# KubeSecOps

Karthik Gaekwad
Principal Engineer
Oracle Inc



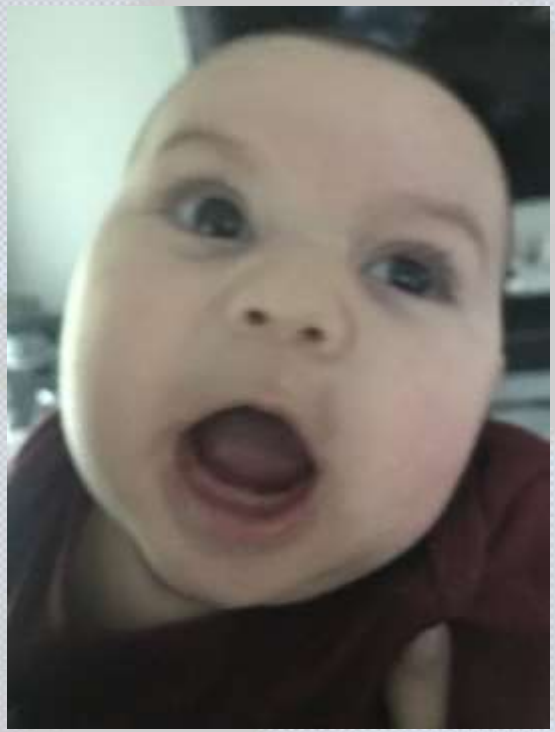
October 17, 2018

# Hello!

- I’m Karthik Gaekwad
- NOT a DBA

ORACLE
Cloud Native Labs

- https://cloudnative.oracle.com/
- Cloud Native evangelist at Oracle Cloud Infrastructure
- Used to be a developer on the OKE Team.



**@iteration1**

# Hello!



- Been in Industry 15 years.
- In general, I like building stuff with friends.
  - A maintainer for Gauntlt- Open source security scanner.
- Love Teaching and building community.
  - Run Devopsdays Austin, Container Days, Cloud Austin.
  - Chair All Day Devops Cloud Native track.
  - LinkedIn Learning Author for Learning Kubernetes (and more).

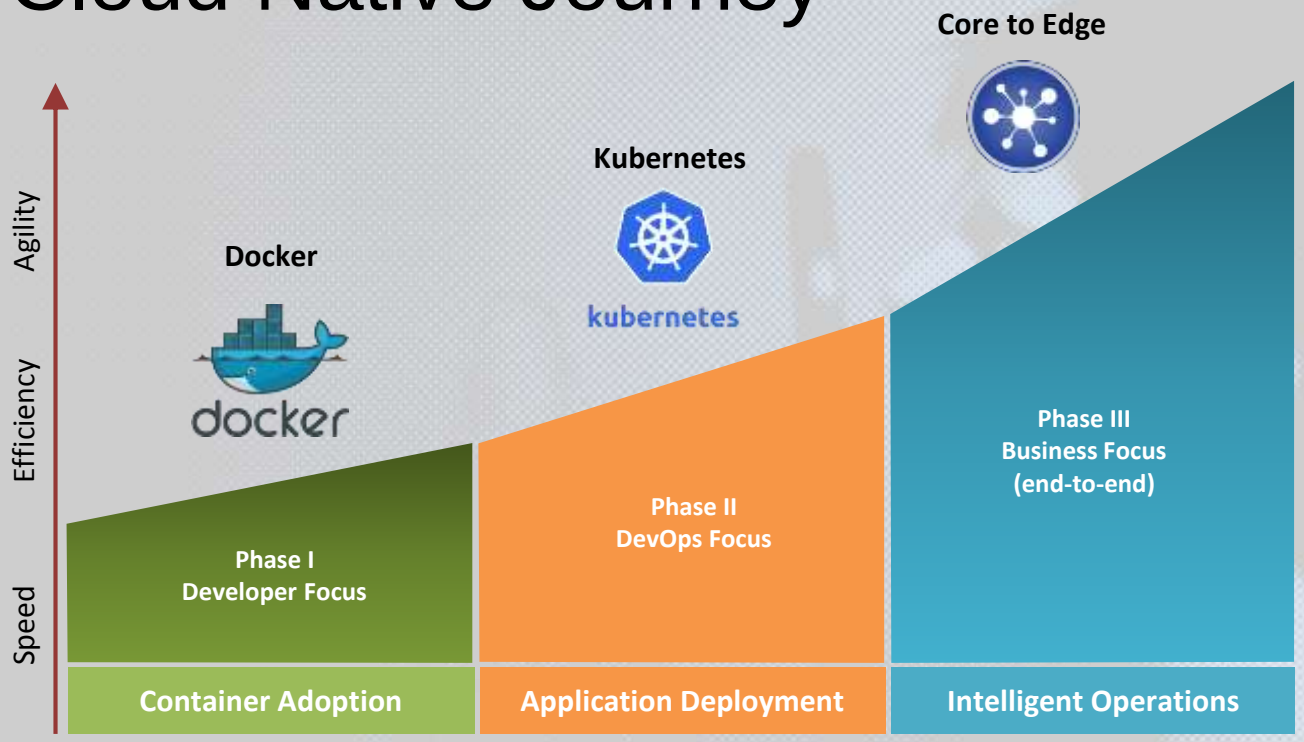
# Need an OCI Trial Account?

ORACLE®

Cloud Infrastructure

**http://bitly.com/ocicloud**

# The Cloud Native Journey




**Focus**
**Applications**
**Automation**
**Community**

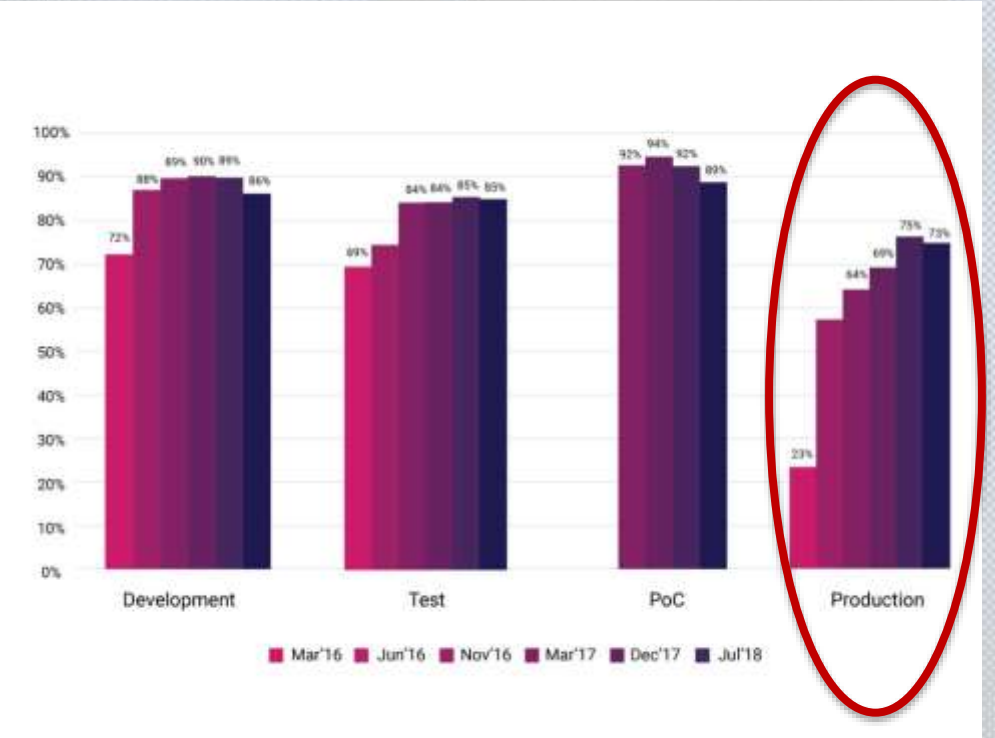
**Developer adoption**
**Dev/Test apps**
**Simple orchestration**
**Individual developers**

**DevOps deployment**
**Production apps**
**Advanced orchestration**
**Teams & lines of business**

**End-to-end integration**
**Digital business apps**
**Serverless, DevSecOps, & ML**
**Cloud native enterprises**

# Latest CNCF Survey: August 2018

Where Does Your
Company Use Containers?



