Secure your Kubernetes Containers

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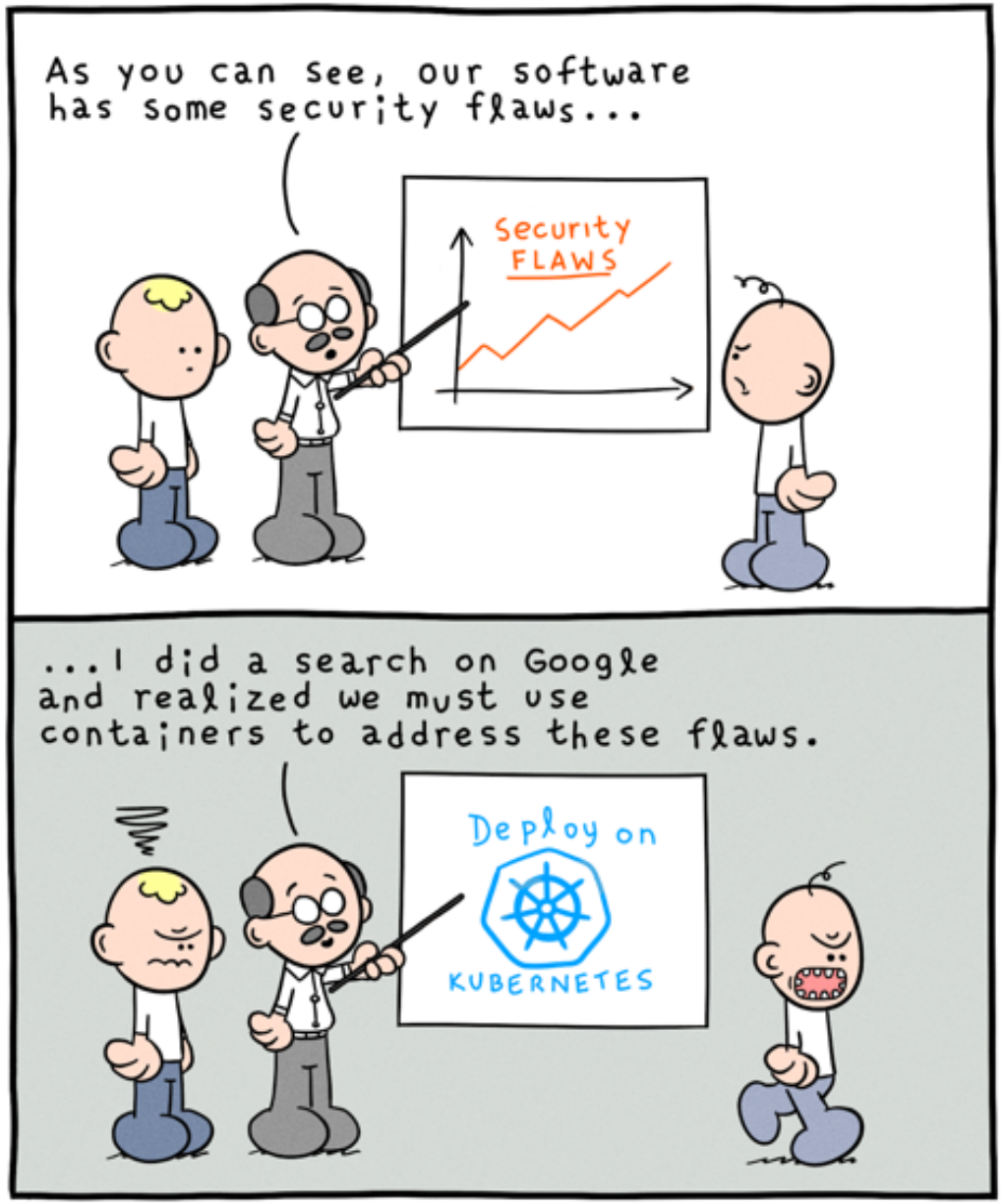
