Chapter 6: Kubernetes for Continuous Integration

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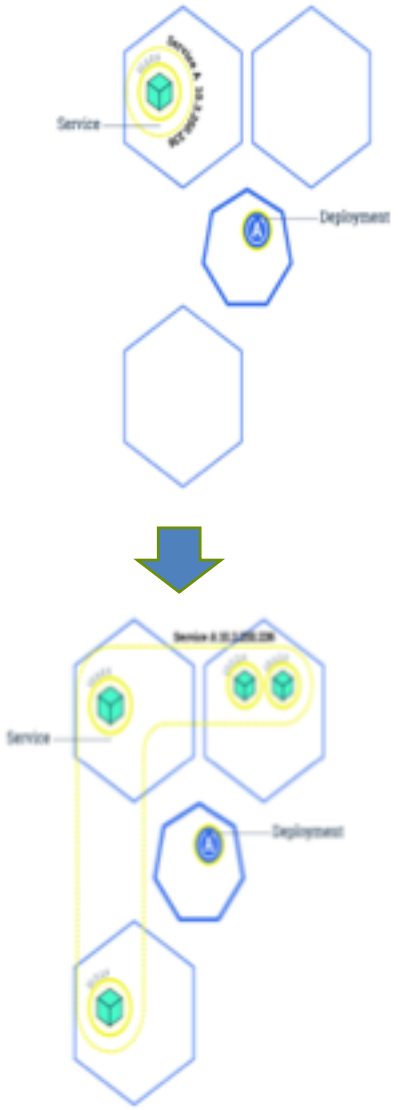
Zero Downtime Scaling

Kubernetes: Scaling

Changing the number of resources to meet a desired state

- Accomplished by adjusting the number of replicas in a deployment
- Accommodates both scaling up and scaling down to a minimum of 0
- Traffic is automatically sent to newly created instances through the service load balancer
- Can be used to enable rolling updates without downtime



$ kubectl scale deployments/<deployment> --replicas=<new num>

$ kubectl scale deploy/nginx --replicas=4

```
peter@Azure:~$ kubectl run nginx --image nginx --port 80
deployment "nginx" created
peter@Azure:~$
peter@Azure:~$ kubectl get deployments
NAME      DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
nginx     1         1         1            1           39s
peter@Azure:~$ kubectl scale deployments/nginx --replicas=2
deployment "nginx" scaled
peter@Azure:~$ kubectl get deployments
NAME      DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
nginx     2         2         2            1           1m
```

Note: Make sure to delete the deployments or replicasets when trying to clear out pods. Many a new user has repeated deleted pods and gotten frustrated when they respawn (as the deployments/replicasets are programed to do).

```
root@ip-172-31-0-112:~/code# kubectl run nginx --image nginx --port 80
deployment.apps/nginx created
root@ip-172-31-0-112:~/code#
root@ip-172-31-0-112:~/code# kubectl get deployments
NAME               DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
nginx              1         1         1            1           8s
nginx-deployment   3         3         3            3           17m
redis              1         1         1            1           33m
root@ip-172-31-0-112:~/code#
root@ip-172-31-0-112:~/code# kubectl scale deployments/nginx --replicas=3
deployment.extensions/nginx scaled
root@ip-172-31-0-112:~/code# kubectl get deployments
NAME               DESIRED   CURRENT   UP-TO-DATE   AVAILABLE   AGE
nginx              3         3         3            3           34s
nginx-deployment   3         3         3            3           18m
redis              1         1         1            1           33m
root@ip-172-31-0-112:~/code# kubectl get pods
NAME                                READY     STATUS    RESTARTS   AGE
nginx-6f858d4d45-b4cv2              1/1       Running   0          42s
nginx-6f858d4d45-g42mg              1/1       Running   0          16s
nginx-6f858d4d45-l69jv              1/1       Running   0          16s
nginx-apparmor                      1/1       Running   0          30m
nginx-deployment-67594d6bf6-7v5lk   1/1       Running   0          12m
nginx-deployment-67594d6bf6-fdqx2   1/1       Running   0          18m
nginx-deployment-67594d6bf6-sx62p   1/1       Running   0          18m
redis-7869f8966-sq8xm               1/1       Running   0          33m
```

Autoscaling and HPA (Horizontal Pod Autoscaler)

Kubernetes: Pod Auto Scaling

HPA – Horizontal Pod Autoscaler:

Based on memory and CPU utilization by a pod, autoscaling scales up or down the number of pods

$ kubectl autoscale deployment nginx --min=2 --max=10

$ kubectl autoscale deployment nginx-deployment --max=5 --cpu-percent=80

$ kubectl get hpa

$ kubectl get hpa

NAME	REFERENCE	TARGETS	MINPODS	MAXPODS	REPLICAS	AGE
nginx	Deployment/nginx	<unknown>/80%	1	4	3	12m
nginx-deployment	Deployment/nginx-deployment	<unknown>/80%	2	5	0	5s

Kubernetes: Cluster AutoScaler

Adds or removes *Nodes* in a *Cluster* based on resource requests from *Pods and to meet workloads*

Possible only in cloud:

AWS, GCE, Azure, etc.

When does auto scale up kicked in?

- Pods not getting scheduled and # nodes within user-defined limit

Kubernetes: Cluster AutoScaler

When does auto scale down kicked in?

