

Continuous Kubernetes Security

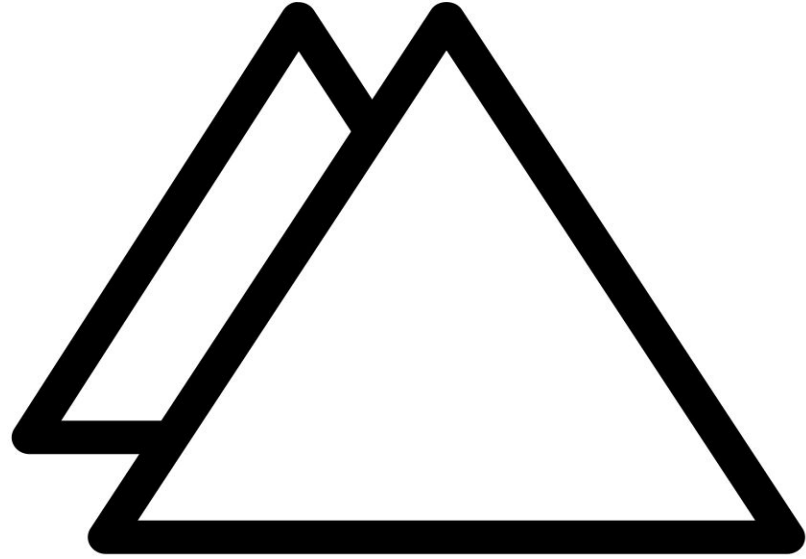
@sublimino and @controlplaneio





I'm:

- Andy
- Dev-like
- Sec-ish
- Ops-y



controlplane

Is this Kubernetes cluster secure?







LIVE

BREAKING NEWS

LOCAL FISH IN GREAT MOOD TODAY

19:41

THE WATER TASTES GREAT AND THERE'S 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.

