Kubernetes Policies 101

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Agenda

- Kubernetes, policies and configurations
- Admission Controllers
- Is It Enough?
- From reactive to proactive

About Me

Eran Leib
Co-Founder, VP Product Management

Co-Founder & VP of Product Management at Apolicy and has more than 20 years of experience in security, identity, access and policies.
Prior to Apolicy, I co-founded Whitebox Security, a Data Access Governance platform that was acquired by SailPoint Technologies (NYSE: SAIL).
I enjoy hiking, movies, snowboarding, Lego (but not stepping on them!), cooking (without burning stuff) and traveling for fun.

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“The future of app development has arrived, and cloud-native architecture has paved the way”

Capgemini

BUT

“The complexity of the cloud native Environment is all too likely to become all-out chaos.”

THENEWSTACK

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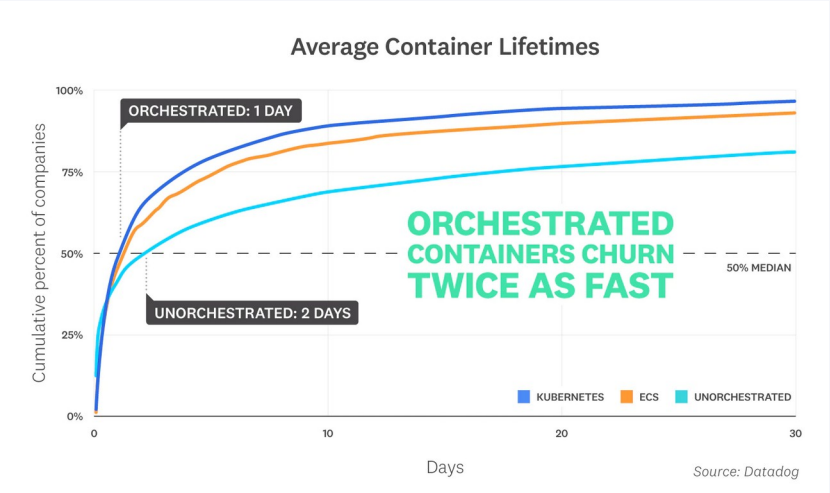
The Dynamic Nature Of Kubernetes

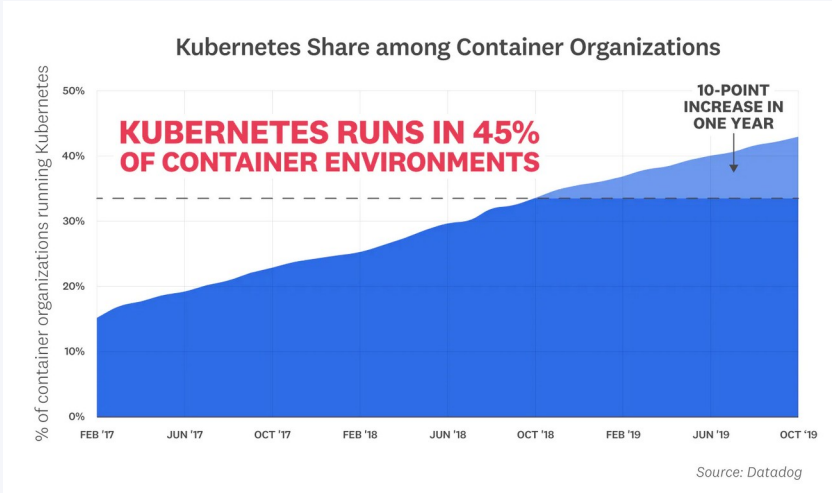
Kubernetes: Up and Running
Brendan Burns, Joe Beda, Kelsey Hightower

“Kubernetes is a very dynamic system. The system is involved in placing pods on nodes, making sure they are up and running, and rescheduling them as needed.
… The API-driven nature of the system encourages others to create higher levels of automation.”

