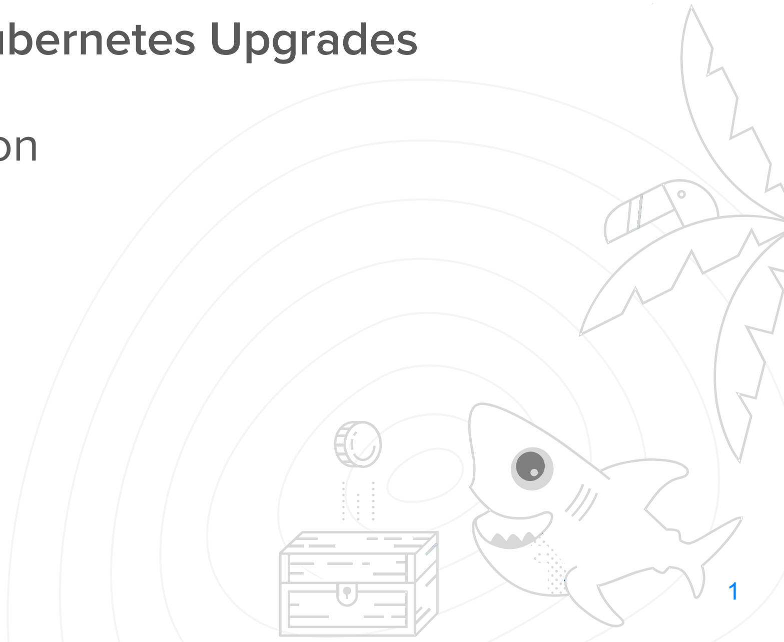
20,000 Upgrades Later

Lessons From a Year of Managed Kubernetes Upgrades

Adam Wolfe Gordon

DigitalOcean



This Talk Started One(ish) Year Ago...

Me, in Barcelona

DO, in Barcelona

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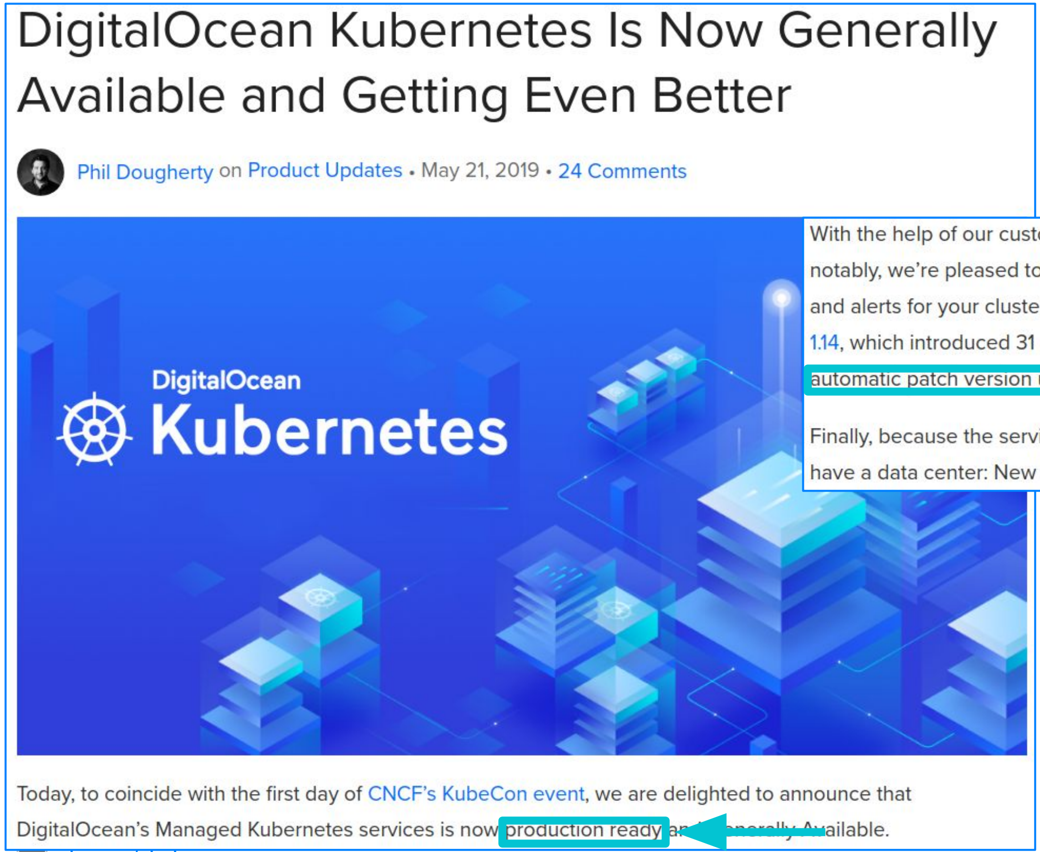
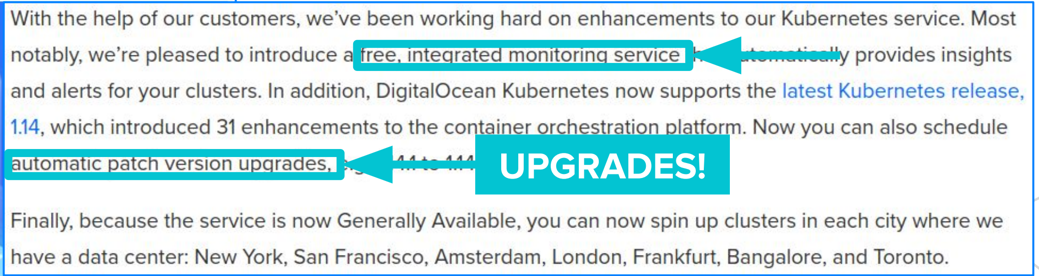
Generally Available?



