Enforcing Bespoke Policies in Kubernetes

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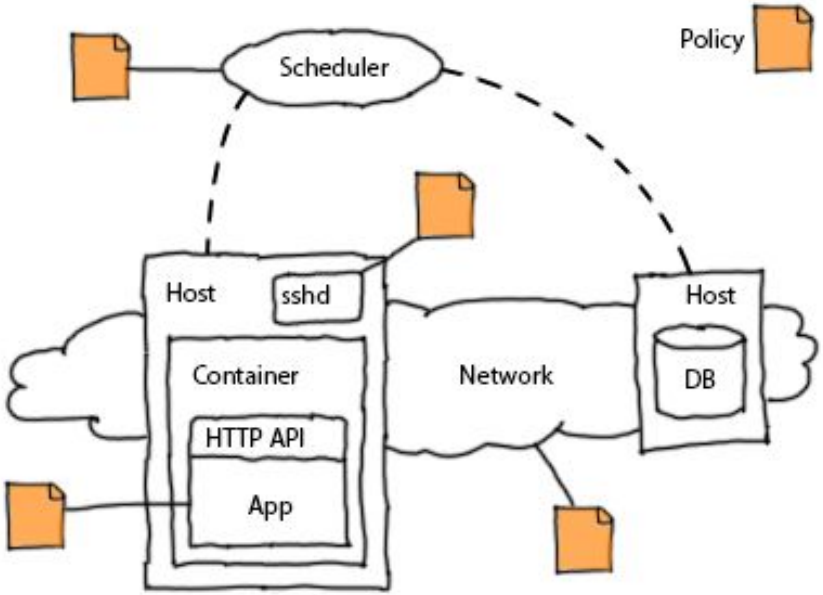
Overview

- What Is Policy?
- Example Scenario
- Admission Control
- Open Policy Agent

What Is Policy?

- Every organization has unique policies that affect the entire stack and change over time
- Policies are sets of rules that govern how the system *should* behave
- Policies are vital to the long-term success of organizations



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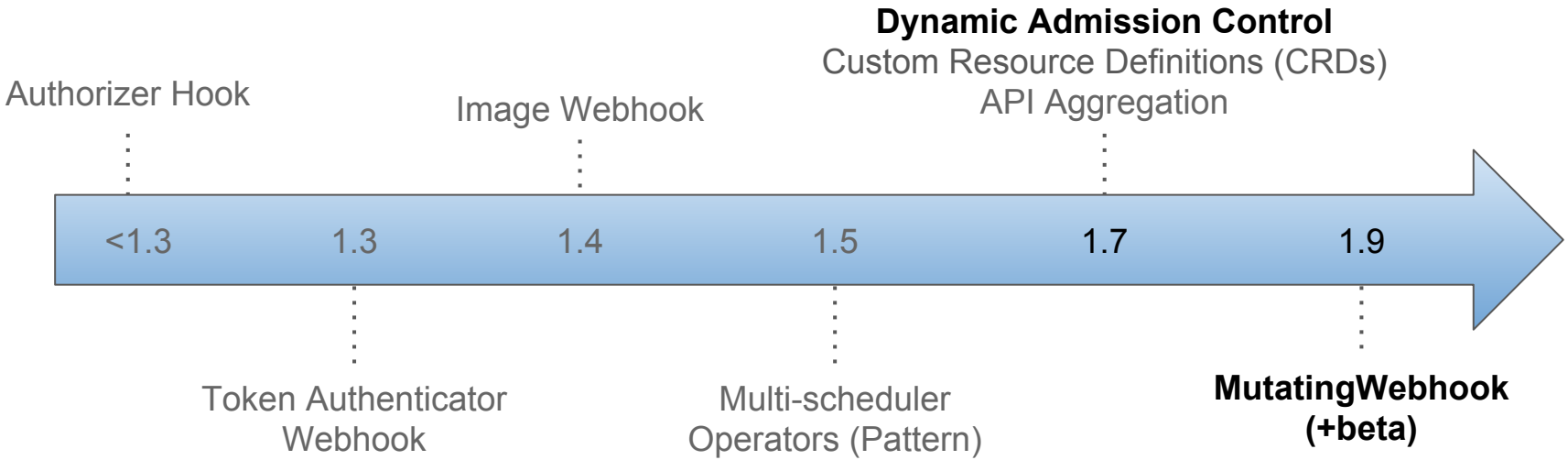
Example Scenario