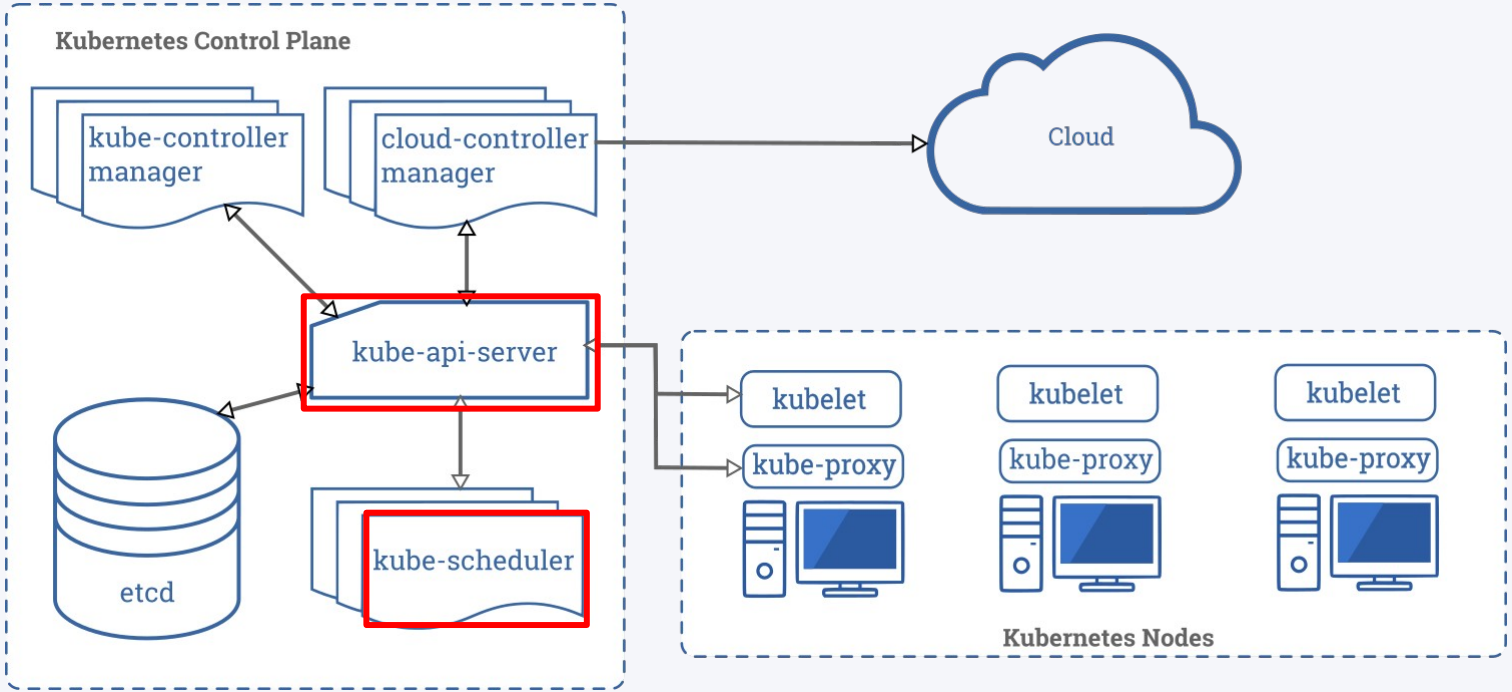
Ephemeral & Complex Is The New Norm

- More clusters
- More workloads per clusters
- Extensive use of microservices
- More multi-cloud environments





What Do We Want To Control?



Policies vs. Configurations

- Configuration is a group of attributes defining behavior parameters, capabilities parameters & labels (of any kind) of an object
- In kubernetes, configuration defines the desired state of the object and its behavior

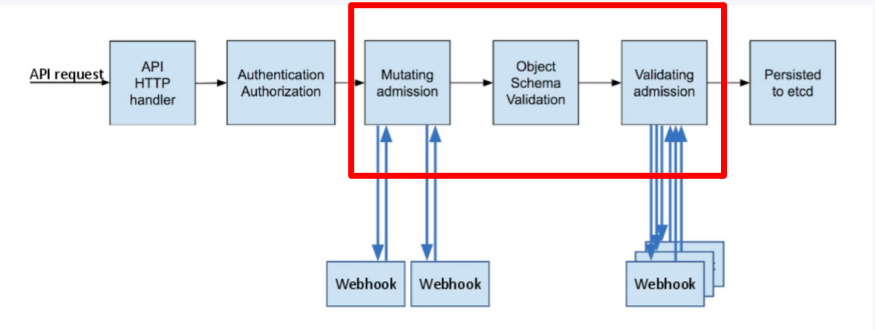
- Policy is a group of attributes defining allowed/denied of behavior/configuration for other objects
- In kubernetes the policy mostly defines guardrails for the desired state

Declarative Infra. & Policy - Winning Duo

- Kubernetes is a declarative infrastructure
- The components’ configurations describe their desired state
- Kubernetes is responsible to achieve the desired state
- The “magic” is in the controller - Genie not included!
- There are many controllers with at least one policy each

