

RSA® Conference 2019

San Francisco | March 4–8 | Moscone Center



BETTER.

SESSION ID: ASD-W10

Practical Approaches to Cloud Native Security

Karthik Gaekwad

Principal Engineer
Oracle Inc
@iteration1



#RSAC

RSA® Conference 2019

Slides are here:

<http://bitly.com/cloudnative-rsa>

Hello

- I'm Karthik Gaekwad
- NOT a DBA



- <https://cloudnative.oracle.com/>
- Cloud Native Evangelist at Oracle Cloud
- Past: Developer on the Oracle Managed Kubernetes Team

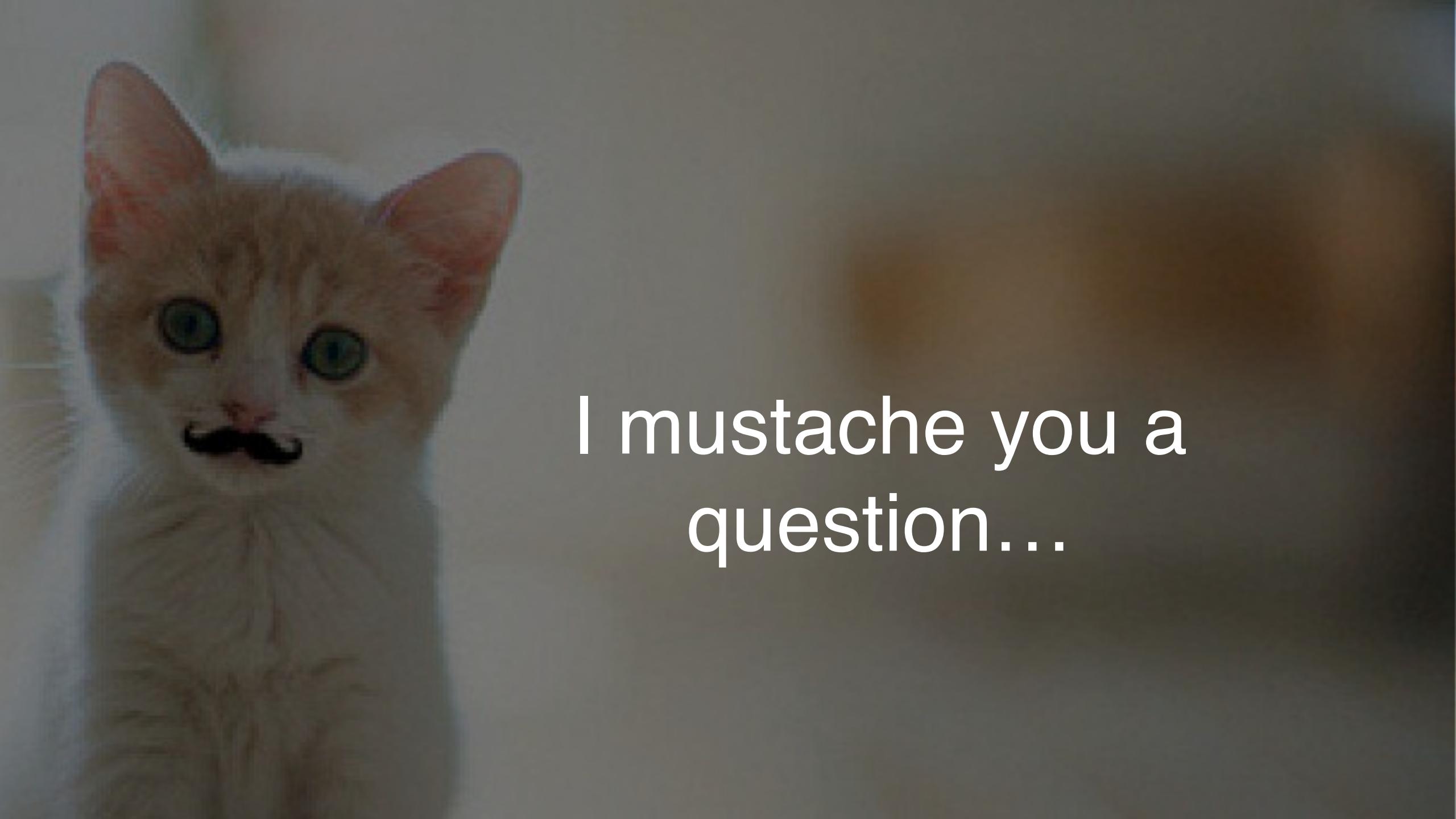


@iteration1

Hello



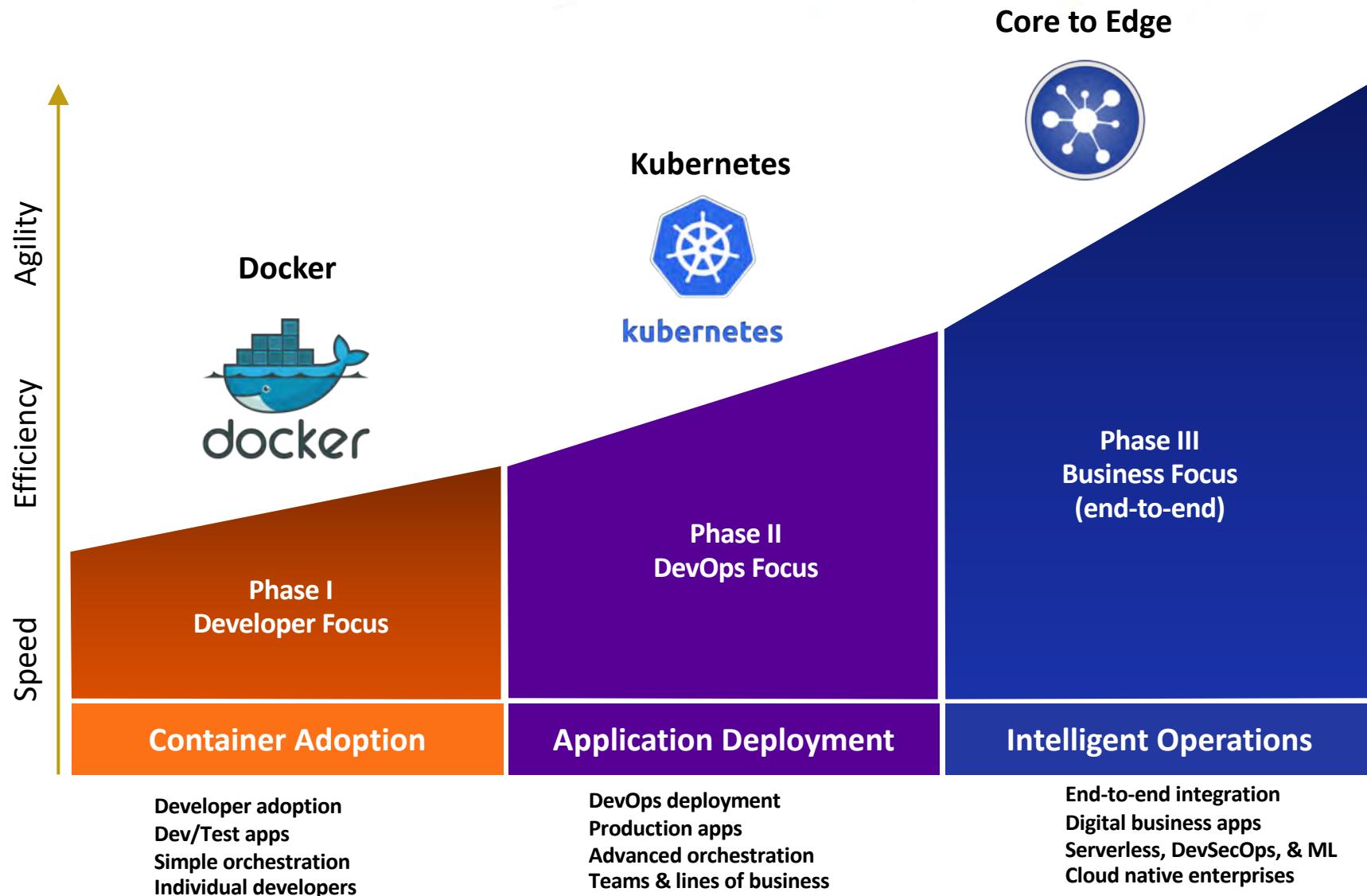
- Been in Industry for 15 years.
- In general, I like building stuff with friends.
 - Maintainer for Gauntlet- Open source security scanner.
- Love Teaching and building community.
 - Run Devopsdays Austin, Container Days, Cloud Austin.
 - Chair All Day Devops Cloud Native track.
 - LinkedIn Learning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

A close-up photograph of a fluffy white cat's face. The cat has large, expressive green eyes and a small black mustache. It is looking directly at the camera with a neutral expression.

