

Kubernetes for Continuous Integration

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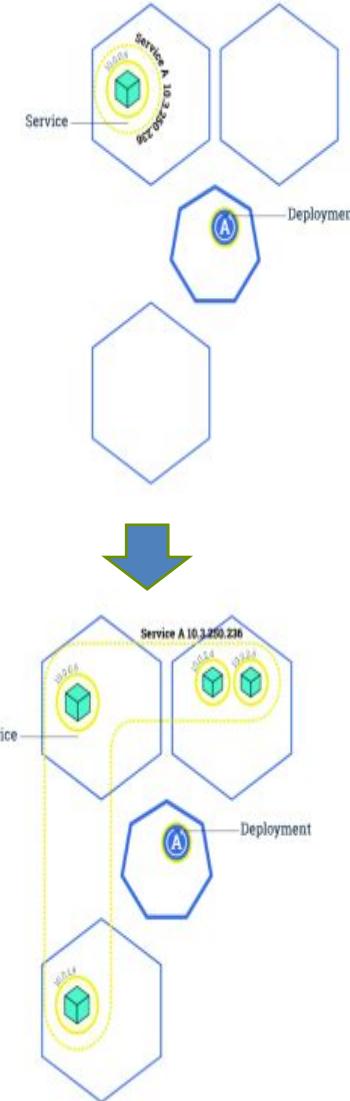
- Scaling and autoscaling
- Deployment Strategies
 - Rolling update
 - Recreate
 - Blue Green
 - Canary
- Service Discovery

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 replicaset when trying to clear out pods. Many a new user has repeated deleted pods and gotten frustrated when they respawn (as the deployments/replicaset 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-6f858d4d45-169jv        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

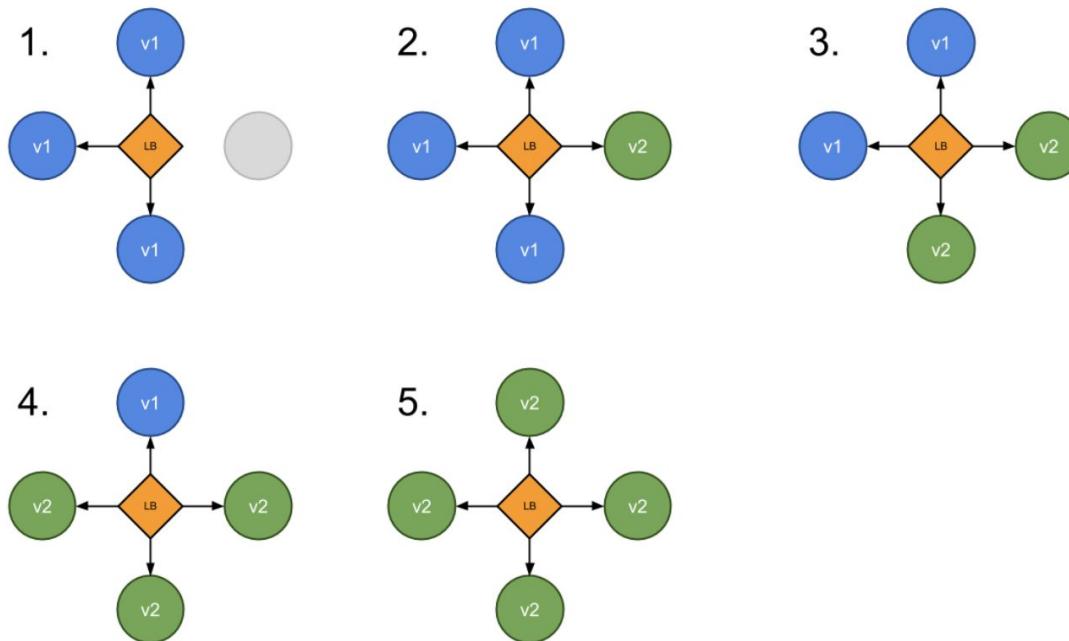
Recreate –

```
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:

 httpGet:

 path: /

 port: 8080

 initialDelaySeconds: 5

 periodSeconds: 5

 successThreshold: 1

 # when the container is ready to accept traffic

\$ 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
-----  -----  -----  -----            -----  -----  -----  -----
lm        lm        1  deployment-controller  Normal      ScalingReplicaSet  Scaled up replica set nginx-2688028062 to 1
lm        lm        1  deployment-controller  Normal      ScalingReplicaSet  Scaled down replica set nginx-1295584306 to 0
lm        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 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