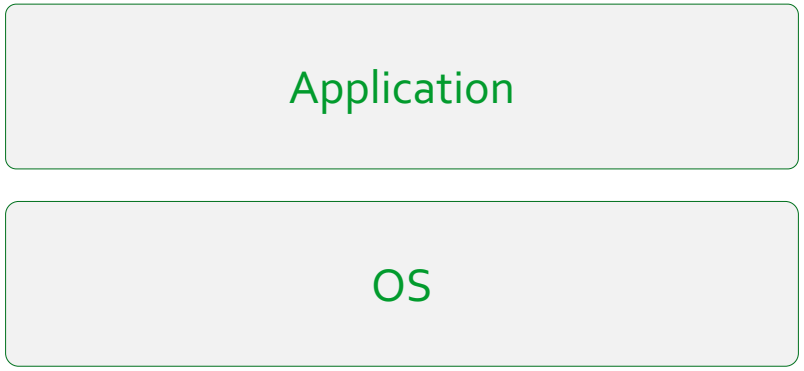
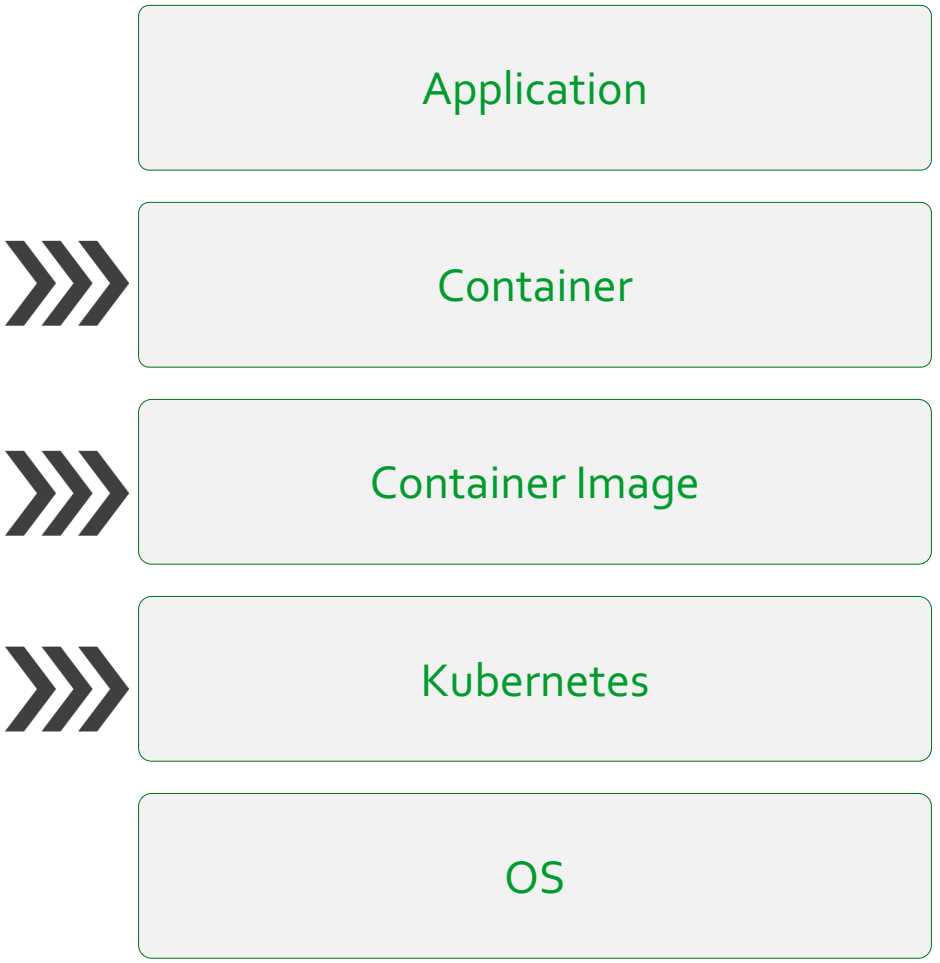
@hossambarakat_


