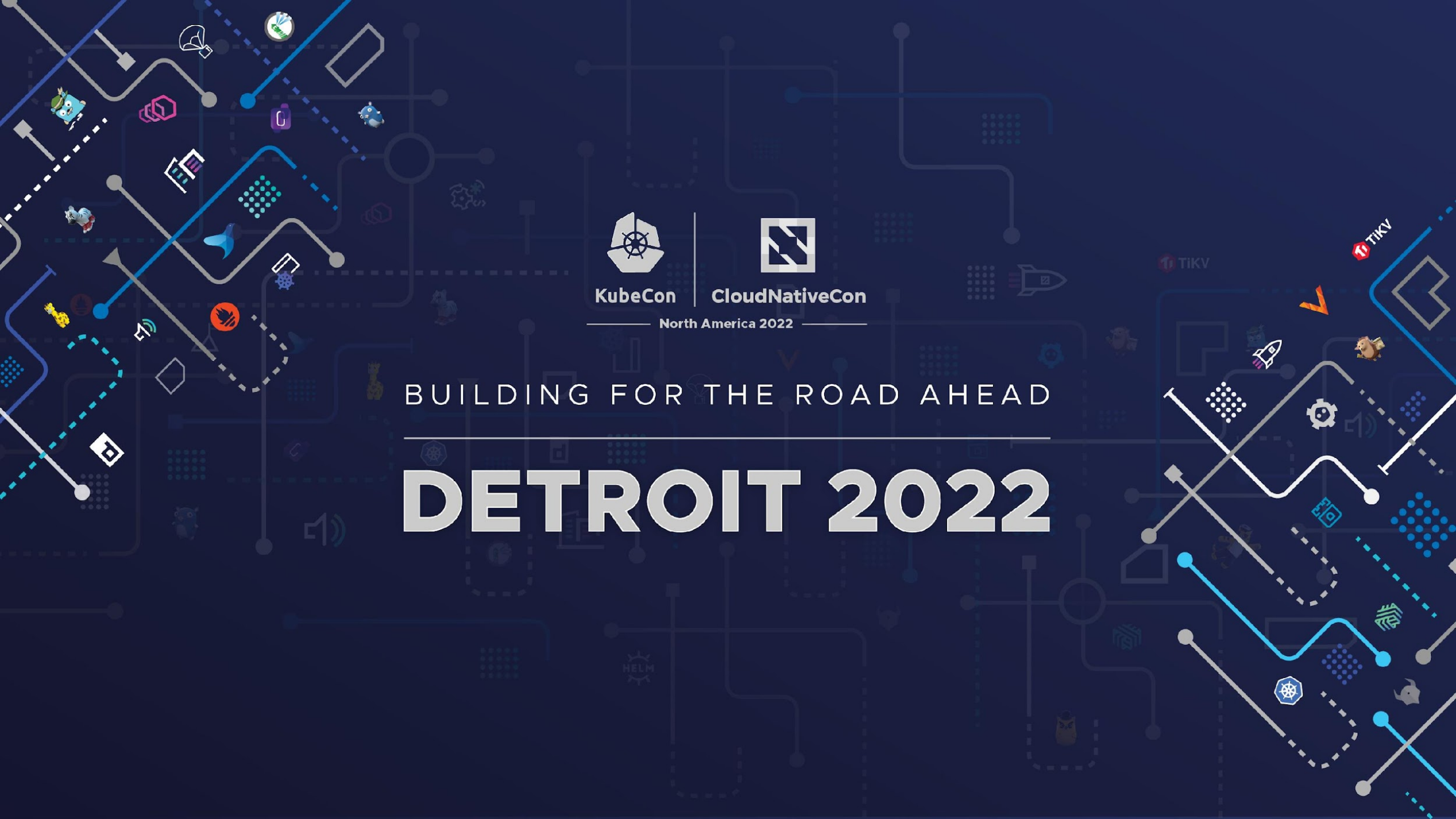
KubeCon
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Tutorial: Reducing the Sticker Price of Kubernetes Security

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DETROIT 2022

October 24-28, 2021

Pushkar Joglekar
Tooling sub-project maintainer,
Kubernetes SIG Security

$whoami

@PuDiJoglekar

- Kubernetes SIG Security - Tooling Lead
- CNCF TAG Security - Tech Lead
- Associate Kubernetes Security Response Committee Member
- Formerly VMware Tanzu, Staff Security Engineer
- Based in San Francisco Bay Area
- Loves Cycling, Chai, Curries, Camera and Cricket :)
- More about me: https://pushkarj.github.io

Before we Begin

@PuDiJoglekar

- This is a 90 minute tutorial:
  - 10 mins: Intro & Prerequisites
  - 20 mins: First task (5 mins break)
  - 25 mins: Second task (5 mins break)
  - 30 mins: Third task (5 mins break)
  - 5 mins: Wrap up & Further Reading!