- **Alice** and **Bob** work for AcmeCorp
- Bob needs shell access to containers running on Kubernetes
- Bob cannot be trusted with access to **privileged containers** running in the **production namespace**

Alice
Platform Engineer

Bob
App Engineer

Kubernetes Extensibility



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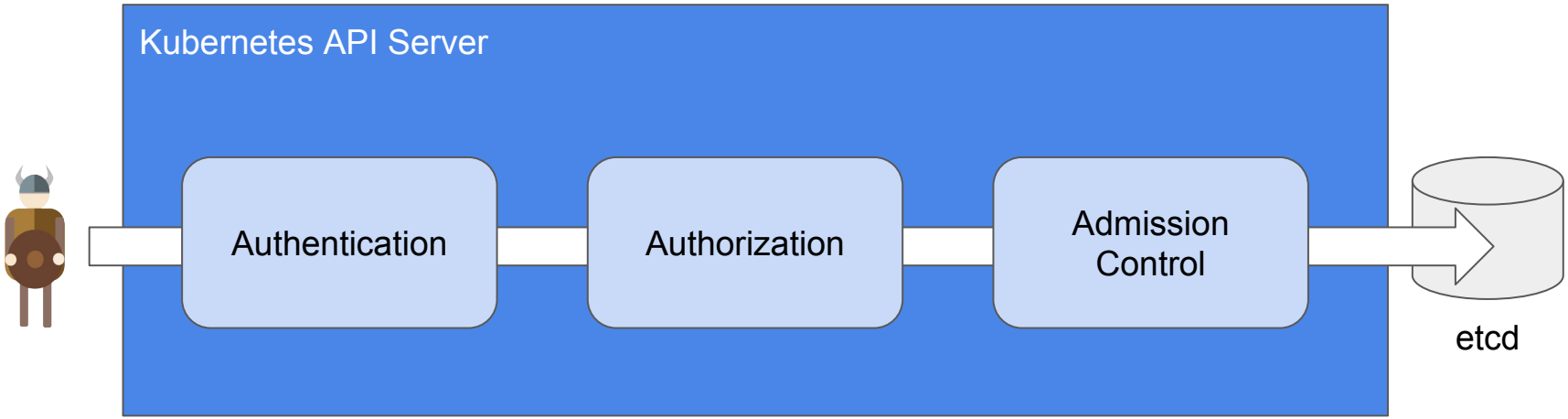
Admission Control



