Docker and Kubernetes

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Docker

Docker

- A portable store of a single component and its dependencies
- Not a VM
- Boots in under a second

Docker Hub

Docker Hub

- Like GitHub but for containers.
- Default registry.
- Can have your own Docker registries.
- Amazon offers Elastic Cloud Registry (ECR).

Docker Hub: Common Images

- `debian`
- `alpine`
- `nginx`
- `redis`
- `erlang`
- `elixir`

Container Versions

From official Elixir container:

- `1.10.2,1.10,latest`
- `1.10.2-slim,1.10-slim, slim`
- `1.10.2-alpine,1.10-alpine,alpine`
- `1.9.4,1.9`
- `1.9.4-slim,1.9-slim`
- `1.9.4-alpine,1.9-alpine`

Image Variants

- Default images typically use Debian.
- Slim images have only minimal dependencies included.
- Alpine images are also small but include Busybox.
- Busybox includes common CLI commands with minified functionality.

Dockerfile

Dockerfile

- Repeatable set of instructions to make a container.
- Each command is a layer.
- When rebuiling, previous layers don't need to run if nothing changes.
- Can include more than one image for multi-stage builds.

Dockerfile Example

Dockerfile: Part 1/4

```
# The version of Alpine to use for the final image
# This should match the version of Alpine that the `elixir:1.10-alpine` image uses
ARG ALPINE_VERSION=3.11

FROM elixir:1.10-alpine AS builder

# Private hex.pm key
ARG HEX_KEY

# By convention, /opt is typically used for applications
WORKDIR /opt/app

# This step installs all the build tools we'll need
RUN apk update && \
  apk upgrade --no-cache && \
  apk add --no-cache \
    git \
    build-base && \
  mix local.rebar --force && \
  mix local.hex --force
```

Dockerfile: Part 2/4

```
# Cache the dependency fetching
COPY mix.exs mix.exs
COPY mix.lock mix.lock
COPY VERSION VERSION

RUN mix hex.organization auth tubitv --key $HEX_KEY
RUN mix deps.get
RUN MIX_ENV=test mix deps.compile

COPY lib lib
COPY test test

RUN mix test
```

Dockerfile: Part 3/4

```
RUN MIX_ENV=prod mix deps.compile
RUN MIX_ENV=prod mix compile

ENV MIX_ENV=prod

RUN \
  mkdir -p /opt/built && \
  mix release && \
  cp _build/${MIX_ENV}/*.tar.gz /opt/built/built.tar.gz && \
  cd /opt/built && \
  tar -xzf *.tar.gz && \
  rm *.tar.gz
```

Dockerfile: Part 4/4

```
# From this line onwards, we're in a new image, which will be the image used in production
FROM alpine:${ALPINE_VERSION}

RUN apk update && \
    apk add --no-cache \
    bash \
    openssl-dev

WORKDIR /opt/app

COPY --from=builder /opt/built .

EXPOSE 18001

CMD /opt/app/bin/crm start
```

Why Multi-stage Builds?

- Building code requires toolchains and other dependencies.
- These aren't needed when running the build artifacts.
- Especially true when bundling the Erlang VM.
- Smaller, faster containers.
- Smaller attack surface.

```
$ docker build --build-arg HEX_KEY='REDACTED' -t crm -f docker_crm/Dockerfile .

$ docker images
REPOSITORY    TAG                 IMAGE ID            CREATED             SIZE
crm           latest              a28e197ebd00        10 minutes ago      24.1MB
<none>        <none>              6d44057c3e65        10 minutes ago      335MB
```

Kubernetes

Kubernetes

- Open source container-orchestration system built by Google.
- Greek for "helmsman" or "pilot"
- Often called k8s (k-eight letters-s)

Terminology

Pods

- A collection of containers and volumes.
- Typcially one container per pod.
- All containers in a pod share an IP address.
- Erlang's EPMD has problems with multiple containers per volume.
- Planned to fix in future version of Erlang.