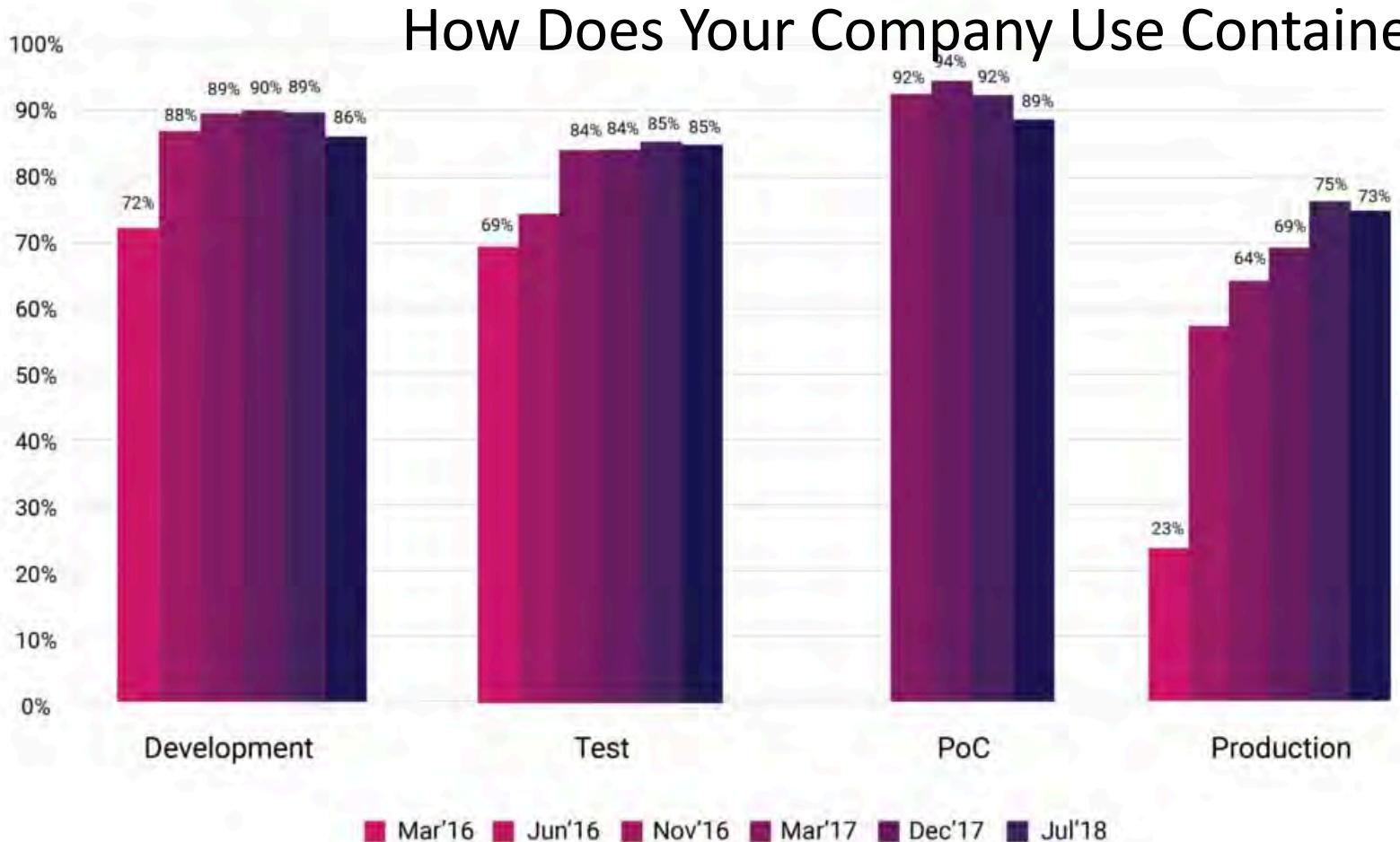
I mustache you a
question...

The Cloud Native Journey

#RSAC



CNCF Survey: August 2018

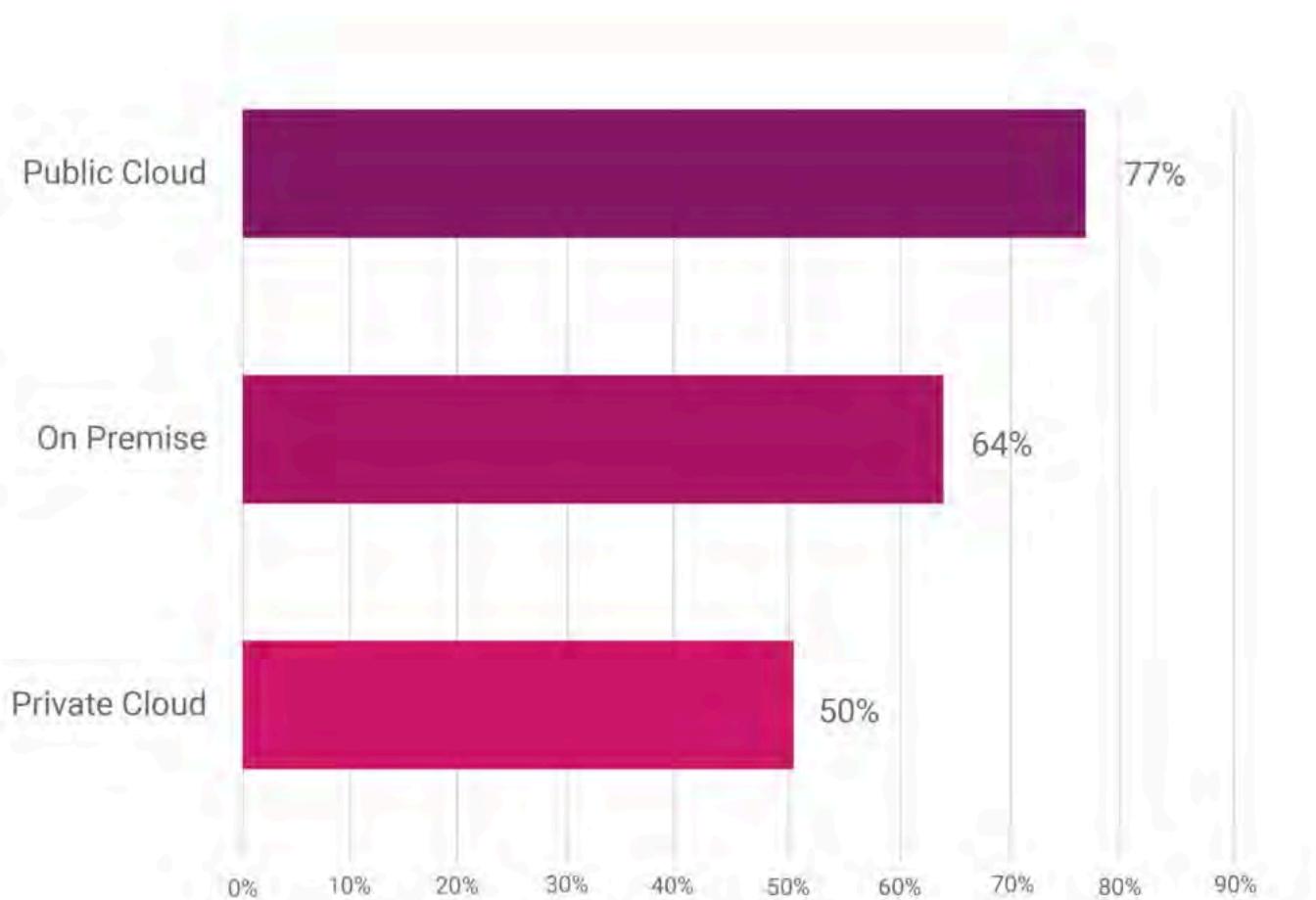


Lots of adoption on dev/staging

Continued production increase

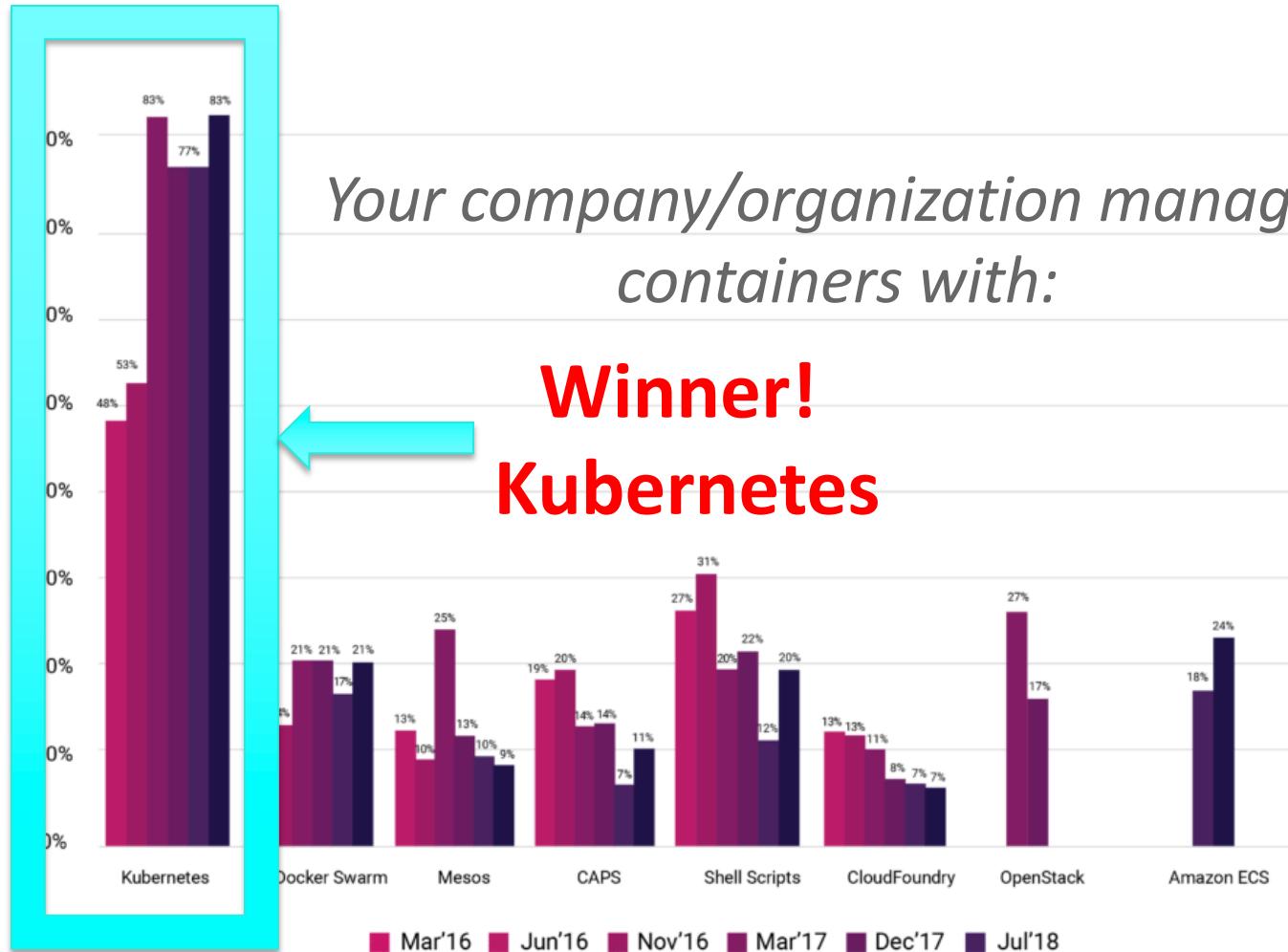
CNCF Survey: August 2018

How Does Your Company Use Containers and Where?



