# Kubernetes on AWS

## with Amazon EKS

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Jan 2019

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# Running containers in development is easy…

```
$ vi Dockerfile
$ docker build -t mykillerapp:0.0.1 .
$ docker run -it mykillerapp:0.0.1
```

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# Moving to production is harder…


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# Common questions

- How do I deploy my containers to hosts?
  - How do I do zero downtime or  blue green deployments?
- How do I keep my containers alive?
- How can my containers talk to each other?
  - Linking? Service Discovery?
- How can I configure my containers at runtime?
  - What about secrets?
- How do I best optimise my "pool of compute”?

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# What is Kubernetes?

Open source container management platform

Helps you run containers at scale

Gives you primitives for building modern applications

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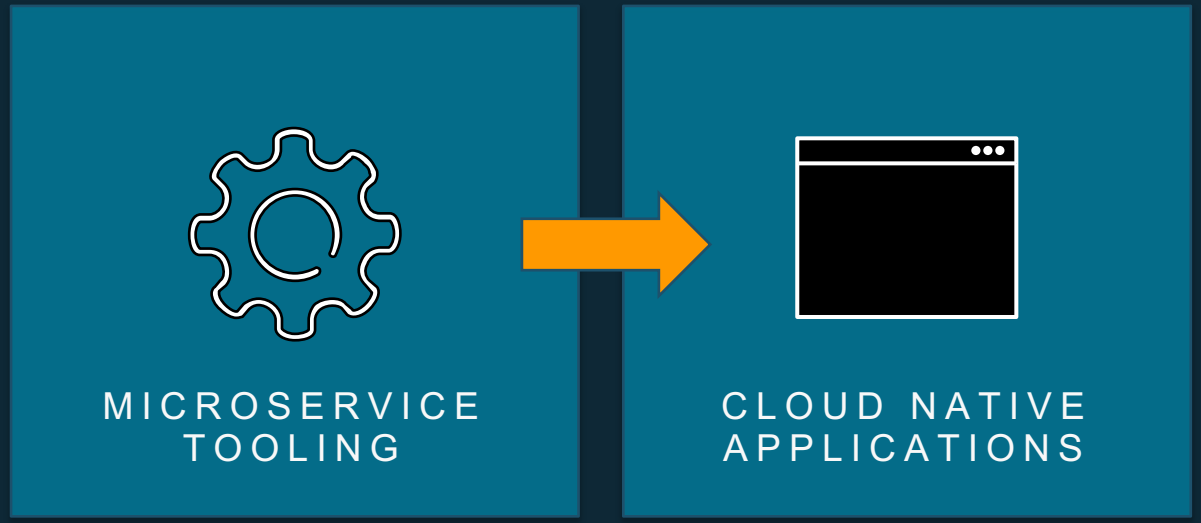
# Cloud-native applications

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# 51%

of Kubernetes workloads run on AWS today

— Cloud Native Computing Foundation

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# “Run Kubernetes for me.”

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# “Native AWS Integrations.”

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"An Open Source Kubernetes Experience."

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# Amazon EKS

## ELASTIC CONTAINER SERVICE FOR KUBERNETES (EKS)

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Amazon EKS is certified Kubernetes conformant so you can use all existing plugins and tooling from the Kubernetes community.

Any application running on any standard Kubernetes environment is fully compatible.

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# Kubernetes Developer Experience

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# Deploying some containers

## $ kubectl run nginx --image=nginx --replicas=3 --port=80

```
deployment "nginx" created
```

## $ kubectl get deployments

```
NAME       DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
nginx      3         3         3            3           5s
```

## $ kubectl get pods

```
NAME                     READY     STATUS    RESTARTS   AGE
nginx-4293833666-20vr8   1/1       Running   0          2m
nginx-4293833666-3gzfw   1/1       Running   0          2m
nginx-4293833666-7nBiH   1/1       Running   0          2m
```

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# Exposing pods as services

Three options:

ClusterIP virtual IP, accessible from all nodes

LoadBalancer automatically creates a public ELB (using IAM role)

NodePort bind service to the same port on every host

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# Services: ClusterIP

$ kubectl run nginx --image=nginx --replicas 3 --port=80
$ kubectl expose deployment nginx
$ kubectl get services

```
NAME         TYPE           CLUSTER-IP      EXTERNAL-IP   PORT(S)   AGE
nginx        ClusterIP      100.67.104.10   <none>        80/TCP    17s
```

Now all hosts can connect to 100.67.104.10 (or via DNS as nginx)

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# Services: LoadBalancer

```
$ kubectl run nginx --image=nginx --replicas 3 --port=80
$ kubectl expose deployment nginx --type=LoadBalancer
$ kubectl get services -o=wide
```

```
NAME      TYPE           CLUSTER-IP      EXTERNAL-IP                                                                PORT(S)
nginx     LoadBalancer   100.70.217.164  a5cefe533ac1d11e7a38f0a67818e472-1987464052.eu-west-1.elb.amazonaws.com     80:31108/TCP
```

| DNS name | Availability Zones | Type | Port Configuration |
|---|---|---|---|
| a5cefe533ac1d11e7a38f0a67818e472-1987464052.eu-west-1.elb.amazonaws.com | eu-west-1b, eu-west-1c, eu-west-1a | classic | 80 (TCP) forwarding to 31108 (TCP) |

| Instance ID | Name | Availability Zone | Status | Actions |
|---|---|---|---|---|
| i-0478980a1a86faa09 | micro.k8s.demothe.cloud | eu-west-1b | InService | Remove from Load Balancer |
| i-0885393f80f3db7de | micro.k8s.demothe.cloud | eu-west-1a | InService | Remove from Load Balancer |
| i-0d701a00358fb084f | micro.k8s.demothe.cloud | eu-west-1c | InService | Remove from Load Balancer |
| i-0a3b00eeabdf3b0ce | micro.k8s.demothe.cloud | eu-west-1c | InService | Remove from Load Balancer |
| i-08617f4b745d3bb74 | micro.k8s.demothe.cloud | eu-west-1b | InService | Remove from Load Balancer |
| i-077d170e688971c98 | micro.k8s.demothe.cloud | eu-west-1a | InService | Remove from Load Balancer |

# Declarative Configuration as Code

$ kubectl get deployment nginx -oyaml > deployment.yaml

$ kubectl apply –f deployment.yaml

$ kubectl delete –f deployment.yaml

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# Diagnose & inspect

## $ kubectl logs <pod>

```
100.103.136.0 - - [06/Oct/2017:11:30:47 +0000] "GET / HTTP/1.1" 200 612 "-" "curl/7.54.0" "-"
```

## $ kubectl attach <pod>

```
100.103.136.0 - - [06/Oct/2017:11:30:47 +0000] "GET / HTTP/1.1" 200 612 "-" "curl/7.54.0" "-"
100.103.136.0 - - [06/Oct/2017:11:37:25 +0000] "GET / HTTP/1.1" 200 612 "-" "curl/7.54.0" "-"
100.103.136.0 - - [06/Oct/2017:11:37:25 +0000] "GET / HTTP/1.1" 200 612 "-" "curl/7.54.0" "-"
100.103.136.0 - - [06/Oct/2017:11:37:25 +0000] "GET / HTTP/1.1" 200 612 "-" "curl/7.54.0" "-"
100.103.136.0 - - [06/Oct/2017:11:37:25 +0000] "GET / HTTP/1.1" 200 612 "-" "curl/7.54.0" "-"
<ctrl + c>
```

## $ kubectl exec -it <pod> -- /bin/bash

```
root@nginx-1423793266-xw3km:/#
```

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# Local experience

**Docker for Mac** Easy to get up and running with a local Kubernetes installation in minutes on MacOS. Only available in 'edge' channel today.

**Minikube** is a tool that makes it easy to run Kubernetes locally. Minikube runs a single-node Kubernetes cluster inside a VM on your laptop for users looking to try out Kubernetes or develop with it day-to-day.