```

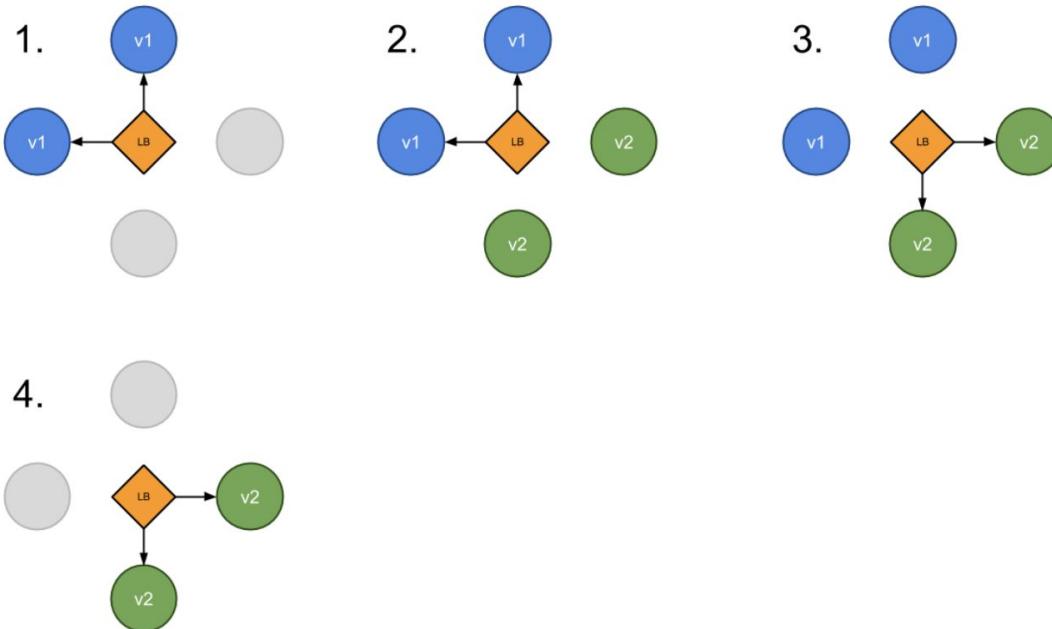
`kubectl rollout status deployment nginx`

`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

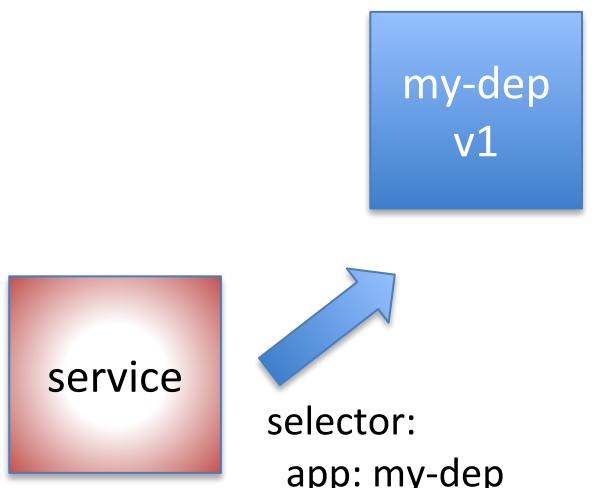
(+)