Adoption over public and on-prem

Kubernetes Dominates Container Management



Good News, Bad News...

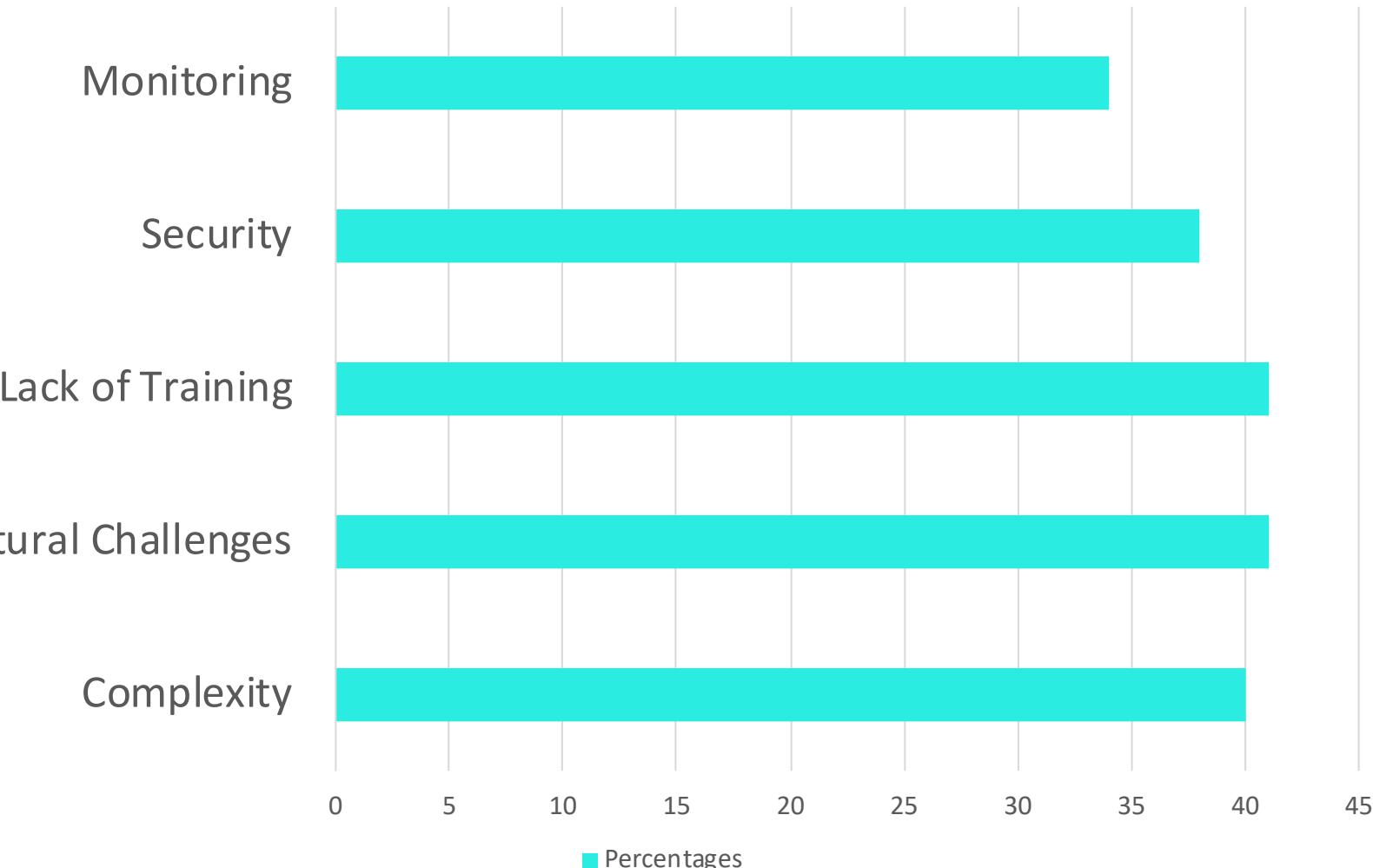
Many Projects...



Good usage
in dev/prod

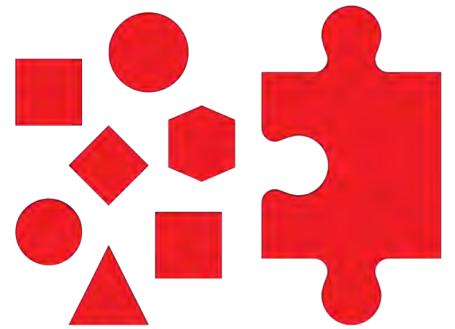
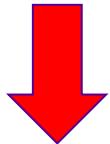
But...

Top 5 challenges to cloud native adoption...



Kubernetes & Cloud Native Challenges

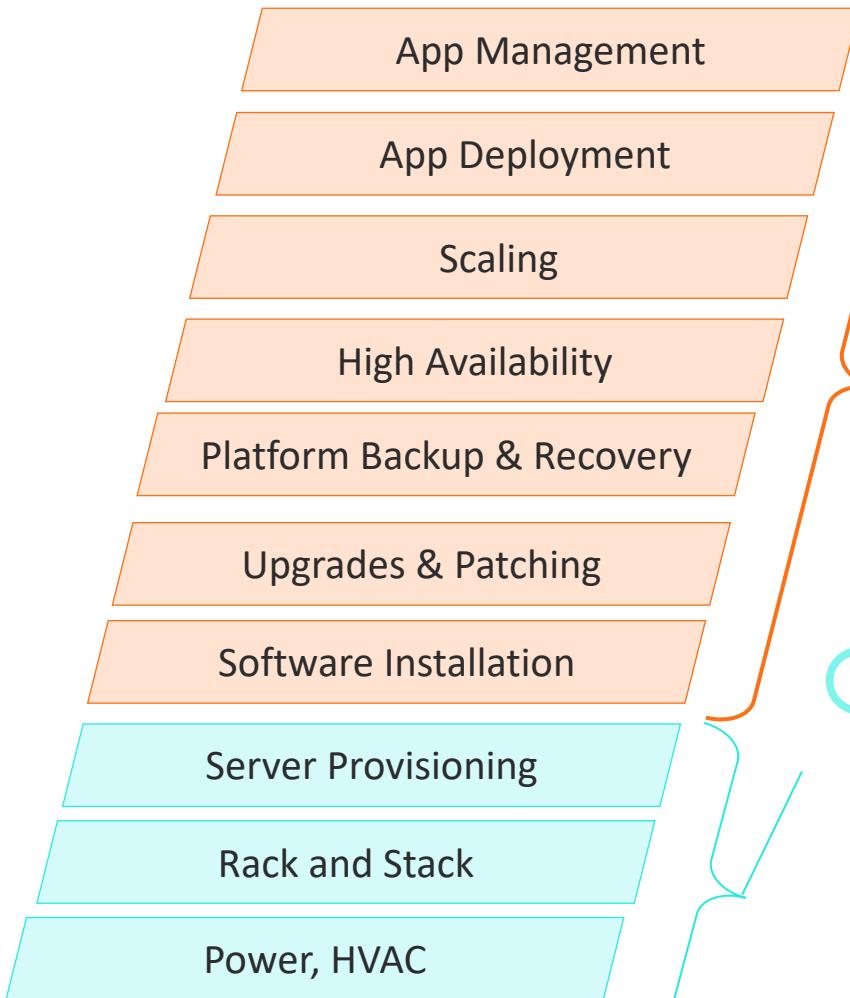
- Managing, maintaining, upgrading Kubernetes Control Plane
 - API Server, etcd, scheduler etc....
- Managing, maintaining, upgrading Kubernetes Data Plane
 - In place upgrades, deploy parallel cluster etc....
- Figuring out container networking & storage
 - Overlays, persistent storage etc... - it should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



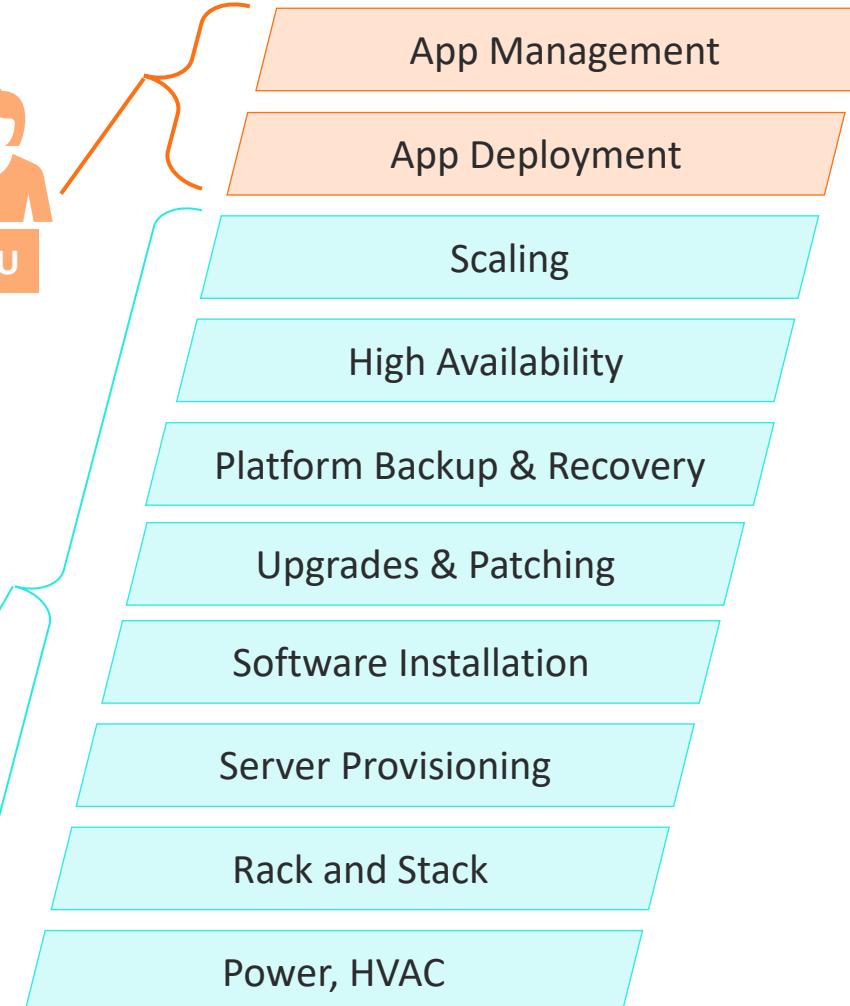
Source: Oracle Customer Survey 2018

How Are Teams Addressing Complexity, Training Issues?