https://github.com/kubernetes/minikube

**Telepresence** allows you to transparently mount your local development folder into a remote cluster.

https://www.telepresence.io/

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# Demo

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# EKS Architecture

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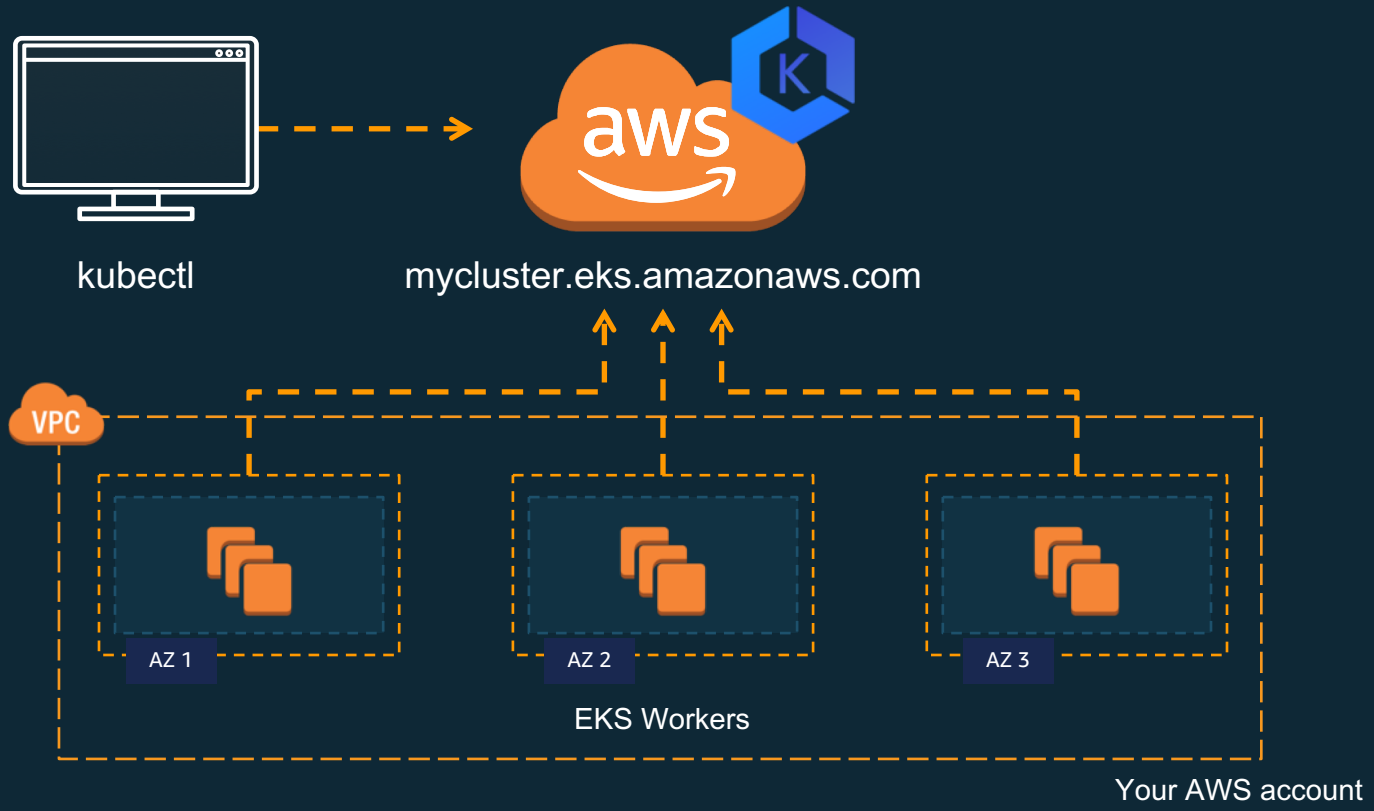
# Amazon EKS

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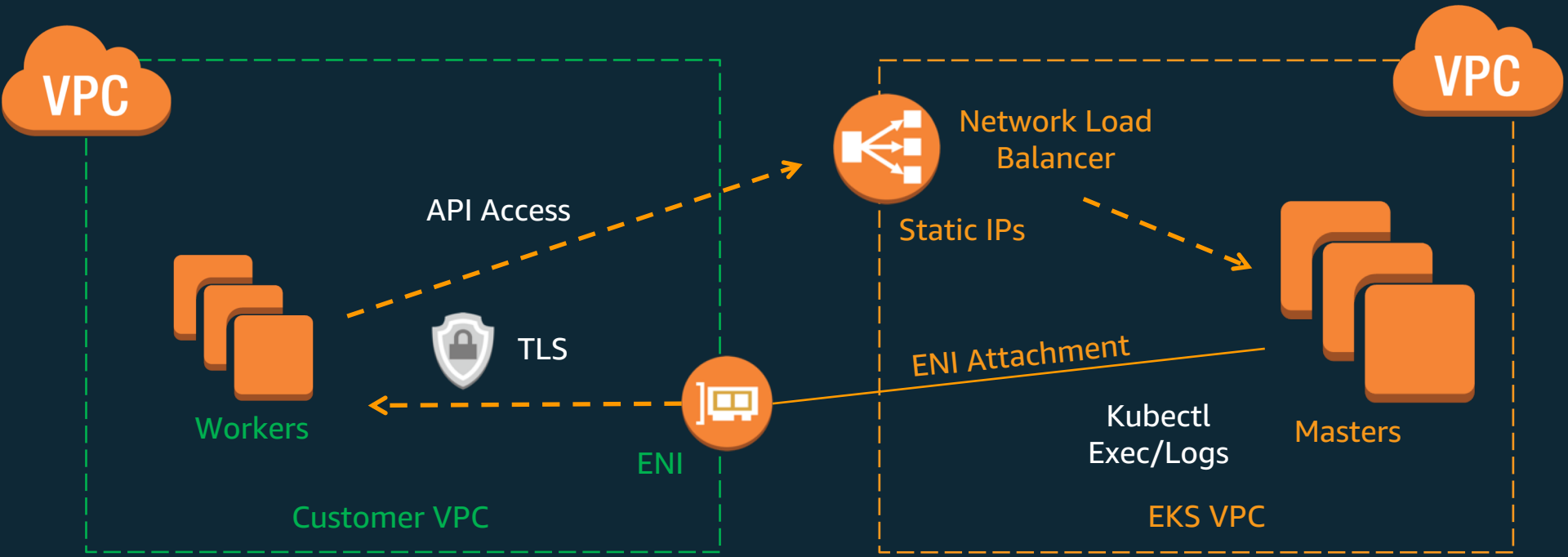
# Cross-account Kubernetes

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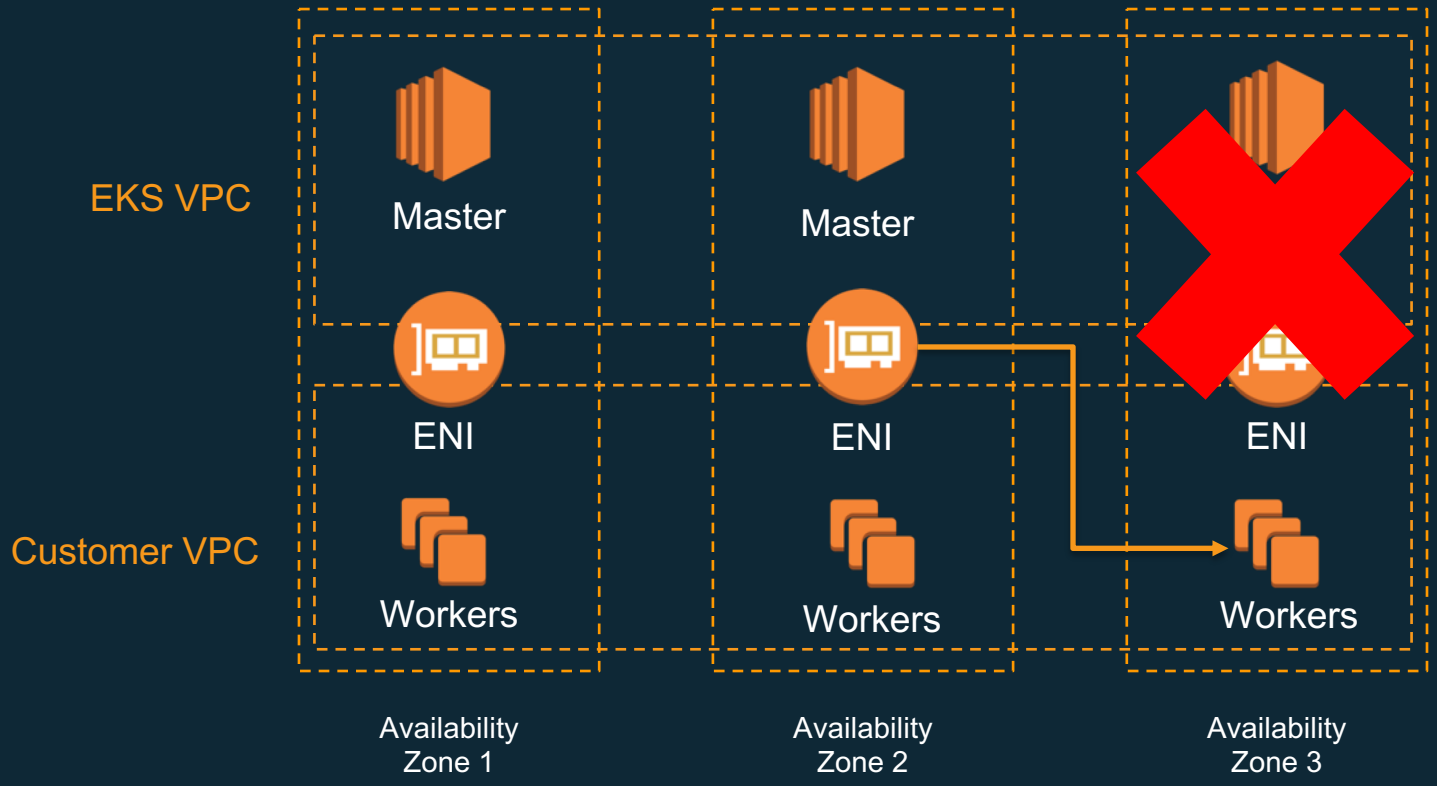
# EKS Cross-Account Networking: Availability Zones

