



# Networking with Kubernetes!

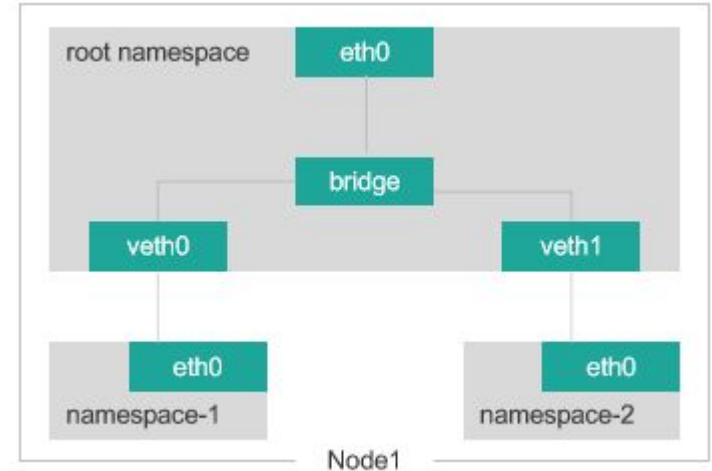


# Part 1

# Intro: K8S Networking

## Namespace

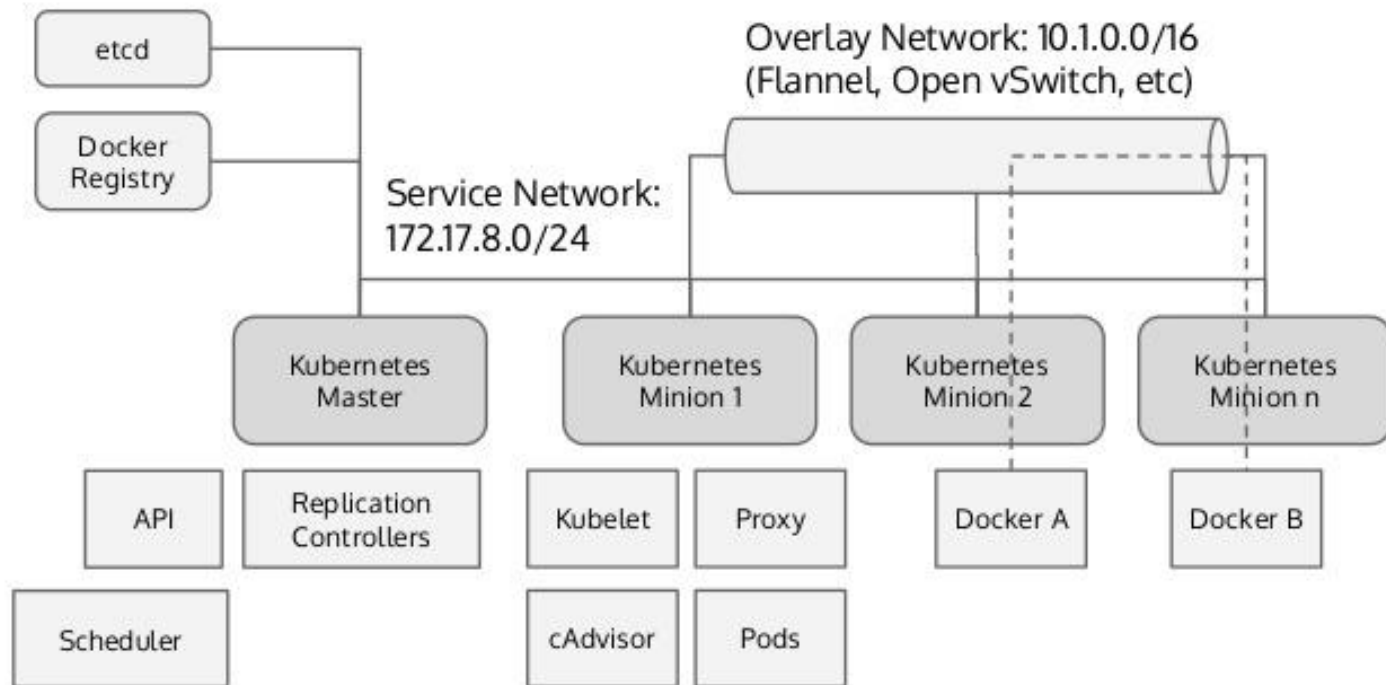
- Linux kernel has 6 types of namespaces: *pid,net,mnt,uts,ipc,user*
- Network namespaces provide a brand-new network stack for all the processes within the namespace.
- That includes network interfaces, routing tables and iptables rules



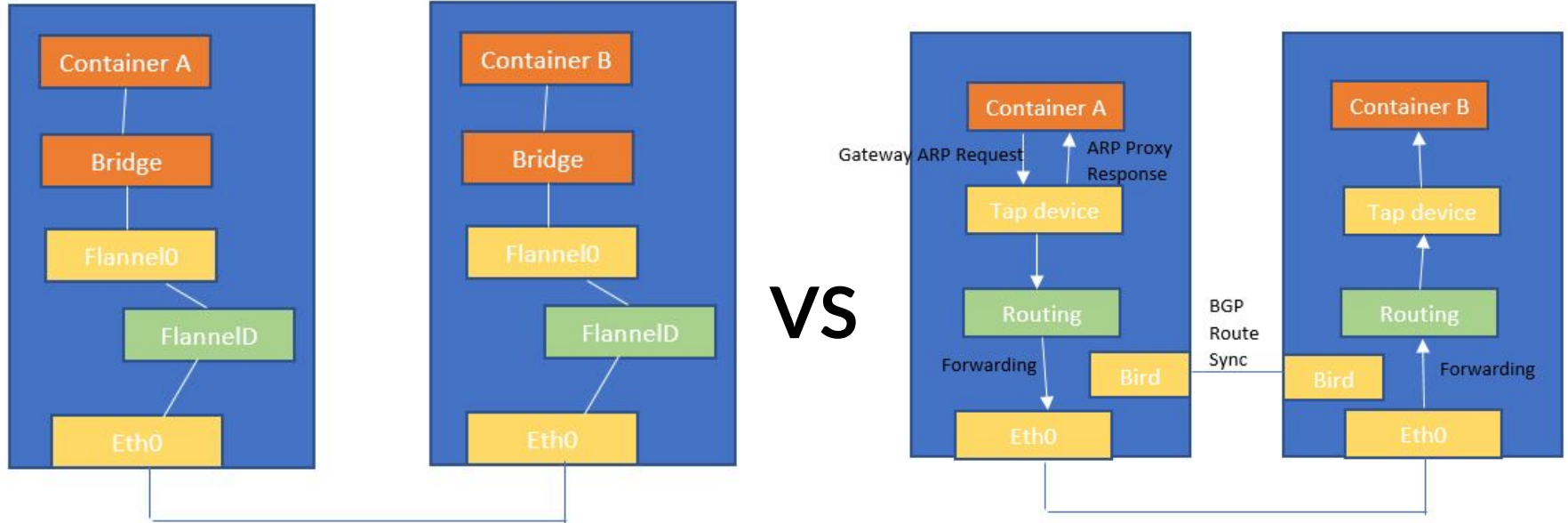
**Live demo: Play with namespaces and cgroups.**