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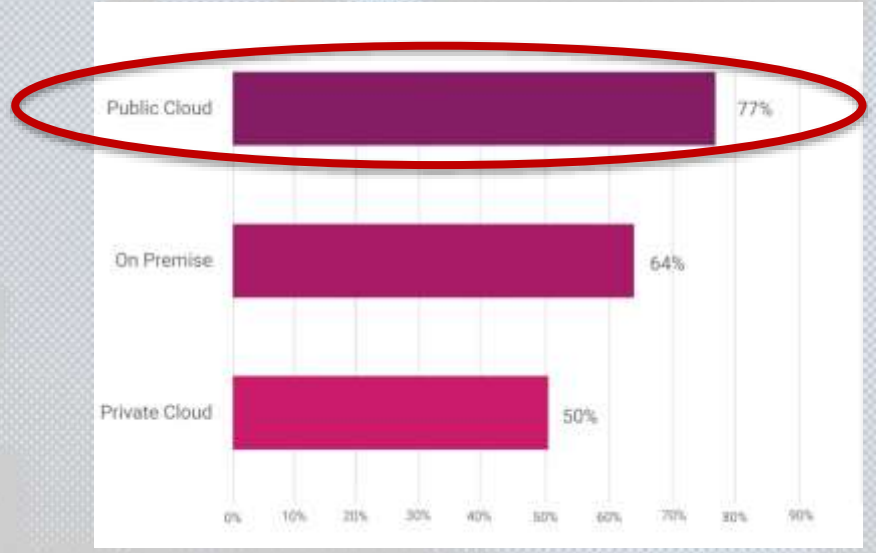
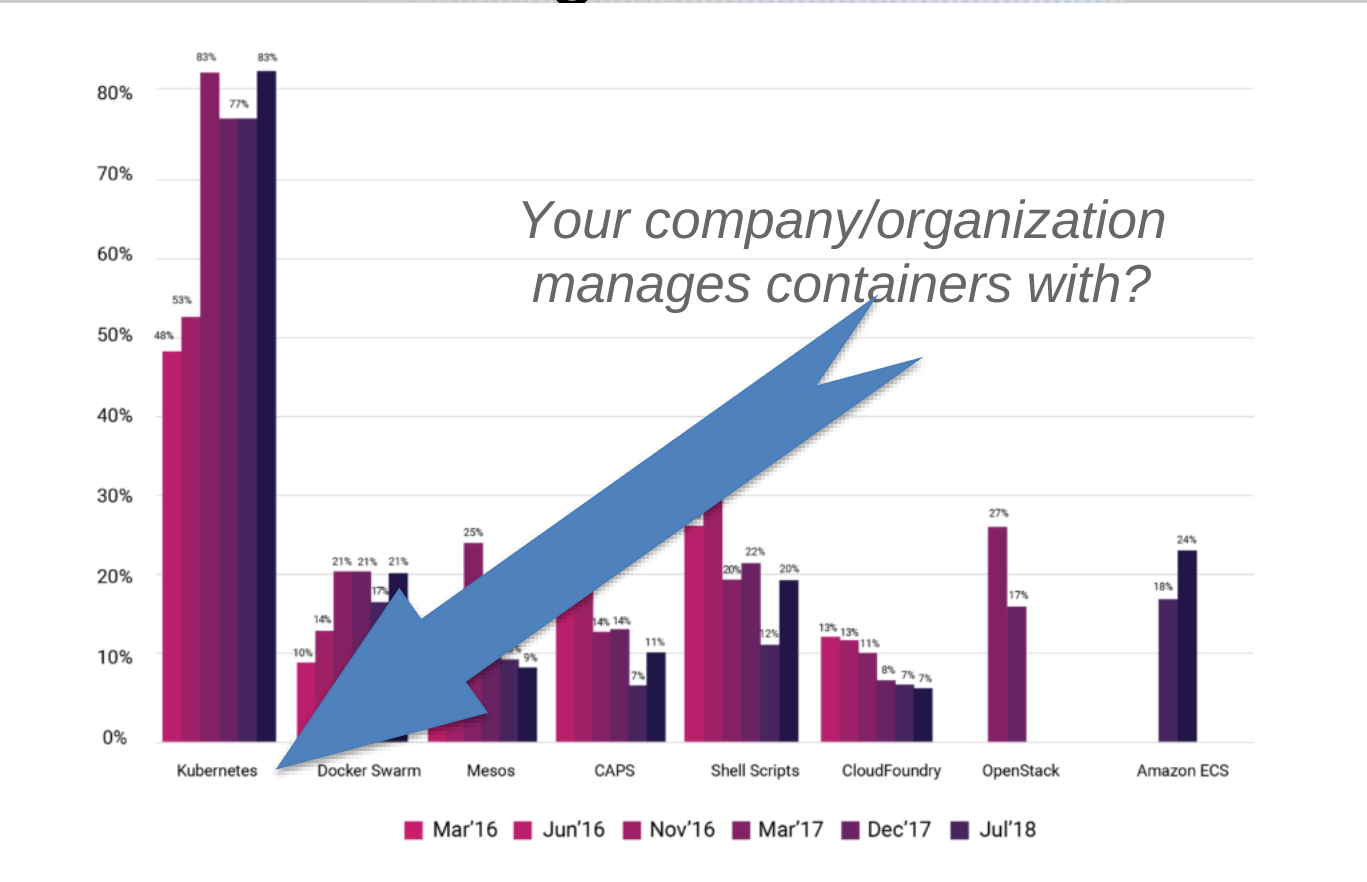
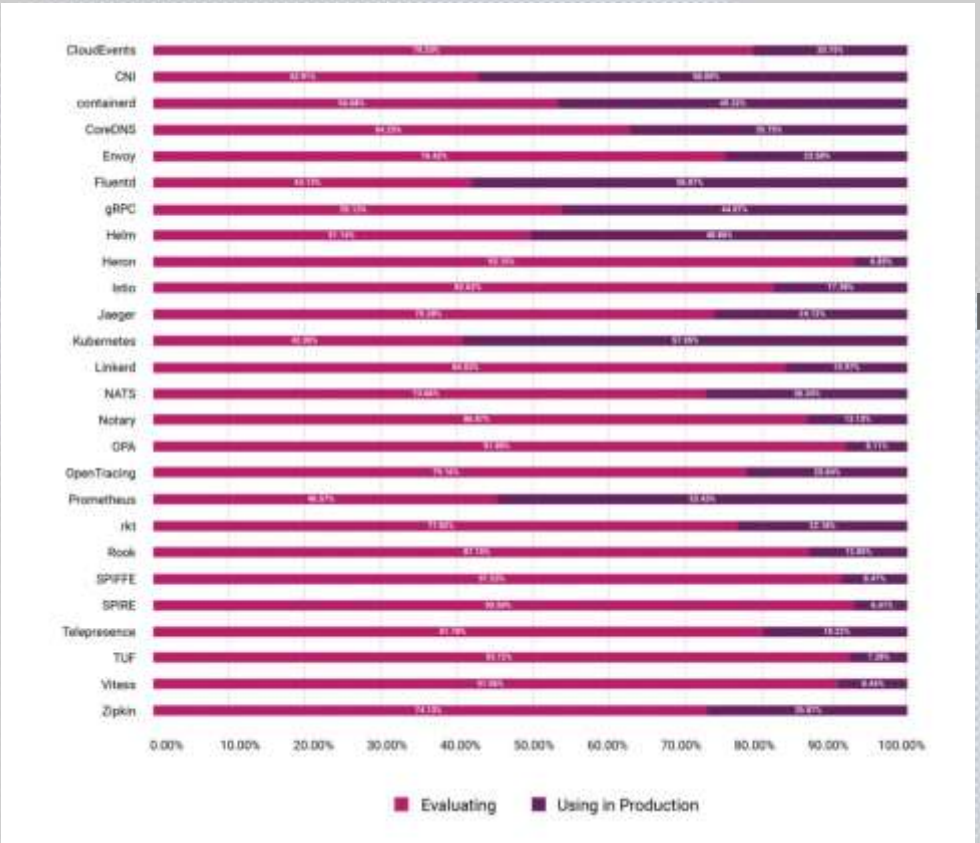


