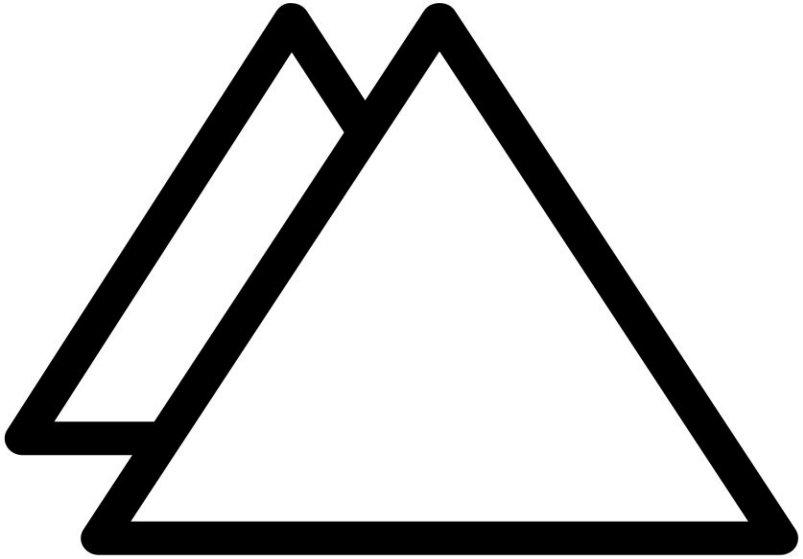
Continuous Kubernetes Security

@sublimino and @controlplaneio


I’m:
- Andy
- Dev-like
- Sec-ish
- Ops-y



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Is this Kubernetes cluster secure?


LIVE
BREAKING NEWS
LOCAL FISH IN GREAT MOOD TODAY
19:41
THE WATER TASTES GREAT AND THERES NO PREDATORS AROUND AT THE MOMENT


Lake Berryessa is 1 Foot Over the
Glory Hole Spillway
& Hwy 128 is Closed on Saturday!
2-18-17 Lake Berryessa News Drone Report
Napa County, California

How secure is Kubernetes?

What this Kubernetes talk is about

- Common Pwns
- Hardening the Control Plane
- Securing Workloads and Networks
- Hard and Soft Multi Tenancy
- Continuous Security

Common Pwns

kubelet-exploit

There were discussions (https://github.com/kubernetes/kubernetes/issues/11816, https://github.com/kubernetes/kubernetes/issues/3168, https://github.com/kubernetes/kubernetes/issues/7965), but looks like nobody cares.

Everybody who has access to the service kubelet port (10250), even without a certificate, can execute any command inside the container.

```
# /run/%namespace%/%pod_name%/%container_name%
$ curl -k -XPOST "https://k8s-node-1:10250/run/kube-system/node-exporter-iuwg7/node-exporter" -d "cmd=ls -l
total 12
drwxr-xr-x   13 root     root           148 Aug 26 11:31 .
drwxr-xr-x   13 root     root           148 Aug 26 11:31 ..
-rwxr-xr-x    1 root     root             0 Aug 26 11:31 .dockerenv
drwxr-xr-x    2 root     root          8192 May  5 22:22 bin
drwxr-xr-x    5 root     root           380 Aug 26 11:31 dev
drwxr-xr-x    3 root     root           135 Aug 26 11:31 etc
drwxr-xr-x    2 nobody   nogroup          6 Mar 18 16:38 home
drwxr-xr-x    2 root     root             6 Apr 23 11:17 lib
dr-xr-xr-x  353 root     root             0 Aug 26 07:14 proc
drwxr-xr-x    2 root     root             6 Mar 18 16:38 root
dr-xr-xr-x   13 root     root             0 Aug 26 15:12 sys
drwxrwxrwt    2 root     root             6 Mar 18 16:38 tmp
drwxr-xr-x    4 root     root            31 Apr 23 11:17 usr
drwxr-xr-x    5 root     root            41 Aug 26 11:31 var
```

This makes namespaces/authentication and other security implementations in Kubernetes useless because by default any app inside the scheduled pod can access this port.

https://github.com/kayrus/kubelet-exploit

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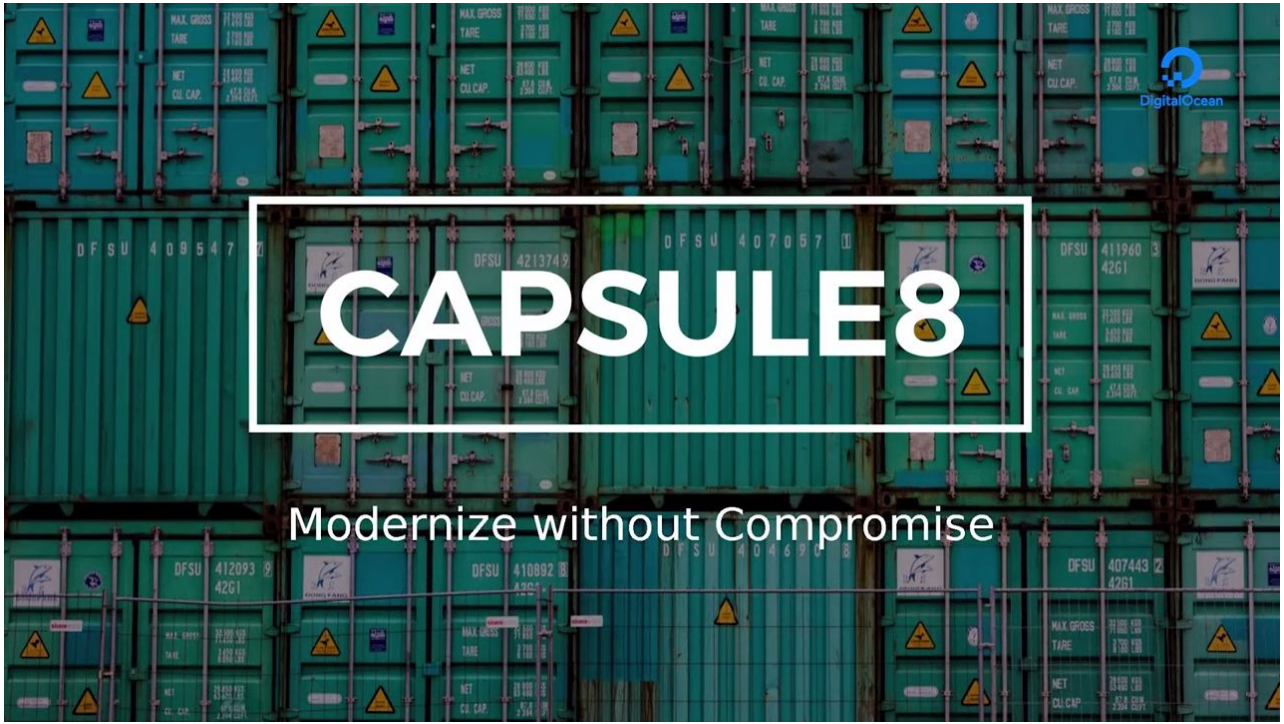
Security vs Features

No RBAC



[Attacking Kubernetes - Dino Dai Zovi, Capsule8]

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No Workload Security

[Building for Trust: How to Secure Your Kubernetes Cluster [I] - Alexander Mohr & Jess Frazelle]

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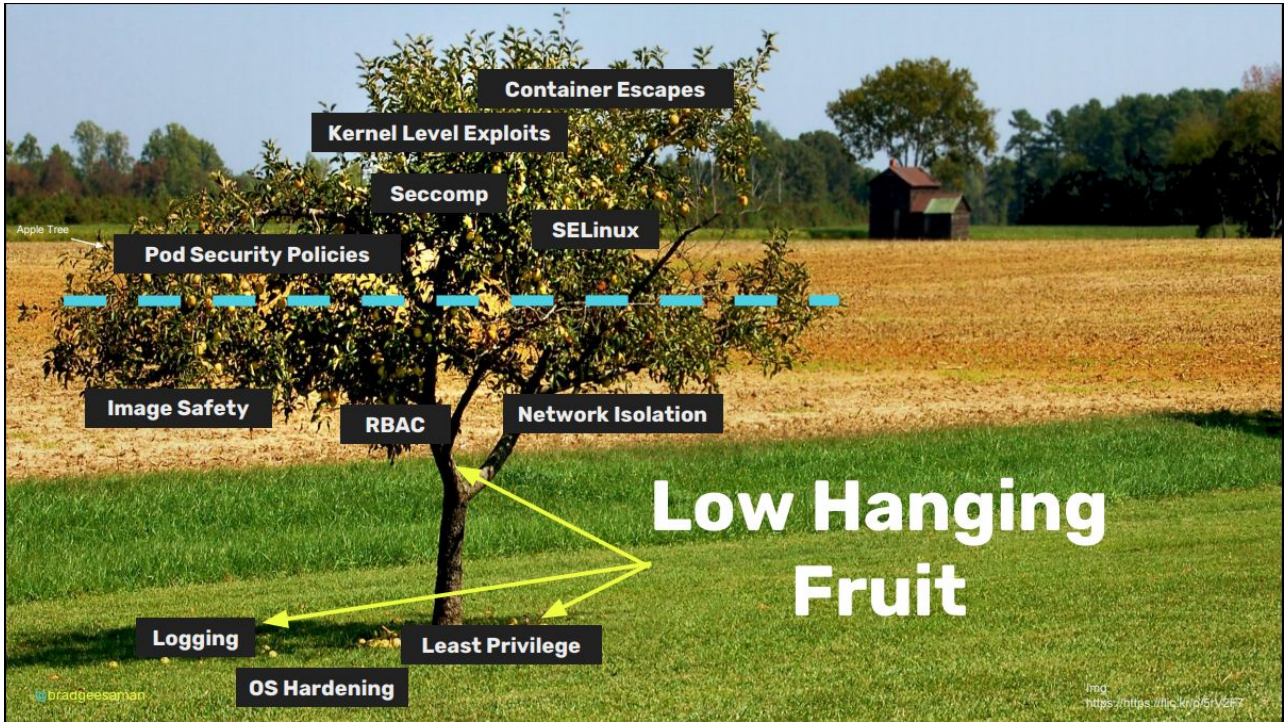
No Security - Cluster Edition



[Hacking and Hardening Kubernetes Clusters by Example - Brad Geesaman, Symantec]

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Helm

[Exploring The Security Of Helm](#) / [Using SSL Between Helm and Tiller](#)