Pulse Check

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Mac OS:

- M1 (use *darwin-arm64* binaries)
- Intel (use *darwin-amd64* binaries)

Windows (use *windows* binaries)

Linux (use *linux* binaries)

Note

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If Mac or Windows: you will need Docker Desktop.

Choice of your lab machine is up to you but…

Please DO **NOT** RUN this tutorial on **Shared / Corporate / Production** machines

Introduction

@PuDiJoglekar

- Secure by Design
- Built-in v/s Bolted-on
- Transparent
- It Just Works! User Experience
- <whispers> *Low Cost* </whispers>

Focus

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Built-in Kubernetes Security Features!

Tasks

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- **First**: *Verify* “Signed” Container Images
- **Second**: *Enforce* “Baseline” Pod Security
- **Third**: *Enable* “RuntimeDefault” SecComp Filter

Prerequisite Knowledge

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- Unix Commands e.g.
  - curl
  - file redirects
  - file editors
- Kubernetes Basics e.g.
  - Namespaces
  - Pods
  - Images

Prerequisite Tooling - Pulse Check

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- git
- go
- kind
- docker
- kubectl
- cosign
- curl

Asking Questions

@PuDiJoglekar

- Ask Early and Often
- Create GitHub Issues in the tutorial repo:
  - Helps with debugging and follow up
- If needed, use the 5 min breaks too for questions
- Will be hanging around for a few mins after the session

Let’s start

@PuDiJoglekar

```
git clone https://github.com/PushkarJ/kccncna-22-tutorial.git
```

Demo

First Task:

Verify “Signed” Images

Sign and Verify

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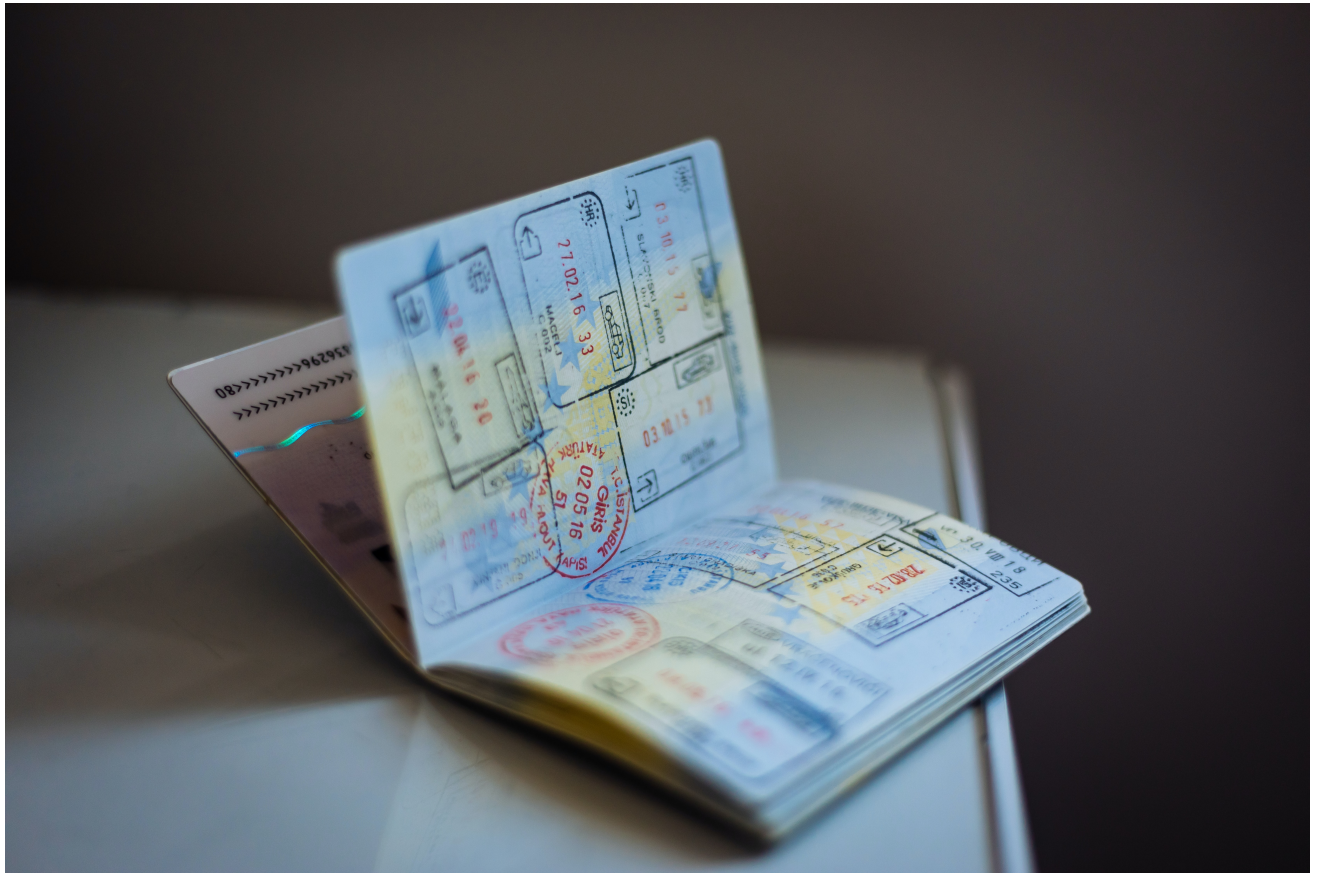