DigitalOcean Kubernetes Is Now Generally Available and Getting Even Better

Phil Dougherty on Product Updates • May 21, 2019 • 24 Comments

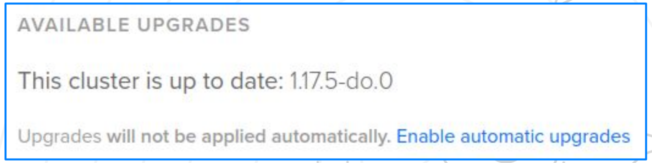
Today, to coincide with the first day of CNCF's KubeCon event, we are delighted to announce that DigitalOcean's Managed Kubernetes services is now production ready and generally Available.



With the help of our customers, we've been working hard on enhancements to our Kubernetes service. Most notably, we're pleased to introduce a free, integrated monitoring service that automatically provides insights and alerts for your clusters. In addition, DigitalOcean Kubernetes now supports the latest Kubernetes release, 1.14, which introduced 31 enhancements to the container orchestration platform. Now you can also schedule automatic patch version upgrades, e.g. 1.14.1 to 1.14.

UPGRADES!

Finally, because the service is now Generally Available, you can now spin up clusters in each city where we have a data center: New York, San Francisco, Amsterdam, London, Frankfurt, Bangalore, and Toronto.



AVAILABLE UPGRADES

This cluster is up to date: 1.17.5-do.0

Upgrades will not be applied automatically. Enable automatic upgrades

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~~20,000~~ 35,000 Upgrades Later

Lessons From a Year of Managed Kubernetes Upgrades

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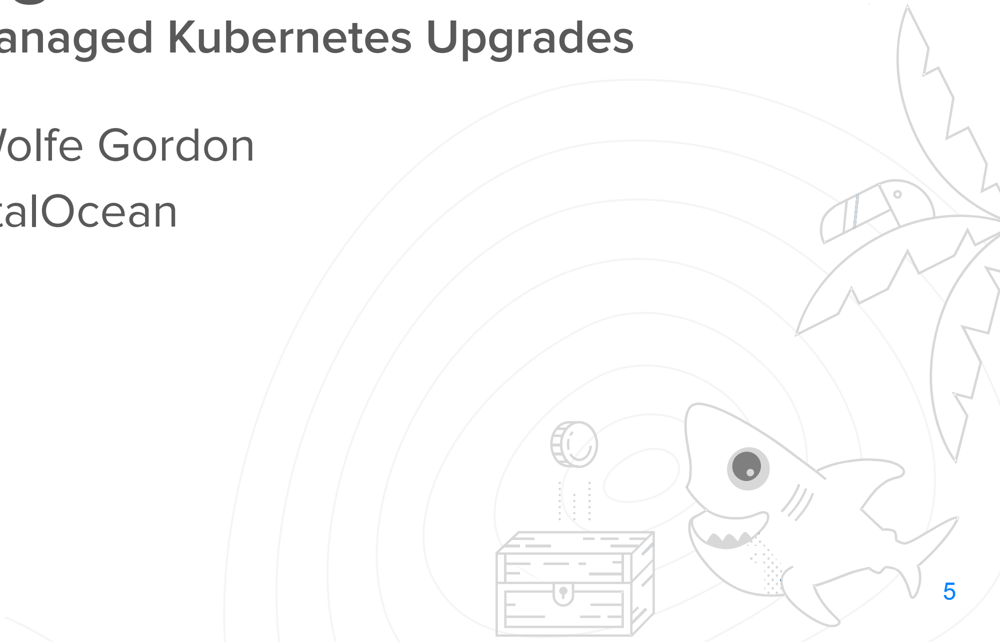

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Disclaimers!