Pods

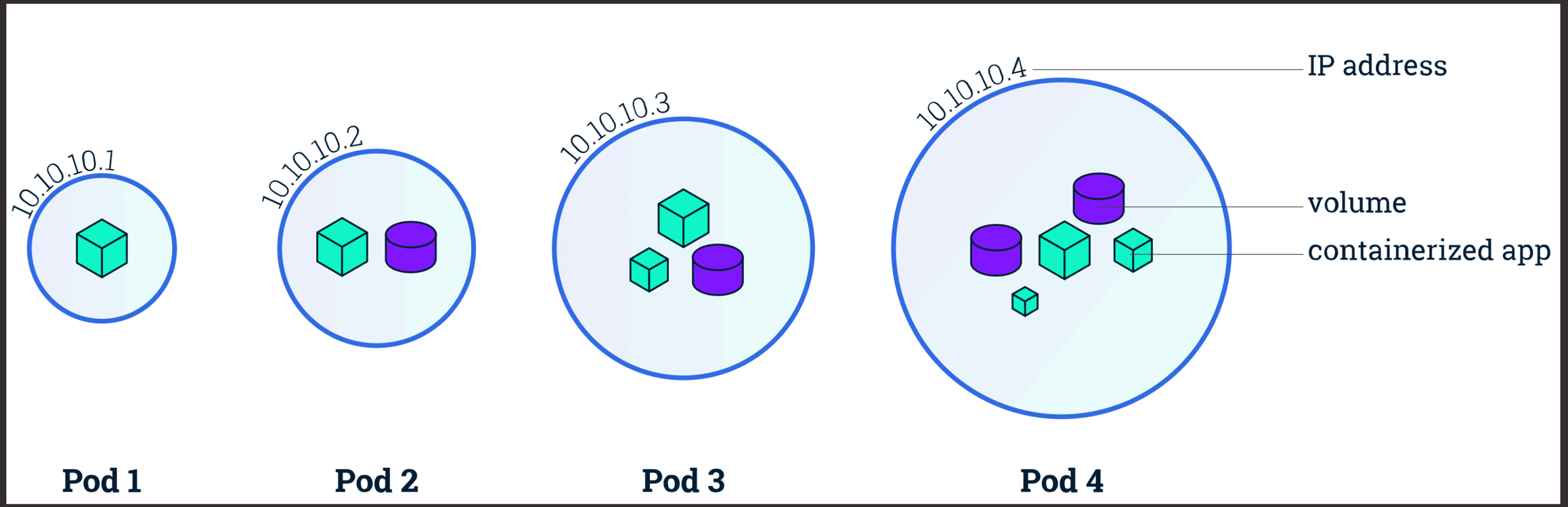


Image: https://kubernetes.io/docs/tutorials/kubernetes-basics/explore/explore-intro/

Node

- A worker machine in the cluster
- Runs pods
- May be physical or virtual
- Runs Kubelet to communicate with Kubernetes Master
- Run a container runtime (ex. Docker, rkt)