Photo by Global Residence Index on Unsplash

Sign and Verify

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- Signed by makers: Private Key
- Verified by end users: Public Key
- Tells you where an artifact came from
- Forging of signature is dependent on access to signing key
  - Should be kept private

Get All Images

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```
curl -Ls https://sbom.k8s.io/$(curl -Ls https://dl.k8s.io/
release/latest.txt)/release | grep 'PackageName:
registry.k8s.io/' | awk '{print $2}' > images.txt

input=images.txt
while IFS= read -r image
do
  COSIGN_EXPERIMENTAL=1 cosign verify "$image"
done < "$input"
```

Verify One image

@PuDiJoglekar

```
COSIGN_EXPERIMENTAL=1 cosign verify \
registry.k8s.io/kube-apiserver-amd64:v1.25.2
```

Verify All Images

@PuDiJoglekar

```
input=images.txt
while IFS= read -r image
do
  COSIGN_EXPERIMENTAL=1 cosign verify "$image"
done < "$input"
```

Demo

5 mins…
Break / Catch Up

Stretch, Drink Water, Relax your eyes

Second Task:

Enforce “Baseline” Pod Security

PSP: deprecated and removed

@PuDiJoglekar

Pod Security Policy (PSP):

* Deprecated (since v1.21)

* Removed (since v1.25)

For migration from Pod Security Policy to Pod Security Admission: https://sched.co/182Jx (happened Thursday)

Pod Security Standards

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Restricted

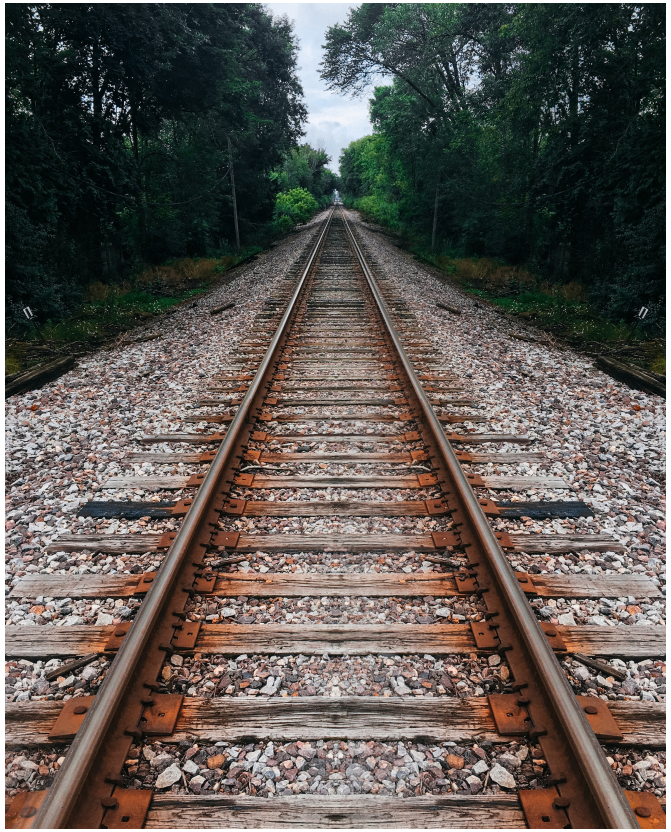

Photo by Tom Barrett on Unsplash

Baseline

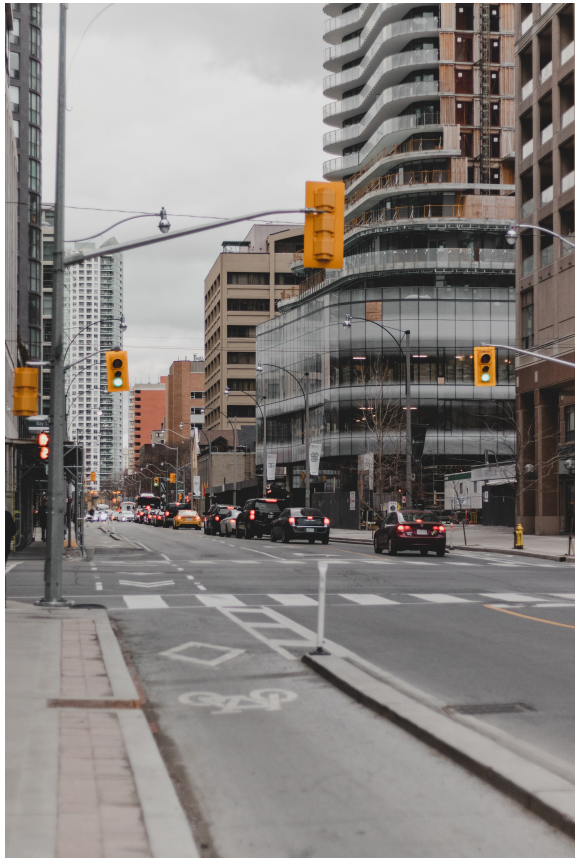

Photo by Omar Quazi on Unsplash

Privileged

Photo by Connor McSheffrey on Unsplash

Pod Security Standards

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* Opinionated set of Pod Security Configurations
* From lowest to highest risk:
    * Restricted, Baseline, Privileged

Pod Security Admission

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Lightweight built-in pod security (standards) admission controller

- No Extra installation steps needed
- Feature *Enabled* by default but…
- No PSS is *configured* by default
- Two ways to configure: *cluster* level and *namespace* level

Setting up Cluster Level Pod Security

@PuDiJoglekar