- Pod requests on a node lower than a user-defined threshold
- Checks performed on each pod in the node
  - Pod runs a DaemonSet – it's safe
  - Removing the pod does not bring down minimum number of replica
  - Pod doesn't use local storage
  - Kube-system pods are not moved

Continuous Deployment Strategies

Strategies

Able to reliably and safely deploy, rollback and orchestrate software.

List of strategies:

- **Recreate**
- **Ramped (Rolling update) Deployments**
- Blue/Green Deployments
- Canary Releases

Strategies - Recreate

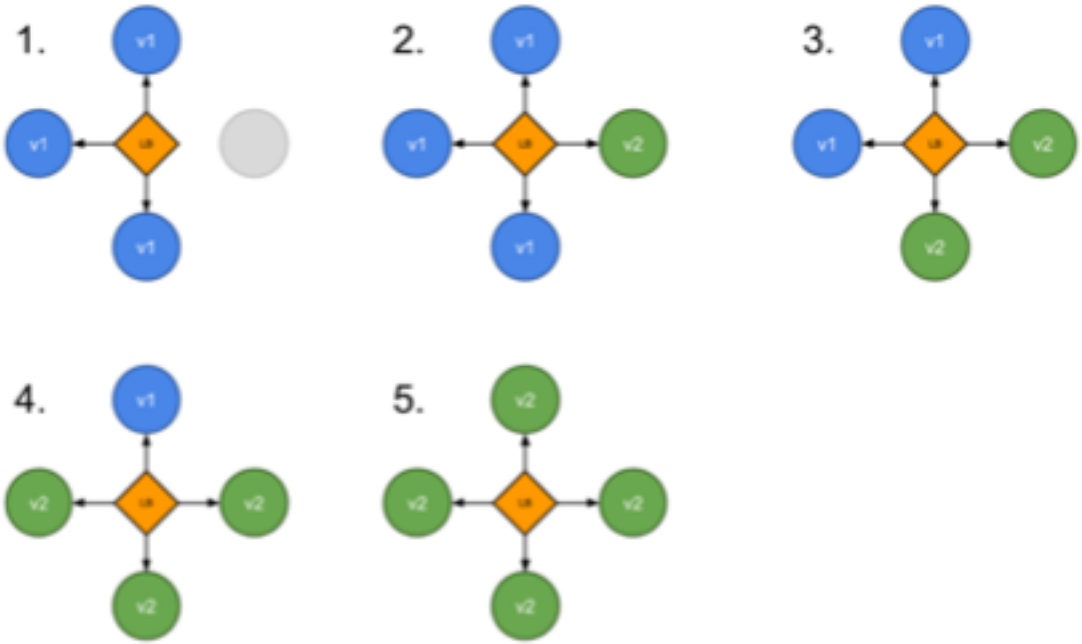
Recreate –

```
spec:
  replicas: 3
  selector:
    matchLabels:
      app: my-app
  strategy:
    type: Recreate
    spec:
      containers:
      - name: my-app
        image: my-image
```

- terminate all the running instances then recreate them with the newer version
- application state entirely renewed
- not a true continuous deployment strategy
- downtime
- conceptual simplicity

Strategies – Ramped or Rolling update

Ramped or Rolling Update



- A secondary ReplicaSet is created with the new version of the application
- The number of replicas of the old version is decreased and the new version is increased
- Until the correct number of replicas is reached

Strategies – Ramped or Rolling update

Best Practice

- Should be accompanied by some kind of a basic health check
- To verify the new instances are ready to provide services
- To avoid downtime

- **Keep in mind**
- The old and the new version run side by side.
- Requires full backward compatibility of our API and schema changes
- Careful API versioning whenever backward compatibility gets broken.

➢ If deployment exposed as service, the service will load-balance traffic to only active and available pods

Strategies – Ramped or Rolling update

```
spec:
  replicas: 3
  strategy:
    type: RollingUpdate
    rollingUpdate:
      maxSurge: 2 or x%              # max number of pods can be created over desired
      maxUnavailable: 1 or x%        # define how many pods can be unavailable
containers:
- image: nginx:2.0
  readinessProbe:                    # when the container is ready to accept traffic
    httpGet:
      path: /
      port: 8080
      initialDelaySeconds: 5
      periodSeconds: 5
      successThreshold: 1
```

$ kubectl set image <deployment> <new-image>

```
peter@Azure:~$ kubectl run nginx --image nginx:1.12.1 --port 80
deployment "nginx" created
peter@Azure:~$ kubectl set image deployments/nginx nginx=nginx:latest
deployment "nginx" image updated
peter@Azure:~$ kubectl describe deployment nginx
Name:                   nginx
Namespace:              default
CreationTimestamp:      Fri, 15 Sep 2017 13:08:50 +0000
Labels:                 run=nginx
Annotations:            deployment.kubernetes.io/revision=2
Selector:               run=nginx
Replicas:               1 desired | 1 updated | 1 total | 1 available | 0 unavailable
StrategyType:           RollingUpdate
MinReadySeconds:        0
RollingUpdateStrategy:  1 max unavailable, 1 max surge
Pod Template:
  Labels:       run=nginx
  Containers:
   nginx:
    Image:              nginx:latest
    Port:               80/TCP
    Environment:        <none>
    Mounts:             <none>
  Volumes:              <none>
Conditions:
  Type          Status  Reason
  ----          ------  ------
  Available     True    MinimumReplicasAvailable
OldReplicaSets: <none>
NewReplicaSet:  nginx-2688028062 (1/1 replicas created)
Events:
  FirstSeen     LastSeen        Count   From                    SubObjectPath   Type        Reason              Message
  ---------     --------        -----   ----                    -------------   --------    ------              -------
  32s           32s             1       deployment-controller                   Normal      ScalingReplicaSet   Scaled up replica set nginx-1295584306 to 1
  10s           10s             1       deployment-controller                   Normal      ScalingReplicaSet   Scaled up replica set nginx-2688028062 to 1
  10s           10s             1       deployment-controller                   Normal      ScalingReplicaSet   Scaled down replica set nginx-1295584306 to 0
```