As you can see, our software has some security flaws...
Security FLAWS
...I did a search on Google and realized we must use containers to address these flaws.
Deploy on
KUBERNETES
Daniel Stori {turnoff.us}

Attack Vectors

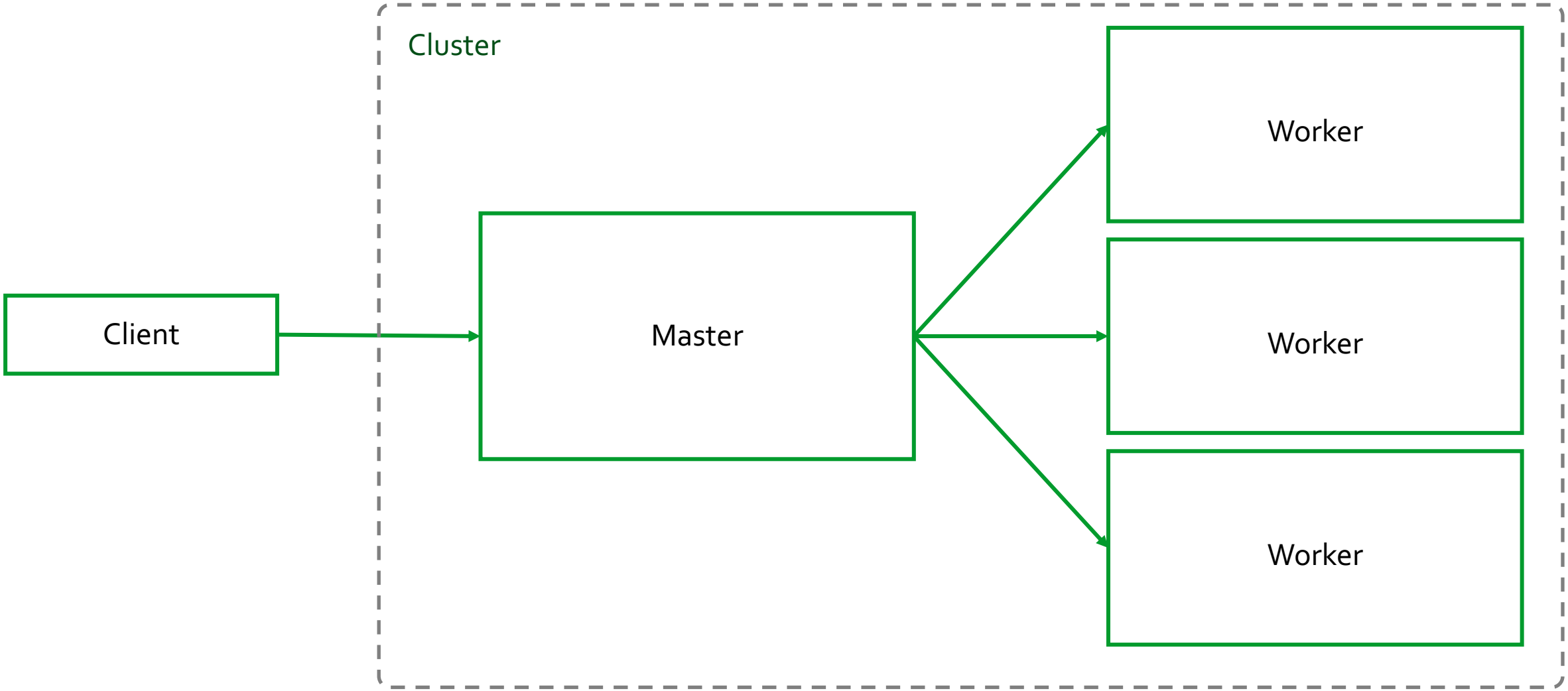


Attack Vectors

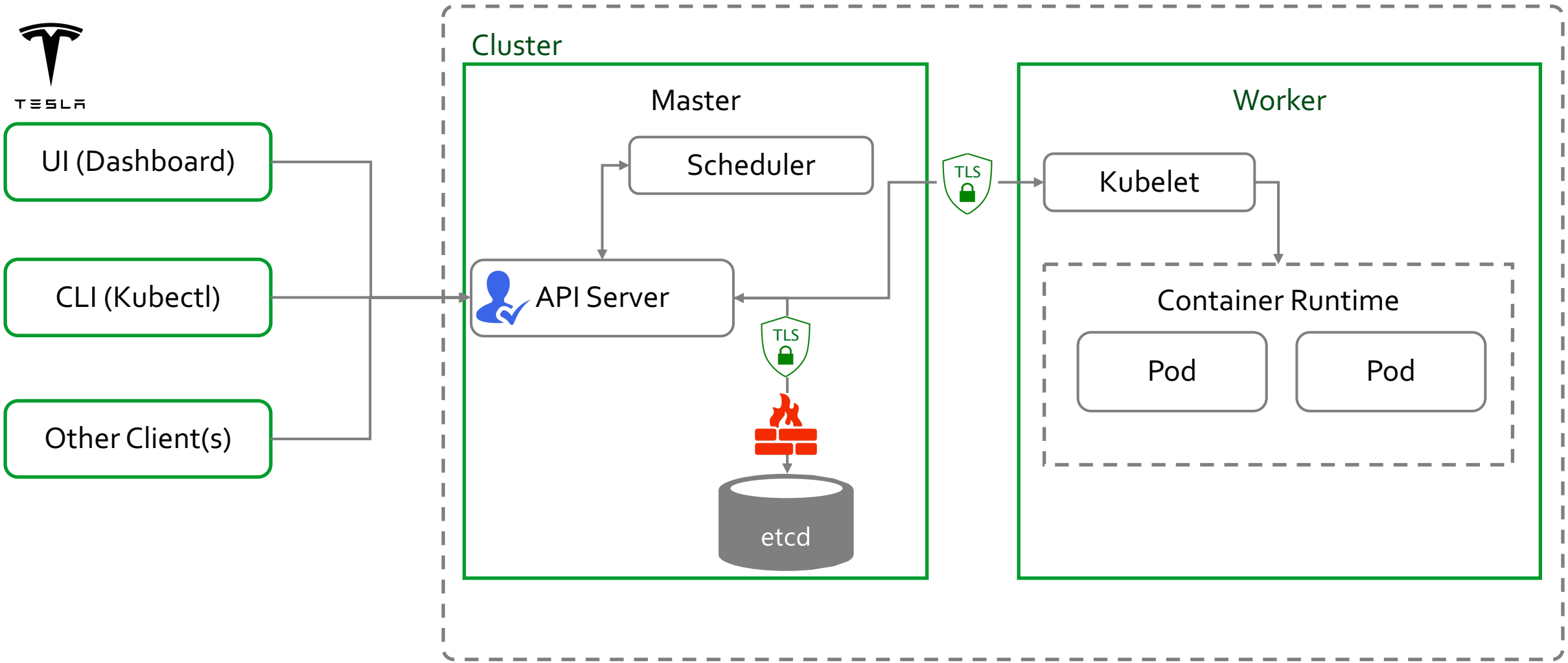


Kubernetes Cluster

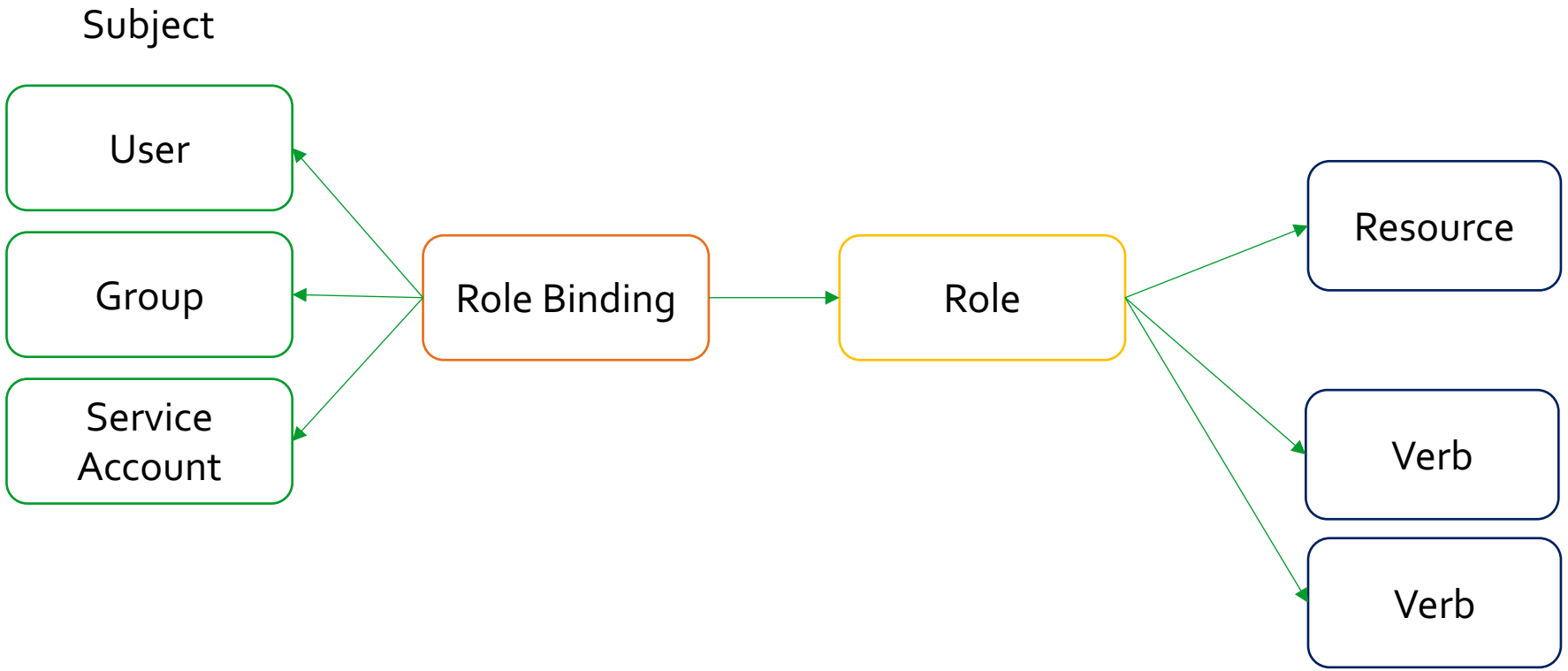
Kubernetes Architecture



Kubernetes Architecture



Role Based Access Control (RBAC)



Service Account

```
apiVersion: v1
kind: ServiceAccount
metadata:
  name: webapp-service-account
  namespace: default
```

Role Based Access Control (RBAC)

Role

```
kind: Role
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: my-role
  namespace: default
rules:
  - apiGroups: [""]
    resources: ["pods"]
    verbs: ["get", "list"]
```

Role Binding

```
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: my-role-binding
  namespace: default
subjects:
  - kind: ServiceAccount
    name: webapp-service-account
    namespace: default
roleRef:
  kind: Role
  name: my-role
  apiGroup: rbac.authorization.k8s.io
```

Role Based Access Control (RBAC)

Pod

```
kind: Pod
apiVersion: v1
metadata:
  name: webapp
spec:
  serviceAccountName: webapp-service-account
  containers:
  - name: webapp
    image: hossambarakat/k8s-security-webapp
    ports:
        - containerPort: 3000
```