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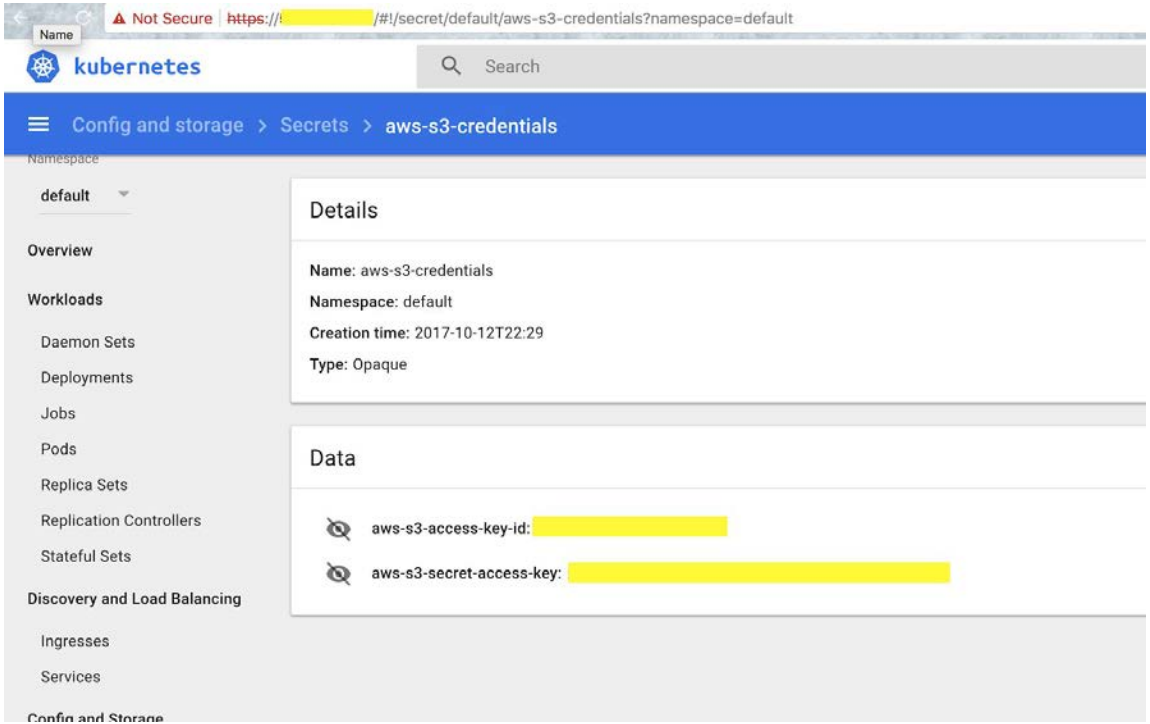
Unsecured Dashboard - Tesla



[Lessons from the Cryptojacking Attack at Tesla - RedLock CSI Team]

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CVE-2017-1002101 - subpath volume mount handling allows arbitrary file access in host filesystem #60813

New issue

Closed **liggitt** opened this issue 7 days ago · 2 comments

liggitt commented 7 days ago • edited — Member

CVSS:3.0/AV:N/AC:L/PR:L/UI:N/S:U/C:H/I:H/A:H

This vulnerability allows containers using subpath volume mounts with any volume type (including non-privileged pods, subject to file permissions) to access files/directories outside of the volume, including the host's filesystem.

Thanks to Maxim Ivanov for reporting this problem.

Vulnerable versions:

- Kubernetes 1.3.x-1.6.x
- Kubernetes 1.7.0-1.7.13
- Kubernetes 1.8.0-1.8.8
- Kubernetes 1.9.0-1.9.3

Vulnerable configurations:

- Clusters that allow untrusted users to control pod spec content, and prevent host filesystem access via hostPath volumes (or other volume types) using PodSecurityPolicy (or custom admission plugins)
- Clusters that make use of subpath volume mounts with untrusted containers or containers that can be compromised

Vulnerability impact:
A specially crafted pod spec combined with malicious container behavior can allow read/write access to arbitrary files outside volumes specified in the pod, including the host's filesystem. This can be accomplished with any volume type, including emptyDir, and can be accomplished with a non-privileged pod (subject to file permissions).

Assignees
liggitt
jsafrane
msau42

Labels
area/security
kind/bug
priority/critical-urgent
sig/storage
status/approved-for-milestone
status/in-progress

Projects
None yet

Milestone
v1.10

5 participants

[CVE-2017-1002101 - subpath volume mount handling allows arbitrary file access in host filesystem #60813]

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even with authentication enabled on Kubelet, it only applies to the HTTPS port (10250). Meaning the read-only HTTP port (10255) still stays open without any means to protect besides network ACL’s.

https://medium.com/handy-tech/analysis-of-a-kubernetes-hack-backdooring-through-kubelet-823be5c3d67c

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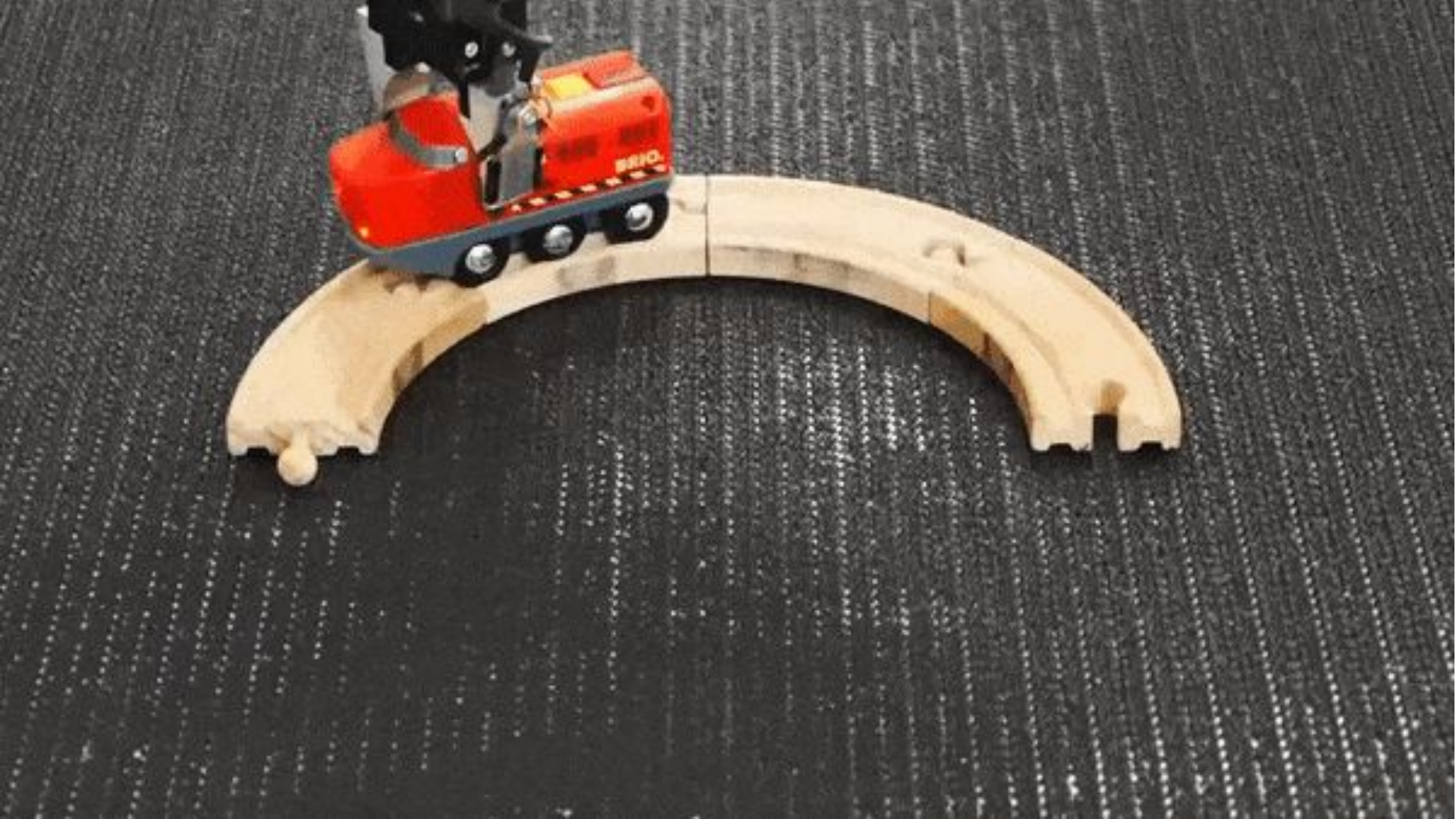
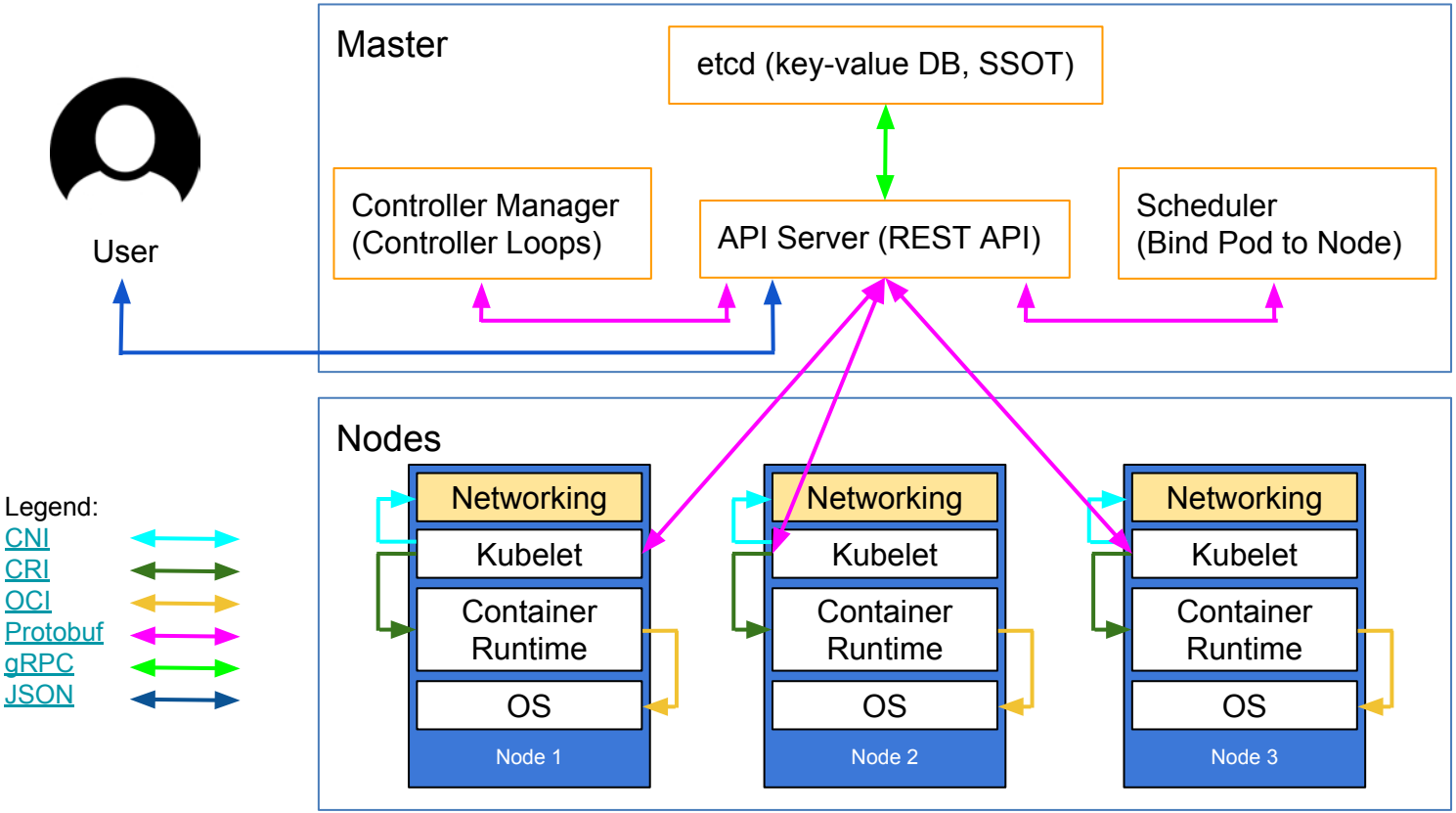
What is Continuous Security?