# Kubernetes Architecture



# Flannel VS Calico



# Pods

## Pods

- Lowest common denominator in K8S. Pod is comprised of one or more containers along with a "pause" container
- Pause container act as the "parent" container for other containers inside the pod. One of it's primary responsibilities is to bring up the network namespace
- Great for the redundancy: Termination of other containers do not result in termination of the network namespace

```
[root@Master1 ~]# kubectl get pods --namespace web -o wide
```

NAME	READY	STATUS	AGE	IP	NODE
nginx-deployment-76bf4969df-5xzv7	1/1	Running	7m53s	172.31.155.17	Worker-1



```
[root@Worker-1 ~]# docker ps
```

CONTAINER ID	IMAGE	COMMAND	CREATED	NAMES
93490bfce728	docker.io/nginx@sha256	"nginx -g 'daemon off'"	47 seconds ago	k8s_nginx_nginx-deployment
2ef012ea5db0	k8s.gcr.io/pause:3.1	"/pause"	57 seconds ago	k8s_POD_nginx-deployment

## Accessing Pod Namespaces

### Accessing Pod Namespaces

- Multiple ways to access pod namespaces
- 'kubectl exec -it'
- 'docker exec -it'
- nsenter ("namespace enter", let you run commands that are installed on the host but not on the container)

```
[root@worker-1 ~]# docker ps
```

CONTAINER ID	IMAGE	COMMAND	CREATED	NAMES
5b54f2a44c3b	d8233ab899d4	"sleep 3600"	35 minutes ago	k8s_busybox_busybox0-6hc7c
43e42c45522b	k8s.gcr.io/pause:3.1	"/pause"	10 hours ago	k8s_POD_busybox0-6hc7c

```
[root@worker-1 ~]# docker inspect -f '{{.State.Pid}}' 5b54f2a44c3b
21388

[root@worker-1 ~]# nsenter -t 21388 -n ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
17: eth0@if18: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
    link/ether fa:4d:26:0b:4a:c7 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.1.196/32 brd 192.168.1.196 scope global eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::f84d:26ff:fe0b:4ac7/64 scope link
        valid_lft forever preferred_lft forever
```

```
[root@worker-1 ~]# docker inspect -f '{{.State.Pid}}' 43e42c45522b
8112

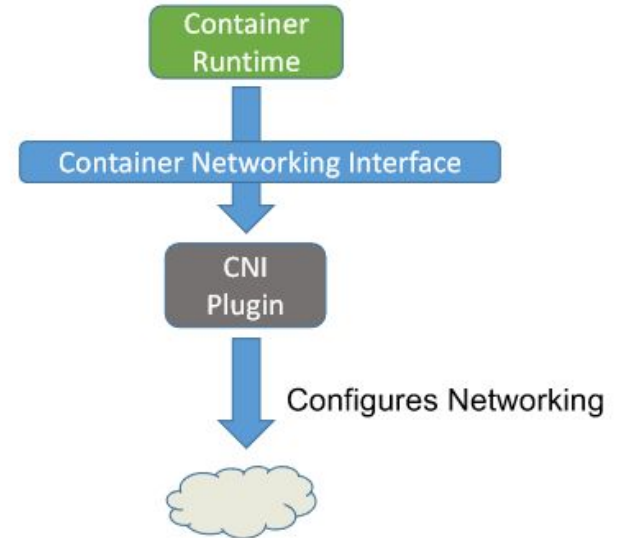
[root@worker-1 ~]# nsenter -t 8112 -n ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
17: eth0@if18: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP
    link/ether fa:4d:26:0b:4a:c7 brd ff:ff:ff:ff:ff:ff link-netnsid 0
    inet 192.168.1.196/32 brd 192.168.1.196 scope global eth0
        valid_lft forever preferred_lft forever
    inet6 fe80::f84d:26ff:fe0b:4ac7/64 scope link
        valid_lft forever preferred_lft forever
```

Both containers belong to the same pod => Same Network Namespace => same 'ip a' output