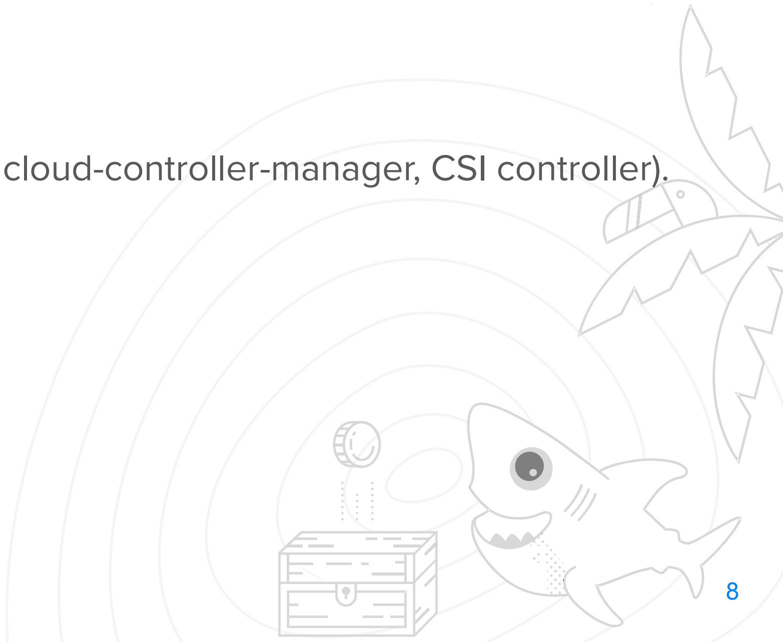
- Lessons from **our** upgrade process.
    - You might upgrade differently!
- Upgrades of **our** customers' clusters.
    - Your workloads might be different!

How to Upgrade Kubernetes

1. Upgrade the control plane.
2. Upgrade the worker nodes.
3. ???
4. Profit!

How to Upgrade Kubernetes

1. Upgrade the control plane.
   a. Update any resources that aren’t supported in the target version.
   b. Upgrade etcd (if needed).
   c. Upgrade kube-apiserver.
   d. Upgrade kube-controller-manager.
   e. Upgrade kube-scheduler.
   f. Upgrade your CNI plugin (if needed).
   g. Upgrade provider-specific components (e.g. cloud-controller-manager, CSI controller).
   h. Upgrade kubelet and kubectl.
2. Upgrade the worker nodes.
   a. Cordon and drain a worker node.
   b. Update kubelet configuration (if needed).
   c. Upgrade the kubelet.
   d. Uncordon the node.
   e. Repeat for each node in the cluster.



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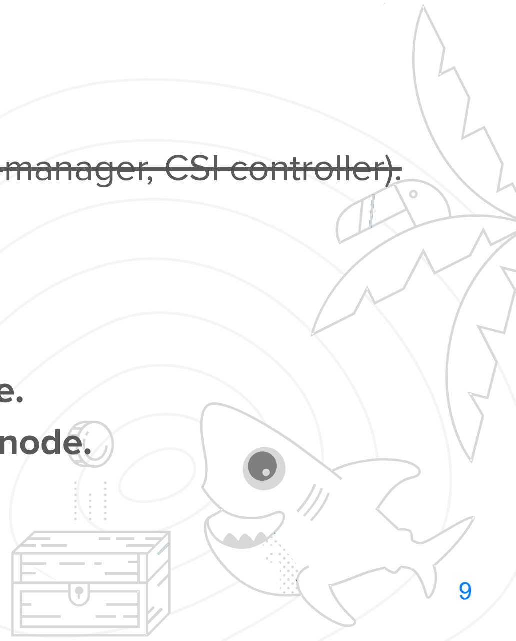
Shortcut: Upgrade via Node Replacement

1. Upgrade the control plane.
    a. Update any resources that aren't supported in the target version.
    ~~b. Upgrade etcd (if needed).~~ **b. Destroy the original control plane node.**
    ~~c. Upgrade kube-apiserver.~~ **c. Provision a new control plane node.**
    ~~d. Upgrade kube-controller-manager.~~
    ~~e. Upgrade kube-scheduler.~~
    ~~f. Upgrade your CNI plugin (if needed).~~
    ~~g. Upgrade provider-specific components (e.g. cloud-controller-manager, CSI controller).~~
    ~~h. Upgrade kubelet and kubectl.~~
2. Upgrade the worker nodes.
    a. Cordon and drain a worker node.
    ~~b. Update kubelet configuration (if needed).~~ **b. Destroy the node.**
    ~~c. Upgrade the kubelet.~~ **c. Provision a new node.**
    ~~d. Uncordon the node.~~
    e. Repeat for each node in the cluster.