Customer Managed



Fully-Managed



Benefits

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

A close-up of Gene Wilder as Willy Wonka. He has his signature wide, toothy smile, blue eyes, and curly brown hair. His right hand is propped under his chin, and he is wearing his signature purple velvet jacket over a green vest.

Which brings us to security...

A scene from The Simpsons. Homer Simpson is in a factory or industrial setting, looking surprised or worried. He is wearing a tan jumpsuit and a hard hat. In the background, there is a sign that reads "3 DAYS WITHOUT AN ACCIDENT".

DAYS WITHOUT
AN ACCIDENT

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

#341876 SSRF in Exchange leads to ROOT access in all instances

State: Resolved (Closed) **Severity:** Medium (6.9)

Disclosed publicly: May 23, 2018 4:09pm -0500 **Participants:**

Reported To: Shopify **Visibility:** Public (Full)

Asset: exchange.shopify.com (Domain) **Weakness:** Server-Side Request Forgery (SSRF)

Bounty: \$25,000

SUMMARY BY SHOPIFY

Shopify infrastructure is isolated into subsets of infrastructure. @0xacb reported it was possible to gain root access to any container in one particular subset by exploiting a server side request forgery bug in the screenshotting functionality of Shopify Exchange. Within an hour of receiving the report, we disabled the vulnerable service, began auditing applications in all subsets and remediating across all our infrastructure. The vulnerable subset did not include Shopify core.

After auditing all services, we fixed the bug by deploying a metadata concealment proxy to disable access to metadata information. We also disabled access to internal IPs on all infrastructure subsets. We awarded this \$25,000 as a Shopify Core RCE since some applications in this subset do have access to some Shopify core data and systems.

TIMELINE

Apr 22nd (5 months ago)
Oxacb submitted a report to Shopify.
The Exploit Chain - How to get root access on all Shopify instances

1 - Access Google Cloud Metadata

- 1: Create a store (partners.shopify.com)
- 2: Edit the template `password.liquid` and add the following content:

```
<script>
window.location="http://metadata.google.internal/computeMetadata/v1beta1/instance/service-accounts/default
// iframes don't work here because Google Cloud sets the "X-Frame-Options: SAMEORIGIN" header.
</script>
```

- Shopify: Server Side request Forgery
- Get kubelet certs/private key
- Root access to any container in part of infrastructure.
- <https://hackerone.com/reports/341876>

CVE's Happen...

In a Nutshell, Kubernetes...

... has had [70,892 commits](#) made by [2,241 contributors](#)
representing [1,537,561 lines of code](#)

In a Nutshell, docker...

... has had [257,984 commits](#) made by [11,382 contributors](#)
representing [9,236,254 lines of code](#)

Even more relevant with increased
production usage of containers...

CVE's Happen...

In a Nutshell, Kubernetes...

... has had [70,892 commits](#) made by [2,241 contributors](#)
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Privilege
Escalation

CVE-2018-1002105: proxy request handling in kube-apiserver can leave vulnerable TCP connections #71411

Container
Escaping

[DOCKER SECURITY UPDATE: CVE-2019-5736 AND CONTAINER SECURITY BEST PRACTICES](#)

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

 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

10.0.128.13

Tencent cloud computing

Added on 2018-09-26 19:15:25 GMT

 China

[Details](#)

13.236.207.66

2.compute.amazonaws.com

Amazon Corporate Services Pty

Added on 2018-09-26 19:08:40 GMT

 Australia, Sydney

[Details](#)



50.84.184.84

Spectrum Business

Added on 2018-09-26 18:52:54 GMT

 United States, Flower Mound

[Details](#)

192.168.4.66

Red Hat

Added on 2018-09-26 18:49:53 GMT

 United States

[Details](#)

192.168.4.221

Amazon.com

Added on 2018-09-26 18:45:20 GMT

 United States, Ashburn

[Details](#)

etcd

Name: etcd_10.0.128.13

Version: 3.3.2

Uptime: 79h30m33.232103055s

Peers: http://10.0.128.13:2380

etcd

Name: NFR-50nodeap-southeast-2002

Version: 3.3.2

Uptime: 54h22m1.357953836s

Peers: http://13.236.207.66:2380

etcd

Name: core2

Version: 2.2.5

Uptime: 5h38m59.402175596s

Peers: http://10.11.36.2:2380, http://10.11.36.2:7001

etcd

Name: rdocloud-devstack4.rdocloud

Version: 3.2.17

Uptime: 633h2m38.382059797s

Peers: http://192.168.4.6:2380

etcd

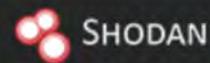
Name: master-0

Version: 3.2.18

Uptime: 20m19.490052863s

ORACLE®

ference2019



port:"2379" product:"etcd"



Explore

Downloads

Reports

Developer Pricing

Enterprise Access

Maps

Share Search

Download Results

Create Report

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CN China
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2.compute.amazonaws.com
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AU Australia, Sydney
[Details](#)

cloud

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Spectrum Business
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US United States, Flower Mound
[Details](#)

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50.7.158.264.221

Amazon.com
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US United States, Ashburn
[Details](#)

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

SHODAN port:"2379" product:"etcd" Explore Downloads Reports Developer Pricing Enterprise Access

TOTAL RESULTS 2,367

Maps Share Search Download Results Create Report

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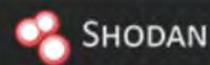
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2.com [REDACTED] zonaws.com
Amazon Corporate Services Pty
Added on 2018-09-26 19:08:40 GMT
Australia, Sydney
DigitalOcean.com

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Version: 3.3.2
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Amazon.com [REDACTED] spectrum Business
Added on 2018-09-26 18:52:54 GMT
United States, Flower Mound
DigitalOcean.com

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10.0.128.13

Amazon.com
Added on 2018-09-26 18:52:54 GMT
United States, Flower Mound
Details

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Version: 3.2.1
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Peers: http://10.0.128.13:2380, http://10.0.128.13:7001