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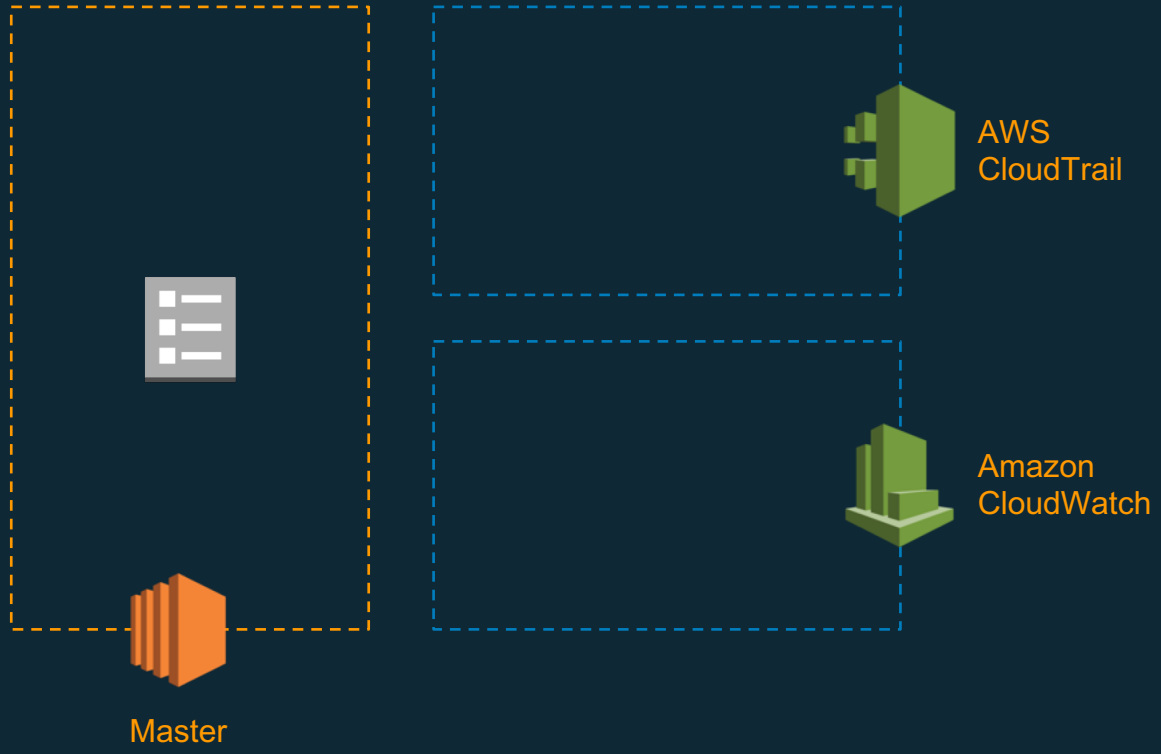
# Master access and visibility

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# What about K8s/etcd upgrades?

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# Kubernetes Upgrades


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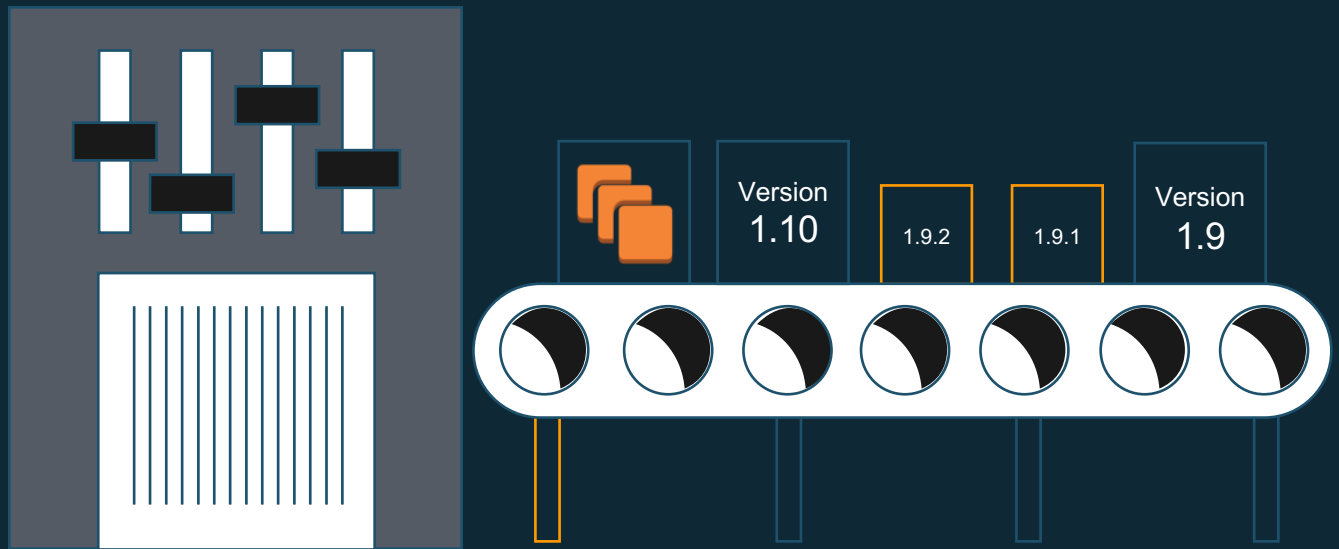
# Kubernetes Upgrades

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# How do I provision EKS Worker Nodes?

HashiCorp
Packer

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# How do I get started?

**eksctl CLI**
**https://eksctl.io**

***CloudFormation, APIs, CLI etc available too**

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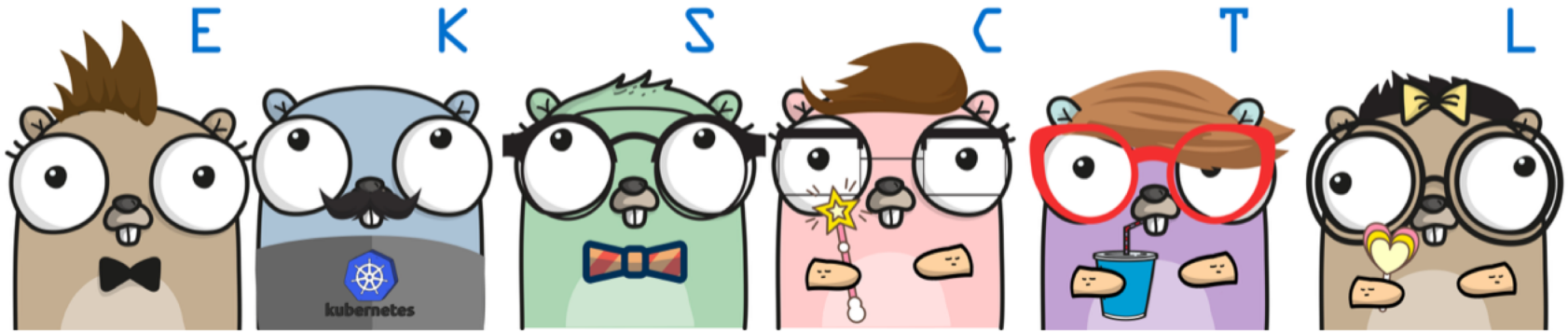
# `eksctl` - a CLI for Amazon EKS

circleci passing | coverage 15% | go report A

`eksctl` is a simple CLI tool for creating clusters on EKS - Amazon's new managed Kubernetes service for EC2. It is written in Go, and based on Amazon's official CloudFormation templates.

You can create a cluster in minutes with just one command – **`eksctl create cluster`**!

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# Kubernetes / AWS integrations

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*AWS Integration:*

# *Identity and Access Management (IAM)*

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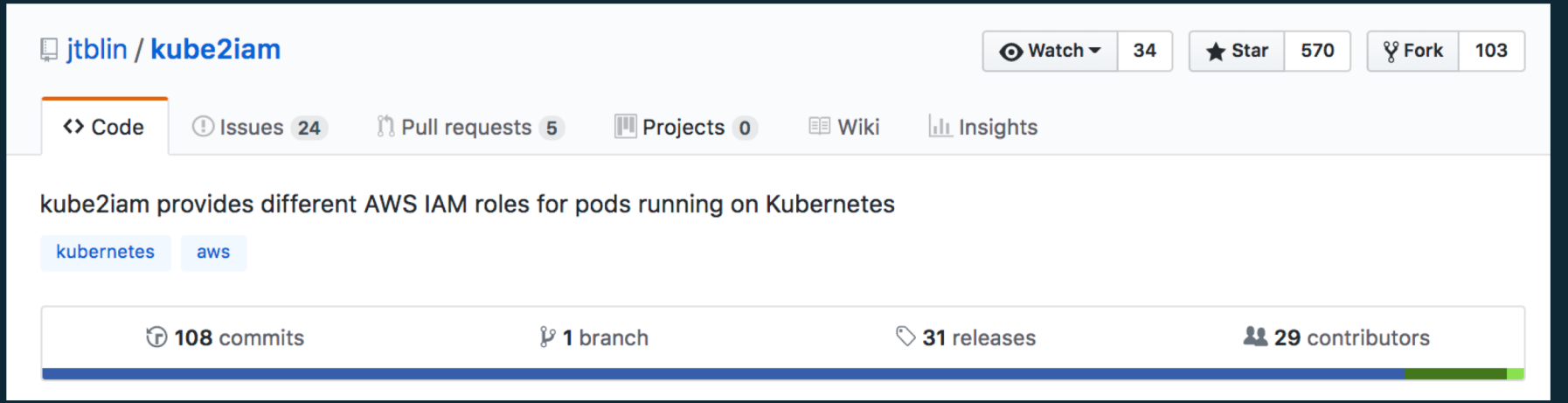
# I want to give a pod permissions to an AWS service