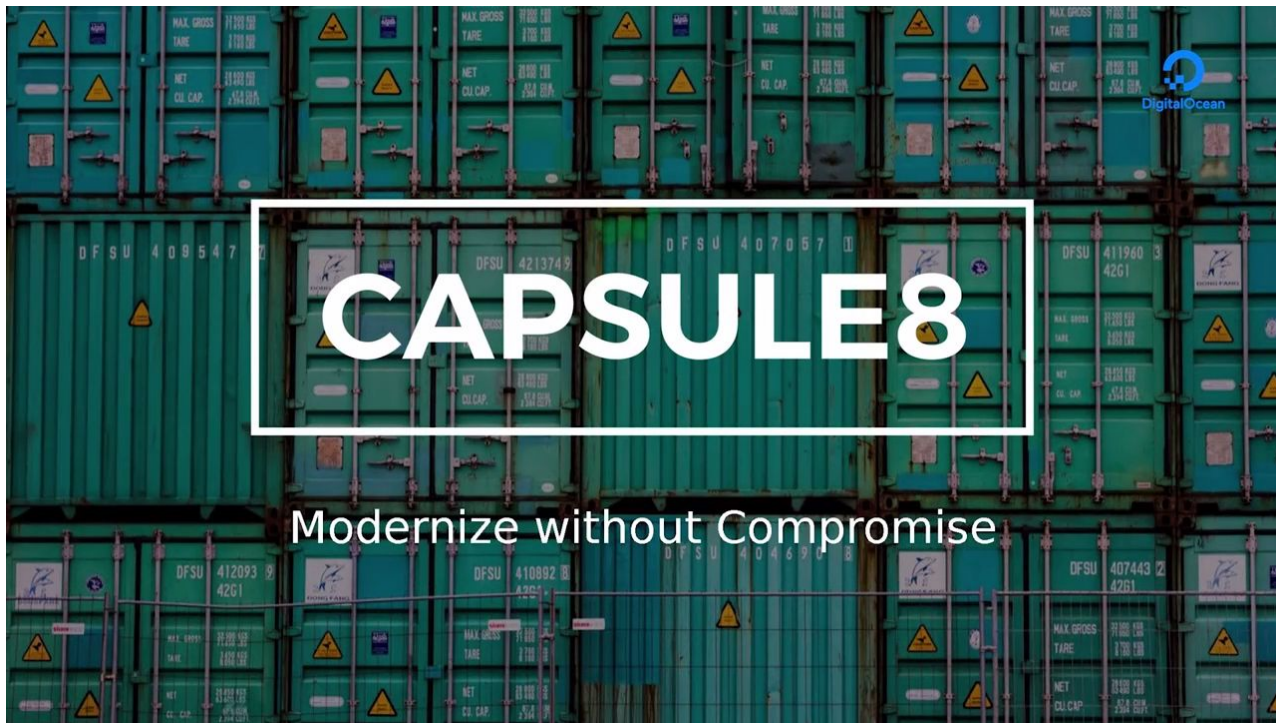
```
# /run/%namespace%/%pod_name%/%container_name%
$ curl -k -XPOST "https://k8s-node-1:10250/run/kube-system/node-exporter-iuwg7/node-exporter" -d "cmd=ls -l
total 12
drwxr-xr-x 13 root    root          148 Aug 26 11:31 .
drwxr-xr-x 13 root    root          148 Aug 26 11:31 ..
-rwxr-xr-x  1 root    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.



Security vs Features

No RBAC



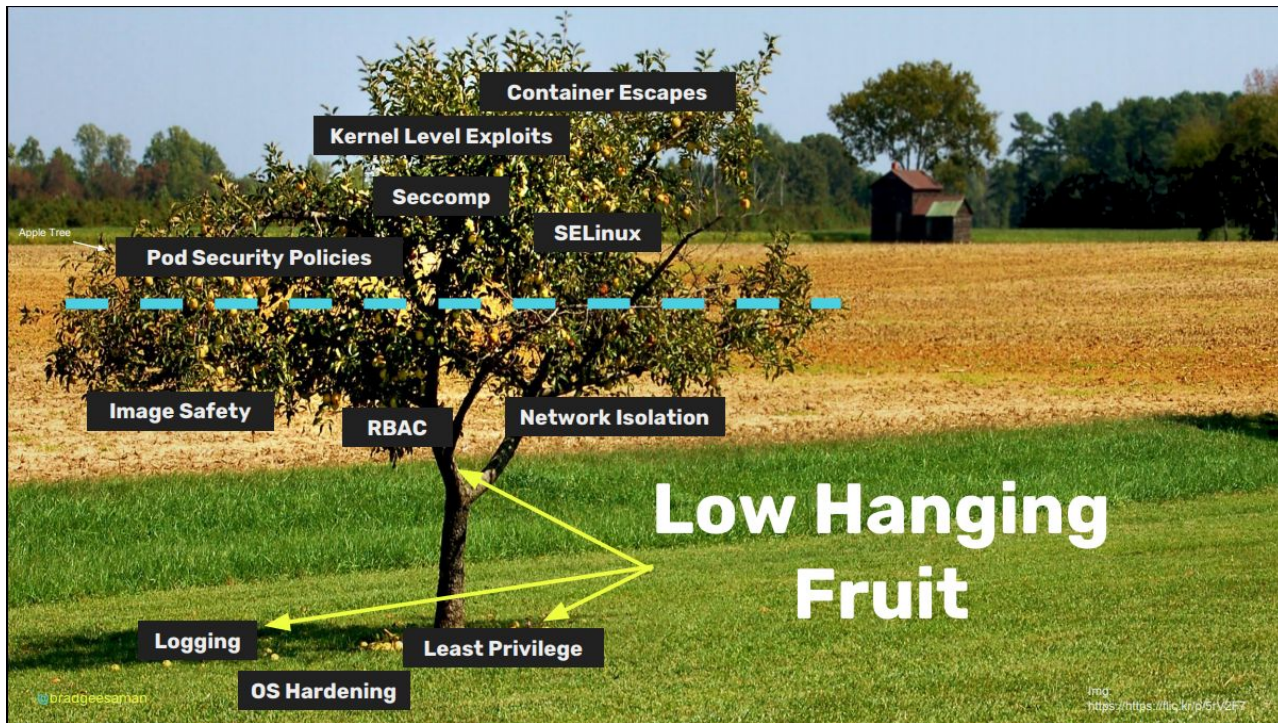
No Workload Security



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



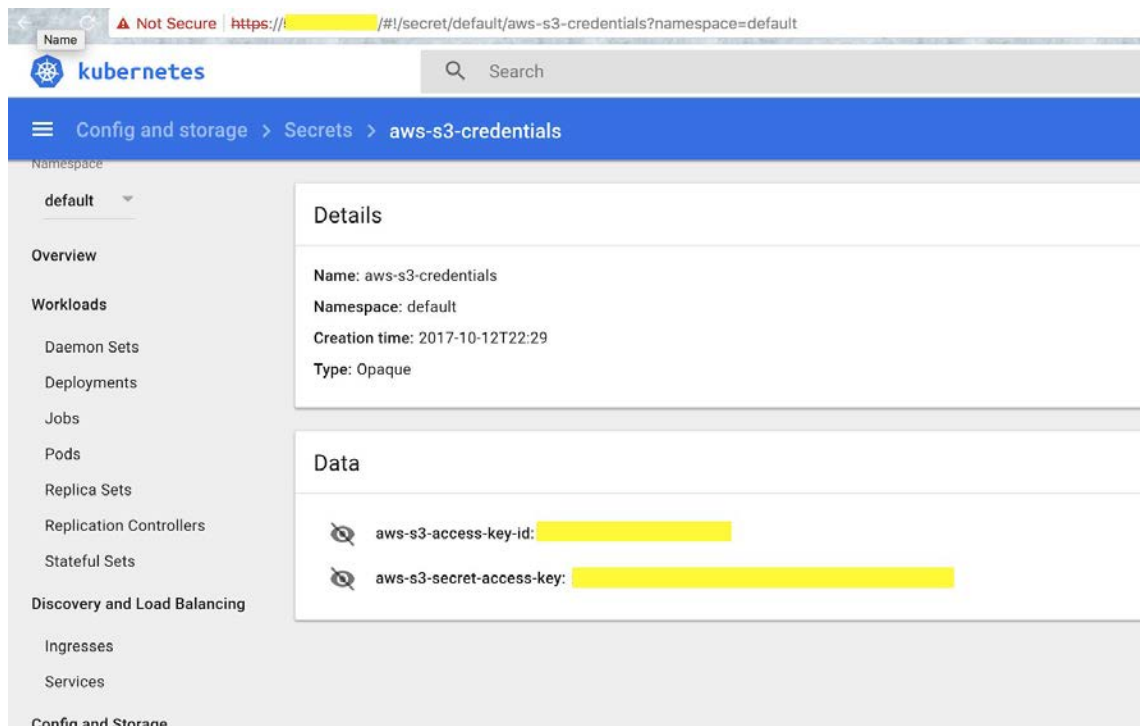
No Security - Cluster Edition



Helm



Unsecured Dashboard - Tesla



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

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

New issue



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



controlplane

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

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>



What is Continuous Security?

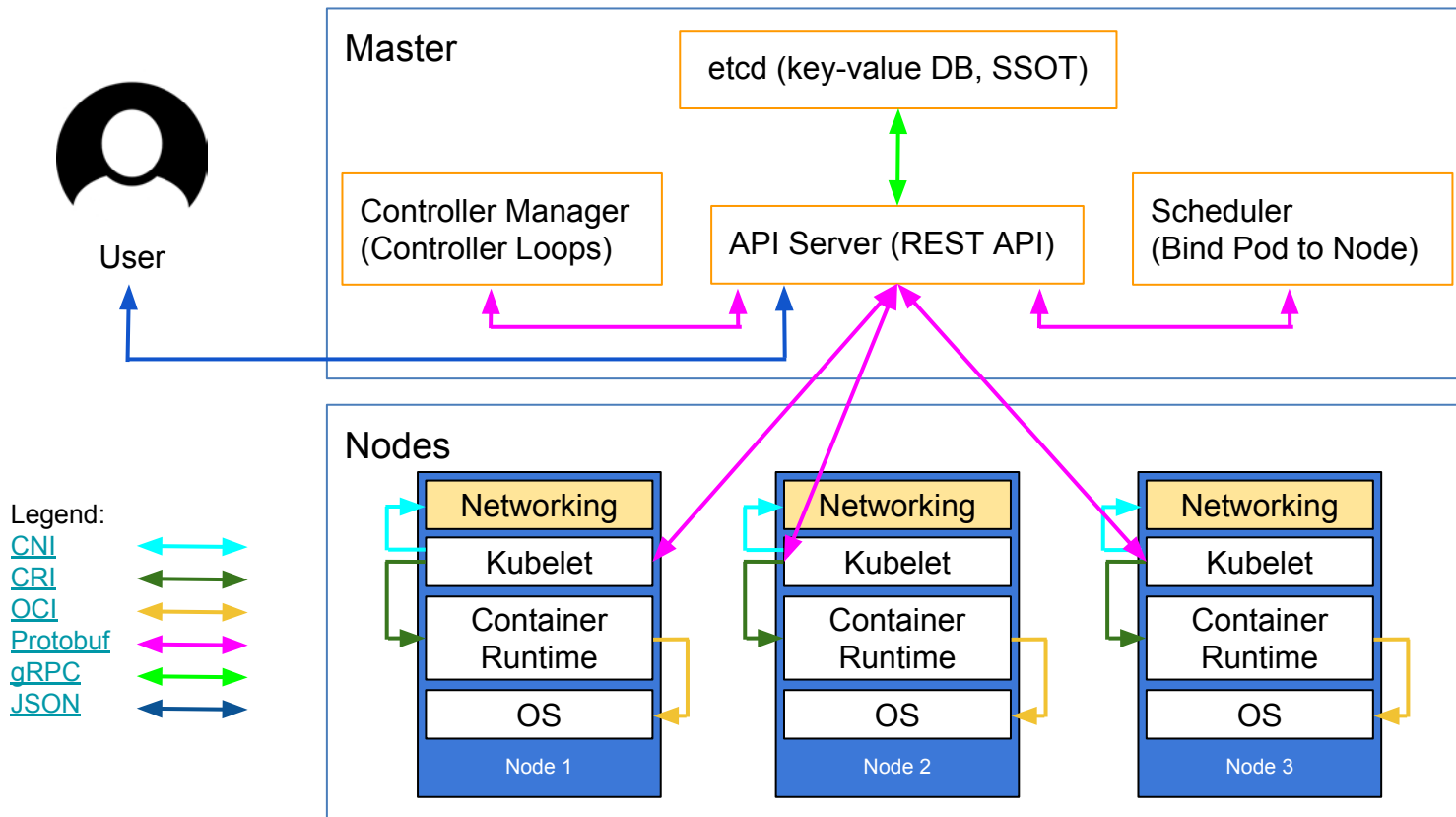
- Infrastructure as Code