# Container Management IS Kubernetes



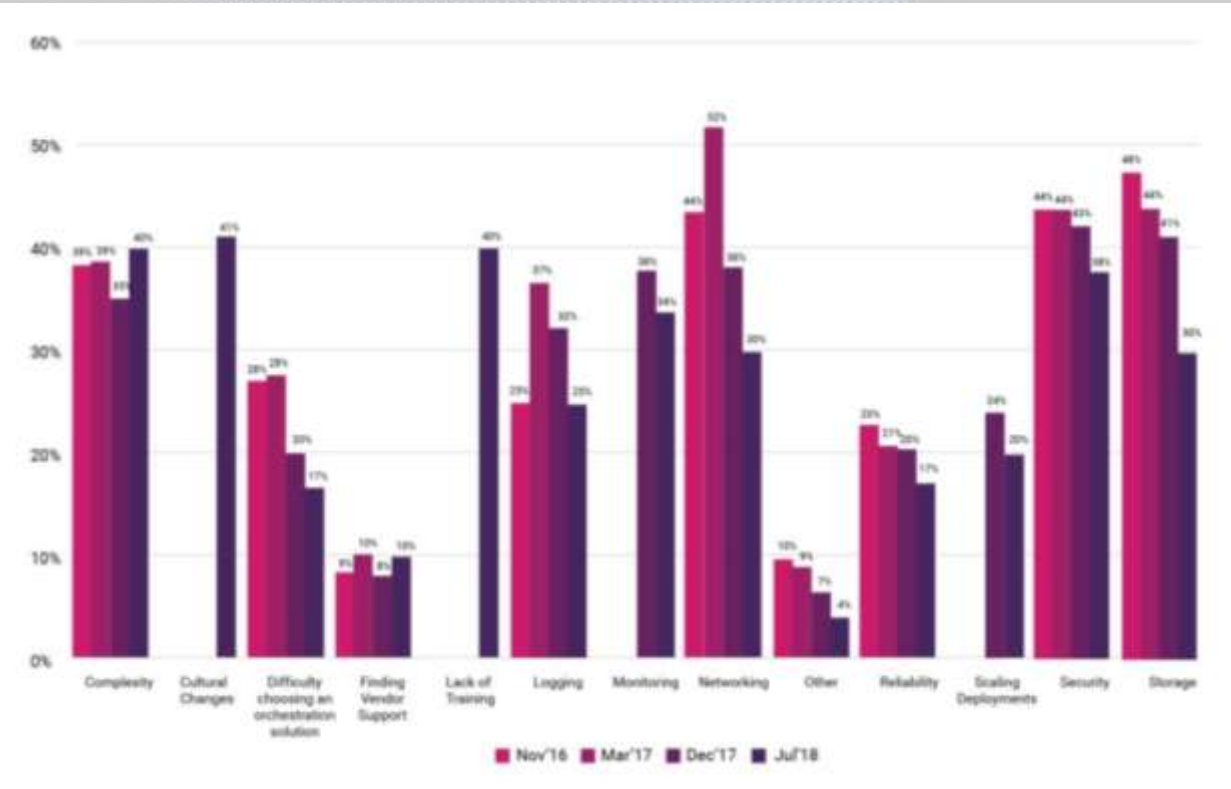
# Good News, Bad News…

**<u>Good</u>**: On average, CNCF project usage is up over 200% since the Dec 2017!




**But…**

# Complexity, Culture, Training, & Security Issues Remain



# Kubernetes & Cloud Native Challenges

- Managing, maintaining, upgrading Kubernetes Control Plane
  - API Server, etcd, scheduler etc….
- Managing, maintaining, upgrading Kubernetes Data Plane
  - In place upgrades, deploy parallel cluster etc….
- Figuring out container networking & storage
  - Overlays, persistent storage etc… - it should just work
- Managing Teams
  - How do I manage & control team access to my clusters?
- Security, security, security

Source: Oracle Customer Survey 2018

# How Teams Address Issues?

**Customer Managed**

- App Management
- App Deployment
- Scaling
- High Availability
- Platform Backup & Recovery
- Upgrades & Patching
- Software Installation
- Server Provisioning
- Rack and Stack
- Power, HVAC


**Fully-Managed**

- App Management
- App Deployment
- Scaling
- High Availability
- Platform Backup & Recovery
- Upgrades & Patching
- Software Installation
- Server Provisioning
- Rack and Stack
- Power, HVAC

## Benefits

- ✓ Faster Time to Deploy
- ✓ Lower Risk
- ✓ Accelerate Innovation


Which brings us to security…

# Security….


Where no news, is good news!

# Unsecured K8s dashboards


< Back

Research

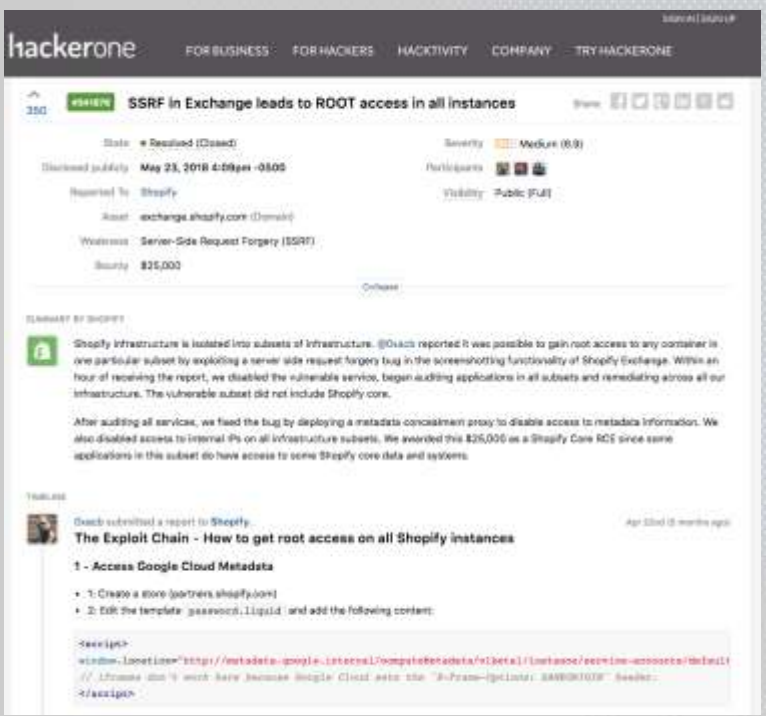
**Lessons from the Cryptojacking Attack at Tesla**

by RedLock CSI Team | 02.20.18, 6:00 AM

- Unsecured Kubernetes Dashboard with account creds.
- Used this to mine cryptocurrency.
- 2017: Aviva
- 2018: Tesla, Weight Watchers

- https://redlock.io/blog/cryptojacking-tesla

# Kubelet credentials hack




- Shopify: Server Side request Forgery
- Get kubelet certs/private key
- Root access to any container in part of infrastructure.

- https://hackerone.com/reports/341876

https://www.shodan.io/search?query=port%3A"2379"+product%3A"etcd"

SHODAN port:"2379" product:"etcd"

Explore | Downloads | Reports | Developer Pricing | Enterprise Access

Exploits | Maps | Share Search | Download Results | Create Report

TOTAL RESULTS

2,367

TOP COUNTRIES

| | |
|---|---|
| China | 933 |
| United States | 602 |
| Germany | 153 |
| France | 110 |
| Singapore | 67 |

TOP ORGANIZATIONS

| | |
|---|---|
| Amazon.com | 323 |
| Hangzhou Alibaba Advertising Co.,Ltd. | 276 |
| Tencent cloud computing | 207 |
| Hetzner Online GmbH | 70 |
| Digital Ocean | 70 |

TOP OPERATING SYSTEMS

| | |
|---|---|
| Linux 3.x | 1 |

TOP VERSIONS

| | |
|---|---|
| 3.3.2 | 299 |
| 3.2.18 | 138 |
| 3.3.9 | 128 |
| 3.2.22 | 123 |
| 3.2.17 | 82 |

[redacted]
Tencent cloud computing
Added on 2018-09-26 19:18:25 GMT
China
Details

```
etcd
Name: etcd_10.0.128.13
Version: 3.3.2
Uptime: 79h30m33.232103055s
Peers: http://10.0.128.13:2380
```

[redacted]
2.compute.amazonaws.com
Amazon Corporate Services Pty
Added on 2018-09-26 19:08:40 GMT
Australia, Sydney
Details
cloud

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etcd
Name: NFR-50nodeap-southeast-2002
Version: 3.3.2
Uptime: 54h22m1.357953836s
Peers: http://13.236.207.66:2380
```

[redacted]
Spectrum Business
Added on 2018-09-26 18:52:04 GMT
United States, Flower Mound
Details