Note: Rolling updates can also be undone

$ kubectl rollout undo <deployment>

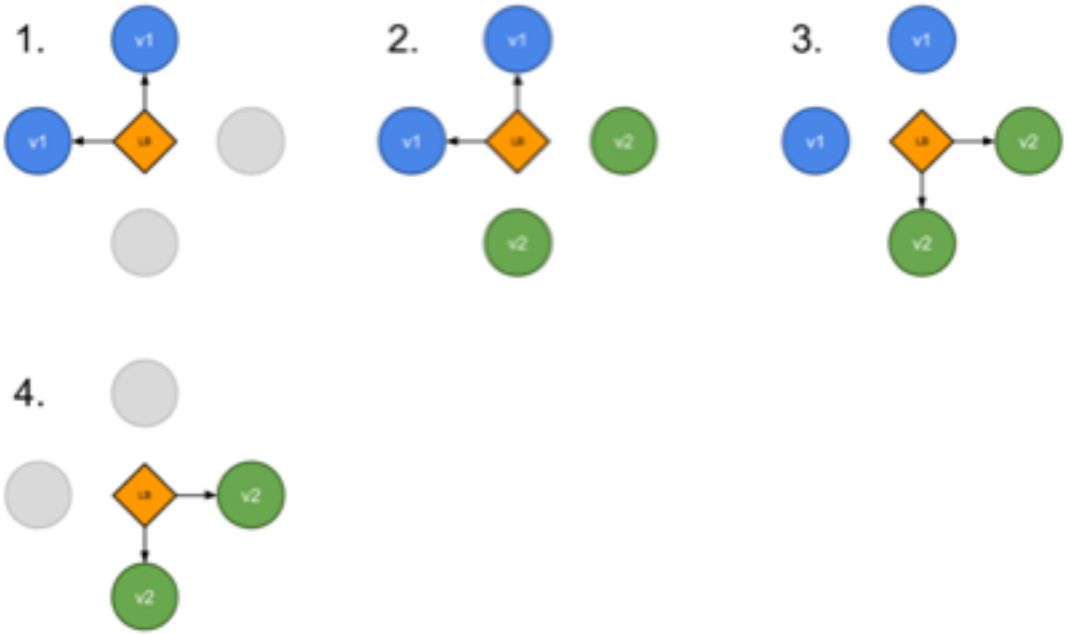
```
peter@Azure:~$ kubectl rollout undo deployments/nginx
deployment "nginx" rolled back
peter@Azure:~$ kubectl describe deployments/nginx
Name:                   nginx
Namespace:              default
CreationTimestamp:      Fri, 15 Sep 2017 13:36:49 +0000
Labels:                 run=nginx
Annotations:            deployment.kubernetes.io/revision=3
Selector:               run=nginx
Replicas:               1 desired | 1 updated | 1 total | 1 available | 0 unavailable
StrategyType:           RollingUpdate
MinReadySeconds:        0
RollingUpdateStrategy:  1 max unavailable, 1 max surge
Pod Template:
  Labels:       run=nginx
  Containers:
   nginx:
    Image:              nginx:1.12.1
    Port:               80/TCP
    Environment:        <none>
    Mounts:             <none>
  Volumes:              <none>
Conditions:
  Type          Status  Reason
  ----          ------  ------
  Available     True    MinimumReplicasAvailable
OldReplicaSets: <none>
NewReplicaSet:  nginx-1295584306 (1/1 replicas created)
Events:
  FirstSeen     LastSeen        Count   From                    SubObjectPath   Type        Reason              Message
  ---------     --------        -----   ----                    -------------   --------    ------              -------
  1m            1m              1       deployment-controller                   Normal      ScalingReplicaSet   Scaled up replica set nginx-2688028062 to 1
  1m            1m              1       deployment-controller                   Normal      ScalingReplicaSet   Scaled down replica set nginx-1295584306 to 0
  1m            10s             2       deployment-controller                   Normal      ScalingReplicaSet   Scaled up replica set nginx-1295584306 to 1
  10s           10s             1       deployment-controller                   Normal      DeploymentRollback  Rolled back deployment "nginx" to revision 1
  10s           10s             1       deployment-controller                   Normal      ScalingReplicaSet   Scaled down replica set nginx-2688028062 to 0
```