Node

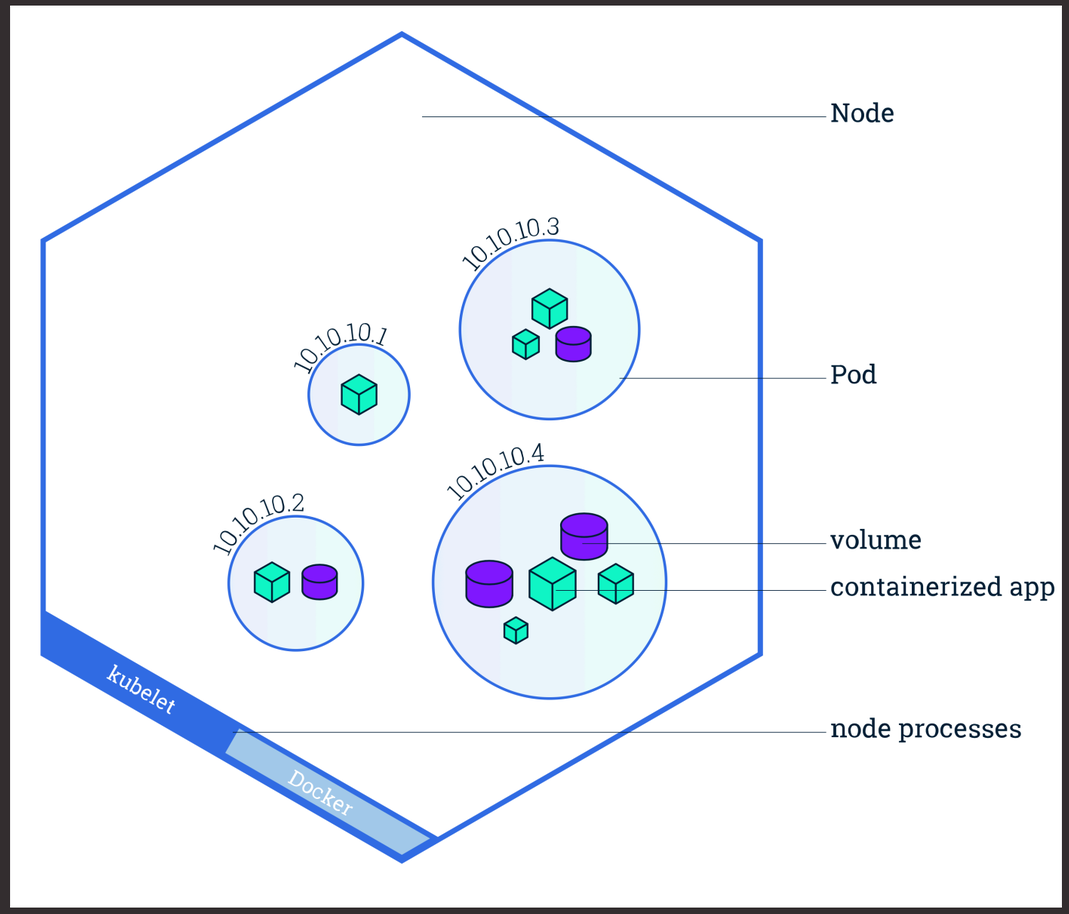


Image: https://kubernetes.io/docs/tutorials/kubernetes-basics/explore/explore-intro/

Replica Sets

- Maintains a stable set of pods.

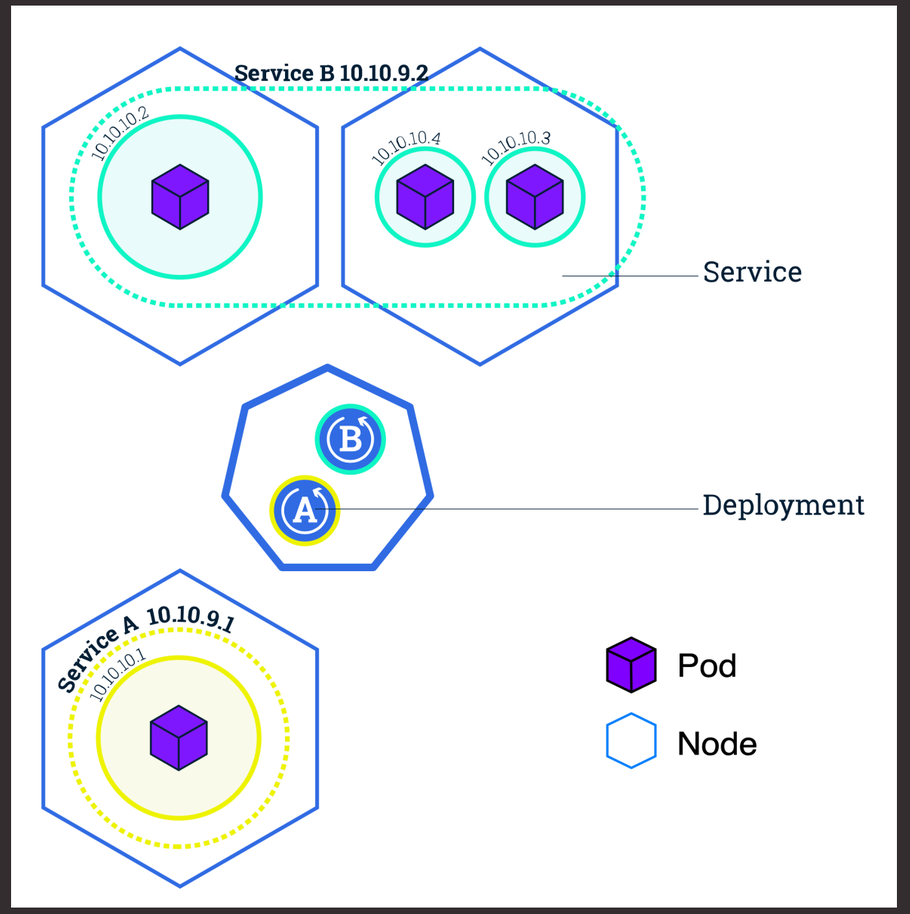
Deployment

- Controls and updates pods and replica sets.
- Prefered to working with pods and replica sets directly.
- Allows for rolling back to a previous deployment.

Service

- A logical set of pods and a policy by which to access them.
- Publicly exposes a pod or deployment.
- Balances load between pods.

Service



https://kubernetes.io/docs/tutorials/kubernetes-basics/expose/expose-intro/

Namespaces

- A logical grouping of resources.
- When a namespace is deleted, so is everything in the namespace.
- Great for ensuring everything is cleaned up.