```
etcd
Name: core2
Version: 2.2.5
Uptime: 5h38m59.402175596s
Peers: http://10.11.36.2:2380, http://10.11.36.2:7001
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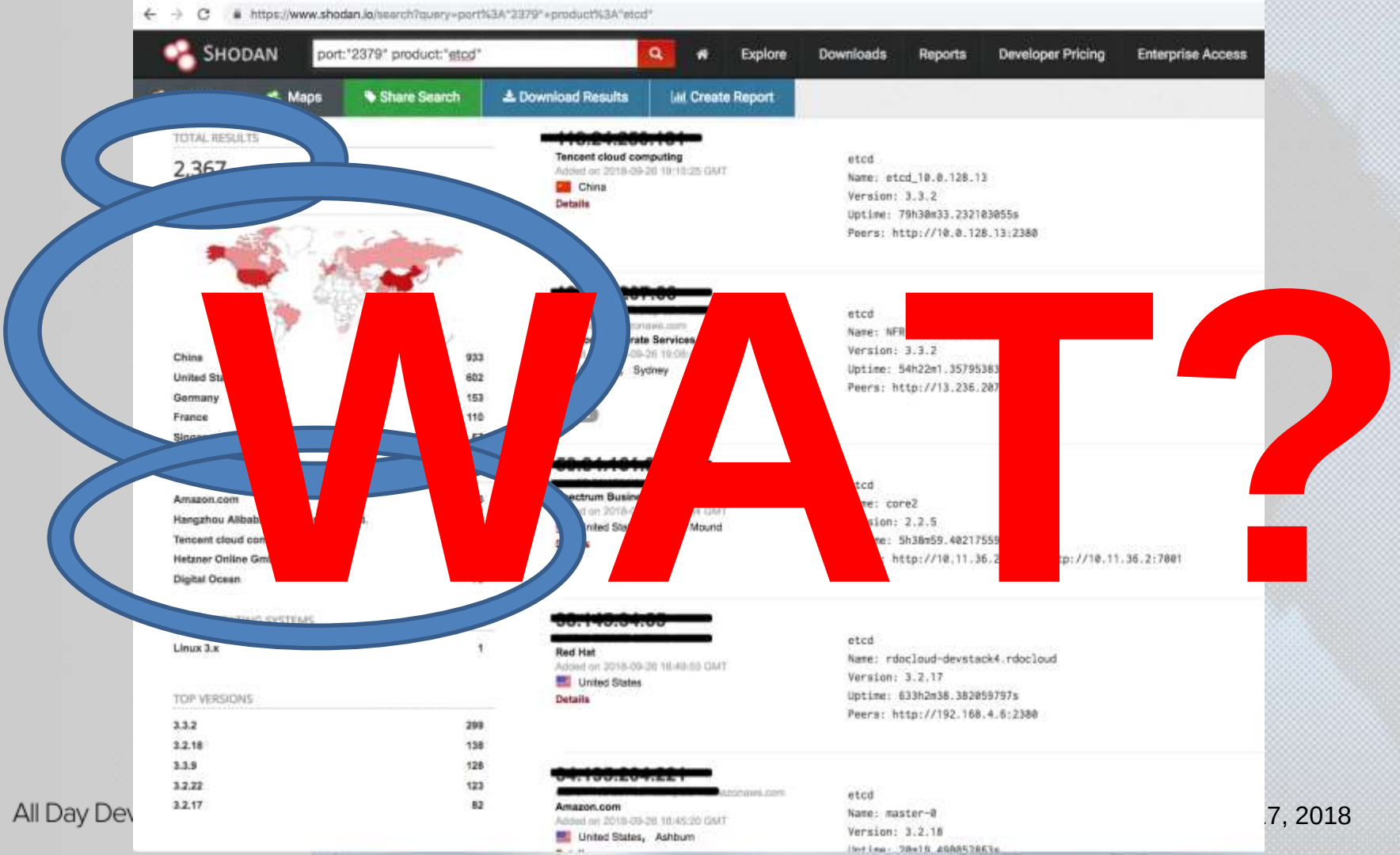
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Explore
Downloads
Reports
Developer Pricing
Enterprise Access
Maps
Share Search
Download Results
Create Report
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United States, Ashburn
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WAT?


How did we get here?


“Kubernetes is too complicated”


“Kubernetes is too complicated”
“We hope it’ll get easier”


I want to get better!
But where to start?

# Let’s look at:

- Attack Surface
  - More importantly, how to limit damage
- Security related features in K8s
  - The more you know, the better you build
- Opensource Tooling to help
  - Because we all need help

# Attack Surface

# Attack Surface

**Goal: Reduce the attack surface**

Analysis for:

- Host
- Container (Images and running)
- Kubernetes Cluster

# Attack Surface: Host

- These are the machines you're running Kubernetes on.
- Age old principles of Linux still apply:
  - Enable SELinux
  - AppArmor
  - Seccomp
  - Hardened Images
- Goal: Minimize privilege to applications running on the host

- *Good news*: Already a wealth of information on this subject!
  - http://lmgtfy.com/?q=how+to+reduce+attack+surface+linux

# Attack Surface: Container Images

**GOAL: Know your base image when building containers**

# Attack Surface: Container Images

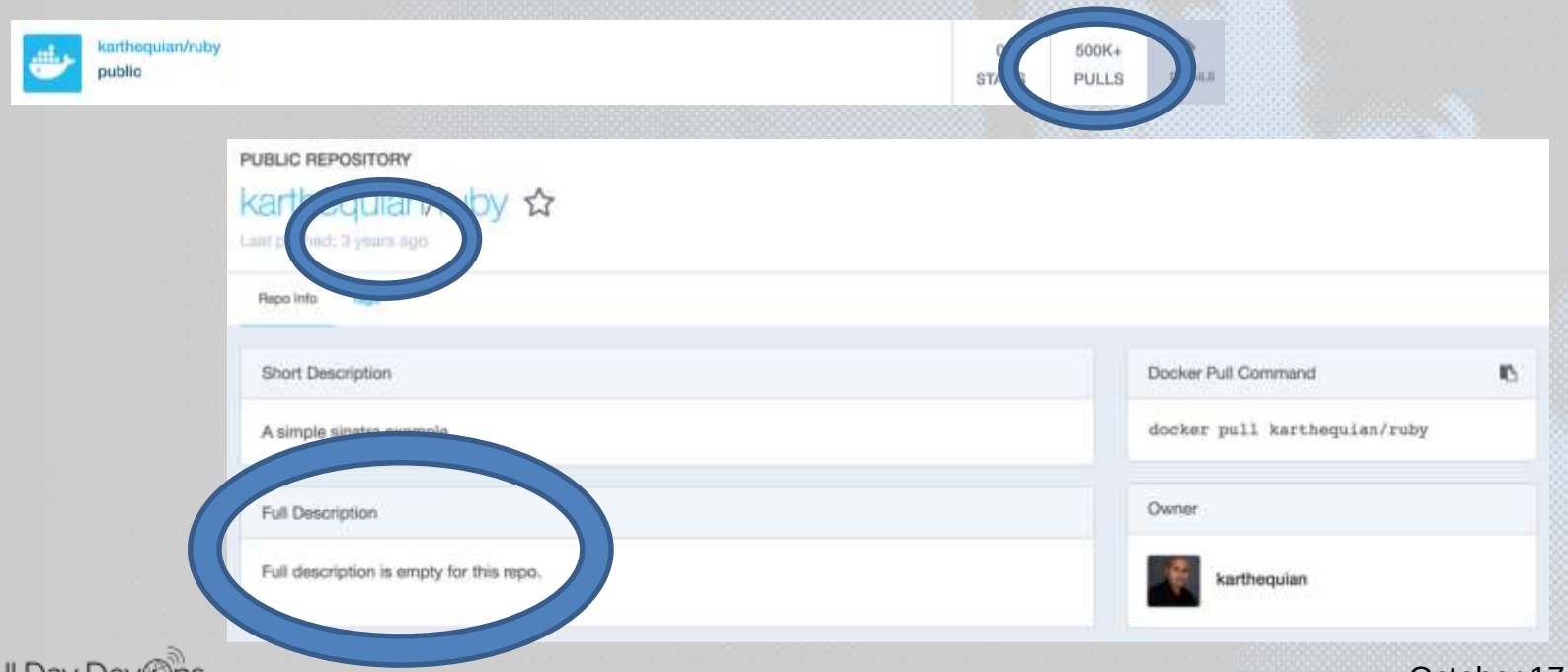
**GOAL: Know your base image when building containers**



**BTW, this is just a ruby helloworld app

# Attack Surface: Container Images

**GOAL: Know your base image when building containers**



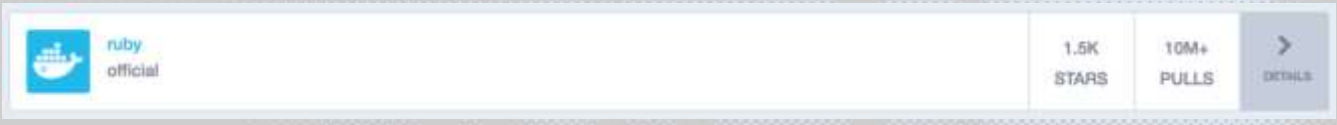



Full disclosure: I'm karthequian; I created this as a ruby 101 container for learning purposes only

# Attack Surface: Container Images

**GOAL: Know your base image when building containers**

When in doubt, stick to an official images!