- Infrastructure as Code
- Security as Code
- Continuous Delivery


BRIO

Hardening the Kubernetes Control Plane



By Lucas Käldström

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Minimum Viable Security

TLS Everywhere

> Note that **some components and installation methods may enable local ports over HTTP** and administrators should familiarize themselves with the settings of each component to identify potentially unsecured traffic.

https://kubernetes.io/docs/tasks/administer-cluster/securing-a-cluster/#use-transport-level-security-tls-for-all-api-traffic

Bootstrapping TLS

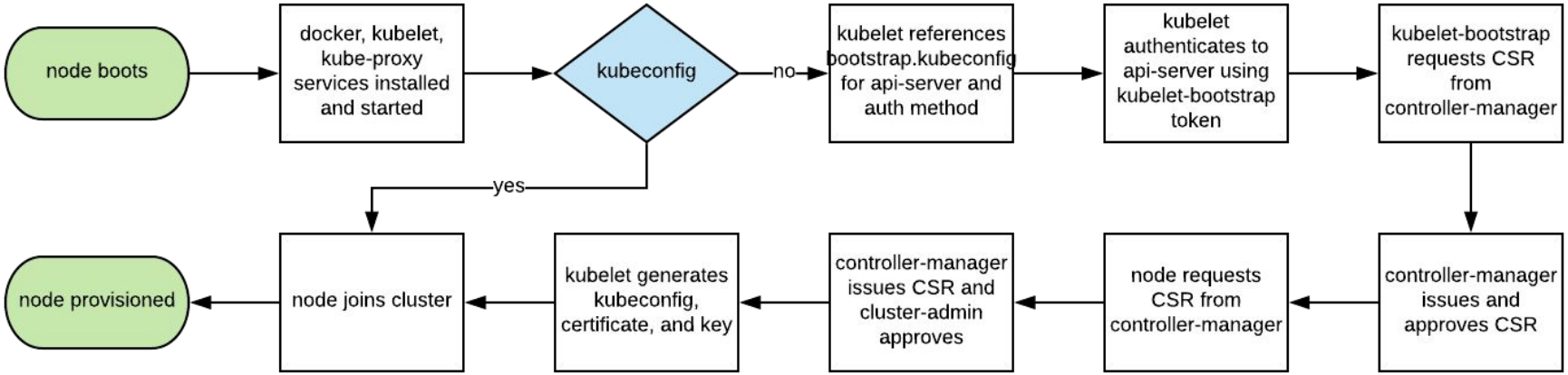
Kubernetes the Hard Way

- https://github.com/kelseyhightower/kubernetes-the-hard-way/blob/master/docs/04-certificate-authority.md

Kubelet TLS Bootstrap (still beta, stable v1.11?)

- https://kubernetes.io/docs/admin/kubelet-tls-bootstrapping/
- https://github.com/kubernetes/features/issues/43

Bootstrapping TLS



https://medium.com/@toddrosner/kubernetes-tls-bootstrapping-cf203776abc7

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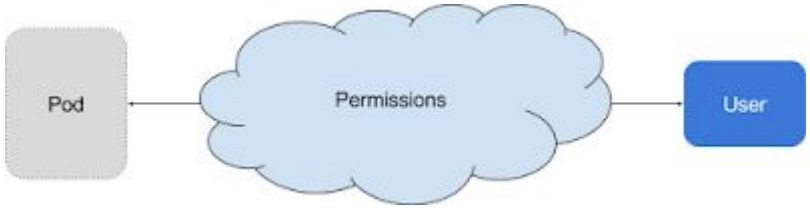
Enable RBAC



[RBAC Support in Kubernetes](#) (stable v1.8)

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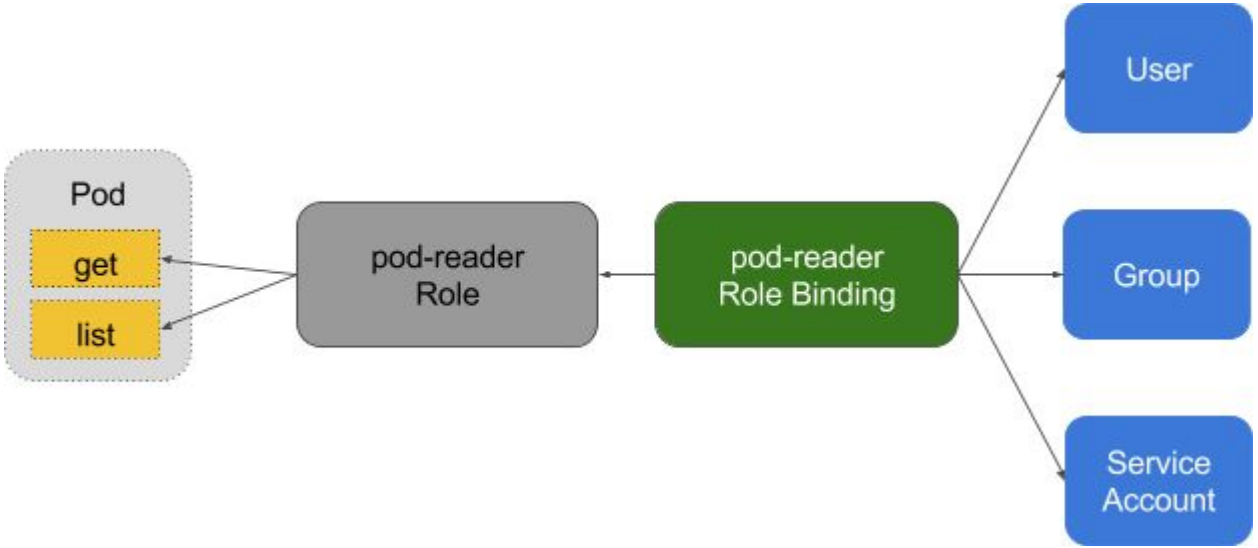
Enable RBAC



[RBAC Support in Kubernetes](#) (stable v1.8)

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External Auth to API Server (e.g. via `kubectl`)

- https://thenewstack.io/kubernetes-single-sign-one-less-identity/
- https://github.com/coreos/dex - OpenID Connect Identity (OIDC) and OAuth 2.0 provider with pluggable connectors
- https://github.com/negz/kuberos - OIDC authentication helper for kubectl (also https://cloud.google.com/community/tutorials/kubernetes-auth-openid-rbac)
- https://github.com/micahhausler/k8s-oidc-helper - helper tool for authenticating to Kubernetes using Google's OpenID Connect

Disable legacy authorization on GKE

```
--no-enable-legacy-authorization
```

Disable API server read only port (default: 8080)

```
--insecure-port=0
```

Disable API server read only port (default: 8080)

```
andy@kube-master:~ [0]# curl localhost:8080/api/v1/secrets?limit=1
{
  "kind": "SecretList",
  "apiVersion": "v1",
  "metadata": {...},
  "items": [
    {
      "metadata": {
        "name": "default-token-dhj8b",
        "namespace": "default",
        ...
        "annotations": {
          "kubernetes.io/service-account.name": "default",
          "kubernetes.io/service-account.uid": "a7e874b7-6186-11e8-92ba-4af3186f8390"
        }
      },
      "data": {
        "ca.crt": "LS0tLS1CRUdJTiBD...",
        "namespace": "ZGVmYXVsdA==",
        "token": "ZXlKaGJHY..."
      },
      "type": "kubernetes.io/service-account-token"
    }
  ]
}
```

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No `system:anonymous` role for anonymous user (API server flag)

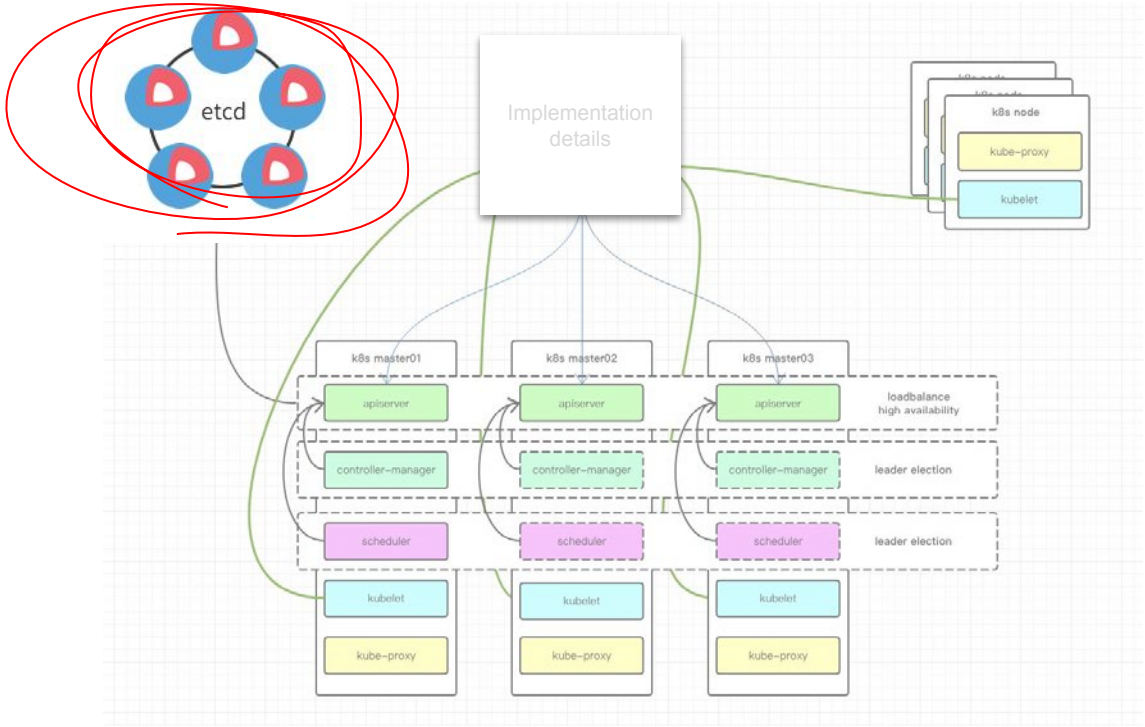
```
--anonymous-auth=false
```

No `system:anonymous` role for anonymous user (API server flag)

```
andy@localhost:~ [0]# curl https://kube-master:6443/version

{
  "major": "1",
  "minor": "10",
  "gitVersion": "v1.10.3",
  "gitCommit": "2bba0127d85d5a46ab4b778548be28623b32d0b0",
  "gitTreeState": "clean",
  "buildDate": "2018-05-21T09:05:37Z",
  "goVersion": "go1.9.3",
  "compiler": "gc",
  "platform": "linux/amd64"
}
```