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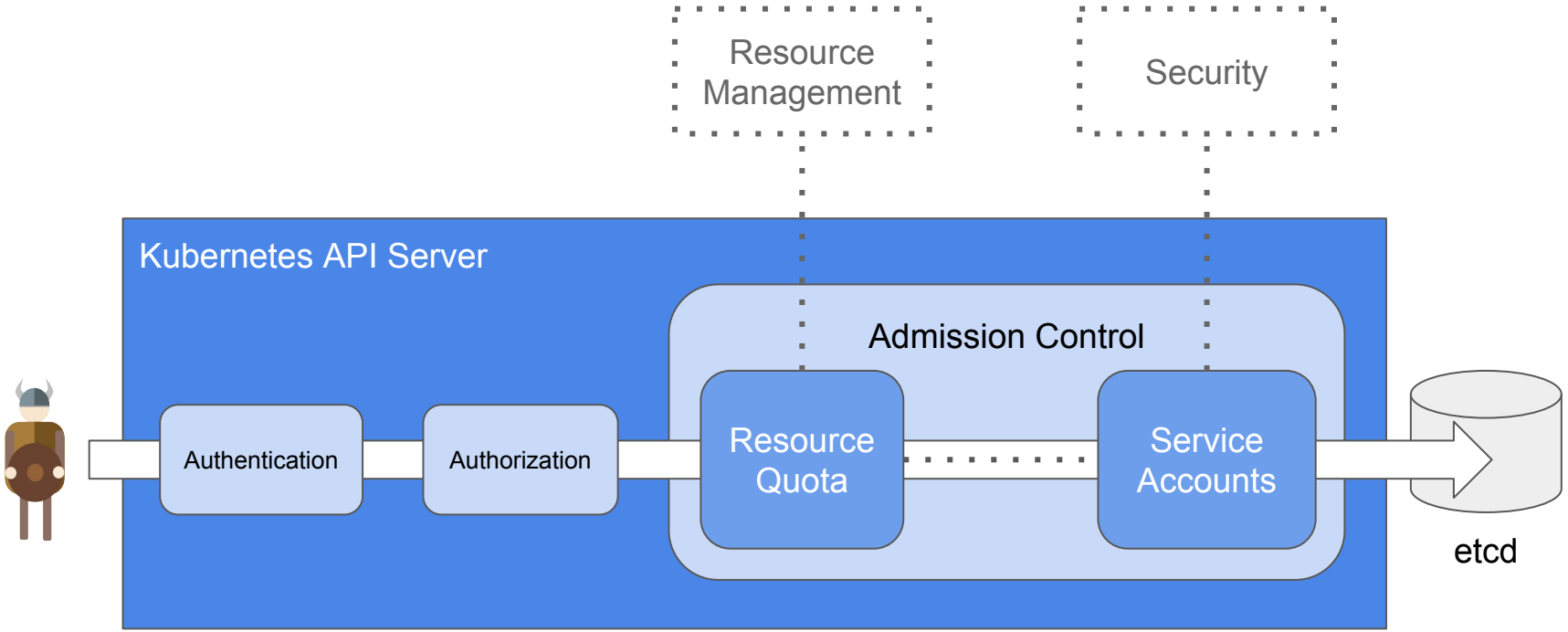
Admission Control