```
apiVersion: apiserver.config.k8s.io/v1
kind: AdmissionConfiguration
plugins:
- name: PodSecurity
  configuration:
    apiVersion: pod-security.admission.config.k8s.io/v1
    kind: PodSecurityConfiguration
    defaults:
      enforce: "baseline"
      enforce-version: "latest"
      audit: "restricted"
      audit-version: "latest"
      warn: "restricted"
      warn-version: "latest"
    exemptions:
      usernames: []
      runtimeClasses: []
      namespaces: [kube-system]
```

Enforce, Warn and Audit Modes

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Enforce (blocking): Pod Creation Fails if the configured Pod Security Standards are unmet

Warn (non-blocking): Warns the User about violations of configured Pod Security Standards but creates the pod

Audit (non-blocking): Violations of configured Pod Security Standards are logged in Kubernetes API Audit logs

Pod Security Exemptions

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Covers special circumstances:

- Where the pods, users, runtimes can not conform to cluster level pod security
- We will use namespace exemption in this tutorial

Creating a Cluster with Pod Security

@PuDiJoglekar

```
kind: Cluster
apiVersion: kind.x-k8s.io/v1alpha4
nodes:
- role: control-plane
  kubeadmConfigPatches:
  - |
    kind: ClusterConfiguration
    apiServer:
        extraArgs:
          admission-control-config-file: /etc/config/
cluster-level-pss.yaml

</snip>
```

Minimal Pod Spec

@PuDiJoglekar

```
apiVersion: v1
kind: Pod
metadata:
  name: nginx
spec:
  containers:
    - image: nginx
      name: nginx
      ports:
        - containerPort: 80
```

Minimal Pod Spec - Warnings

@PuDiJoglekar

Warning: would violate PodSecurity "restricted:latest":

- allowPrivilegeEscalation != false (container "nginx" must set *securityContext.allowPrivilegeEscalation=false*),
- unrestricted capabilities (container "nginx" must set *securityContext.capabilities.drop=["ALL"]*),
- runAsNonRoot != true (pod or container "nginx" must set securityContext.runAsNonRoot=true),
- seccompProfile (pod or container "nginx" must set *securityContext.seccompProfile.type* to "RuntimeDefault" or "Localhost")

Test that passes “restricted” PSS

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```
apiVersion: v1
kind: Pod
metadata:
  name: nginx-r-pss
spec:
  containers:
    - image: nginx
      name: nginx-r-pss
      securityContext:
        runAsNonRoot: true
        seccompProfile:
          type: RuntimeDefault
        allowPrivilegeEscalation: false
        capabilities:
          drop: ["ALL"]
      ports:
        - containerPort: 80
```

Demo

5 mins…
Break / Catch Up

Stretch, Drink Water, Relax your eyes

Third Task:

Enable “RuntimeDefault” SecComp Profile

What is SecComp?

