What is Kubernetes?

What Is Kubernetes?

- Kubernetes is Greek for "helmsman", your guide through unknown waters, nice but not true :-)
- Kubernetes is the linux kernel of distributed systems
- Kubernetes is the linux of the cloud!
- Kubernetes is a platform and container orchestration tool for automating deployment, scaling, and operations of application containers.
- Kubernetes supports, Containerd, CRI-O, Kata containers (formerly clear and hyper) and Virtlet

Containers?

- What is a Container Engine?
- Where are the differences between Docker, CRI-O or Containerd runtimes?
- How does Kubernetes work with container runtimes?
- Which is the best solution?
  - Linux Container Internals by Scott McCarty → →
  - Container Runtimes and Kubernetes by Fahed Dorgaa →
  - Kubernetes Runtime Comparison →

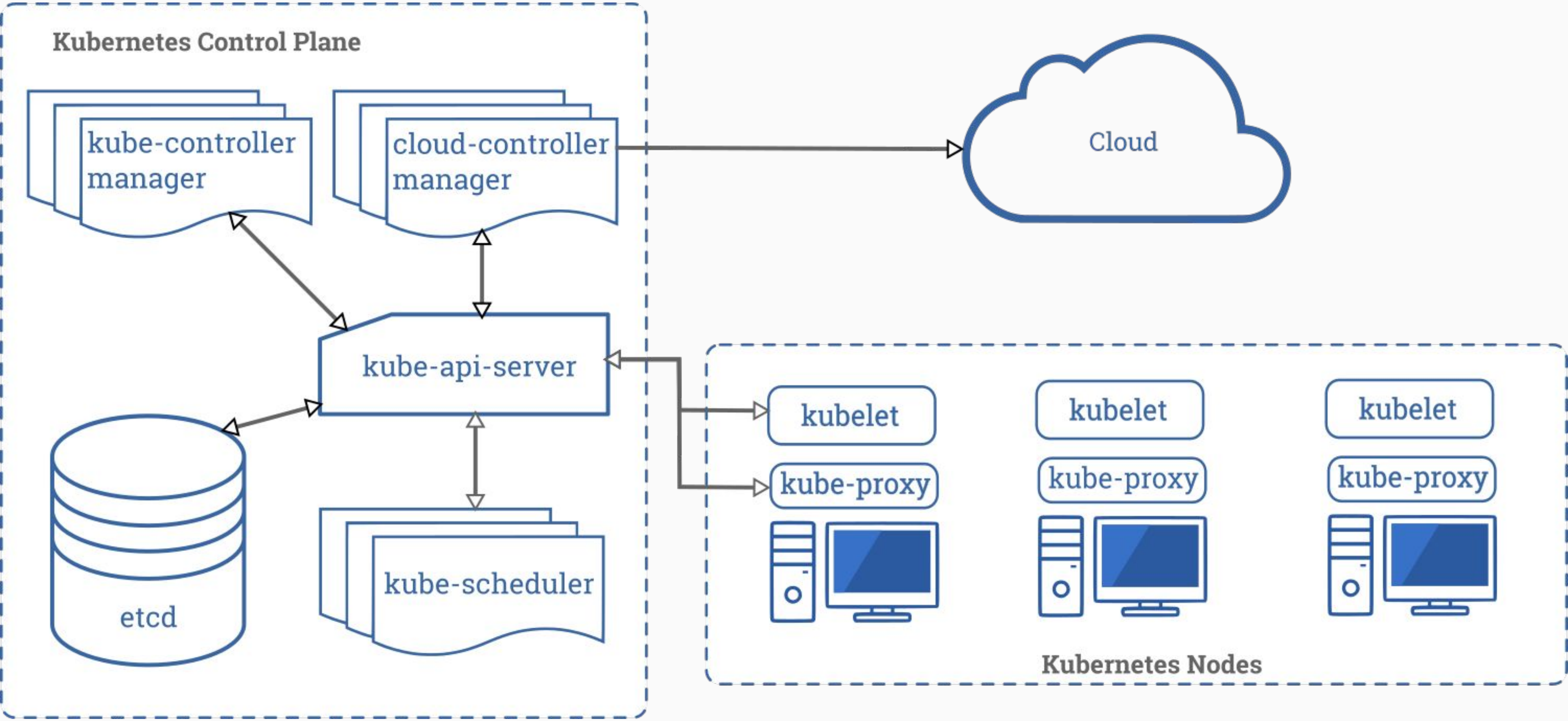
How Kubernetes works?

How Kubernetes works?

In Kubernetes, there is a master node and multiple worker nodes, each worker node can handle multiple pods. Pods are just a bunch of containers clustered together as a working unit. You can start designing your applications using pods. Once your pods are ready, you can specify pod definitions to the master node, and how many you want to deploy. From this point, Kubernetes is in control. It takes the pods and deploys them to the worker nods.

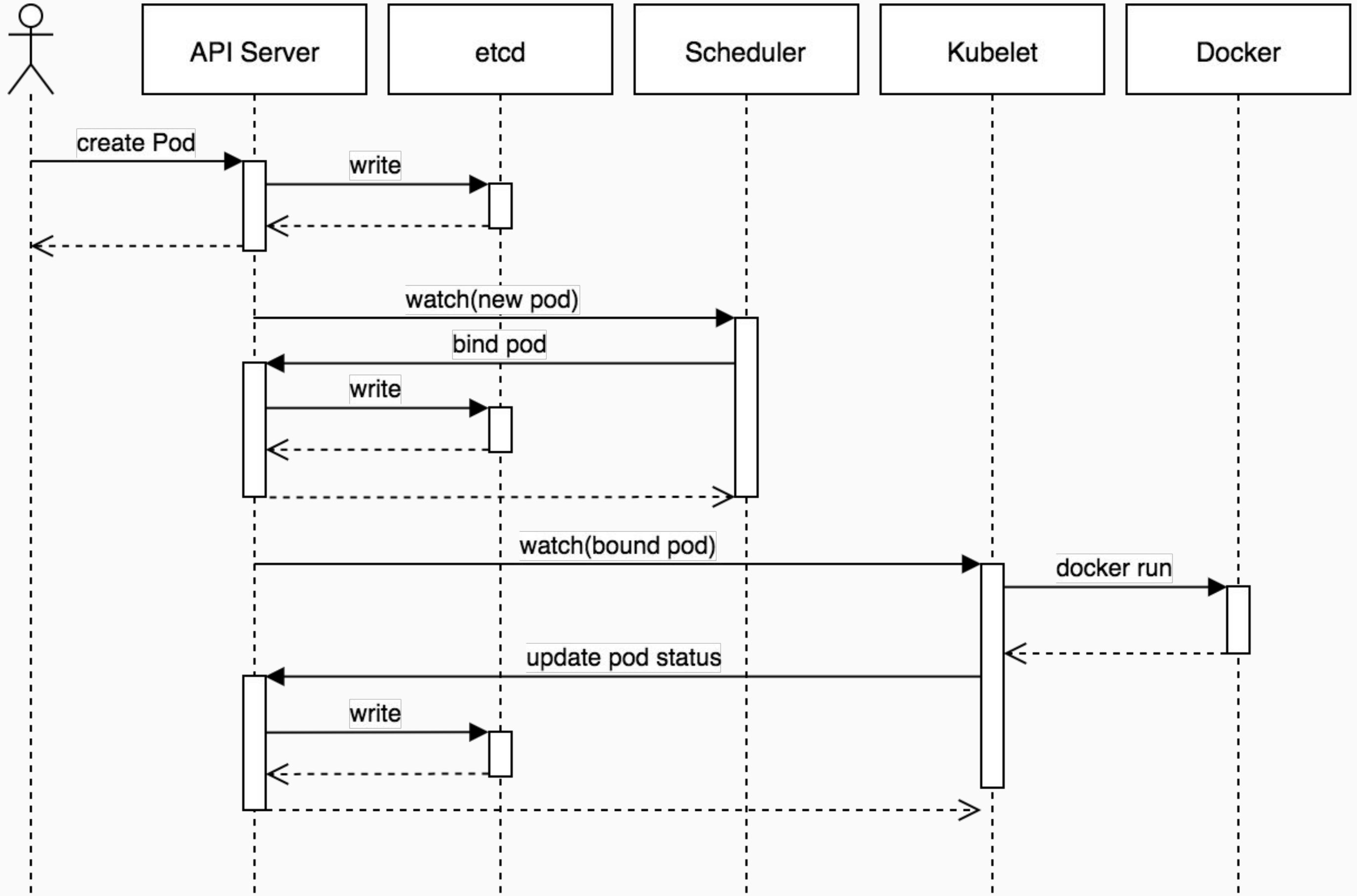
Source: https://itnext.io/successful-short-kubernetes-stories-for-devops-architects-677f8bfed803

Kubernetes Components



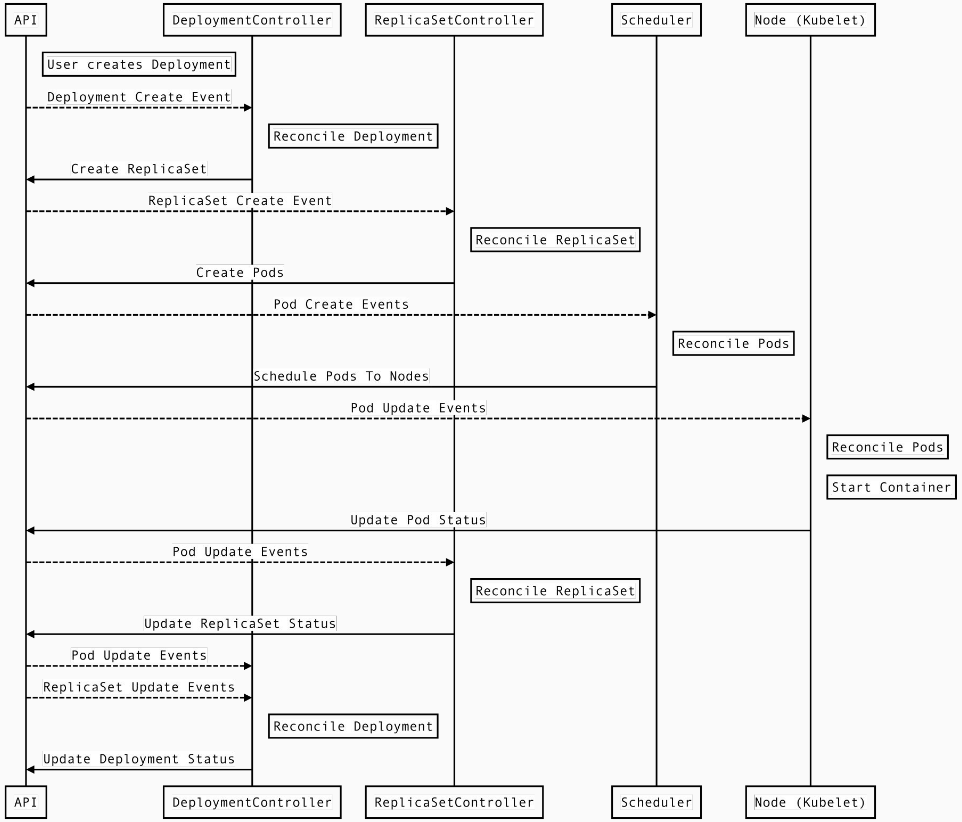
Source: https://kubernetes.io/docs/concepts/overview/components/#master-components

A Typical Flow: How K8s API works



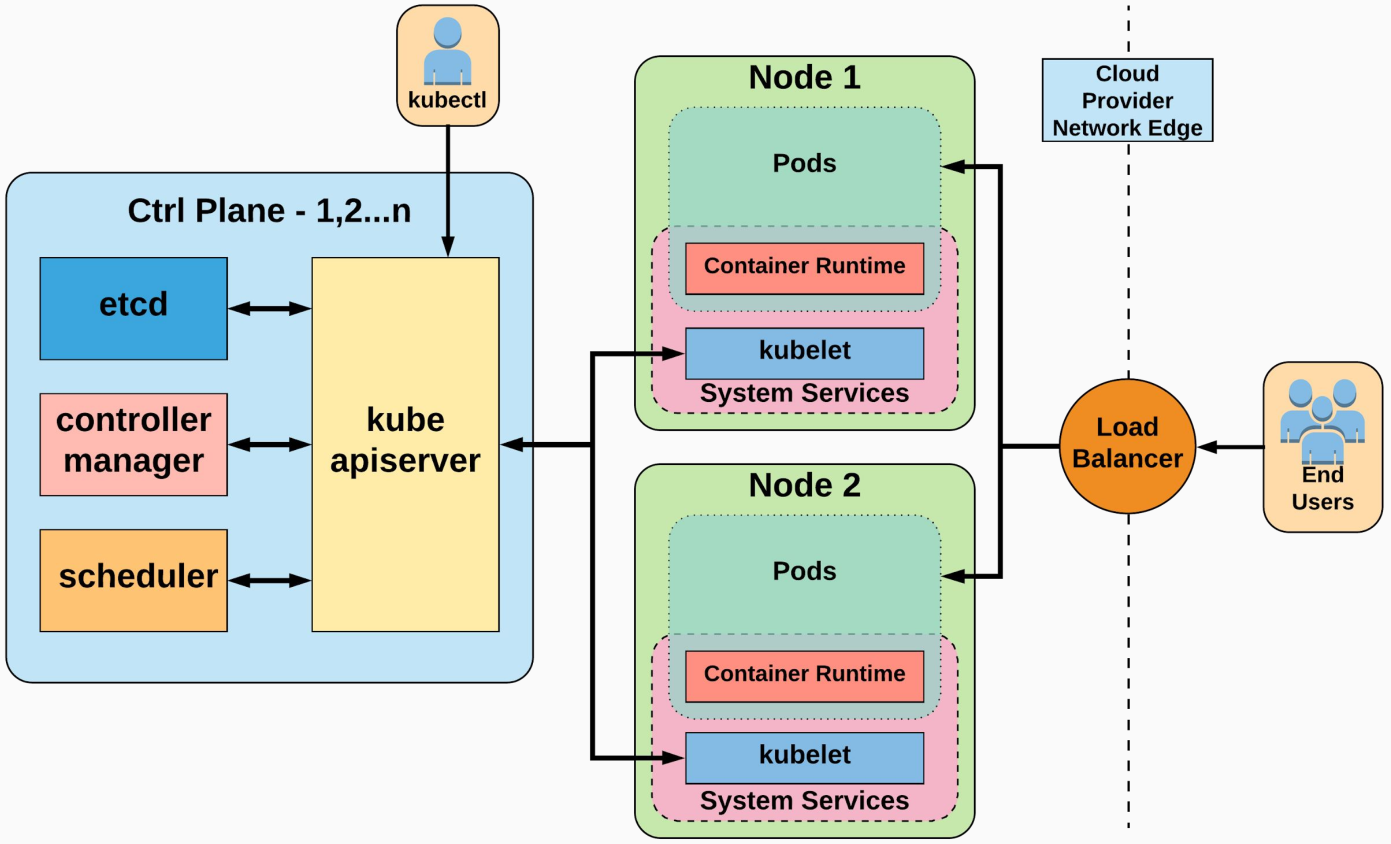
Source: https://blog.heptio.com/core-kubernetes-jazz-improv-over-orchestration-a7903ea92ca