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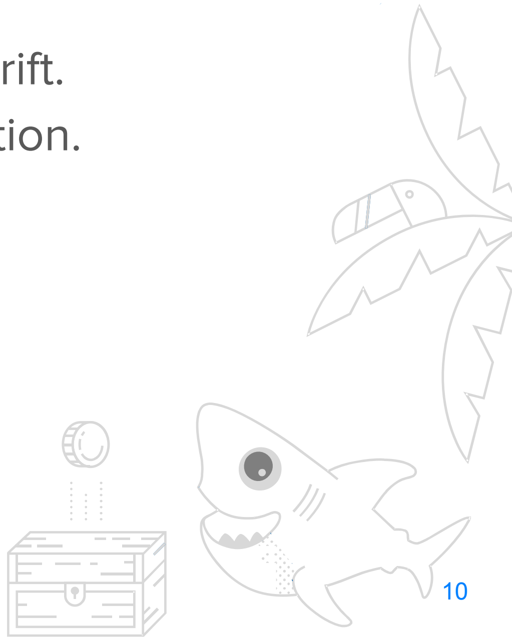
Advantages of Node Replacement

- Clean slate - no chance for configuration drift.
- Fewer steps to manage - good for automation.
- Same process works for all release types.
    - (Mostly)



Things We Got Right

Upgrades via Node Replacement

Problems
Ch-ch-changes

- Custom node configuration is reset.
- Node names change.
- Node IPs change.
- Node labels and taints lost.

Lessons for Operators
Managing Change

- Re-use node names and IPs if possible.
- Retain labels or provide a good alternative.
- Retain taints or provide a good alternative.
- Provide simple ingress/load balancing.

Lessons for Developers
Tolerating Change

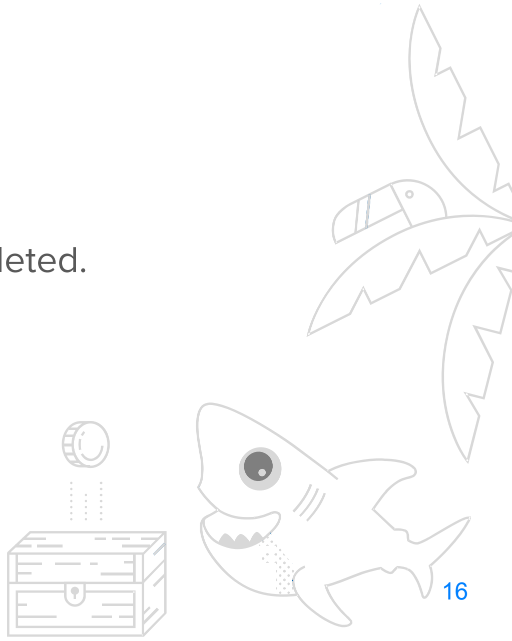
- Use Kubernetes to do node customization.
  - DaemonSets
  - Init containers
- Don’t use node names for scheduling.
- Use provider-supported label/taint settings.
- Use provider-supported load balancing.

Things We Got Wrong

Break Before Make

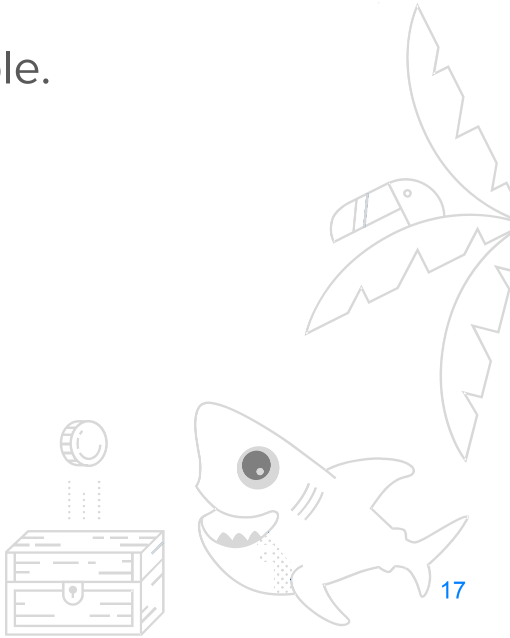
Problems
Drain to Nowhere

- Insufficient capacity to drain nodes.
- Downtime in single-node clusters.
- Extra churn for workloads.
    - Might be drained to a node that’s about to be deleted.



Lessons for Operators
Drainage Capacity

- Add nodes before deleting nodes if possible.
- Consider reserving capacity.



Lessons for Developers
Expect to be Drained

- Leave capacity for a node to be drained.

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Things We Got Wrong

Replacing Nodes One by One

Problems
Ants Go Marching

- Replacing nodes one-by-one is slow.
- Workloads can get stuck draining
  - Making replacement even slower.
- Upgrades need to be expedient.

Lessons for Operators
Rapid Replacement

- Drain and replace multiple nodes at once.
  - This usually requires make-before-break.
- Set reasonable drain timeouts.

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Lessons for Developers
Unclog Your Drains

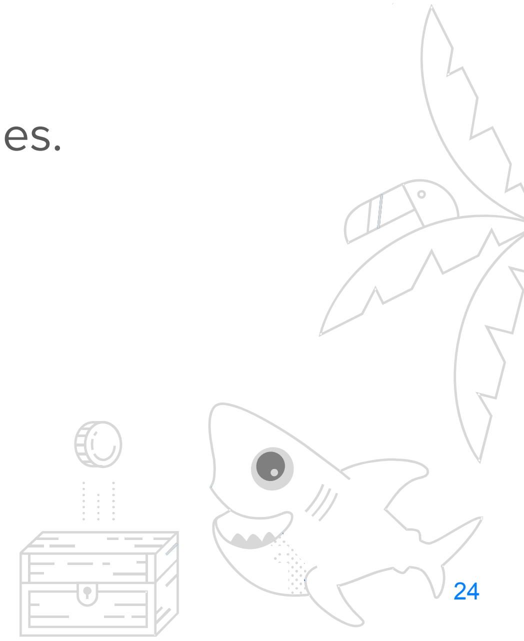
- Make sure your workloads can be evicted.
  - Safely: Use PodDisruptionBudgets.
  - Quickly: Respond to signals.
- Test this!