- Security as Code
- Continuous Delivery





Hardening the Kubernetes Control Plane





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

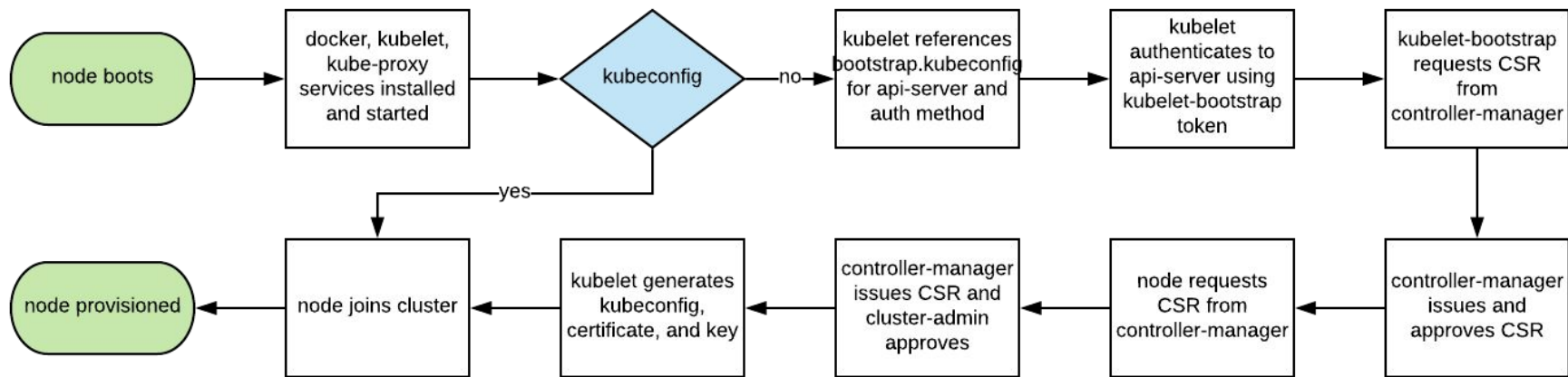
- <https://github.com/kelseyhightower/kubernetes-the-hard-way/blob/master/docs/04-certificate-authority.md>

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

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



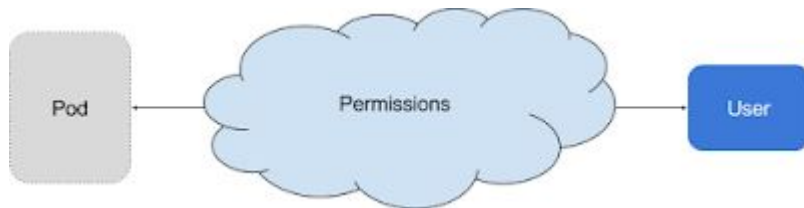
Bootstrapping TLS



<https://medium.com/@todrosner/kubernetes-tls-bootstrapping-cf203776abc7>

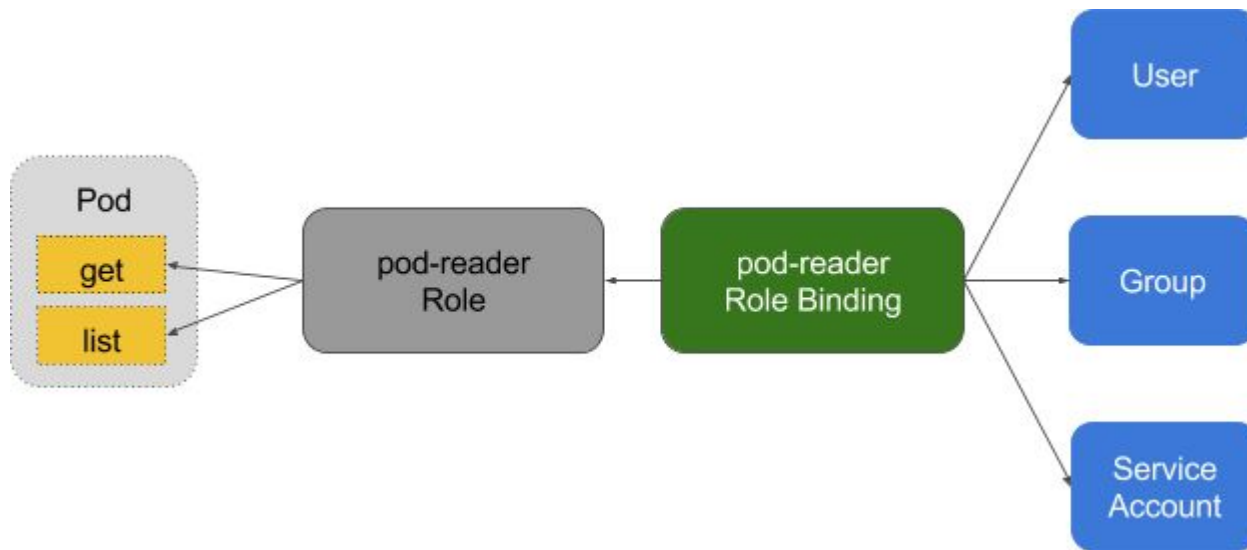


Enable RBAC



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

Enable RBAC



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

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

- <https://thenewstack.io/kubernetes-single-sign-on-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": "LS0tLS1CRUdJTjIBD...",
        "namespace": "ZGVmYXVsdA==",
        "token": "ZXlKaGJHY..."
      },
      "type": "kubernetes.io/service-account-token"
    }
  ]
}
```