Or start from a sane base image (example: alpine linux)

# Attack Surface: Container Images

**GOAL: Smaller the image, the better**

- Less things for an attacker to exploit.
- Quicker to push, quicker to pull.

# Attack Surface: Container Images

**GOAL: Don’t rely on :latest tag**

- :latest image yesterday might not be :latest image tomorrow
- Instead, you’d want to know what specific version you’re operating with.

- Side benefit: If there is a new vulnerability announced for OS version x.y.z, you know immediately whether you’re running that version!

# Attack Surface: Container Images

**GOAL: Check for vulnerabilities periodically**

- Plenty of ways to do this in registries. We'll cover more in the tooling section

# Attack Surface: Running Containers

**GOAL: Don’t run as root**

- Containers running as root might be completely unnecessary for the actual application.
- If compromised, attacker can do a lot more things..
- Pod security policies can help (we’ll see how later).

# Attack Surface: Running Containers

**GOAL: Limit host mounts**

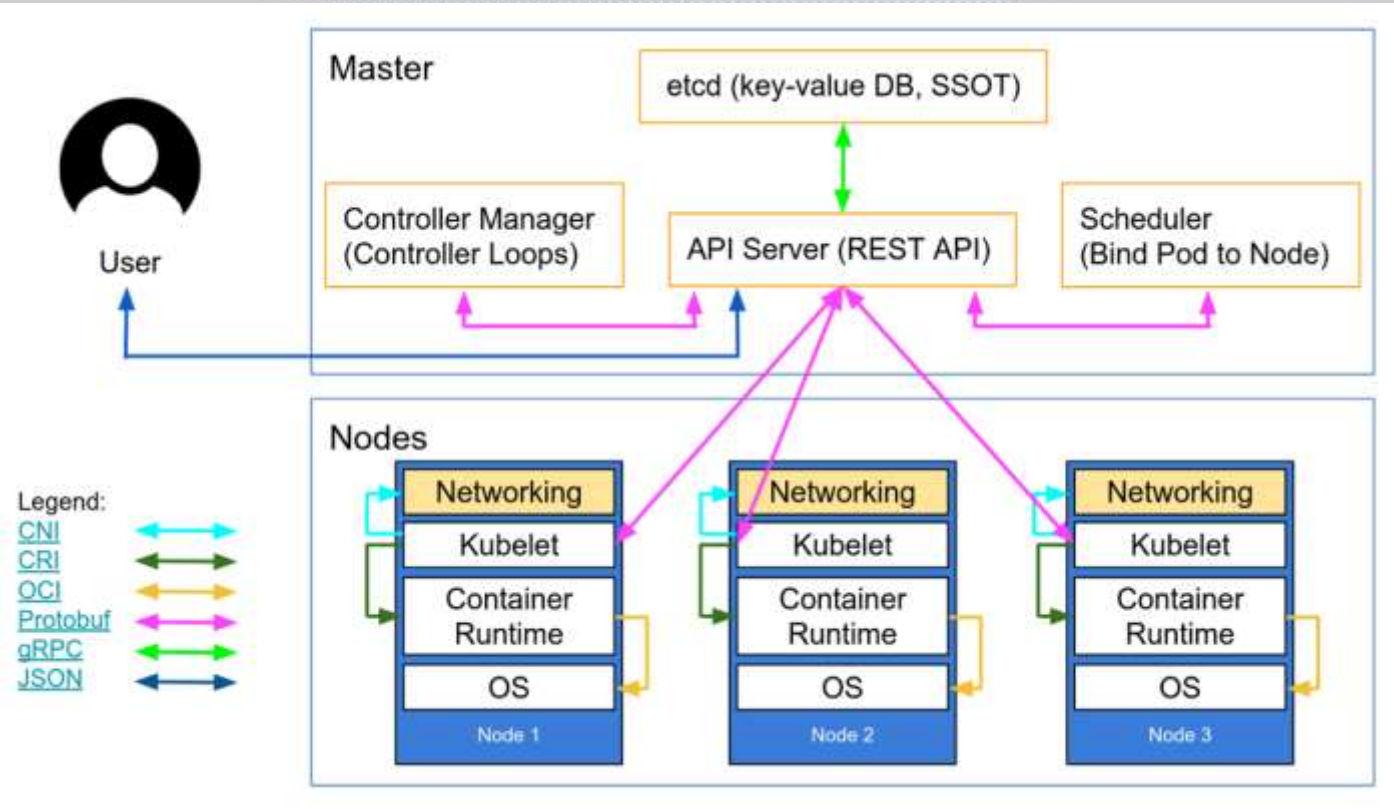
- Be wary of images that require broad access to paths on the host
- Limit your host mount to a smaller subset of directories
- Reduces blast radius on compromise

# Attack Surface: Kubernetes Cluster

# Kubernetes Cluster- TLS

## TLS ALL THE THINGS

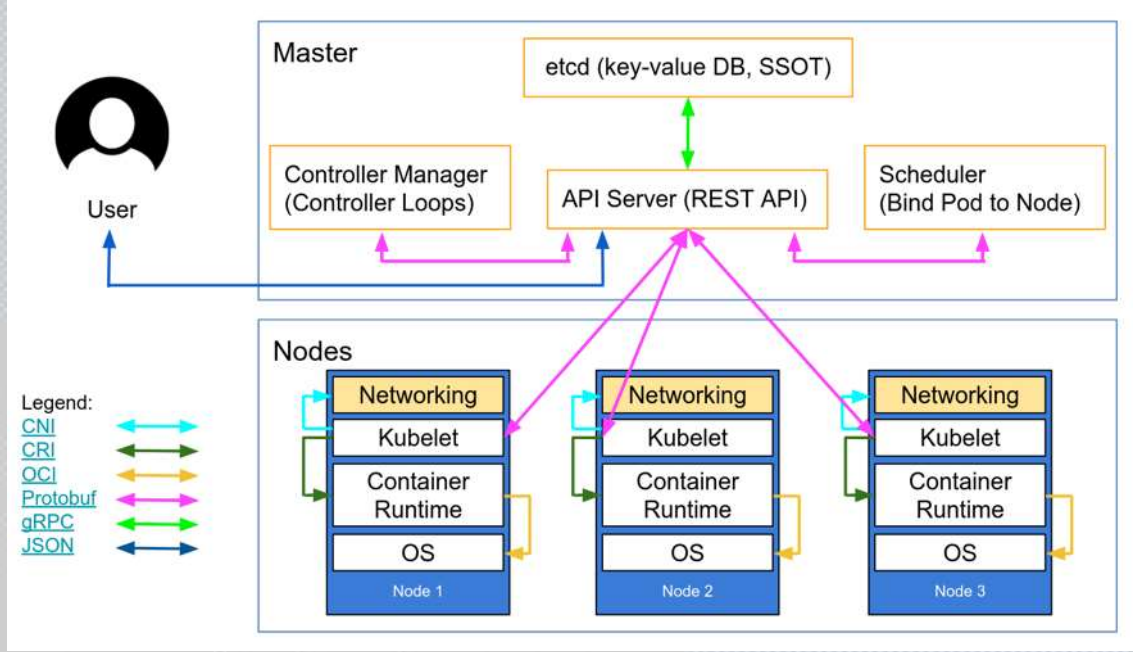
# Kubernetes Cluster- TLS



# Kubernetes Cluster- TLS

TLS Checklist:

1. User and Master
2. Nodes and Master
3. Everything etcd
4. Kubelet to API Server




We’re a little
better off now.
But what else to do?

# K8s Features

How can the platform help me make secure choices?

# K8s Features

Authentication

Authorization

Audit Logging

Network Policies

Pod security policies

Kubernetes Secrets

# Authentication and Authorization

Do you know how you are authenticating with Kubernetes?

Many ways to Authenticate

- Client Certs
- Static token file
- Service Account tokens
- OpenID
- Webhook Mode
- And more (https://kubernetes.io/docs/reference/access-authn-authz/authentication/)


Goal: Pick a strategy that fits your use case
Whatever you do,
DO NOT YOLO!


If you DO NOT YOLO...
You can pick an authz strategy..