Note: Rollbacks can also be also enacted with zero-downtime

```
root@ip-172-31-0-112:~/code# kubectl rollout undo deployments/nginx
deployment.extensions/nginx
root@ip-172-31-0-112:~/code# kubectl describe deployments/nginx
Name:                   nginx
Namespace:              default
CreationTimestamp:      Thu, 19 Jul 2018 04:00:55 +0000
Labels:                 run=nginx
Annotations:            deployment.kubernetes.io/revision=3
Selector:               run=nginx
Replicas:               1 desired | 1 updated | 1 total | 1 available | 0 unavailable
StrategyType:           RollingUpdate
MinReadySeconds:        0
RollingUpdateStrategy:  25% max unavailable, 25% max surge
Pod Template:
  Labels:  run=nginx
  Containers:
   nginx:
    Image:        nginx:1.12.1
    Port:         80/TCP
    Host Port:    0/TCP
    Environment:  <none>
    Mounts:       <none>
  Volumes:        <none>
Conditions:
  Type           Status  Reason
  ----           ------  ------
  Available      True    MinimumReplicasAvailable
  Progressing    True    NewReplicaSetAvailable
OldReplicaSets:  <none>
NewReplicaSet:   nginx-7f9bc86464 (1/1 replicas created)
Events:
  Type    Reason             Age              From                   Message
  ----    ------             ----             ----                   -------
  Normal  ScalingReplicaSet  1m               deployment-controller  Scaled up replica set nginx-6c486b77db to 1
  Normal  ScalingReplicaSet  1m               deployment-controller  Scaled down replica set nginx-7f9bc86464 to 0
  Normal  ScalingReplicaSet  18s (x2 over 2m)  deployment-controller  Scaled up replica set nginx-7f9bc86464 to 1
  Normal  DeploymentRollback  18s              deployment-controller  Rolled back deployment "nginx" to revision 1
  Normal  ScalingReplicaSet  17s              deployment-controller  Scaled down replica set nginx-6c486b77db to 0
```

kubectl rollout status deployment nginx
kubectl rollout history deployment nginx
kubectl rollout history deployment/nginx --revision=3
kubectl rollout undo deployment/nginx --to-revision <num>

Strategies – Blue Green Deployment



- "green" version is deployed alongside "blue"
- Test the new version
- Update the Service object (load balancer) to send traffic to the new version by replacing the version label in the selector field

Strategies – Blue Green Deployment

(-)

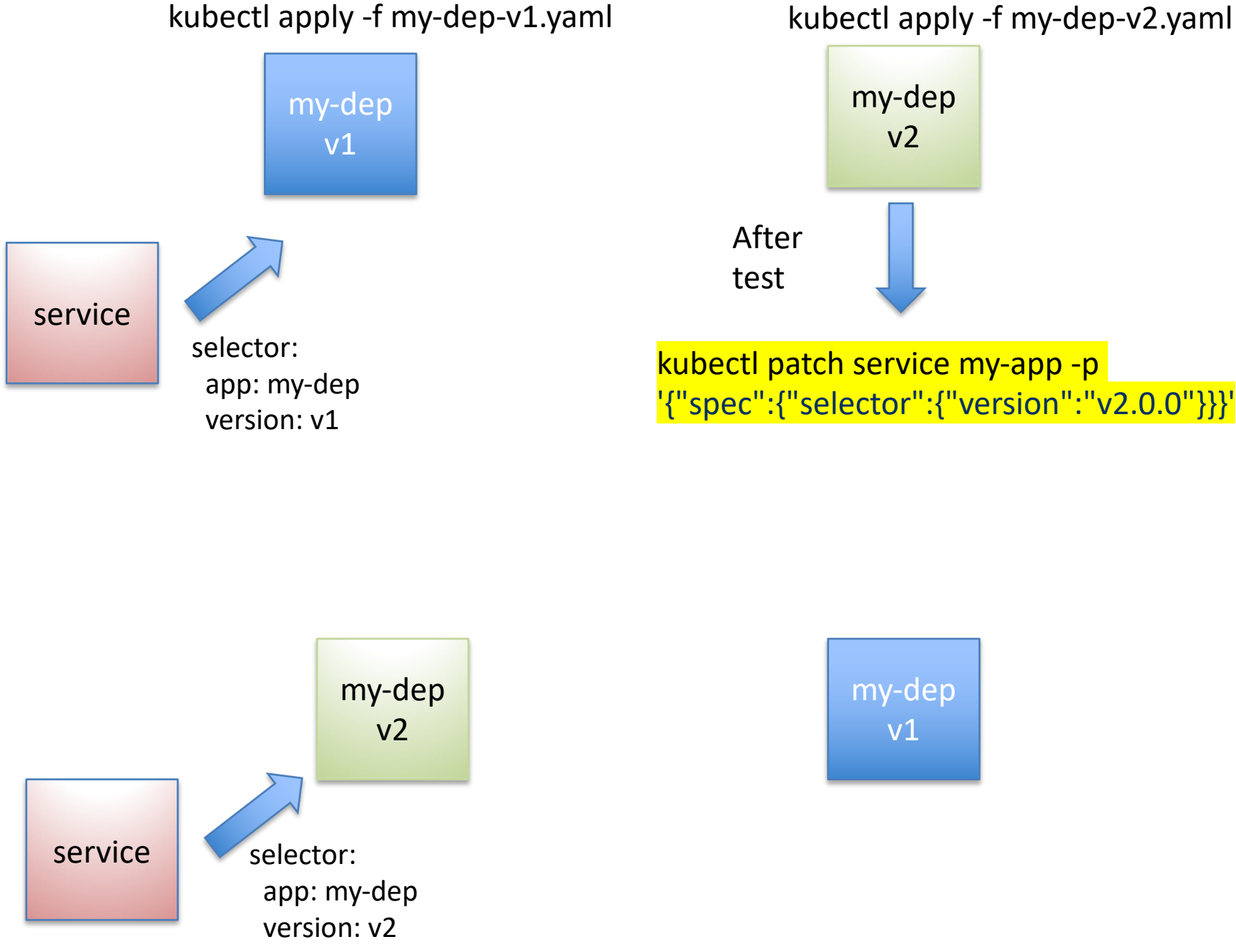
- Requires double the resources
- Proper test of the entire platform