Configuration

Configuration Options

- YAML (preferred)
- JSON
- `kubectl`

Example: Namespace

```yaml
apiVersion: v1
kind: Namespace
metadata:
  name: crm
```

Example: Pod

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: crm-pod
  labels:
    app: crm-pod
spec:
  containers:
    - name: crm-pod
      image: crm
      ports:
        - containerPort: 18001
```

Example: Service

```yaml
apiVersion: v1
kind: Service
metadata:
  name: crm-node
spec:
  type: NodePort
  ports:
  - port: 18001
    protocol: TCP
    targetPort: 18001
    nodePort: 30080
  selector:
    app: crm-node
```

Demo

Create Deployment

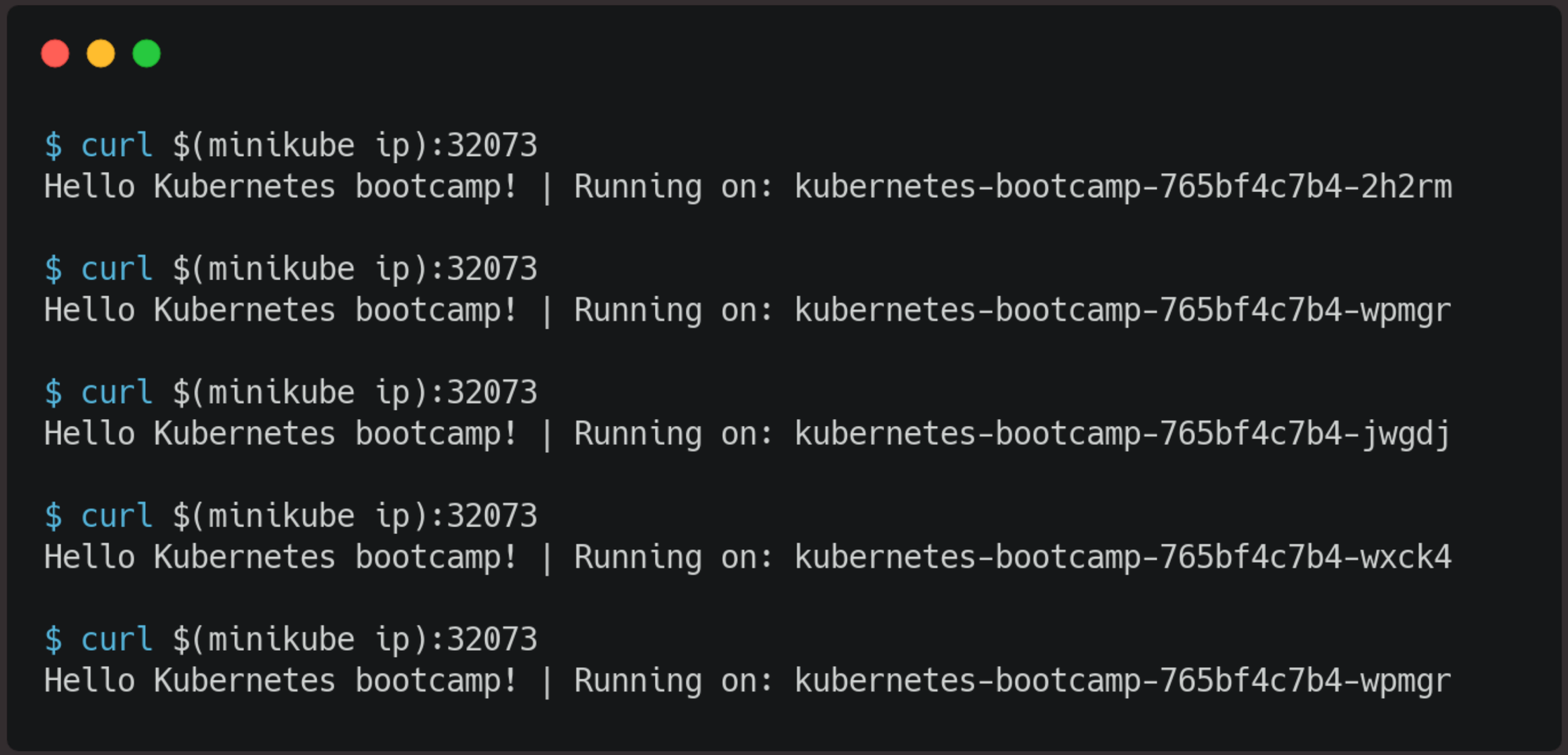
```
$ kubectl get nodes
NAME       STATUS   ROLES    AGE   VERSION
minikube   Ready    master   19s   v1.17.3