# Authentication and Authorization

https://kubernetes.io/docs/reference/access-authn-authz/authorization/

## Authorization Modules

- **Node** - A special-purpose authorizer that grants permissions to kubelets based on the pods they are scheduled to run. To learn more about using the Node authorization mode, see Node Authorization.
- **ABAC** - Attribute-based access control (ABAC) defines an access control paradigm whereby access rights are granted to users through the use of policies which combine attributes together. The policies can use any type of attributes (user attributes, resource attributes, object, environment attributes, etc). To learn more about using the ABAC mode, see ABAC Mode.
- **RBAC** - Role-based access control (RBAC) is a method of regulating access to computer or network resources based on the roles of individual users within an enterprise. In this context, access is the ability of an individual user to perform a specific task, such as view, create, or modify a file. To learn more about using the RBAC mode, see RBAC Mode
  - When specified RBAC (Role-Based Access Control) uses the `rbac.authorization.k8s.io` API group to drive authorization decisions, allowing admins to dynamically configure permission policies through the Kubernetes API.
  - To enable RBAC, start the apiserver with `--authorization-mode=RBAC`.
- **Webhook** - A WebHook is an HTTP callback: an HTTP POST that occurs when something happens; a simple event-notification via HTTP POST. A web application implementing WebHooks will POST a message to a URL when certain things happen. To learn more about using the Webhook mode, see Webhook Mode.

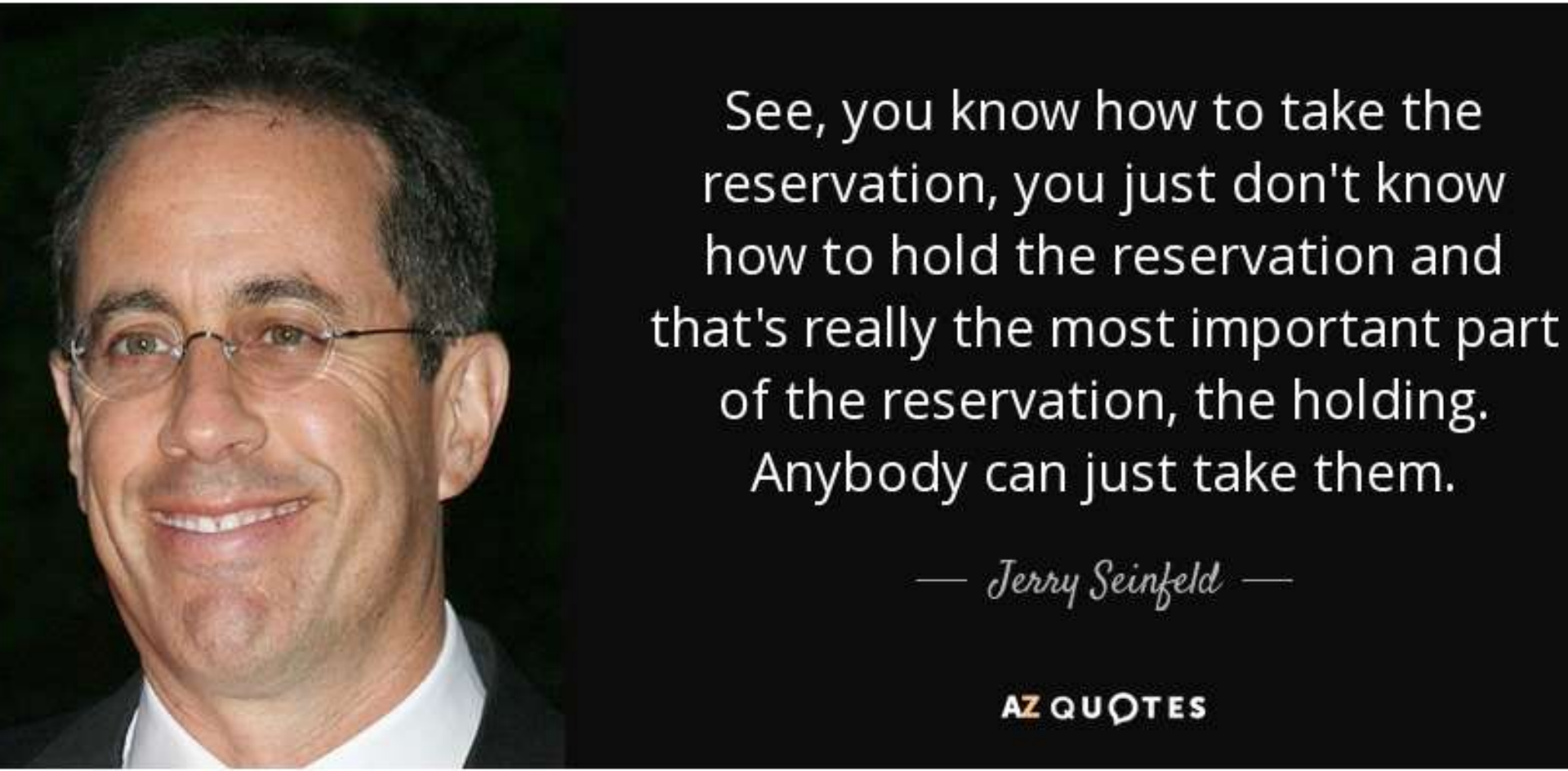
# Authentication and Authorization

- Pro tip: Nobody uses ABAC anymore. Don't be that guy….
- RBAC is the defacto standard
  - Based on roles and role bindings
  - Good set of defaults: https://github.com/uruddarraju/kubernetes-rbac-policies
- Can use multiple authorizers together, but can get confusing.
  - 1st authorizer to authorize passes authz

# Kubernetes Cluster- Audit Logs

- Wat?
- “Kubernetes auditing provides a security-relevant chronological set of records documenting the sequence of activities that have affected system by individual users, administrators or other components of the system.”
- Answers: What/when/who/where information on security events.

- **Your job:** Periodically watch Kubernetes Audit logs
- https://kubernetes.io/docs/tasks/debug-application-cluster/audit/


See, you know how to take the reservation, you just don't know how to hold the reservation and that's really the most important part of the reservation, the holding. Anybody can just take them.
— Jerry Seinfeld —
AZ QUOTES

# Kubernetes Cluster- Network Policies

- Consider adding a network policy to the cluster…
- Default Policy: All pods can talk to all other pods.
- Consider limiting this with a Network Policy
- https://kubernetes.io/docs/concepts/services-networking/network-policies/

# Kubernetes Cluster- Pod Security Policies

- Consider adding Pod Security policies
- PodSecurityPolicy: A Defined set of conditions a pod must run with.
- Think of this as authorization for pods.

# Kubernetes Cluster: Pod Security Policies

| Control Aspect | Field Names |
|---|---|
| Running of privileged containers | `privileged` |
| Usage of host namespaces | `hostPID`, `hostIPC` |
| Usage of host networking and ports | `hostNetwork`, `hostPorts` |
| Usage of volume types | `volumes` |
| Usage of the host filesystem | `allowedHostPaths` |
| White list of Flexvolume drivers | `allowedFlexVolumes` |
| Allocating an FSGroup that owns the pod's volumes | `fsGroup` |
| Requiring the use of a read only root file system | `readOnlyRootFilesystem` |
| The user and group IDs of the container | `runAsUser`, `supplementalGroups` |
| Restricting escalation to root privileges | `allowPrivilegeEscalation`, `defaultAllowPrivilegeEscalation` |
| Linux capabilities | `defaultAddCapabilities`, `requiredDropCapabilities`, `allowedCapabilities` |
| The SELinux context of the container | `seLinux` |
| The AppArmor profile used by containers | annotations |
| The seccomp profile used by containers | annotations |
| The sysctl profile used by containers | annotations |

Capability for an admin to control specific actions

https://kubernetes.io/docs/concepts/policy/pod-security-policy/#what-is-a-pod-security-policy