(+)

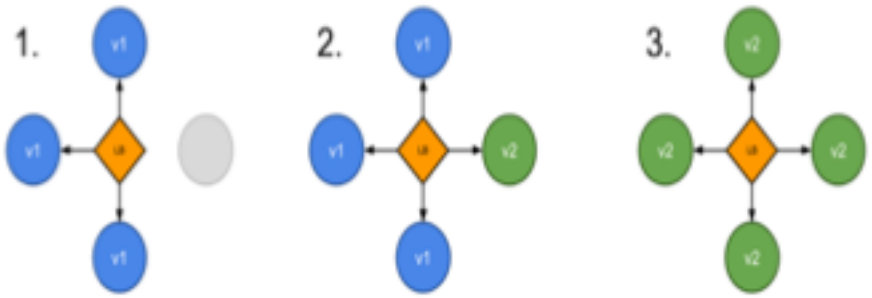
- No downtime
- Easy rollback

Steps to follow

- v1 is serving traffic
- deploy v2
- wait until v2 is ready
- switch incoming traffic from v1 to v2
- shutdown v1


kubectl apply -f my-dep-v1.yaml
my-dep
v1
service
selector:
app: my-dep
version: v1
kubectl apply -f my-dep-v2.yaml
my-dep
v2
After
test
kubectl patch service my-app -p
'{"spec":{"selector":{"version":"v2.0.0"}}}'
my-dep
v2
service
selector:
app: my-dep
version: v2
my-dep
v1

Strategies – Canary Deployment



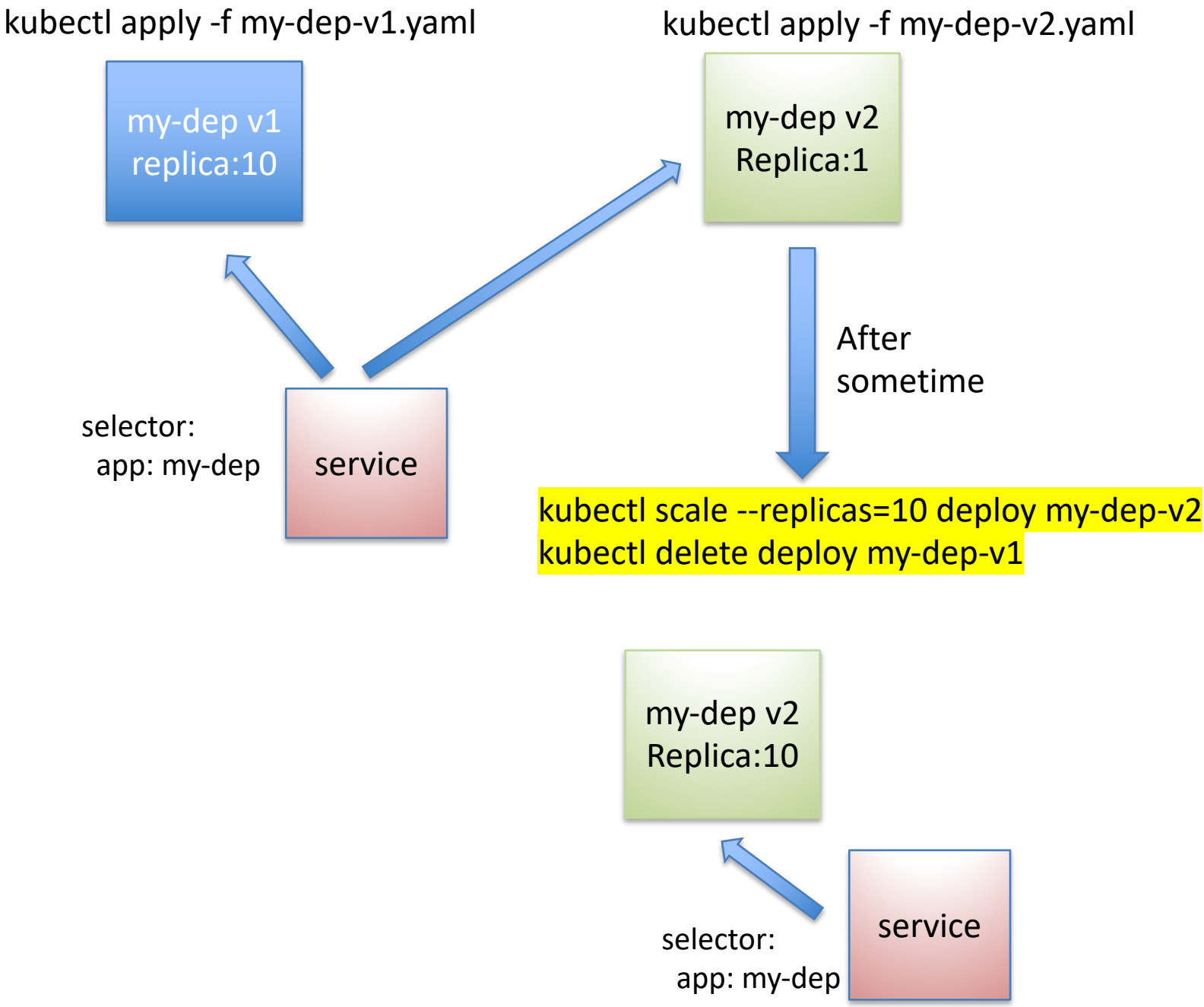
- Route a subset of users to a new functionality.
- Can be done using two Deployments with common pod labels.
- One replica of the new version is released alongside the old version
- Then after some time and if no error is detected, scale up the number of replicas of the new version and delete the old deployment.