10.0.128.13

Red Hat
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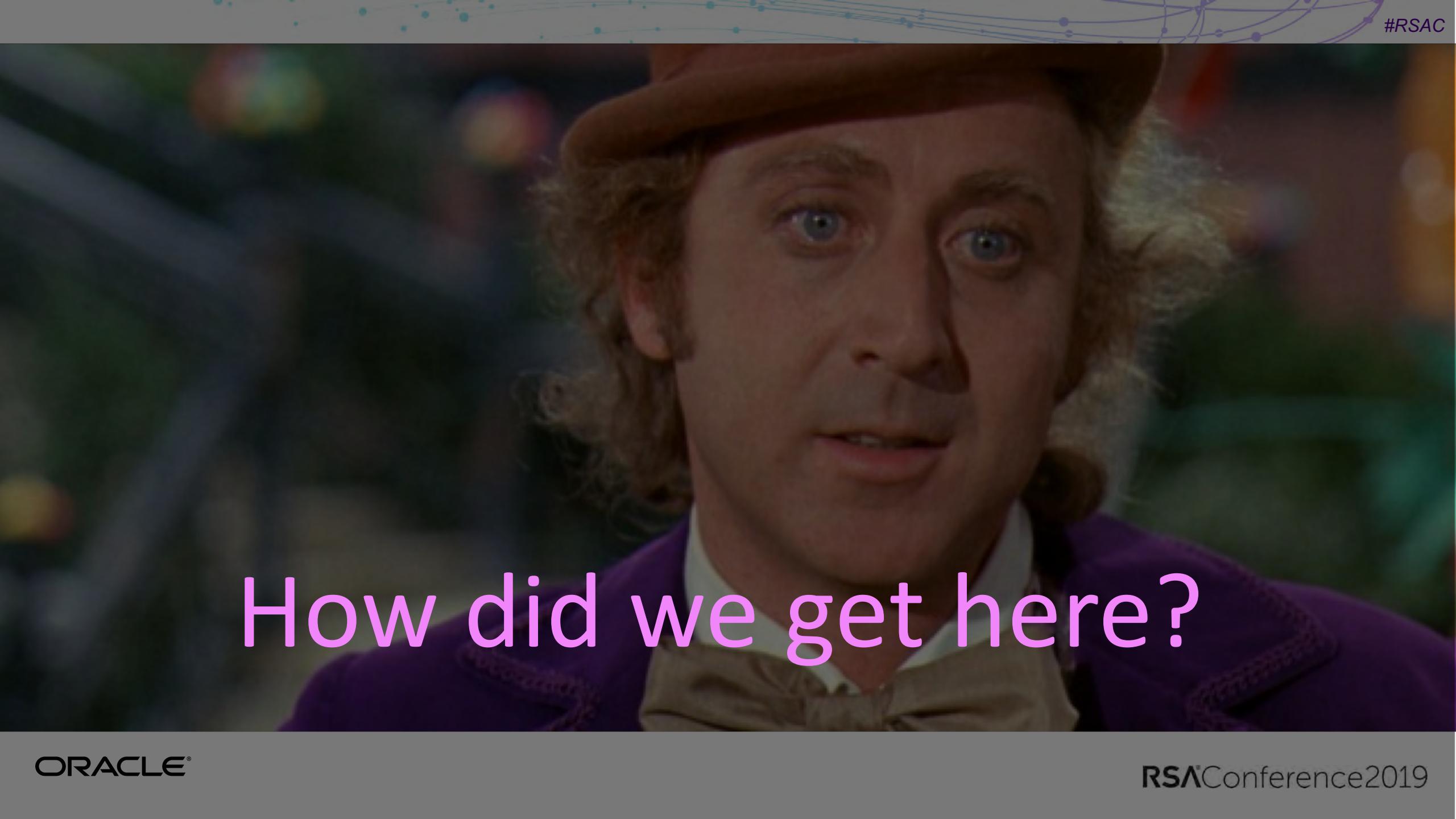
etcd
Name: rdcloud-devstack4.rdocloud
Version: 3.2.17
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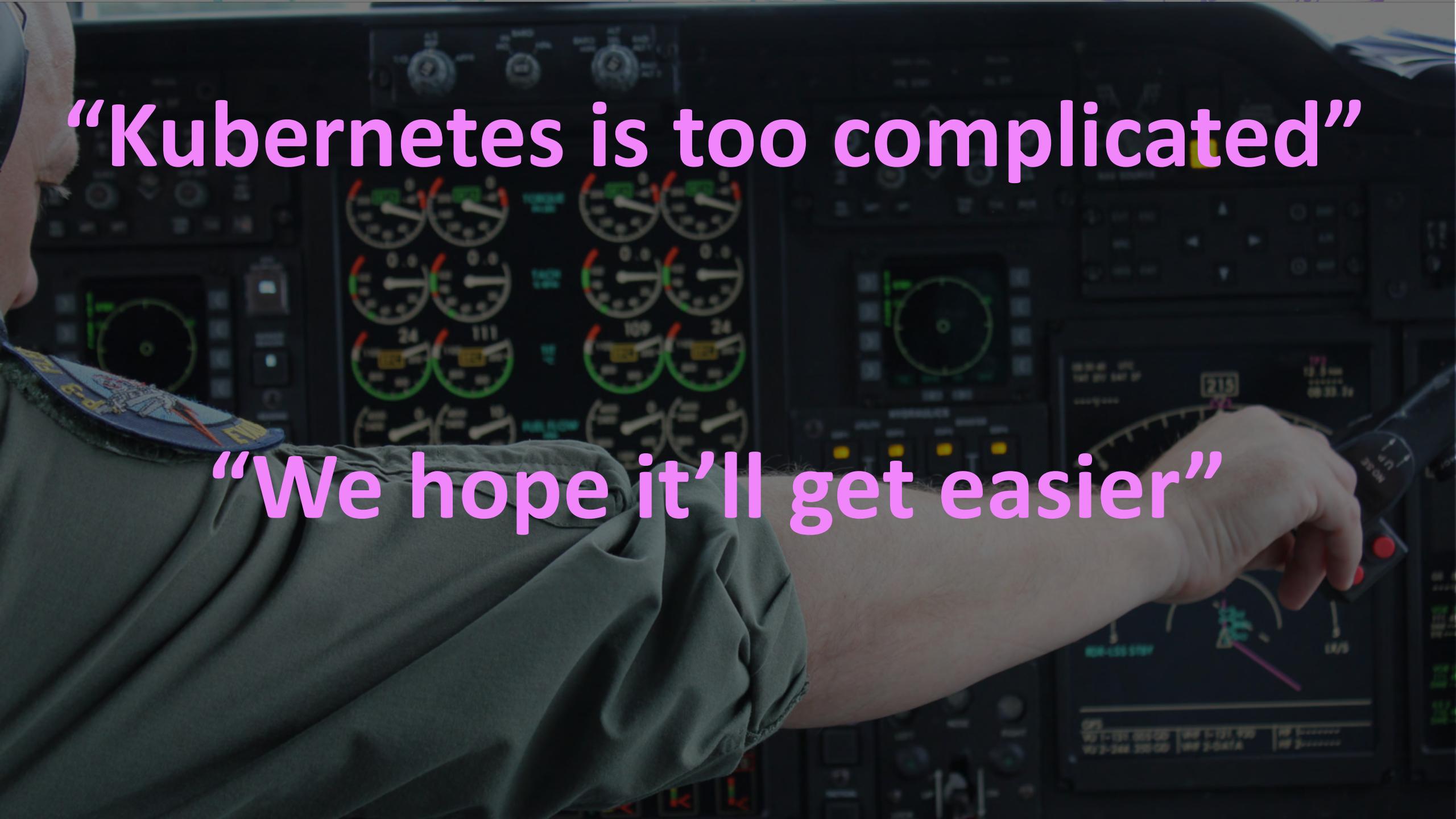
WAT?



How did we get here?

“Kubernetes is too complicated”



A close-up photograph of a pilot's arm and shoulder. The pilot is wearing a dark green flight suit with a name tag that partially reads "EVAN". They are seated in a cockpit, with a complex array of circular instruments and digital displays visible in the background. The lighting is dim, typical of an aircraft interior.

“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(s)
 - Container (Images and running)
 - Kubernetes Cluster

Attack Surface: Host

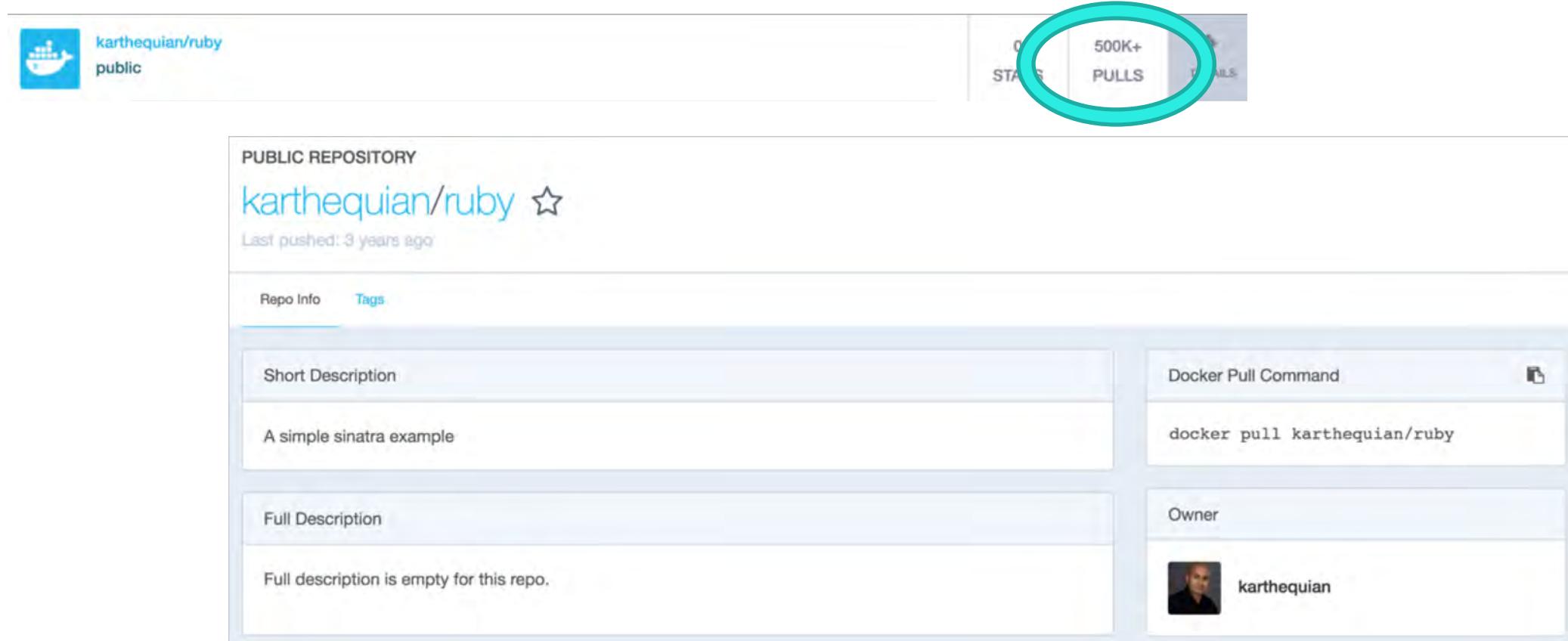
- These are the machines you're running Kubernetes on.
- Age old principles of Linux still apply:
 - Enable SELinux
 - AppArmor
 - Seccomp
 - Hardened Images
- Goal: Minimize privilege to applications running on the host
- Good news: Already a wealth of information on this subject!
 - <http://lmgtfy.com/?q=how+to+reduce+attack+surface+linux>