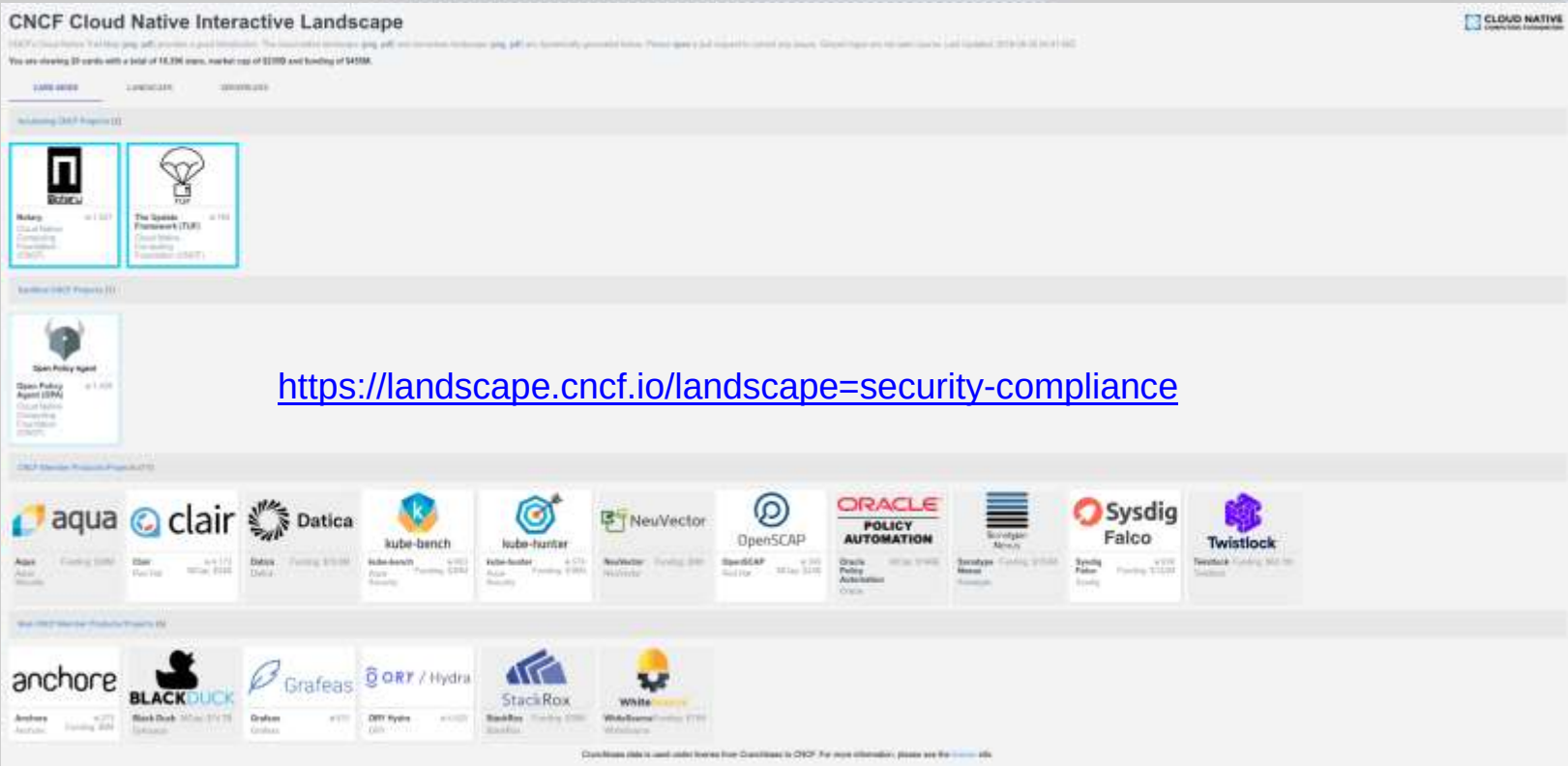
# Kubernetes Secrets

- **GOAL: Use Kubernetes secrets to store sensitive data instead of config maps.**

- Also look at: secrets encryption provider.
  - Controls how etcd encrypts API data
  - **--experimental-encryption-provider-config**
- https://kubernetes.io/docs/tasks/administer-cluster/encrypt-data/

# Opensource Tooling

# Keep tabs on the CNCF Security landscape




https://landscape.cncf.io/landscape=security-compliance

# CNCF Projects

TUF

- “The Update Framework”
- Is a framework or a methodology.
- Used for secure software updates.
- Based on ideas surrounding trust and integrity.

Notary

- Is a project.
- Based on TUF.
- A solution to secure software updates and distribution.
- Used in Docker Trusted Registry.

# Clair

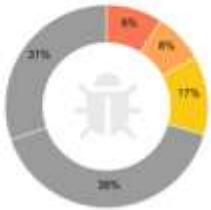
- Open source project for the static analysis of vulnerabilities in containers.
- Find vulnerable images in your repo.
- Built into quay.io, but you can add to your own repo.

- https://github.com/coreos/clair

QUAY Repositories Tutorial Docs Blog jakedt

example/repository

56c0fa71e47b




Quay Security Scanner has detected **13** vulnerabilities.

Patches are available for **4** vulnerabilities.

- **1** High-level vulnerabilities.
- **1** Medium-level vulnerabilities.
- **2** Low-level vulnerabilities.
- **5** Negligible-level vulnerabilities.
- **4** Unknown-level vulnerabilities.

## Image Vulnerabilities

Filter Vulnerabilities... Only show fixable

| CVE | SEVERITY | PACKAGE | CURRENT VERSION | FIXED IN VERSION | INTRODUCED IN IMAGE |
|---|---|---|---|---|---|
| CVE-2013-7445 | High | linux | 3.16.7-ckt20-1+deb8u3 | None | RUN apt-get up. |
| CVE-2015-5276 | Medium | gcc-4.9 | 4.9.2-10 | None | ADD file:b5391. |
| CVE-2016-2856 | Low | glibc | 2.19-18+deb8u3 | None | ADD file:b5391. |
| CVE-2016-0823 | Low | linux | 3.16.7-ckt20-1+deb8u3 | None | RUN apt-get up. |
| CVE-2005-3660 | Negligible * | linux | 3.16.7-ckt20-1+deb8u3 | None | RUN apt-get up. |
| CVE-2015-4003 | Negligible * | linux | 3.16.7-ckt20-1+deb8u3 | None | RUN apt-get up. |
| CVE-2008-4108 | Negligible * | python-defaults | 2.7.9-1 | None | RUN apt-get up. |
| CVE-2015-8830 | Negligible | linux | 3.16.7-ckt20-1+deb8u3 | 3.16.7-ckt20-1+deb8u4 | RUN apt-get up. |
| CVE-2013-4392 | Negligible * | systemd | 215-17+deb8u3 | None | ADD file:b5391. |
| CVE-2015-7515 | Unknown | linux | 3.16.7-ckt20-1+deb8u3 | None | RUN apt-get up. |
| CVE-2015-8816 | Unknown | linux | 3.16.7-ckt20-1+deb8u3 | 3.16.7-ckt20-1+deb8u4 | RUN apt-get up. |
| CVE-2016-2547 | Unknown | linux | 3.16.7-ckt20-1+deb8u3 | 3.16.7-ckt20-1+deb8u4 | RUN apt-get up. |
| CVE-2016-2545 | Unknown | linux | 3.16.7-ckt20-1+deb8u3 | 3.16.7-ckt20-1+deb8u4 | RUN apt-get up. |

 Terms Privacy Security About Contact All Systems Operational

CoreOS

# Kube-bench

- Checks whether a Kubernetes cluster is deployed according to security best practices.
- Run this after creating your K8s cluster.
- https://github.com/aquasecurity/kube-bench
- Defined by the CIS Benchmarks Docs: https://www.cisecurity.org/cis-benchmarks/
- Run it against your Kubernetes Master, or Kubernetes node.

# Kube-bench example

```
~$ kubectl logs kube-bench-node
[INFO] 2 Worker Node Security Configuration
[INFO] 2.1 Kubelet
[FAIL] 2.1.1 Ensure that the --allow-privileged argument is set to false (Scored)
[PASS] 2.1.2 Ensure that the --anonymous-auth argument is set to false (Scored)
[PASS] 2.1.3 Ensure that the --authorization-mode argument is not set to AlwaysAllow (Scored)
[PASS] 2.1.4 Ensure that the --client-ca-file argument is set as appropriate (Scored)
[PASS] 2.1.5 Ensure that the --read-only-port argument is set to 0 (Scored)
[FAIL] 2.1.6 Ensure that the --streaming-connection-idle-timeout argument is not set to 0 (Scored)
[FAIL] 2.1.7 Ensure that the --protect-kernel-defaults argument is set to true (Scored)
[FAIL] 2.1.8 Ensure that the --make-iptables-util-chains argument is set to true (Scored)
[FAIL] 2.1.9 Ensure that the --keep-terminated-pod-volumes argument is set to false (Scored)
[FAIL] 2.1.10 Ensure that the --hostname-override argument is not set (Scored)
[FAIL] 2.1.11 Ensure that the --event-qps argument is set to 0 (Scored)
[PASS] 2.1.12 Ensure that the --tls-cert-file and --tls-private-key-file arguments are set as appropriate (Scored)
[PASS] 2.1.13 Ensure that the --cadvisor-port argument is set to 0 (Scored)
[FAIL] 2.1.14 Ensure that the RotateKubeletClientCertificate argument is set to true
[FAIL] 2.1.15 Ensure that the RotateKubeletServerCertificate argument is set to true
[INFO] 2.2 Configuration Files
[FAIL] 2.2.1 Ensure that the kubelet.conf file permissions are set to 644 or more restrictive (Scored)
[FAIL] 2.2.2 Ensure that the kubelet.conf file ownership is set to root:root (Scored)
[FAIL] 2.2.3 Ensure that the kubelet service file permissions are set to 644 or more restrictive (Scored)
[FAIL] 2.2.4 2.2.4 Ensure that the kubelet service file ownership is set to root:root (Scored)
[FAIL] 2.2.5 Ensure that the proxy kubeconfig file permissions are set to 644 or more restrictive (Scored)
[FAIL] 2.2.6 Ensure that the proxy kubeconfig file ownership is set to root:root (Scored)
[WARN] 2.2.7 Ensure that the certificate authorities file permissions are set to 644 or more restrictive (Scored)
[WARN] 2.2.8 Ensure that the client certificate authorities file ownership is set to root:root
```