@PuDiJoglekar

- It’s a system call filter
- One of the fundamental isolation technologies used in containers
- Blocking system calls that would break isolation boundaries

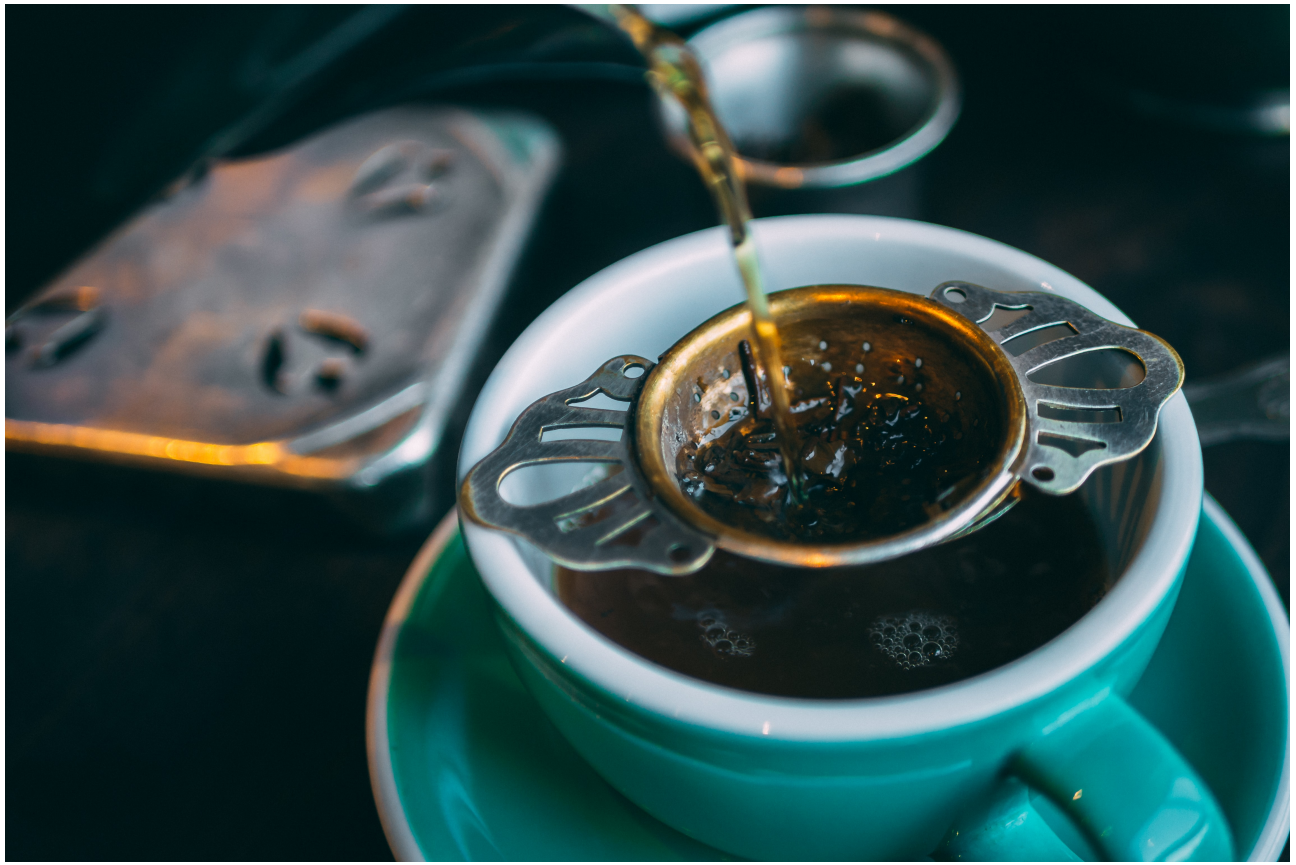

Photo by Matt Seymour on Unsplash

What is SecComp?

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How many system calls exist in a typical linux system?

300 and counting

What is RuntimeDefault?