Separate, Firewalled etcd Cluster



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Rotate keys

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Securing Workloads

Containers

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Containers

- Namespaces
- cgroups
- seccomp-bpf
- AppArmor / SELinux
- Users
- Capabilities

Pods

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Pods

```
apiVersion: v1
kind: Pod
metadata:
  name: nfs-server
  labels:
    role: nfs-server
spec:
  containers:
    - name: nfs-server
      image: jsafrane/nfs-data
      securityContext:
        privileged: true
```

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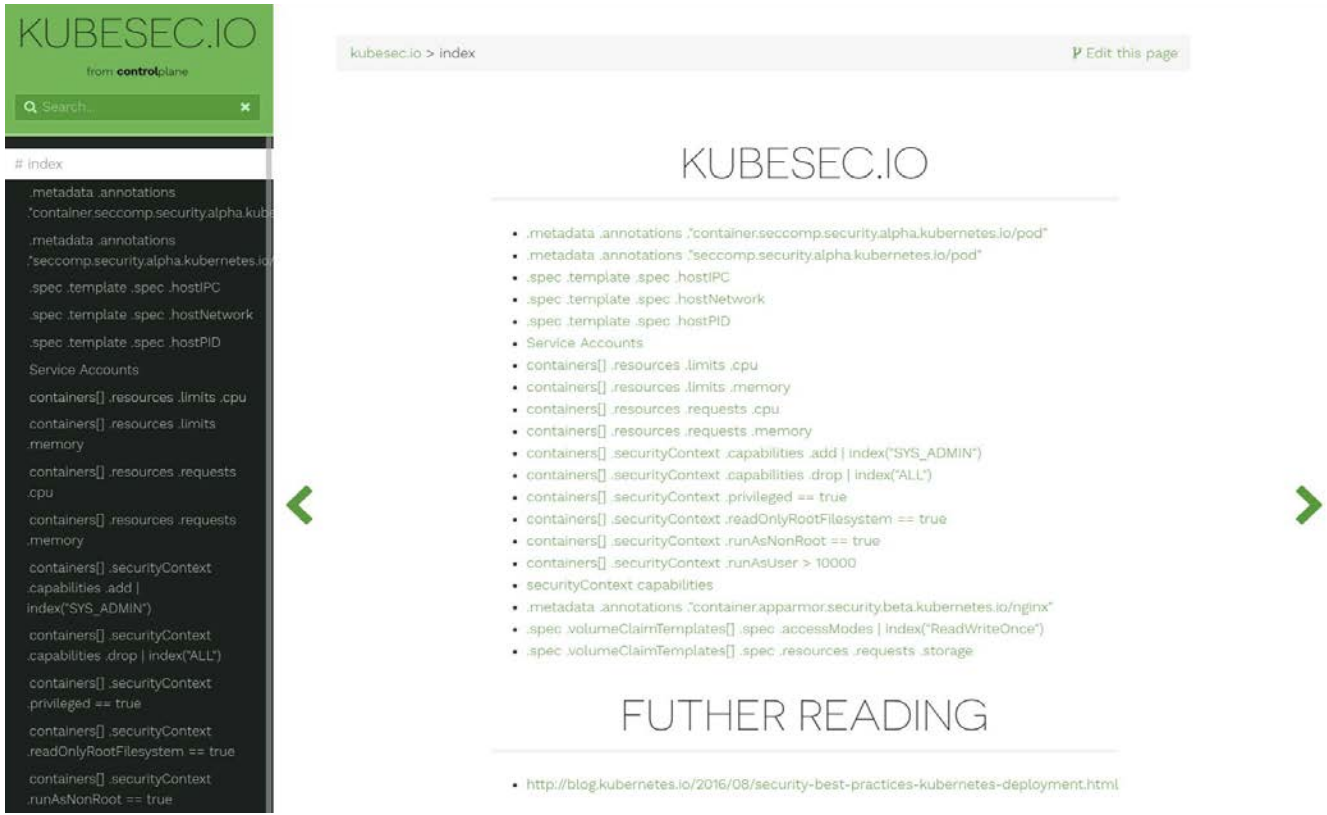
kubesec.io - risk score for K8S YAML



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kubesec.io - example insecure pod


```
{
  "score": -30,
  "scoring": {
    "critical": [{
      "selector": "containers[] .securityContext .privileged == true",
      "reason": "Privileged containers can allow almost completely unrestricted host access"
    }],
    "advise": [{
      "selector": "containers[] .securityContext .runAsNonRoot == true",
      "reason": "Force the running image to run as a non-root user to ensure least privilege"
    }, {
      "selector": "containers[] .securityContext .capabilities .drop",
      "reason": "Reducing kernel capabilities available to a container limits its attack surface",
      "href": "https://kubernetes.io/docs/tasks/configure-pod-container/security-context/"
    },
   ...
```


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PodSecurityPolicies

```yaml
apiVersion: extensions/v1beta1
kind: PodSecurityPolicy
metadata:
 name: restricted
 annotations:
   seccomp.security.alpha.kubernetes.io/allowedProfileNames: 'docker/default'
   apparmor.security.beta.kubernetes.io/allowedProfileNames: 'runtime/default'
   seccomp.security.alpha.kubernetes.io/defaultProfileName:  'docker/default'
   apparmor.security.beta.kubernetes.io/defaultProfileName:  'runtime/default'
spec:
 privileged: false
 allowPrivilegeEscalation: false  # Required to prevent escalations to root.
 # 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'
   ...
 hostNetwork: false
 hostIPC: false
 hostPID: false
 runAsUser:
   rule: 'MustRunAsNonRoot' # Require the container to run without root privileges.
 ...
```

https://gist.github.com/tallclair/11981031b6bfa829bb1fb9dcb7e026b0

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Resource Linting

- https://kubesec.io/ - calculate “risk” of Kubernetes resource YAML by use of security features
- https://github.com/garethr/kubetest - unit tests for your Kubernetes configurations

Deployments

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thockin @thockin · Mar 1

Omega turned out to be a bunch of useful technologies that were back-integrated into Borg, rather than a full reboot.

1 1 4

Joe Beda @jbeda · Mar 1

It heavily influenced k8s too. For instance, the way that labels work to relate thing is based on a lot of ideas that were designed/prototyped/explored with both Omega and GCP.

2 1 6

Brian Grant
@bgrant0607

Following

Replying to @jbeda @thockin and 3 others

Yes, labels, pods, watch, async. controllers, to name a few things.

1:11 AM - 2 Mar 2018

https://twitter.com/jbeda/status/969351665240305664

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Services

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Services

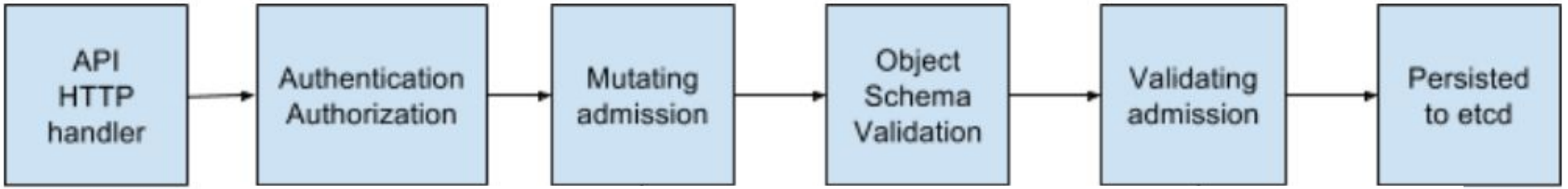
```yaml
kind: Service
apiVersion: v1
metadata:
  name: my-service
spec:
  selector:
    app: MyApp
  ports:
  - protocol: TCP
    port: 443
    targetPort: 8443
```

ServiceAccounts

> “We recommend you create and use a minimally privileged service account to run your Kubernetes Engine Cluster”

https://cloudplatform.googleblog.com/2017/11/precious-cargo-securing-containers-with-Kubernetes-Engine-18.html

API Admission Controllers



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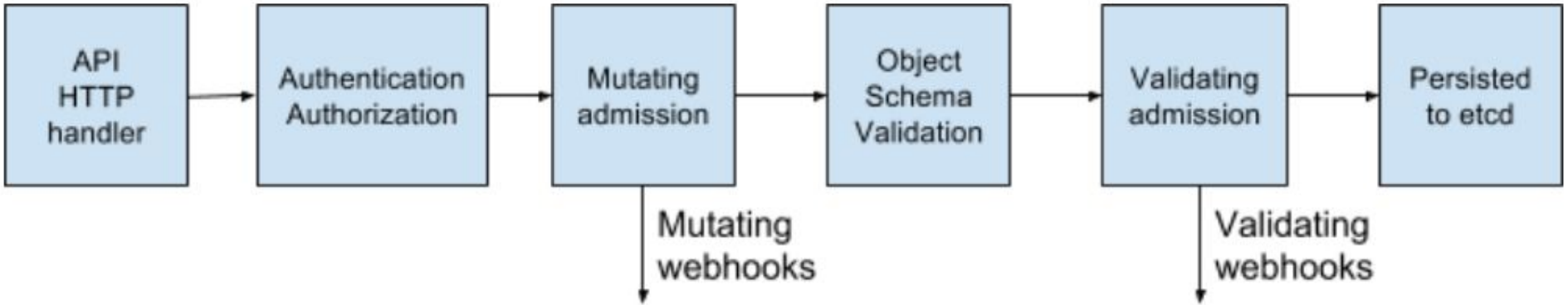
Extensible Admission Controllers



http://blog.kubernetes.io/2018/01/extensible-admission-is-beta.html

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Docs: Recommended Admission Controllers

```
--admission-control=${CONTROLLERS}

# ORDER MATTERS. For versions >= v1.9.0
```

- NamespaceLifecycle
- LimitRanger
- ServiceAccount
- PersistentVolumeLabel
- DefaultStorageClass
- DefaultTolerationSeconds
- MutatingAdmissionWebhook
- ValidatingAdmissionWebhook
- ResourceQuota

https://kubernetes.io/docs/admin/admission-controllers/#is-there-a-recommended-set-of-admission-controllers-to-use

