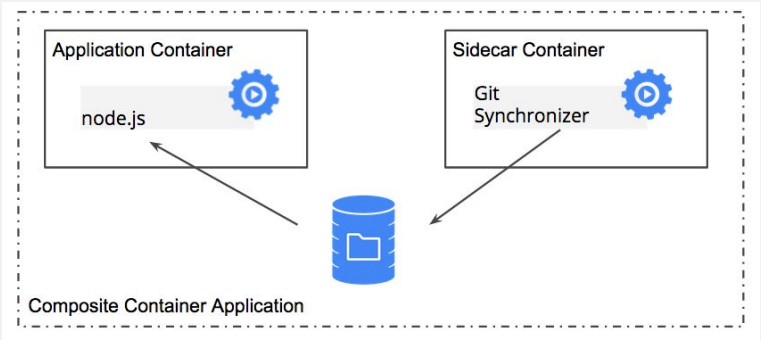


Adapter Container

Quelle: http://blog.kubernetes.io/2015/06/the-distributed-system-toolkit-patterns.html

Sidecar Containers

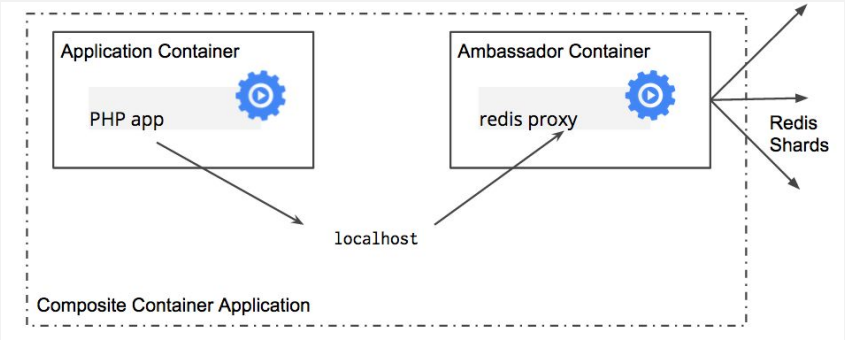
Sidecar containers extend and enhance the "main" container, they take existing containers and make them better. As an example, consider a container that runs the Nginx web server. Add a different container that syncs the file system with a git repository, share the file system between the containers and you have built Git push-to-deploy. But you've done it in a modular manner where the git synchronizer can be built by a different team, and can be reused across many different web servers (Apache, Python, Tomcat, etc). **Because of this modularity, you only have to write and test your git synchronizer once and reuse it across numerous apps**. And if someone else writes it, you don't even need to do that.



Quelle: https://kubernetes.io/blog/2015/06/the-distributed-system-toolkit-patterns/

Ambassador containers

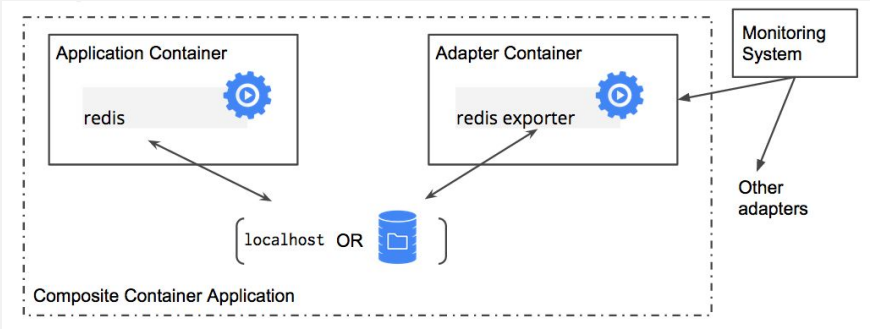
Ambassador containers proxy a local connection to the world. As an example, consider a Redis cluster with read-replicas and a single write master. You can create a Pod that groups your main application with a Redis ambassador container. **The ambassador is a proxy is responsible for splitting reads and writes and sending them on to the appropriate servers**. Because these two containers share a network namespace, they share an IP address and your application can open a connection on “localhost” and find the proxy without any service discovery. **As far as your main application is concerned, it is simply connecting to a Redis server on localhost**. This is powerful, not just because of separation of concerns and the fact that different teams can easily own the components, but also because in the development environment, you can simply skip the proxy and connect directly to a Redis server that is running on localhost.



Quelle: https://kubernetes.io/blog/2015/06/the-distributed-system-toolkit-patterns/

Adapter containers

Adapter containers standardize and normalize output. Consider the task of monitoring N different applications. Each application may be built with a different way of exporting monitoring data. (e.g. JMX, StatsD, application specific statistics) but every monitoring system expects a consistent and uniform data model for the monitoring data it collects. **By using the adapter pattern of composite containers, you can transform the heterogeneous monitoring data from different systems into a single unified representation** by creating Pods that groups the application containers with adapters that know how to do the transformation. Again because these Pods share namespaces and file systems, the coordination of these two containers is simple and straightforward.



Quelle: https://kubernetes.io/blog/2015/06/the-distributed-system-toolkit-patterns/