- Runs as a DaemonSet on your workers
- Creates iptables rules to redirect metadata service to kube2iam
- Add annotations to your pods to grant them AWS IAM Roles

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# kube2iam example

```yaml
apiVersion: extensions/v1beta1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  replicas: 3
  template:
    metadata:
      annotations:
        iam.amazonaws.com/role: arn:aws:iam:123567989012/role/nginx-role
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.9.1
        ports:
        - containerPort: 80
```

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# I want to use AWS accounts to operate Kubernetes

An open source approach to integrating
AWS IAM authentication with Kubernetes


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# ~/.kube/config (with IAM)

```
apiVersion: v1
clusters:
- cluster:
    certificate-authority-data: REDACTED
    server: https://F7C341FA2AF732DAC328FB150F48979C.sk1.us-west-2.eks.amazonaws.com
  name: eks
contexts:
- context:
    cluster: eks
    user: eks
  name: eks
current-context: eks
kind: Config
users:
- name: eks
  user:
    exec:
      apiVersion: client.authentication.k8s.io/v1alpha1
      command: heptio-authenticator-aws
      args:
      - token
      - -i
      - <cluster name>
```

Config file is no longer user-specific ☺

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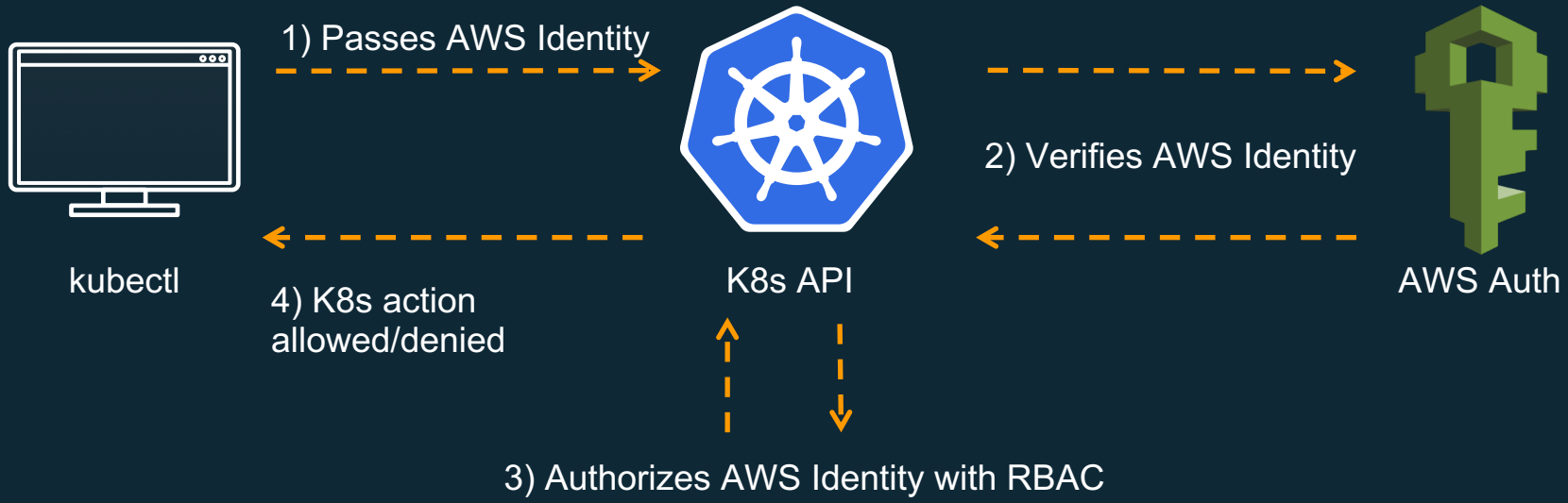
# IAM Authentication with kubectl

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*AWS Integration:*

# *Container Registry: Amazon ECR*

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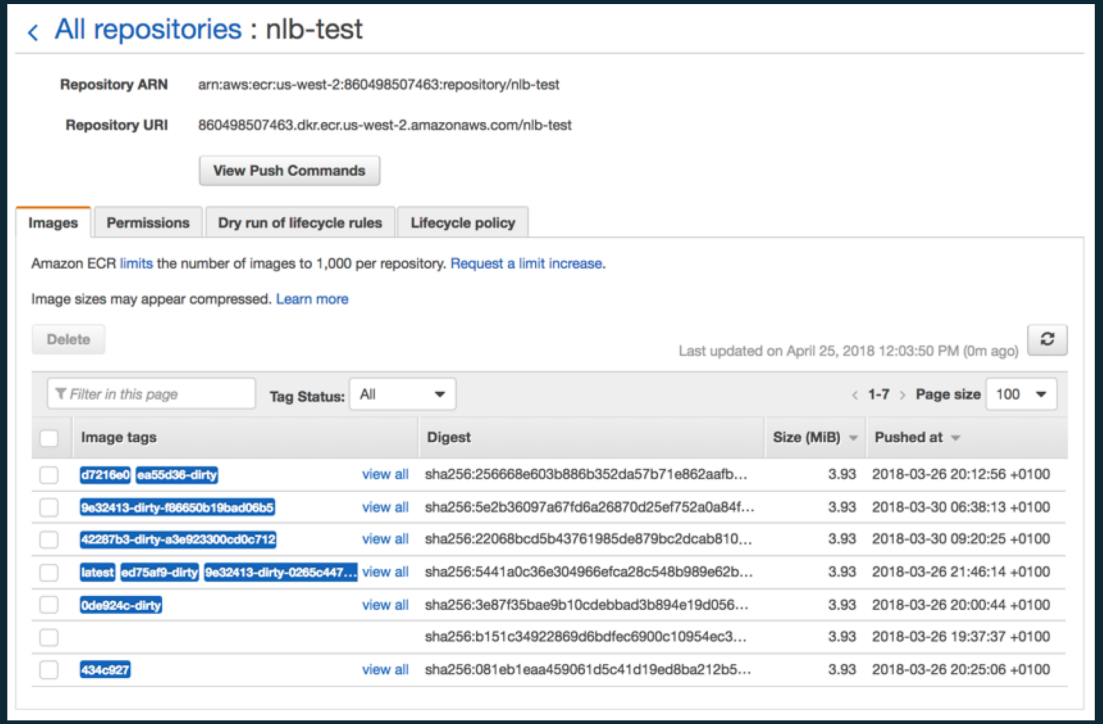
# Amazon ECR




- Simple to create
- High Availability by default
- IAM permissions
- Lifecycle rules
- Encrypted at rest
- Billed on storage

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# *Helm*

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# Helm

- Package manager that allows you to bundle up deployment resources and publish them


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# Using helm

```
❯ helm search nginx
NAME                    CHART VERSION   APP VERSION     DESCRIPTION
stable/nginx-ingress    0.12.3          0.12.0          An nginx Ingress controller that uses ConfigMap...
stable/nginx-lego       0.3.1                           Chart for nginx-ingress-controller and kube-lego
stable/gcloud-endpoints 0.1.0                           Develop, deploy, protect and monitor your APIs ...

❯ helm list
NAME            REVISION        UPDATED                         STATUS          CHART           NAMESPACE
kube2iam        1               Sat Mar 31 20:02:48 2018        DEPLOYED        kube2iam-0.8.3  kube-system

> helm install stable/nginx-ingress --name nginx-ingress --set rbac.create=true

[displays README + information about deployment]

❯ kubectl get services -owide

NAME                            TYPE          CLUSTER-IP      EXTERNAL-IP                                                                 PORT(S)                      AGE     SELECTOR
kubernetes                      ClusterIP     172.20.0.1      <none>                                                                      443/TCP                      8d      <none>
nginx-ingress-controller        LoadBalancer  172.20.23.100   af403dd953b5c11e8a6d20a4d0bdc52d-2083699508.eu-west-1.elb.amazonaws.com     80:30501/TCP,443:30740/TCP   53s     app=nginx-ingress,component=controller,release=nginx-ingress
nginx-ingress-default-backend   ClusterIP     172.20.20.7     <none>                                                                      80/TCP                       53s     app=nginx-ingress,component=default-backend,release=nginx-ingress
```

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# Hosting Helm repositories

- Anywhere that serves HTTP can host a helm repo
- There's a handy plugin for S3!
- This means IAM Role = auth for your repo ☺