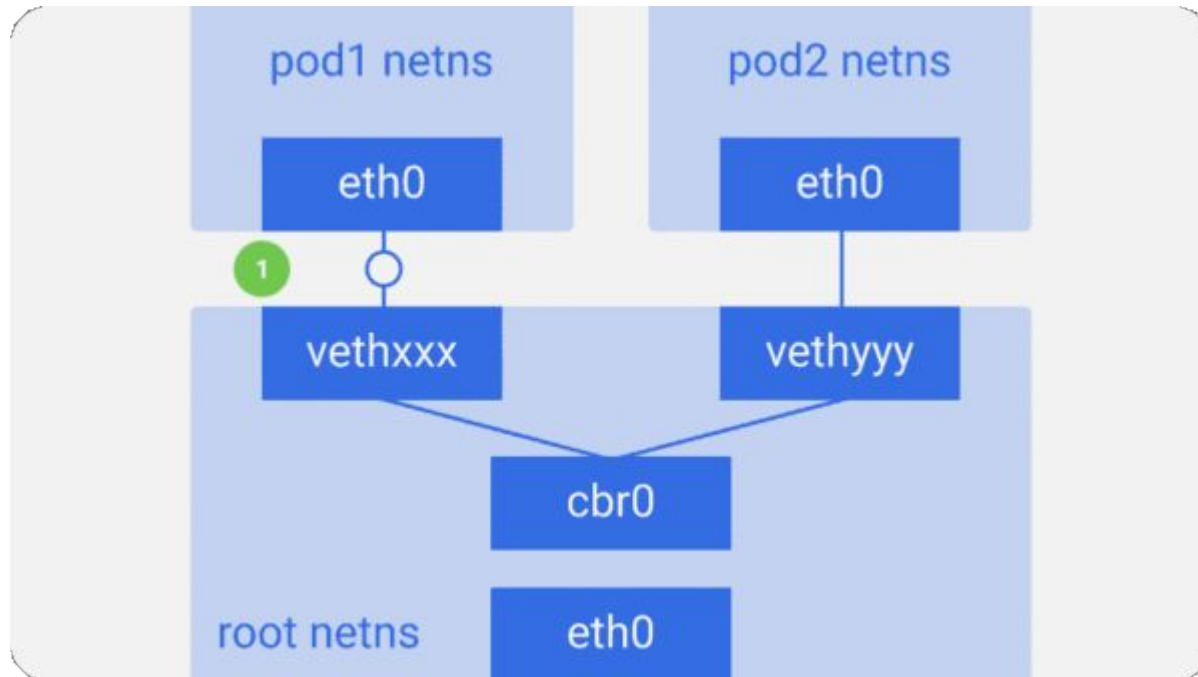


# Container Networking Interface : CNI

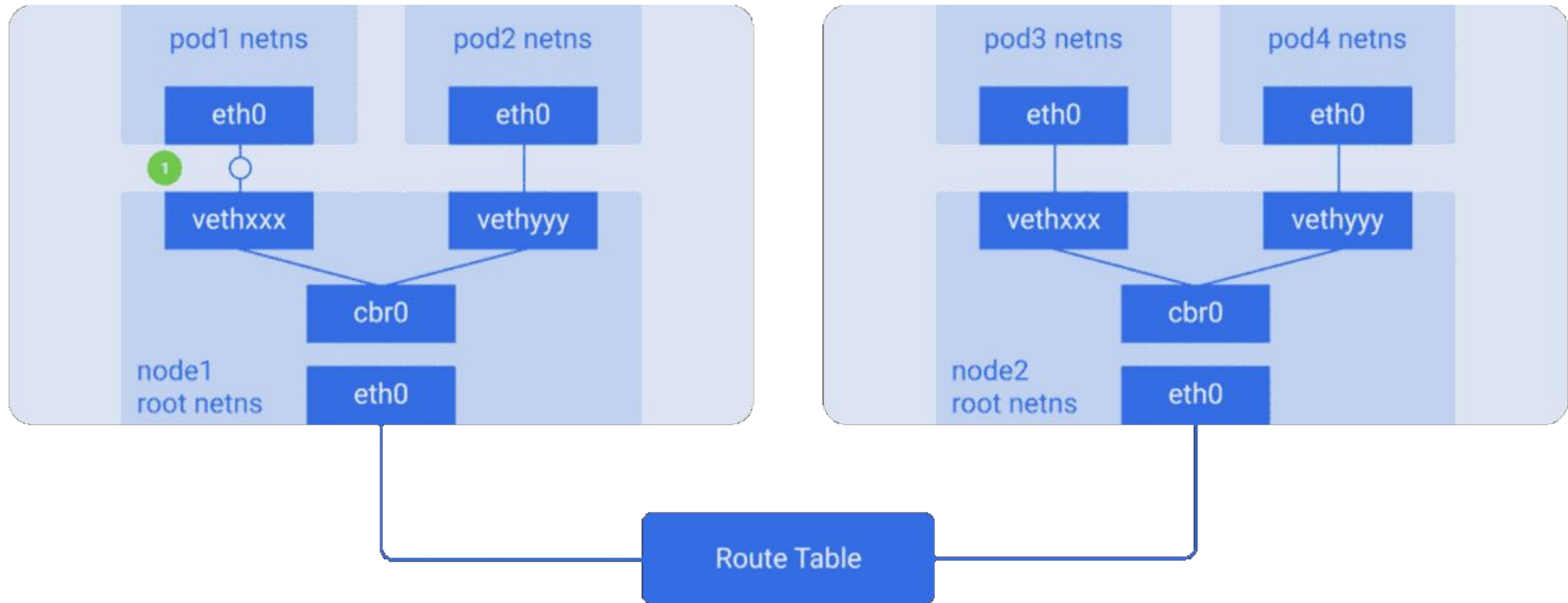
- Interface between container runtime and network implementation
- Network plugin implements the CNI spec. It takes a container runtime and configure (attach/detach) it to the network
- CNI plugin is an executable (in: /opt/cni/bin)
- When invoked it reads in a JSON config & Environment Variables to get all the required parameters to configure the container with the network



## Intra-node communication



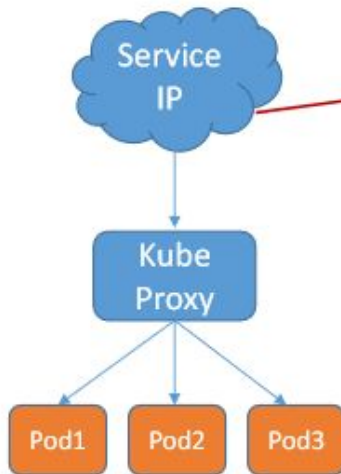
# Inter-node communication



# Back to the Basics

## Services

- Pods are mortal
- Need a higher level abstractions: Services
- “Service” in Kubernetes is a conceptual concept. Service is not a process/daemon. Outside networks doesn't learn Service IP addresses
- Implemented through Kube Proxy with IPTables rules



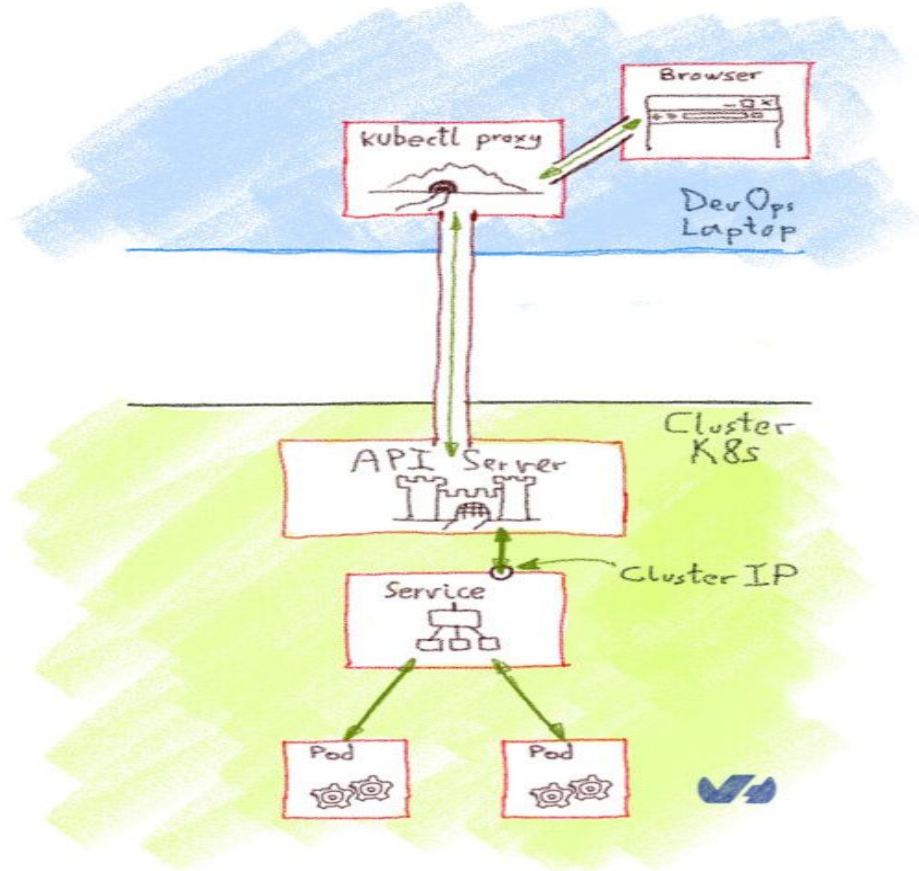
```
$ kubectl get services -n demo -o wide
```

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE	SELECTOR
hostnames	ClusterIP	10.96.13.117	<none>	80/TCP	23h	app=hostnames