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

`--anonymous-auth=false`



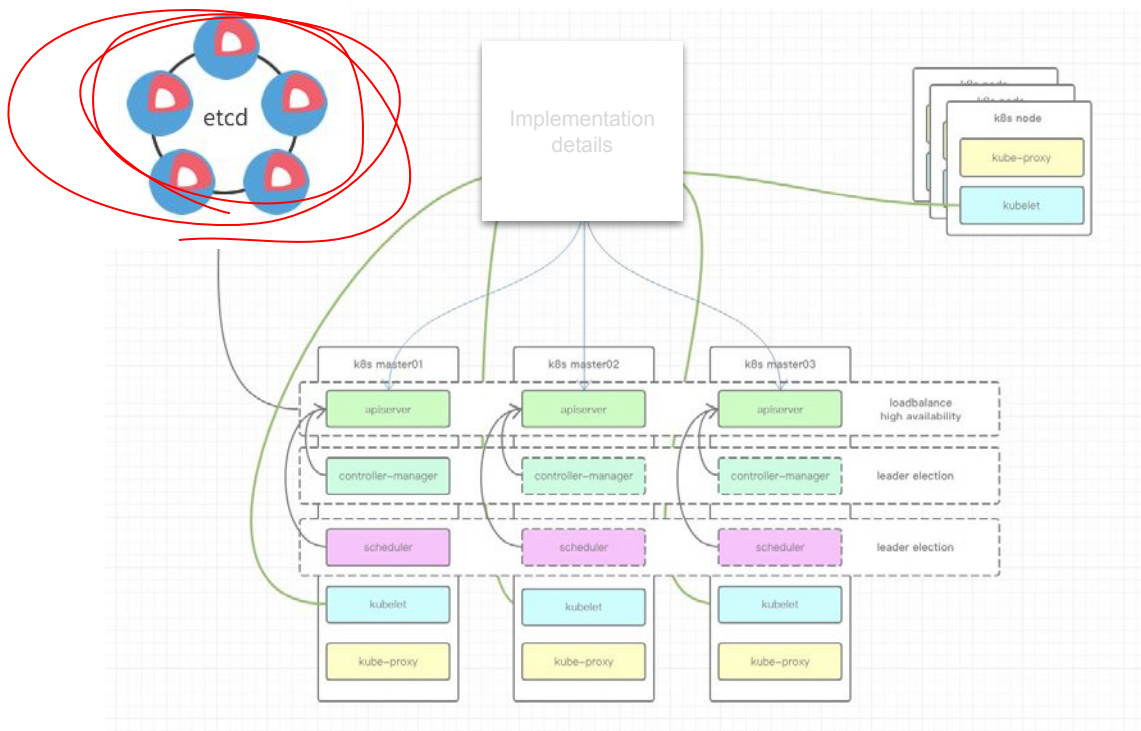
No system:anonymous role for anonymous user (API server flag)

```
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



Rotate keys



Securing Workloads



Containers



Containers

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



Pods



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
```



kubesecc.io - risk score for K8S YAML



index

```
.metadata.annotations
'container.seccomp.security.alpha.kubernetes.io/pod'
.metadata.annotations
'seccomp.security.alpha.kubernetes.io/pod'
.spec.template.spec.hostIPC
.spec.template.spec.hostNetwork
.spec.template.spec.hostPID
Service Accounts
containers[].resources.limits.cpu
containers[].resources.limits.memory
containers[].resources.requests.cpu
containers[].resources.requests.memory
containers[].securityContext.capabilities.add | index("SYS_ADMIN")
containers[].securityContext.capabilities.drop | index("ALL")
containers[].securityContext.privileged == true
containers[].securityContext.readOnlyRootFilesystem == true
containers[].securityContext.runAsNonRoot == true
```

kubesecc.io > index

[Edit this page](#)