- https://github.com/hypnoglow/helm-s3

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*AWS Integration:*

# *Networking*

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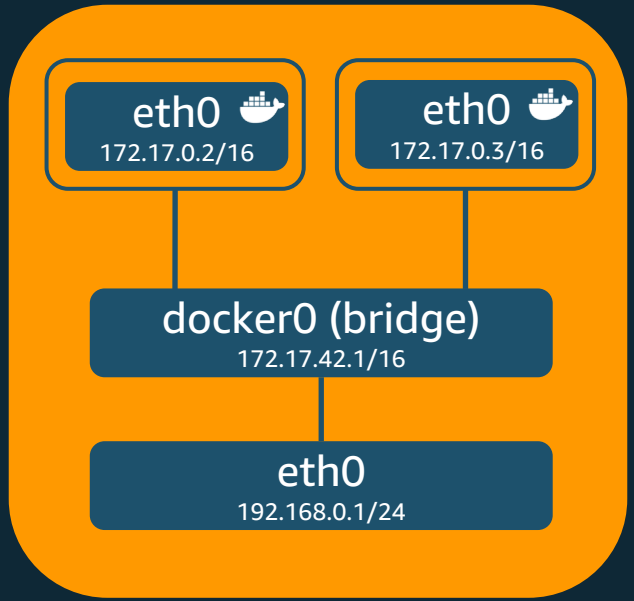
# Docker: Bridged networking




```
$ docker run -p 8080:80 nginx
```

Running a container with ports mapped sets up a NAT with iptables

```
192.168.0.1:80 -> 172.17.0.2:8080
```

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# Docker: Bridged networking


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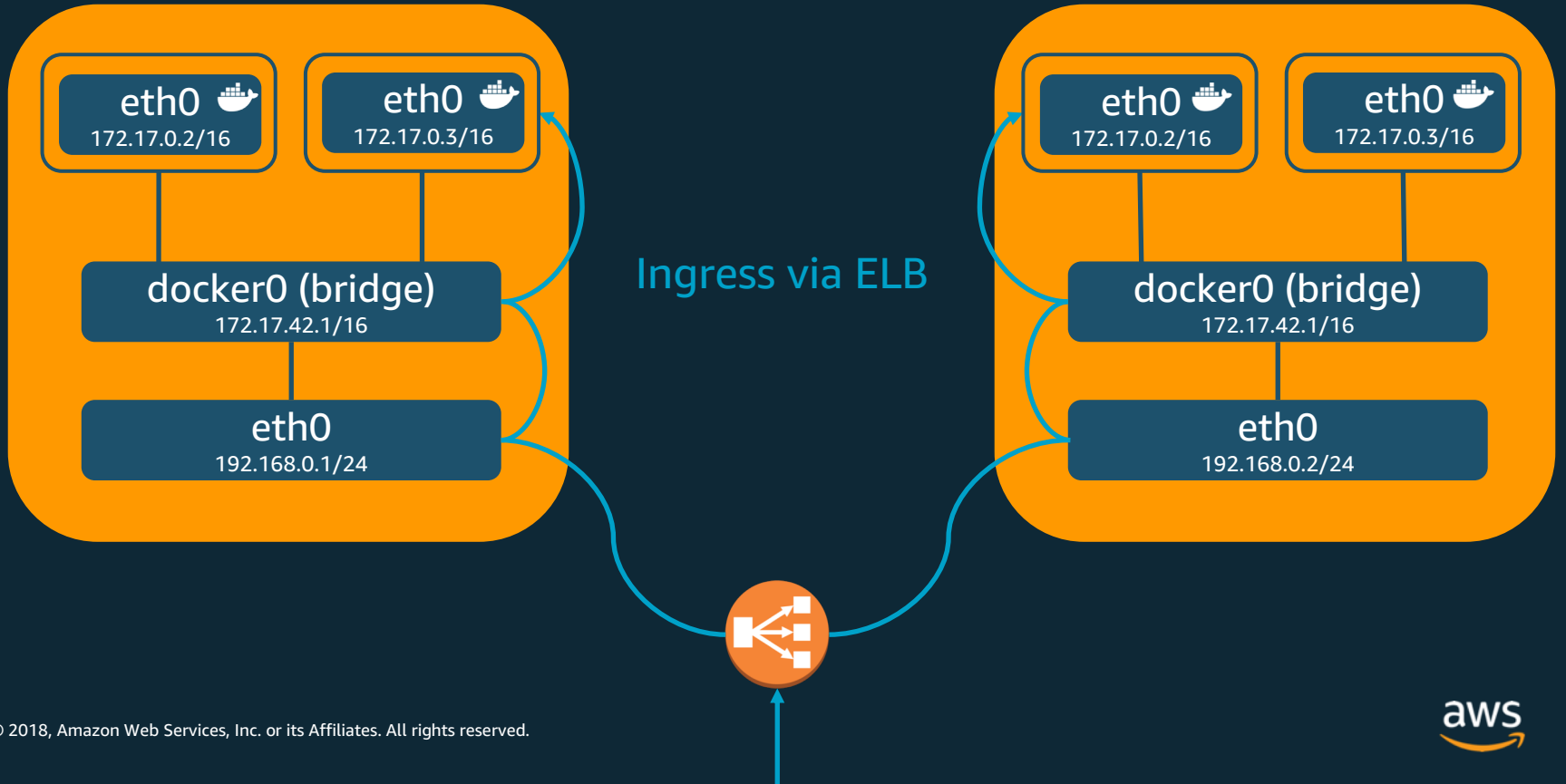
# Docker: Bridged networking

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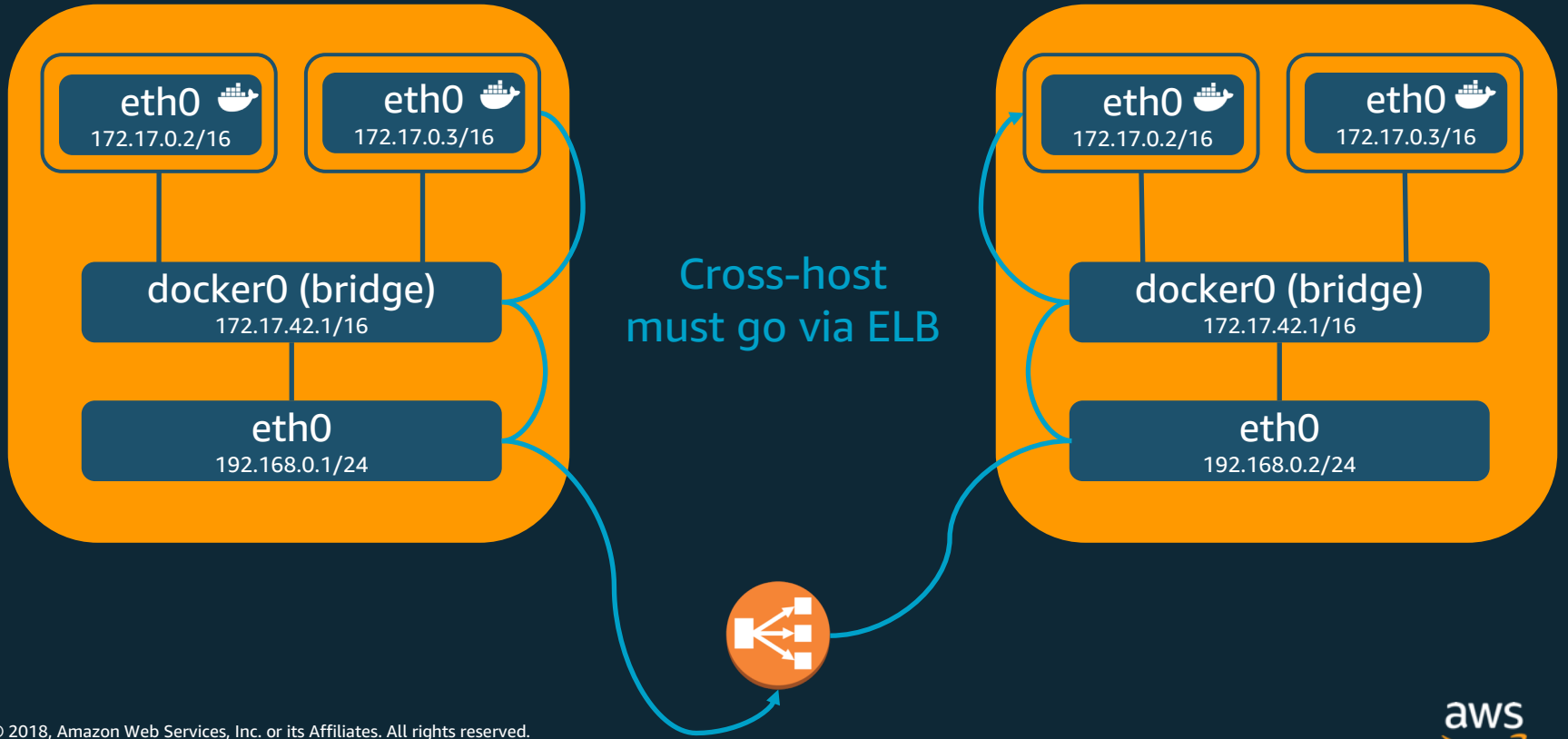
# Docker: Bridged networking