Attack Surface: Container Images

GOAL: Know your base image when building containers

Attack Surface: Container Images

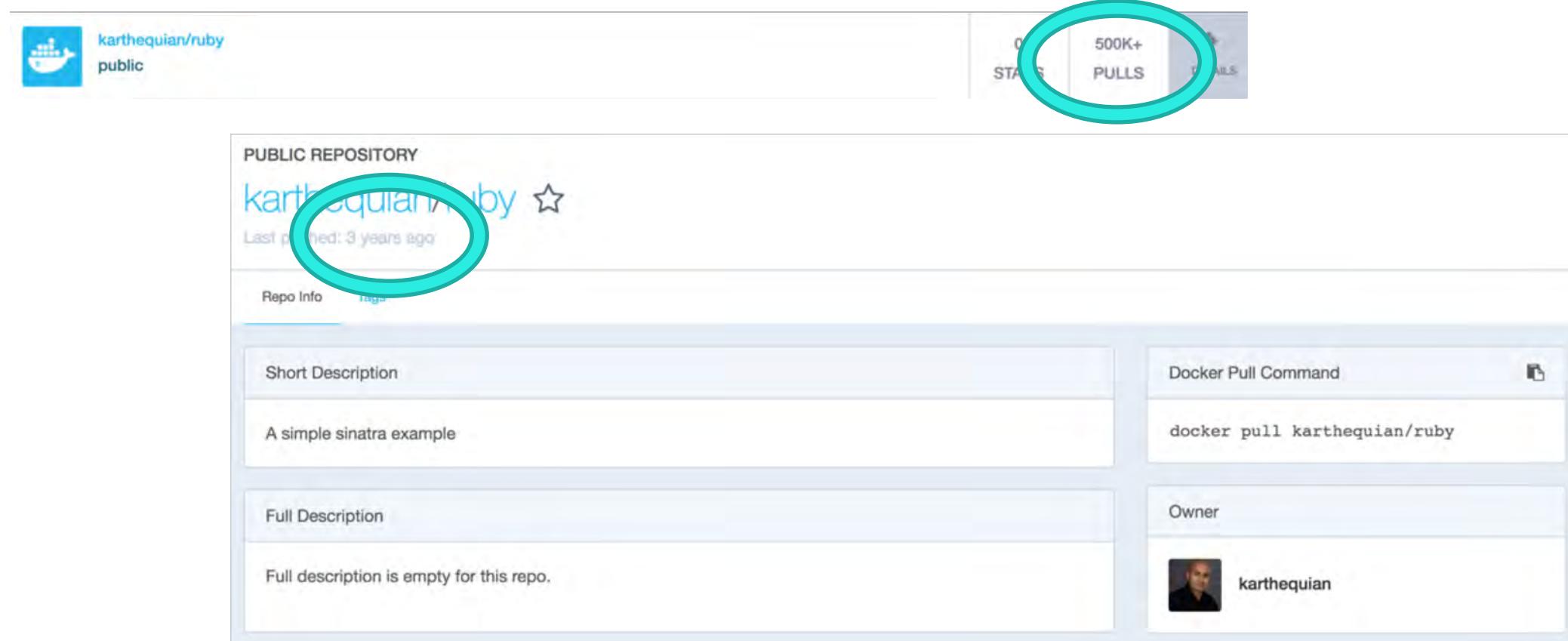
GOAL: Know your base image when building containers



**BTW, this is just a ruby helloworld app

Attack Surface: Container Images

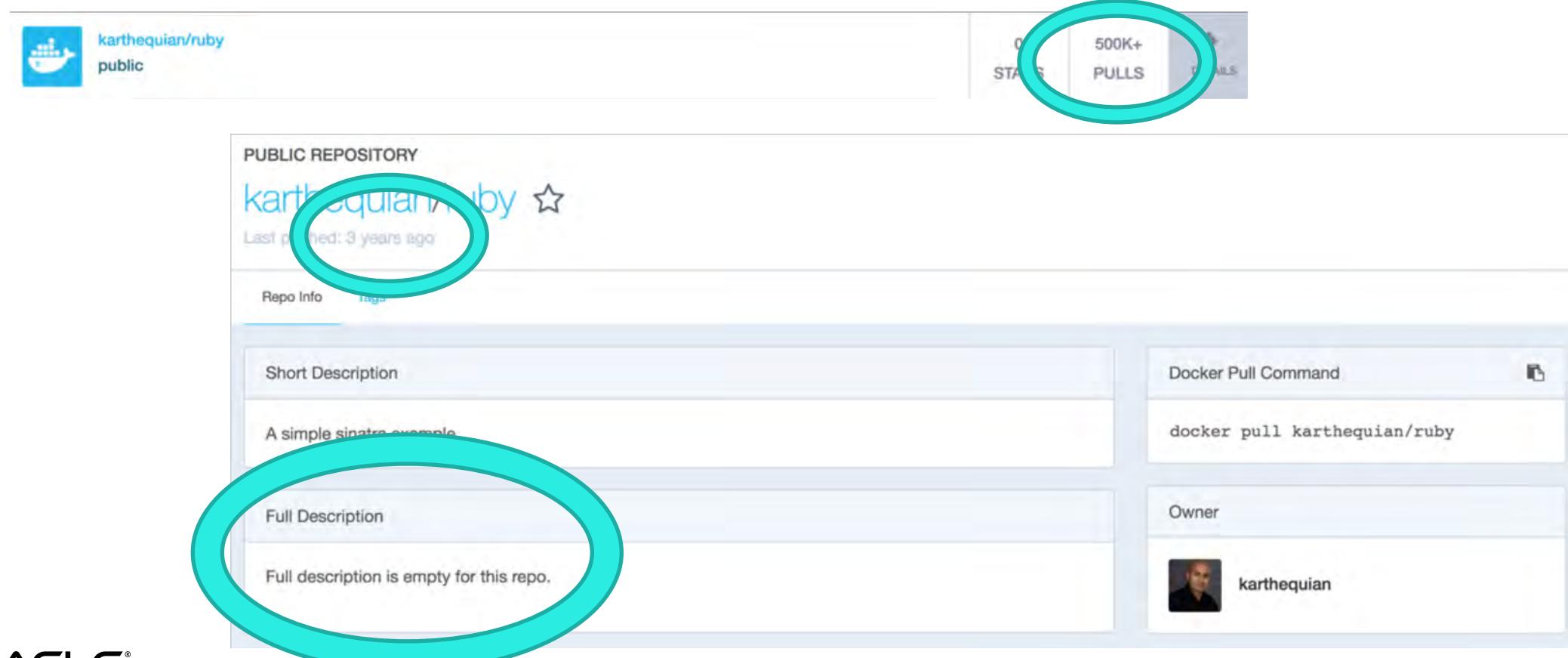
GOAL: Know your base image when building containers