Kubernetes Component Flow



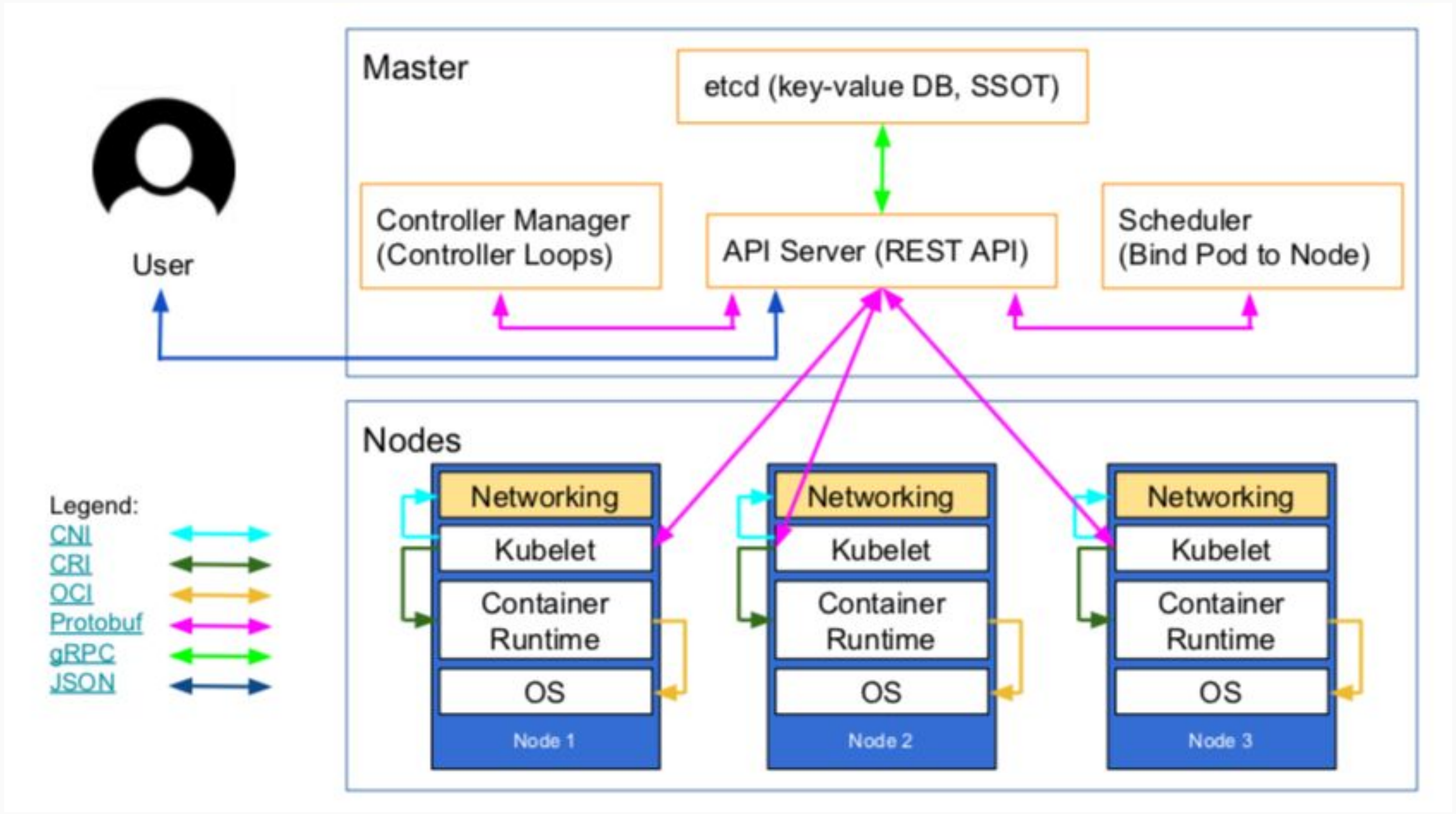
Source: https://medium.com/payscale-tech/imperative-vs-declarative-a-kubernetes-tutorial-4be66c5d8914

Kubernetes Architecture Overview



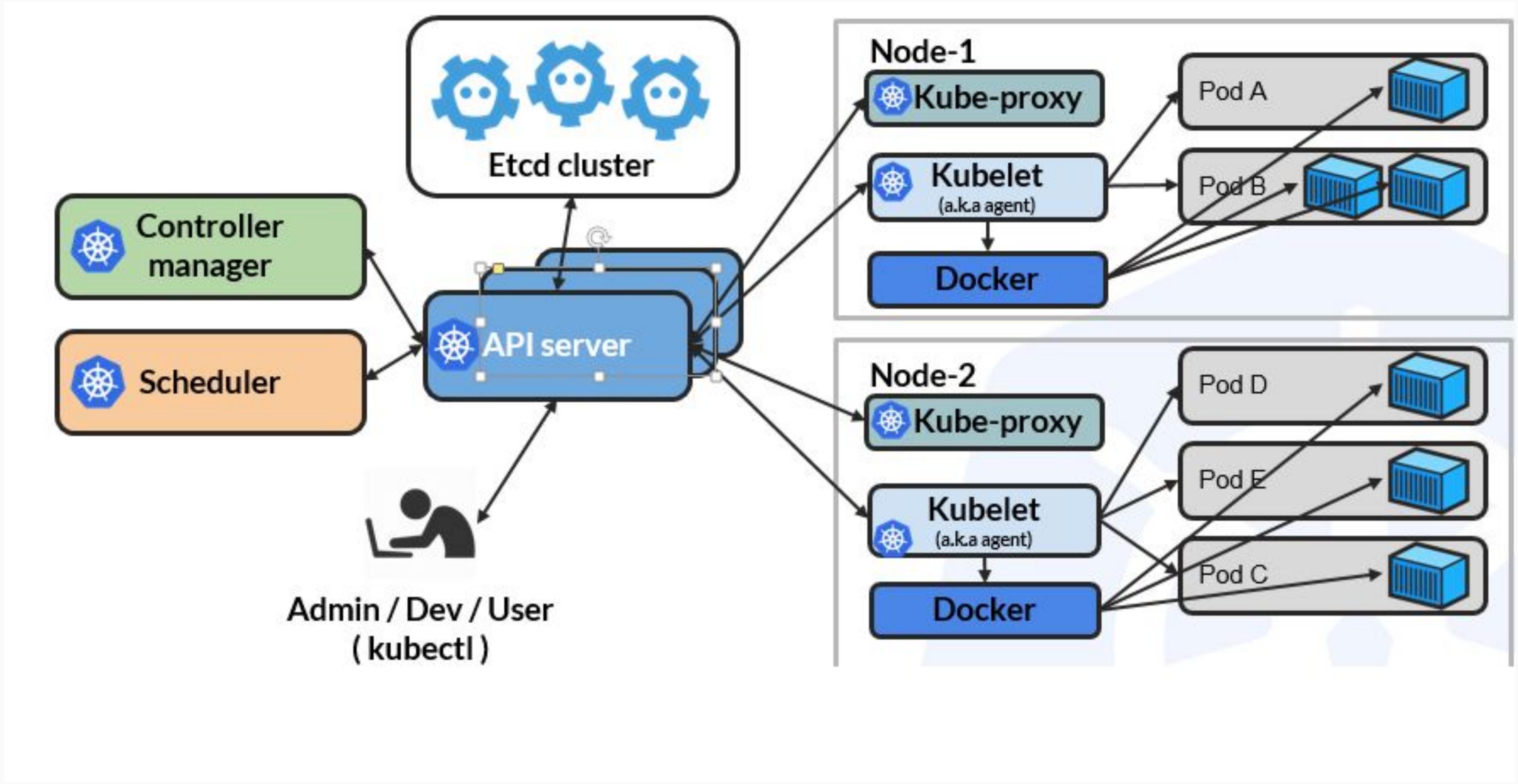
Source: [Introduction to Kubernetes]

Kubernetes' High-Level Architecture Overview

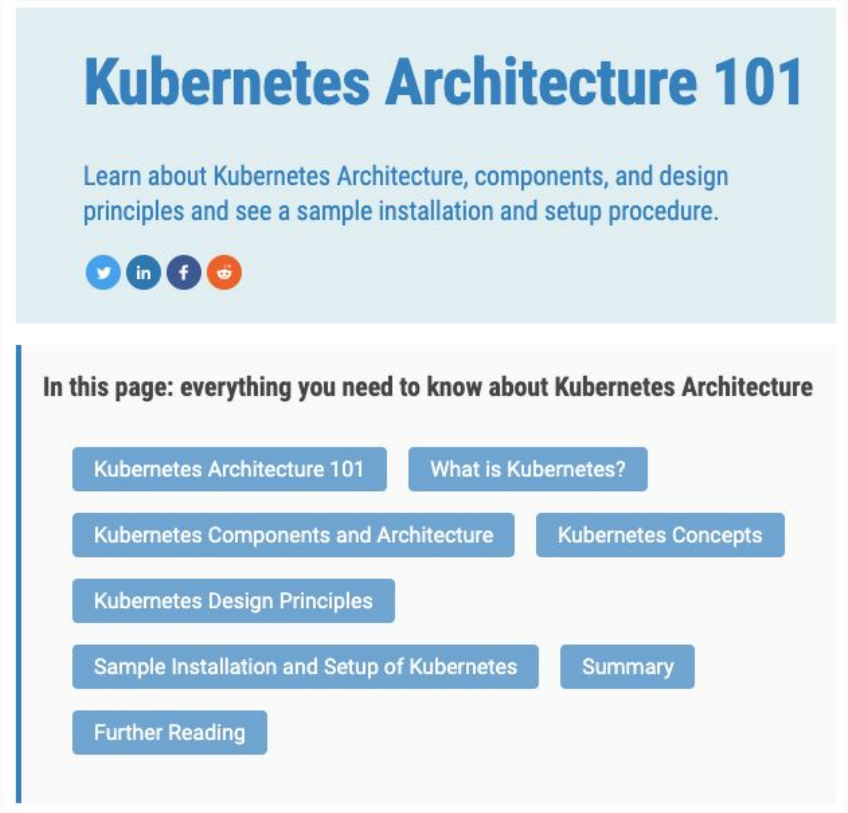


Source: https://www.weave.works/blog/what-does-production-ready-really-mean-for-a-kubernetes-cluster

Kubernetes’ High-Level Architecture Overview



Kubernetes Architecture 101



Kubernetes Architecture 101

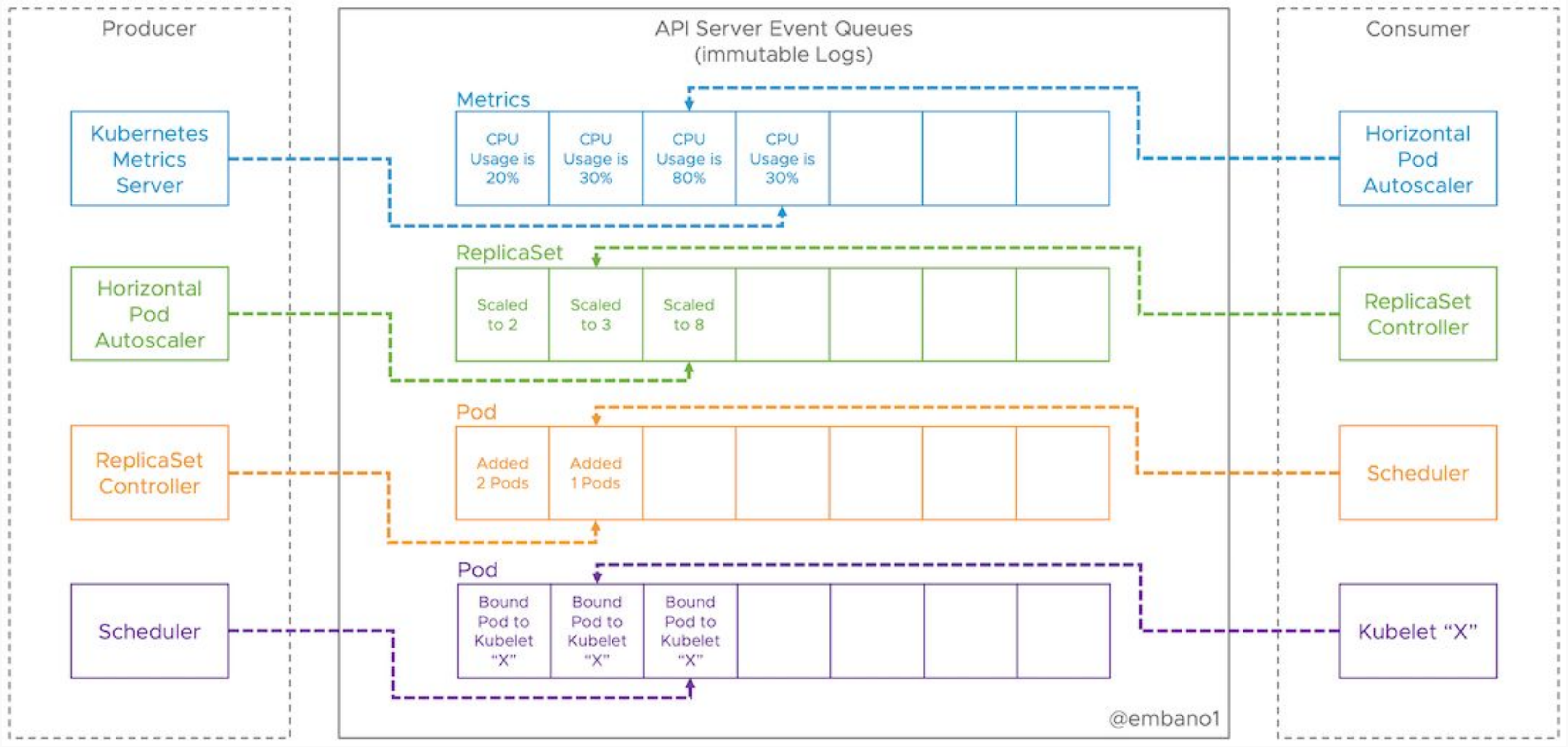
Learn about Kubernetes Architecture, components, and design principles and see a sample installation and setup procedure.

In this page: everything you need to know about Kubernetes Architecture

Source: https://www.aquasec.com/wiki/display/containers/Kubernetes+Architecture+101

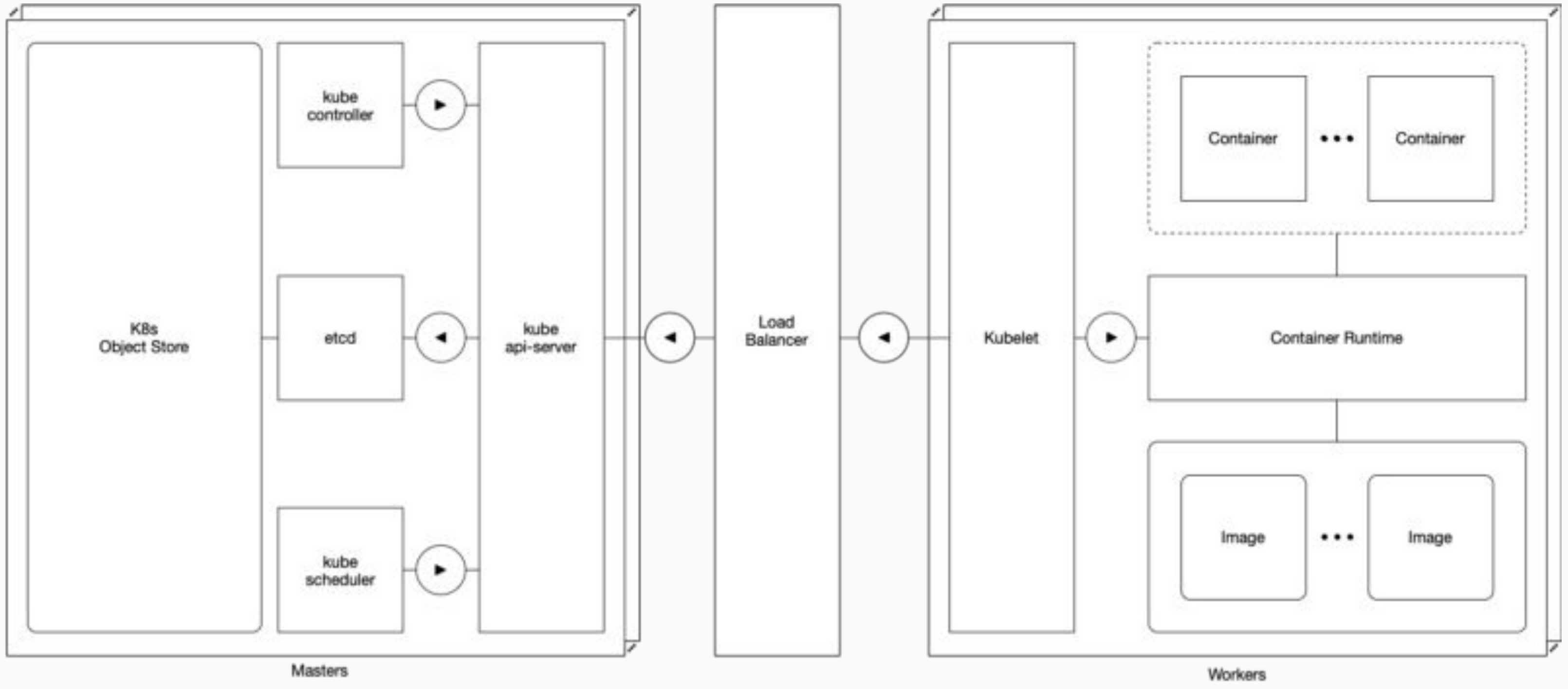
Kubernetes is like Kafka: Event-Driven Architecture

Kubernetes: “Autonomous processes reacting to events from the API server”.