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Tells Kubernetes to use the *seccomp* profile of the underlying container runtime e.g. containerd, cri-o

Enabling SecComp for your Cluster

@PuDiJoglekar

Three choices:

- `Unconfined` i.e. bypass container runtime seccomp profile: Default for many years in Kubernetes
- Stricter profiles:
  - `RuntimeDefault`: inherit container runtime default profile
  - `LocalHost`: custom seccomp profile for your pod

Default SecComp Profile

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Containerd: https://github.com/containerd/containerd/blob/main/contrib/seccomp/seccomp_default.go#L56-L479

CRI-O: https://github.com/cri-o/cri-o/blob/main/vendor/github.com/containers/common/pkg/seccomp/default_linux.go#L45-L887

Docker: https://docs.docker.com/engine/security/seccomp/

Customizing SecComp ~~Pizza~~ Profile

@RuDiLoglekar

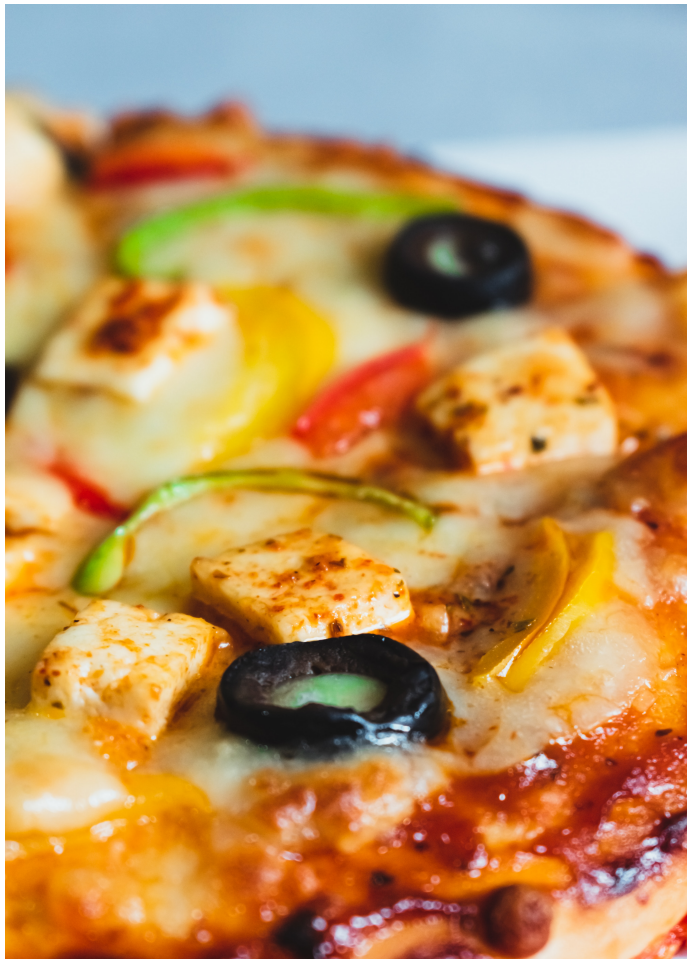

Photo by ABHISHEK HAJARE on Unsplash

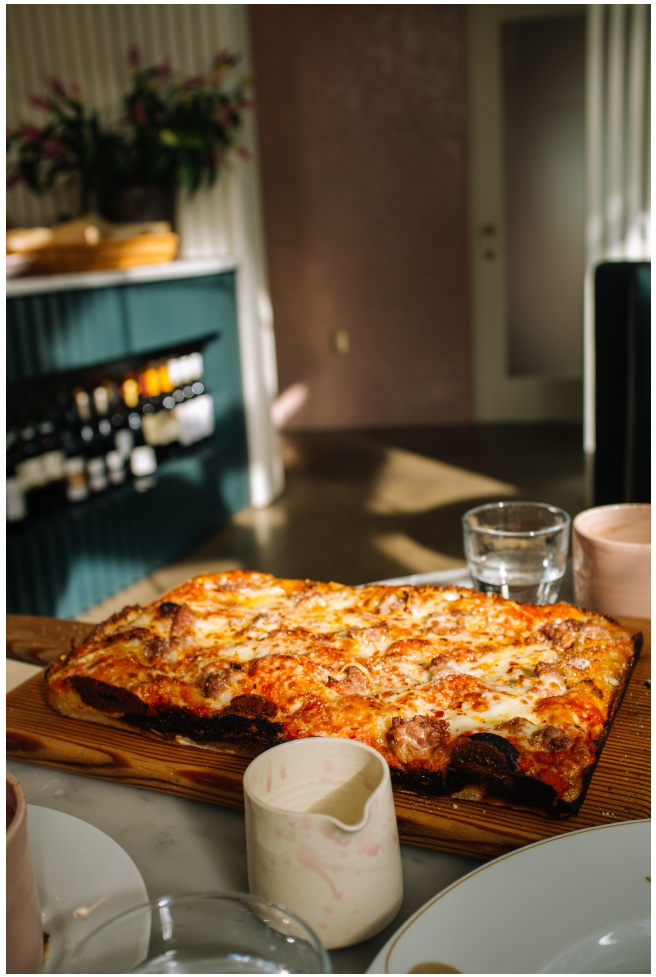

Photo by H Liu on Unsplash

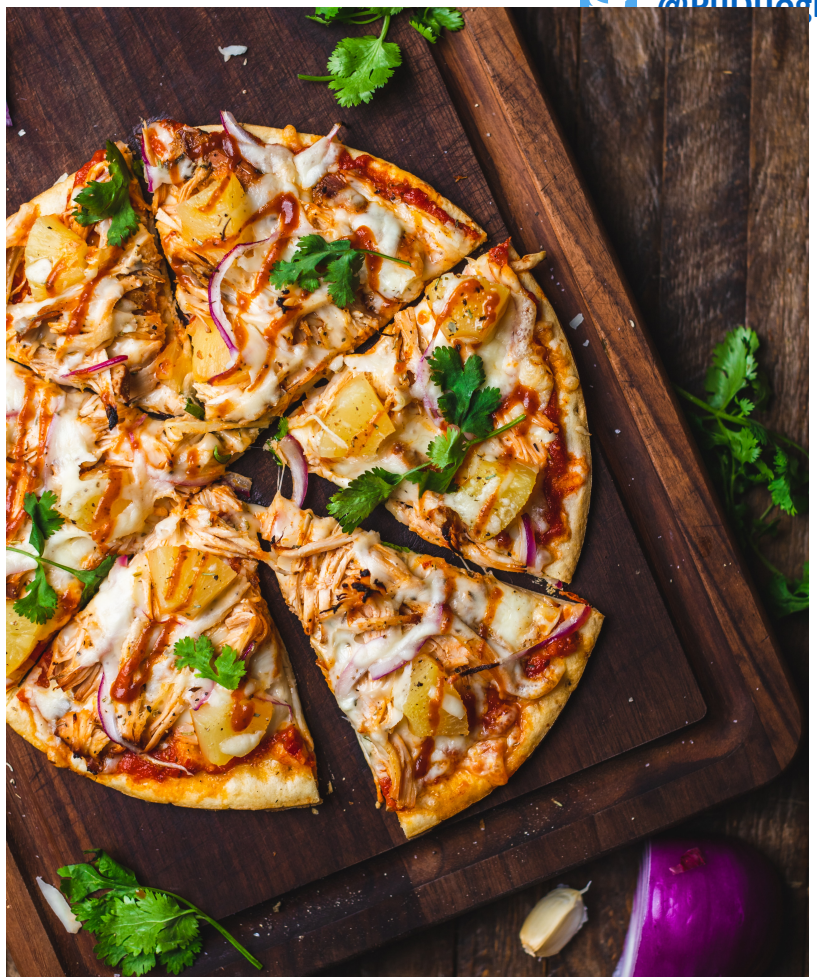

Photo by Chad Montano on Unsplash

Testing Isolation Boundaries

@PuDiJoglekar

- Blocking system calls limits exposure to kernel and thus limits attack surface
- Change (of date and time) in one container should not allow change of date and time for local containers