KUBESEC.IO

- .metadata.annotations 'container.seccomp.security.alpha.kubernetes.io/pod'
- .metadata.annotations 'seccomp.security.alpha.kubernetes.io/pod'
- .spec.template.spec.hostIPC
- .spec.template.spec.hostNetwork
- .spec.template.spec.hostPID
- Service Accounts
- containers[].resources.limits.cpu
- containers[].resources.limits.memory
- containers[].resources.requests.cpu
- containers[].resources.requests.memory
- containers[].securityContext.capabilities.add | index("SYS_ADMIN")
- containers[].securityContext.capabilities.drop | index("ALL")
- containers[].securityContext.privileged == true
- containers[].securityContext.readOnlyRootFilesystem == true
- containers[].securityContext.runAsNonRoot == true
- containers[].securityContext.runAsUser > 10000
- securityContext.capabilities
- .metadata.annotations 'container.apparmor.security.beta.kubernetes.io/nginx'
- .spec.volumeClaimTemplates[].spec.accessModes | index("ReadWriteOnce")
- .spec.volumeClaimTemplates[].spec.resources.requests.storage

FUTHER READING

- <http://blog.kubernetes.io/2016/08/security-best-practices-kubernetes-deployment.html>



controlplane

kubesecc.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/"
    }],
    ...
  }
}
```



PodSecurityPolicies

```
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.
  ...
```



controlplane

Resource Linting

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

Deployments





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



controlplane

Services



Services

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



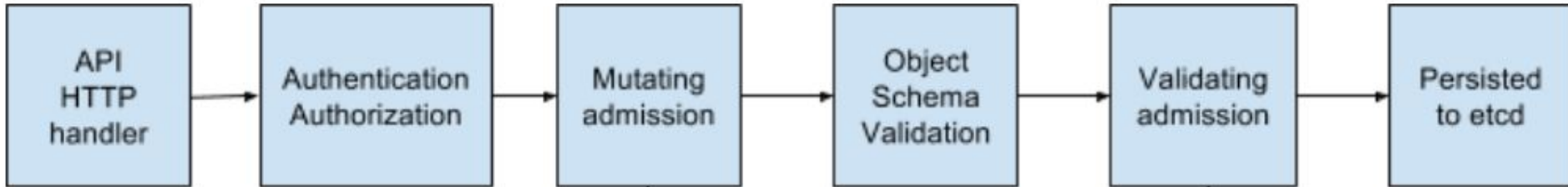
ServiceAccounts

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

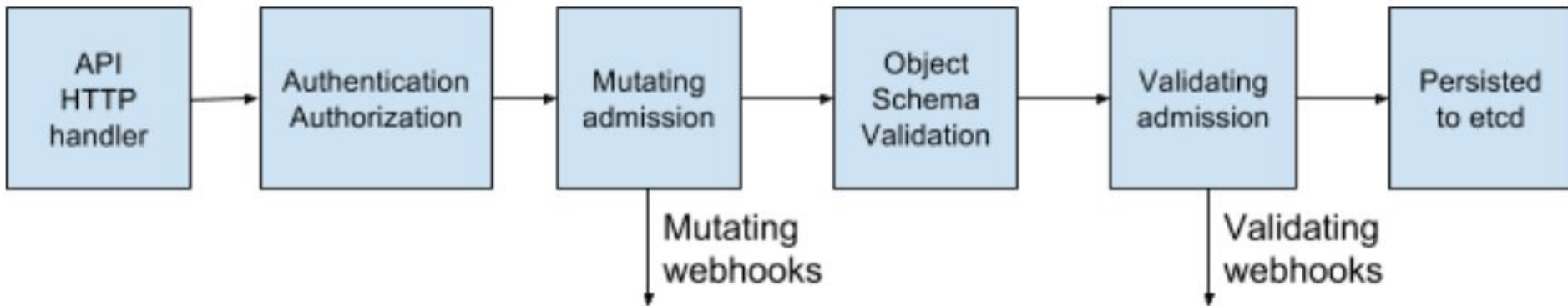
<https://cloudplatform.googleblog.com/2017/11/precious-cargo-securing-containers-with-Kubernetes-Engine-18.html>



API Admission Controllers



Extensible Admission Controllers



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



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>



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/>



```
$ 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>



Admission Controllers: ServiceAccount

automation for serviceAccounts

if not exist, set:

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



Admission Controllers in GKE



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/>



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/kubesecc>
- 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 sonobuoy
- <https://github.com/bgeesaman/kubeatf> - spin up, test, and destroy Kubernetes clusters in a human and CI/CD friendly way