- No downtime
- Easy rollback

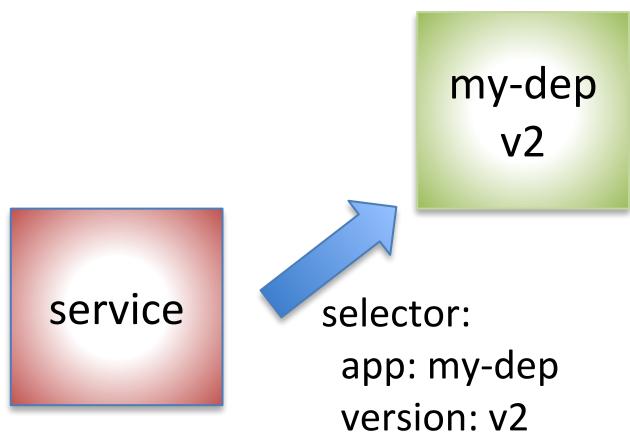
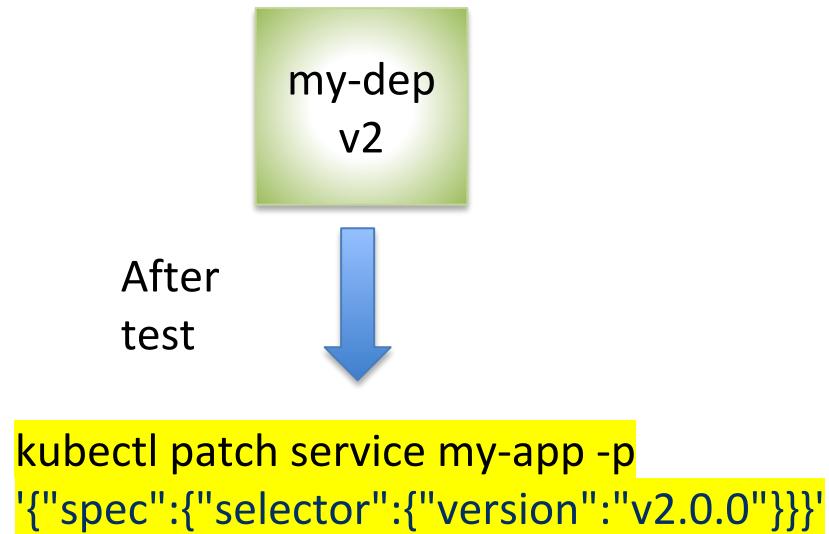
Steps to follow

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

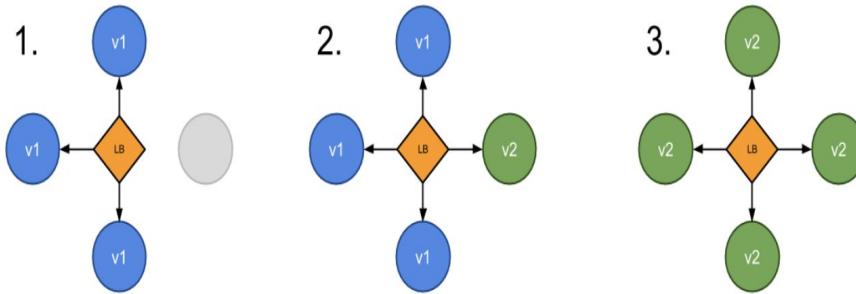
kubectl apply -f my-dep-v1.yaml



kubectl apply -f my-dep-v2.yaml



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

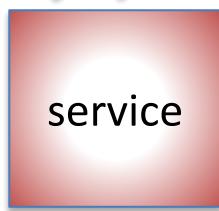
Steps to follow

- 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



selector:
app: my-dep



kubectl apply -f my-dep-v2.yaml



After
sometime

kubectl scale --replicas=10 deploy my-dep-v2
kubectl delete deploy my-dep-v1



selector:
app: my-dep



Exercise 4 – (scaling, Auto scaling, rollout)

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

cd to the ex4

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

Service Discovery



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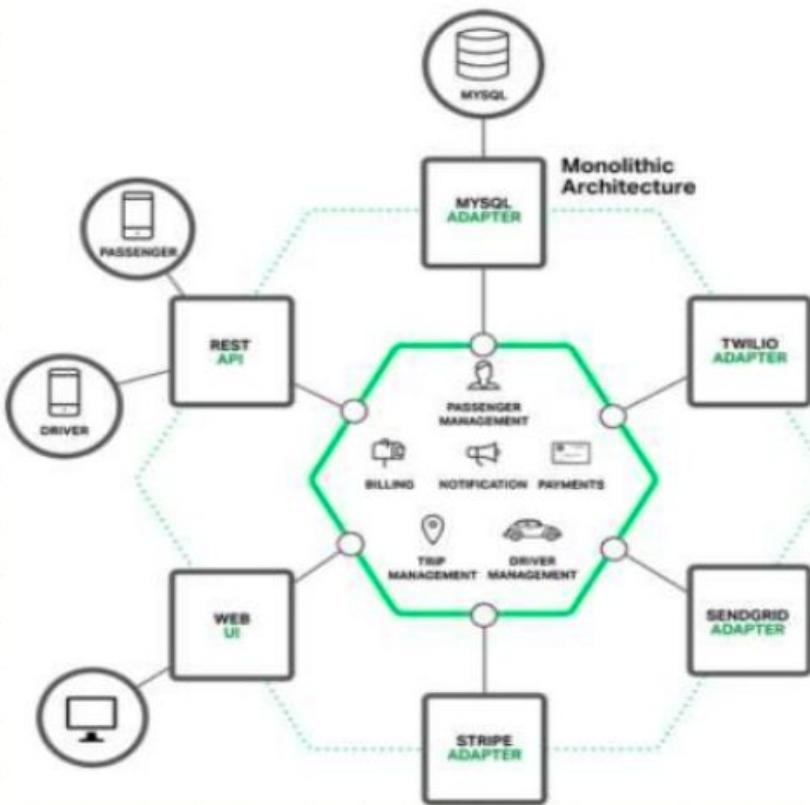