Strategies – Canary Deployment

(-)
- Slow rollout

(+)
- Fast rollback
- Good for error rate & performance monitoring

Steps to follow
- 10 replicas of v1 is serving traffic
- deploy 1 replicas v2 (meaning ~10% of traffic)
- Wait enough time to confirm that v2 is stable and not throwing unexpected errors
- scale up v2 replicas to 10
- wait until all instances are ready
- shutdown v1


kubectl apply -f my-dep-v1.yaml
kubectl apply -f my-dep-v2.yaml
my-dep v1
replica:10
my-dep v2
Replica:1
After
sometime
selector:
app: my-dep
service
kubectl scale --replicas=10 deploy my-dep-v2
kubectl delete deploy my-dep-v1
my-dep v2
Replica:10
selector:
app: my-dep
service

Exercise 4 – (scaling, Auto scaling, rollout)

- For a previously created deployment scale the number of replicas
- see the difference in replicasets, pods , and see with a describe
- Rolling update, undo and see the changes in replica sets

cd to the ex4

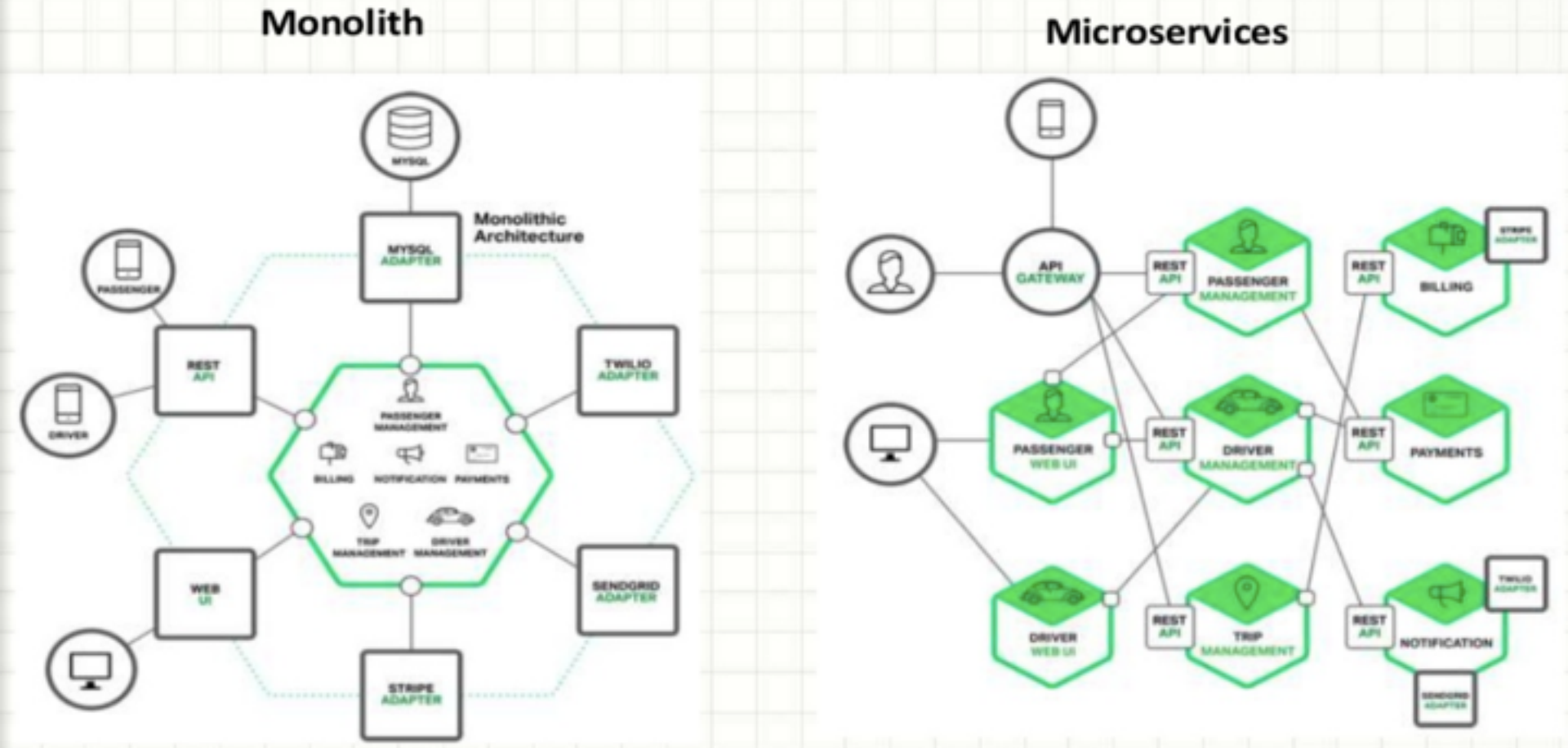
https://github.com/shekhar2010us/kubernetes_teach_git/blob/master/ex4/scaling_rolling.md

Service Discovery

Service Discovery

Migrating from a monolithic architecture to a Microservices based architecture where each service loosely coupled and horizontally scaled will require a service discovery mechanism to ensure that the REST API endpoints of the ephemeral services (say, docker containers running inside PODs) are resolved or detected. The IP addresses of the containers (or the PODs) being transient will need automated mechanism to resolve or convey the current IP addresses.