$ kubectl create deployment kubernetes-bootcamp --image=gcr.io/google-
samples/kubernetes-bootcamp:v1
deployment.apps/kubernetes-bootcamp created

$ kubectl get deployments
NAME                  READY   UP-TO-DATE   AVAILABLE   AGE
kubernetes-bootcamp   1/1     1            1           10s

$ kubectl get replicasets
NAME                             DESIRED   CURRENT   READY   AGE
kubernetes-bootcamp-69fbc6f4cf   1         1         1       76s

$ kubectl get pods
NAME                                   READY   STATUS    RESTARTS   AGE
kubernetes-bootcamp-69fbc6f4cf-4kp5l   1/1     Running   0          91s
```

Create Service

```
$ kubectl expose deployment/kubernetes-bootcamp --type="NodePort" --port 8080
service/kubernetes-bootcamp exposed

$ kubectl get services
NAME                  TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)          AGE
kubernetes            ClusterIP   10.96.0.1      <none>        443/TCP          28s
kubernetes-bootcamp   NodePort    10.102.72.34   <none>        8080:32073/TCP   15s

$ curl $(minikube ip):32073
Hello Kubernetes bootcamp! | Running on: kubernetes-bootcamp-765bf4c7b4-hzrmd
```

Scale Up

```
$ kubectl scale deployments/kubernetes-bootcamp --replicas=4
deployment.apps/kubernetes-bootcamp scaled

$ kubectl get replicasets
NAME                                DESIRED   CURRENT   READY   AGE
kubernetes-bootcamp-765bf4c7b4      4         4         4       104s

$ kubectl get pods
NAME                                      READY   STATUS    RESTARTS   AGE
kubernetes-bootcamp-765bf4c7b4-2h2rm      1/1     Running   0          13s
kubernetes-bootcamp-765bf4c7b4-jwgdj      1/1     Running   0          13s
kubernetes-bootcamp-765bf4c7b4-wpmgr      1/1     Running   0          13s
kubernetes-bootcamp-765bf4c7b4-wxck4      1/1     Running   0          104s
```


$ curl $(minikube ip):32073
Hello Kubernetes bootcamp! | Running on: kubernetes-bootcamp-765bf4c7b4-2h2rm
$ curl $(minikube ip):32073
Hello Kubernetes bootcamp! | Running on: kubernetes-bootcamp-765bf4c7b4-wpmgr
$ curl $(minikube ip):32073
Hello Kubernetes bootcamp! | Running on: kubernetes-bootcamp-765bf4c7b4-jwgdj
$ curl $(minikube ip):32073
Hello Kubernetes bootcamp! | Running on: kubernetes-bootcamp-765bf4c7b4-wxck4
$ curl $(minikube ip):32073
Hello Kubernetes bootcamp! | Running on: kubernetes-bootcamp-765bf4c7b4-wpmgr

Scale Down

```
$ kubectl scale deployments/kubernetes-bootcamp --replicas=2
deployment.apps/kubernetes-bootcamp scaled

$ kubectl get deployments
NAME                  READY   UP-TO-DATE   AVAILABLE   AGE
kubernetes-bootcamp   2/2     2            2           2m44s

$ kubectl get pods
NAME                                  READY   STATUS        RESTARTS   AGE
kubernetes-bootcamp-765bf4c7b4-5zvvx  1/1     Terminating   0          2m11s
kubernetes-bootcamp-765bf4c7b4-hhhjz  1/1     Running       0          2m58s
kubernetes-bootcamp-765bf4c7b4-rwmqc  1/1     Terminating   0          2m11s
kubernetes-bootcamp-765bf4c7b4-z8jm4  1/1     Running       0          2m11s

$ kubectl get pods
NAME                                  READY   STATUS    RESTARTS   AGE
kubernetes-bootcamp-765bf4c7b4-hhhjz  1/1     Running   0          3m20s
kubernetes-bootcamp-765bf4c7b4-z8jm4  1/1     Running   0          2m33s
```

Autoscale

```
$ kubectl autoscale deployment/kubernetes-bootcamp --min=2 --max=10 --cpu-
percent=70
horizontalpodautoscaler.autoscaling/kubernetes-bootcamp autoscaled