Service Discovery

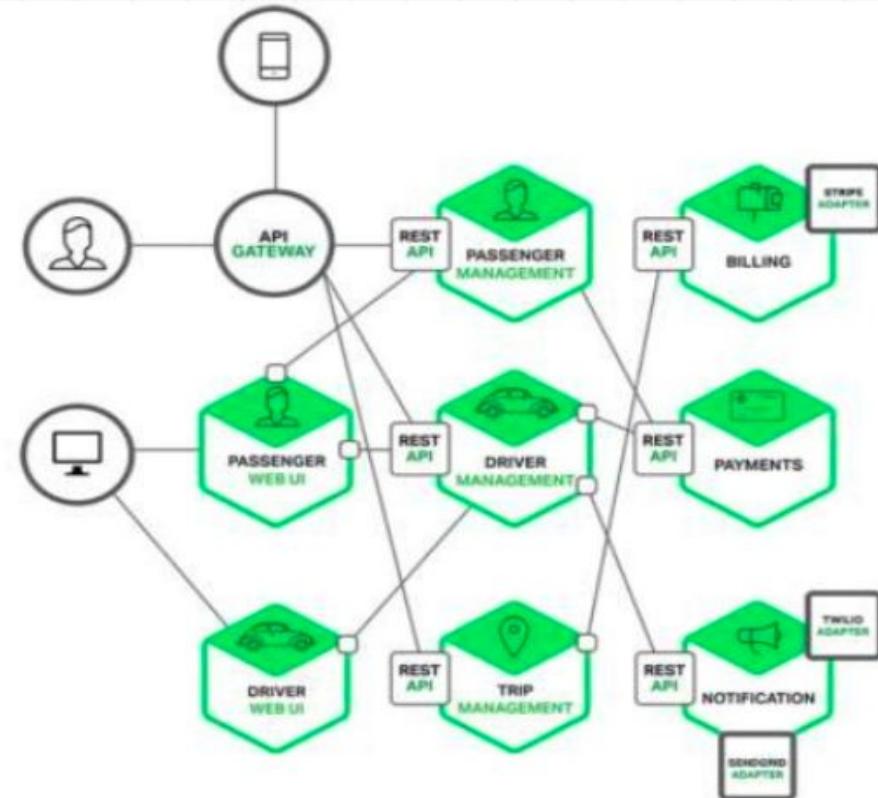
Migrating from a monolithic architecture to a Microservices based architecture where each service loosely coupled and horizontally scaled will require a service discovery mechanism to ensure that the REST API endpoints of the ephemeral services (say, docker containers running inside PODs) are resolved 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

Monolith



Microservices



Service Discovery

**So how do we keep
track of all the
microservices?**



Service Discovery!