Source: Events, the DNA of Kubernetes

Kubernetes HA



Don’t miss: https://medium.com/@dominik.tornow/kubernetes-high-availability-d2c9cbbdd864

Core Concepts of Kubernetes (1)

- Pod →
- Label and selectors →
- Controllers
  - Deployments →
  - ReplicaSet →
  - ReplicationController →
  - DaemonSet →
- Service →

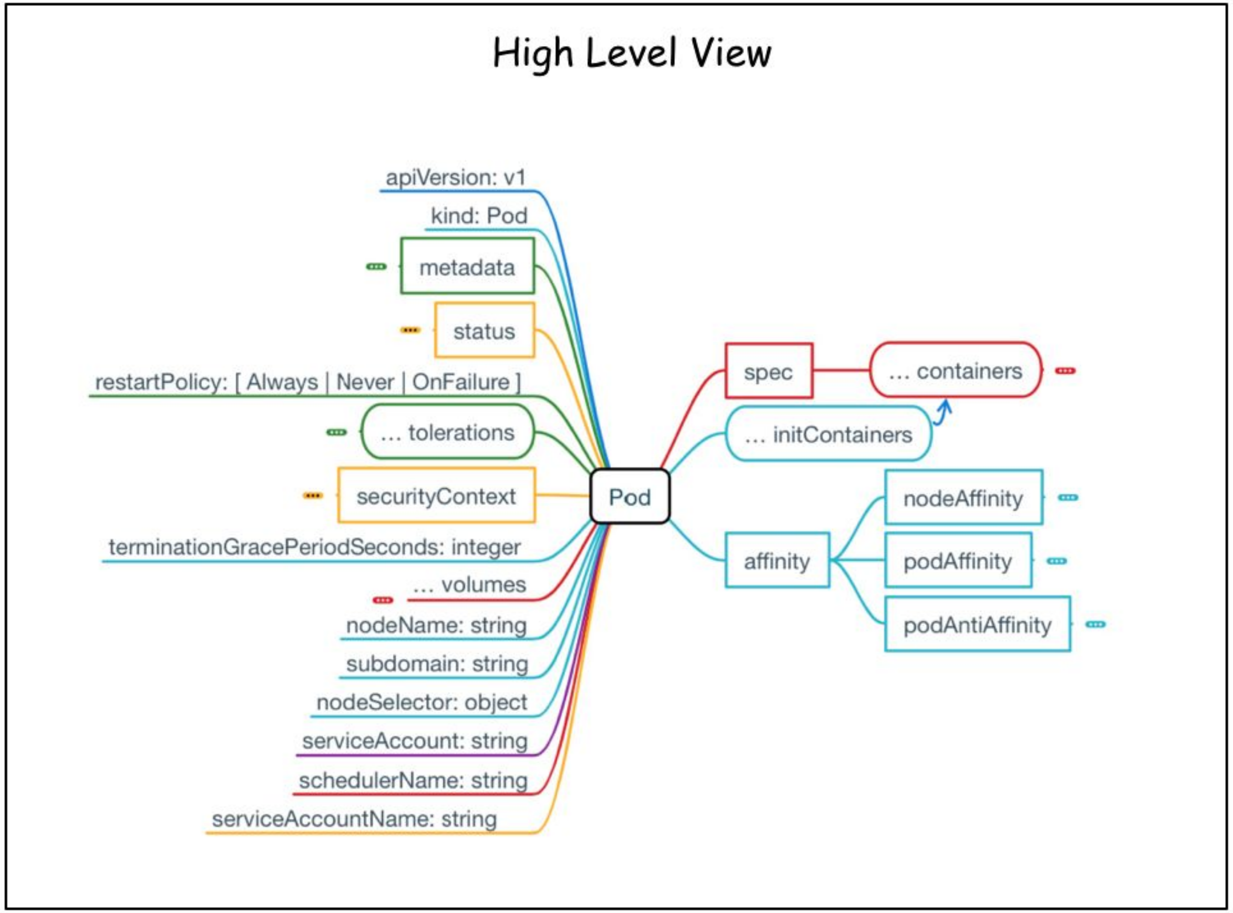
Core Concepts of Kubernetes (2)

- StatefulSets →
- ConfigMaps →
- Secrets →
- Persistent Volumes (attaching storage to containers) →
- Life Cycle of Applications in Kubernetes →
  - Updating Pods
  - Rolling updates
  - Rollback

Kubernetes resources explained (1)

	Resource (abbr.) [API version]	Description
	Namespace* (ns) [v1]	Enables organizing resources into non-overlapping groups (for example, per tenant)
Deploying Workloads	Pod (po) [v1]	The basic deployable unit containing one or more processes in co-located containers
	ReplicaSet	Keeps one or more pod replicas running
	ReplicationController	The older, less-powerful equivalent of a ReplicaSet
	Job	Runs pods that perform a completable task
	CronJob	Runs a scheduled job once or periodically
	DaemonSet	Runs one pod replica per node (on all nodes or only on those matching a node selector)
	StatefulSet	Runs stateful pods with a stable identity
	Deployment	Declarative deployment and updates of pods

The Pod Cheat Sheet



Source: The Pod Cheat Sheet by the awesome Jimmy Song

Kubernetes resources explained (2)

	Resource (abbr.) [API version]	Description
Services	**Service** (svc) [v1]	Exposes one or more pods at a single and stable IP address and port pair
	Endpoints (ep) [v1]	Defines which pods (or other servers) are exposed through a service
	Ingress (ing) [extensions/v1beta1]	Exposes one or more services to external clients through a single externally reachable IP address
Config	ConfigMap (cm) [v1]	A key-value map for storing non-sensitive config options for apps and exposing it to them
	Secret [v1]	Like a ConfigMap, but for sensitive data
Storage	PersistentVolume* (pv) [v1]	Points to persistent storage that can be mounted into a pod through a PersistentVolumeClaim
	PersistentVolumeClaim (pvc) [v1]	A request for and claim to a PersistentVolume
	StorageClass* (sc) [storage.k8s.io/v1]	Defines the type of storage in a PersistentVolumeClaim

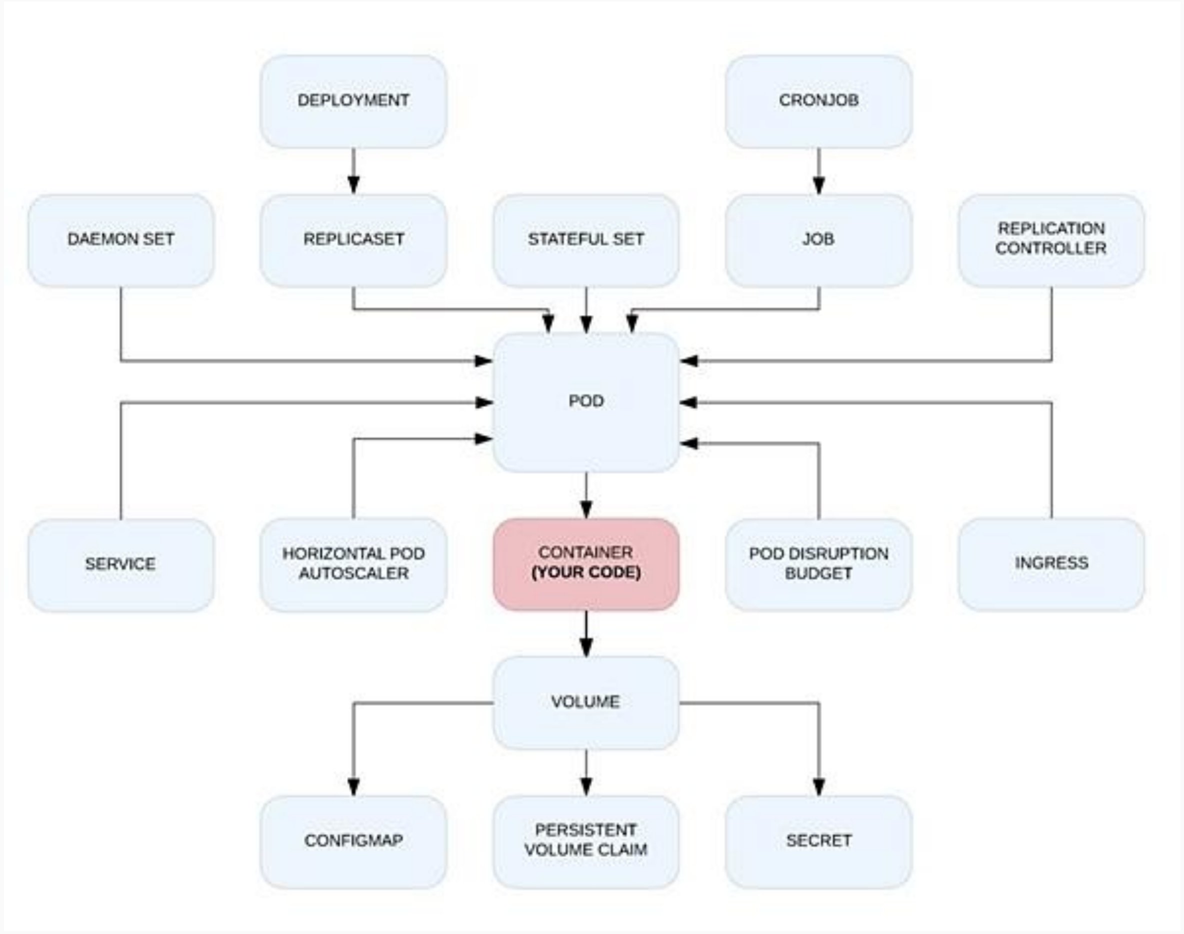
Kubernetes resources explained (4)

	Resource (abbr.) [API version]	Description
Scaling	HorizontalPodAutoscaler (hpa) [autoscaling/v2beta1**]	Automatically scales number of pod replicas based on CPU usage or another metric
	PodDisruptionBudget (pdb) [policy/v1beta1]	Defines the minimum number of pods that must remain running when evacuating nodes
Resources	LimitRange (limits) [v1]	Defines the min, max, default limits, and default requests for pods in a namespace
	ResourceQuota (quota) [v1]	Defines the amount of computational resources available to pods in the namespace
Cluster state	Node* (no) [v1]	Represents a Kubernetes worker node
	Cluster* [federation/v1beta1]	A Kubernetes cluster (used in cluster federation)
	ComponentStatus* (cs) [v1]	Status of a Control Plane component
	Event (ev) [v1]	A report of something that occurred in the cluster

Kubernetes resources explained (4)

	Resource (abbr.) [API version]	Description
Security	ServiceAccount (sa) [v1]	An account used by apps running in pods
	Role [rbac.authorization.k8s.io/v1]	Defines which actions a subject may perform on which resources (per namespace)
	ClusterRole* [rbac.authorization.k8s.io/v1]	Like Role, but for cluster-level resources or to grant access to resources across all namespaces
	RoleBinding [rbac.authorization.k8s.io/v1]	Defines who can perform the actions defined in a Role or ClusterRole (within a namespace)
	ClusterRoleBinding* [rbac.authorization.k8s.io/v1]	Like RoleBinding, but across all namespaces
	PodSecurityPolicy* (psp) [extensions/v1beta1]	A cluster-level resource that defines which security-sensitive features pods can use
	NetworkPolicy (netpol) [networking.k8s.io/v1]	Isolates the network between pods by specifying which pods can connect to each other

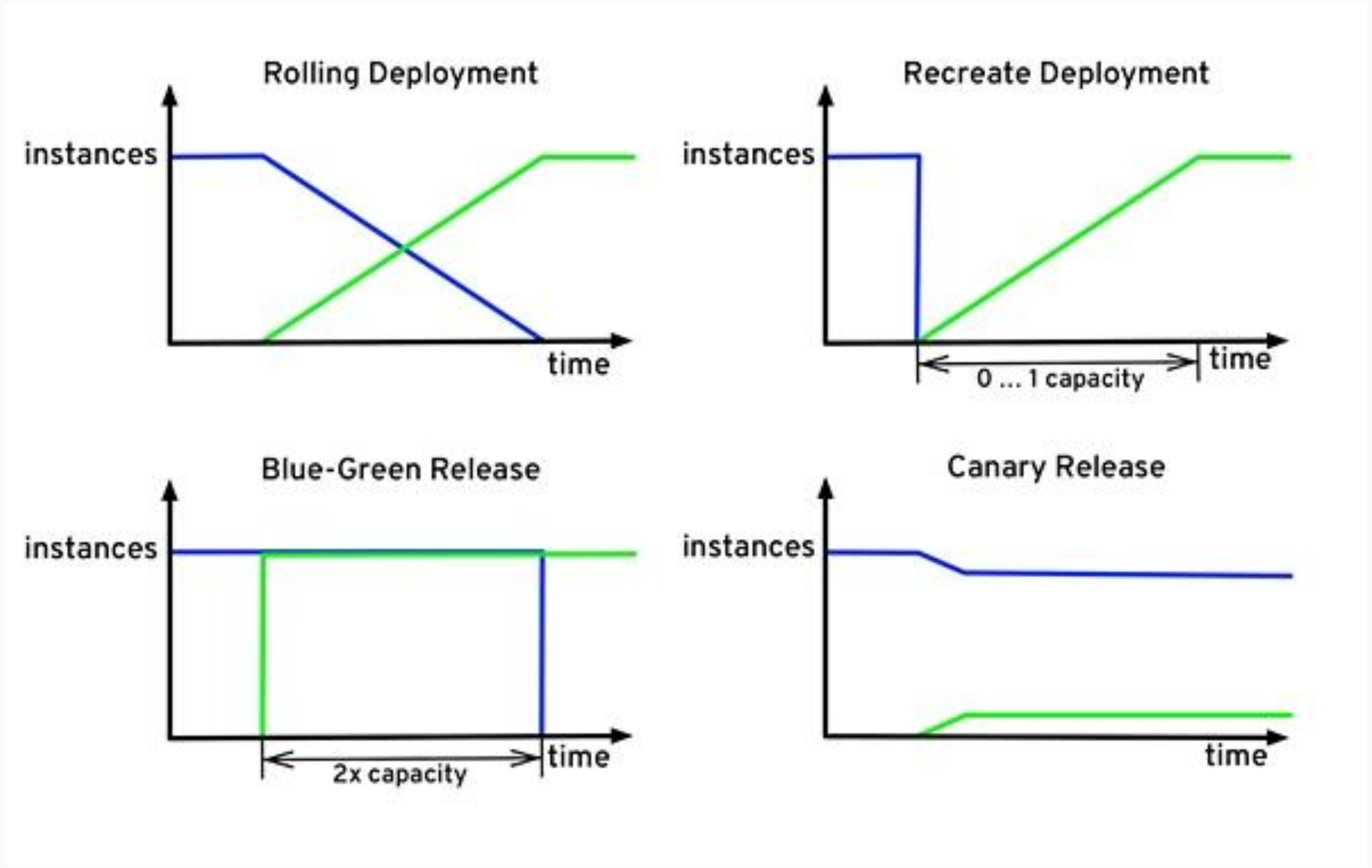
Application dependency on Kubernetes primitives