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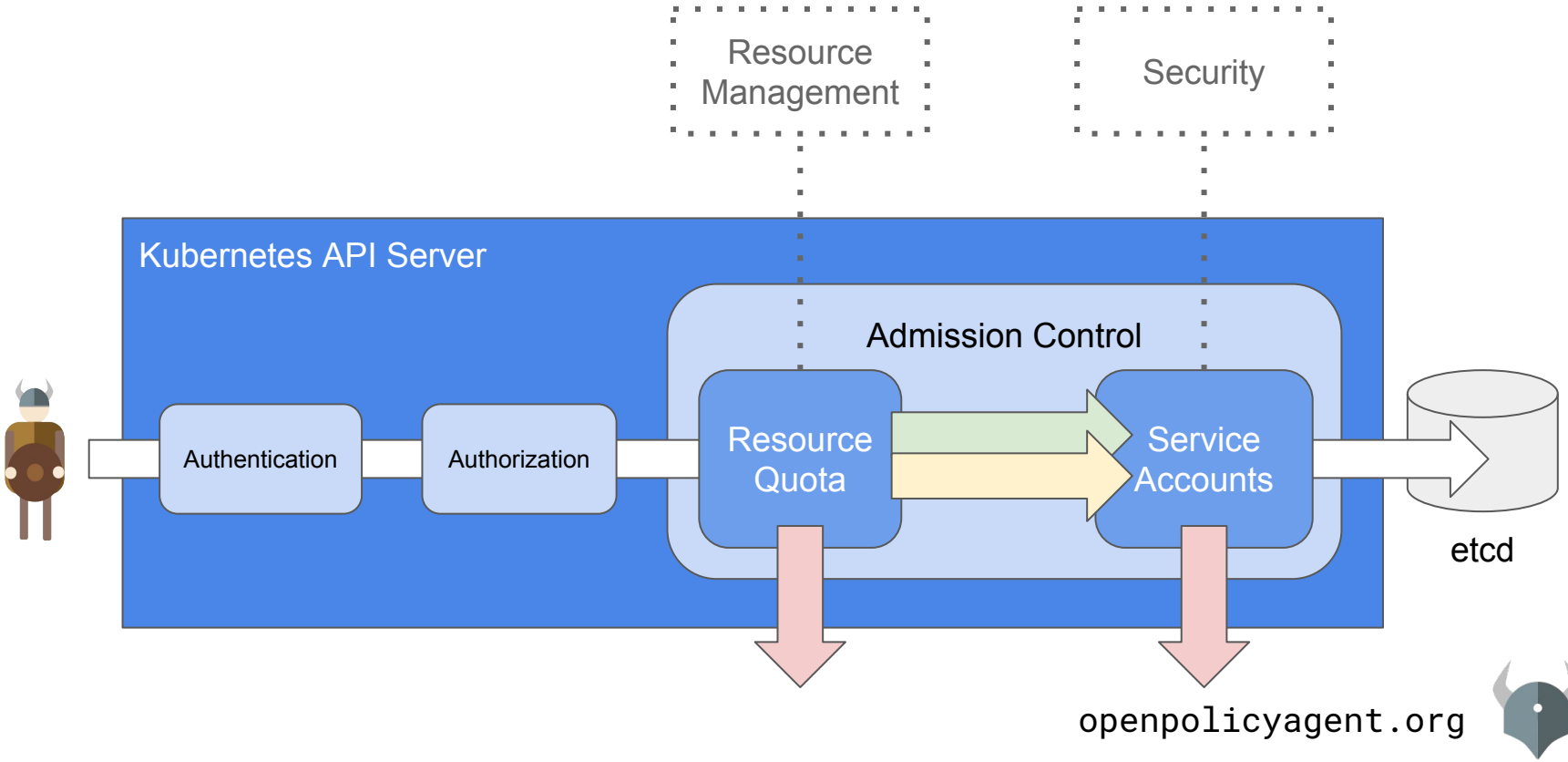
Admission Control



Admission Control: Before 1.7

- Static compilation & configuration
  - 30+ admission controllers
  - 1-4 added per release
  - Command line arguments
  - Static configuration files

admit
deny
exec
limitranger
namespace
resourcequota
securitycontext
serviceaccount
initialresources
alwayspullimages
antiaffinity
persistentvolume
security
imagepolicy
storageclass
gc
podnodeselector
defaulttolerationseconds
podpreset
initialization
noderestriction
podtolerationrestriction
schedulingpolicy
image/imagelimitrangerplugin
image/imagepolicyplugin
ingress/ingress
project/lifecycle
project/podnodeenvironment
project/projectrequestlimit
quota/quotaclusterresourceoverride
quota/clusterquota
quota/runonceduration
scheduler/podnodeconstraints
security/constraint

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Admission Control: Before 1.7

- Static compilation & configuration
  - 30+ admission controllers
  - 1-4 added per release
  - Command line arguments
  - Static configuration files

- Example Scenario
  - Alice forks Kubernetes into a private repository
  - Alice implements the policy inside the plugin framework
  - Alice now has to build, push, and upgrade Kubernetes itself

admit
deny
exec
limitranger
namespace
resourcequota
securitycontext
serviceaccount
initialresources
alwayspullimages
antiaffinity
persistentvolume
security
imagepolicy
storageclass
gc
podnodeselector
defaulttolerationseconds
podpreset
initialization
noderestriction
podtolerationrestriction
schedulingpolicy
image/imagelimitrangerplugin
image/imagepolicyplugin
ingress/ingress
project/lifecycle

bobprotectionpolicy

project/podnodeenvironment
project/projectrequestlimit
quota/quotaclusterresourceoverride
quota/clusterquota
quota/runonceduration
scheduler/podnodeconstraints
security/constraint