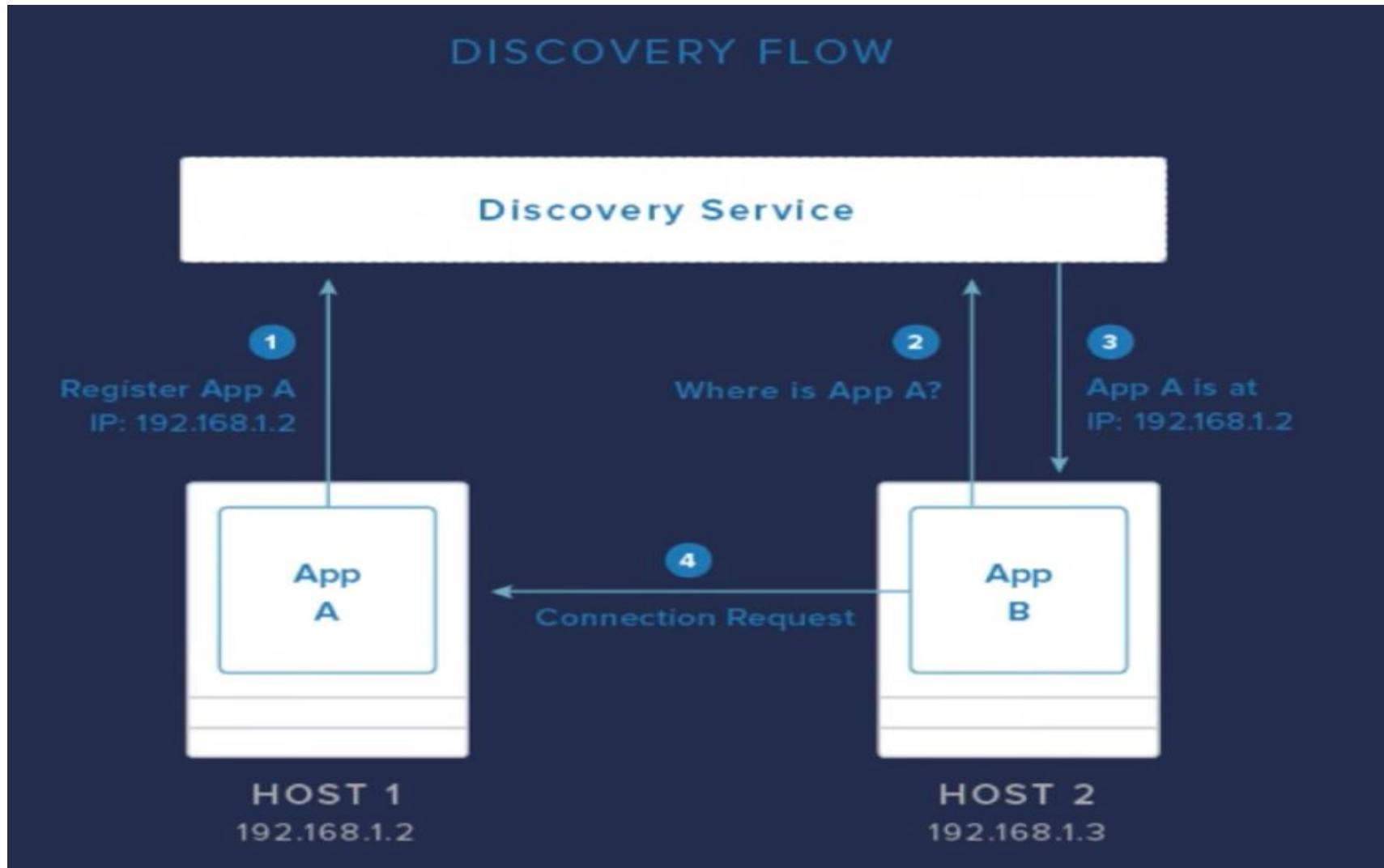
Service Discovery

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



Service Discovery Tools

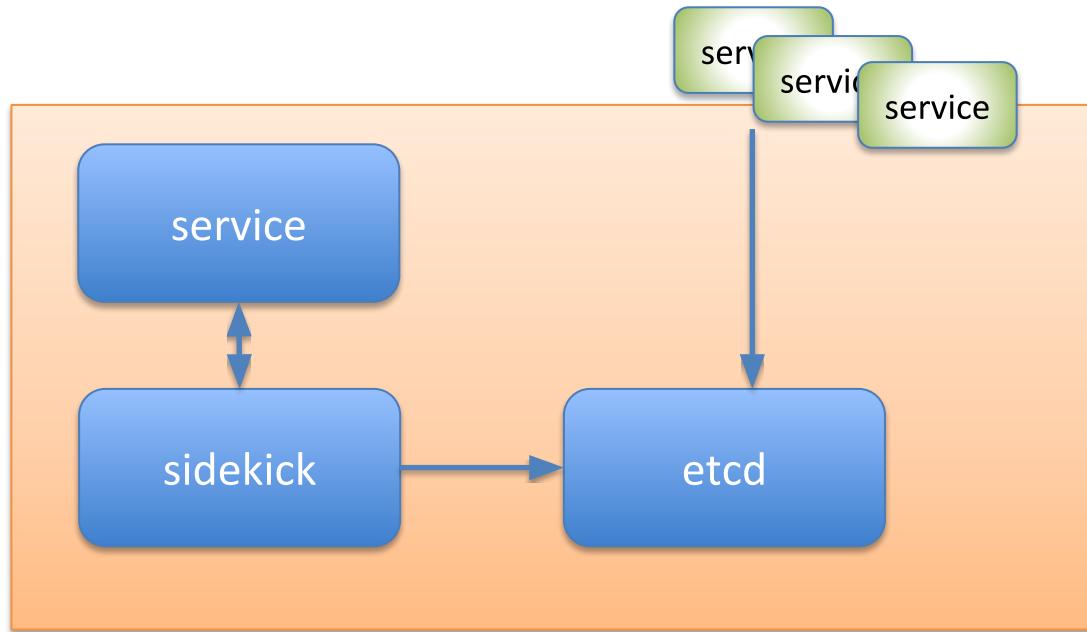
What are some Service Discovery tools?