Things We Got Wrong (but felt so right)

Minor Version Upgrades are Easy

Lessons for Operators
Don’t Worry, Be Happy

- Minor version upgrades aren’t that scary.
- Try to use the same process for all upgrades.



Things We Got Right

Disabling Alpha Features

Lessons for Operators
Wait for Beta

- Alpha features are disabled by default.
- Alpha features are likely to change/break.
- Beta features are less likely to change.
- Consider the upgrade tradeoff.

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Lessons for Developers
Alpha as a Last Resort

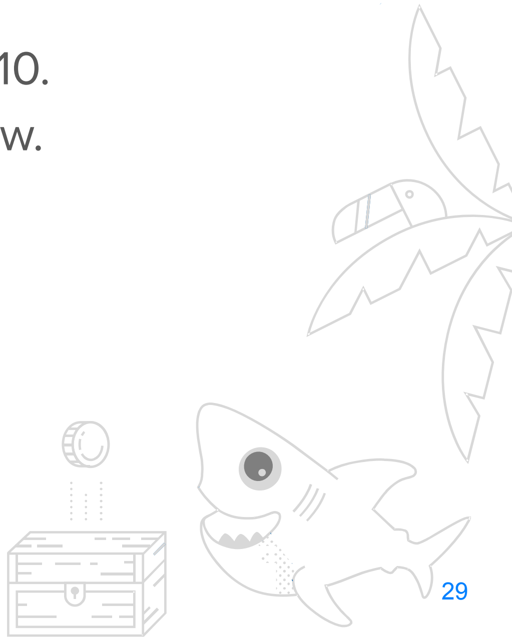
- Avoid using alpha features if possible.
- Read release notes before upgrading.

Common Problems

Container Storage Interface (CSI)

CSI Problems
Beta

- CSI was promoted to beta in Kubernetes 1.10.
- Supporting components were relatively new.
- CSI drivers were relatively new.
- Out-of-sync state.
- Far fewer problems in recent releases.



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CSI Problems
Driver Names

- In early CSI specs, com.example.csi.
- In later CSI specs, csi.example.com.
- The name is immutable in Kubernetes!
- Solution: detect and persist old naming.

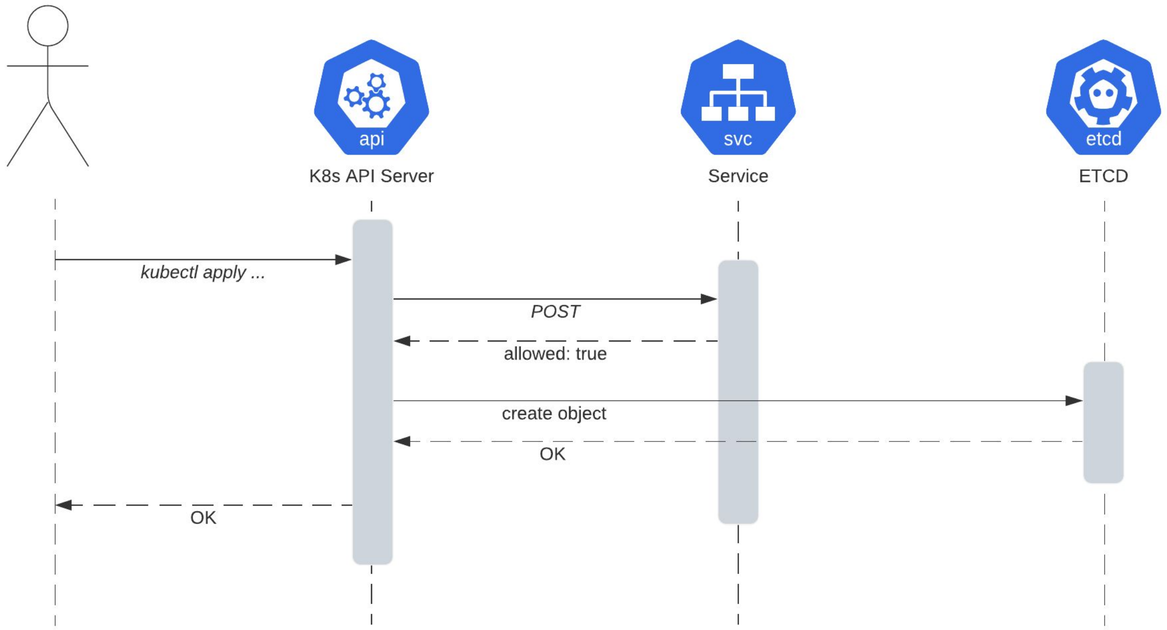
Lessons
Beware the CSI

- If you’re using CSI, carefully test upgrades.
- Watch for workloads that get stuck.
- Use Kubernetes 1.14+ if possible.

