CLOUD NATIVE COMPUTING FOUNDATION

Deployment Strategies on Kubernetes

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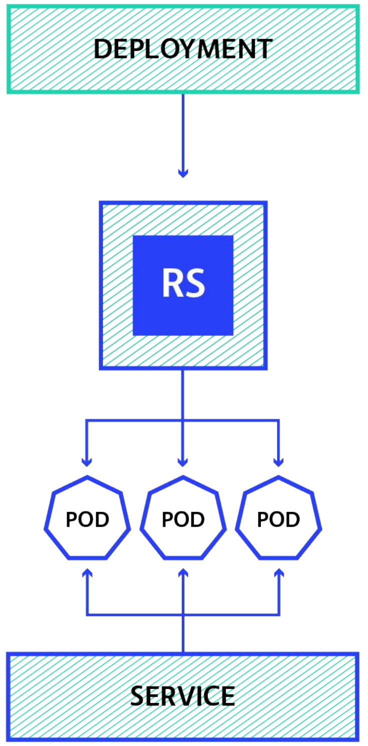
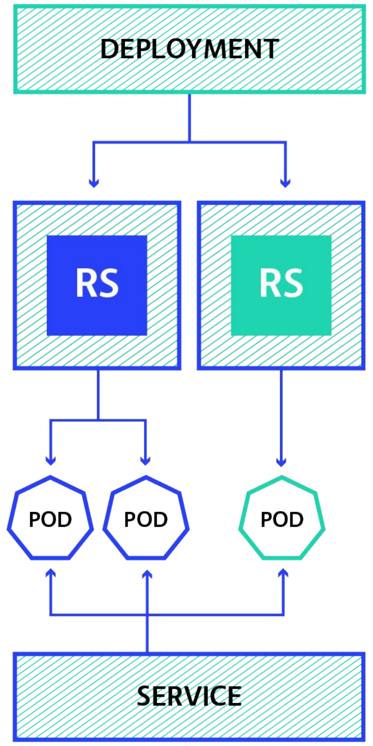
Agenda

- Kubernetes in brief
- Look at 6 different strategies
    - Recreate
    - Ramped
    - Blue/Green
    - Canary
    - A/B Testing
    - Shadow
- Sum-up
- Next

Kubernetes in brief

Deployments, replica-sets, pods and services





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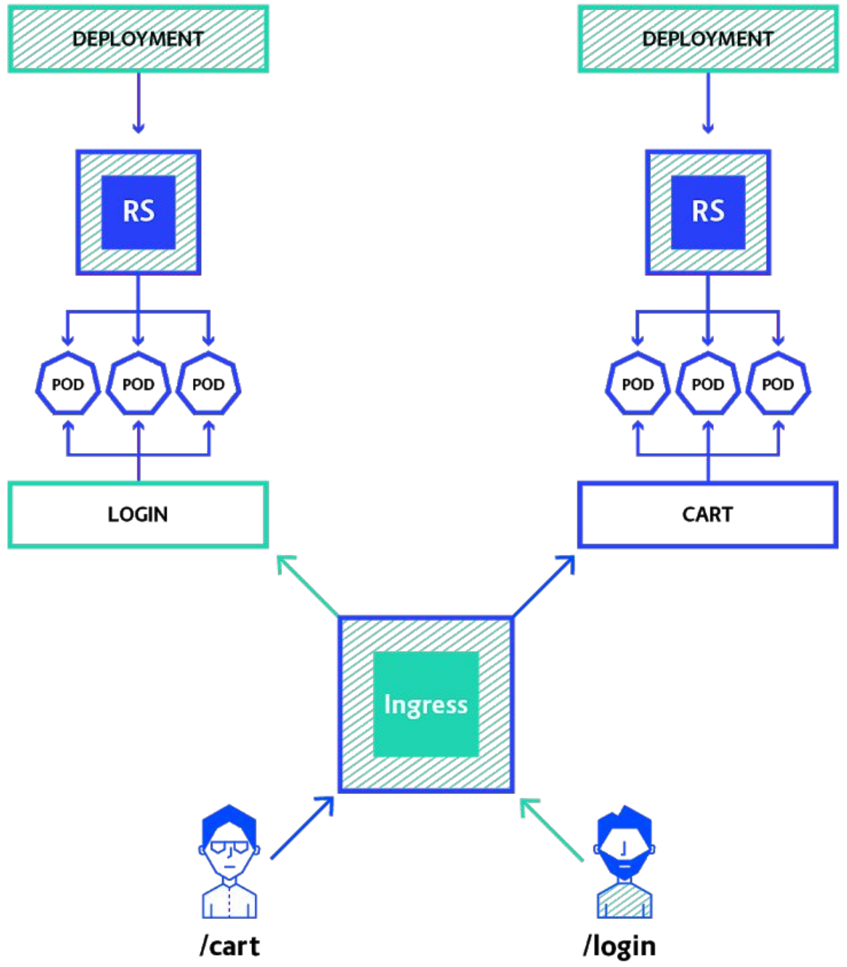
Kubernetes in brief

Advanced routing using Ingress

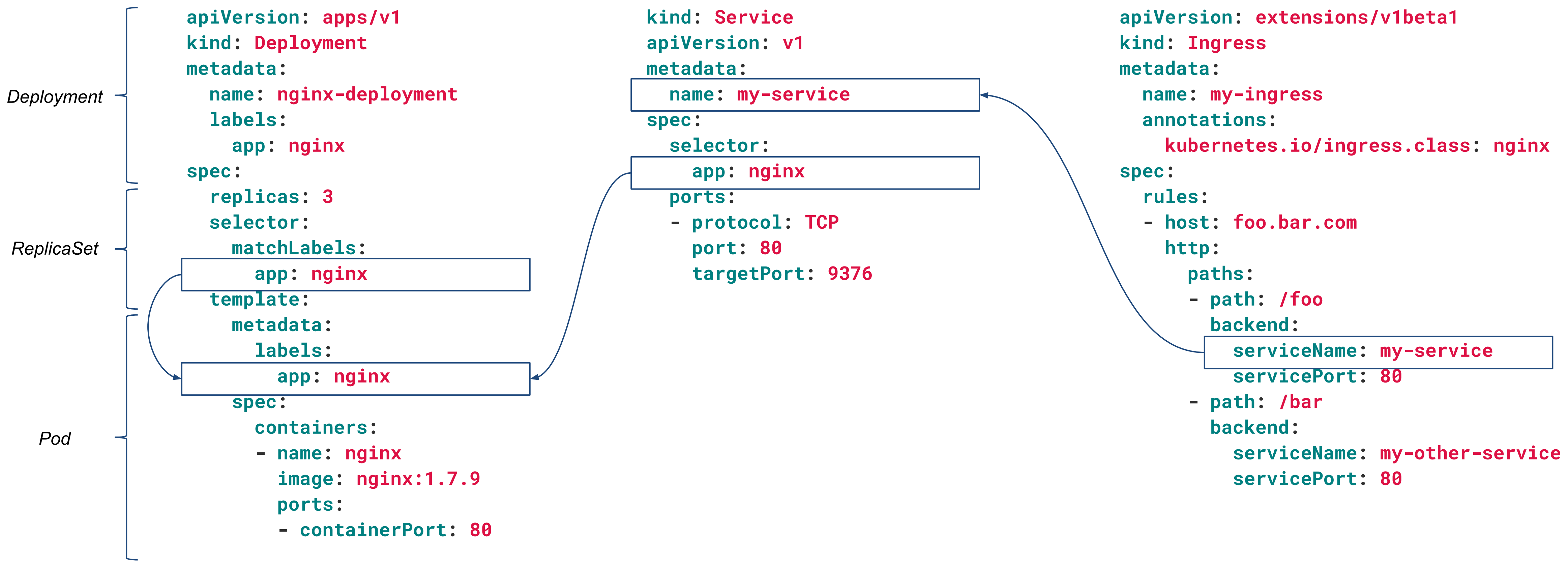


Ingress controllers:

- Nginx
- HA Proxy
- Traefik
- Istio
- Linkerd
- GKE
- etc.