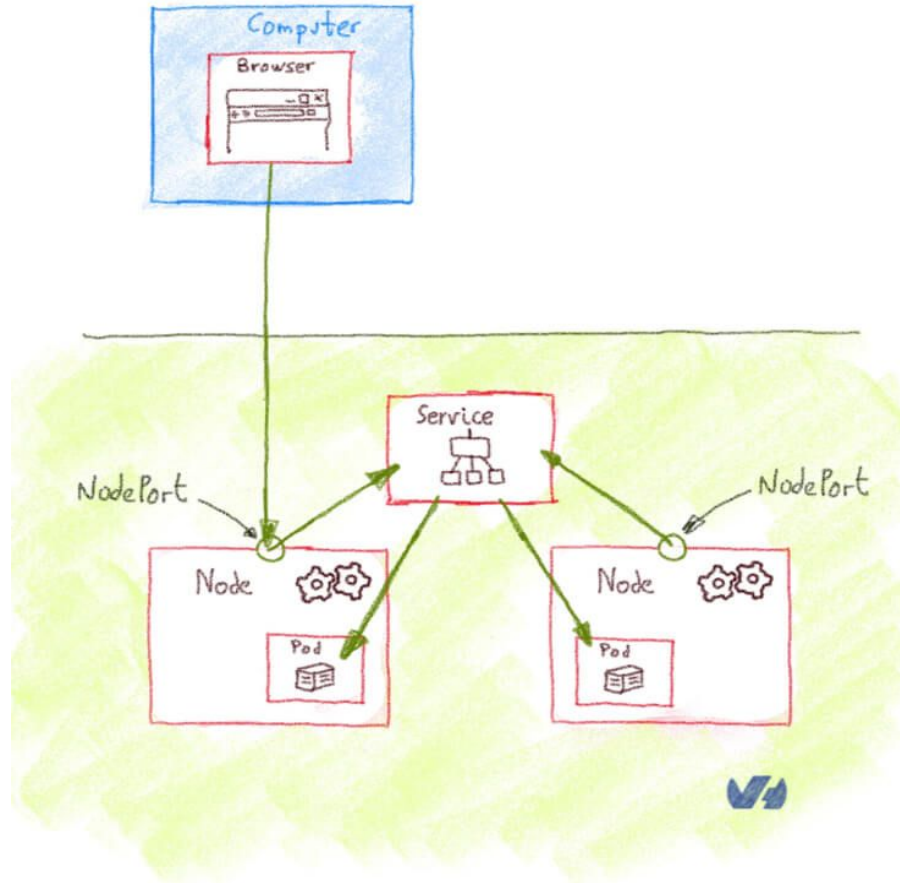
```
$ kubectl describe service -n demo
```

Name: hostnames  
Namespace: demo  
Labels: <none>  
Annotations: <none>  
Selector: app=hostnames  
Type: ClusterIP  
IP: 10.96.13.117  
Port: default 80/TCP  
TargetPort: 9376/TCP  
Endpoints: 192.168.1.63:9376,192.168.2.171:9376,192.168.3.155:9376  
Session Affinity: None  
Events: <none>

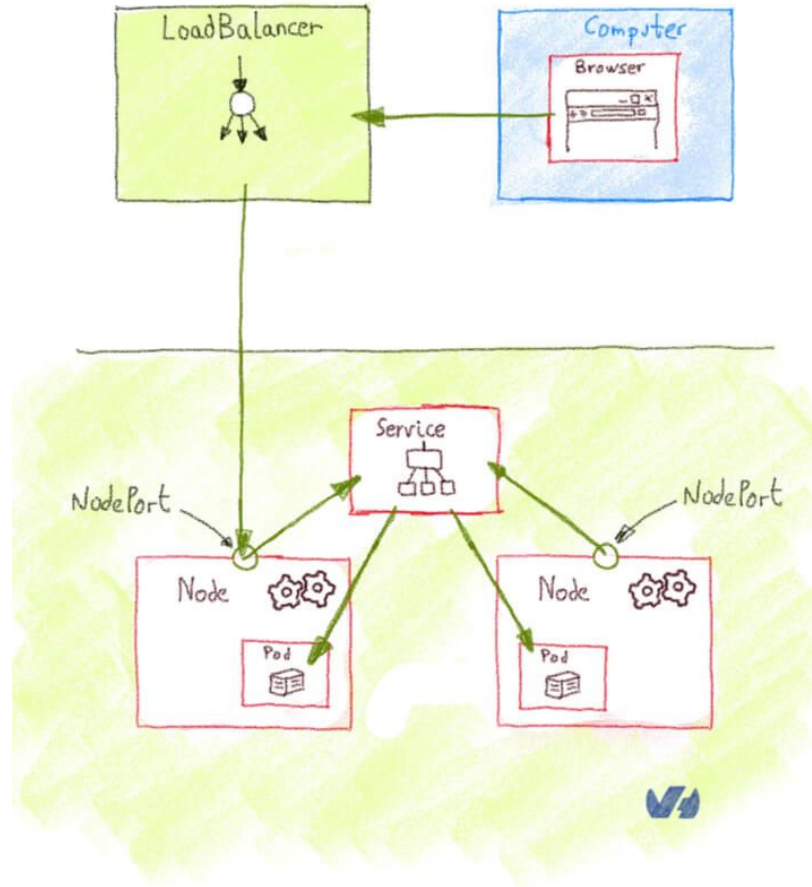
# ClusterIP: Service is accessed via 'ClusterIP'



# NodePort: Service is accessed via 'NodeIP:port'



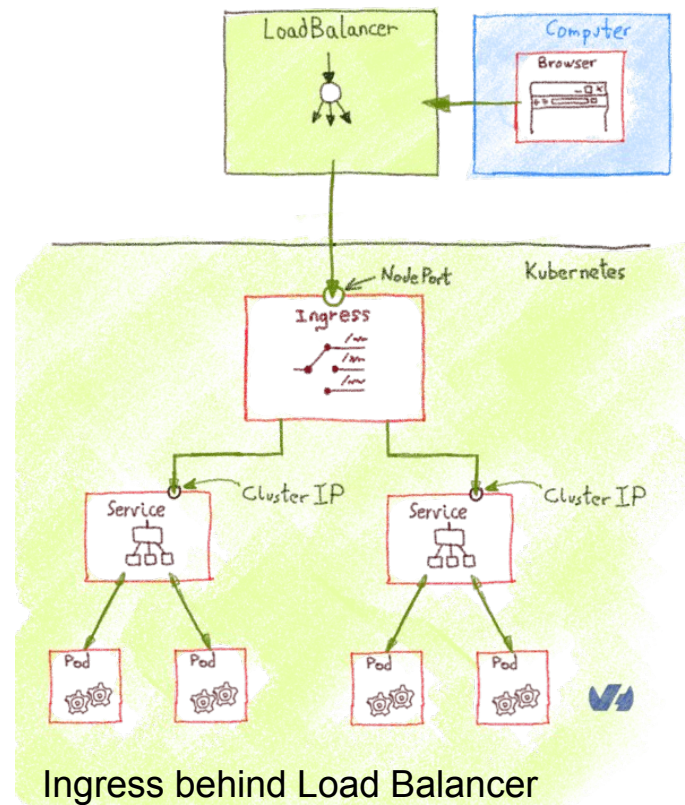
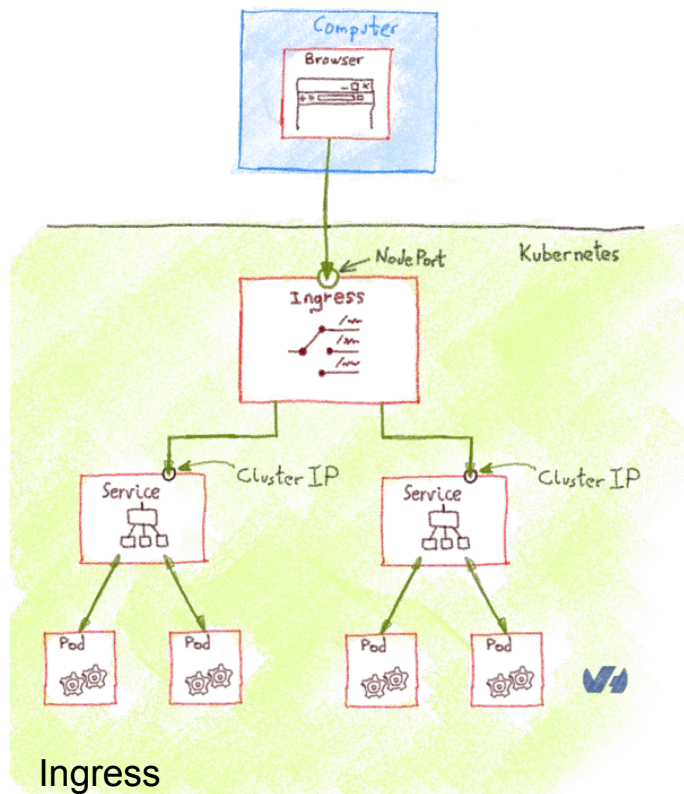
# LoadBalancer: Service is accessed via Loadbalancer