# Kubesec

- Helps you quantify risk for Kubernetes resources.
- Run against your K8s applications (deployments/pods/daemonsets etc)
- https://kubesec.io/ from controlplane

- Can be used standalone, or as a kubectl plugin (https://github.com/stefanprodan/kubectl-kubesec)

# Kubesec example

```
~$ kubectl -n kube-system plugin scan deployment/kubernetes-dashboard
scanning deployment kubernetes-dashboard
deployment/kubernetes-dashboard kubesec.io score 3
-----------------
Advise
1. containers[] .securityContext .runAsNonRoot == true
Force the running image to run as a non-root user to ensure least privilege
2. containers[] .securityContext .capabilities .drop
Reducing kernel capabilities available to a container limits its attack surface
3. containers[] .securityContext .readOnlyRootFilesystem == true
An immutable root filesystem can prevent malicious binaries being added to PATH and increase attack cost
4. containers[] .securityContext .runAsUser > 10000
Run as a high-UID user to avoid conflicts with the host's user table
5. containers[] .securityContext .capabilities .drop | index("ALL")
Drop all capabilities and add only those required to reduce syscall attack surface
~$
```

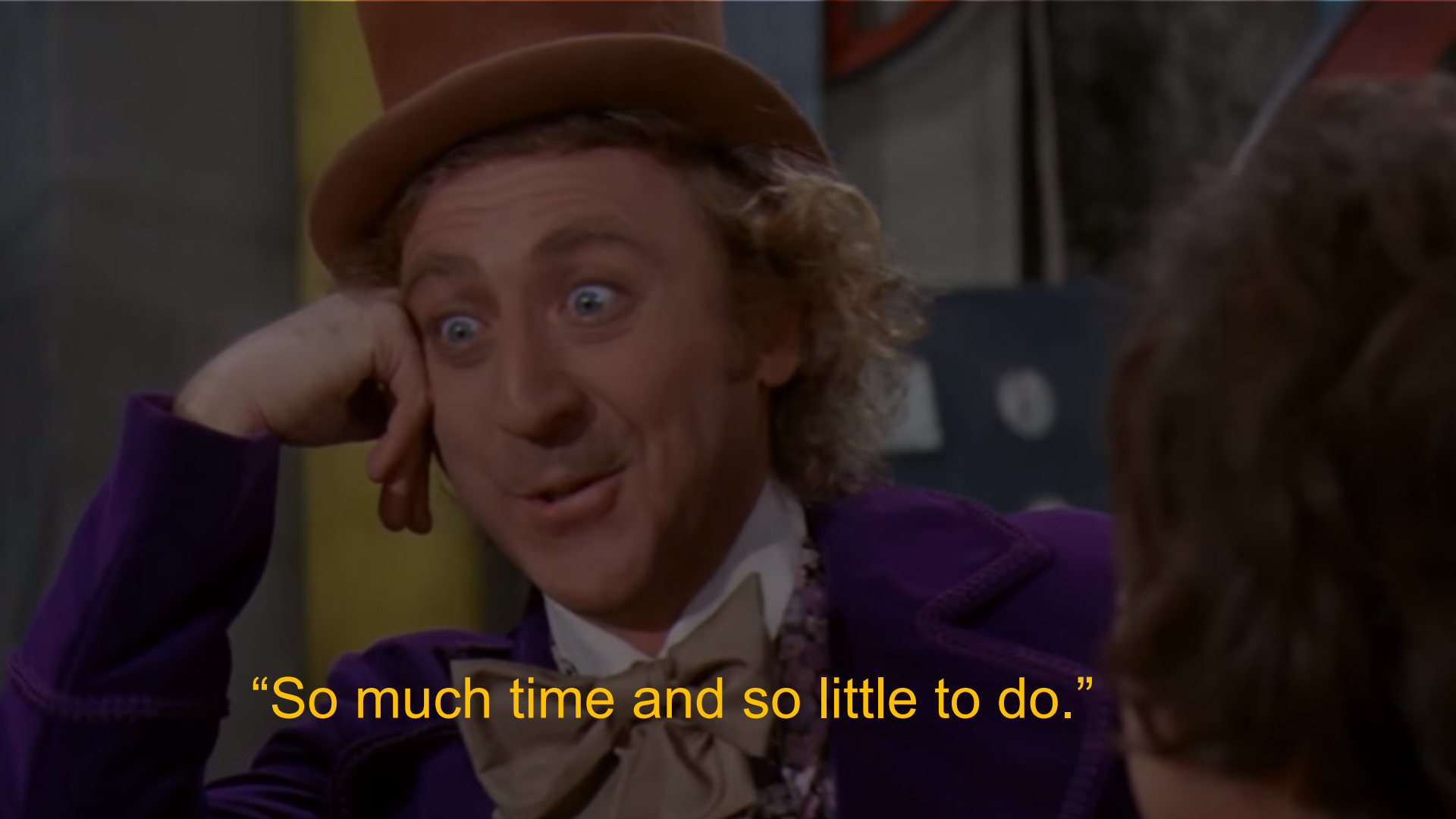
# Kubeaudit

- Opensourced from Shopify.
- Auditing your applications in your K8s cluster.
- https://github.com/Shopify/kubeaudit
- Little more targeted than Kubesec.

```
kubeaudit is a program that will help you audit
your Kubernetes clusters. Specify -l to run kubeaudit using ~/.kube/config
otherwise it will attempt to create an in-cluster client.

#patcheswelcome

Usage:
  kubeaudit [command]

Available Commands:
  allowpe     Audit containers that allow privilege escalation
  caps        Audit container for capabilities
  help        Help about any command
  image       Audit container images
  nonroot     Audit containers running as root
  np          Audit namespace network policies
  priv        Audit containers running as root
  rootfs      Audit containers with read only root filesystems
  sat         Audit automountServiceAccountToken = true pods against an empty (default) service account
  version     Print the version number of kubeaudit

Flags:
  -a, --allPods             Audit againsts pods in all the phases (default Running Phase)
  -h, --help                help for kubeaudit
  -j, --json                Enable json logging
  -c, --kubeconfig string   config file (default is $HOME/.kube/config
  -l, --local               Local mode, uses ~/.kube/config as configuration
  -f, --manifest string     yaml configuration to audit
  -v, --verbose string      Set the debug level (default "INFO")

Use "kubeaudit [command] --help" for more information about a command.
```

# Kubeaudit example

```
~$ /Users/karthik/Downloads/kubeaudit_0.2.0_darwin_amd64/kubeaudit allowpe -c /Users/karthik/.kube/config
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=dotnetworld Namespace=default
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=javademo Namespace=default
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=prom-demo-prometheus-alertmanager Namespace=default
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=prom-demo-prometheus-kube-state-metrics Namespace=default
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=prom-demo-prometheus-pushgateway Namespace=default
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=prom-demo-prometheus-server Namespace=default
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=wishlist-deployment Namespace=default
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=contour Namespace=heptio-contour
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=kube-dns Namespace=kube-system
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=kube-dns-autoscaler Namespace=kube-system
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=kubernetes-dashboard Namespace=kube-system
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=oci-volume-provisioner Namespace=kube-system
ERRO[0003] SecurityContext not set, please set it!       KubeType=deployment Name=tiller-deploy Namespace=kube-system
ERRO[0003] SecurityContext not set, please set it!       KubeType=daemonSet Name=prom-demo-prometheus-node-exporter Namespace=default
ERRO[0003] AllowPrivilegeEscalation not set which allows privilege escalation, please set to false  KubeType=daemonSet Name=kube-flannel-ds Namespace=kube-syste
ERRO[0003] AllowPrivilegeEscalation not set which allows privilege escalation, please set to false  KubeType=daemonSet Name=kube-proxy Namespace=kube-system
```


“So much time and so little to do.”

# Couple more resources to look at:

- 11 ways not to get hacked: https://kubernetes.io/blog/2018/07/18/11-ways-not-to-get-hacked

- K8s security (from Image Hygiene to Network Policy): https://speakerdeck.com/mhausenblas/kubernetes-security-from-image-hygiene-to-network-policies

# KEEP CALM AND KUBE ON

*@iteration1*

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