CIS Kubernetes Benchmark

- Document that provide guidance for establishing a secure configuration posture for Kubernetes
- Specific recommendations with a description, rationale, method of audit and remediation
- Can be automated with kube-bench

Container Images

Images Security

- Never run as root
  - Set USER in Dockerfile
- Minimal base image
  - Alpine 2 MB
  - Ubuntu 60 MB
- Trusted base image
- Private image registry
- Do **NOT** use latest tag
- Vulnerability scans

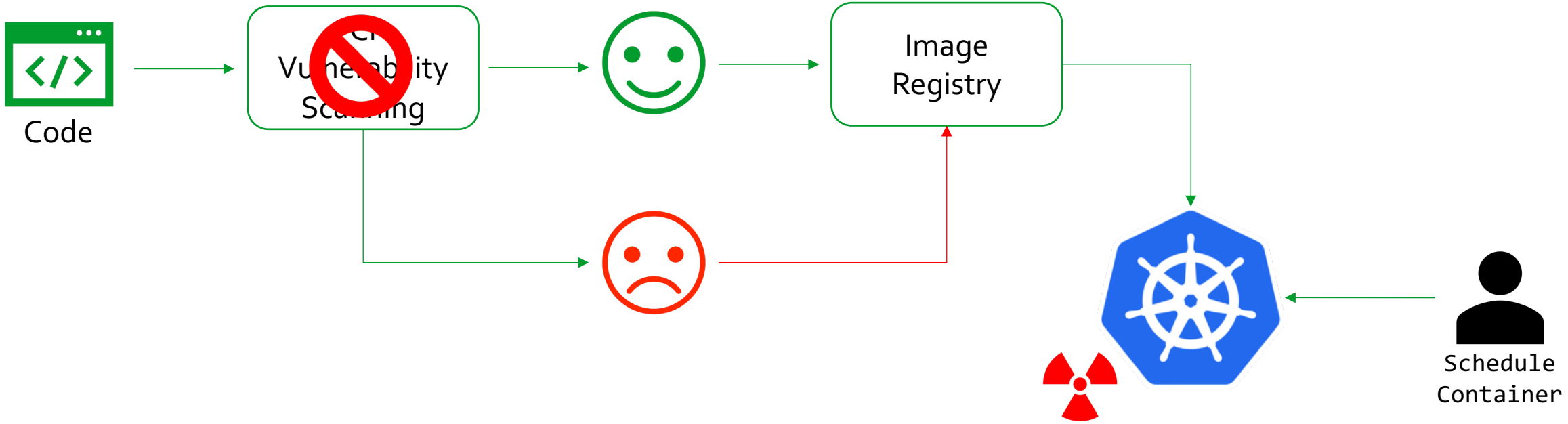
Image Scanning Tools

- aquasecurity/trivy
- coreos/clair
- optiopay/klar
- aquasecurity/microscanner
- Aqua Security
- Twistlock