**BTW, this is just a ruby helloworld app

Attack Surface: Container Images

GOAL: Know your base image when building containers



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

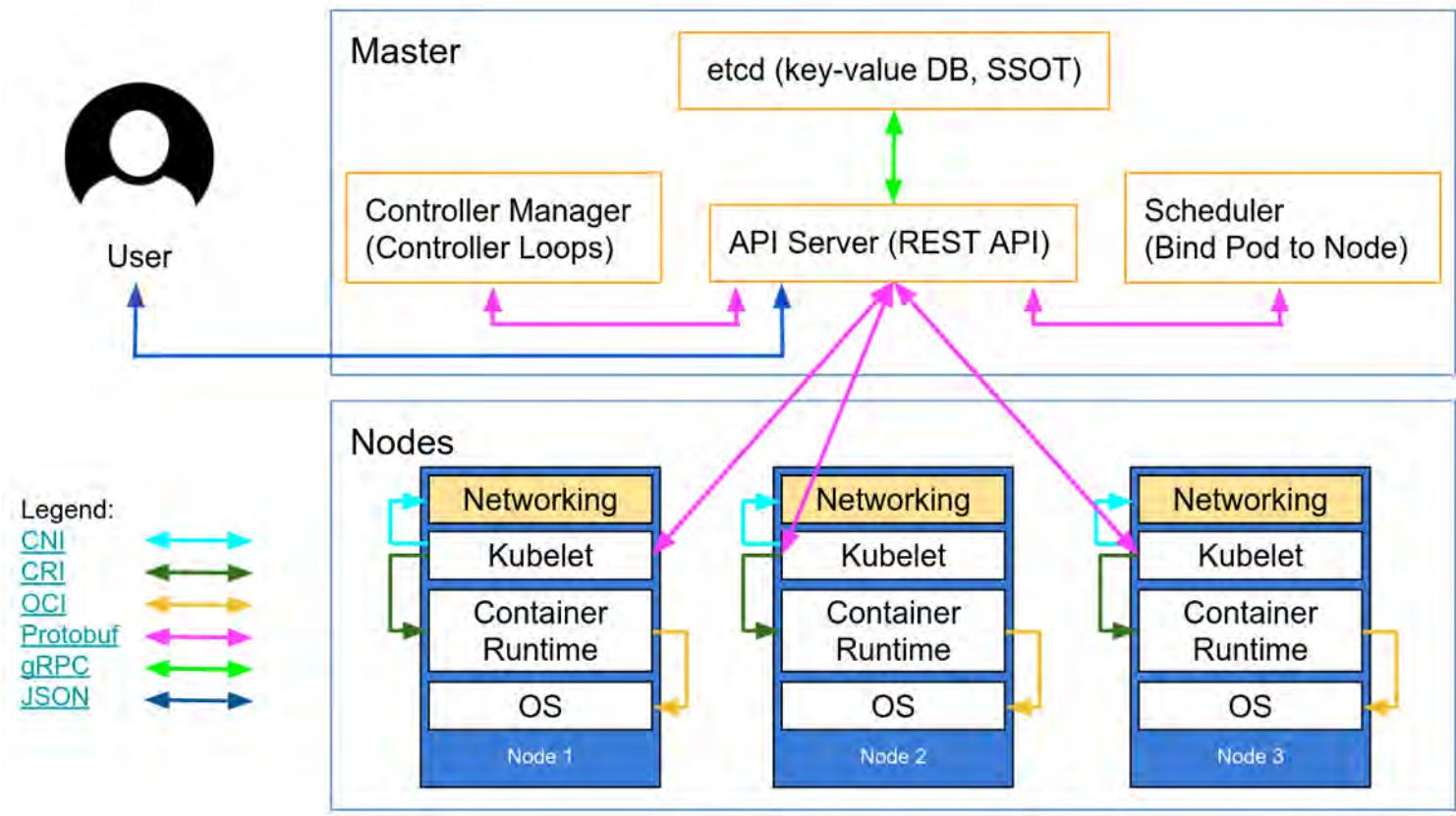
Kubernetes Cluster- TLS

TLS ALL THE THINGS

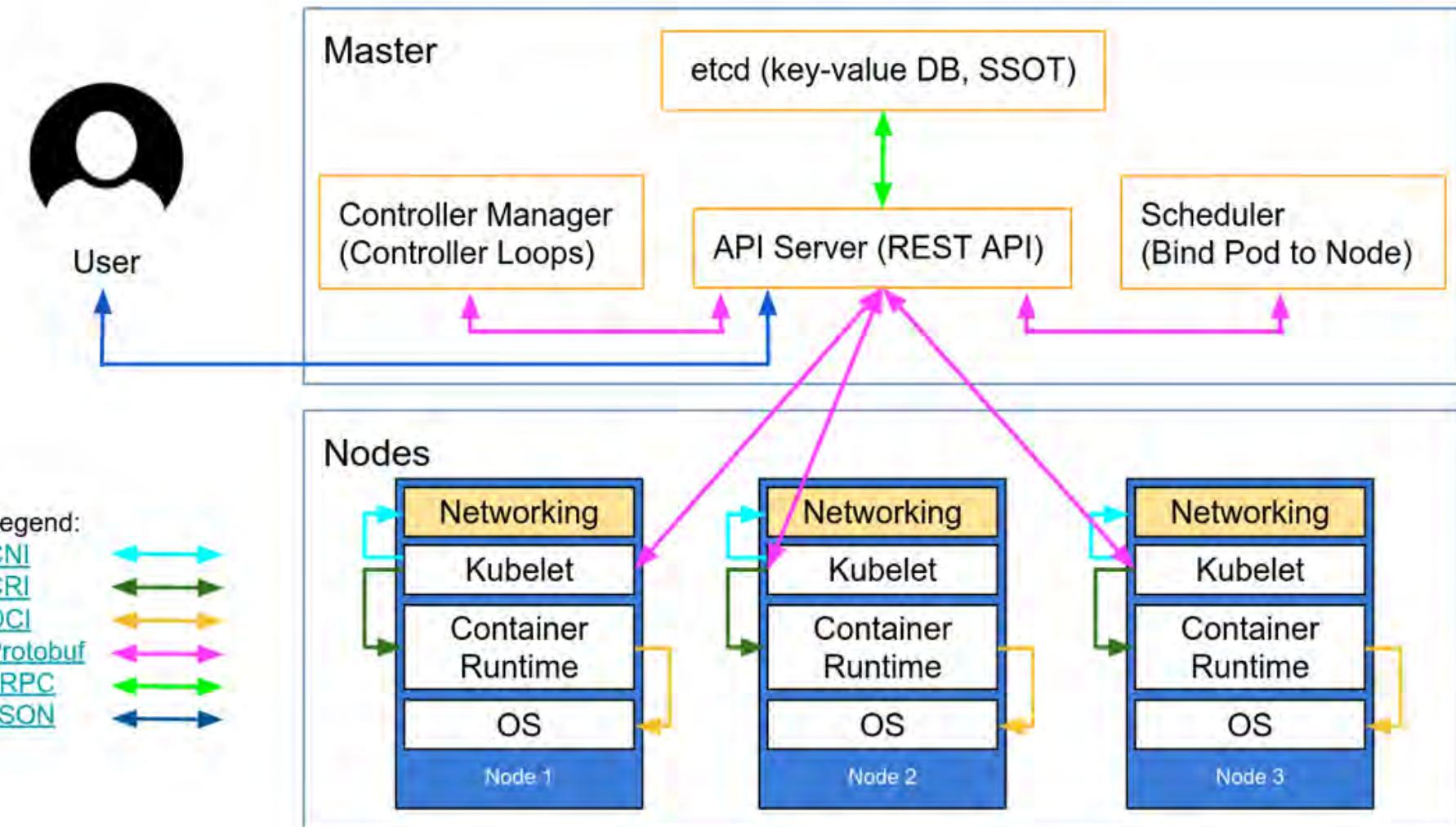


Kubernetes Cluster- TLS

- TLS Checklist:
 1. Nodes and Master
 2. User and Master
 3. Everything etcd
 4. Kubelet to API Server

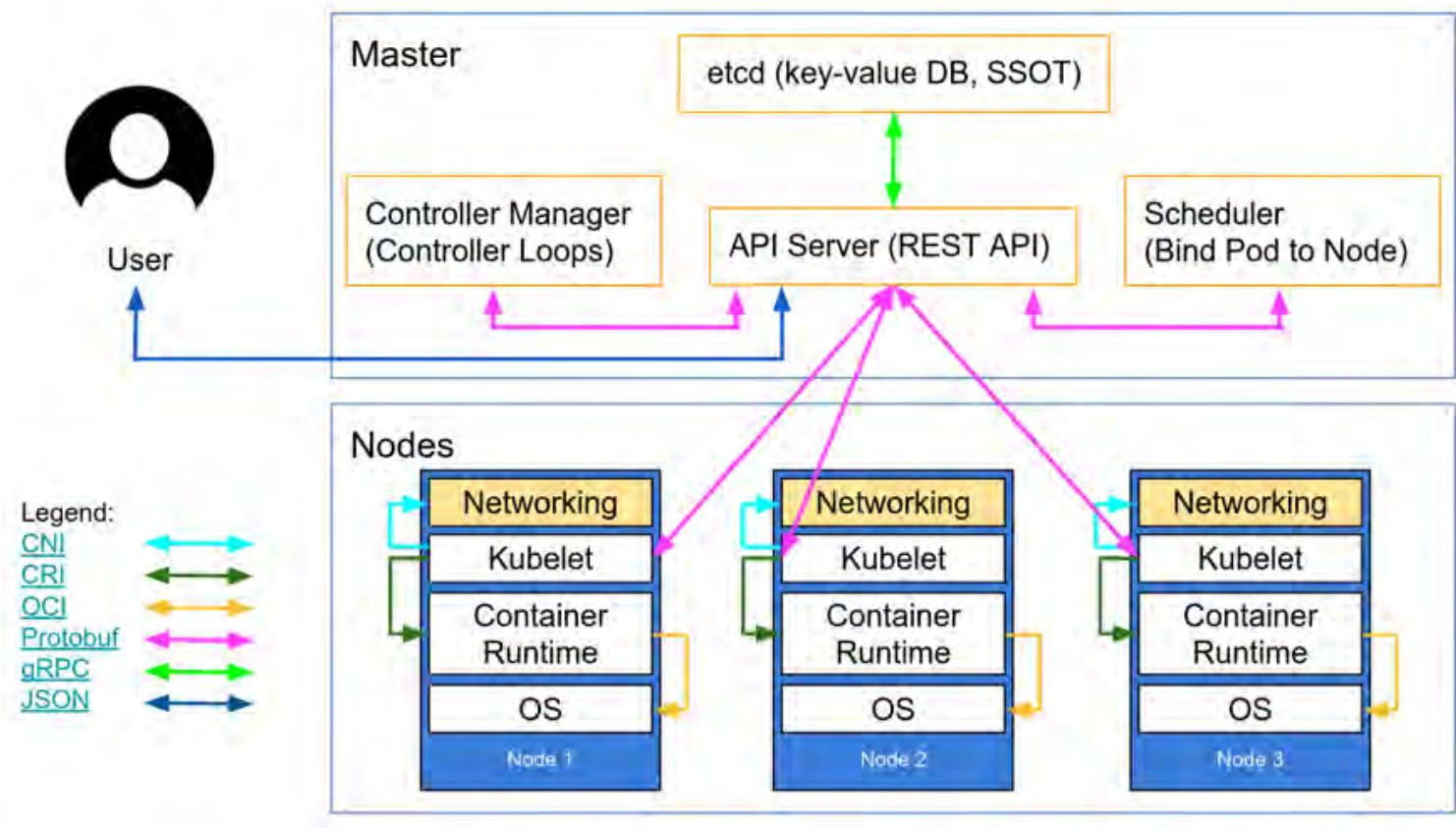


Kubernetes Cluster- TLS



Kubernetes Cluster- TLS

- TLS Checklist:
 1. User and Master
 2. Nodes and Master
 3. Everything etcd
 4. Kubelet to API Server



CVE's

GOAL: Have an upgrade strategy

- Because...CVE's are fixed in new minor versions.
- Don't treat K8s as "install once, run all the time".
- Make your K8s install repeatable for different versions.
- ..Or use a Managed Provider.
 - Either automatically patch for you, or tell you what to do.

A close-up shot of Willy Wonka from the movie "Willy Wonka & the Chocolate Factory". He is wearing his signature brown top hat and purple suit. He is looking slightly upwards and to the right with a thoughtful expression. His right hand is raised, holding a small, colorful flower between his fingers. The background is dark and out of focus.

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

- Kubernetes Secrets
- Authentication
- Authorization
- Audit Logging
- Network Policies
- Pod security policies



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/>

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!

A close-up photograph of a fluffy, light-colored cat with large, wide-open eyes looking directly at the camera. The cat is positioned behind a textured, light-colored surface, possibly a couch or chair. The lighting is soft, highlighting the cat's fur and eyes.

If you DO NOT YOLO...

You can pick an authz strategy..

Authentication and 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](#).

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

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/uruddaraju/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

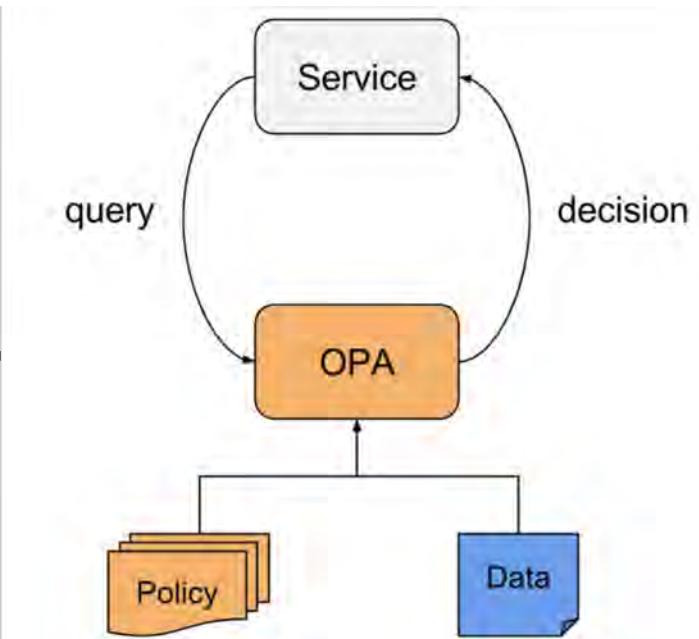
Capability for an admin to control specific actions

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

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

Open Policy Agent

- Policy based control for your whole environment.
- Full featured Policy Engine to offload policy decisions from each application/service.
 - Deploy OPA alongside your service
 - Add policy data to OPA's store
 - Query OPA on decisions.
- Great idea, still early, watch this space..
- Standardize policies for all clusters
- <https://www.openpolicyagent.org/>



Opensource Tooling



Keep tabs on the CNCF Security landscape

CNCF Cloud Native Interactive Landscape

CNCF's Cloud Native Trail Map (png, pdf) provides a good introduction. The cloud native landscape (png, pdf) and enterprise landscape (png, pdf) are dynamically generated based on GitHub pull requests to correct any issues. Current license is MIT, open source. Last Update: 2018-08-26 04:01:06Z. You are viewing 20 cards with a total of 16,396 stars, market cap of \$235B and funding of \$455M.