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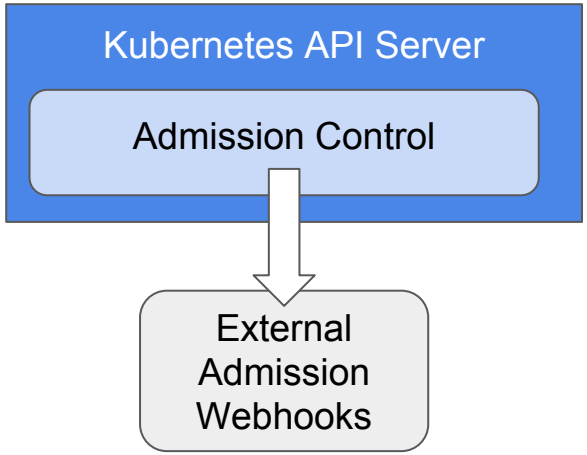
Admission Control: Webhooks

- Admission controllers can be implemented as webhooks that run on top of Kubernetes
- Webhooks can **allow** or **deny** incoming requests
  - Before etcd is updated
  - Before clients are notified
- Webhooks are configured **dynamically** via Kubernetes APIs



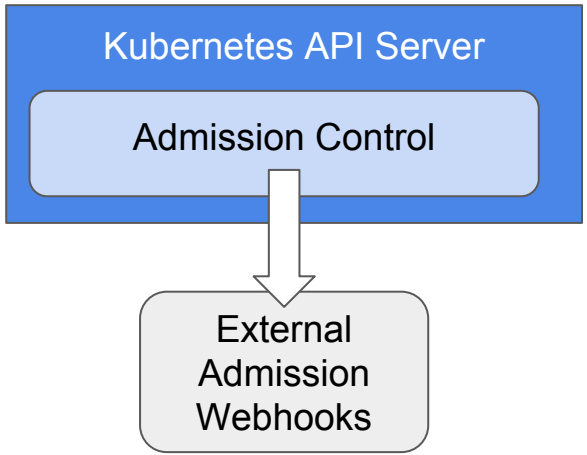
Admission Control: Webhooks

- The API Server calls webhooks whose configuration rules match the incoming request:

```
match [
  {operations: [“create”], kinds: [“pods”]},
  {operations: [“delete”], kinds: [“services”]}
]
```

- Rules can include wildcards:

```
match [
  {operations: [“*”], kinds: [“*”]}
]
```



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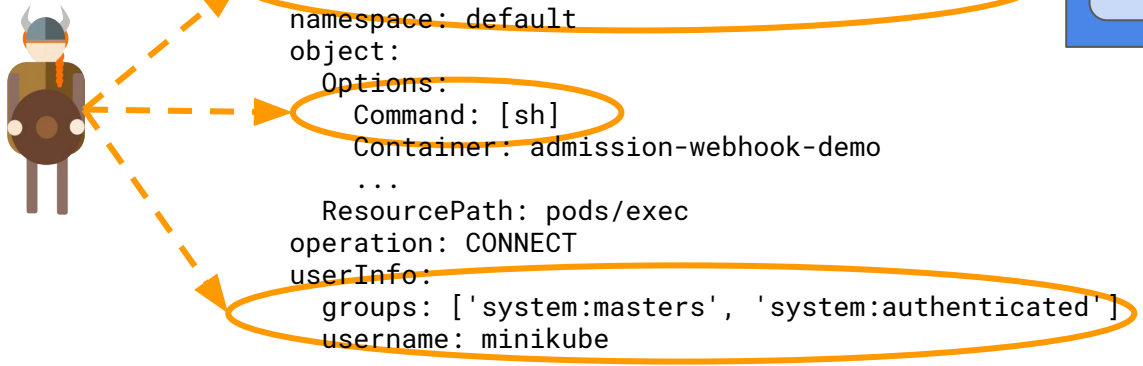
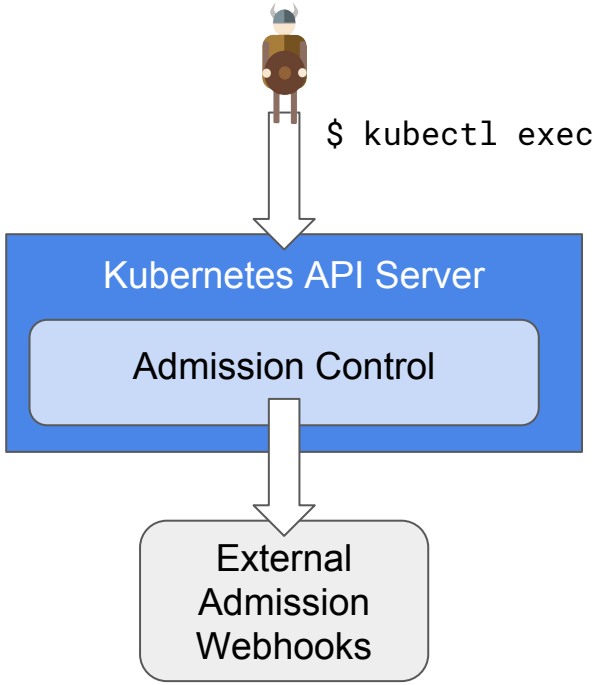
Admission Control: Webhooks