Our Focus today - Admission Controllers

- Admission controllers validate creation and changes to Kubernetes objects before the API server persists them to etcd
- The admission controllers enforce the configuration policies
- They run serialy and pass/reject the entire request according to their defined policy
- More specifically:
  Controllers with complex or `coded policies`



ImagePolicyWebhook

- Images are the core of the workload
- ImagePolicyWebhook check they comply with your policy
- All requests goes through inspection and include all the workloads' images and annotations
- Default deny is more secure, however, if no one is there to take the call your cluster would be down and nothing would be admitted!
- Default allow is the easy way out - not the right way

Sample Request & Response

```
{
  "apiVersion":"imagepolicy.k8s.io/v1alpha1",
  "kind":"ImageReview",
  "spec":{
    "containers":[
      {
        "image":"myrepo/myimage:v1"
      },
      {
        "image":"myrepo/myimage@sha256:beb6bd6a68f114c1dc2ea4b28db81bdf91de202a9014972bec5e4d9171d90ed"
      }
    ],
    "annotations":{
      "mycluster.image-policy.k8s.io/ticket-1234": "break-glass"
    },
    "namespace":"mynamespace"
  }
}
```


```
{
  "apiVersion": "imagepolicy.k8s.io/v1alpha1",
  "kind": "ImageReview",
  "status": {
    "allowed": false,
    "reason": "image currently blacklisted"
  }
}
```

Image Policy - Shortcomings

- No OOTB simple policy to overcome the simple use cases
- Operations vs Security instead of Secured Operations
  - Default allow vs default deny
- Doesn’t have full context of the workload - only the annotations
- Cannot filter which requests come in (e.g. kube-system)

Resources - Quotas & Limits

- Kubernetes provides two ways of policing the resources distribution
- The ResourceQuota object defines the quota per namespace
- The LimitRanger object defines the limits per workload inside the namespace
- ResourceQuota defined by Cluster Admin and LimitRanger by the namespace admin
- Any running workload will not be affected until recreated

ResourceQuota

- ResourceQuota is an admission controller enforcing the policy
- To enforce it, you must create a ResourceQuota object in each namespace
- With no object defined, the namespace can use resources without limits
- Using a quota should be in tandem with LimitRanger to make sure default values are assigned on resources
  - Your Pod can be rejected if resources are not defined and LimitRanger is not used

LimitRanger

- LimitRanger defines ranges for CPU/RAM/Storage for a Pod/Container inside the namespace
- The admission controller defines, MIN/MAX, ratio between request/limit and default values
- A LimitRanger object must be defined to enforce the limits
- Without a limit, any workload can create starvation for the others
- If the LimitRanger allows more resources than the ResourceQuota you will run into contention and Pod creation failures

Pod Security Policy (PSP)

- PSP defines the security guardrails for workloads in the cluster
- PSP works with policy profiles
  - The workload service account must be able to ‘use’ the PSP to enforce it
  - Each profile is a complete set of the parameters
  - A workload will “choose” the easiest path in that will allow it in as-is
- Hint: Recently a list of 3 standard profiles was published
  - https://kubernetes.io/docs/concepts/security/pod-security-standards/

‘The three profiles defined here have a clear linear progression from most secure (restricted) to least secure (privileged), and cover a broad set of workloads. Privileges required above the baseline policy are typically very application specific, so we do not offer a standard profile in this niche. This is not to say that the privileged profile should always be used in this case, but that ***policies in this space need to be defined on a case-by-case basis****.”*

PSP - What’s Covered

- Workload <> Host isolation parameters (Network, process, FS)
- Container Security Context (user, group, capabilities)
- Volumes (allowed types, root FS, etc)
- Privilege Escalations (privileged, allow escalation)

A total of 20+ parameters

Privileged

```
apiVersion: policy/v1beta1
kind: PodSecurityPolicy
metadata:
  name: privileged
  annotations:
    seccomp.security.alpha.kubernetes.io/allowedProfileNames: '*'
spec:
  privileged: true
  allowPrivilegeEscalation: true
  allowedCapabilities:
  - '*'
  volumes:
  - '*'
  hostNetwork: true
  hostPorts:
  - min: 0
    max: 65535
  hostIPC: true
  hostPID: true
  runAsUser:
    rule: 'RunAsAny'
  seLinux:
    rule: 'RunAsAny'
  supplementalGroups:
    rule: 'RunAsAny'
  fsGroup:
    rule: 'RunAsAny'
```