- This is why SYS_TIME system call and its corresponding capability is blocked in default *seccomp* profile of container runtimes

Set SecComp Default to RuntimeDefault

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```
kind: Cluster
apiVersion: kind.x-k8s.io/v1alpha4
featureGates:
  SeccompDefault: true
nodes:
  - role: control-plane
    image: kindest/
node:v1.25.0@sha256:6e0f9005eba4010e364aa1bb25c8d7c64f050f744258eb68c4eb40c284c3c0dd
    kubeadmConfigPatches:
      - |
        kind: JoinConfiguration
        nodeRegistration:
          kubeletExtraArgs:
            seccomp-default: "true"
  - role: worker
    image: kindest/
node:v1.25.0@sha256:6e0f9005eba4010e364aa1bb25c8d7c64f050f744258eb68c4eb40c284c3c0dd
    kubeadmConfigPatches:
      - |
        kind: JoinConfiguration
        nodeRegistration:
          kubeletExtraArgs:
            seccomp-default: "true"
```

With Seccomp: Change of Date and Time

@PuDiJoglekar

```
kubecon:seccomp tutorial$ kubectl exec --stdin --tty
forever-asleep -- /bin/bash
root@forever-asleep:/# date 010709342000
date: cannot set date: Operation not permitted
Fri Jan  7 09:34:00 UTC 2000


root@forever-asleep:/# date
Thu Oct  6 03:36:24 UTC 2022
```

Without Seccomp: Change of Date and Time

@PuDiJoglekar