Kubernetes in brief

Configuration



Deployment configuration:

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
  labels:
    app: nginx
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.7.9
        ports:
        - containerPort: 80
```

Service configuration:

```
kind: Service
apiVersion: v1
metadata:
  name: my-service
spec:
  selector:
    app: nginx
  ports:
  - protocol: TCP
    port: 80
    targetPort: 9376
```

Ingress configuration:

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: my-ingress
  annotations:
    kubernetes.io/ingress.class: nginx
spec:
  rules:
  - host: foo.bar.com
    http:
      paths:
      - path: /foo
        backend:
          serviceName: my-service
          servicePort: 80
      - path: /bar
        backend:
          serviceName: my-other-service
          servicePort: 80
```

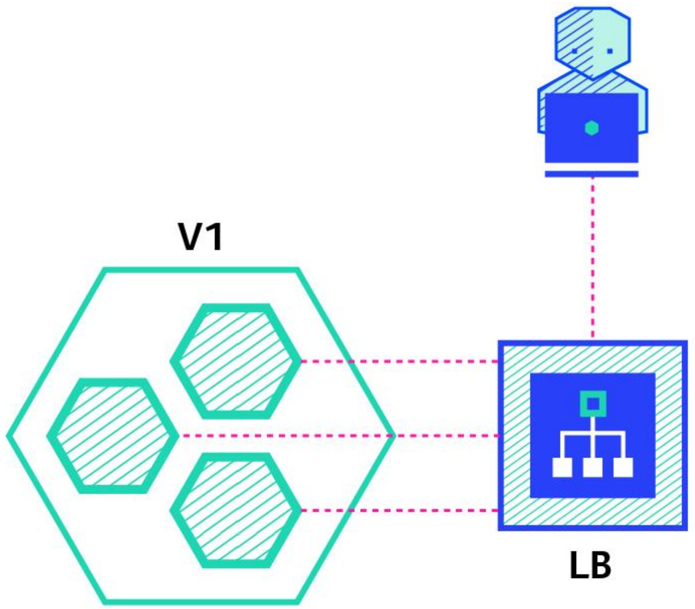
Deployment strategies

- Recreate *native*
- Ramped *native*
- Blue/Green *extra step needed*
- Canary *extra step needed*
- A/B Testing *require additional component*
- Shadow *require additional component*

Get your hands on: https://github.com/ContainerSolutions/k8s-deployment-strategies

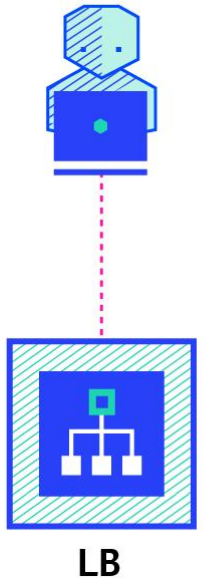
Recreate

Recreate



In this case [LB] *is a Kubernetes Service*

Recreate



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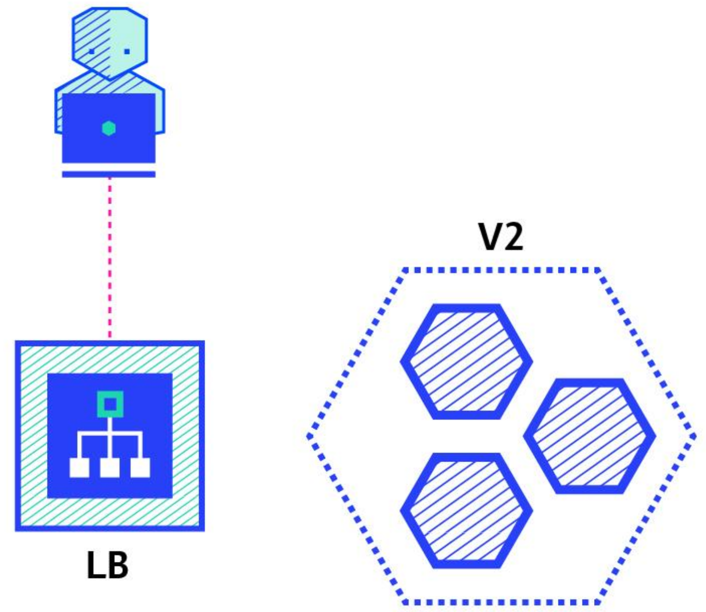
Recreate



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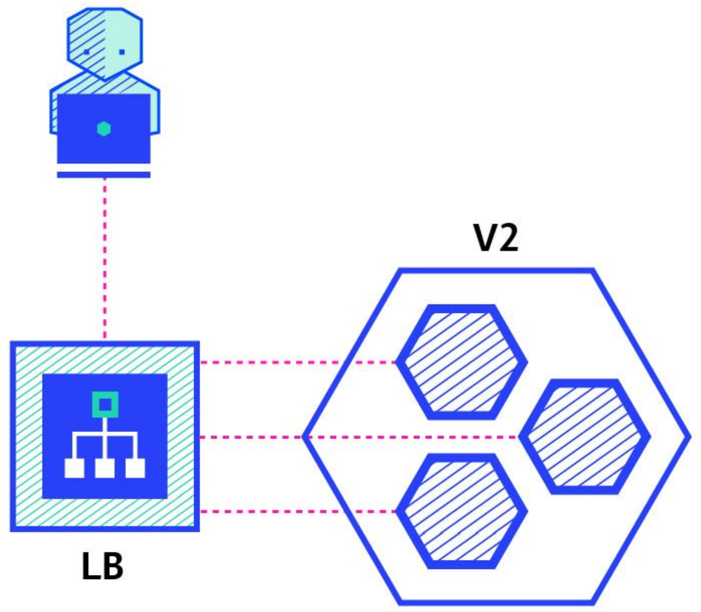
Recreate



In this case [LB] *is a Kubernetes Service*

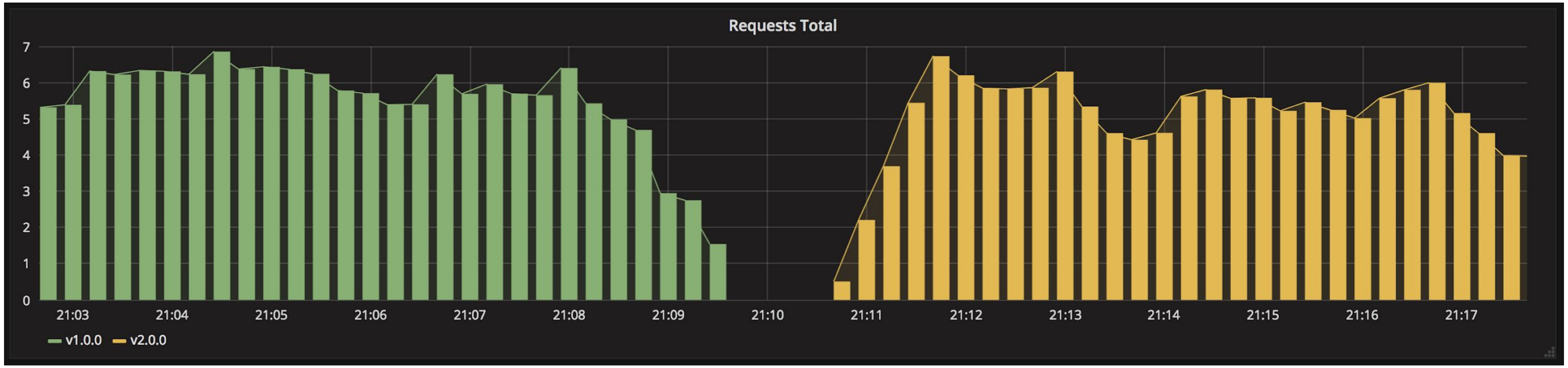
Recreate

```
[...]
kind: Deployment
spec:
    replicas: 3
    strategy:
        type: Recreate
[...]
```

```
$ kubectl apply -f ./manifest.yaml
```

Recreate

Pattern of the traffic during a release



Service unavailable

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Recreate

Pros:

- easy to setup

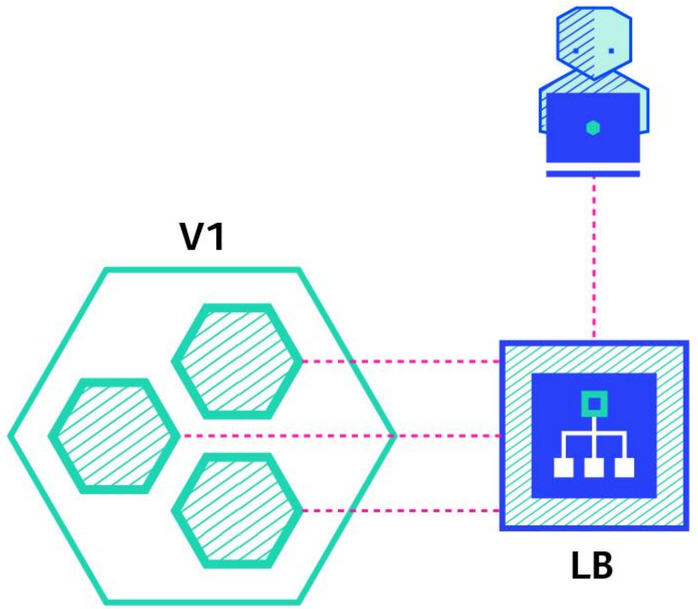
Cons:

- high impact on the user, expect downtime that depends on both shutdown and boot duration of the application