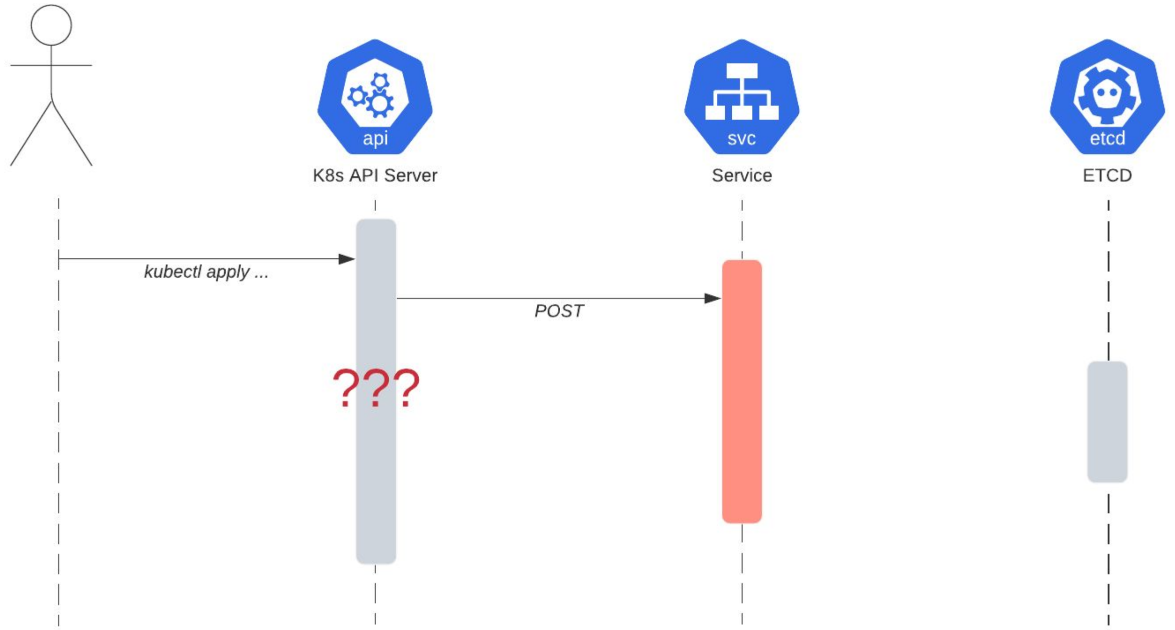
Common Problems

Admission Control Webhooks

Admission Control Webhooks Overview



Admission Control Webhooks Overview



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Admission Control Webhooks Overview

```yaml
apiVersion: admissionregistration.k8s.io/v1
kind: ValidatingWebhookConfiguration
metadata:
  name: webhook.example.com
webhooks:
- name: webhook.example.com
  rules:
  - apiGroups:   [""]
    apiVersions: ["v1"]
    operations:  ["CREATE"]
    resources:   ["pods"]
    scope:       "Namespaced"
  clientConfig:
    service:
      namespace: "webhook-namespace"
      name: "webhook-service"
  admissionReviewVersions: ["v1", "v1beta1"]
  sideEffects: None
  timeoutSeconds: 30
  failurePolicy: Ignore
```

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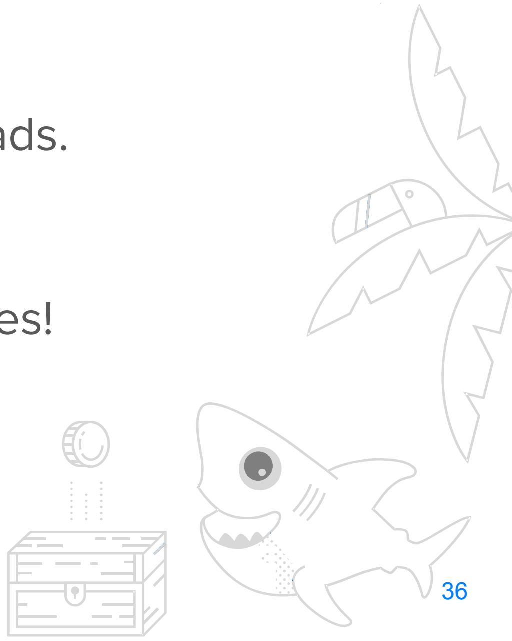
Admission Control Webhooks
Trouble for Upgrades

- Upgrades update system components.
- Some of these components run as workloads.
  - Usually in the kube-system namespace.
- Webhooks can prevent these updates.
- Webhooks can also affect their own services!