Source: Kubernetes effect by Bilgin Ibryam

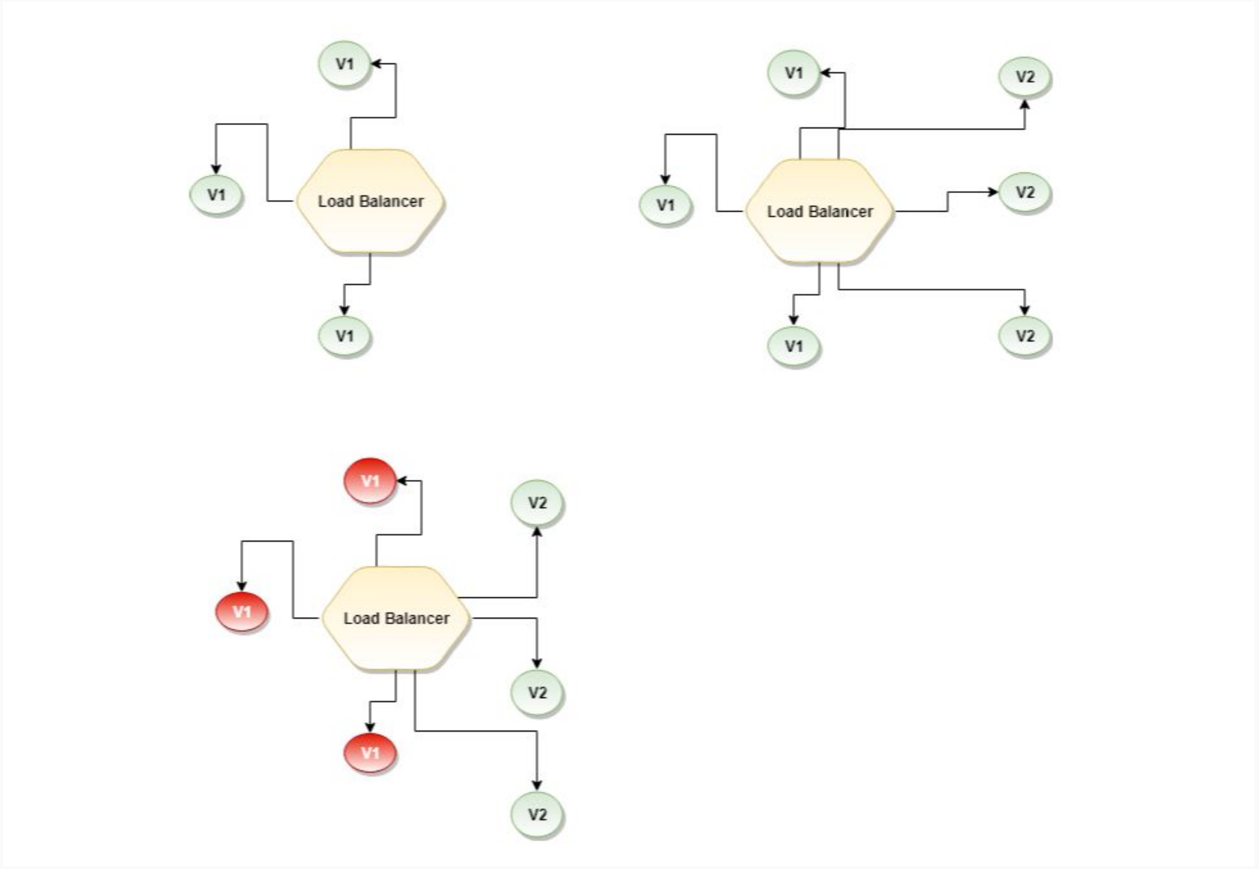
Deployment and Release Strategy

Deployment and Release Strategy with Kubernetes



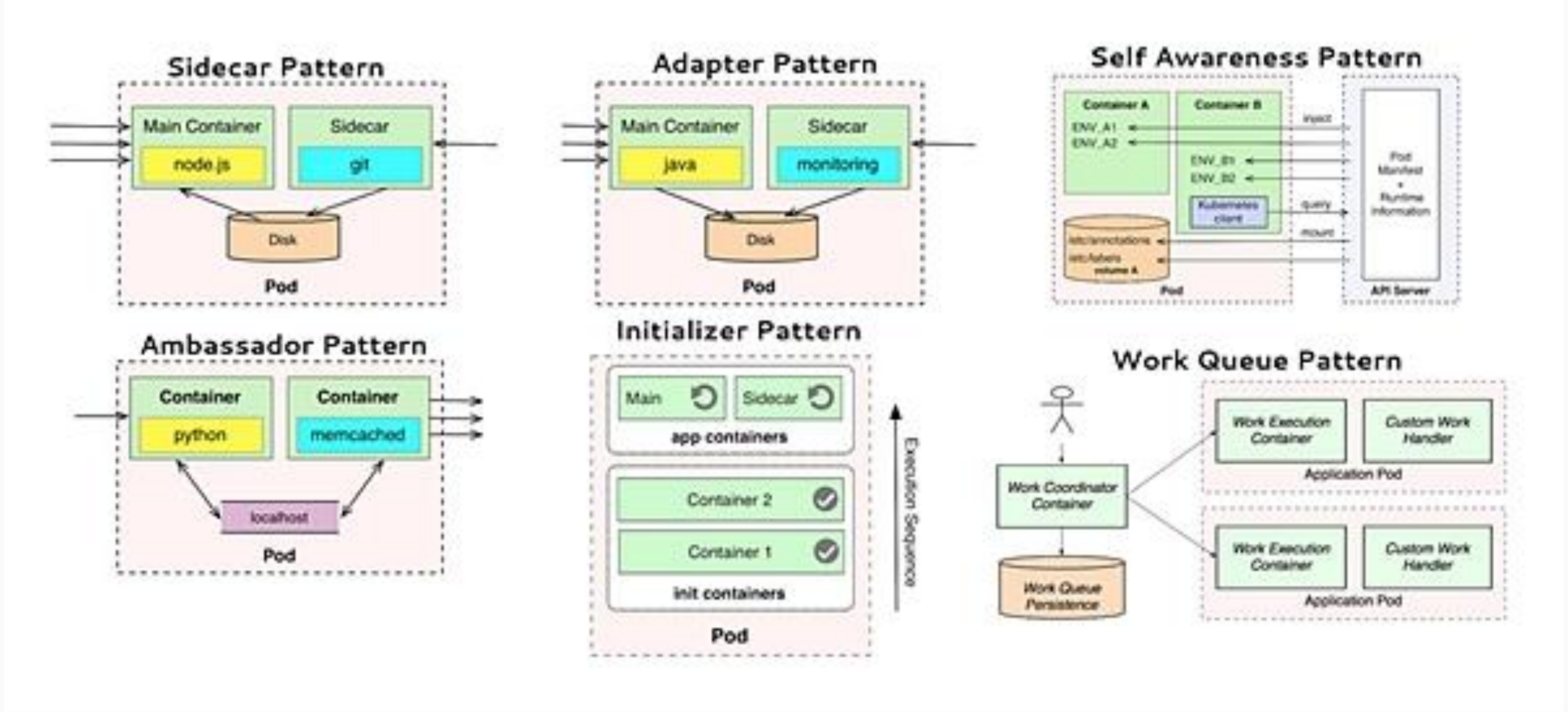
Source: Kubernetes effect by Bilgin Ibryam

Kubernetes Deployment Strategy Types



Source: Kubernetes Deployment Strategy Types

Local and distributed abstractions and primitives



Source: Kubernetes effect by Bilgin Ibryam

Getting Started

Getting started with Kubernetes

- Kubernetes.IO documentation →
- Kubernetes Bootcamp →
- Install Kubernetes CLI kubectl →
- Create a local cluster with
  - Docker For Desktop →
  - Minikube →
  - MiniShift →
  - DinD → or Kind →

Local Development Environment using Minikube

- Follow this Minikube tutorial by the awesome Abhishek Tiwari
  - https://abhishek-tiwari.com/local-development-environment-for-kubernetes-using-minikube/

- Create a Kubernetes cluster on AWS
    - Kubeadm →
    - TK8 & TK8EKS →

Install Kubernetes CLI kubectl

- On macOS: brew install kubectl
- On linux and windows follow the official documentation: https://kubernetes.io/docs/tasks/tools/install-kubectl/

- “kubectl version” gives the client and server version
- “which kubectl”
- alias k=’kubectl’
- Enable shell autocompletion (e.g. on linux):
  - echo "source <(kubectl completion bash)" >> ~/.bashrc

K8s helper tools

- Great kubectl helpers by Ahmet Alp Balkan
  - kubectx and kubens →
- Kubernetes prompt for bash and zsh
  - kube-ps1 →
- Kubed-sh (kube-dash) →
- Kubelogs →
- kns and ktx →
- K9s →
- **The golden Kubernetes Tooling and helpers list** →

Useful aliases

- alias k="kubectl"
- alias g="gcloud"
- alias kx="kubectx"
- alias kn="kubens"
- alias kon="kubeon"
- alias koff="kubeoff"
- alias kcvm="kubectl config view --minify"
- alias kgn="kubectl get nodes"
- alias kgp="kubectl get pods"

Kubectl commands, Cheat Sheets

- Switch to another namespace on the current context (cluster):
  - kubectl config set-context <cluster-name> --namespace=efk
- Switch to another cluster
  - kubectl config use-context <cluster-name>
- Merge kube configs
  - cp ~/.kube/config ~/.kube/config.bak
  - KUBECONFIG=./kubeconfig.yaml:~/.kube/config.bak kubectl config view --flatten > ~/.kube/config
- Again: use kubectx and kubens, it makes the life easier :-)
- A great Cheat Sheet by Denny Zhang →
- Kubectl: most useful commands by Matthew Davis →

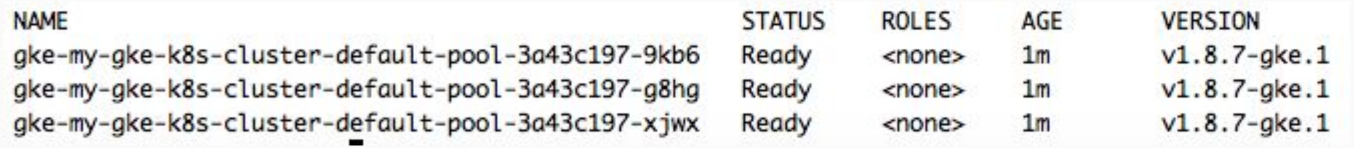
Create a Kubernetes cluster on GKE (1)

- You need an account on GCP with billing enabled
- Create a project and enable GKE service
- Install gcloud SDK / CLI:
  - https://cloud.google.com/sdk/

Source:

Create a Kubernetes cluster on GKE (2)

- gcloud projects create kubernauts-trainings
- gcloud config set project kubernauts-trainings
- gcloud container clusters create my-training-cluster --zone=us-central1-a
    - Note: message=The Kubernetes Engine API is not enabled for project training-220218. Please ensure …
- Kubectl get nodes

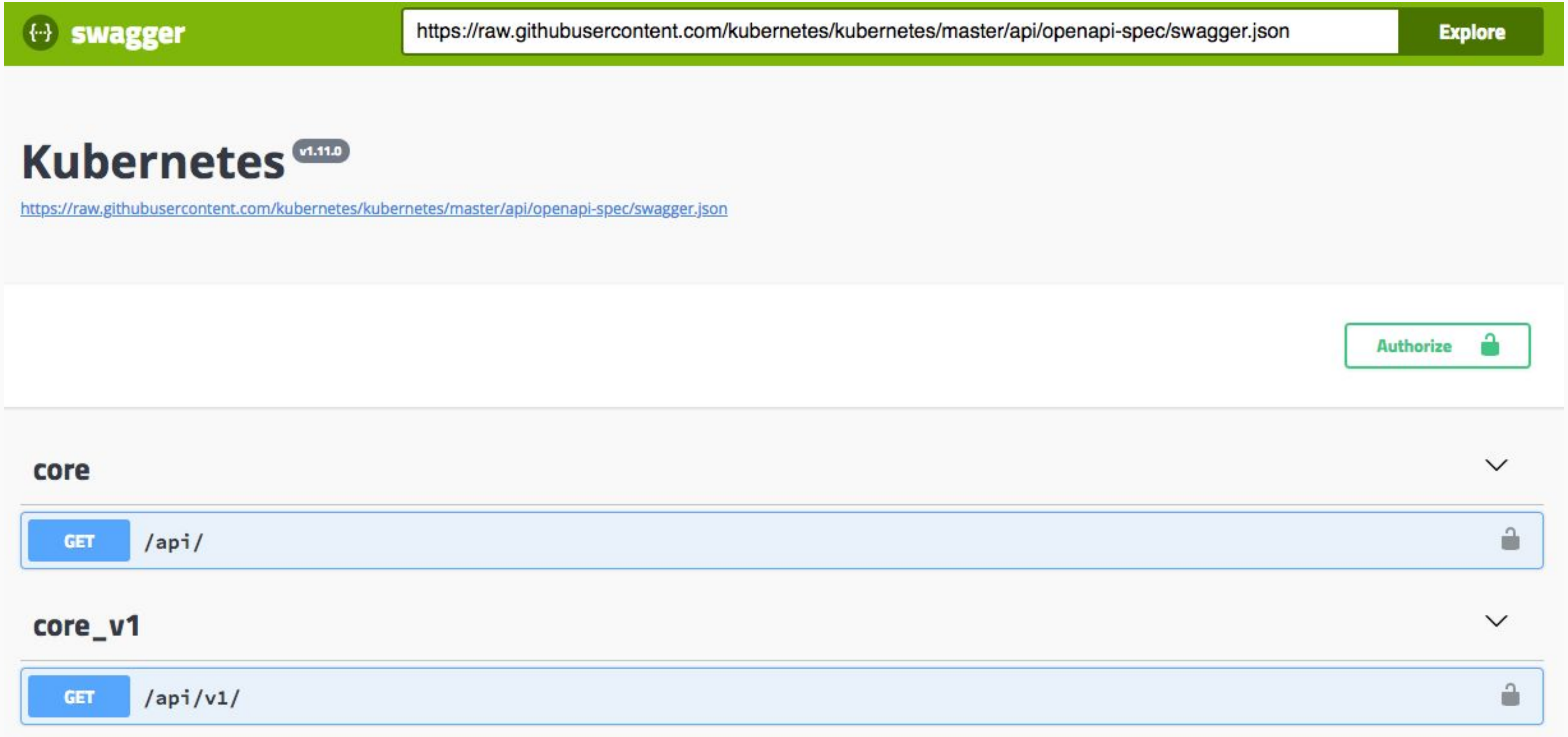


```
NAME                                           STATUS    ROLES     AGE       VERSION
gke-my-gke-k8s-cluster-default-pool-3a43c197-9kb6   Ready     <none>    1m        v1.8.7-gke.1
gke-my-gke-k8s-cluster-default-pool-3a43c197-g8hg   Ready     <none>    1m        v1.8.7-gke.1
gke-my-gke-k8s-cluster-default-pool-3a43c197-xjwx   Ready     <none>    1m        v1.8.7-gke.1
```

Create a Kubernetes cluster on AWS

- Create a Kubernetes cluster on AWS
  - Typhoon →
  - Kubeadm →
  - Kops FastStart →
  - Kubicorn →
  - TK8 →
  - Kubernetes Cluster API →

Kubernetes API Groups, OpenAPI and Swagger UI (2)



https://raw.githubusercontent.com/kubernetes/kubernetes/master/api/openapi-spec/swagger.json

Kubernetes v1.11.0

https://raw.githubusercontent.com/kubernetes/kubernetes/master/api/openapi-spec/swagger.json

core

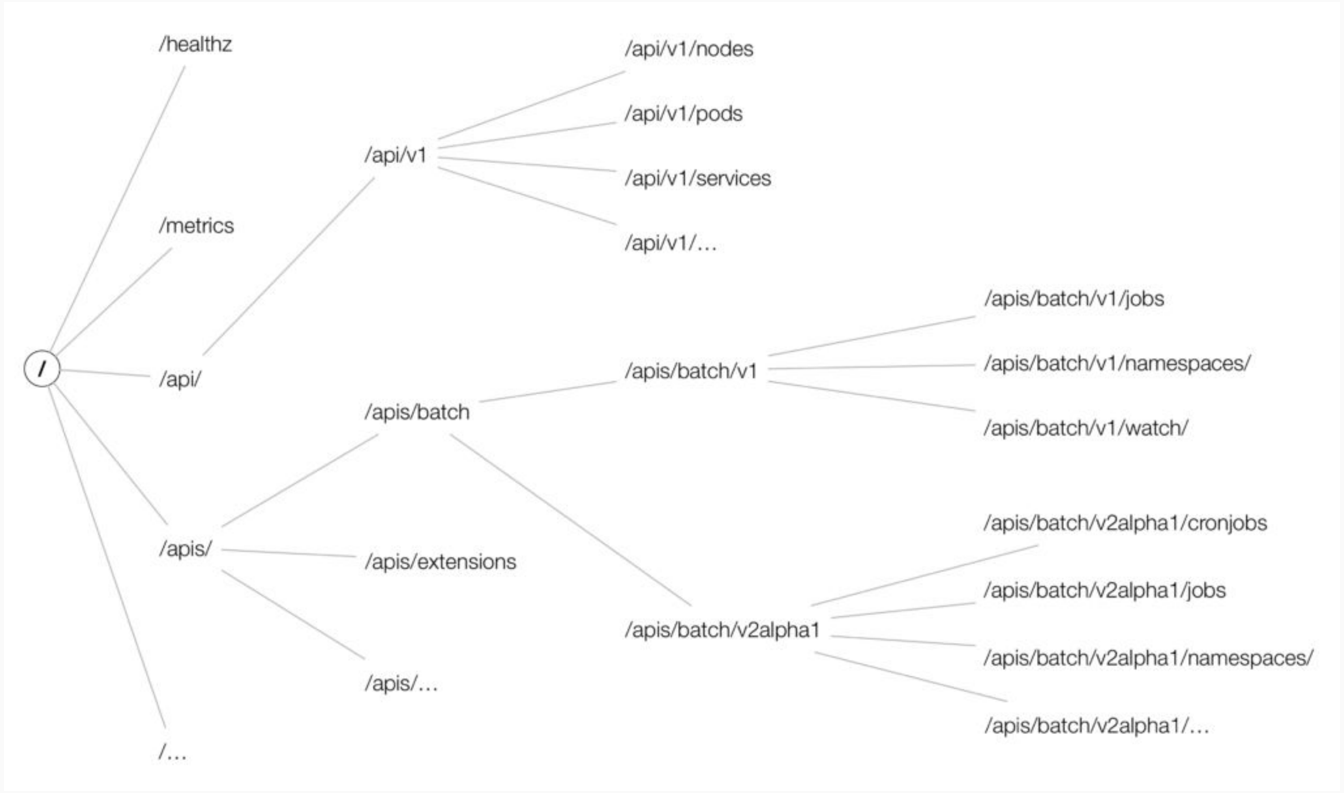
GET /api/

core_v1

GET /api/v1/

Kubernetes API Groups, OpenAPI and Swagger UI (3)