Ramped

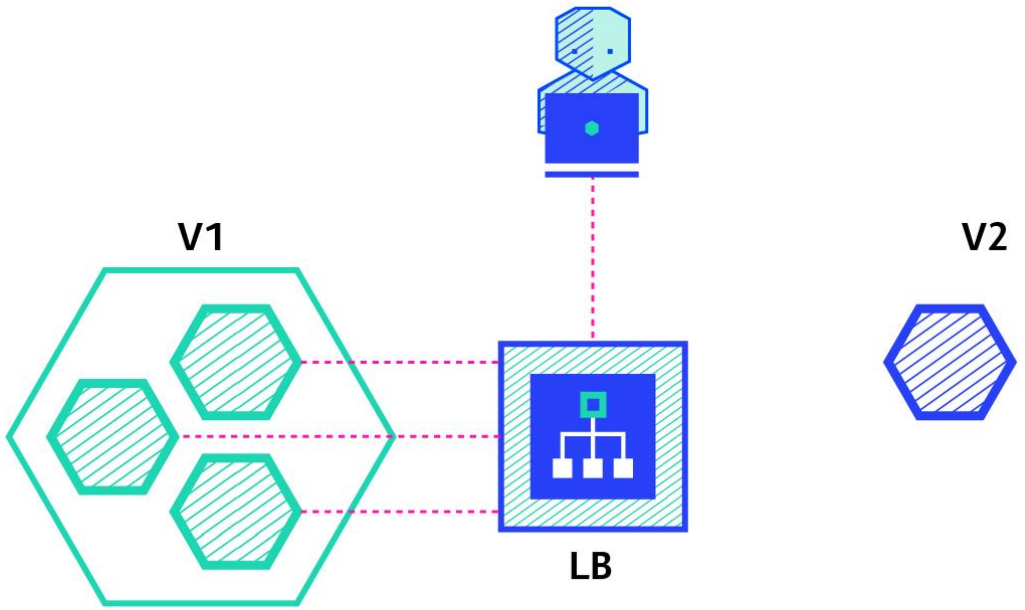
aka incremental, rolling update

Ramped - aka Incremental, Rolling



In this case [LB] *is a Kubernetes Service*

Ramped - aka Incremental, Rolling



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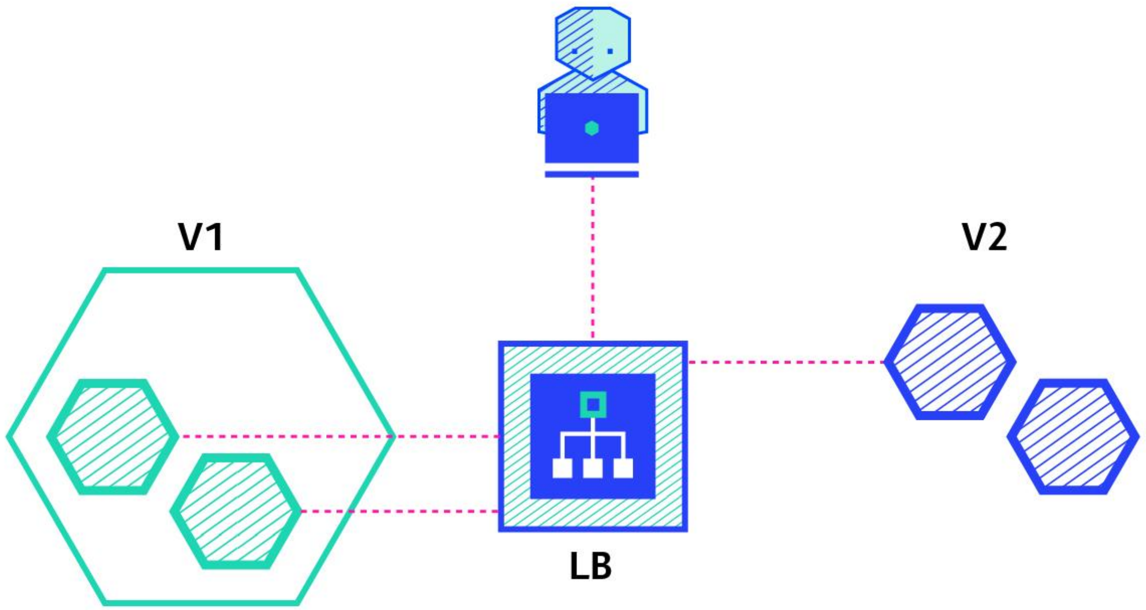

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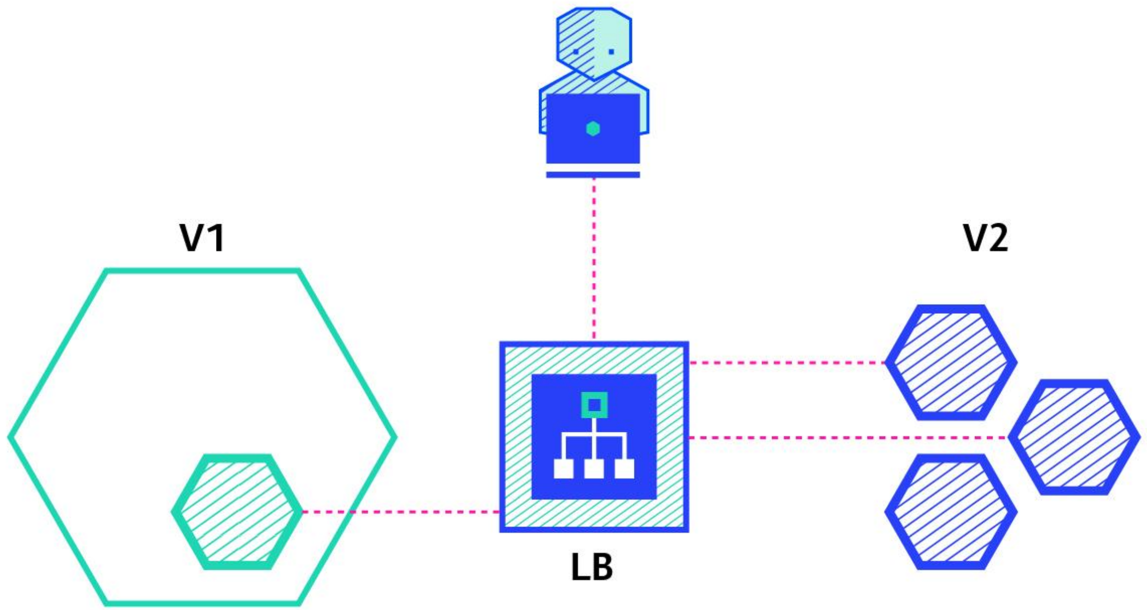
Ramped - aka Incremental, Rolling



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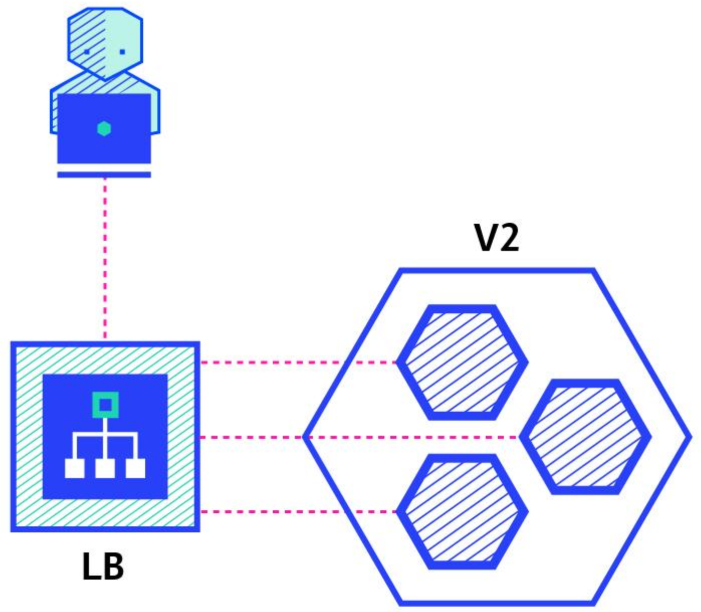


In this case [LB] *is a Kubernetes Service*

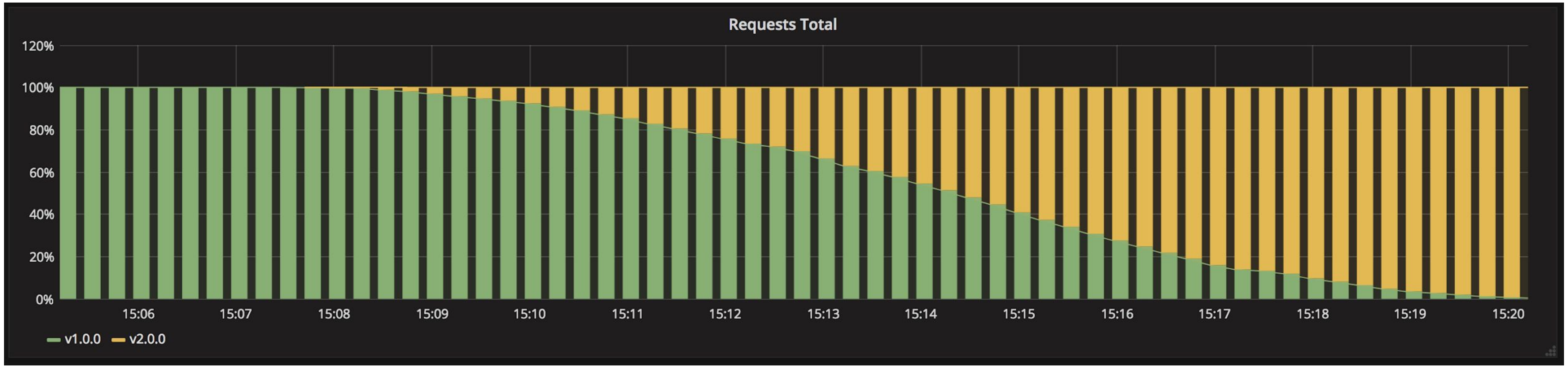
Ramped - aka Incremental, Rolling

```
[...]
kind: Deployment
spec:
  replicas: 3
  strategy:
    type: RollingUpdate
    rollingUpdate:
      maxSurge: 2          # how many pods we can add at a time
      maxUnavailable: 0    # maxUnavailable define how many pods can be
                           # unavailable during the rolling update
[...]
```

```
$ kubectl apply -f ./manifest.yaml
```

Ramped - aka Incremental, Rolling

Pattern of the traffic during a release



Ramped - aka Incremental, Rolling

Pros:

- easy to use
- version is slowly released across instances
- convenient for stateful applications that can handle ongoing rebalancing of the data