CARD MODE **Landscape** **Serverless**

Inviting CNCF Projects (2)

- Notary** Cloud Native Container Foundation (CNCF) Funding: 1.52M Stars: 1,527
- The Update Framework (TUF)** Cloud Native Computing Foundation (CNCF) Funding: 0.7M Stars: 700

Submit CNCF Projects (1)

- Open Policy Agent** Open Policy Agent (OPA) Cloud Native Computing Foundation (CNCF) Funding: 1.43M Stars: 1,438

CNCF Member Product/Projects (11)

- aqua** Aqua Security Funding: 50M Stars: 1,173
- clair** Clair Red Hat Funding: 50M Stars: 1,173
- Datica** Datica Funding: 51.2M Stars: 1,173
- kube-bench** kube-bench Aquar Security Funding: 10M Stars: 576
- kube-hunter** kube-hunter Aquar Security Funding: 5M Stars: 576
- NeuVector** NeuVector Funding: 5M Stars: 576
- OpenSCAP** OpenSCAP Red Hat Funding: 5M Stars: 549
- ORACLE POLICY AUTOMATION** Oracle Policy Automation Oracle Funding: 1M Stars: 549
- Sonatype Nexus** Sonatype Nexus Sonatype Funding: 115M Stars: 535
- Sysdig Falco** Sysdig Falco Sysdig Funding: 112M Stars: 535
- Twistlock** Twistlock Twistlock Funding: 10M Stars: 535

Non-CNCF Member Products/Projects (6)

- anchore** Anchore Funding: 5M Stars: 272
- BLACKDUCK** Black Duck MktCap: \$14.7B Synopsys Funding: 5M Stars: 272
- Grafeas** Grafeas Funding: 3M Stars: 631
- ORY / Hydra** ORY Hydra Funding: 3M Stars: 631
- StackRox** StackRox Shmara Funding: 3M Stars: 631
- WhiteSource** WhiteSource WhiteSource Funding: 11M Stars: 631

Crunchbase data is used under license from Crunchbase to CNCF. For more information, please see the [Crunchbase info](#).

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

CNCF Projects



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

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

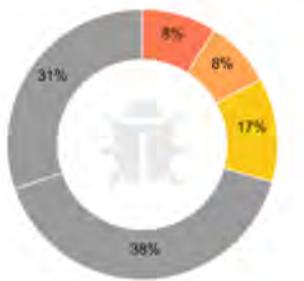
Clair



- 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>

← 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		<button>RUN apt-get up.</button>
CVE-2015-5276	⚠ Medium	gcc-4.9	4.9.2-10		<button>ADD file:b5391.</button>
CVE-2016-2856	⚠ Low	glibc	2.19-18+deb8u3		<button>ADD file:b5391.</button>
CVE-2016-0823	⚠ Low	linux	3.16.7-ckt20-1+deb8u3		<button>RUN apt-get up.</button>
CVE-2005-3660	⚠ Negligible	linux	3.16.7-ckt20-1+deb8u3		<button>RUN apt-get up.</button>
CVE-2015-4003	⚠ Negligible	linux	3.16.7-ckt20-1+deb8u3		<button>RUN apt-get up.</button>
CVE-2008-4108	⚠ Negligible	python-defaults	2.7.9-1		<button>RUN apt-get up.</button>
CVE-2015-8830	⚠ Negligible	linux	3.16.7-ckt20-1+deb8u3	3.16.7-ckt20-1+deb8u4	<button>RUN apt-get up.</button>
CVE-2013-4392	⚠ Negligible	systemd	215-17+deb8u3		<button>ADD file:b5391.</button>
CVE-2015-7515	⚠ Unknown	linux	3.16.7-ckt20-1+deb8u3		<button>RUN apt-get up.</button>
CVE-2015-8816	⚠ Unknown	linux	3.16.7-ckt20-1+deb8u3	3.16.7-ckt20-1+deb8u4	<button>RUN apt-get up.</button>
CVE-2016-2547	⚠ Unknown	linux	3.16.7-ckt20-1+deb8u3	3.16.7-ckt20-1+deb8u4	<button>RUN apt-get up.</button>
CVE-2016-2545	⚠ Unknown	linux	3.16.7-ckt20-1+deb8u3	3.16.7-ckt20-1+deb8u4	<button>RUN apt-get up.</button>

Harbor



- Newer! CNCF Project
- Registry product
- Supports vulnerability scanning, image signing and identity control
- Scope is larger than clair

Harbor

Harbor

Search Harbor...

English

About

< Projects < Repositories < thomas/postgres

thomas/postgres:alpine

Author	anonymity
Architecture	amd64
OS	linux
Docker Version	17.06.2-ce
Scan Completed	Nov 2, 2018



SCAN

Q | C

Vulnerability	Severity	Package	Current version	Fixed in version
CVE-2018-9251	Low	libxml2	2.9.8-r0	2.9.8-r1
CVE-2018-14404	Medium	libxml2	2.9.8-r0	2.9.8-r1
CVE-2018-14567	Medium	libxml2	2.9.8-r0	2.9.8-r1

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 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
```

Kube-hunter

- Penetration Testing tool for Kubernetes clusters.
- Looks for weaknesses in your cluster.
- 2 ways to run:
 - External to cluster (what an attacker sees)
 - Internal to cluster (install as a pod)
- Active and Passive mode.
 - Active mode changes stuff (probably don't use in Prod)
- Read more: <https://kube-hunter.aquasec.com/>
- **ONLY RUN ON YOUR OWN CLUSTER.**



Kube-hunter



172.17.0.1

Node / Master

6 vulnerabilities

SEVERITY	CATEGORY	VULNERABILITY	DESCRIPTION	EVIDENCE
High	Remote Code Execution	Dashboard Exposed	All operations on the cluster are exposed	nodes: minikube
High	Remote Code Execution	Anonymous Authentication	The kubelet is misconfigured, potentially allowing secure access to all requests on the kubelet, without the need to authenticate	
Medium	Information Disclosure	K8s Version Disclosure	The kubernetes version could be obtained from logs in the /metrics endpoint	v1.10.0
Medium	Information Disclosure	Cluster Health Disclosure	By accessing the open /healthz handler, an attacker could get the cluster health state without authenticating	status: ok
Medium	Information Disclosure	Exposed Pods	An attacker could view sensitive information about pods that are bound to a Node using the /pods endpoint	count: 10
Low	Access Risk	Privileged Container	A Privileged container exist on a node. could expose the node/cluster to unwanted root operations	pod: kube-proxy-w8z8b, container: kube-proxy

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")

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-system
ERRO[0003] AllowPrivilegeEscalation not set which allows privilege escalation, please set to false KubeType=daemonSet Name=kube-proxy Namespace=kube-system
```

Sonobuoy by Heptio

- Sonobuoy is a diagnostic tool.
- Tells you whether your cluster is built correctly per best practices.
- vendor-agnostic conformance tests to let you test the cluster.
- End to End tests test that APIs required for your deployment are supported by the cluster.
- Can take a long time to finish (1-3 hours).
- <https://scanner.heptio.com/>



Test Output summary

- Stored in a file called e2e.log

```
→ C GitHub, Inc. [US] | https://github.com/cncf/k8s-conformance/blob/master/v1.11/oke/e2e.log

7630 -----
7631 Sep 19 21:22:51.543: INFO: Running AfterSuite actions on all node
7632 Sep 19 21:22:51.543: INFO: Running AfterSuite actions on node 1
7633 Sep 19 21:22:51.543: INFO: Skipping dumping logs from cluster
7634
7635 Ran 143 of 996 Specs in 5025.706 seconds
7636 SUCCESS! -- 143 Passed | 0 Failed | 0 Pending | 853 Skipped PASS
7637
7638 Ginkgo ran 1 suite in 1h23m46.684104996s
7639 Test Suite Passed
```

Put it all together...



Apply It!

- Day 1:
- Know what version of Docker and Kubernetes you use.
- Understand if your control and data plane nodes are hardened.
- Understand how your Docker containers are built.
- Find out how you authenticate and authorize for your clusters.



Apply It!

- Week 1:
- Build an Automation Pipeline:
 - To build Docker images on code pushes
 - Versioning strategy for code
 - To build your Kubernetes clusters

Apply It!

- **1st Month**
- Sanitize your code:
 - Know your base images
 - Implement versioning for your containers
 - Invest in a registry (or tooling) that does vulnerability scanning
- Kubernetes:
 - Have an upgrade strategy in place
 - Analyze secrets/sensitive cluster data
 - Turn on audit logging

Apply It!

- 3 Months:
- Continuously Monitor
 - Tooling like sonobuoy/Kubesec/Kube-audit/kube-hunter//
- Plan how to address vulnerabilities/CVE's
- K8s:
 - Strategy for Pod Security Policies
 - Strategy for Network Policies
 - Run scans (like kube-bench) on cluster creation

Apply It!

- 6 Months:
- Re-ask day 1 questions.
- Review strategies- is it working? What needs tweaking?
- Review tooling- are there new tools that help? Are existing tools working?
- Review CVE's

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