$ kubectl get deployments
NAME                  READY   UP-TO-DATE   AVAILABLE   AGE
kubernetes-bootcamp   2/2     2            2           2m58s

$ kubectl get replicasets
NAME                             DESIRED   CURRENT   READY   AGE
kubernetes-bootcamp-765bf4c7b4   2         2         2       3m

$ kubectl get pods
NAME                                   READY   STATUS    RESTARTS   AGE
kubernetes-bootcamp-765bf4c7b4-nqf8w   1/1     Running   0          84s
kubernetes-bootcamp-765bf4c7b4-psszr   1/1     Running   0          3m5s
```

Update Container

```
$ kubectl set image deployments/kubernetes-bootcamp kubernetes-
bootcamp=jocatalin/kubernetes-bootcamp:v2
deployment.apps/kubernetes-bootcamp image updated

$ kubectl get pods
NAME                                   READY   STATUS              RESTARTS   AGE
kubernetes-bootcamp-765bf4c7b4-kcfz2   1/1     Running             0          4m
kubernetes-bootcamp-765bf4c7b4-p95kp   1/1     Terminating         0          4m
kubernetes-bootcamp-765bf4c7b4-pc2cp   1/1     Terminating         0          4m
kubernetes-bootcamp-765bf4c7b4-z9g95   1/1     Terminating         0          4m
kubernetes-bootcamp-7d6f8694b6-g287r   0/1     ContainerCreating   0          1s
kubernetes-bootcamp-7d6f8694b6-ksh4j   0/1     ContainerCreating   0          1s
kubernetes-bootcamp-7d6f8694b6-pjvk8   1/1     Running             0          4s
kubernetes-bootcamp-7d6f8694b6-t2s8q   1/1     Running             0          4s

$ kubectl get pods
NAME                                   READY   STATUS    RESTARTS   AGE
kubernetes-bootcamp-7d6f8694b6-g287r   1/1     Running   0          55s
kubernetes-bootcamp-7d6f8694b6-ksh4j   1/1     Running   0          55s
kubernetes-bootcamp-7d6f8694b6-pjvk8   1/1     Running   0          58s
kubernetes-bootcamp-7d6f8694b6-t2s8q   1/1     Running   0          58s
```

Rollback

```
$ kubectl set image deployments/kubernetes-bootcamp kubernetes-
bootcamp=gcr.io/google-samples/kubernetes-bootcamp:v10
deployment.apps/kubernetes-bootcamp image updated

$ kubectl get pods
NAME                                   READY   STATUS             RESTARTS   AGE
kubernetes-bootcamp-7d6f8694b6-g287r   1/1     Running            0          92s
kubernetes-bootcamp-7d6f8694b6-ksh4j   1/1     Terminating        0          92s
kubernetes-bootcamp-7d6f8694b6-pjvk8   1/1     Running            0          95s
kubernetes-bootcamp-7d6f8694b6-t2s8q   1/1     Running            0          95s
kubernetes-bootcamp-886577c5d-2zlt9    0/1     ImagePullBackOff   0          5s
kubernetes-bootcamp-886577c5d-rsxmp    0/1     ErrImagePull       0          5s
```

```
$ kubectl rollout undo deployments/kubernetes-bootcamp
deployment.apps/kubernetes-bootcamp rolled back

$ kubectl get pods
NAME                                   READY   STATUS              RESTARTS   AGE
kubernetes-bootcamp-7d6f8694b6-fj2md   0/1     ContainerCreating   0          2s
kubernetes-bootcamp-7d6f8694b6-g287r   1/1     Running             0          2m
kubernetes-bootcamp-7d6f8694b6-pjvk8   1/1     Running             0          2m
kubernetes-bootcamp-7d6f8694b6-t2s8q   1/1     Running             0          2m
kubernetes-bootcamp-886577c5d-2zlt9    0/1     Terminating         0          73s
kubernetes-bootcamp-886577c5d-rsxmp    0/1     Terminating         0          73s

$ kubectl get pods
NAME                                   READY   STATUS    RESTARTS   AGE
kubernetes-bootcamp-7d6f8694b6-fj2md   1/1     Running   0          24s
kubernetes-bootcamp-7d6f8694b6-g287r   1/1     Running   0          3m2s
kubernetes-bootcamp-7d6f8694b6-pjvk8   1/1     Running   0          3m5s
kubernetes-bootcamp-7d6f8694b6-t2s8q   1/1     Running   0          3m5s
```

Questions?

Resources

- Best practices for writing Dockerfiles
- Docker multi-stage builds
- Learn Kubernetes Basics