# Ingress

Ingress is an API object that manages external access to the services in a cluster.







## Part 2:

# Setting up K8S The Hard Way

On top of Amazon Web Services (AWS)



# 1- Provisioning Compute Resources

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/03-compute-resources.md>

→ **Networking:**

- VPC
- Subnet
- Internet Gateway
- Route Tables
- Security Groups (aka Firewall Rules)

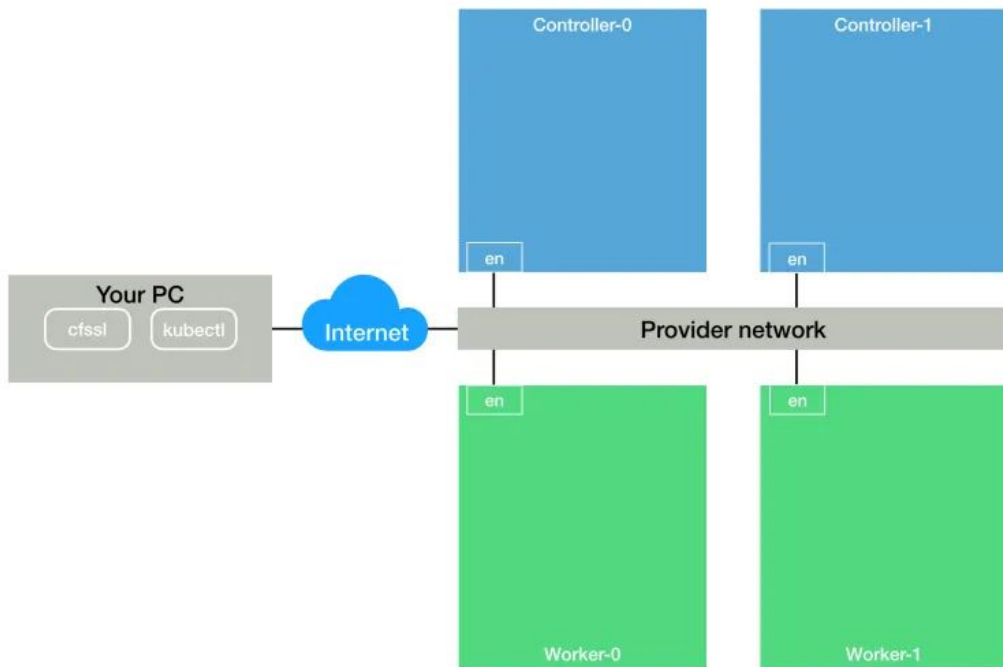
→ Create a Network Load Balancer

→ **Compute Instances:**

- Instance Image + SSH Key Pair
- Kubernetes Controllers
- Kubernetes Workers

# 1- Provisioning Compute Resources

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/03-compute-resources.md>





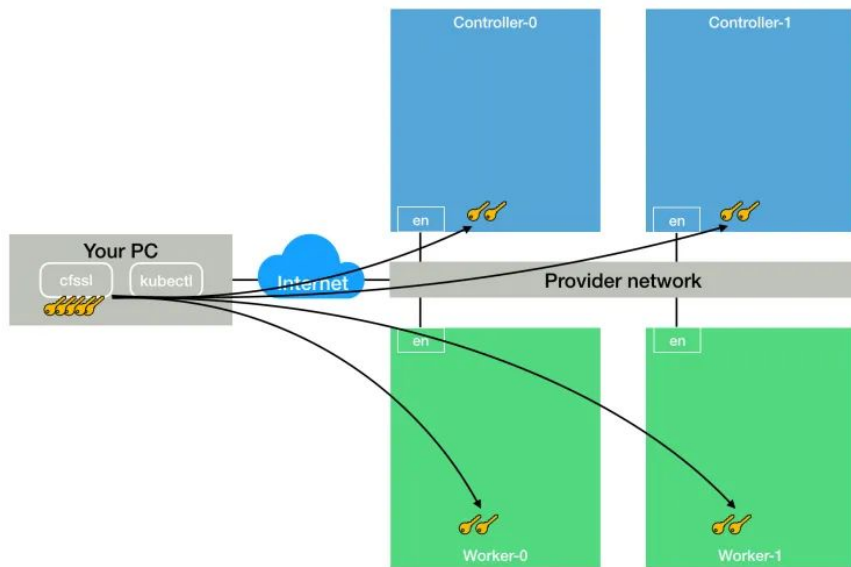
## 2- Provisioning a CA and Generating TLS Certificates

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/04-certificate-authority.md>

- **Certificate Authority**
- **Client and Server Certificates:**
  - The Admin Client Certificate
  - The Kubelet Client Certificates
  - The Controller Manager Client Certificate
  - The Kube Proxy Client Certificate
  - The Scheduler Client Certificate
  - The Kubernetes API Server Certificate
- **The Service Account Key Pair**
- **Distribute the Client and Server Certificates**