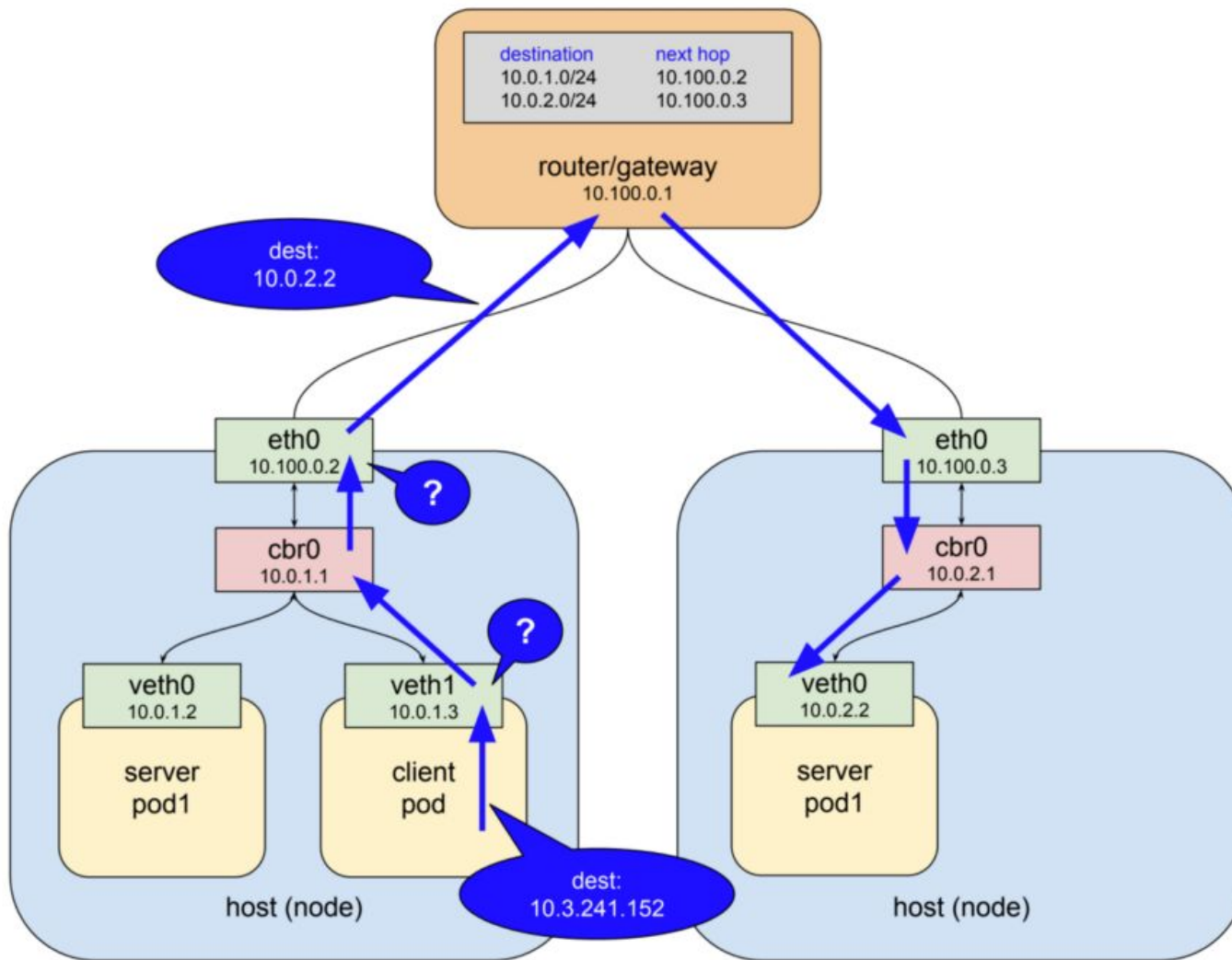


Image Scanning

- <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



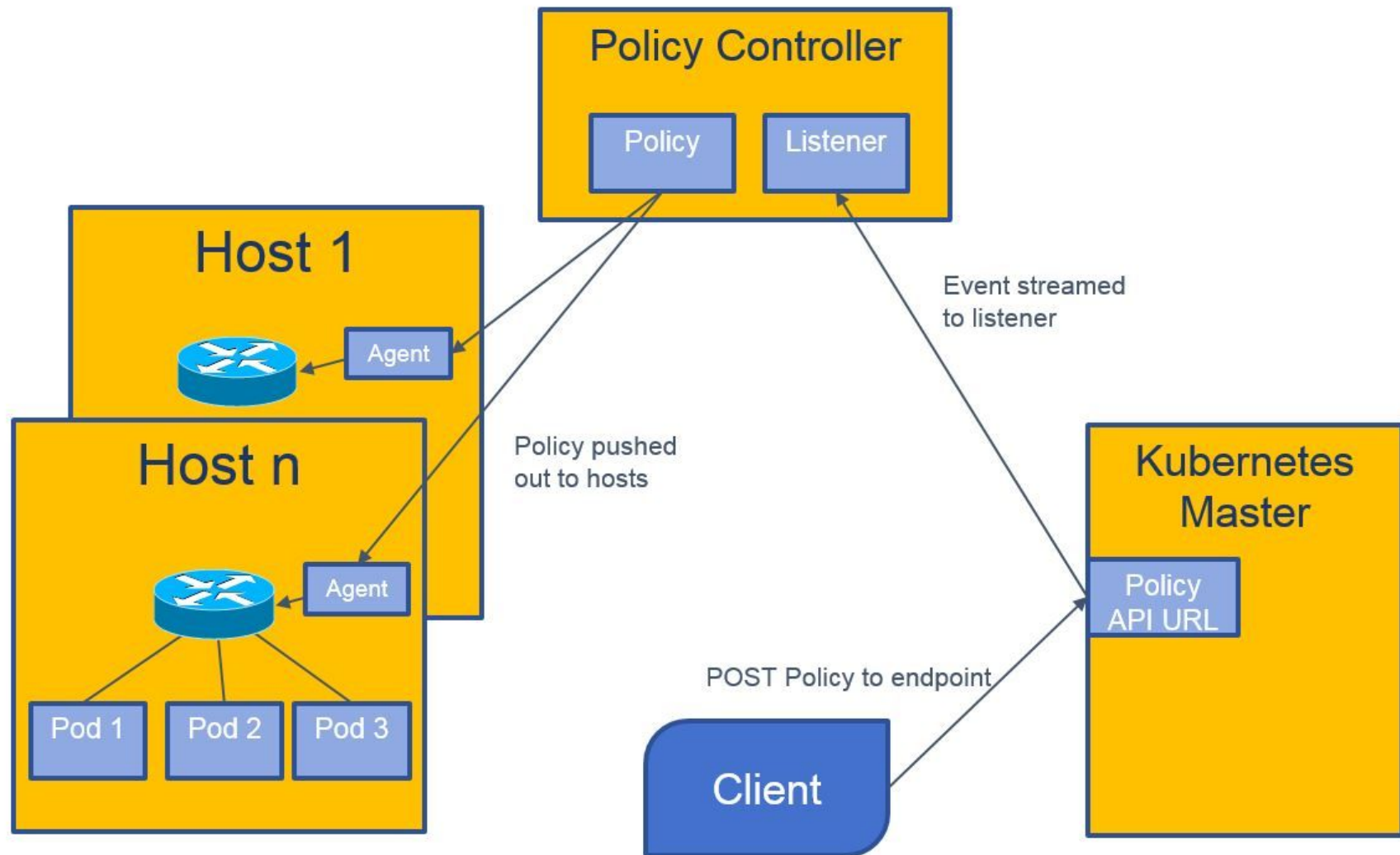


<https://medium.com/google-cloud/understanding-kubernetes-networking-services-f0cb48e4cc82>