Enjoy the Kubernetes API deep dive →



Kubernetes API Groups, OpenAPI and Swagger UI (4)

Get all API resources supported by your K8s cluster:

```
$ kubectl api-resources -o wide
```

Get API resources for a particular API group:

```
$ kubectl api-resources --api-group apps -o wide
```

Get more info about the particular resource:

```
$ kubectl explain configmap
```

Source: https://akomljen.com/kubernetes-api-resources-which-group-and-version-to-use/

Kubernetes API Groups, OpenAPI and Swagger UI (5)

Get all API versions supported by your K8s cluster:

```
$ kubectl api-versions
```

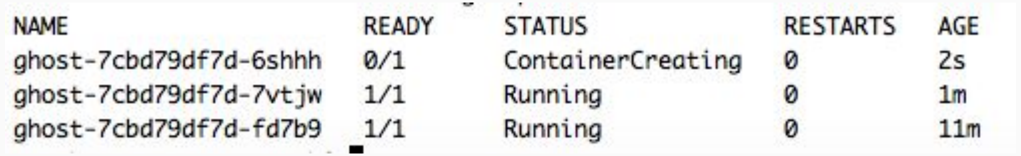
Check if a particular group/version is available for some resource:

```
 $ kubectl get deployments.v1.apps -n kube-system
```

Source: https://akomljen.com/kubernetes-api-resources-which-group-and-version-to-use/

Play with Simple Apps on Kubernetes

- Start the Ghost micro-blogging platform
  - kubectl run ghost --image=ghost:0.9
  - kubectl expose deployments ghost --port=2368 --type=LoadBalancer
  - k expose deployment ghost --port=2368 --external-ip=$(minikube ip) --type=NodePort
  - kubectl get svc
  - kubectl get deploy
  - kubectl edit deploy ghost (change the nr. of replicas to 3)

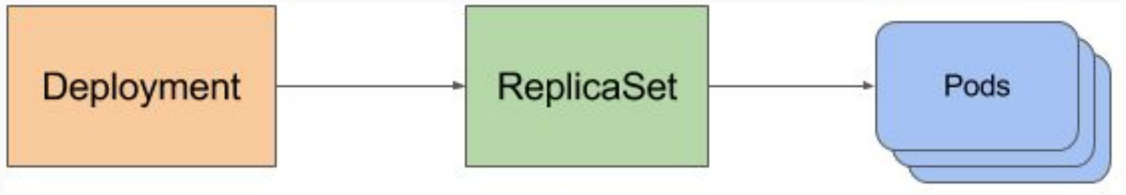


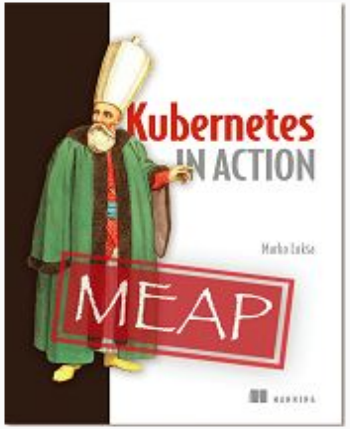
```
NAME                      READY   STATUS              RESTARTS   AGE
ghost-7cbd79df7d-6shhh    0/1     ContainerCreating   0          2s
ghost-7cbd79df7d-7vtjw    1/1     Running             0          1m
ghost-7cbd79df7d-fd7b9    1/1     Running             0          11m
```

Play with Simple Apps on Kubernetes

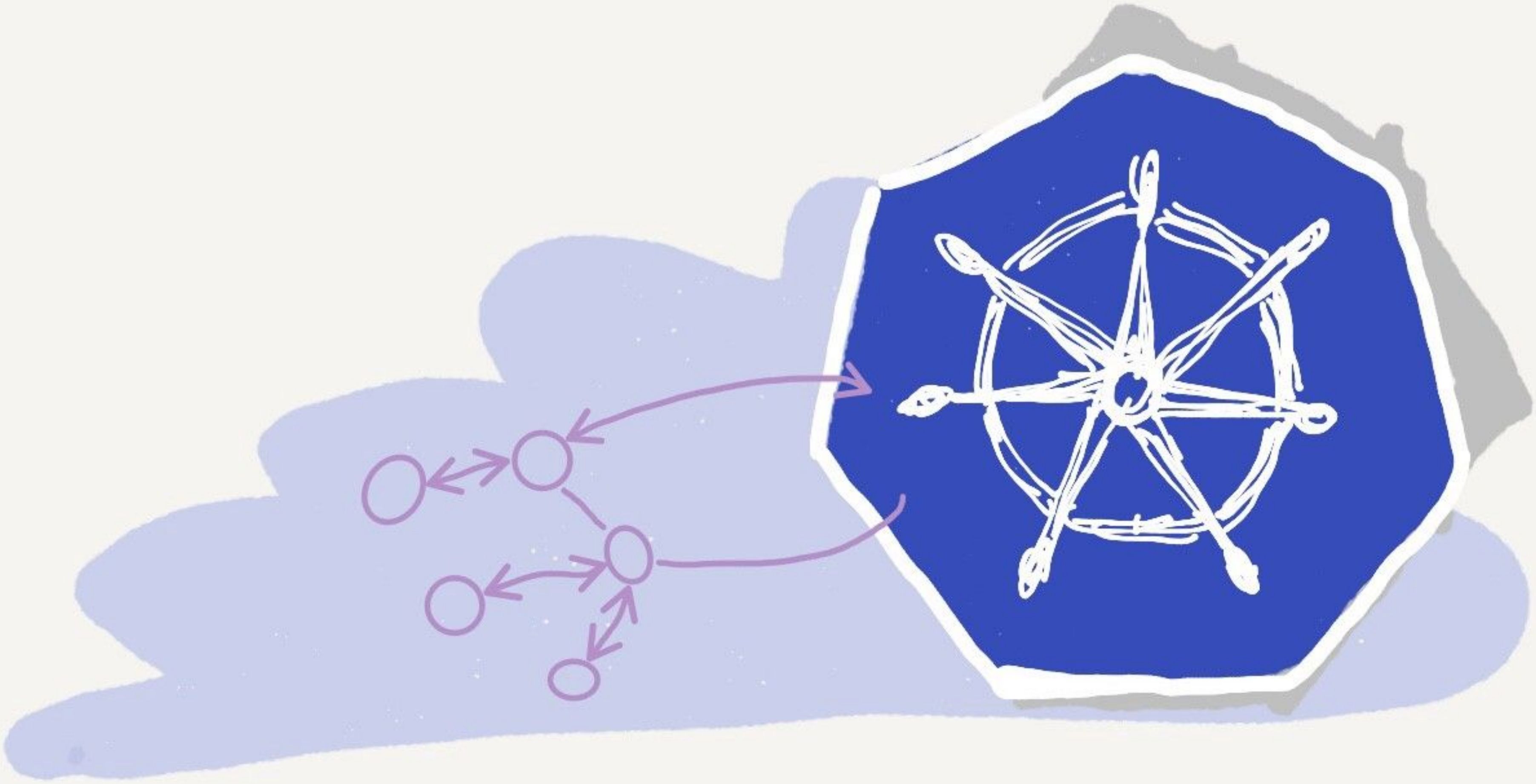
- Log into the pod
  - kubectl exec -it ghost-xxx bash
- Get the logs from the pod
  - kubectl logs ghost-xxx
- Delete the Ghost micro-bloging platform
  - kubectl delete deploy ghost
- Get the cluster state
  - kubectl cluster-info dump --all-namespaces --output-directory=$PWD/cluster-state

- Please read and understand this great free chapter from Kubernetes in Action book by Marko Lukša.



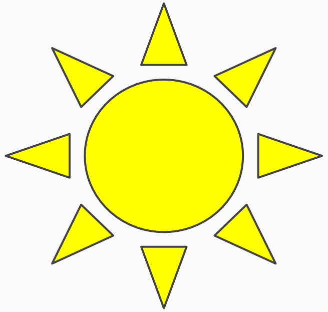


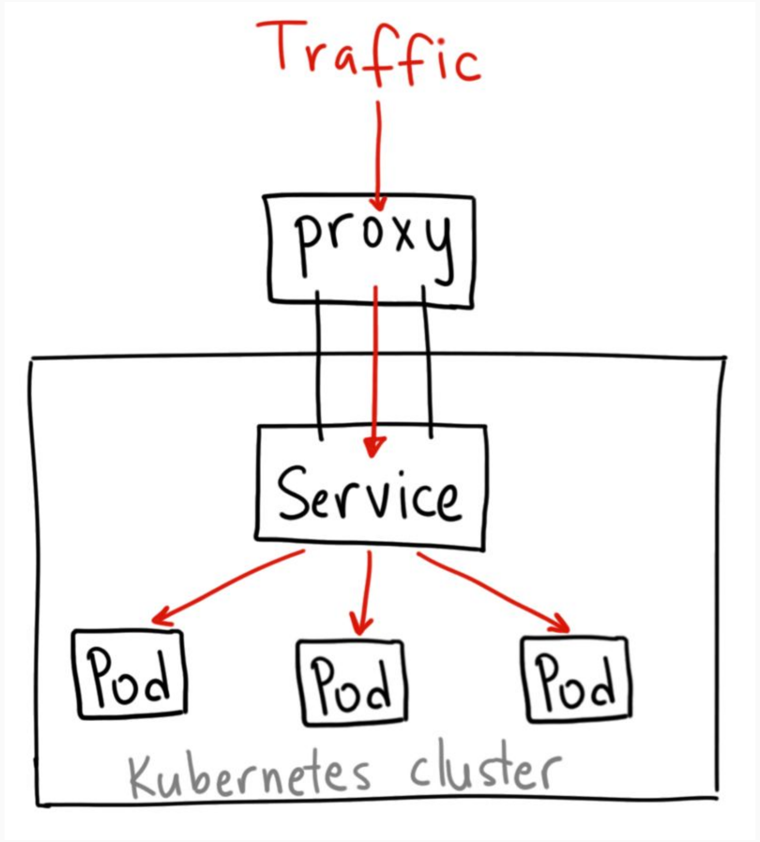
Understanding Kubernetes NodePort vs LoadBalancer vs Ingress (1)



Source: https://medium.com/@metaphorical/internal-and-external-connectivity-in-kubernetes-space-a25cba822089

Understanding Kubernetes NodePort vs LoadBalancer vs Ingress (2)





Source: https://medium.com/google-cloud/kubernetes-nodeport-vs-loadbalancer-vs-ingress-when-should-i-use-what-922f010849e0

Shedding Light on Managing External Access to the Services

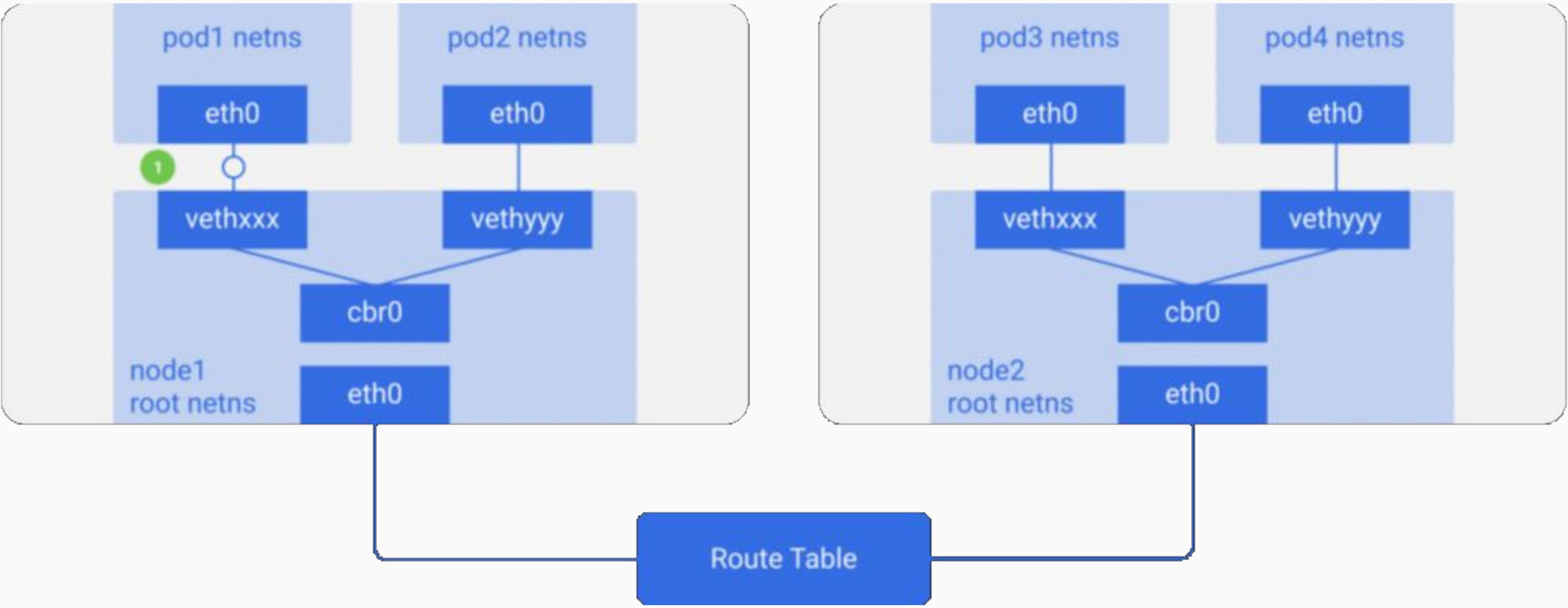
- 3 Ways to expose your services in Kubernetes
  - NodePort
  - External LoadBalancer
    - MetalLB consideration
  - Ingress
    - Ingress Controller
    - Ingress resource
  - More + →
  - More ++ →

Kubernetes ingress with Ambassador

- Ambassador is an open source, Kubernetes-native microservices API gateway built on the Envoy Proxy.
- Ambassador is awesome and powerful, eliminates the shortcomings of Kubernetes ingress capabilities
- Ambassador is easily configured via Kubernetes annotations
- Ambassador is in active development by datawire.io
- Needles to say Ambassador is open source →

Source: https://blog.getambassador.io/kubernetes-ingress-nodeport-load-balancers-and-ingress-controllers-6e29f1c44f2d

Understanding Kubernetes Networking (I)



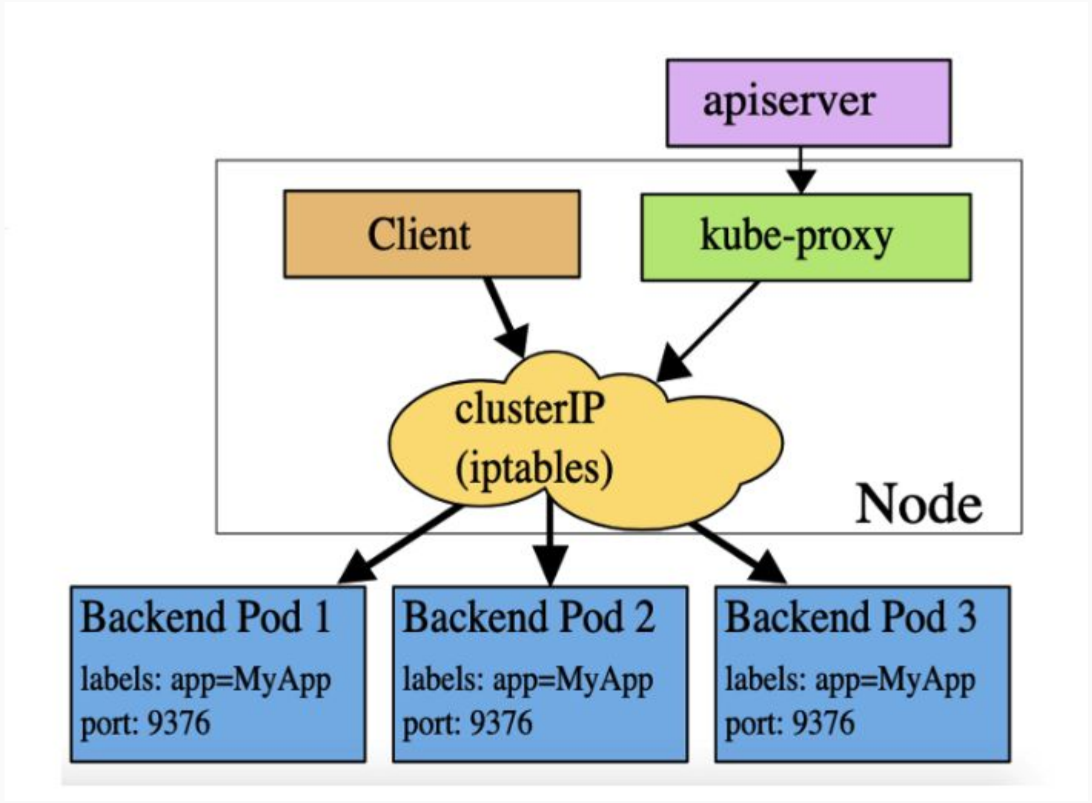
Source: https://itnext.io/an-illustrated-guide-to-kubernetes-networking-part-1-d1ede3322727

Understanding Kubernetes Networking

- Every Pod has a unique IP
- Pod IP is shared by all the containers in this Pod, and it's routable from all the other Pods.
- All containers within a pod can communicate with each other.
- All Pods can communicate with all other Pods without NAT.
- All nodes can communicate with all Pods (and vice-versa) without NAT.
- The IP that a Pod sees itself as, is the same IP that others see it as.