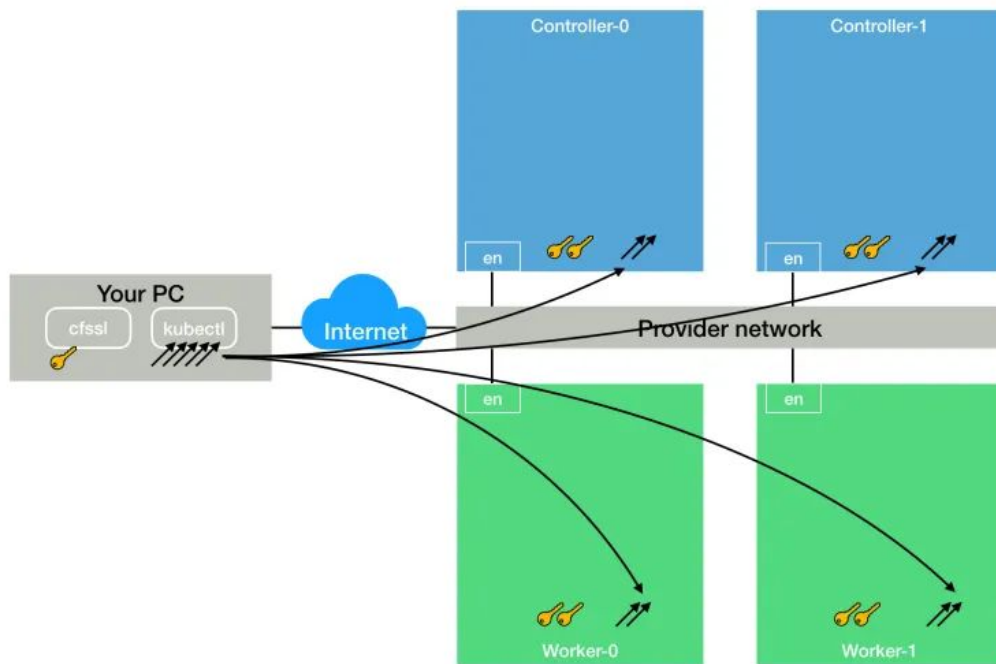
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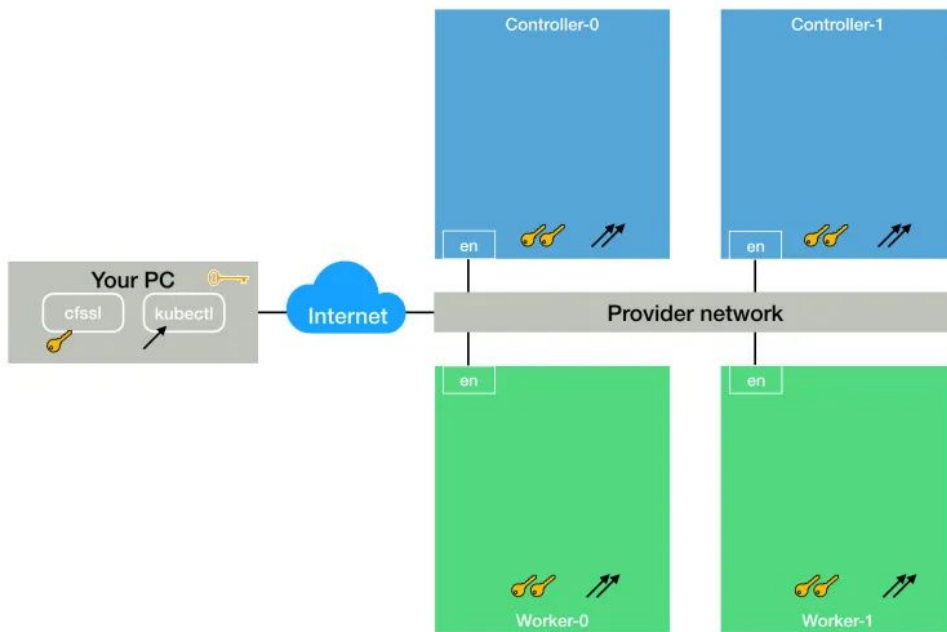
### 3- Generating Kubernetes Configuration Files for Authentication

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/05-kubernetes-configuration-files.md>



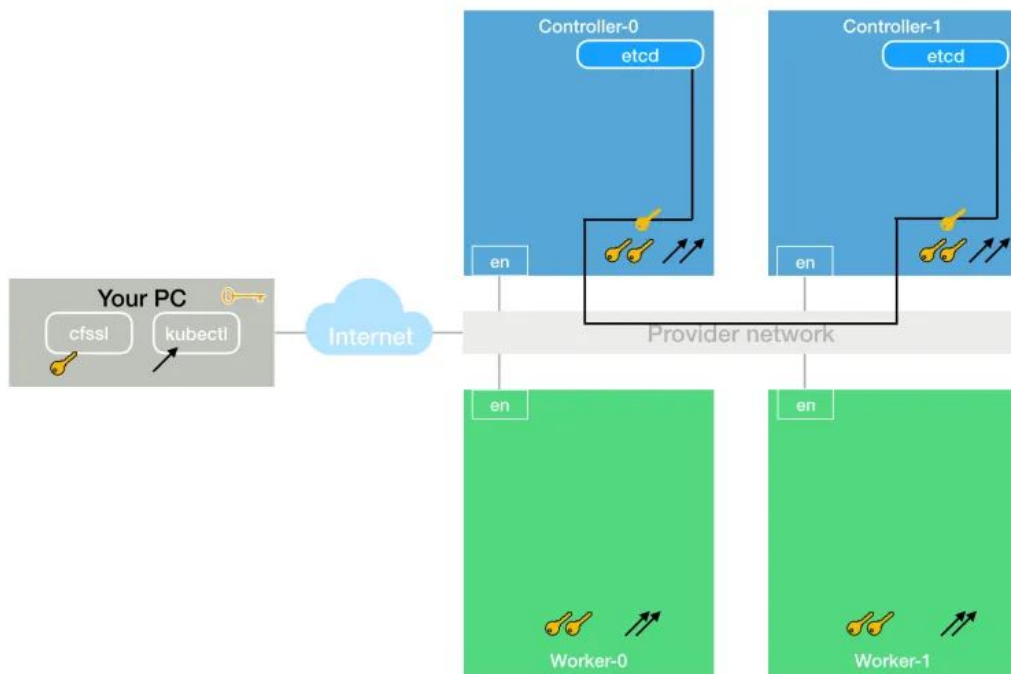
## 4- Generating the Data Encryption Config and Key

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/06-data-encryption-keys.md>