NetworkPolicy

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



```
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




```
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/kubernet-network-policy-recipes>

Kubernetes NetworkPolicy: default deny



```
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





thockin (Tim Hockin) 27 days ago <>

Owner



I really don't think we want to impose DNS refreshing on implementations of NetworkPolicy without a bunch of REALLY REALLY good use cases that just CAN NOT be solved any other way. Do we have such use cases?



thockin (Tim Hockin) closed this 27 days ago

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

Kubernetes NetworkPolicy - NO DNS NAMES



```
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: {}
```

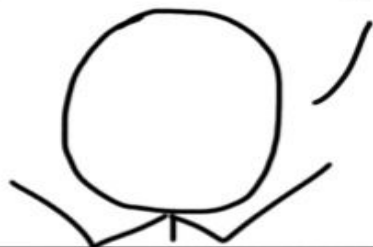
ILLEGAL! NOT ALLOWED!

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

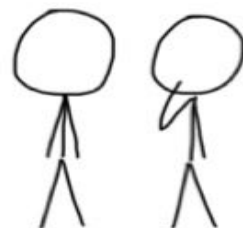
Kubernetes NetworkPolicy - ILLEGAL!



SERVICE MESH!
SERVICE MESH!

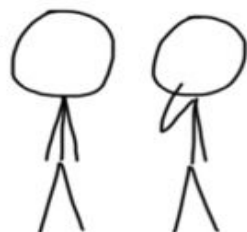


SERVICE MESH!
SERVICE MESH!



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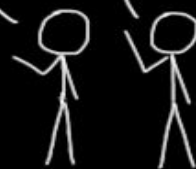
HE'S BROKEN.
NOT THIS AGAIN.
PUT HIM WITH THE REST.



SERVICE MESH?

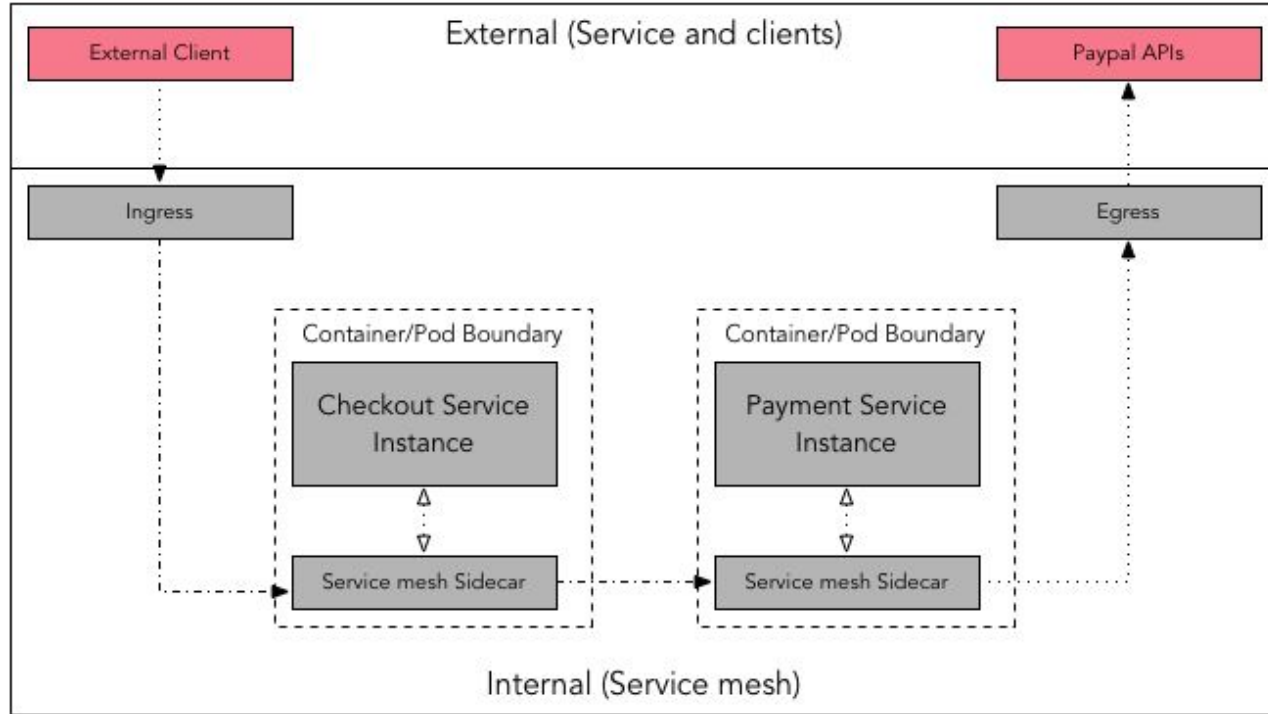


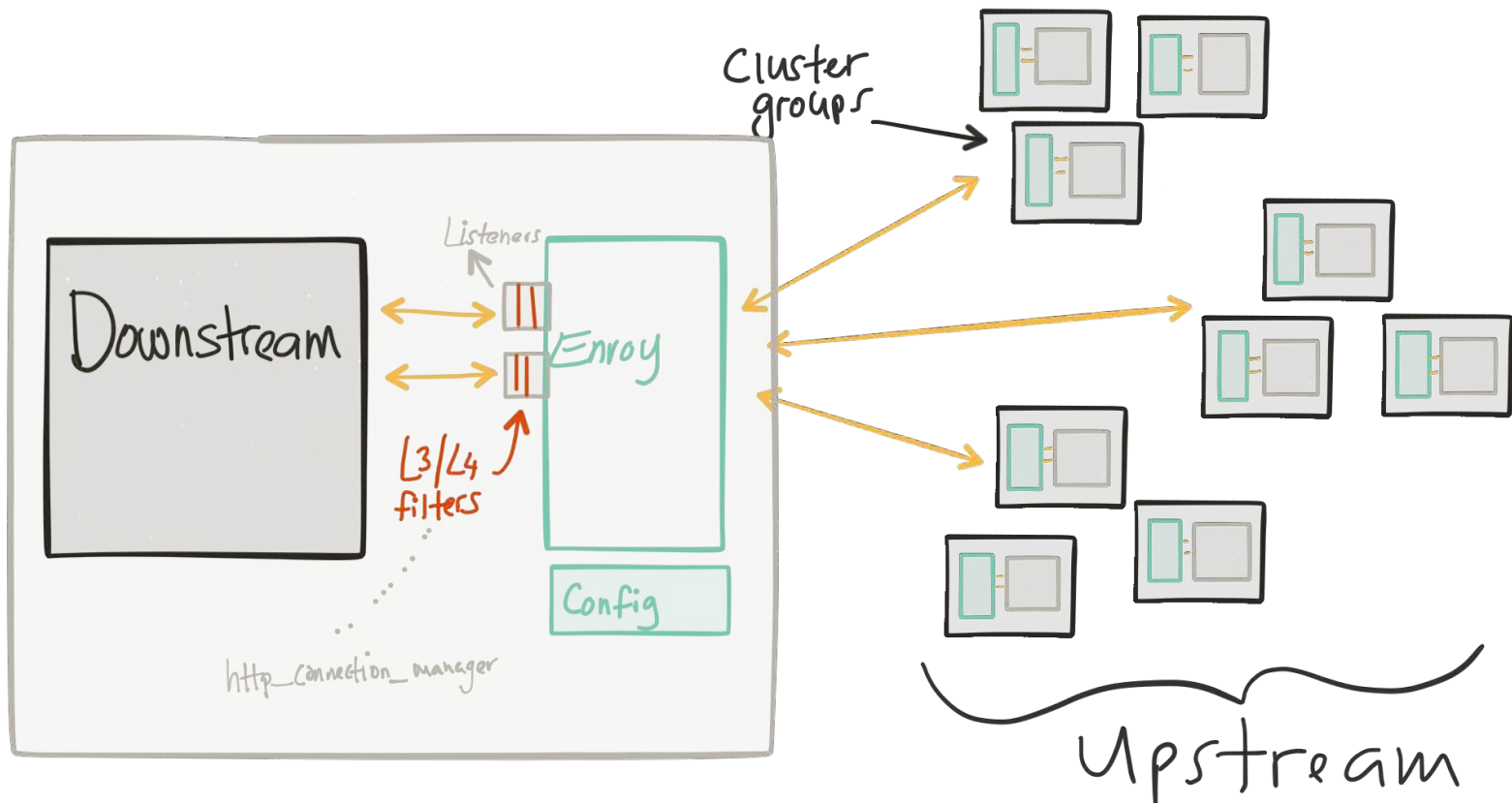
SERVERLESS!
BLOCKCHAIN!
INFRA AS CODE!



@sebiwicb

What is a Service Mesh?





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

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
```