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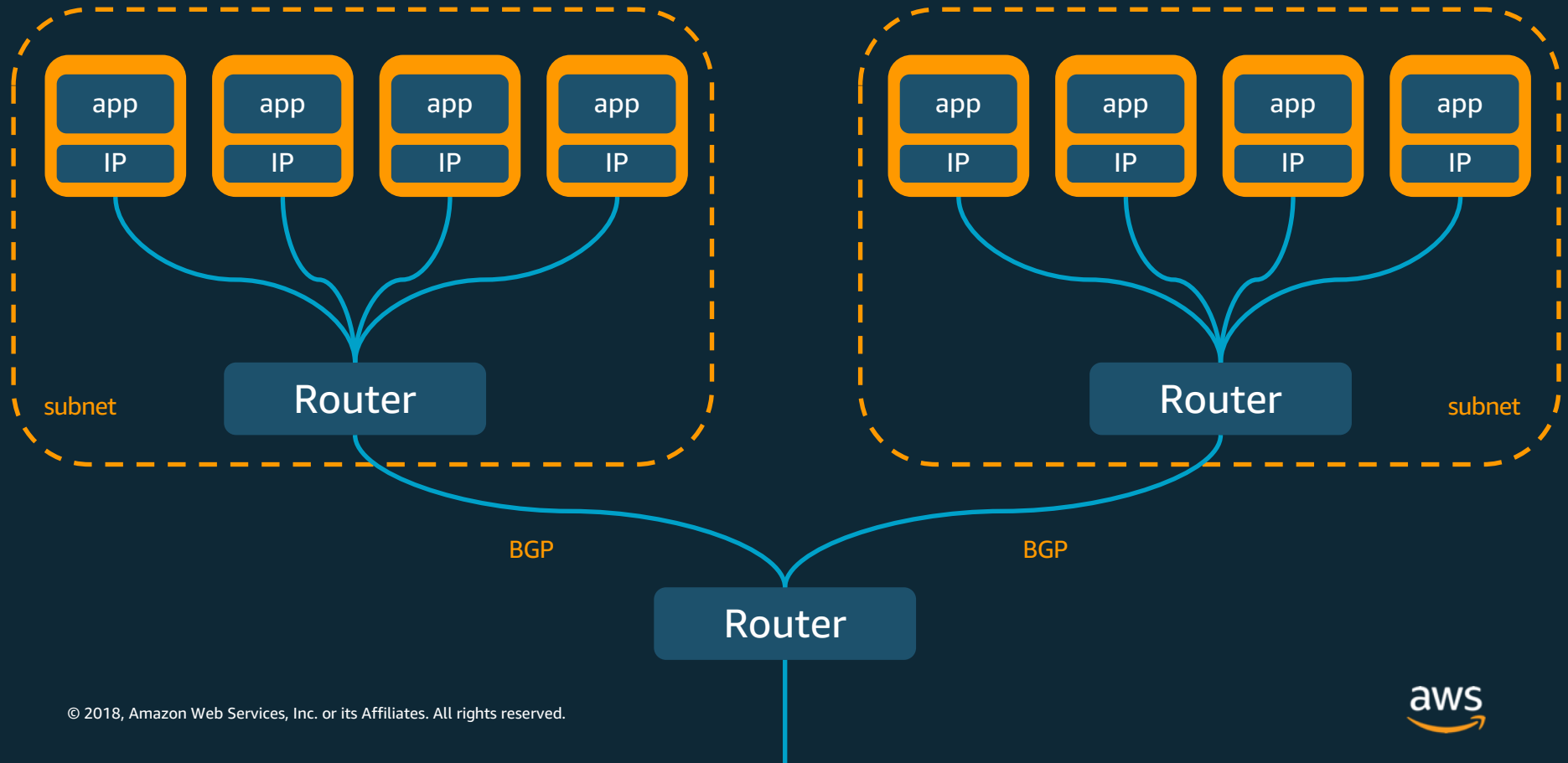
# Back to basics

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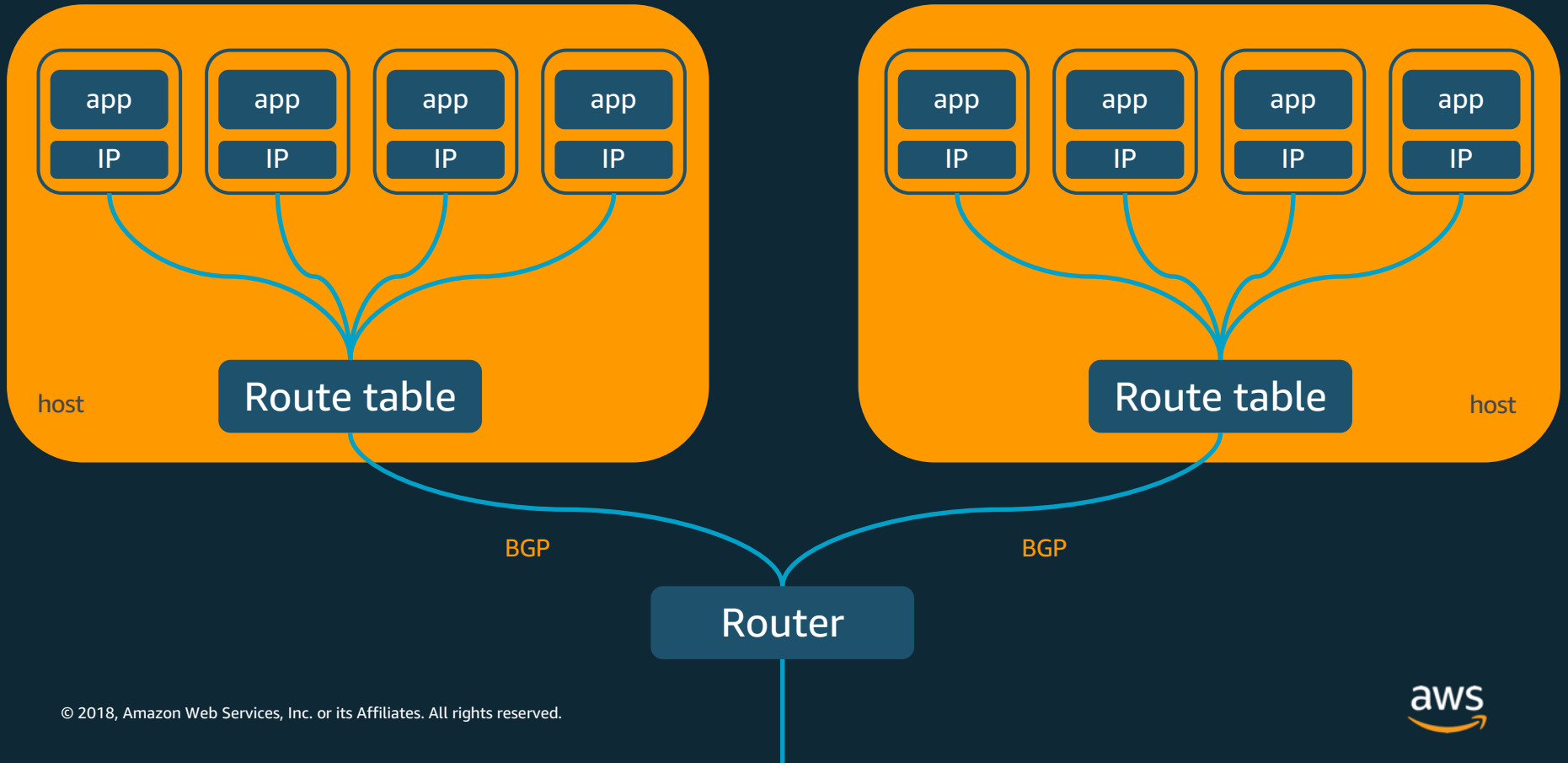
# Kubernetes networking with Calico CNI plugin

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# Kubernetes networking with Calico CNI plugin

- Unlike Docker, there isn't a bridge network*
- All containers can communicate with all other containers without NAT.
- All nodes can communicate with all containers (and vice-versa) without NAT.
- The IP that a container sees itself as is the same IP that others see it as.
- All containers within a pod can access each other on localhost (coordination to avoid conflicts required).

http://blog.mbrt.it/2017-10-01-demystifying-container-networking/
https://kubernetes.io/docs/concepts/cluster-administration/networking/#kubernetes-model

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# A host is connected to the cluster


- Each host gets a network range for containers

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# Some pods are scheduled


- Each host gets a network range for containers
- Each pod gets an IP address in that range
- Now containers on the same host can communicate

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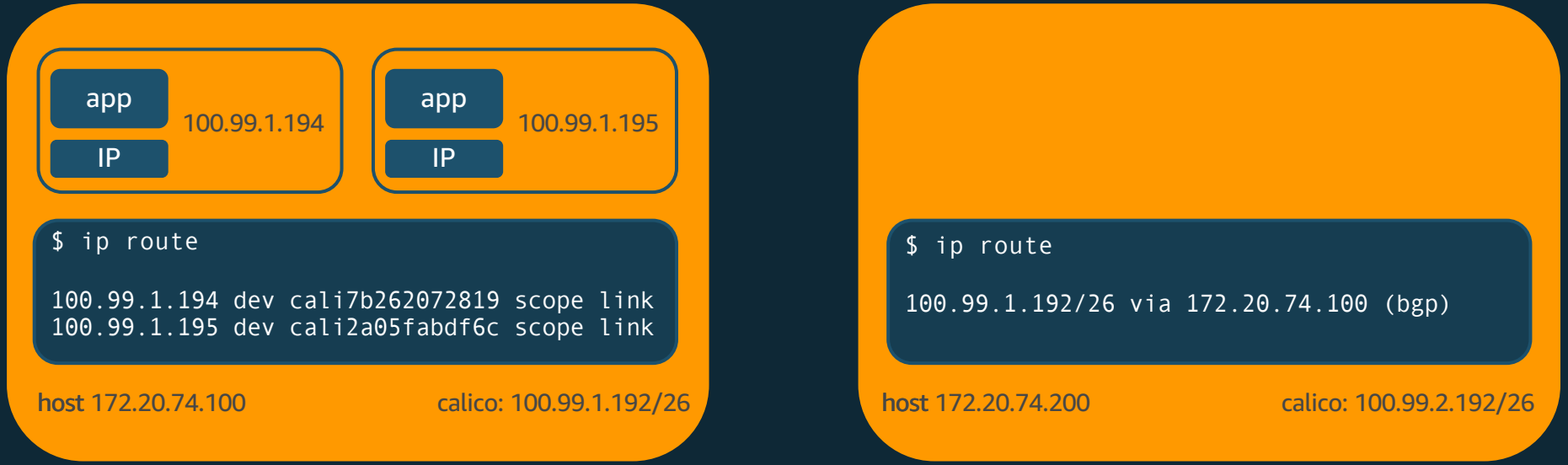
# Routes propagated via BGP