```
kubecon:seccomp tutorial$ kubectl exec --stdin --
tty forever-asleep -- /bin/bash
root@forever-asleep:/# date 010709342000

Fri Jan  7 09:34:00 UTC 2000


root@forever-asleep-again:/# date
Fri Jan  7 09:34:00 UTC 2000
```

Demo

5 mins…
Break / Catch Up

Stretch, Drink Water, Relax your eyes

Bringing it all together!

@PuDiJoglekar

- Verify Images
- Create clusters with:
  - SecComp set as RuntimeDefault
  - Baseline Pod Security Standard Enforced

Demo:
May be try this at home?

Further Reading!

@PuDiJoglekar

All part of official Kubernetes Documentation

- https://kubernetes.io/docs/tasks/administer-cluster/verify-signed-images/
- https://kubernetes.io/docs/tutorials/security/ns-level-pss/
- https://kubernetes.io/docs/tutorials/security/cluster-level-pss/
- https://kubernetes.io/docs/tutorials/security/seccomp/

Questions?

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This is a safe space 😊

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Thank You!

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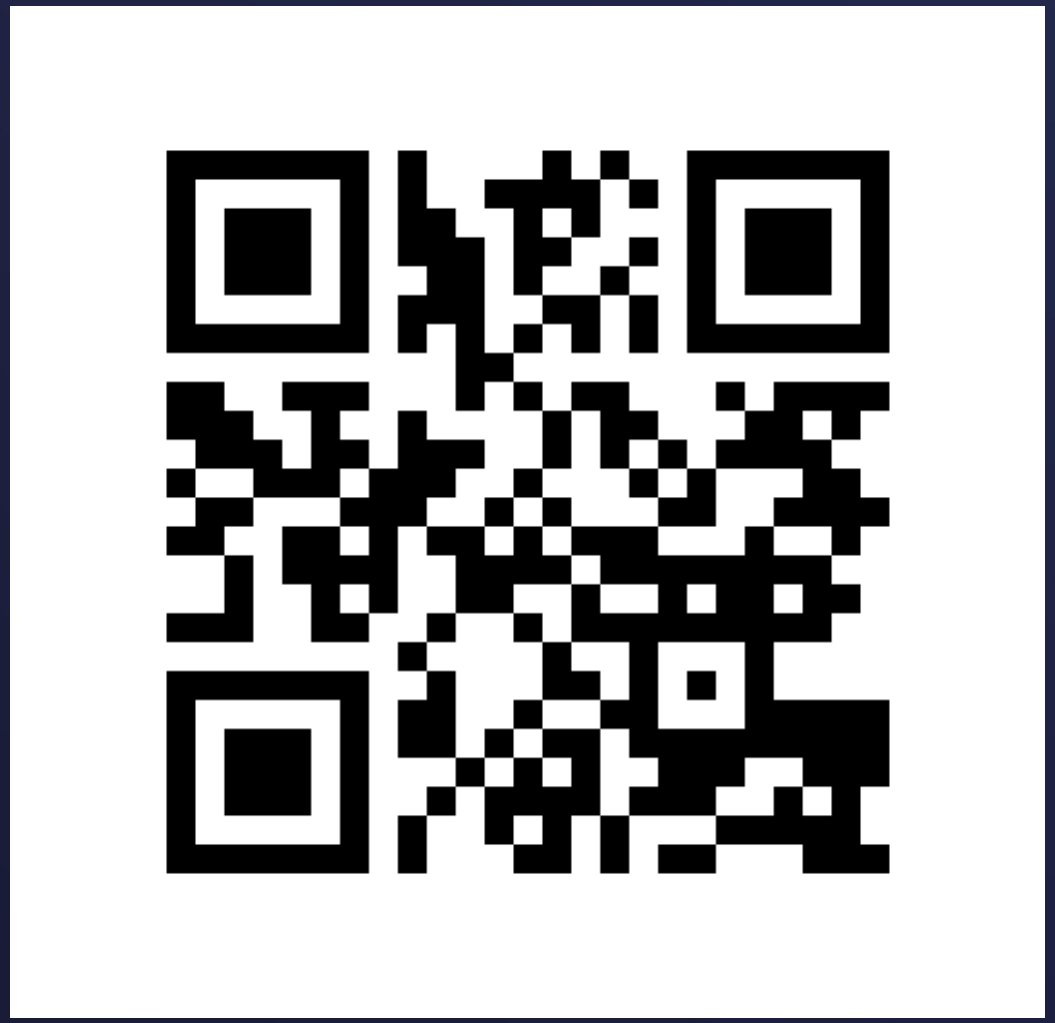

Please scan the QR Code above to leave feedback on this session