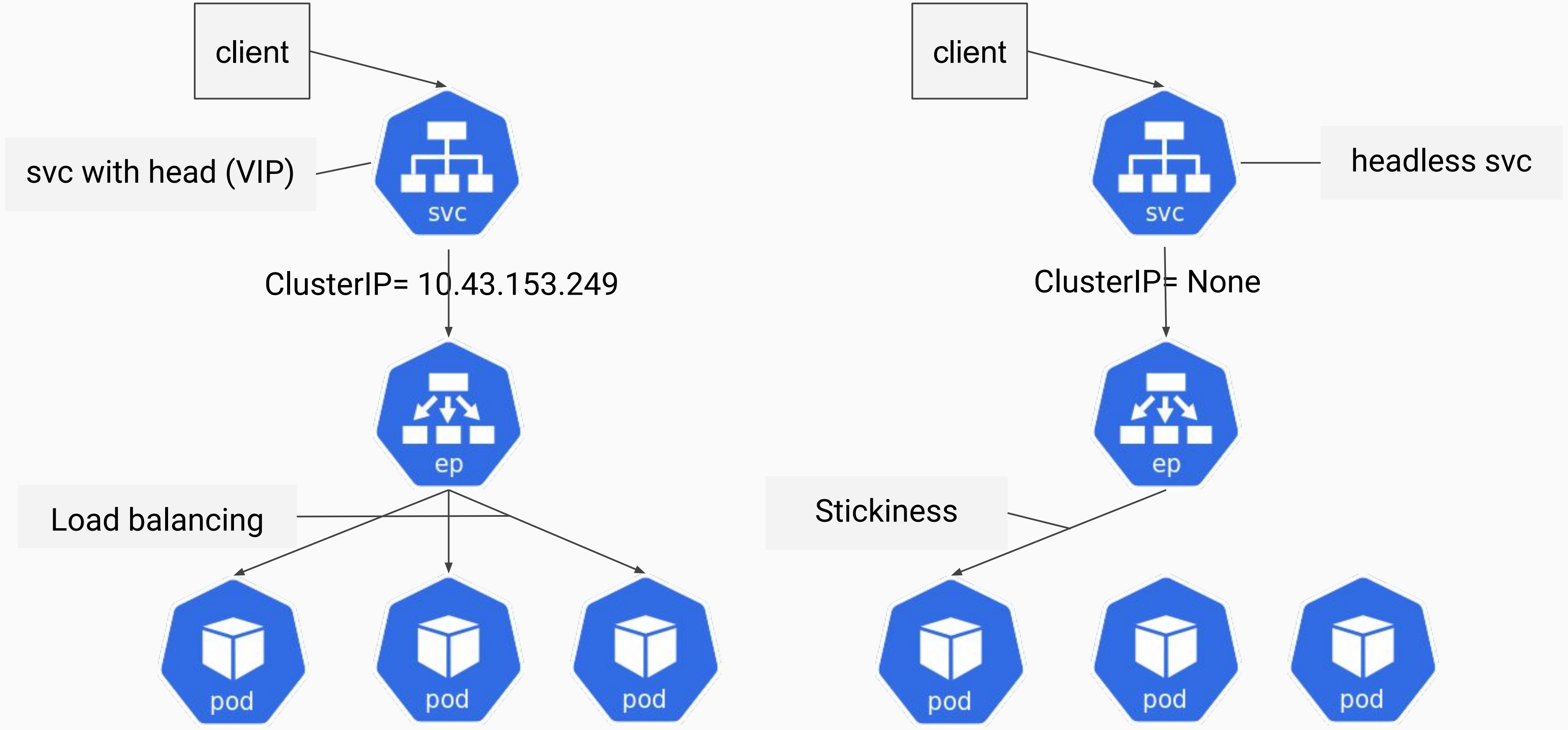
Source: https://itnext.io/an-illustrated-guide-to-kubernetes-networking-part-1-d1ede3322727

Kubernetes Headless vs. ClusterIP and traffic distribution



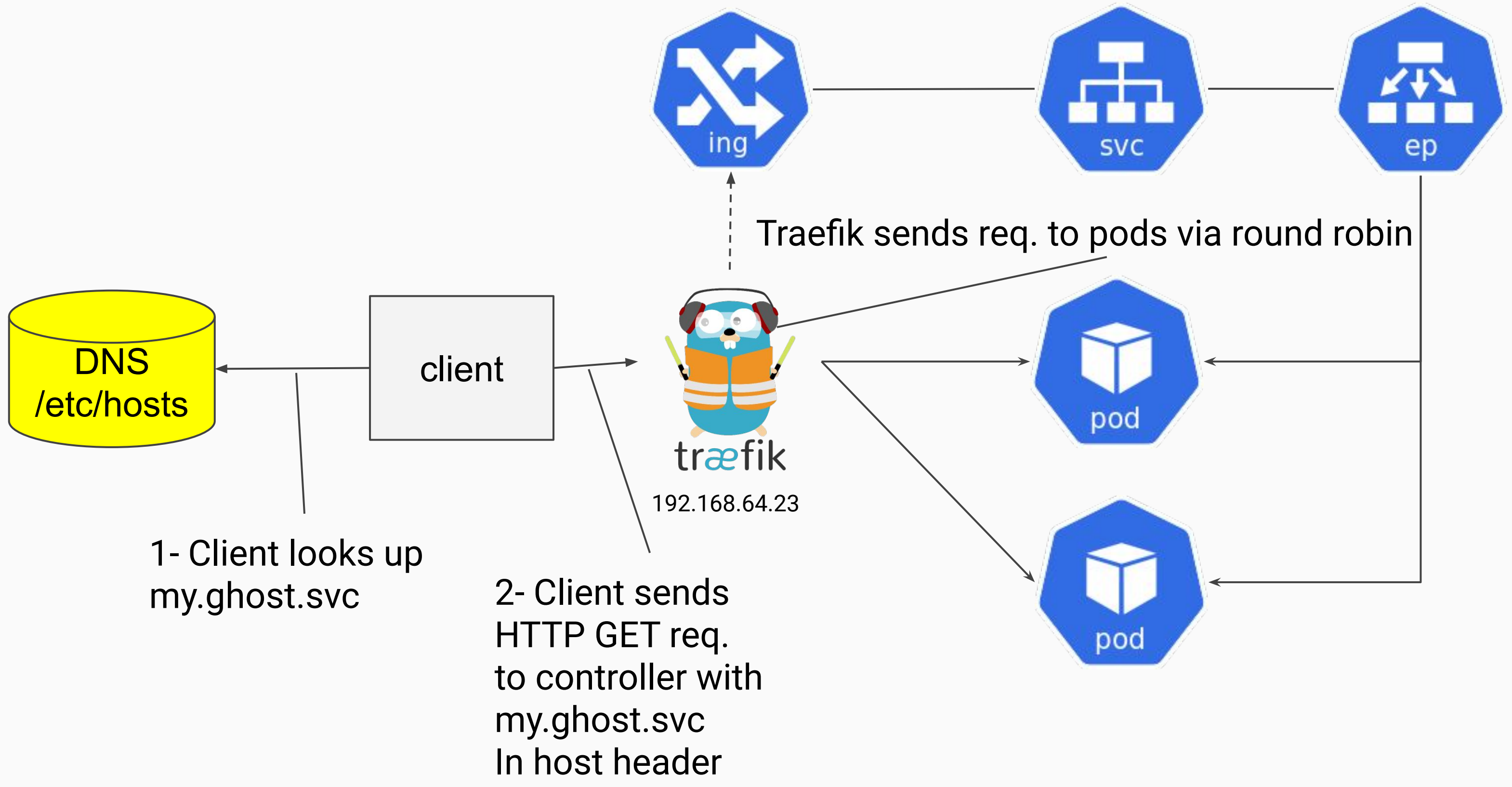
Source: https://medium.com/devopslinks/kubernetes-headless-service-vs-clusterip-and-traffic-distribution-904b058f0dfd

Kubernetes Headless vs. ClusterIP and traffic distribution

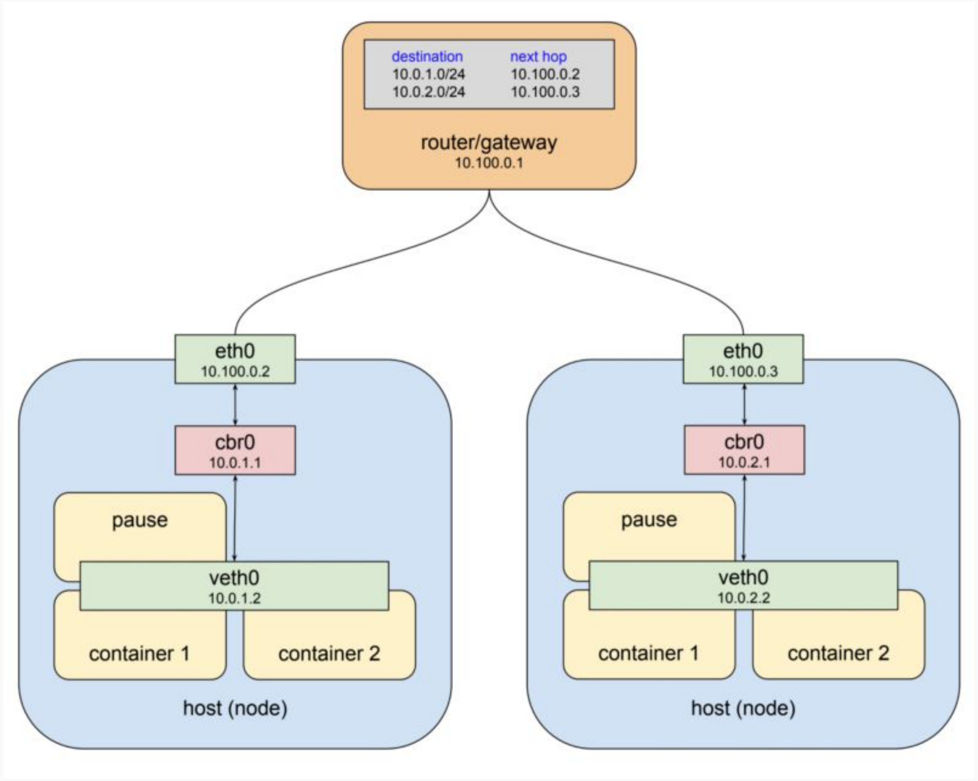


https://github.com/arashkaffamanesh/practical-kubernetes-problems#headless-services-for-stickiness

Ingress Controller (Traefik)

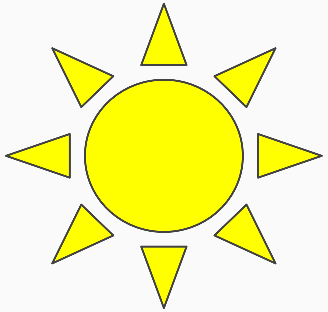


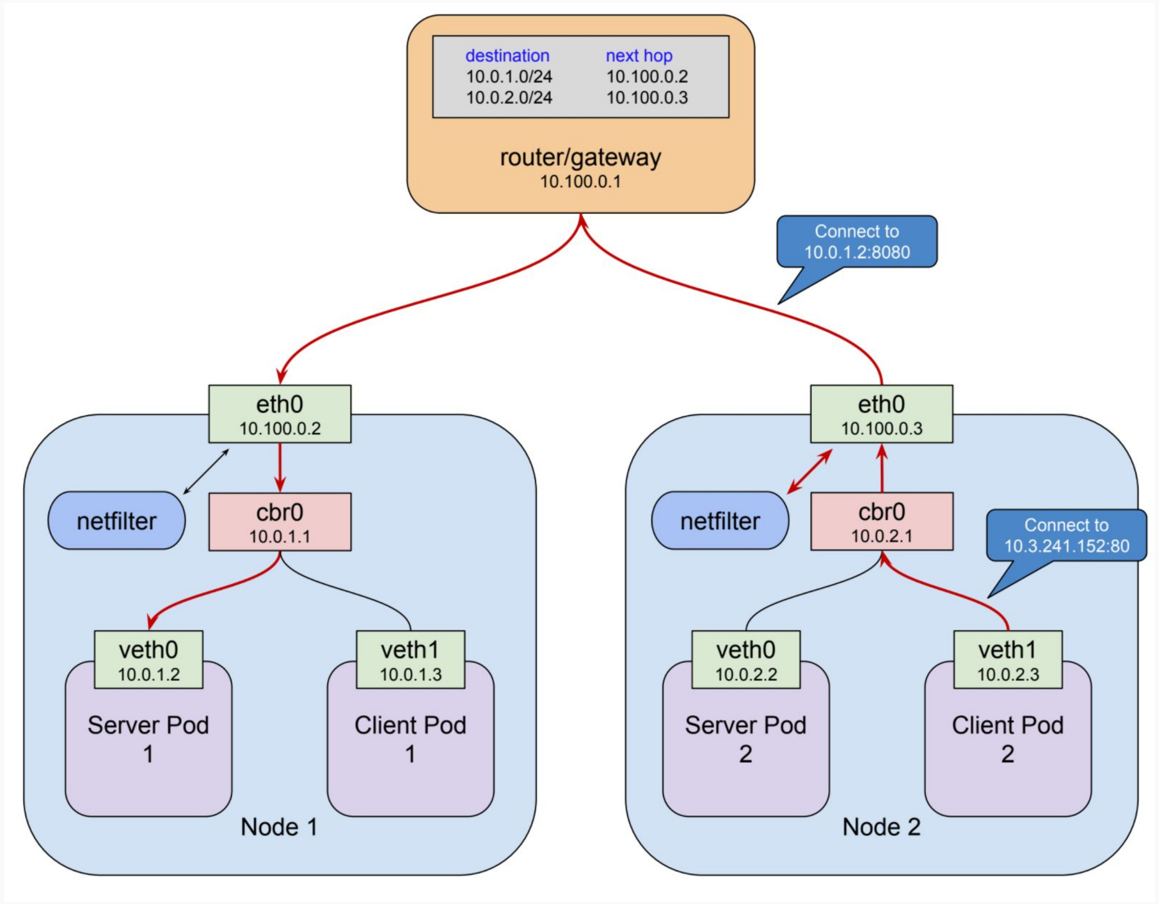
Understanding Kubernetes Networking (II)



Source: https://medium.com/@tao_66792/how-does-the-kubernetes-networking-work-part-1-5e2da2696701

Understanding Kubernetes Networking (III)





Source: https://medium.com/google-cloud/understanding-kubernetes-networking-pods-7117dd28727