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



Service Discovery by etcd

- Etcd can be used as KV store for service registry
- Service itself can directly update etcd or a Sidekick service can be used to update etcd
- Sidekick service serves as **registrator**
- Other services can query etcd database to do the dynamic service discovery



Kubernetes Service Discovery

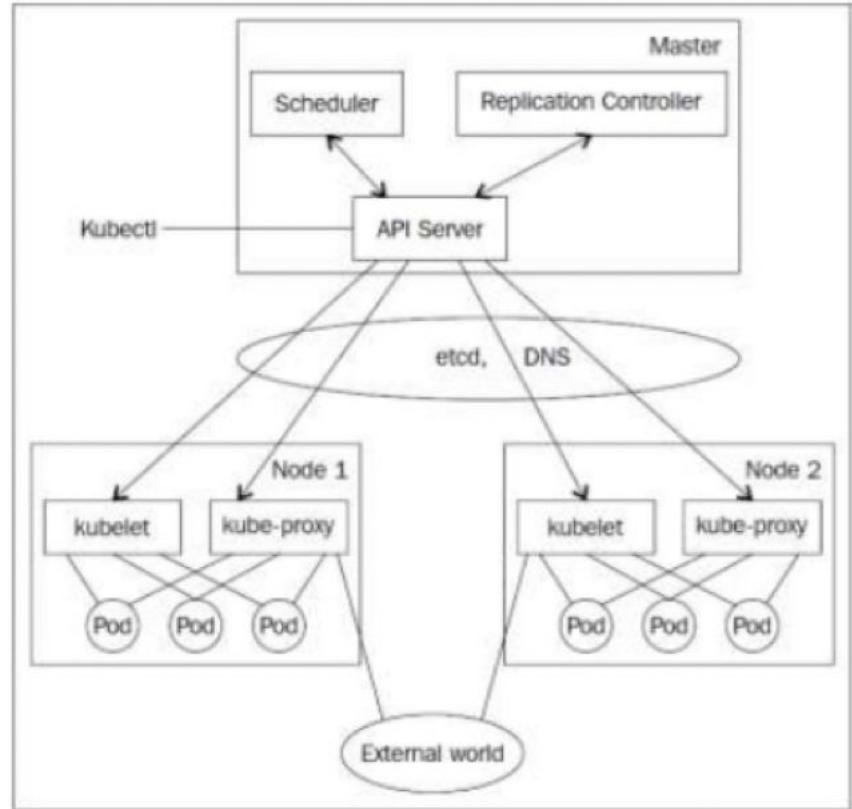
DNS Resolution

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



Service Discovery

- **Services** – get mapped to pods using Selector labels. In the example: “MyApp” is the label
- **Service port** gets mapped to targetPort in the pod

```
{  
  "kind": "Service",  
  "apiVersion": "v1",  
  "metadata": { "name": "my-service" },  
  "spec": {  
    "selector": { "app": "MyApp" },  
    "ports": [  
      {  
        "protocol": "TCP",  
        "port": 80,  
        "targetPort": 9376  
      }  
    ]  
  }  
}
```

Lab: Service Discovery

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

Example using consul:

<https://github.com/hashicorp/demo-consul-101/tree/master/k8s>