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Admission Controllers: ImagePolicyWebhook

allows a **backend webhook** to make admission decisions

Admission Controllers: DenyEscalatingExec

deny exec and attach commands to

pods that run with **escalated privileges**

that allow host access

(privileged, access to host IPC/PID namespaces)

Admission Controllers: LimitRanger

observe the incoming request and ensure that it does not

violate any of the LimitRange constraints

Admission Controllers: ResourceQuota

observe the incoming request and ensure that it does not

violate any of the ResourceQuota constraints

Admission Controllers: NodeRestriction

limits the Node and Pod **objects a kubelet can modify**

kubelets must use credentials in the `system:nodes` group,

with a username in the form `system:node:<nodeName>`

n.b. Node Authorizer authorization mode required

https://kubernetes.io/docs/admin/authorization/node/

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```
$ kubectl describe clusterrole system:node
Name:         system:node
Labels:       kubernetes.io/bootstrapping=rbac-defaults
Annotations:  rbac.authorization.kubernetes.io/autoupdate=true
PolicyRule:
  Resources                                       Non-Resource URLs  Resource Names  Verbs
  ---------                                       -----------------  --------------  -----
  certificatesigningrequests.certificates.k8s.io  []                 []              [create get list watch]
  configmaps                                      []                 []              [get]
  endpoints                                       []                 []              [get]
  events                                          []                 []              [create patch update]
  localsubjectaccessreviews.authorization.k8s.io  []                 []              [create]
  nodes                                           []                 []              [create get list watch delete patch update]
  nodes/status                                    []                 []              [patch update]
  persistentvolumeclaims                          []                 []              [get]
  persistentvolumes                               []                 []              [get]
  pods                                            []                 []              [get list watch create delete]
  pods/eviction                                   []                 []              [create]
  pods/status                                     []                 []              [update]
  secrets                                         []                 []              [get]
  services                                        []                 []              [get list watch]
  subjectaccessreviews.authorization.k8s.io       []                 []              [create]
  tokenreviews.authentication.k8s.io              []                 []              [create]
```

clusterrole system:node

Admission Controllers: NodeRestriction

```
--authorization-mode=Node
```

A kubelet can not:

- alter the state of resources of any Pod it does not manage
- access Secrets, ConfigMaps or Persistent Volumes / PVCs, unless they are bound to a Pod managed by itself
- alter the state of any Node but the one it is running on

https://kubernetes.io/docs/admin/authorization/node/

Admission Controllers: PodSecurityPolicy

determines if it should be admitted based on the **requested**

security context and available Pod Security Policies

https://github.com/kubernetes/examples/tree/master/staging/podsecuritypolicy/rbac

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Admission Controllers: ServiceAccount

automation for serviceAccounts

if not exist, set:

`ServiceAccount`, `ImagePullSecrets`,
`/var/run/secrets/kubernetes.io/serviceaccount volume`

Admission Controllers in GKE

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Admission Controllers: ValidatingAdmissionWebhook (v1.9 beta)

calls validating webhooks in parallel,

rejects pod if any fail

Admission Controllers: ValidatingAdmissionWebhook (v1.9 beta)

https://github.com/kelseyhightower/denyenv-validating-admission-webhook#validating-admission-webhook-configuration

https://github.com/openshift/generic-admission-server

Secrets and Configmaps

```
--experimental-encryption-provider-config
```

- Secrets and configmaps are encrypted at rest with ‘aescbc’
  - If ‘aesgcm’ encryption is used, encryption keys should be rotated frequently
- Secure connection is set between apiserver and etcd
- Only apiserver user can read / edit EncryptionConfig file

https://www.twistlock.com/2017/08/02/kubernetes-secrets-encryption/

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Secrets and Configmaps

- https://kubernetes.io/docs/tasks/administer-cluster/encrypt-data/
- Secure Secret management for Kubernetes (with gpg, Google Cloud KMS and AWS KMS backends) - https://github.com/shyiko/kubesec
- Encryption at rest KMS integration - https://github.com/kubernetes/features/issues/460
- https://medium.com/@mtreacher/using-aws-kms-for-application-secrets-in-kubernetes-149ffb6b4073
- Sealed Secrets - a Kubernetes controller and tool for one-way encrypted Secrets https://github.com/bitnami-labs/sealed-secrets

TokenRequest API (v1.10 alpha)

The TokenRequest API enables creation of tokens that:

- aren't persisted in the Secrets API
- targeted for specific audiences (such as external secret stores)
- have configurable expiries
- bindable to specific pods.

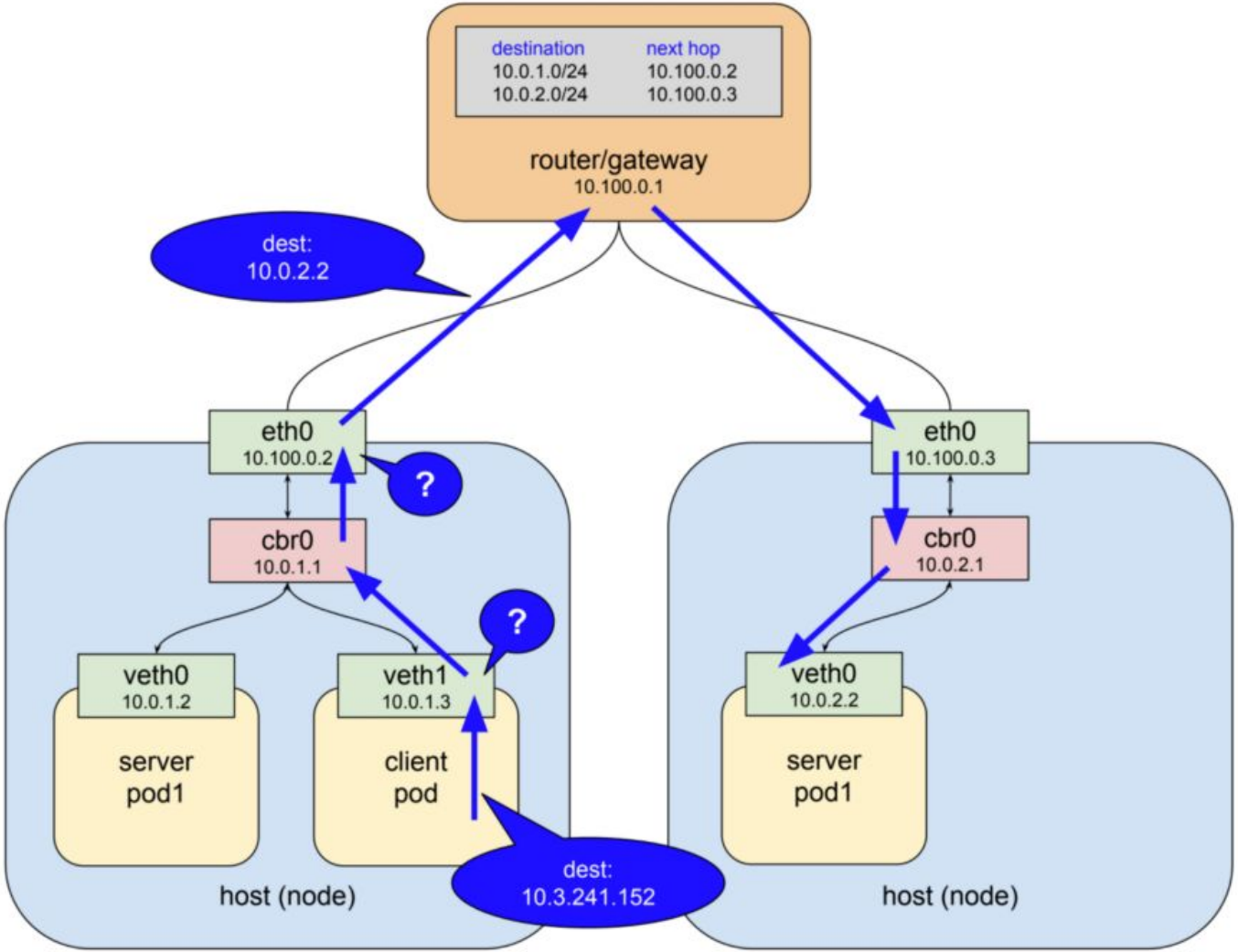
Compliance Scanning

- https://github.com/nccgroup/kube-auto-analyzer - review Kubernetes installations against the CIS Kubernetes 1.8 Benchmark
- https://github.com/aquasecurity/kube-bench - test versions of Kubernetes (1.6, 1.7 and 1.8) against CIS Kubernetes 1.0.0, 1.1.0 and 1.2.0
- https://github.com/heptio/sonobuoy - running a set of Kubernetes conformance tests in an accessible and non-destructive manner
- https://github.com/bgeesaman/sonobuoy-plugin-bulkhead - kube-bench for sonobouy
- https://github.com/bgeesaman/kubeatf - spin up, test, and destroy Kubernetes clusters in a human and CI/CD friendly way

Image Scanning

- https://github.com/coreos/clair
- https://github.com/arminc/clair-local-scan
- https://github.com/optiopay/klar - integration of Clair and Docker Registry
- https://github.com/banyanops/collector
- https://github.com/anchore/anchore-engine

Securing Kubernetes Networking



https://medium.com/google-cloud/understanding-kubernetes-networking-services-f0cb48e4cc82

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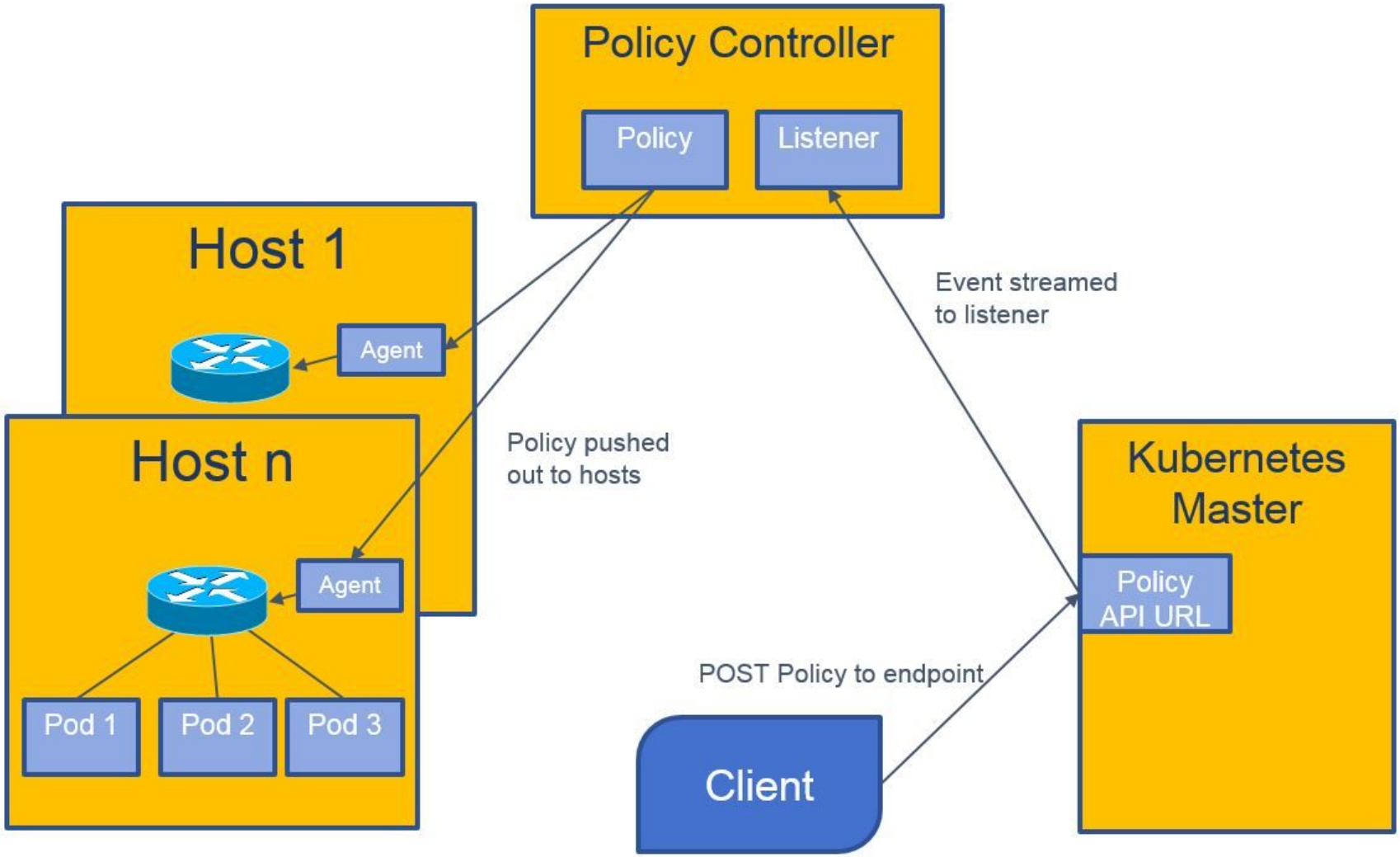
NetworkPolicy

- Calico
- Cilium (Learn more about eBPF)
- Kube-router
- Romana
- Weave Net


Policy Controller
Policy
Listener
Host 1
Agent
Host n
Agent
Pod 1
Pod 2
Pod 3
Policy pushed
out to hosts
Event streamed
to listener
Kubernetes
Master
Policy
API URL
POST Policy to endpoint
Client

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: default-deny
spec:
  podSelector:
```