- The API Server provides the **operation**, **entire object, and user info** in the webhook call



```
kind: AdmissionReview
spec:
  kind: {kind: Pod, version: v1}
  name: admission-webhook-demo-373699553-8srx8
  namespace: default
  object:
    Options:
      Command: [sh]
      Container: admission-webhook-demo
      ...
    ResourcePath: pods/exec
  operation: CONNECT
  userInfo:
    groups: ['system:masters', 'system:authenticated']
    username: minikube
```



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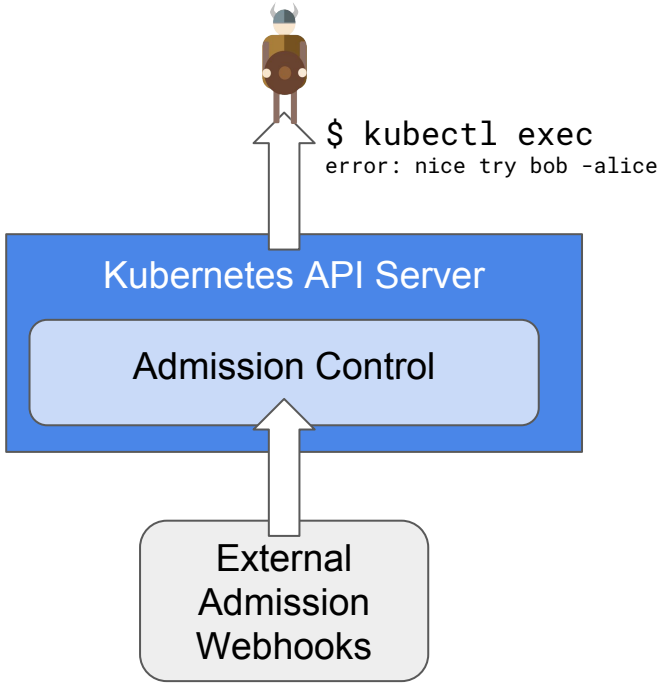
Admission Control: Webhooks

- Webhooks respond with an **AdmissionReview** that indicates whether to **allow** or **deny** the request

```
kind: AdmissionReview
status:
  allowed: false
  reason:
    message: “nice try bob -alice”
```

- The API Server rejects the request **IF ANY** of the webhooks return a denial



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Demo

Webhooks: Lessons Learned

- Be careful with webhook dependencies!
  - Consider performance and availability
  - Avoid side effects
- API server sends “internal representation” of Kubernetes objects over the wire
- API server “fails open” if webhook fails (configurable in 1.9)
- Must serve POST requests at https://<ip>:<port>/ (paths supported in 1.9)
- Client-go vendoring has improved significantly

Webhooks...all the way down?