Route for the host's /26 propagated to all other hosts in the cluster via BGP

Cross host networking is now possible ☺

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# But there is an easier way…

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Native VPC networking with CNI plugin

Pods have the same VPC address inside the pod as on the VPC

Simple, secure networking

Open source and on Github

https://github.com/aws/amazon-vpc-cni-k8s

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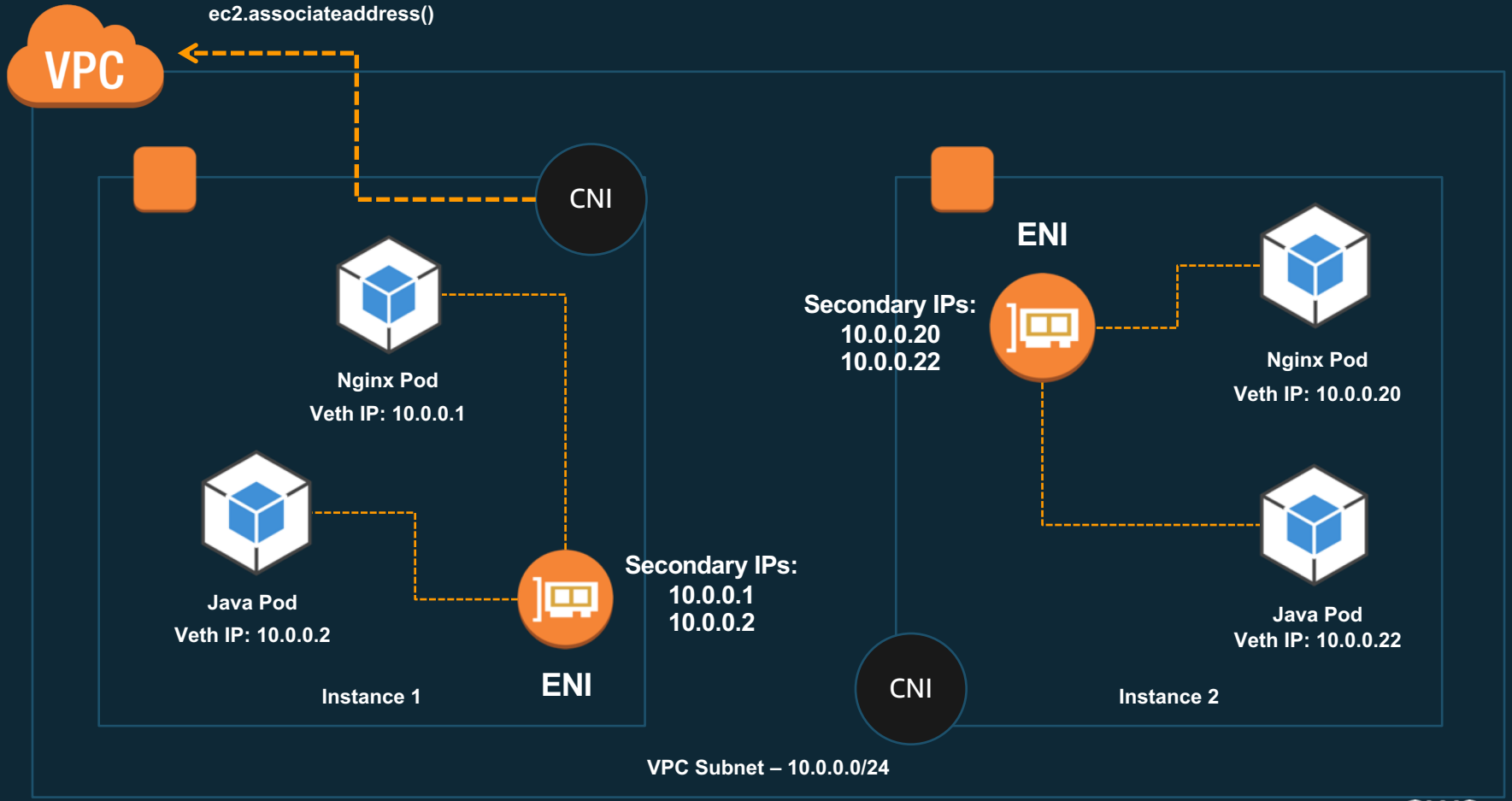


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TIGERA

PROJECT CALICO

Kubernetes Network Policies enforce network security rules

Calico is the leading implementation of the network policy API

Open source, active development (>100 contributors)

Commercial support available from Tigera

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*AWS Integration:*

# *Load Balancers*

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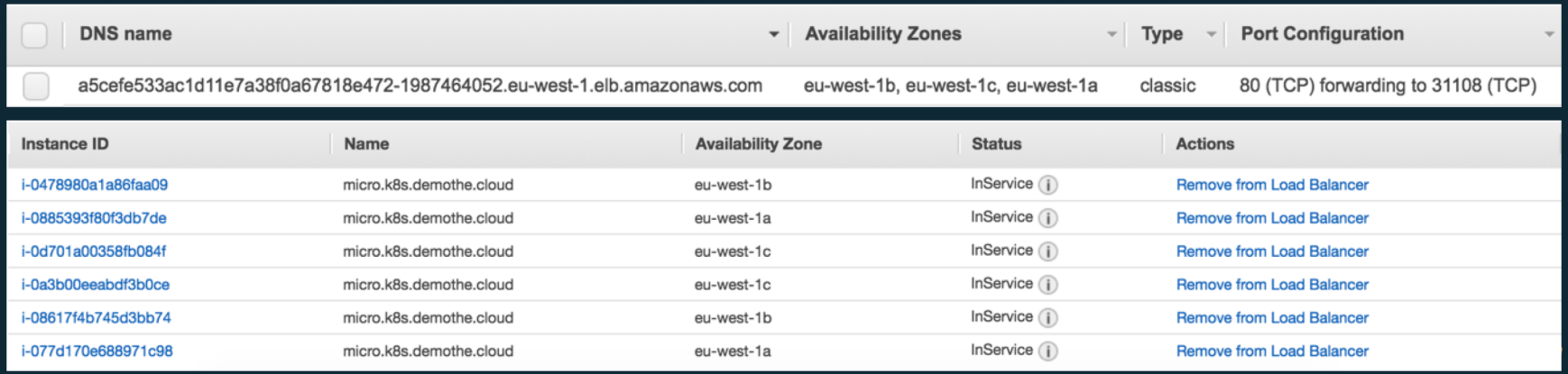
# Services: LoadBalancer

```
$ kubectl run nginx --image=nginx --replicas 3 --port=80
$ kubectl expose deployment nginx --type=LoadBalancer
$ kubectl get services -o=wide
```

```
NAME      TYPE           CLUSTER-IP      EXTERNAL-IP                                                              PORT(S)
nginx     LoadBalancer   100.70.217.164  a5cefe533ac1d11e7a38f0a67818e472-1987464052.eu-west-1.elb.amazonaws.com   80:31108/TCP
```



| DNS name | Availability Zones | Type | Port Configuration |
|---|---|---|---|
| a5cefe533ac1d11e7a38f0a67818e472-1987464052.eu-west-1.elb.amazonaws.com | eu-west-1b, eu-west-1c, eu-west-1a | classic | 80 (TCP) forwarding to 31108 (TCP) |

| Instance ID | Name | Availability Zone | Status | Actions |
|---|---|---|---|---|
| i-0478980a1a86faa09 | micro.k8s.demothe.cloud | eu-west-1b | InService | Remove from Load Balancer |
| i-0885393f80f3db7de | micro.k8s.demothe.cloud | eu-west-1a | InService | Remove from Load Balancer |
| i-0d701a00358fb084f | micro.k8s.demothe.cloud | eu-west-1c | InService | Remove from Load Balancer |
| i-0a3b00eeabdf3b0ce | micro.k8s.demothe.cloud | eu-west-1c | InService | Remove from Load Balancer |
| i-08617f4b745d3bb74 | micro.k8s.demothe.cloud | eu-west-1b | InService | Remove from Load Balancer |
| i-077d170e688971c98 | micro.k8s.demothe.cloud | eu-west-1a | InService | Remove from Load Balancer |