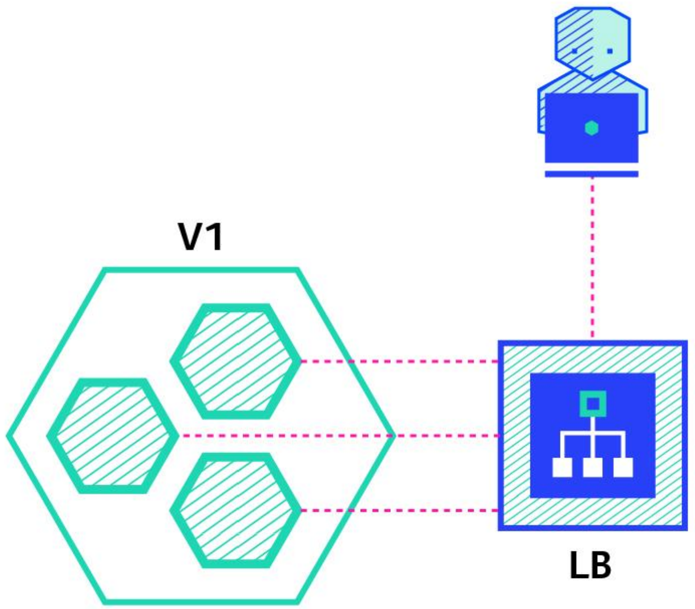
Cons:

- rollout/rollback can take time
- no control over traffic

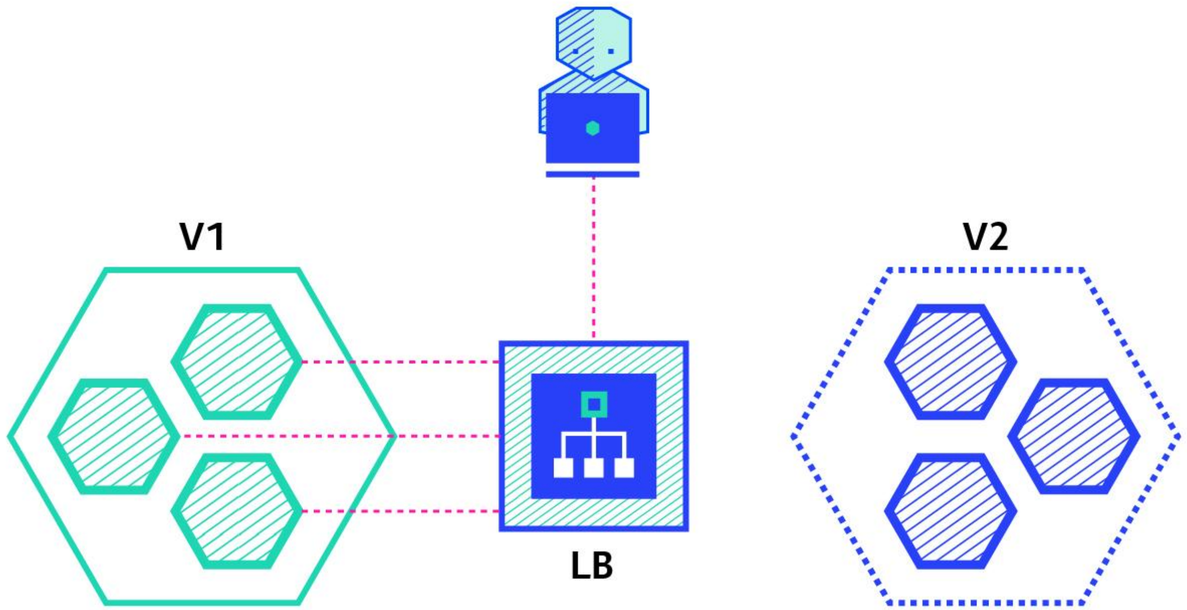
Blue/Green

aka red/black

Blue/Green - aka Red/Black



Blue/Green - aka Red/Black



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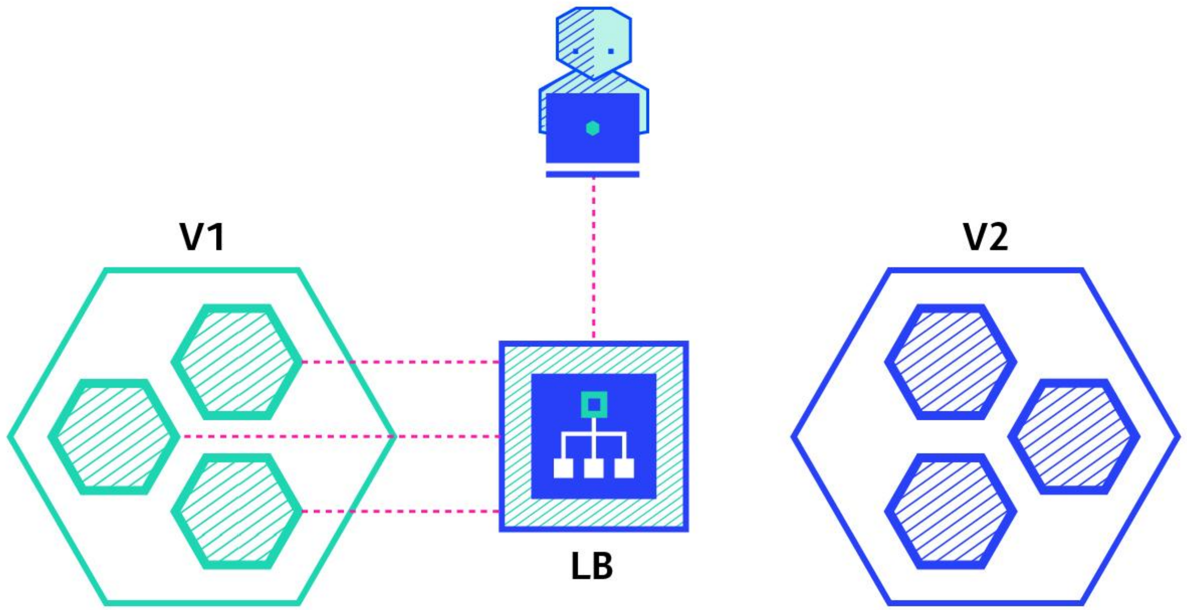
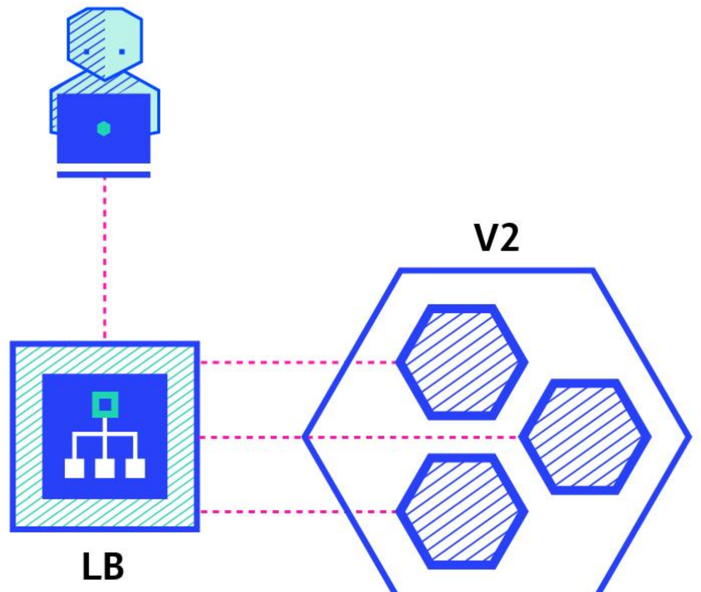
Blue/Green - aka Red/Black



Blue/Green - aka Red/Black



Blue/Green - aka Red/Black

Single service deployment

```
[...]
kind: Service
spec:
  # Note here that we match both the app and the version.
  # When switching traffic, update the label “version” with
  # the appropriate value, ie: v2.0.0
  selector:
    app: my-app
    version: v1.0.0
[...]
```

```
$ kubectl apply -f ./manifest-v2.yaml
$ kubectl patch service my-app -p \
    '{"spec":{"selector":{"version":"v2.0.0"}}}'
$ kubectl delete -f ./manifest-v1.yaml
```

Blue/Green - aka Red/Black

To rollout multiple services at once, use Ingress

```
[...]
kind: Ingress
spec:
  rules:
  - host: login.domain.com
    http:
      paths:
      - backend:
          serviceName: login-v2
          servicePort: 80
  - host: cart.domain.com
    http:
      paths:
      - backend:
          serviceName: cart-v2
          servicePort: 80
[...]
```

```
[...]
kind: Service
metadata:
  name: login-v2
spec:
  selector:
    app: login
    version: v2.0.0
[...]
```

```
[...]
kind: Service
metadata:
  name: cart-v2
spec:
  selector:
    app: cart
    version: v2.0.0
[...]
```

```
$ kubectl apply -f ./manifest-v2.yaml
$ kubectl apply -f ./ingress.yaml
$ kubectl delete -f ./manifest-v1.yaml
```