- Webhooks & Initializers lay the groundwork for extensible policy enforcement
- Policy decisions have been decoupled from enforcement
- Is there a better way to author policies that control who can do what?

```
apiVersion: v1
kind: Pod
metadata:
  labels:
    app: nginx
  name: nginx-1493591563-bvl8q
  namespace: production
spec:
  containers:
  - image: nginx
    imagePullPolicy: Always
    name: nginx
    securityContext:
      privileged: true
  dnsPolicy: ClusterFirst
  nodeName: minikube
  restartPolicy: Always
status:
  containerStatuses:
  - name: nginx
    ready: true
    restartCount: 0
    state:
      running:
        startedAt: 2017-08-01T06:34:22Z
  hostIP: 192.168.99.100
  phase: Running
  podIP: 172.17.0.4
  startTime: 2017-08-01T06:34:13Z
```

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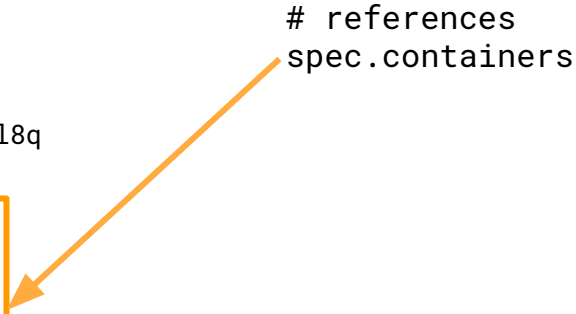

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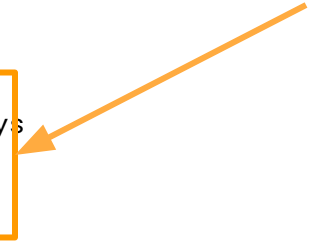
```

```
# references
spec.containers

# variables
container = spec.containers[_]
```



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```
# references
spec.containers

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container = spec.containers[_]

# expressions/assertions
container.securityContext.privileged = true
```

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# functions
is_privileged(container) {
  container.securityContext.privileged = true
}
```

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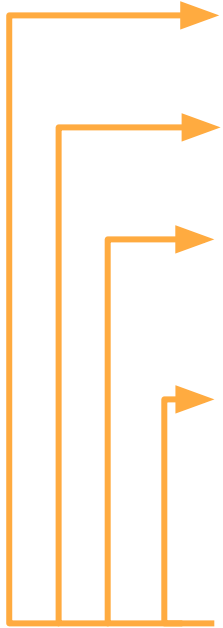

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# references
spec.containers

# variables
container = spec.containers[_]

# expressions/assertions
container.securityContext.privileged = true

# functions
is_privileged(container) {
  container.securityContext.privileged = true
}

# policies
deny {
  review.user      = “bob”
  review.operation = “CONNECT”
  review.namespace = “production”
  is_privileged(spec.containers[_])
}
```

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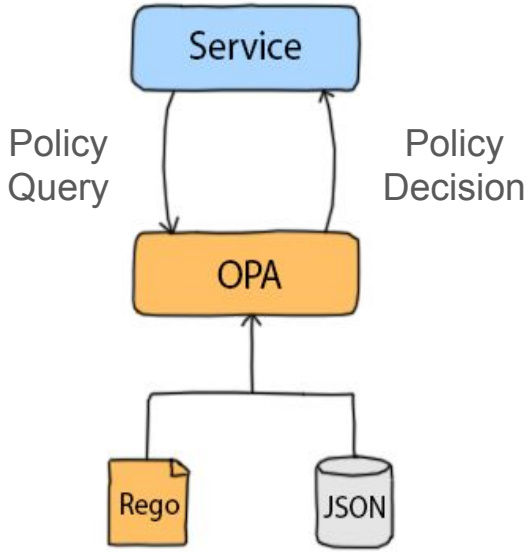
OPA is an open source, general-purpose policy engine