Sample Microservices Architecture



Service Discovery

So how do we keep track of all the microservices?

Service Discovery!

Service Discovery

What should Service Discovery provide?

- **Discover services** dynamically to get IP address and port details to communicate with other services
- **Health check**: Only healthy services should participate in handling traffic
- **Load balancing**: Traffic destined to a particular service should be dynamically load balanced

Service Discovery Tools

What are some Service Discovery tools?

- etcd, by CoreOS
- Consul, by Hashicorp
- Zookeeper, by Apache
- SkyDNS (built on top of etcd)
- Eureka, by Netflix
- Smartstack, by AirBnB

Kubernetes Service Discovery

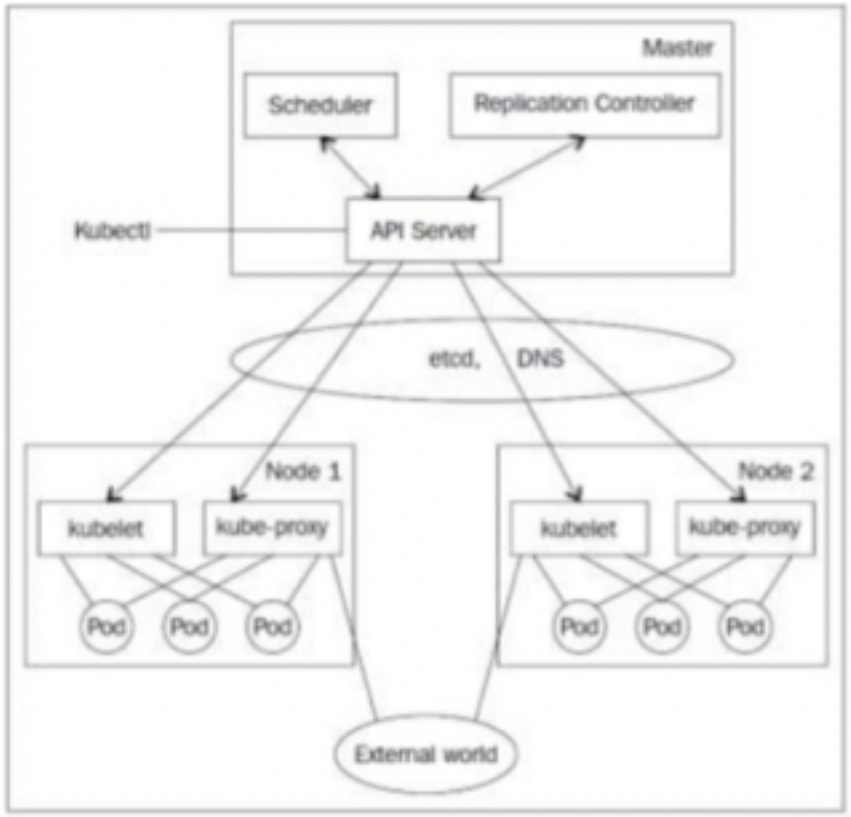
DNS Resolution

Kubernetes has a kube-dns addon that exposes the service's name as a DNS entry. As a result, you can tell your application to connect to a host name.

The service names are scoped within namespaces. This allows you to run different deployment of a service for each namespace (for example, one per developer or one per environments) without having to edit configuration files.

K8s Service Discovery Components

- **SkyDNS** – map Service name to IP address
- **Etcd** – KV store for service database
- **Kubelet** – healthcheck and replication controller takes care of maintaining pod count
- **Kube-proxy** – takes care of load balancing traffic to individual pods. Watches service changes and updates IPTables



Lab: Service Discovery

https://github.com/shekhar2010us/kubernetes_teach_git/blob/master/k8s_service_discovery/service-discovery.md

Example using consul:
https://github.com/hashicorp/demo-consul-101/tree/master/k8s

GitOps

GitOps

- Operating model for building applications on Kubernetes
- Works by using Git as a source of truth for declarative infrastructure and applications.
- Automated CICD pipelines roll out changes to your infrastructure after commits are pushed and approved in Git