https://github.com/ahmetb/kubernetes-network-policy-recipes

Kubernetes NetworkPolicy: default deny

controlplane

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: default-deny
spec:
  podSelector:
    - “*”
```

Illegal syntax, but represents what it actually does (effectively a wildcard)

https://github.com/ahmetb/kubernetes-network-policy-recipes

Kubernetes NetworkPolicy: default deny

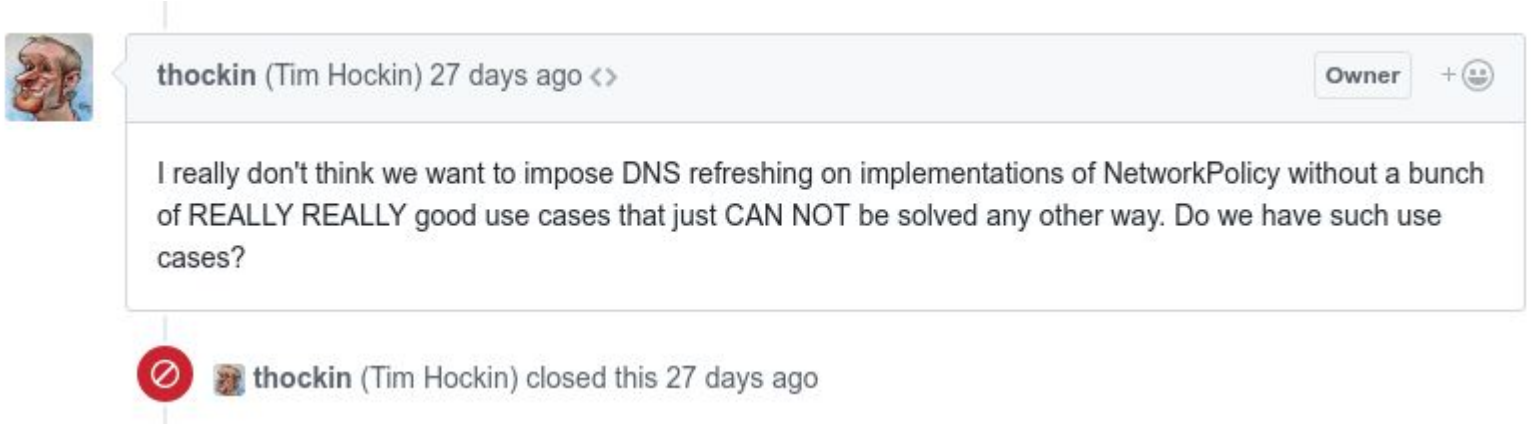
controlplane

```yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: foo-deny-external-egress
spec:
  podSelector:
    matchLabels:
      app: foo
  policyTypes:
  - Egress
  egress:
  - ports:
    - port: 53
      protocol: UDP
    - port: 53
      protocol: TCP
  - to:
    - namespaceSelector: {}
```

https://github.com/ahmetb/kubernetes-network-policy-recipes

Kubernetes NetworkPolicy

controlplane



https://github.com/kubernetes/kubernetes/issues/56901

Kubernetes NetworkPolicy - NO DNS NAMES

controlplane

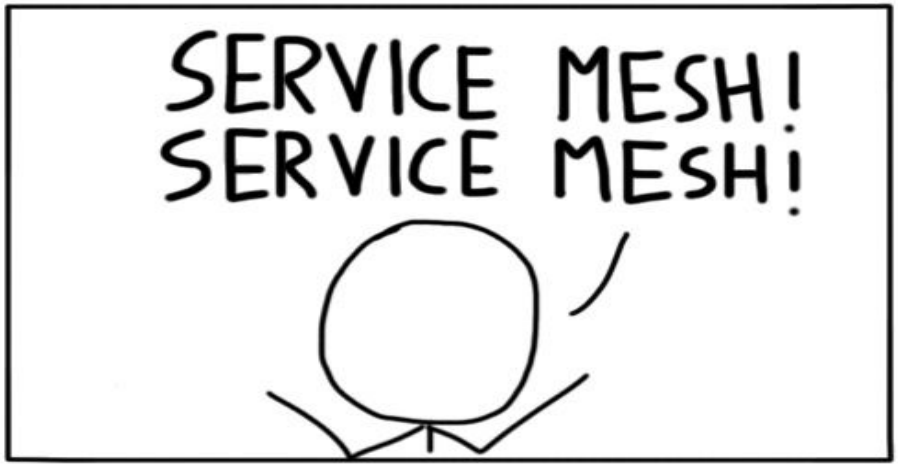
```yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: foo-deny-external-egress
spec:
  podSelector:
    dnsName: control-plane.io
  policyTypes:
  - Egress
  egress:
  - ports:
    - port: 53
      protocol: UDP
    - port: 53
      protocol: TCP
  - to:
    - namespaceSelector: {}
```

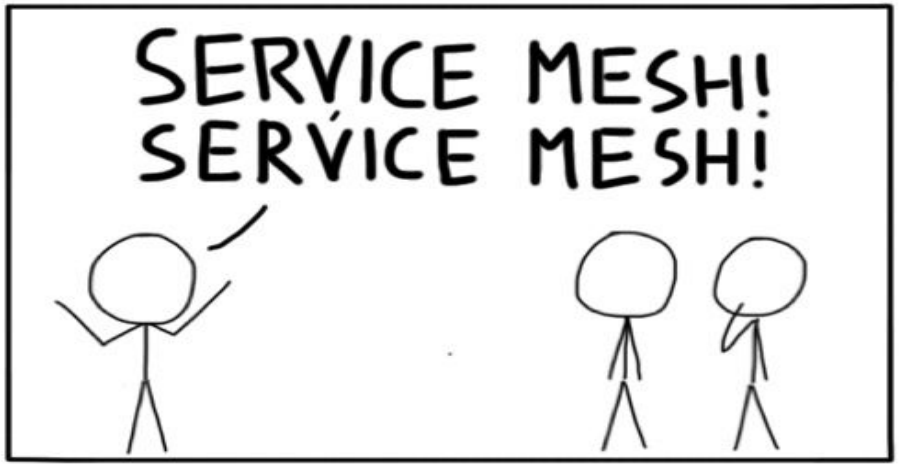
ILLEGAL! NOT ALLOWED!

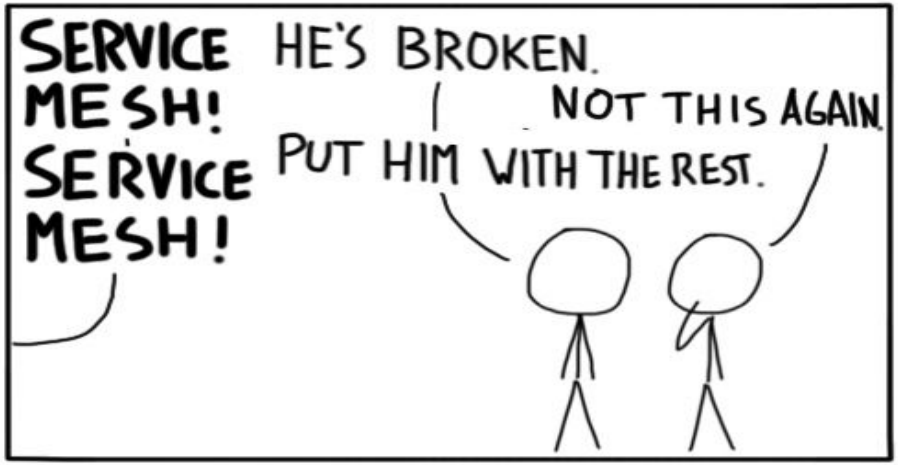
https://github.com/ahmetb/kubernetes-network-policy-recipes

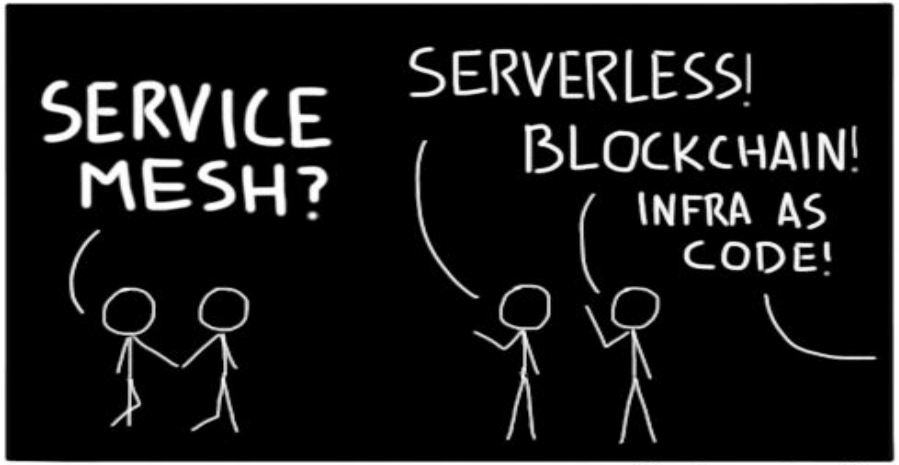
Kubernetes NetworkPolicy - ILLEGAL!

controlplane


SERVICE MESH!
SERVICE MESH!

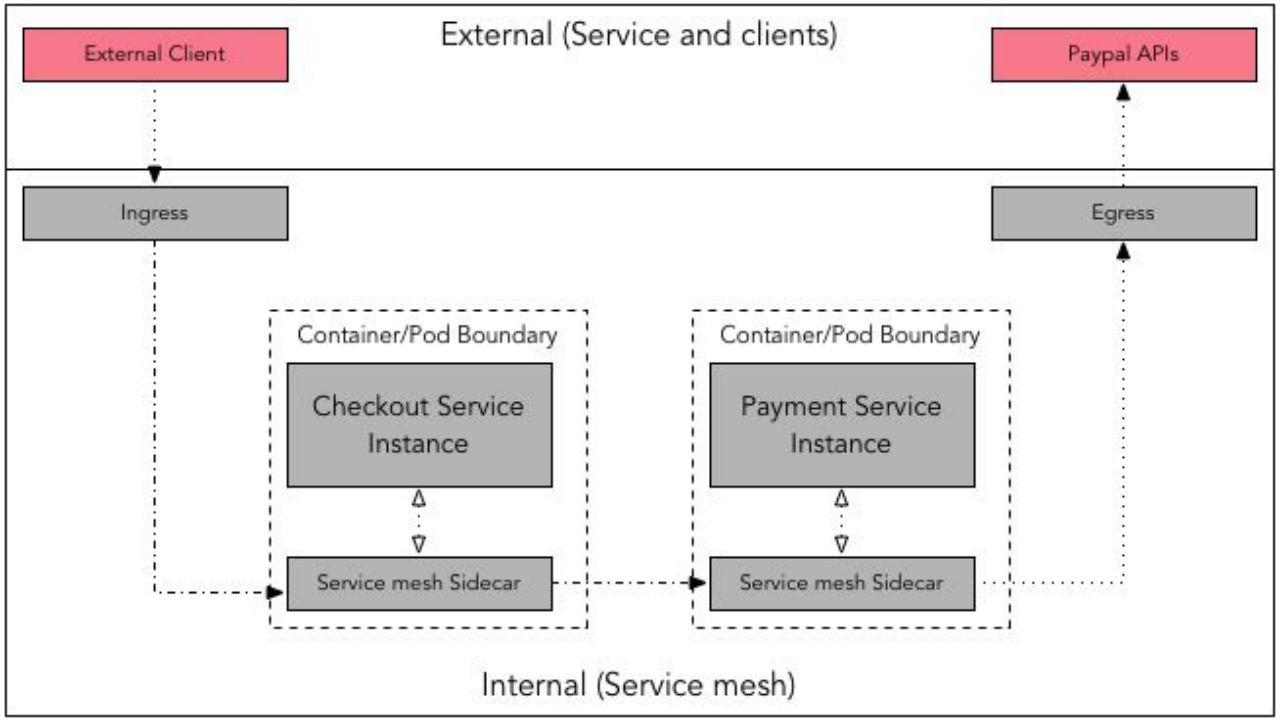

SERVICE MESH!
SERVICE MESH!


SERVICE MESH!
SERVICE MESH!
HE'S BROKEN.
PUT HIM WITH THE REST.
NOT THIS AGAIN.


SERVICE MESH?
SERVERLESS!
BLOCKCHAIN!
INFRA AS CODE!

@sebiwicb

What is a Service Mesh?



https://abhishek-tiwari.com/a-sidecar-for-your-service-mesh/

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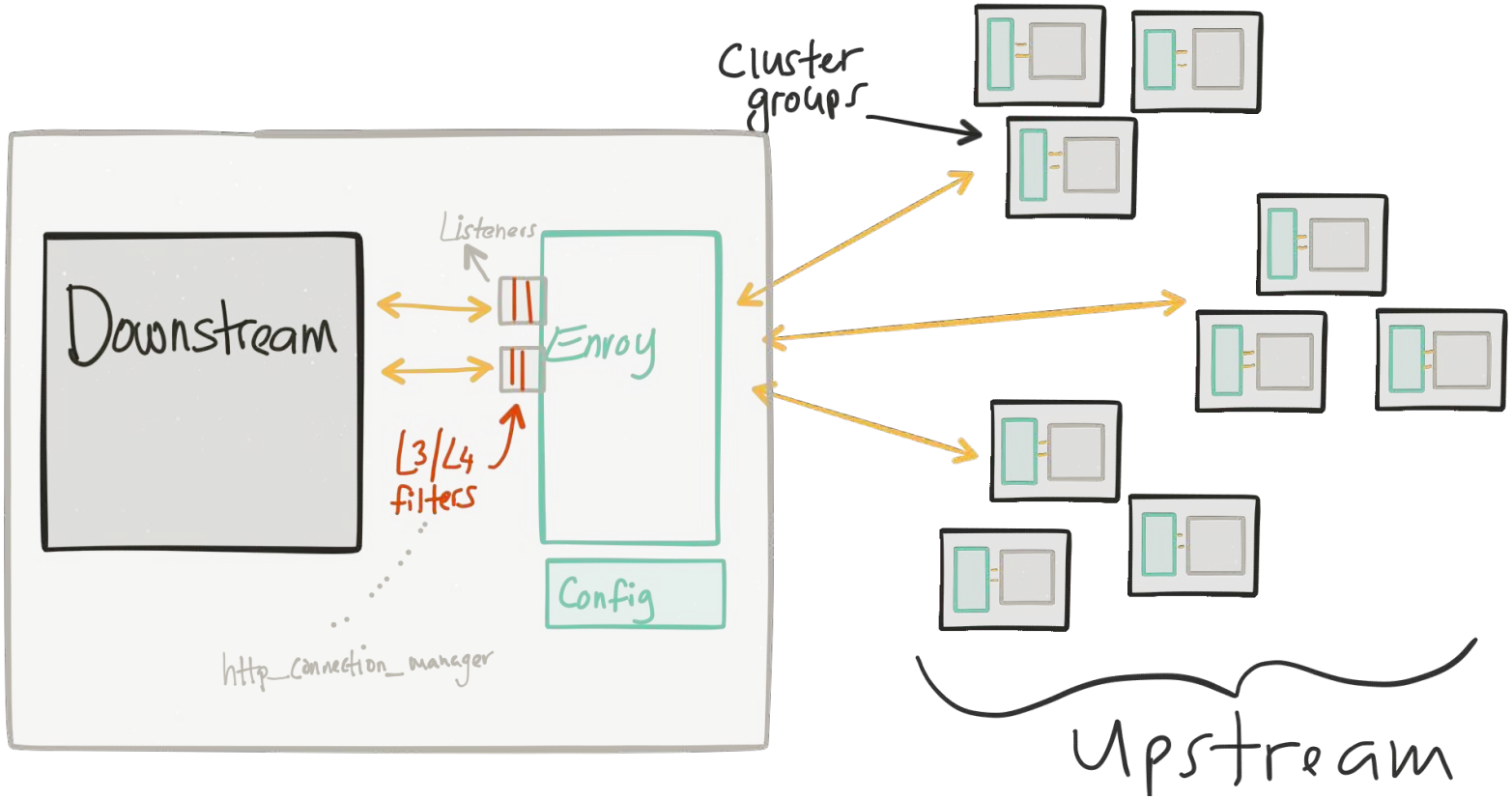

http://blog.christianposta.com/istio-workshop/

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Service Meshes - Istio

- Automatic mutual TLS between services
- Service-level RBAC
- External identity provider integration
- Policy and quota enforcement, dynamic per-request routing
- Deployment strategies such as red/black, canary, dark/mirrored
- Distributed tracing
- Network policy between apps/services, and on ingress/egress

`netassert` - cloud native network testing

- netassert - network security testing for DevSecOps workflows
  https://github.com/controlplaneio/netassert

```
host:
  localhost:
    bitbucket.com:
      - 22
  control-plane.io:
    github.com:
      - 22
```

controlplane

`netassert` - cloud native network testing

```
k8s: # used for Kubernetes pods
  deployment: # only deployments currently supported
    test-frontend: # pod name, defaults to `default` namespace
      test-microservice: 80 # `test-microservice` is the DNS name of the target service
      test-database: -80    # should not be able to access port 80 of `test-database`

    new-namespace:test-microservice:  # `new-namespace` is the namespace name
      test-database.new-namespace: 80 # longer DNS names can be used for other namespaces
      test-frontend.default: 80

    default:test-database:
      test-frontend.default.svc.cluster.local: 80 # full DNS names can be used
      test-microservice.default.svc.cluster.local: -80
      control-plane.io: 443 # we can check remote services too
```

https://github.com/controlplaneio/netassert

controlplane

```
[2018-02-02T16:06:49.124+0000] ./netassert: Results: localhost
TAP version 13
# localhost TCP:30731 closed
ok 1 - localhost TCP:30731 closed
# localhost UDP:1234 closed
ok 2 - localhost UDP:1234 closed
# localhost TCP:22 open
ok 3 - localhost TCP:22 open
# binarysludge.com TCP:443 open
ok 4 - binarysludge.com TCP:443 open
# localhost TCP:999 closed
ok 5 - localhost TCP:999 closed
# control-plane.io TCP:443 open
ok 6 - control-plane.io TCP:443 open
# localhost UDP:555 closed
ok 7 - localhost UDP:555 closed
# control-plane.io TCP:80 open
ok 8 - control-plane.io TCP:80 open
# binarysludge.com TCP:22 open
ok 9 - binarysludge.com TCP:22 open
# binarysludge.com TCP:80 open
ok 10 - binarysludge.com TCP:80 open
# 8.8.8.8 UDP:53 open
ok 11 - 8.8.8.8 UDP:53 open
# google.co.uk TCP:443 open
ok 12 - google.co.uk TCP:443 open
# binarysludge.com TCP:81 open
ok 13 - binarysludge.com TCP:81 open
# 8.8.4.4 UDP:53 open
ok 14 - 8.8.4.4 UDP:53 open