# Configure your load balancers via annotations

```
service.beta.kubernetes.io/ aws-load-balancer-type
service.beta.kubernetes.io/ aws-load-balancer-internal
service.beta.kubernetes.io/ aws-load-balancer-proxy-protocol
service.beta.kubernetes.io/ aws-load-balancer-access-log-emit-interval
service.beta.kubernetes.io/ aws-load-balancer-access-log-enabled
service.beta.kubernetes.io/ aws-load-balancer-access-log-s3-bucket-name
service.beta.kubernetes.io/ aws-load-balancer-access-log-s3-bucket-prefix
service.beta.kubernetes.io/ aws-load-balancer-connection-draining-enabled
service.beta.kubernetes.io/ aws-load-balancer-connection-draining-timeout
service.beta.kubernetes.io/ aws-load-balancer-connection-idle-timeout
service.beta.kubernetes.io/ aws-load-balancer-cross-zone-load-balancing-enabled
service.beta.kubernetes.io/ aws-load-balancer-extra-security-groups
service.beta.kubernetes.io/ aws-load-balancer-ssl-cert
service.beta.kubernetes.io/ aws-load-balancer-ssl-ports
service.beta.kubernetes.io/ aws-load-balancer-ssl-negotiation-policy
service.beta.kubernetes.io/ aws-load-balancer-backend-protocol
service.beta.kubernetes.io/ aws-load-balancer-additional-resource-tags
service.beta.kubernetes.io/ aws-load-balancer-healthcheck-healthy-threshold
service.beta.kubernetes.io/ aws-load-balancer-healthcheck-unhealthy-threshold
service.beta.kubernetes.io/ aws-load-balancer-healthcheck-timeout
service.beta.kubernetes.io/ aws-load-balancer-healthcheck-interval
```

- Draining
- Logging
- SSL Certs
- Tagging
- Security groups
- Health checks

https://github.com/kubernetes/kubernetes/blob/master/pkg/cloudprovider/providers/aws/aws.go

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# Network Load Balancer (layer 4)

```yaml
apiVersion: v1
kind: Service
metadata:
  name: nginx
  namespace: default
  labels:
    app: nginx
  annotations:
    service.beta.kubernetes.io/aws-load-balancer-type: "nlb"
spec:
  type: LoadBalancer
  externalTrafficPolicy: Local
  ports:
  - name: http
    port: 80
    protocol: TCP
    targetPort: 80
  selector:
    app: nginx
```

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# Application Load Balancer (layer 7)

CoreOS ALB Ingress Controller: Supported by AWS

Exposes ALB functionality to Kubernetes via Ingress Resources

Layer 7 load balancing, supports content-based routing by host or path

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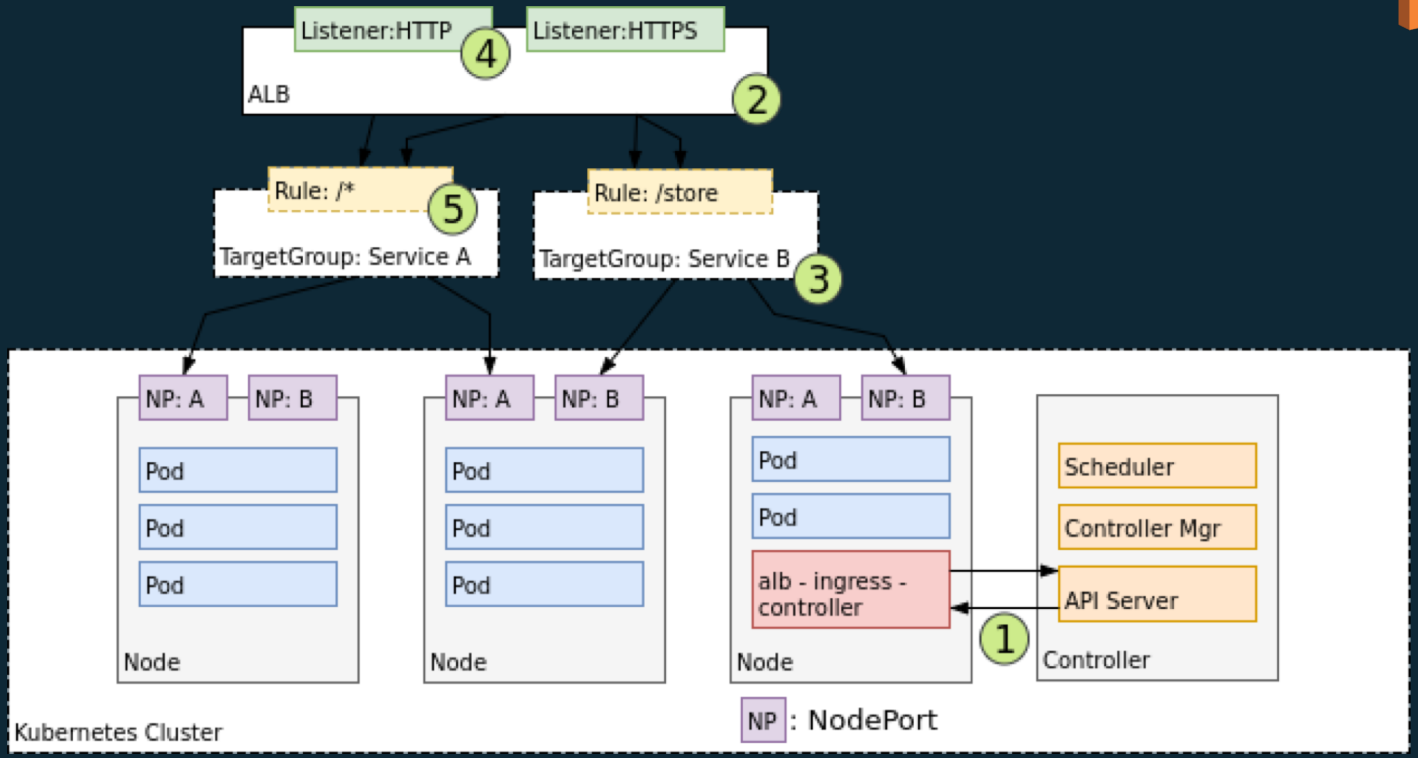
# Load Balancing

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*AWS Integration:*

# *SSL Certificates*

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# FREE SSL certificates with AWS Certificate Manager


- Free SSL certificates
- DNS or email verification
- Automatic rotation!
- Wildcard certs, SAN certs
- Can be applied to AWS Load Balancers, CloudFront distributions and Amazon API Gateway
- Configure certificate for load balanced services/ingress via K8s annotation

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*AWS Integration:*

# *DNS: ExternalDNS*

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# Automatic Route53 DNS creation for services

```
apiVersion: v1
kind: Service
metadata:
  name: nginx
  annotations:
    external-dns.alpha.kubernetes.io/hostname: nginx.demothe.cloud.
spec:
  type: LoadBalancer
  ports:
  - port: 80
    name: http
    targetPort: 80
  selector:
    app: nginx
```

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# …works with ingress too

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: nginx
  annotations:
    kubernetes.io/ingress.class: "nginx"
spec:
  rules:
  - host: nginx.demothe.cloud
    http:
      paths:
      - backend:
          serviceName: nginx
          servicePort: 80
```

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*AWS Integration:*

# *Deployment of other AWS resources*

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# Controllers and Operators

- Controllers in Kubernetes are containers that watch for events, and react to them.
- For example, when a new resource of type xyz is created, speak to the external xyz API and create it
- Operators extend controllers, to add in additional "operations" tasks, such as backups, restores etc

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# Etcd Operator

## Overview

The etcd operator manages etcd clusters deployed to Kubernetes and automates tasks related to operating an etcd cluster.

- Create and Destroy
- Resize
- Failover
- Rolling upgrade
- Backup and Restore

There are more spec examples on setting up clusters with different configurations

Read Best Practices for more information on how to better use etcd operator.

Read RBAC docs for how to setup RBAC rules for etcd operator if RBAC is in place.

Read Developer Guide for setting up a development environment if you want to contribute.

See the Resources and Labels doc for an overview of the resources created by the etcd-operator.

https://github.com/coreos/etcd-operator

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# What about deploying other AWS resources

There's an operator for that!

https://github.com/linki/cloudformation-operator

Defines a Custom Resource Definition (CRD) for 'stacks'.

Paste CloudFormation templates into your Kubernetes YAML files, and let the operator deploy/update/manage them for you.

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# Deploying AWS resources with K8s

```
apiVersion: cloudformation.linki.space/v1alpha1
kind: Stack
metadata:
  name: my-bucket
spec:
  template: |
    ---
    AWSTemplateFormatVersion: '2010-09-09'

    Resources:
      S3Bucket:
        Type::AWS::S3::Bucket
        Properties:
          BucketName: my-bucket
```

Deploy AWS resources right from your K8s YAML files.

User's don't need AWS permissions, the IAM Role for the host(s) running the operator do.

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# To summarise

- Amazon EKS is Kubernetes Compliant, bakes in best practices and allows you to easily create production-ready clusters in minutes.
- Lots of awesome integrations, but all are open source, and not limited to just Amazon EKS
- Open source Kubernetes == Amazon EKS Kubernetes v1.11

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# Thank you!

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