MetallB

- How can you have same experience of using a load balancer service type on your bare metal cluster just like public clouds?
- This is what Metallb aims to solve.
- Layer 2/ARP mode: Only one worker node can respond to the Load Balancer IP address
- BGP mode: This is more scalable, all the worker nodes will respond to the Load Balancer IP address, this means that even of one of the worker nodes is unavailable, other worker nodes will take up the traffic. This is one of the advantages over Layer 2 mode but you need a BGP router on your network (open source routers Free Range Router, Vyos)

Source: https://metallb.universe.tf/

MetallB

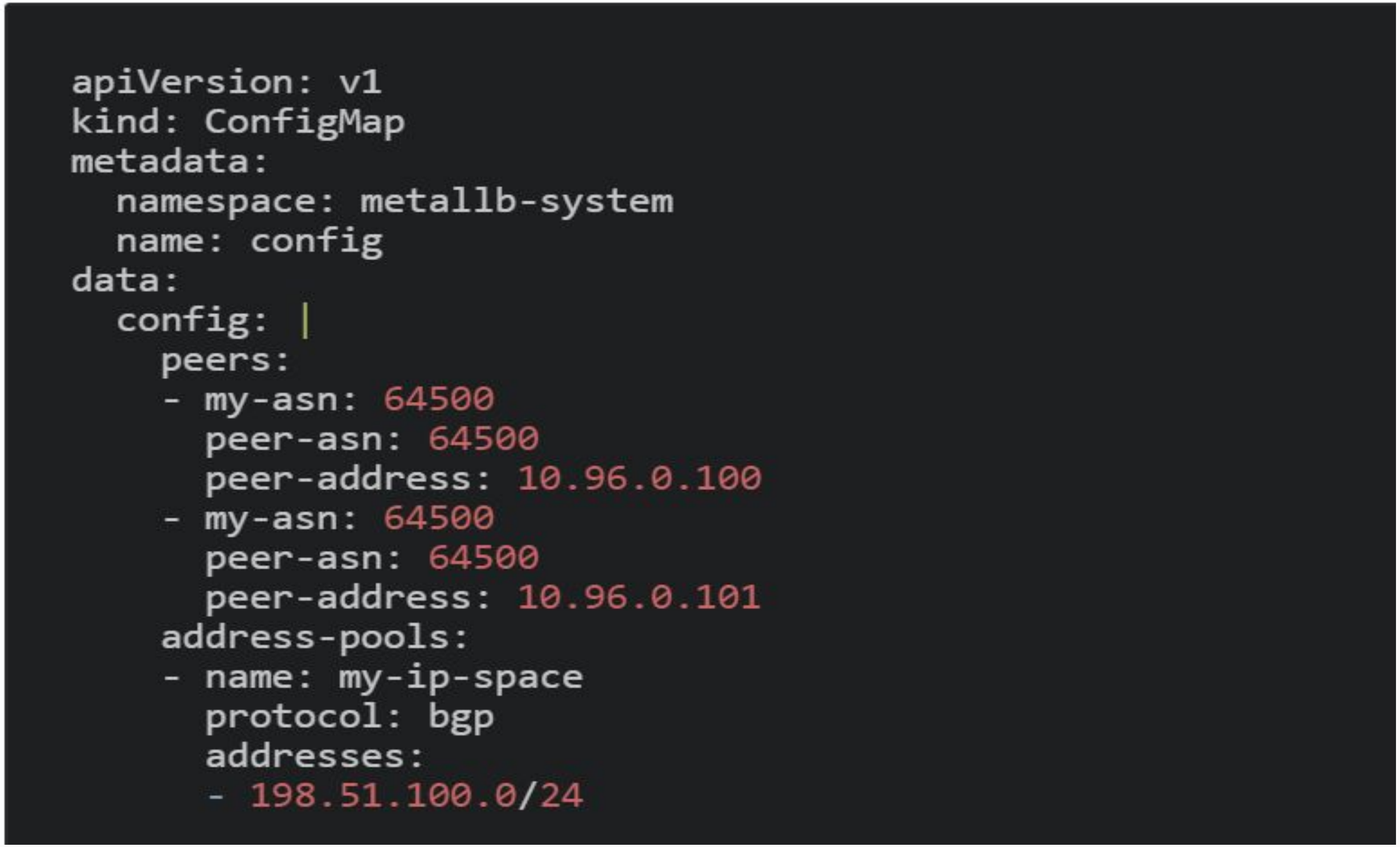
- Work around for the Layer 2 disadvantage is to use a CNI plugin that supports BGP like Kuberouter
- Kuberouter will then advertise the LB IP via BGP as ECMP route which will be available via all the worker nodes.

Source: https://github.com/cloudnativelabs/kube-router/blob/master/docs/user-guide.md#advertising-ips

MetallB Sample ARP Mode Configmap

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: config
data:
  config: |
    address-pools:
    - name: my-ip-space
      protocol: layer2
      addresses:
      - 84.200.xxx.xxx-84.200.xxx.xxx
```

MetallB Sample BGP Mode Configmap



```
apiVersion: v1
kind: ConfigMap
metadata:
  namespace: metallb-system
  name: config
data:
  config: |
    peers:
    - my-asn: 64500
      peer-asn: 64500
      peer-address: 10.96.0.100
    - my-asn: 64500
      peer-asn: 64500
      peer-address: 10.96.0.101
    address-pools:
    - name: my-ip-space
      protocol: bgp
      addresses:
      - 198.51.100.0/24
```

Security

Best Practices (I)

- Make sure to always scan all your Docker Images and Containers for potential threats
- Never use any random Docker Image(s) and always use authorised images in your environment
- Categorise and accordingly split up your cluster through Namespace
- Use Network Policies to implement proper network segmentation and Role Based Access Control(RBAC) to create administrative boundaries between resources for proper segregation and control

Source: https://blog.kubernauts.io/kubernetes-best-practices-d5cbef02fe1b

Best Practices (II)

- Limit SSH access to Kubernetes nodes, and Ask users to use kubectl exec instead.
- Never use Passwords, or API tokens in plain text or as environment variables, use secrets instead
- Use non-root user inside container with proper host to container, UID and GID mapping

Source: https://blog.kubernauts.io/kubernetes-best-practices-d5cbef02fe1b

Managing Secrets in Kubernetes

- If you’re serious about security in Kubernetes, you need a secret management tool that provides a single source of secrets, credentials, attaching security policies, etc.
- In other words, you need Hashicorp Vault.

HashiCorp
Vault

Source: https://blog.kubernauts.io/managing-secrets-in-kubernetes-with-vault-by-hashicorp-f0db45cc208a

Exercises

kubectl cheat sheet

kubectl cheat sheet

→ https://github.com/dennyzhang/cheatsheet-kubernetes-A4

```
$ kubectl get events --sort-by=.metadata.creationTimestamp # List Events sorted by timestamp
$ kubectl get services --sort-by=.metadata.name # List Services Sorted by Name
$ kubectl get pods --sort-by=.metadata.name
$ kubectl get endpoints
$ kubectl explain pods,svc
$ kubectl get pods -A # --all-namespaces
$ kubectl get nodes -o jsonpath='{.items[*].spec.podCIDR}'
$ kubectl get pods -o wide
$ kubectl get pod my-pod -o yaml --export > my-pod.yaml
$ kubectl get pods --show-labels # Show labels for all pods (or other objects)
$ kubectl get pods --sort-by='.status.containerStatuses[0].restartCount'
$ kubectl cluster-info
$ kubectl api-resources
$ kubectl get apiservice
```

Kubernetes by Example

- By the awesome Kubernaut Michael Hausenblas
- Hands-On introduction to Kubernetes →

Note: you can run the examples on minikube, OpenShift, GKE or any other Kubernetes Installations.

Kubernetes Presentations and Tutorials by Bob Killen

- By the awesome Bob Killen
- Introduction to Kubernetes →

  (The best introduction which I know about!)
- Kubernetes Tutorials →

More Exercises

Exercise 1: Create a deployment for nginx ...

- Create a deployment running nginx version 1.12.2 that will run in 2 pods
  - Scale this to 4 pods
  - Scale it back to 2 pods
  - Upgrade the nginx image version to 1.13.8
  - Check the status of the upgrade
  - Check the history
  - Undo the upgrade
  - Delete the deployment

Source:

Exercise 1: Create a deployment for nginx ...

- Create nginx version 1.12.2 with 2 pods
  - kubectl run nginx --image=nginx:1.12.2 --replicas=2 --record
- Scale to 5 pods
  - kubectl scale --replicas=5 deployment nginx
- Scale back to 2 pods
  - kubectl scale --replicas=2 deployment nginx
- Upgrade the nginx image to 1.13.8 version
  - kubectl set image deployment nginx nginx=nginx:1.13.8

Source:

Exercise 1: Create a deployment for nginx ...

- Check the status of the upgrade
  - kubectl **rollout status** deployment nginx
- Get the history of the actions
  - kubectl **rollout history** deployment nginx
- Undo / rollback the upgrade
  - kubectl **rollout undo** deployment nginx
- Delete the deployment
  - k delete deploy/nginx

Source:

Exercise 1: Create a deployment for nginx from a manifest file

- Create the deployment with a manifest:
  - kubectl create -f nginx.yaml

Note: Pods, services, configmaps, secrets in our examples are all part of the /api/v1 API group, while deployments are part of the **/apis/extensions/v1beta1** API group.

The group an object is part of is what is referred to as apiVersion in the object specification, available via the API reference.

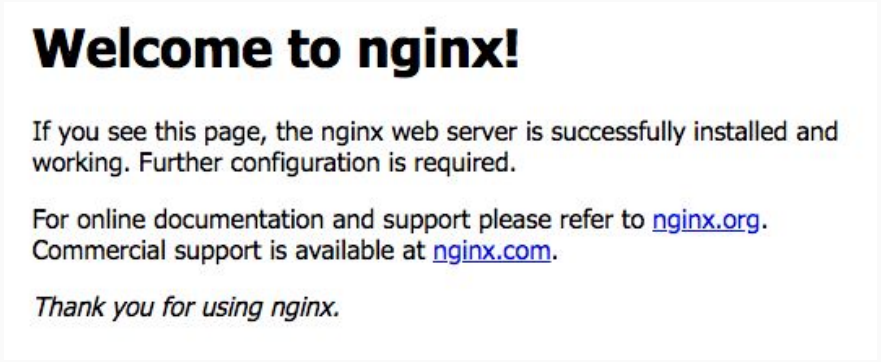
```
$ cat nginx.yaml
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: nginx
  labels:
    app: nginx
spec:
  replicas: 2
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.12.2
        ports:
        - containerPort: 80
```

Exercise 1: Create a deployment for nginx ...

- Edit the deployment: change the replicas to 5 and image version to 1.13.8
  - kubectl **edit deployment** nginx
- Get some info about the deployment and ReplicaSet
  - kubectl get deploy
  - kubectl get rs
  - k get pods -o wide (set alias k='kubectl')
  - k describe pod nginx-xyz

Exercise 1: Create a service to the pods with expose

- kubectl expose deployments nginx --port=80 --type=**LoadBalancer**



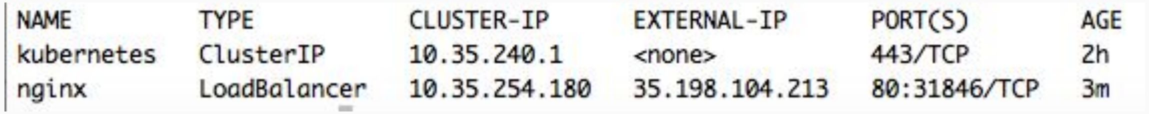
Welcome to nginx!

If you see this page, the nginx web server is successfully installed and working. Further configuration is required.

For online documentation and support please refer to nginx.org.
Commercial support is available at nginx.com.

Thank you for using nginx.

- k get svc



```
NAME         TYPE           CLUSTER-IP      EXTERNAL-IP      PORT(S)        AGE
kubernetes   ClusterIP      10.35.240.1     <none>           443/TCP        2h
nginx        LoadBalancer   10.35.254.180   35.198.104.213   80:31846/TCP   3m
```

Exercise 2: write an ingress rule ...

- Write an ingress rule that redirects calls to /foo to one service and to /bar to another
  - k create -f ingress.yaml

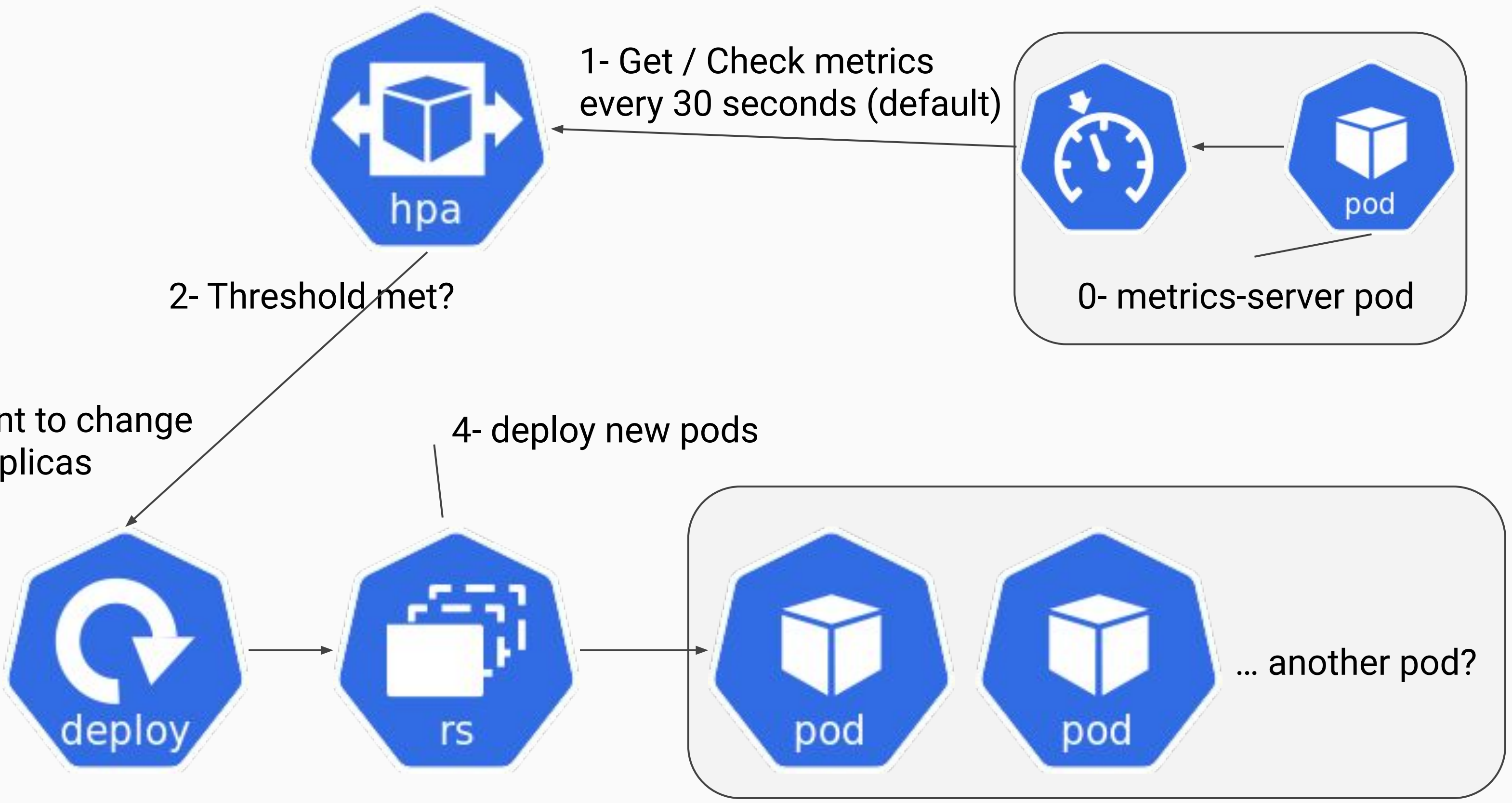
```
$ cat ingress.yaml
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: test
  annotations:
    ingress.kubernetes.io/rewrite-target: /
spec:
  rules:
  - host: kubernauts.io
    http:
      paths:
      - path: /foo
        backend:
          serviceName: s1
          servicePort: 80
      - path: /bar
        backend:
          serviceName: s2
          servicePort: 80
```

Exercise 3: deployment, RC & RS

```
kubectl run kubia --image=luksa/kubia --port=8080 --generator=run/v1
kubectl run kubia --image=luksa/kubia --port=8080
k get svc
k get pods
k get rc
k get rs
kubectl describe rs kubia-57478bf476
k get svc
k expose rc kubia --type=LoadBalancer --name kubia-http
k expose rs kubia --type=LoadBalancer --name kubia-http2
k expose rs kubia-57478bf476 --type=LoadBalancer --name kubia-http2
k get pods
k scale rc kubia --replicas=3
k get pods
k scale rs kubia-57478bf476 --replicas=3 —> can’t work, you should scale the deployment
k scale deployment kubia --replicas=3
K port-forward kubia-xxxxx 8888:8080
        http://127.0.0.1:8888/
```

Note: the kubia image is from the Kubernetes in Action book by Marko Lukša

Exercise 4: horizontal pod autoscaling (hpa)


hpa
1- Get / Check metrics every 30 seconds (default)
pod
0- metrics-server pod
2- Threshold met?
3- ask deployment to change the number of replicas
4- deploy new pods
deploy
rs
pod
pod
... another pod?

Exercise 4: horizontal pod autoscaling (hpa)

- On GKE:

```
kubectl run ghost --image=ghost:0.9 --requests="cpu=100m"
k expose deployment ghost --port=2368 --type=LoadBalancer
k autoscale deployment ghost --min=1 --max=4 --cpu-percent=10
export loadbalancer_ip=$(k get svc -o wide | grep ghost | awk '{print $4}')
while true; do curl http://$loadbalancer_ip:2368/ ; done
k get hpa -w
k describe hpa
```

- On Minikube (hpa doesn't work for now on minikube → bug??)