- Declarative Language (Rego)
  - Is X allowed to call operation Y on resource Z?
  - What clusters should workload X be deployed to?
  - What annotations must be present on object X?
- Library/Daemon (Go)
  - In-memory, zero runtime dependencies
  - Evaluation engine: parser, compiler, interpreter
  - Tooling: REPL, test runner, tracing
- Growing community
  - Sponsored by Styra and Google/Firebase
  - Netflix, Medallia, Huawei, Schuberg Philis, and more...
  - Istio, Kubernetes, Terraform, PAM, AWS, and more...



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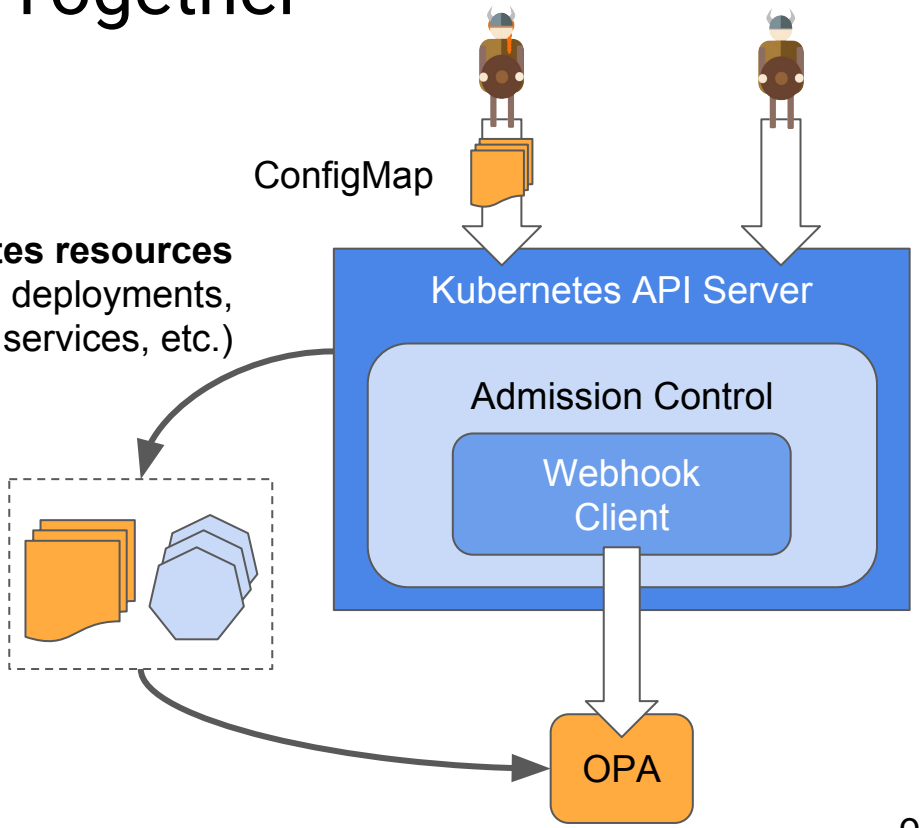
Demo

Putting it Together

policies + **Kubernetes resources**
(nodes, pods, deployments,
services, etc.)



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Conclusions

- Kubernetes extensibility features enable fine-grained administrative control
  - Webhooks to beta in 1.9
- OPA provides a powerful building block for policy enforcement
  - High-level Declarative Policy Language
  - Growing community
- Optimize for change!
  - Decouple policy decisions from enforcement

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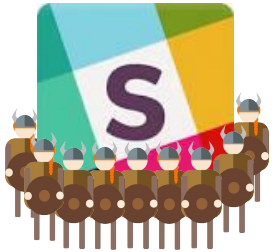
Thank you!



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open-policy-agent/opa (star it!)

tsandall/admission-webhook-demo