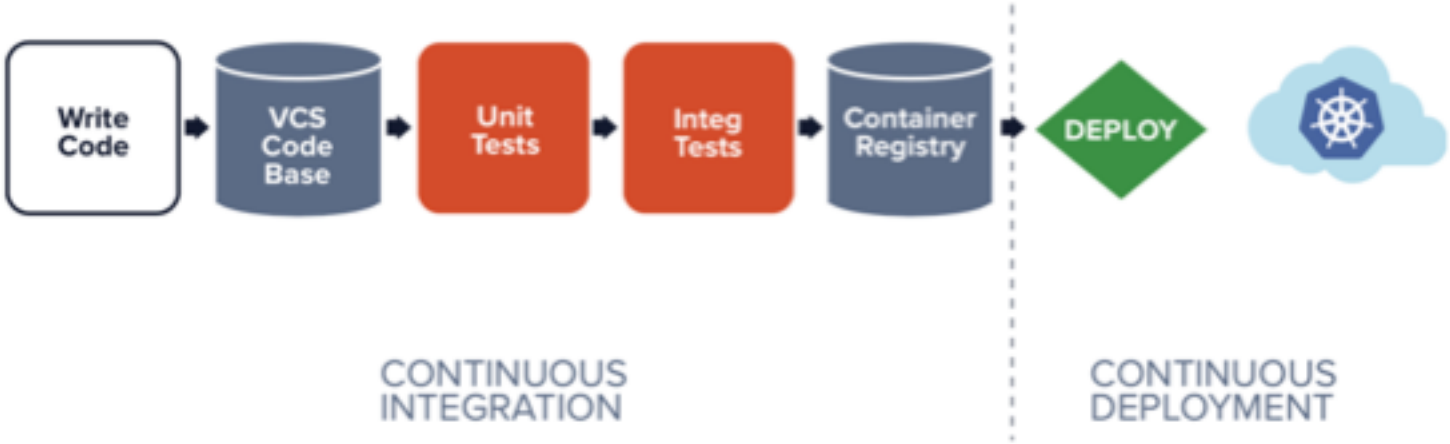
GitOps Principles

- System is described declaratively
- Desired system state in versioned in Git
- Approved changes are auto applied to the system
- Feedback and control loops for operations

GitOps Takeaways

- Developer who uses Git can deploy new features to k8s
- Same workflows are maintained across development and operations
- All changes can be triggered, stored, validated and audited in Git
- Changes can be made by pull request including rollbacks
- Changes can be observed and monitored

Typical CI/CD pipeline



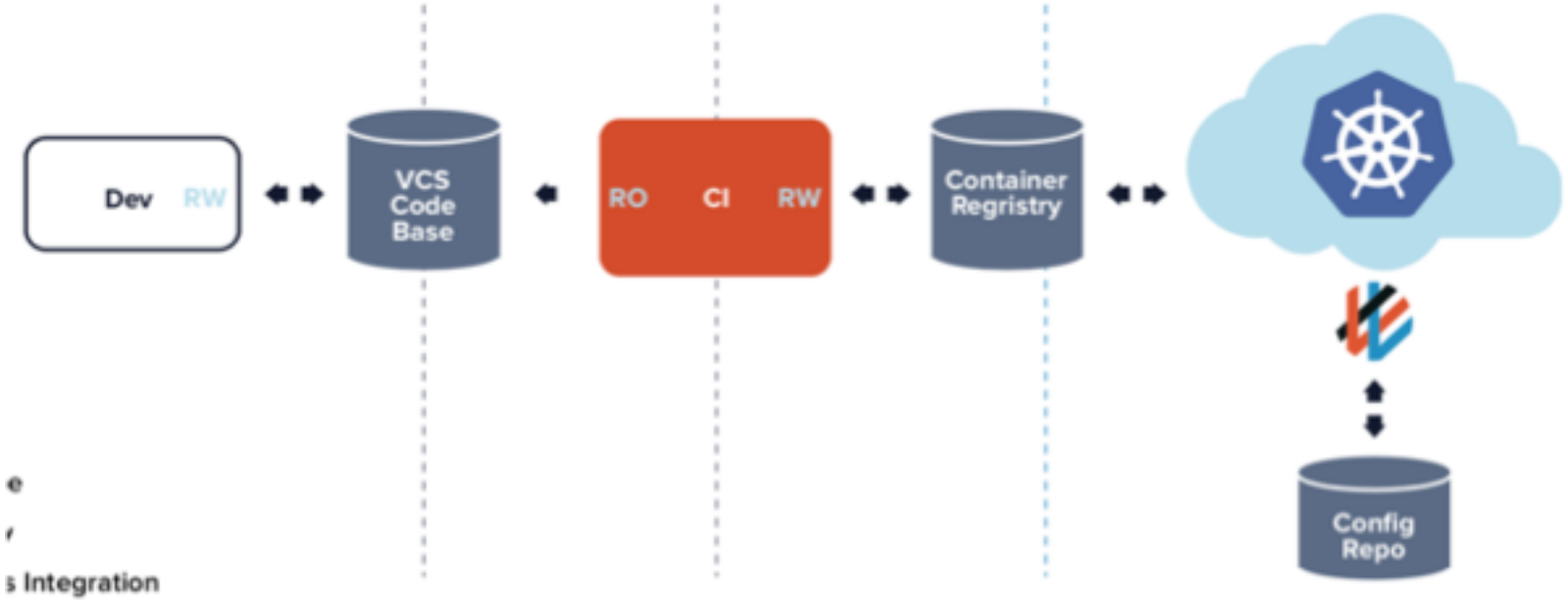
Application is bundled in yaml or helm charts

- CI tool pushes and deploys images to the cluster. For this, you have to share your API credentials with the CI tooling

Is this secure enough ?

- **If cluster goes down?** CI pipeline doesn't have its state easily recorded - Rebuild everything and then re-apply all of the workloads to the new cluster

GitOps Deployment Pipeline



An agent acts on behalf of the cluster. It listens to events relating to custom resource changes, and then applies those changes based on a deployment policy. The agent is responsible for synchronizing **what's in Git with what's running in the cluster**

GitOps Seperates CI and CD

CI Tooling Test, Build, Scan, Publish	CD Tooling Sync Git with prod cluster
Runs outside the production cluster	Runs inside the production cluster
Read access to the code repository	Read/Write access to configuration repository
Read/Write access to container repository	Read access to image repository
Read/Write access to the continuous integration environment	Read/Write access to the production cluster

GitOps on OpenShift – End Goal

- New version proposed via Pull request
- Webhook fires on merge
- New version rolls out