## 5- Bootstrapping the etcd Cluster

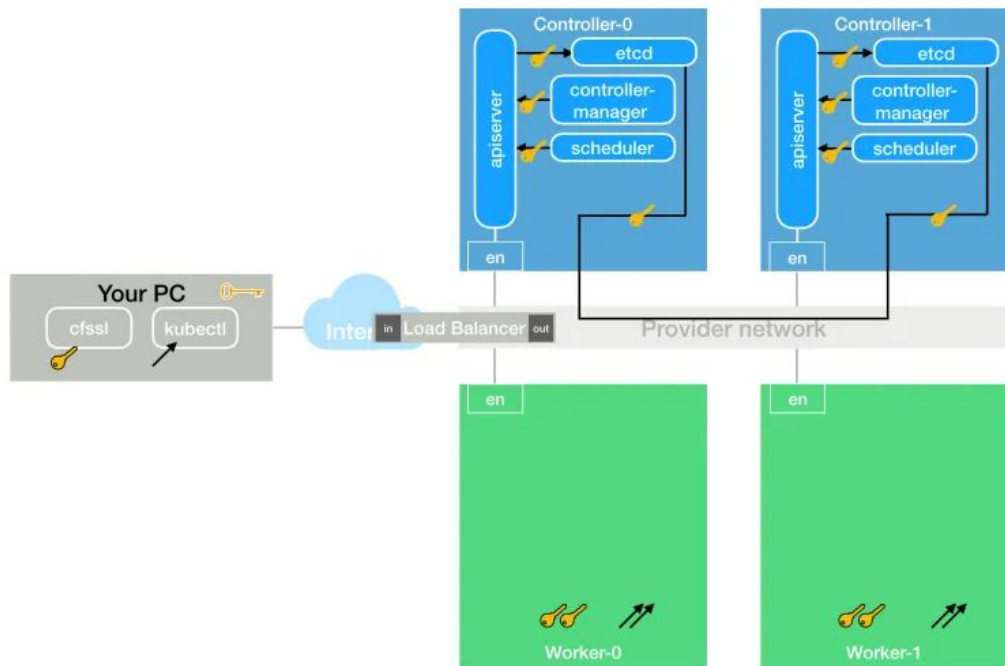
<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/07-bootstrapping-etcd.md>





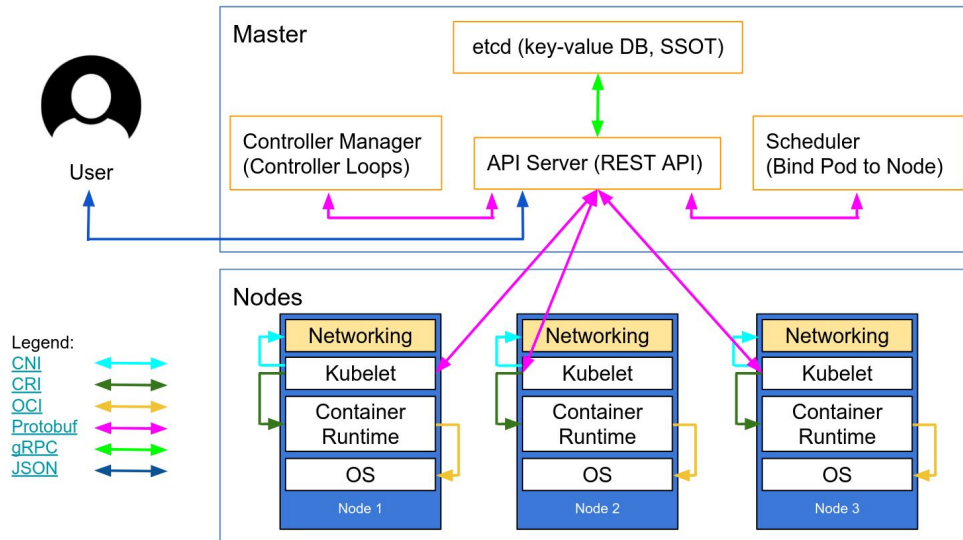
## 6- Bootstrapping the Kubernetes Control Plane

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/08-bootstrapping-kubernetes-controllers.md>



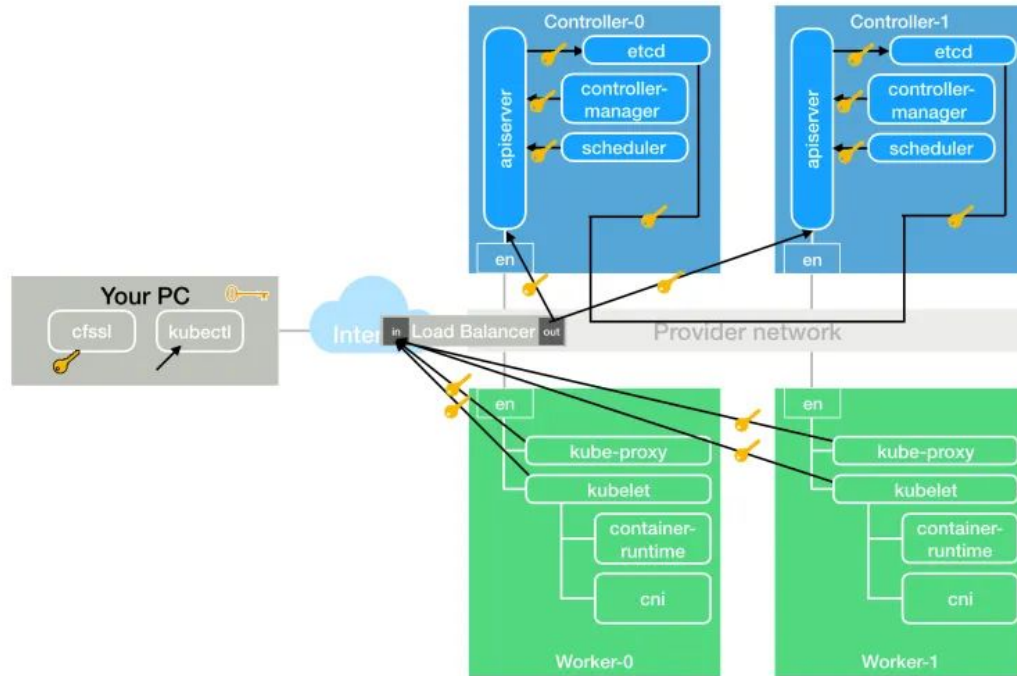
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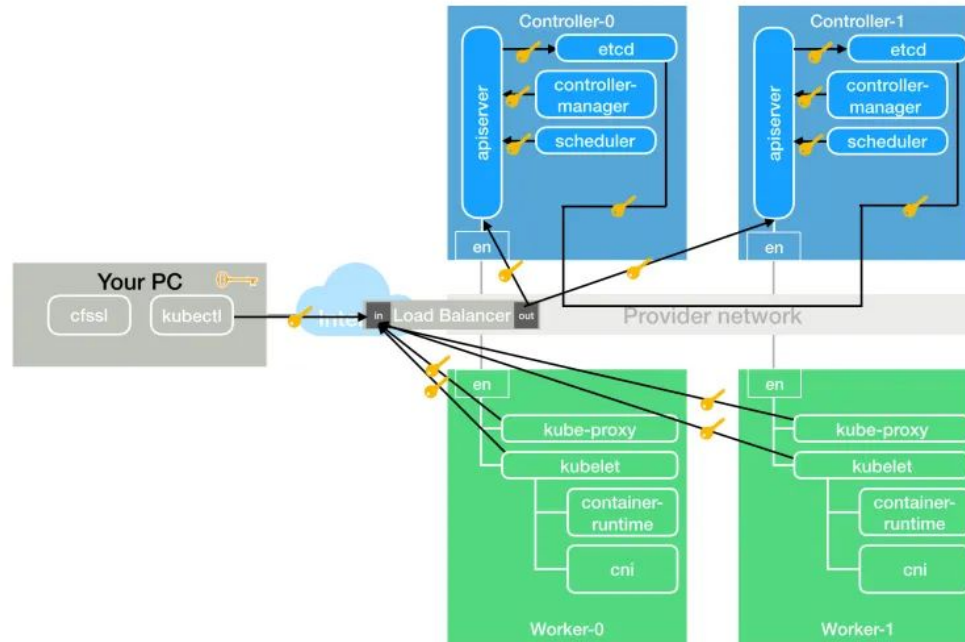
# 7- Bootstrapping the Kubernetes Worker Nodes