Restricted

```
apiVersion: policy/v1beta1
kind: PodSecurityPolicy
metadata:
  name: restricted
...
spec:
  privileged: false
  # Required to prevent escalations to root.
  allowPrivilegeEscalation: false
  # This is redundant with non-root + disallow privilege escalation,
  # but we can provide it for defense in depth.
  requiredDropCapabilities:
    - ALL
  # Allow core volume types.
  volumes:
    - 'configMap'
    - 'emptyDir'
    - 'projected'
    - 'secret'
    - 'downwardAPI'
    # Assume that persistentVolumes set up by the cluster admin are safe to use.
    - 'persistentVolumeClaim'
  hostNetwork: false
  hostIPC: false
  hostPID: false
  runAsUser:
    # Require the container to run without root privileges.
    rule: 'MustRunAsNonRoot'
...
```

Hard To Manage & Harder To Enforce

- Every permutation/exception you want make = new PSP
  … and a new role
  … and a new role binding
  Managing access to the psp is managing how it’s applied
- An admitted workload shows which PSP admitted it
  … a failed one, go figure :(
- Unlike other controllers, it is not managing a specific aspect but a broad set of capabilities

Labels, Labels, Labels

- Labeling is a cornerstone in Kubernetes
- Label selector - Is the primitive for grouping objects
- Some of the places where label selectors are used in:
  - Scheduling workloads to nodes - e.g. schedule PCI workloads on PCI approved nodes using PCI label
  - Selecting services for workload - exposing the web component only through a service
  - Any kubectl command can use label selectors
- It is also used to “document” the objects (app, owner etc.)
  - Hint: Annotations are a better way for documenting


SIMPLE LABEL POLICY ADMISSION CONTROLLER
SHUT UP AND TAKE MY MONEY!
imgflip.com

Mutating Admission Controllers

- The first type of admission controllers to evaluate
- Multiple admission controllers can exist.
- They run serially, mutate the request and pass it forward
  - Only requests which meet the specific controller are evaluated
  - This should be used with caution as it changes the original request
- Receives the whole request with all fields as input
- Recommended to use for setting unset values rather than changing existing ones
  - Hint: Use these to automatically add missing labels

Validating Admission Controllers

- The last type admission controller to evaluate
- They run in parallel and each can fail the whole request
  - Only requests which meet the specific controller are evaluated
- Receives the whole request with all fields as input
- The good: Anything is possible...
- The bad: Anything is possible!

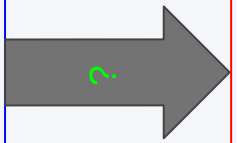
Sample Request & Response


```
{
  "apiVersion": "admission.k8s.io/v1",
  "kind": "AdmissionReview",
  "request": {
    "uid": "705ab4f5-6393-11e8-b7cc-42010a800002",

    "kind": {"group":"autoscaling","version":"v1","kind":"Scale"},
    "resource": {"group":"apps","version":"v1","resource":"deployments"},
    "subResource": "scale",
    "requestKind": {"group":"autoscaling","version":"v1","kind":"Scale"},
    "requestResource": {"group":"apps","version":"v1","resource":"deployments"},
    "requestSubResource": "scale",
    "name": "my-deployment",
    "namespace": "my-namespace",
    "operation": "UPDATE",

    "userInfo": {
      "username": "admin",
      "uid": "014fbff9a07c",
      "groups": ["system:authenticated","my-admin-group"],
      "extra": {
        "some-key":["some-value1", "some-value2"]
      }
    },

    "object": {"apiVersion":"autoscaling/v1","kind":"Scale",...},
    "oldObject": {"apiVersion":"autoscaling/v1","kind":"Scale",...},
    "options": {"apiVersion":"meta.k8s.io/v1","kind":"UpdateOptions",...},
    "dryRun": false
  }
}
```


```
{
  "apiVersion":
"admission.k8s.io/v1",
  "kind": "AdmissionReview",
  "response": {
    "uid": "<value from
request.uid>",
    "allowed": false,
    "status": {
      "code": 403,
      "message": "You cannot do this
because..."
    }
  }
}
```

Pinpoint Admission Controllers

- Some admission controllers are controlling a single focused aspect of the process, hence their policy is very simple and it is enforced cluster-wide
- To name a few (some are alpha/beta):
  - AlwaysPullImages
  - DefaultStorageClass
  - EventRateLimit
  - PodNodeSelector