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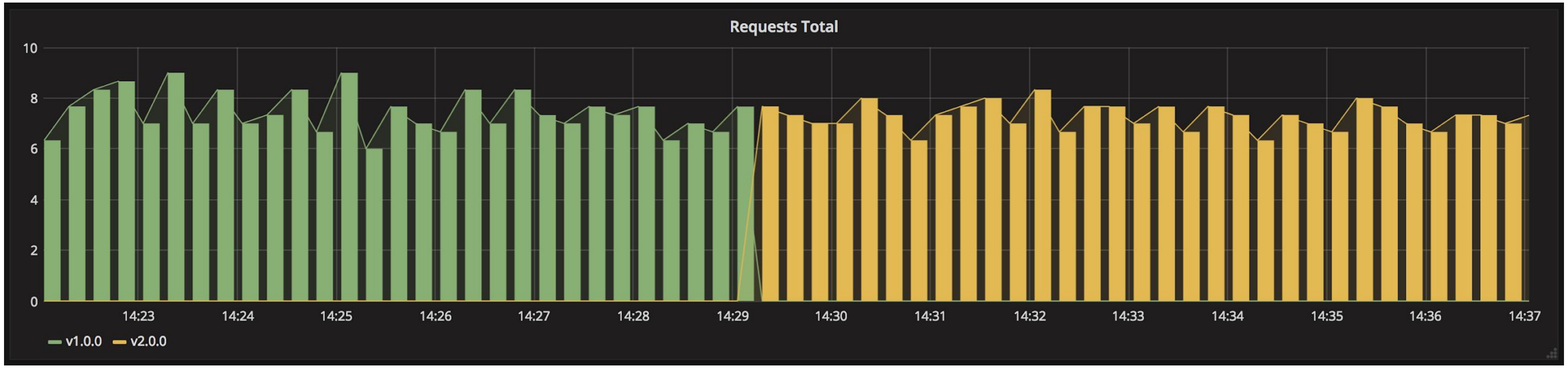
Blue/Green - aka Red/Black

Pattern of the traffic during a release



Blue/Green - aka Red/Black

Pros:

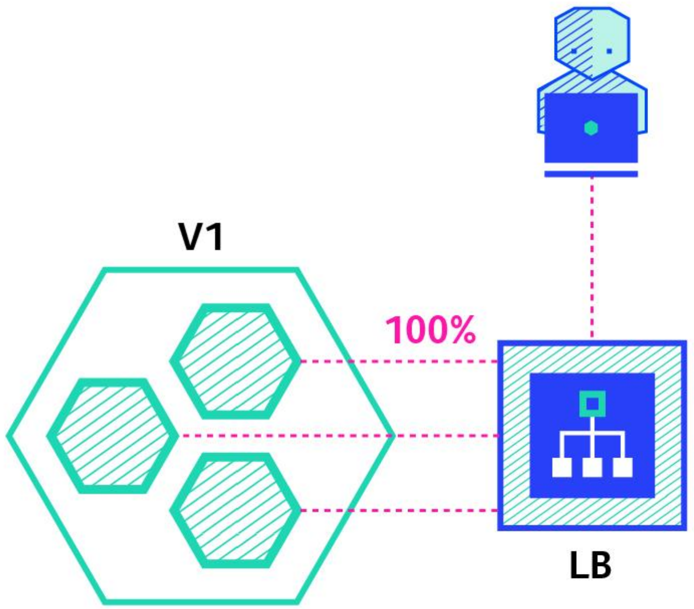
- instant rollout/rollback
- good fit for front-end that load versioned assets from the same server
- dirty way to fix application dependency hell

Cons:

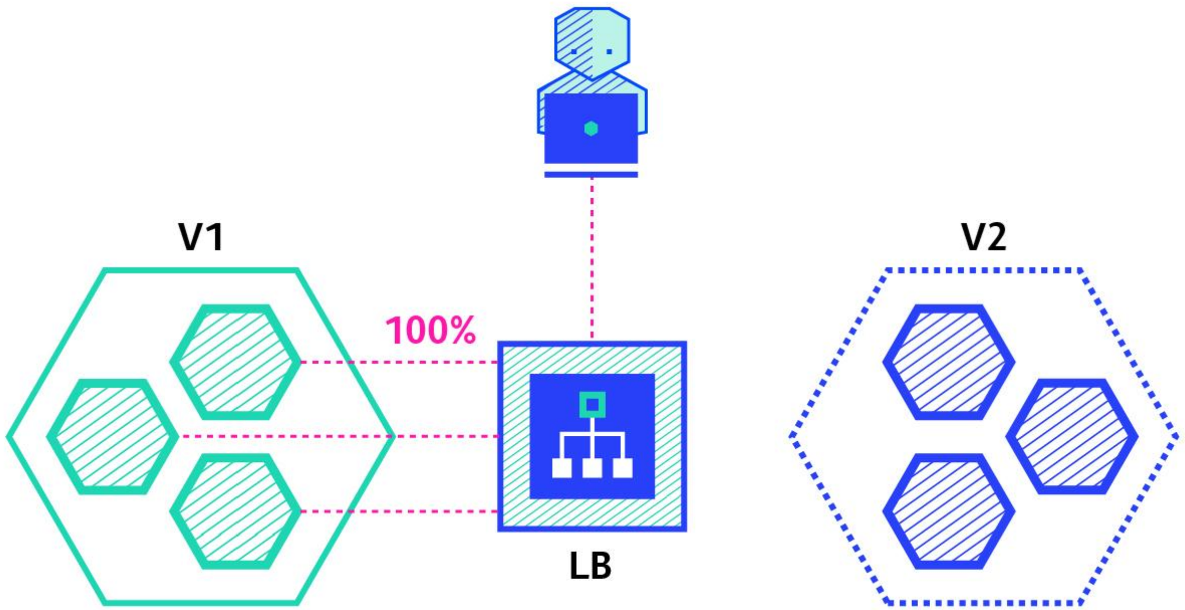
- expensive as it requires double the resources
- proper test of the entire platform should be done before releasing to production

Canary

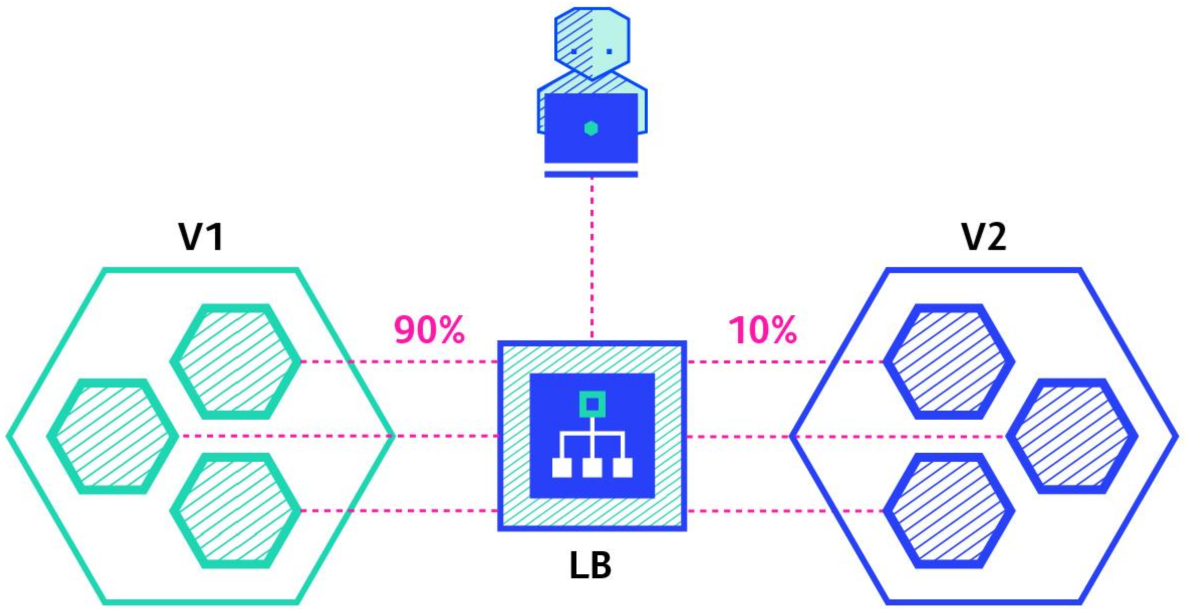
Canary



Canary



Canary



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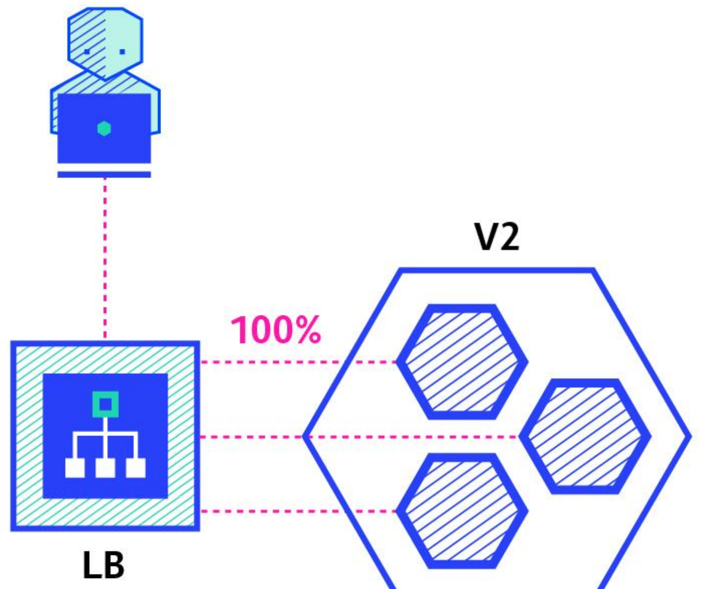
Canary