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/09-bootstrapping-kubernetes-workers.md>



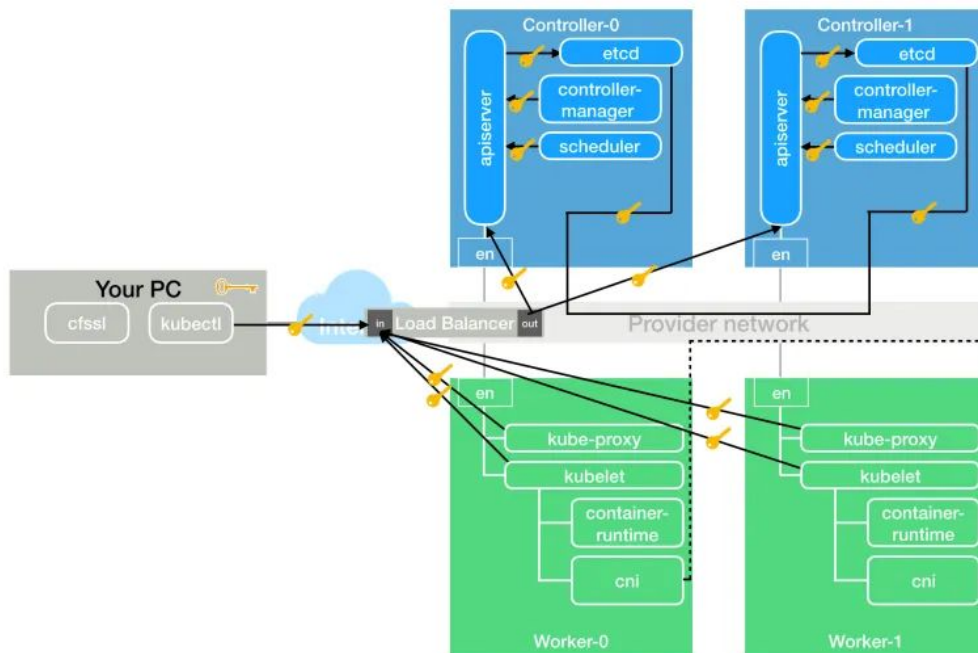
## 8- Configuring kubectl for Remote Access

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/10-configuring-kubectl.md>



## 9- Provisioning Pod Network Routes

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/11-pod-network-routes.md>

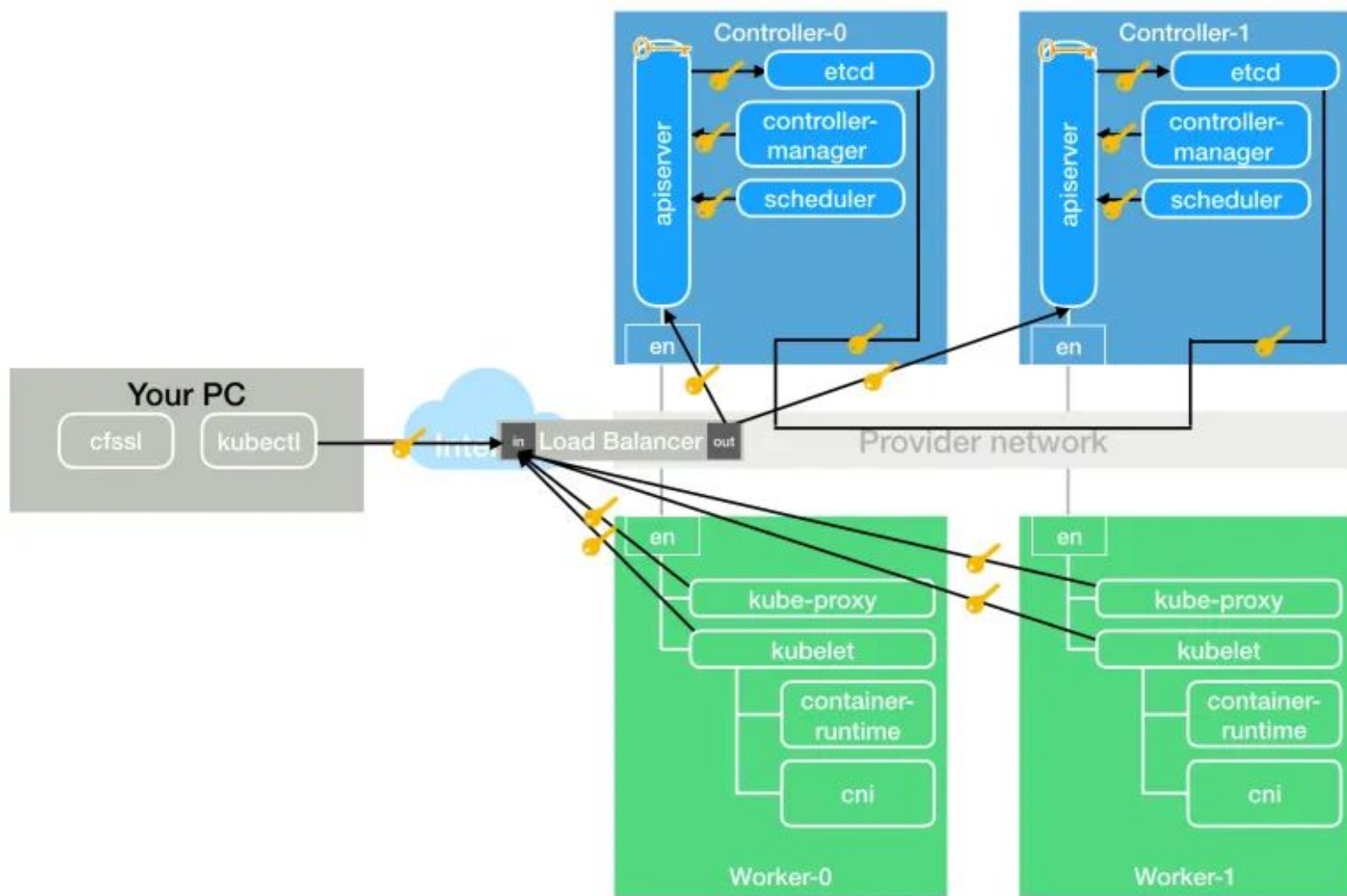




## 10- Deploying the DNS Cluster Add-on

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/12-dns-addon.md>

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## 12- Cleaning Up

<https://github.com/TunisJAM/kubernetes-the-hard-way-aws/blob/master/docs/14-cleanup.md>





## **Part 4:**

# **Istio, a modern service mesh**

# ISTIO architecture