Recap

- Admission controllers are a great mechanism to enforce policies
- Their policies are managed in many places making it complex to understand the actual effective policy
- Moving to multi cloud and multi cluster complicates things even more

4 Things To Do Today

- Check which admission controllers are enabled
  - kubectl get pods -n kube-system | grep apiserver
  - kubectl describe pods <apiserver pod> -n kube-system | grep admission
  - The above is for vanilla kubernetes.
  - For each cloud provider check the specific documentation
- Start namespacing, it will make your policy management better and easier
- Stop using “default” service account name - use named accounts
- Enable basic PodSecurityPolicy using the restricted, baseline, privileged example
  - https://kubernetes.io/docs/concepts/policy/pod-security-policy/

POLICIES IN ACTION DEMO

So What’s The Problem?

- There is a clear need to decouple policy from the controllers’ code
- Kubernetes dynamic nature teaches us that policies evolve and will continue to evolve over time
- Multi cluster & cloud expansion will push the need for a centrally managed and orchestrated policies even further
- Too many enforcement points and overlaps between controllers can end up in an all out chaos
- It is highly recommended to manage and enforce the same policies from dev and all the way to production

Policy-As-Code

A good first step in the right direction!

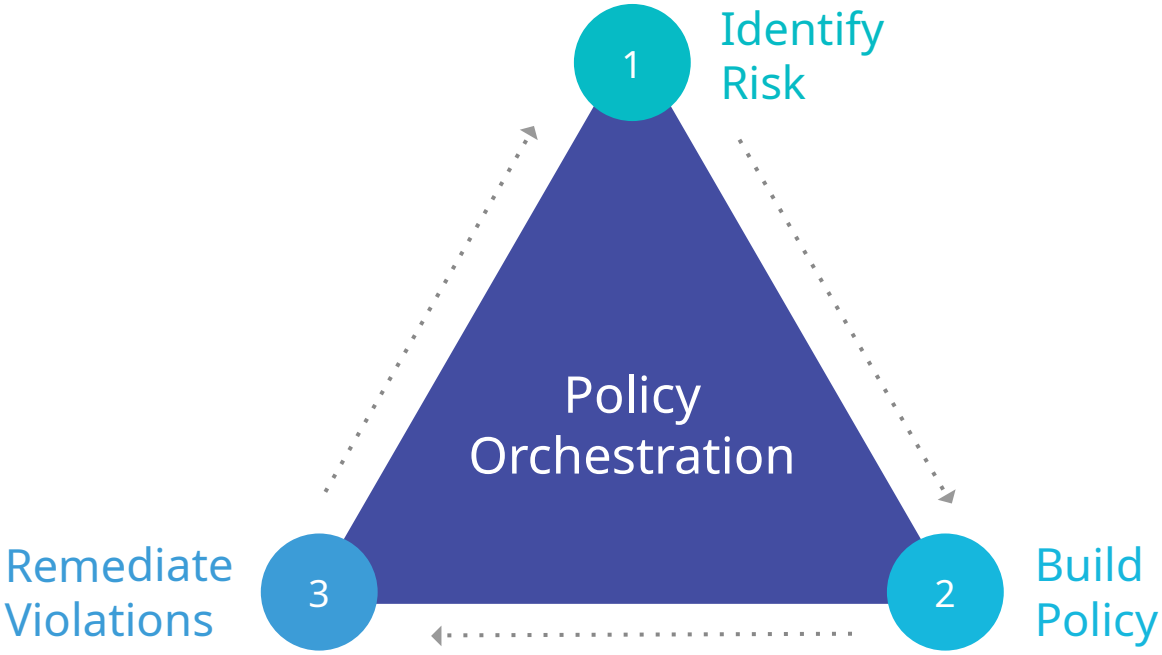
- Policy-as-code allows to decuple policy from code
- Enables declarative policy

- Some solutions works with Kubernetes natively
- OPA Gatekeeper - a great example and a good place to start

Consistent Actions > Consistent Results

- Admission controllers are not enough
- They are the last gate keepers before the cluster
- It is important to have them but it’s more important to identify issues way ahead
- The same policy guiding admission controller must be enforced in earlier stages (Git & CD processes)

Risk To Policy To Remediation -



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Kubernetes Policy, Risk Maturity Model

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It’s time for

Better Kubernetes

Be Risk Smart

Assess workload exposure and prioritize risks for action

Be Declarative

Achieve the workload state you’ve declared

Be Right

Prevent issues before they arise

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