Canary

```
[...]
kind: Deployment
metadata:
  name: my-app-v1
spec:
  replicas: 9
  template:
    labels:
      app: my-app
      version: v1.0.0
[...]
```

```
[...]
kind: Deployment
metadata:
  name: my-app-v2
spec:
  replicas: 1
  template:
    labels:
      app: my-app
      version: v2.0.0
[...]
```

```
[...]
kind: Service
metadata:
  name: my-app
spec:
  selector:
    app: my-app
[...]
```

```
$ kubectl apply -f ./manifest-v2.yaml
$ kubectl scale deploy/my-app-v2 --replicas=10
$ kubectl delete -f ./manifest-v1.yaml
```

Canary

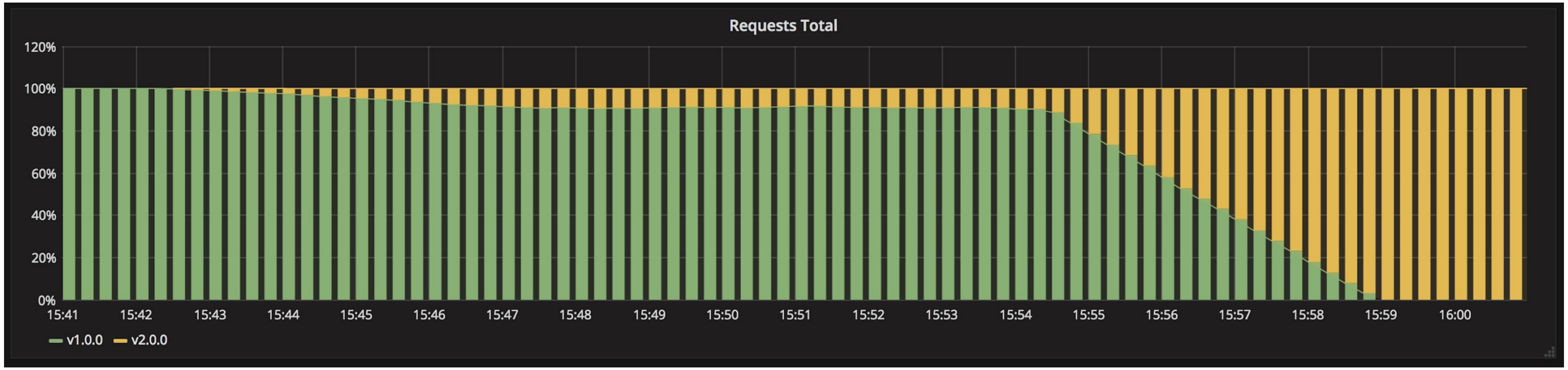
Example of shifting traffic based on weight (percentage) using *Istio*

```
[...]
kind: RouteRule
metadata:
  name: my-app
spec:
  destination:
    name: my-app
  route:
  - labels:
      version: v1.0.0
    weight: 90           # 90% traffic
  - labels:
      version: v2.0.0
    weight: 10           # 10% traffic
[...]
```

```
$ kubectl apply -f ./manifest-v2.yaml
$ kubectl apply -f ./routerule.yaml
```

Canary

Pattern of the traffic during a release



Canary

Pros:

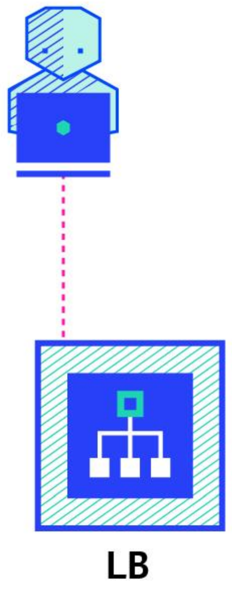
- version released for a subset of users
- convenient for error rate and performance monitoring
- fast rollback

Cons:

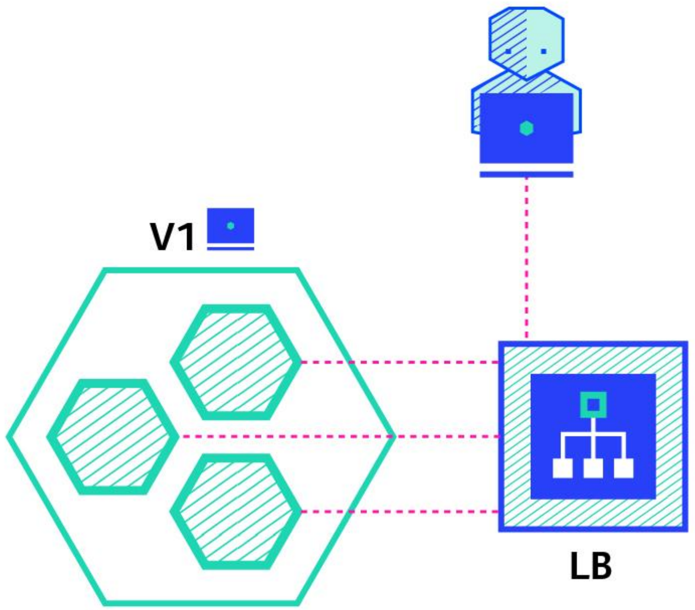
- slow rollout
- sticky sessions might be required
- precise traffic shifting would require additional tool like Istio or Linkerd

A/B Testing

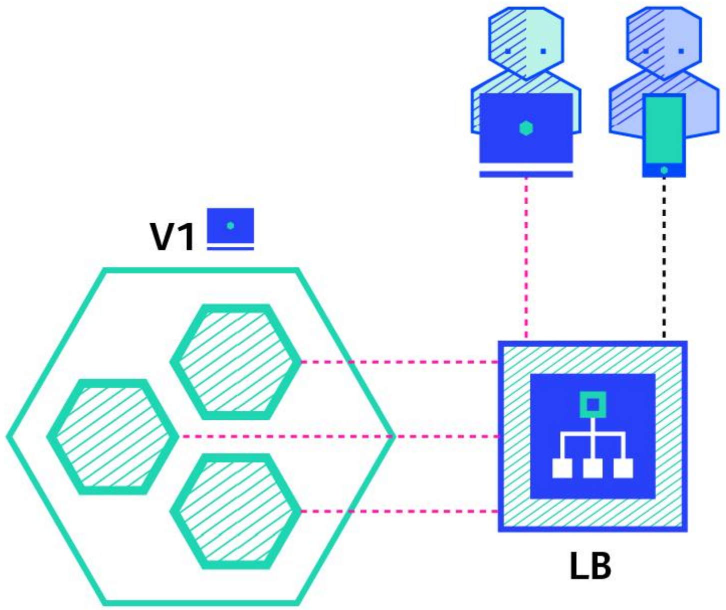
A/B Testing



A/B Testing



A/B Testing



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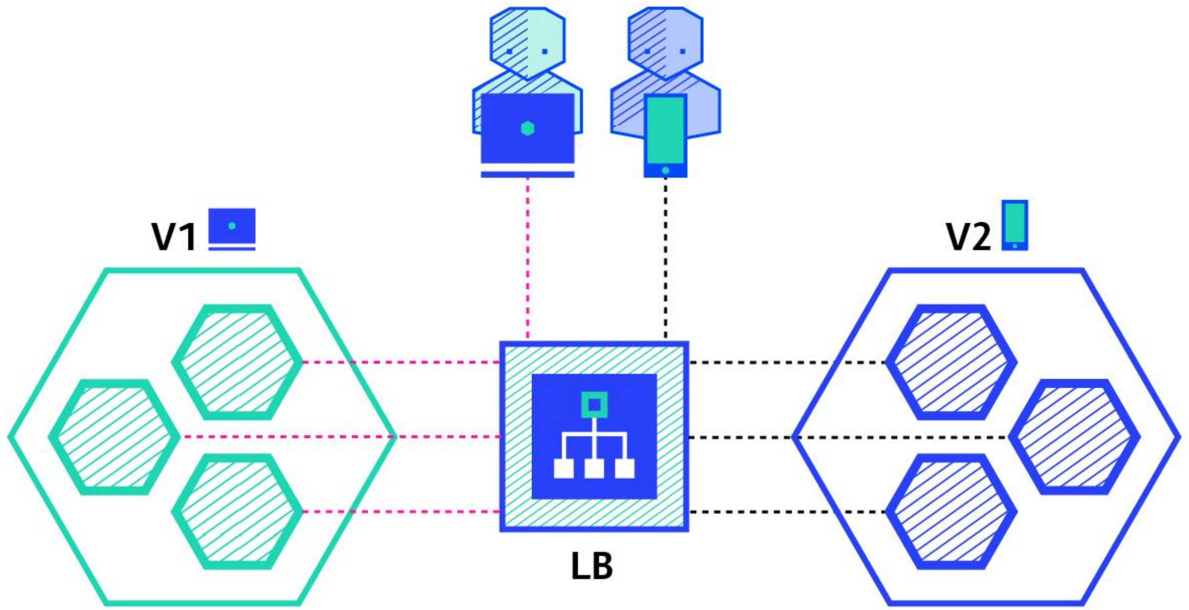
A/B Testing



Possible conditions:

- *Geolocalisation*
- *Language*
- *Cookie*
- *User Agent (device, OS, etc.)*
- *Custom Header*
- *Query parameters*