1..14
# tests 14
# pass 14
# fail 0

[2018-02-02T16:06:49.129+0000] ./netassert: localhost pass
```

Cloud Native Dynamic Firewalls

- Network Policy recipes - https://github.com/ahmetb/kubernetes-network-policy-recipes
- WeaveNet Network Policy - https://kubernetes.io/docs/tasks/administer-cluster/weave-network-policy/
- NeuVector Container Firewall - https://neuvector.com/products/
- Tesla Compromise mitigation - https://www.tigera.io/tesla-compromise-network-policy/

Recap

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Multi Tenancy Principles

Secure Hosts

- Minimal attack surface
  - CoreOS (RIP), forked as FlatCar Linux- https://coreos.com/ and https://kinvolk.io/
  - Red Hat Atomic - https://www.redhat.com/en/resources/enterprise-linux-atomic-host-datasheet
  - Ubuntu Core -https://www.ubuntu.com/core
  - Container-Optimized OS from Google - https://cloud.google.com/container-optimized-os/docs/
- Security extensions enabled, configured, and monitored
- Immutable infrastructure
- Group nodes by type, usage, and security level

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No Routes To:

- cadvisor
- heapster
- kubelet
- kubernetes dashboard
- etcd

Proxy to Metadata APIs

- https://github.com/jtblin/kube2iam - provides different AWS IAM roles for pods running on Kubernetes
- https://github.com/uswitch/kiam - allows cluster users to associate IAM roles to Pods
- https://github.com/heptio/authenticator - allow AWS IAM credentials to authenticate to a Kubernetes cluster
- https://github.com/GoogleCloudPlatform/k8s-metadata-proxy - a simple proxy for serving concealed metadata to container workloads

MULTI TENANCY: Soft

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MULTI TENANCY: Soft

- Isolate by namespace
  - don't forget the default networkpolicy and podsecuritypolicy
  - assign limits to the namespace with LimitRanges
    https://kubernetes.io/docs/tasks/administer-cluster/memory-default-namespace/
- Separate dev/test from production
- Image scanning
  - private registry and build artefacts/supply chain

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MULTI TENANCY: Soft

- Policed, scanned, compliant base images
  - minimal attack surface
  - FROM scratch if possible
- Deploy admission controllers, pod security policies, etc
- Everything as code
  - https://www.weave.works/blog/gitops-operations-by-pull-request

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MULTI TENANCY: Hard

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MULTI TENANCY: Hard

- All users untrusted, potentially malicious
    - comfortable running code from multiple third parties, with the potential for malice that implies, in the same cluster
- Only co-tenant along your existing security boundaries
- Segregate logically by application type, security level, and/or physically by project/account
- Separate node pools for different tenants

Container Runtimes

- **runc** - CLI tool for spawning and running containers according to the OCI specification https://github.com/opencontainers/runc
- **cri-o** - Open Container Initiative-based implementation of Kubernetes Container Runtime Interface https://github.com/kubernetes-incubator/cri-o
- **Kata Containers** - hardware virtualized containers https://katacontainers.io/
- **VirtualKubelet** - a Kubernetes kubelet implementation https://github.com/virtual-kubelet/virtual-kubelet
- **LXC/LXD, rkt, systemd-nspawn - https://coreos.com/rkt/docs/latest/rkt-vs-other-projects.html**

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MULTI TENANCY: Hard

- this may not look a lot like hard multitenancy?
  - it's still running a centralised control plane
- run kubedns in a sidecar to restrict DNS leakage
- mixed vm and container workload
  - Dan Walsh nailed it
  - "glasshouse VMs"
- Defence in depth
- Remote logging

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MULTI TENANCY: Hard

TREAT CONTAINER SERVICES JUST LIKE REGULAR SERVICES

Drop privileges as quickly as possible

Run your services as non Root whenever possible

Treat root within a container the same as root outside of the container

"Docker is about running random crap from the internet as root on your host"

Only run containers from trusted parties

https://www.weave.works/blog/container-security-with-dan-walsh-redhat

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IDS: Not a problem while undetected

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IDS Vendors

- https://www.twistlock.com/
- https://www.aquasec.com/
- https://www.blackducksoftware.com/
- https://github.com/capsule8/capsule8
- https://sysdig.com/

RBAC

- https://github.com/uruddarraju/kubernetes-rbac-policies - RBAC policies for cluster services
- https://github.com/liggitt/audit2rbac - autogenerate RBAC policies based on Kubernetes audit logs

Audit Logs in GKE

```
{
 insertId: "1yr52hqdv1hr"
 labels: {…}
 logName: "projects/dev/logs/cloudaudit.googleapis.com%2Factivity"
 operation: {…}
 protoPayload: {…}
 receiveTimestamp: "2018-03-12T20:45:04.497610612Z"
 resource: {…}
 severity: "NOTICE"
 timestamp: "2018-03-12T20:44:45.213721Z"
}
```

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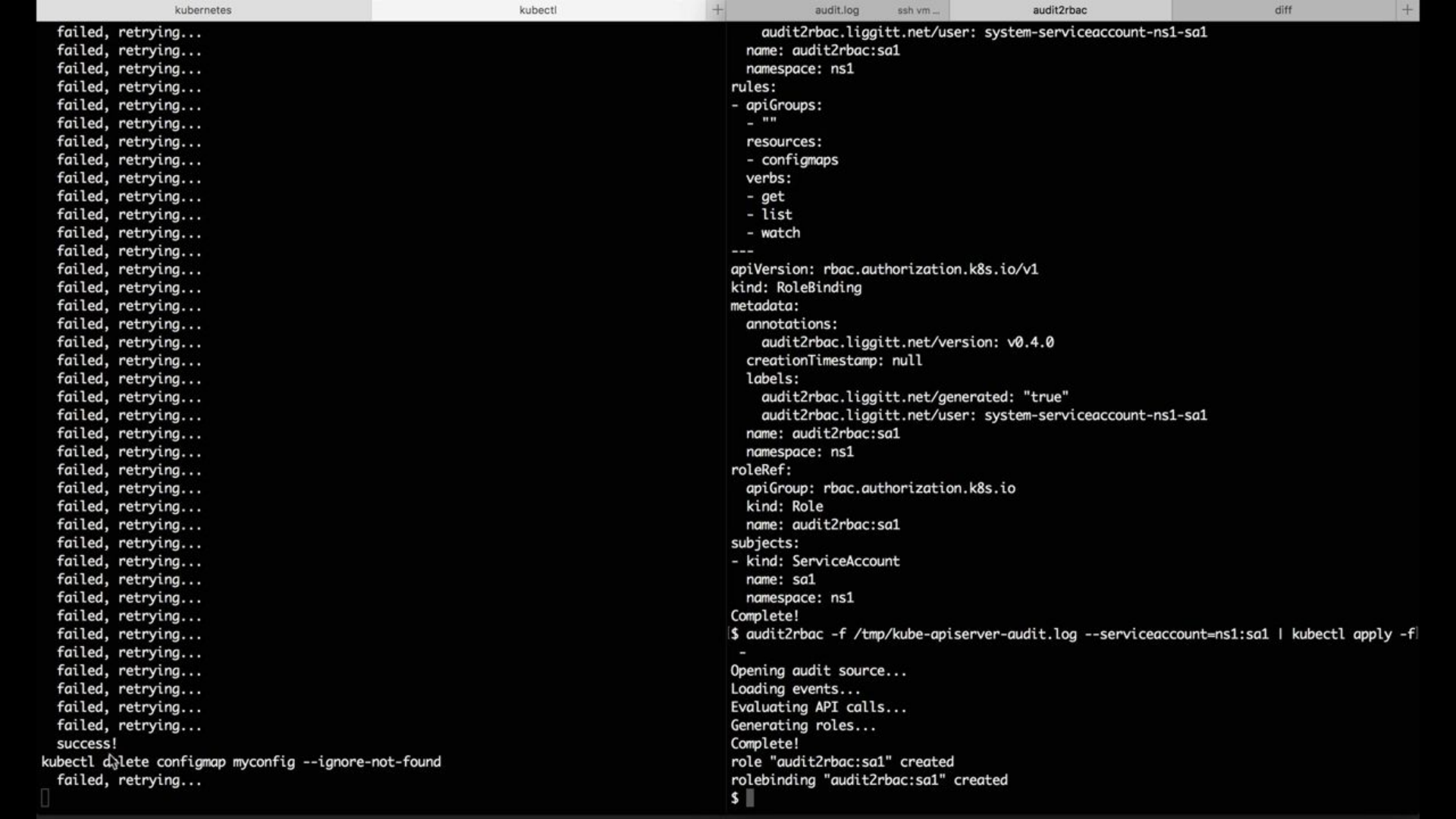
kubernetes
kubectl
audit.log
ssh vm ...
audit2rbac
diff
failed, retrying...
success!
kubectl delete configmap myconfig --ignore-not-found
audit2rbac.liggitt.net/user: system-serviceaccount-ns1-sa1
name: audit2rbac:sa1
namespace: ns1
rules:
- apiGroups:
- ""
resources:
- configmaps
verbs:
- get
- list
- watch
---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
annotations:
audit2rbac.liggitt.net/version: v0.4.0
creationTimestamp: null
labels:
audit2rbac.liggitt.net/generated: "true"
audit2rbac.liggitt.net/user: system-serviceaccount-ns1-sa1
name: audit2rbac:sa1
namespace: ns1
roleRef:
apiGroup: rbac.authorization.k8s.io
kind: Role
name: audit2rbac:sa1
subjects:
- kind: ServiceAccount
name: sa1
namespace: ns1
Complete!
$ audit2rbac -f /tmp/kube-apiserver-audit.log --serviceaccount=ns1:sa1 | kubectl apply -f -
Opening audit source...
Loading events...
Evaluating API calls...
Generating roles...
Complete!
role "audit2rbac:sa1" created
rolebinding "audit2rbac:sa1" created
$

Docker

- https://www.youtube.com/watch?v=7mzbIOtcIaQ - Jessie Frazelle's History of Containers keynote
- https://github.com/openSUSE/umoci - a complete manipulation tool for OCI images
- https://github.com/projectatomic/skopeo - work with remote images registries to retrieve information and images, and sign content
- https://contained.af - Docker/Kubernetes CTF (https://github.com/jessfraz/contained.af)

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Persisting Configuration: Continuous Security

Continuous Security

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Continuous Infra Security

- The system can continually self-validate
- Test pipelines are more robust
- Highly skilled penetration testers are free to focus on the “high-hanging fruit”

Conclusion

- The brave new world of Kubernetes increases attack surface and potential for misconfiguration
- Lots of new security primitives are landing
- The only way to iterate quickly is: supported by a test suite
- Security testing keeps you young