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>



```
[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
```



controlplane

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



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



No Routes To:

- cadvisor
- heapster
- kubelet
- kubernetes dashboard
- etcd

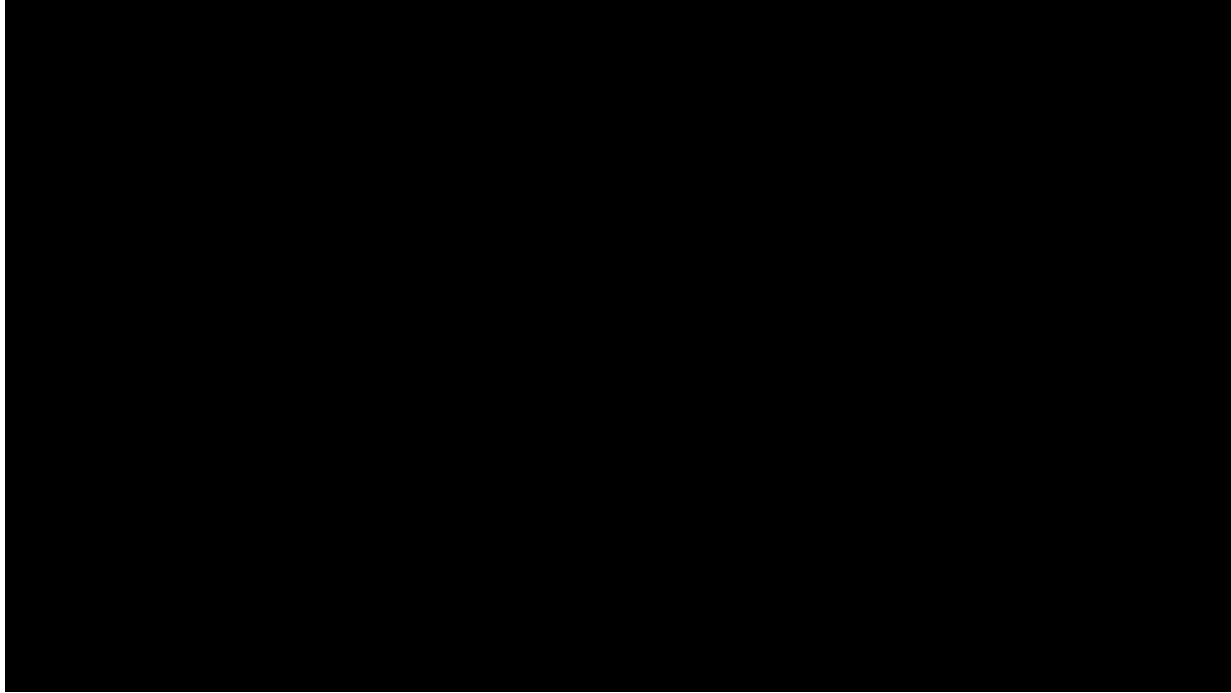


Proxy to Metadata APIs

- <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



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

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>



MULTI TENANCY: Hard



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>



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



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>





IDS: Not a problem while undetected

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"
}
```



```
kubectl delete configmap myconfig --ignore-not-found
failed, retrying...
```

```
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=7mzblOtclaQ> - 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>)



Persisting Configuration: Continuous Security



Continuous Security



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