A/B Testing

Example of shifting traffic based on request Headers using *Istio*

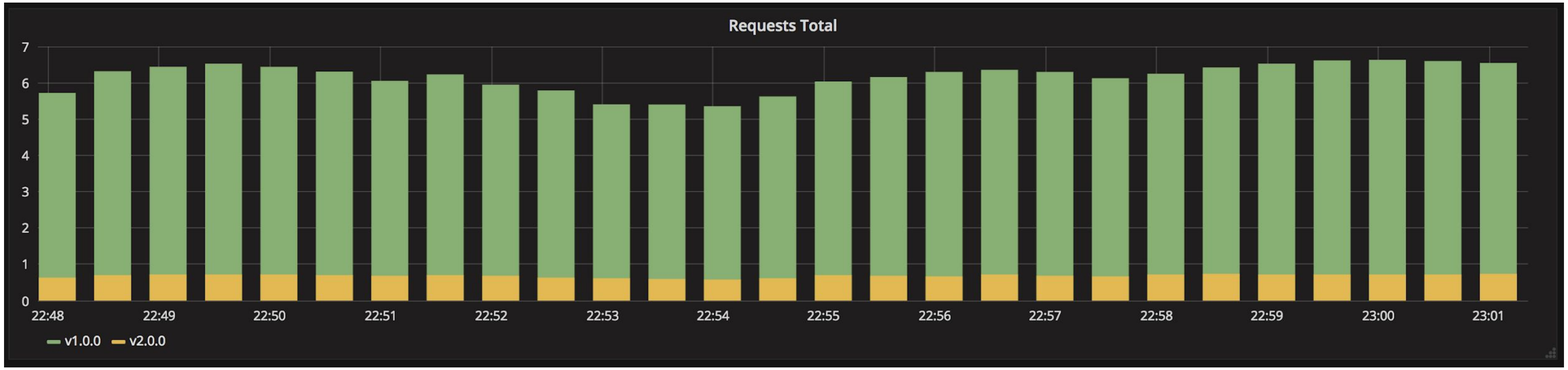
```
[...]
kind: RouteRule
metadata:
  name: my-app-v1
spec:
  destination:
    name: my-app
  route:
  - labels:
      version: v1.0.0
  match:
    request:
      headers:
        x-api-version:
          exact: "v1.0.0"
[...]
```

```
[...]
kind: RouteRule
metadata:
  name: my-app-v2
spec:
  destination:
    name: my-app
  route:
  - labels:
      version: v2.0.0
  match:
    request:
      headers:
        x-api-version:
          exact: "v2.0.0"
[...]
```

```
$ kubectl apply -f ./manifest-v2.yaml
$ kubectl apply -f ./routerule.yaml
```

A/B Testing

Pattern of the traffic during a release



A/B Testing

Pros:

- several versions run in parallel
- full control over the traffic distribution
- great tool that can be used for business purpose to improve conversion

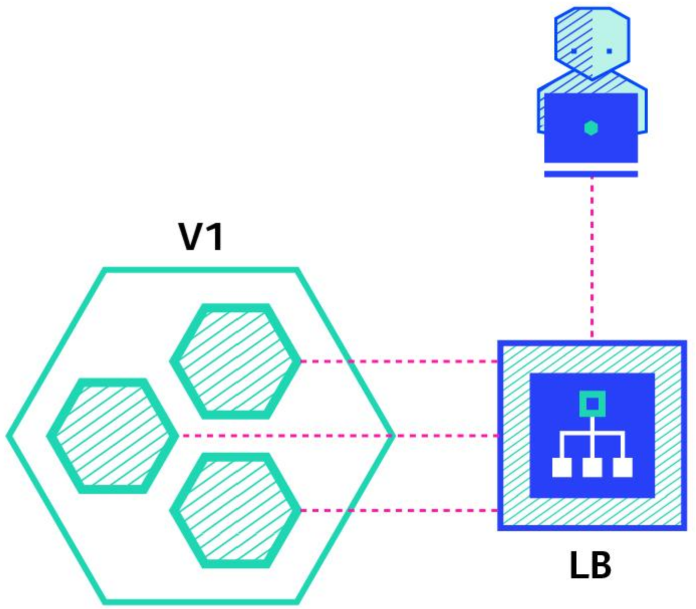
Cons:

- requires intelligent load balancer (Istio, Linkerd, etc.)
- hard to troubleshoot errors for a given session, distributed tracing becomes mandatory

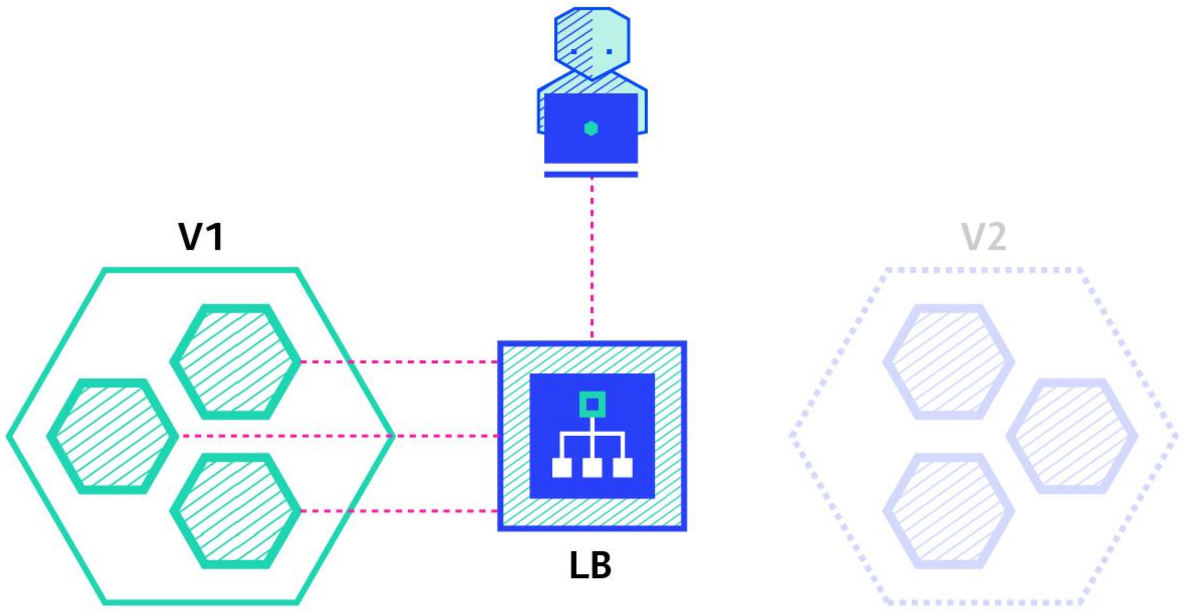
Shadow

aka Mirrored, Dark

Shadow - aka Mirrored, Dark



Shadow - aka Mirrored, Dark



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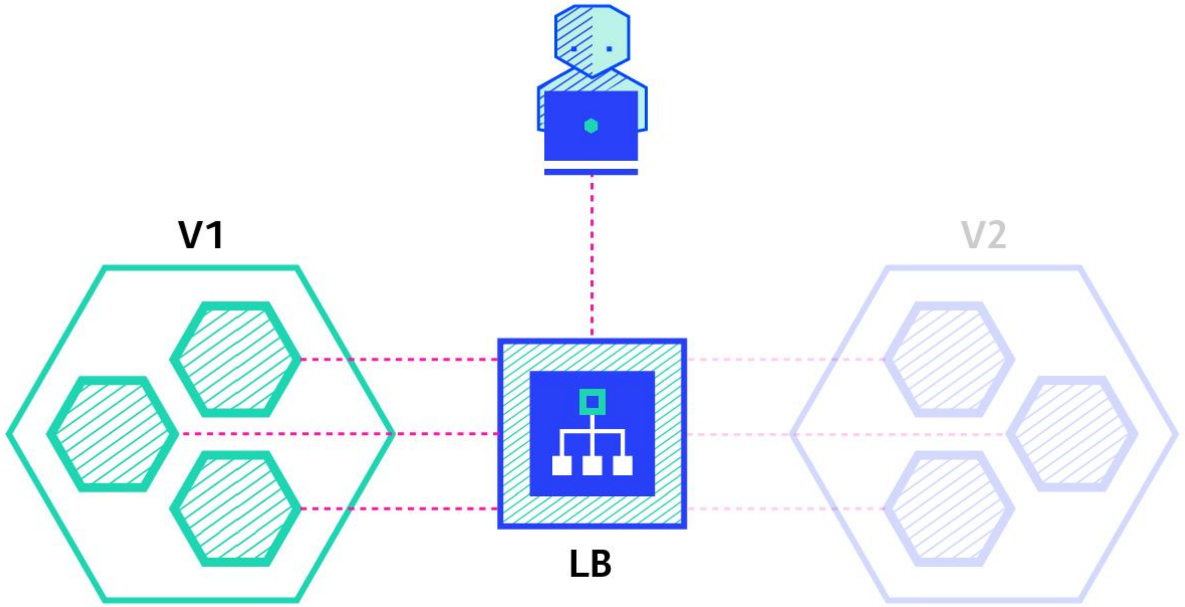
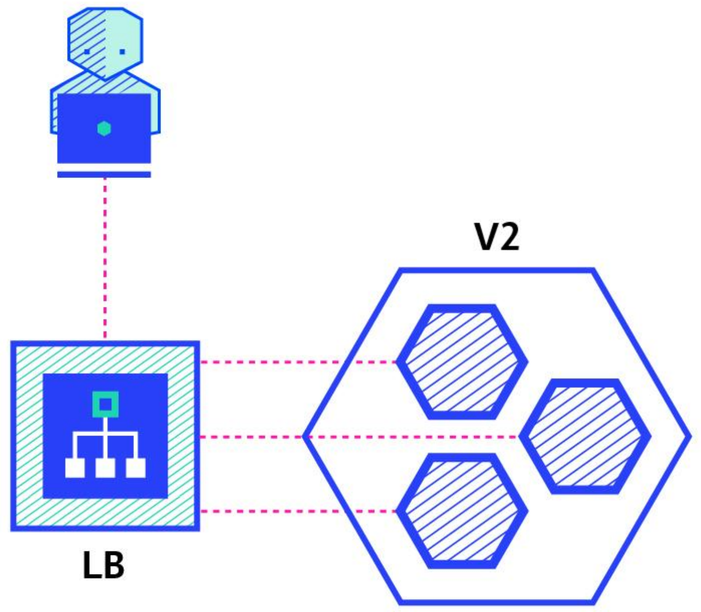
Shadow - aka Mirrored, Dark