Admission Control Webhooks: Problems

```yaml
apiVersion: admissionregistration.k8s.io/v1
kind: ValidatingWebhookConfiguration
metadata:
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    apiVersions: ["v1"]
    operations:  ["CREATE"]
    resources:   ["pods"]
    scope:       "Namespaced"
  clientConfig:
    service:
      namespace: "webhook-namespace"
      name: "webhook-service"
  admissionReviewVersions: ["v1", "v1beta1"]
  sideEffects: None
  timeoutSeconds: 30
  failurePolicy: Fail
```

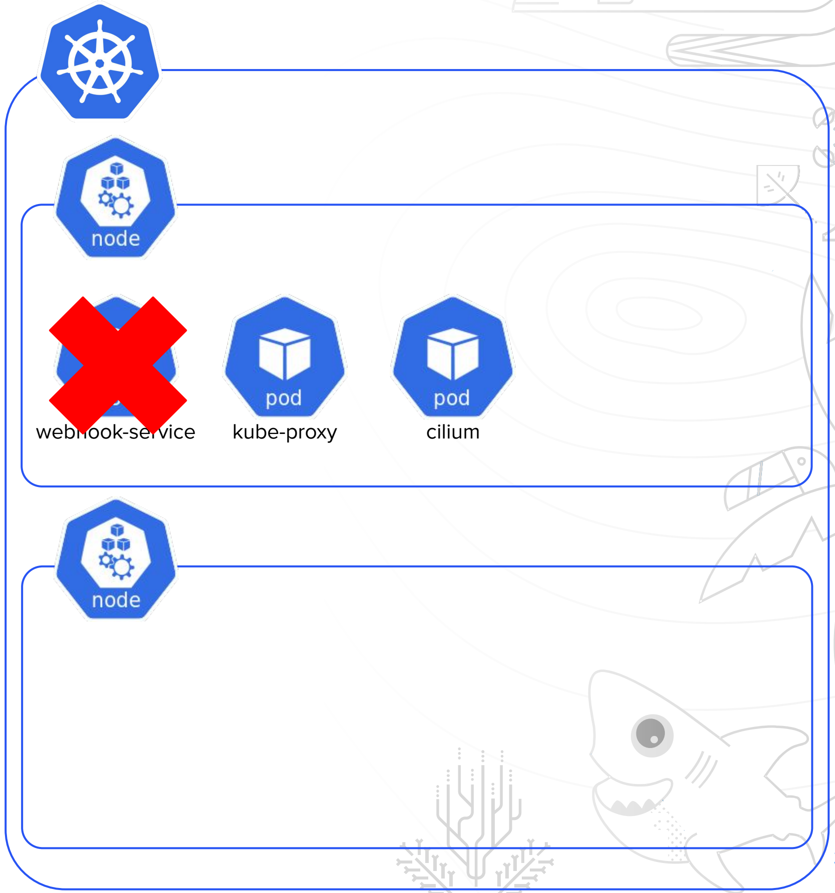

Admission Control Webhooks: Solutions

```yaml
apiVersion: admissionregistration.k8s.io/v1
kind: ValidatingWebhookConfiguration
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    resources:   ["pods"]
    scope:       "Namespaced"
  clientConfig:
    service:
      namespace: "webhook-namespace"
      name: "webhook-service"
  admissionReviewVersions: ["v1", "v1beta1"]
  sideEffects: None
  timeoutSeconds: 30 ←
  failurePolicy: Ignore ←
```

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Admission Control Webhooks: Solutions

```yaml
apiVersion: admissionregistration.k8s.io/v1
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webhooks:
- name: webhook.example.com
  rules:
  - apiGroups:   [""]
    apiVersions: ["v1"]
    operations:  ["CREATE"]
    resources:   ["pods"]
    scope:       "Namespaced"
  clientConfig:
    service:
      namespace: "webhook-namespace"
      name: "webhook-service"
  admissionReviewVersions: ["v1", "v1beta1"]
  sideEffects: None
  timeoutSeconds: 5
  failurePolicy: Ignore
```

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Admission Control Webhooks: Solutions

```yaml
apiVersion: admissionregistration.k8s.io/v1
kind: ValidatingWebhookConfiguration
metadata:
  name: webhook.example.com
webhooks:
- name: webhook.example.com
  namespaceSelector:
    matchExpressions:
    - key: system-critical
      operator: DoesNotExist
...
  clientConfig:
    service:
      namespace: "webhook-namespace"
      name: "webhook-service"
  admissionReviewVersions: ["v1", "v1beta1"]
  sideEffects: None
  timeoutSeconds: 5
  failurePolicy: Fail
```