```
minikube addons enable heapster
kubectl run ghost --image=ghost:0.9 --requests="cpu=100m"
k expose deployment ghost --port=2368 --type=NodePort --external-ip=$(minikube ip)
k autoscale deployment ghost --min=1 --max=4 --cpu-percent=10
while true; do curl http://$(minikube ip):2368/ ; done
k get hpa -w
k describe hpa
```

→ unable to get metrics for resource cpu

Exercise 5: deploying replicated stateful applications

```
gcloud compute disks create --size=1GiB --zone=us-central1-a pv-a
gcloud compute disks create --size=1GiB --zone=us-central1-a  pv-b
gcloud compute disks create --size=1GiB --zone=us-central1-a  pv-c
k create -f persistent-volumes-gcepd.yaml
k create -f kubia-service-headless.yaml
k create -f kubia-statefulset.yaml
k get po
k get po kubia-0 -o yaml
k get pvc
k proxy
k create -f kubia-service-public.yaml
k proxy
```

Note: This example is from the Chapter 10 of the [Kubernetes in Action book by Marko Lukša]

Exercise 6: Play with RBAC

```
minikube stop
minikube start --extra-config=apiserver.Authorization.Mode=RBAC
k create ns foo
k create ns bar
k run test --image=luksa/kubectl-proxy -n foo
k run test --image=luksa/kubectl-proxy -n bar
k get po -n foo
k get po -n bar
k exec -it test-xxxxxxxxx-yyyyy -n foo sh
k exec -it test-yyyyyyyyy-xxxxx -n bar sh
curl localhost:8001/api/v1/namespaces/foo/services
curl localhost:8001/api/v1/namespaces/bar/services
cd Chapter12/
cat service-reader.yaml
k create -f service-reader.yaml -n foo
k create role service-reader --verb=get --verb=list --resource=services -n bar
k create rolebinding test --role=service-reader --serviceaccount=foo:default -n foo
k create rolebinding test --role=service-reader --serviceaccount=bar:default -n bar
k edit rolebinding test -n foo
k edit rolebinding test -n bar
```

Note: This example is from the Chapter 12 of the [Kubernetes in Action book by Marko Lukša]()

Practical K8s Problems

https://github.com/arashkaffamanesh/practical-kubernetes-problems

Tips & Tricks

Tips & Tricks (I)

- List all Persistent Volumes sorted by their name
  - kubectl get pv | grep -v NAME | sort -k 2 -rh
- Find which pod is taking max CPU
  - kubectl top pod
- Find which node is taking max CPU
  - kubectl top node
- Getting a Detailed Snapshot of the Cluster State
  - kubectl cluster-info dump --all-namespaces > cluster-state
- Save the manifest of a running pod
  - kubectl get pod name -o yaml --export > pod.yml
- Save the manifest of a running deployment
  - kubectl get deploy name -o yaml --export > deploy.yml
- Use dry-run to create a manifest for a deployment
  - kubectl run ghost --image=ghost --restart=Always --expose --port=80 --output=yaml --dry-run > ghost.yaml
  - k apply -f ghost.yaml
  - k get all
- Delete evicted pods

  -
    ```
    kubectl get po -A -o json | jq  '.items[] | select(.status.reason!=null) | select(.status.reason | contains("Evicted")) | "kubectl delete po \(.metadata.name) -n \(.metadata.namespace)"' | xargs -n 1 bash -c
    ```

Tips & Tricks (II)

- Find all deployments which have no resource limits set
  - kubectl get deploy -o json |

    jq ".items[] | select(.spec.template.spec.containers[].resources.limits==null) | {DeploymentName:.metadata.name}"
- Create a yaml for a job
  - kubectl run --generator=job/v1 test --image=nginx --dry-run -o yaml
- Find all pods in the cluster which are not running
  - kubectl get pod --all-namespaces -o json | jq '.items[] | select(.status.phase!="Running") | [.metadata.namespace,.metadata.name,.status.phase] | join(":")'
- List the top 3 nodes with the highest CPU usage
  - kubectl top nodes | sort --reverse --numeric -k 3 | head -n3
- List the top 3 nodes with the highest MEM usage
  - kubectl top nodes | sort --reverse --numeric -k 5 | head -n3
- Get rolling Update details for deployments
  - kubectl get deploy -o json |

     jq ".items[] | {name:.metadata.name} + .spec.strategy.rollingUpdate"
- List pods and its corresponding containers
  - kubectl get pods -o='custom-columns=PODS:.metadata.name,CONTAINERS:.spec.containers[*].name'

Tips & Tricks (III)

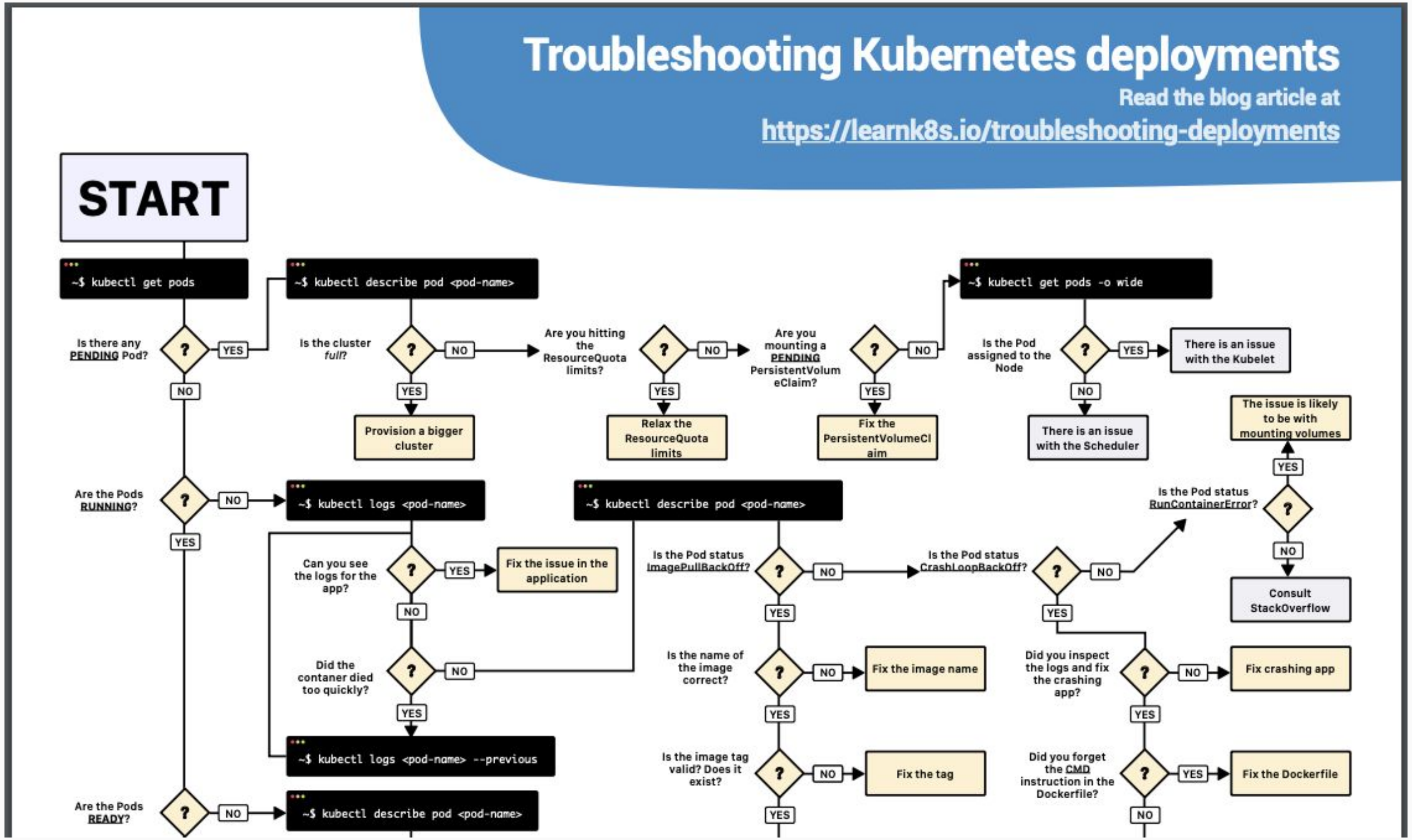
- Troubleshoot a faulty node
  - Check the status of kubelet
    - systemctl status kubelet
  - If it's running, check the logs locally with
    - journalctl -u kubelet
  - If it's not running, you probably need to start it:
    - systemctl restart kubelet
  - If a node is not getting pods schedule to it, describe the node
    - kubectl describe node <nodename>
  - If your pods are stuck in pending, check your scheduler services:
    - systemctl status kube-scheduler
  - Or by scheduler pods in a kubeadm / rancher cluster
    - kubectl get pods -n kube-system
    - kubectl logs kube-scheduler-master -n kube-system
- Get quota for each node:

  kubectl get nodes --no-headers | awk '{print $1}' | xargs -I {} sh -c 'echo {}; kubectl describe node {} | grep Allocated -A 5 | grep -ve Event -ve Allocated -ve percent -ve -- ; echo'
- Get nodes which have no taints

  ```
  kubectl get nodes -o json | jq  -r '.items[] | select(.spec.taints == null) | "\(.metadata.name)"'
  ```
- Find out the unused/unupdated deployments in your clusters

  ```
  kubectl get deploy --all-namespaces -ojson | jq '.items[] | "\(.metadata.namespace) \(.metadata.name) \(.spec.replicas)
  \(.status.conditions[0].lastUpdateTime)"'
  ```

Tips & Tricks (IV)


Troubleshooting Kubernetes deployments
Read the blog article at
https://learnk8s.io/troubleshooting-deployments
START
Is there any PENDING Pod?
YES
NO
Is the cluster full?
NO
YES
Provision a bigger cluster
Are you hitting the ResourceQuota limits?
NO
YES
Relax the ResourceQuota limits
Are you mounting a PENDING PersistentVolumeClaim?
NO
YES
Fix the PersistentVolumeClaim
Is the Pod assigned to the Node
YES
There is an issue with the Kubelet
NO
There is an issue with the Scheduler
Are the Pods RUNNING?
NO
YES
Can you see the logs for the app?
YES
Fix the issue in the application
NO
Did the contaner died too quickly?
NO
YES
Is the Pod status ImagePullBackOff?
NO
YES
Is the Pod status CrashLoopBackOff?
NO
YES
Is the Pod status RunContainerError?
YES
The issue is likely to be with mounting volumes
NO
Consult StackOverflow
Is the name of the image correct?
NO
Fix the image name
YES
Is the image tag valid? Does it exist?
NO
Fix the tag
YES
Did you inspect the logs and fix the crashing app?
NO
Fix crashing app
YES
Did you forget the CMD instruction in the Dockerfile?
YES
Fix the Dockerfile
NO
Are the Pods READY?
NO

```
~$ kubectl get pods
~$ kubectl describe pod <pod-name>
~$ kubectl get pods -o wide
~$ kubectl logs <pod-name>
~$ kubectl describe pod <pod-name>
~$ kubectl logs <pod-name> --previous
~$ kubectl describe pod <pod-name>
```

https://learnk8s.io/troubleshooting-deployments

K8s Practice Questions

Practice Questions (I)

- Create a yaml for a job that calculates the value of pi
- Create an Nginx Pod and attach an EmptyDir volume to it.
- Create an Nginx deployment in the namespace “kube-cologne” and corresponding service of type NodePort . Service should be accessible on HTTP (80) and HTTPS (443)
- Add label to a node as "arch=gpu"
- Create a Role in the “conference” namespace to grant read access to pods.
- Create a RoleBinding to grant the "pod-reader" role to a user "john" within the “conference” namespace.
- Create an Horizontal Pod Autoscaler to automatically scale the Deployment if the CPU usage is above 50%.

Practice Questions (II)

- Deploy a default Network Policy for each resources in the default namespace to deny all ingress and egress traffic.
- Create a pod that contain multiple containers : nginx, redis, postgres with a single YAML file.
- Deploy nginx application but with extra security using PodSecurityPolicy
- Create a Config map from file.
- Create a Pod using the busybox image to display the entire content of the above ConfigMap mounted as Volumes.
- Create configmap from literal values
- Create a Pod using the busybox image to display the entire ConfigMap in environment variables automatically.
- Create a ResourceQuota in a namespace "kube-cologne" that allows maximum of

Practice Questions (III)

- Create ResourceQuota for a namespace "quota-namespace"
- Create Pod quota for a namespace "pod-quota"
- Deployment Exercise
    - Create nginx deployment and scale to 3
    - Check the history of the previous Nginx deployment
    - Update the Nginx version to the 1.9.1 in the previous deployment
    - Check the history of the deployment to note the new entry
- Add liveness and readiness probe to kuard container

And the solutions:

https://github.com/ipochi/k8s-practice-questions/blob/master/practice-questions-with-solutions.md

General Questions

General Questions

- What happens to services, when the control plane goes down?
  - The services are not affected as far they don’t change. e.g. if you expose a service to the world via LB it should still work.
- If it is not exposed via LB, how can pods can communicate with a service internally, if control pane is down. How does the pod know about which end points this service is connected to?
  - Those endpoint are defined by kube-proxy (iptable) in the node , when you add a new service the iptable of kube-proxy is updated, no matter the plane control falls or not. You need to know that the nodes can work without api-server thanks to the kubelet with static manifests

Source: https://kubernauts.slack.com/archives/G6CCNMVKM/p1562305149191600

Advanced Exercises

Exercise 7: Load Testing with Apache Jmeter on Kubernetes and OpenShift

- A more complete example: https://goo.gl/k5rFpb

Exercise 8: Running Rancher on Kubernetes

- TK8 on Github:

  https://github.com/kubernauts/tk8

Exercise 9: Kafka Confluent on Kubernetes or OpenShift

- Github link:
  - https://github.com/kubernauts/kafka-confluent-platform

APACHE kafka®
A distributed streaming platform

Exercise 10: Strimzi Kafka Operator

- Github link:
  - https://github.com/strimzi/strimzi-kafka-operator
- Apache Kafka® on Kubernetes®
  - →

Exercise 11: Cassandra on Kubernetes

- Cassandra Operator →

Get in Touch

1. Slack - https://kubernauts-slack-join.herokuapp.com/
2. #kubernetes-teachers on https://kubernetes.slack.com
3. GitHub - https://github.com/kubernauts
4. Twitter - @kubernauts
5. Meetup group - https://www.meetup.com/kubernauts/
6. And finally, kubernauts.io, kubernauts.de &

   kubernauts.academy (coming in Q3 / 19)

Tooling and Helpers
Here you go:

The Golden Kubernetes Tooling and Helpers list

Cloud Native Storage

Cloud Native Storage on Kubernetes®

Need Training On-Site?

https://kubernauts.de

Kubernauts' Kubernetes Online Training

on July 2nd and 3rd

https://kubernauts.de/en/training/index.htmlkubernetes-training-course.html

We Love To Learn From You, Join Us, We're Hiring!

https://kubernauts.de/en/careers/