Shadow - aka Mirrored, Dark



Shadow - aka Mirrored, Dark

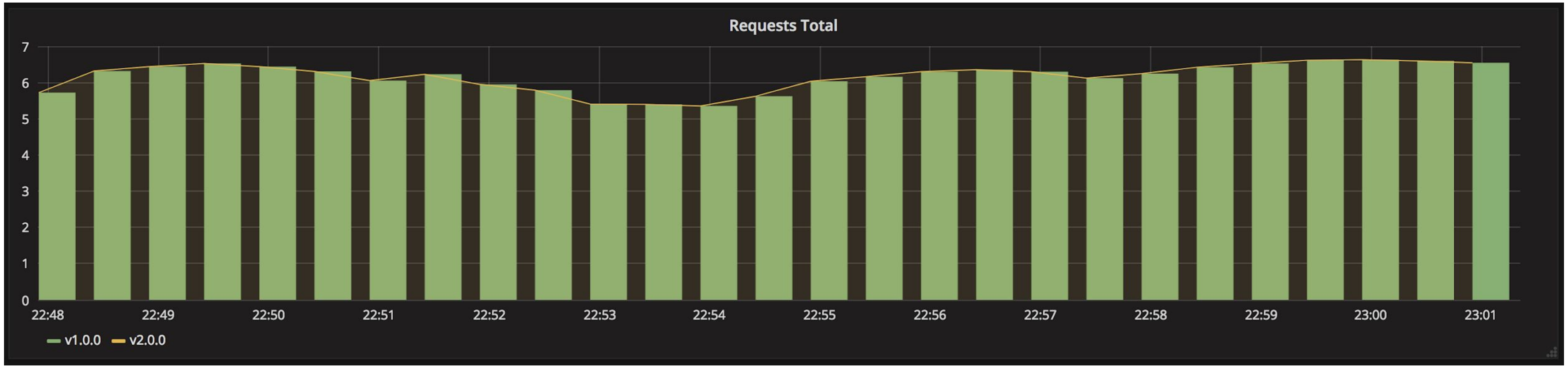
Example of mirroring traffic using *Istio*

```
[...]
kind: RouteRule
spec:
  destination:
    name: my-app
  route:
  - labels:
      version: v1.0.0
    weight: 100
  - labels:
      version: v2.0.0
    weight: 0
  mirror:
    name: my-app-v2
    labels:
      version: v2.0.0
[...]
```

```
$ kubectl apply -f ./manifest-v2.yaml
$ kubectl apply -f ./routerule.yaml
```

Shadow - aka Mirrored, Dark

Pattern of the traffic during a release



Shadow - aka Mirrored, Dark

Pros:

- performance testing of the application with production traffic
- no impact on the user
- no rollout until the stability and performance of the application meet the requirements

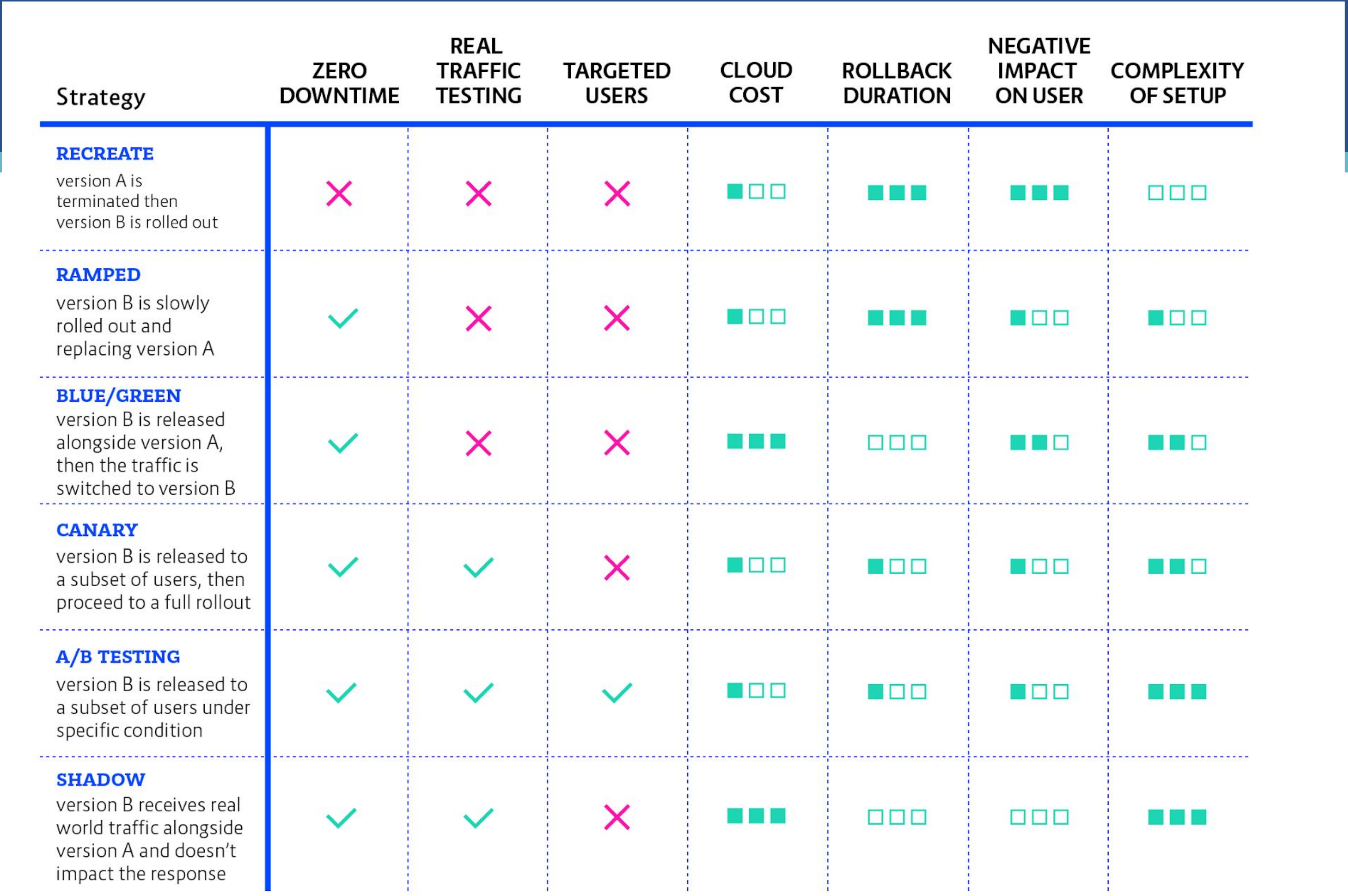
Cons:

- complex to setup
- expensive as it requires double the resources
- not a true user test and can be misleading
- requires mocking/stubbing service for certain cases

Sum-up

- **recreate** if downtime is not a problem
- **recreate** and **ramped** doesn’t require any extra step (kubectl apply is enough)
- **ramped** and **blue/green** deployment are usually a good fit and easy to use
- **blue/green** is a good fit for front-end that load versioned assets from the same server
- **blue/green** and **shadow** can be expensive
- **canary** and **a/b** testing should be used if little confidence on the quality of the release
- **canary**, **a/b testing** and **shadow** might require additional cluster component

Sum-up



Strategy	ZERO DOWNTIME	REAL TRAFFIC TESTING	TARGETED USERS	CLOUD COST	ROLLBACK DURATION	NEGATIVE IMPACT ON USER	COMPLEXITY OF SETUP
RECREATE version A is terminated then version B is rolled out	✗	✗	✗	■□□	■■■	■■■	□□□
RAMPED version B is slowly rolled out and replacing version A	✓	✗	✗	■□□	■■■	■□□	■□□
BLUE/GREEN version B is released alongside version A, then the traffic is switched to version B	✓	✗	✗	■■■	□□□	■■□	■■□
CANARY version B is released to a subset of users, then proceed to a full rollout	✓	✓	✗	■□□	■□□	■□□	■■□
A/B TESTING version B is released to a subset of users under specific condition	✓	✓	✓	■□□	■□□	■□□	■■■
SHADOW version B receives real world traffic alongside version A and doesn't impact the response	✓	✓	✗	■■■	□□□	□□□	■■■

Next

Hands on ***Kubernetes deployment strategies***:

https://github.com/ContainerSolutions/k8s-deployment-strategies

Blog post about strategies:

https://container-solutions.com/kubernetes-deployment-strategies

https://thenewstack.io/deployment-strategies

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Thank You