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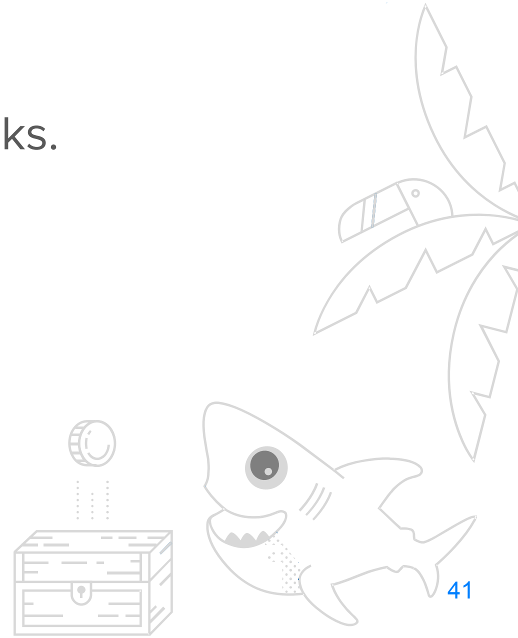
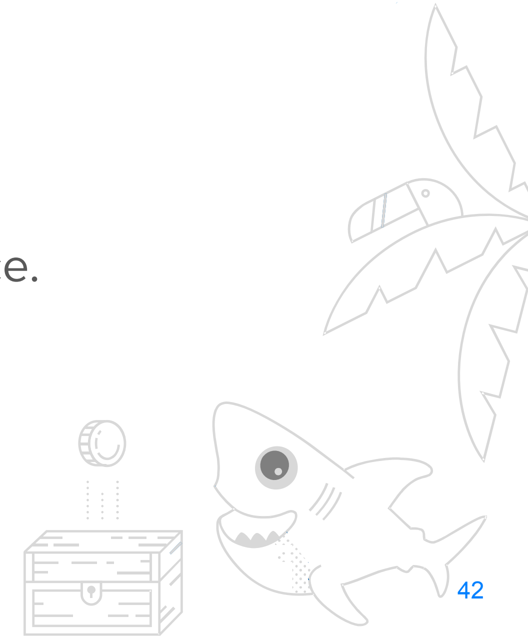
Lessons for Operators
Webhooks are Trouble

- Check webhook config before upgrading.
- Consider a mutating webhook for webhooks.



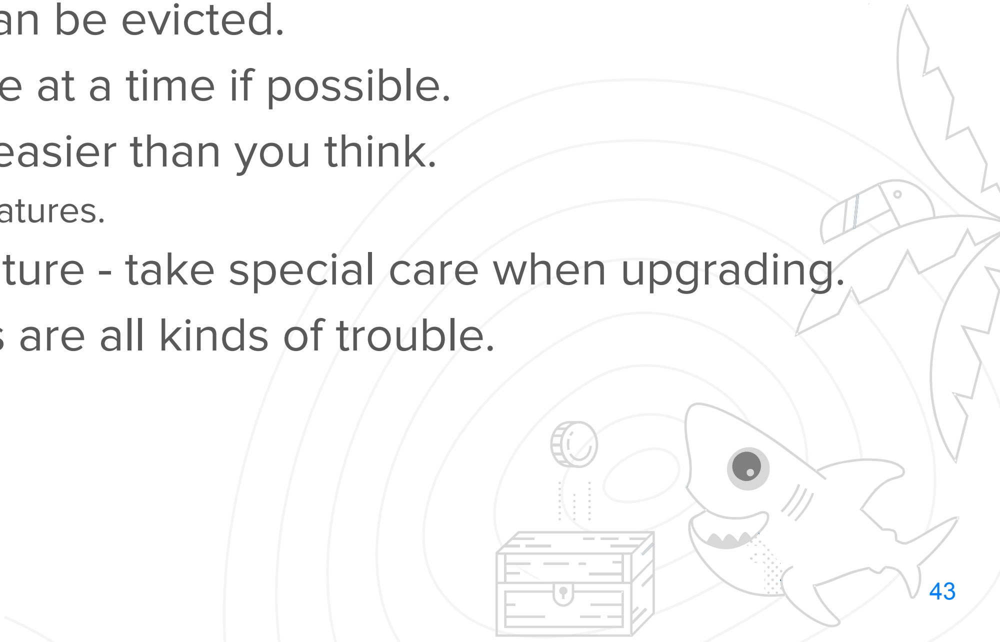
Lessons for Developers
Be Careful with Webhooks

- Set failurePolicy to Ignore if possible.
- Set timeout much lower than 30 seconds.
- Exclude kube-system.
- Exclude the webhook service's namespace.
  - Or run the webhook service outside the cluster.
- Exclude any other critical namespaces.



Wrap Up

- Consider upgrading via node replacement.
  - Retain node names and IP addresses if you can.
  - Workloads should assume that nodes will go away.
  - Create new nodes before destroying old ones, if possible.
- Make sure your workloads can be evicted.
- Upgrade more than one node at a time if possible.
- Minor version upgrades are easier than you think.
  - Especially if you avoid alpha features.
- CSI is just now becoming mature - take special care when upgrading.
- Admission control webhooks are all kinds of trouble.
  - Check your targets.
  - Check your failure policies.
  - Check your timeouts.



Questions?

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