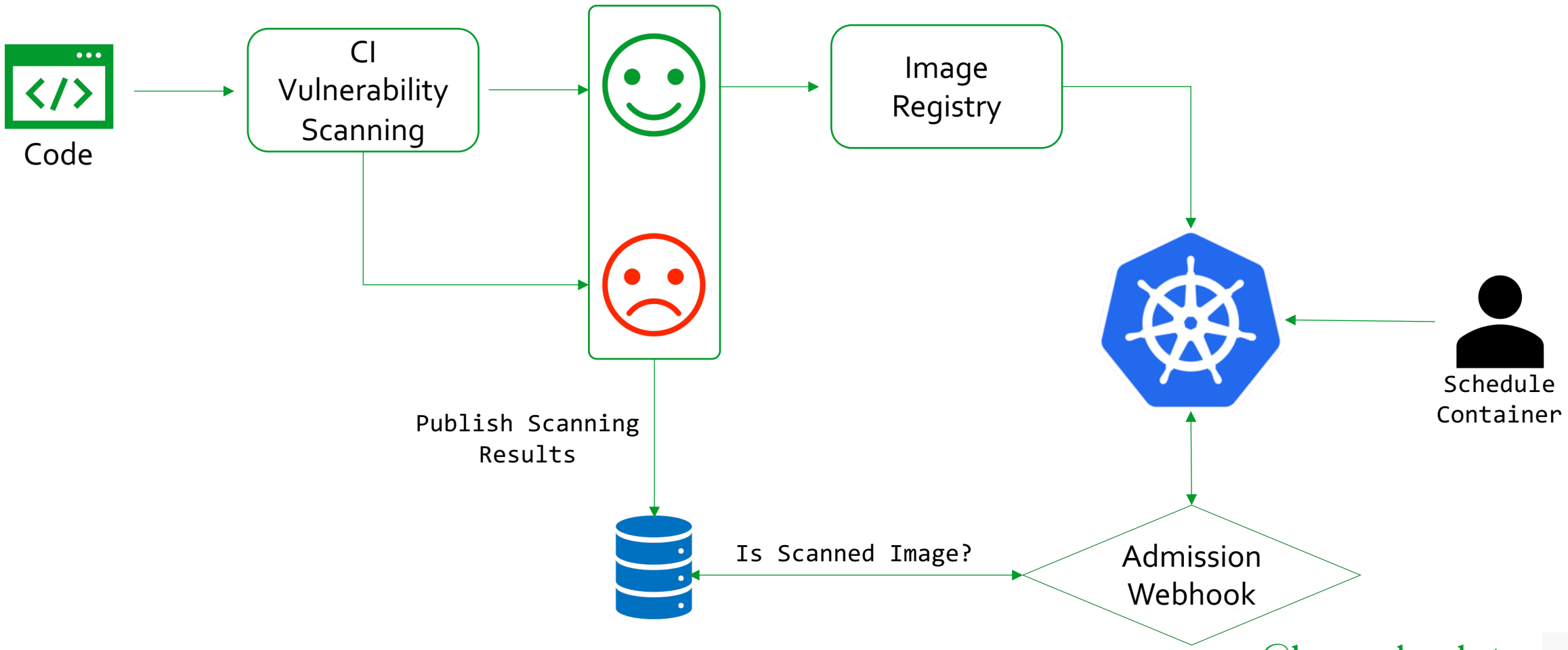
Trivy

```
➜  ~ trivy hossambarakat/k8s-security-webapp
2019-09-09T09:20:34.097+1000    INFO    Updating vulnerability database...
2019-09-09T09:20:35.024+1000    WARN    You should avoid using the :latest tag as it is cached. You need to specify '--clear-cache' option when :latest image is chan
2019-09-09T09:20:36.060+1000    INFO    Detecting Alpine vulnerabilities...

hossambarakat/k8s-security-webapp (alpine 3.9.4)
================================================
Total: 1 (UNKNOWN: 0, LOW: 0, MEDIUM: 0, HIGH: 1, CRITICAL: 0)

+---------+------------------+----------+-------------------+---------------+--------------------------------+
| LIBRARY | VULNERABILITY ID | SEVERITY | INSTALLED VERSION | FIXED VERSION |             TITLE              |
+---------+------------------+----------+-------------------+---------------+--------------------------------+
| musl    | CVE-2019-14697   | HIGH     | 1.1.20-r4         | 1.1.20-r5     | musl libc through 1.1.23       |
|         |                  |          |                   |               | has an x87 floating-point      |
|         |                  |          |                   |               | stack adjustment imbalance,    |
|         |                  |          |                   |               | related...                     |
+---------+------------------+----------+-------------------+---------------+--------------------------------+
➜  ~
```

Vulnerability Scanning CI Pipeline Integration

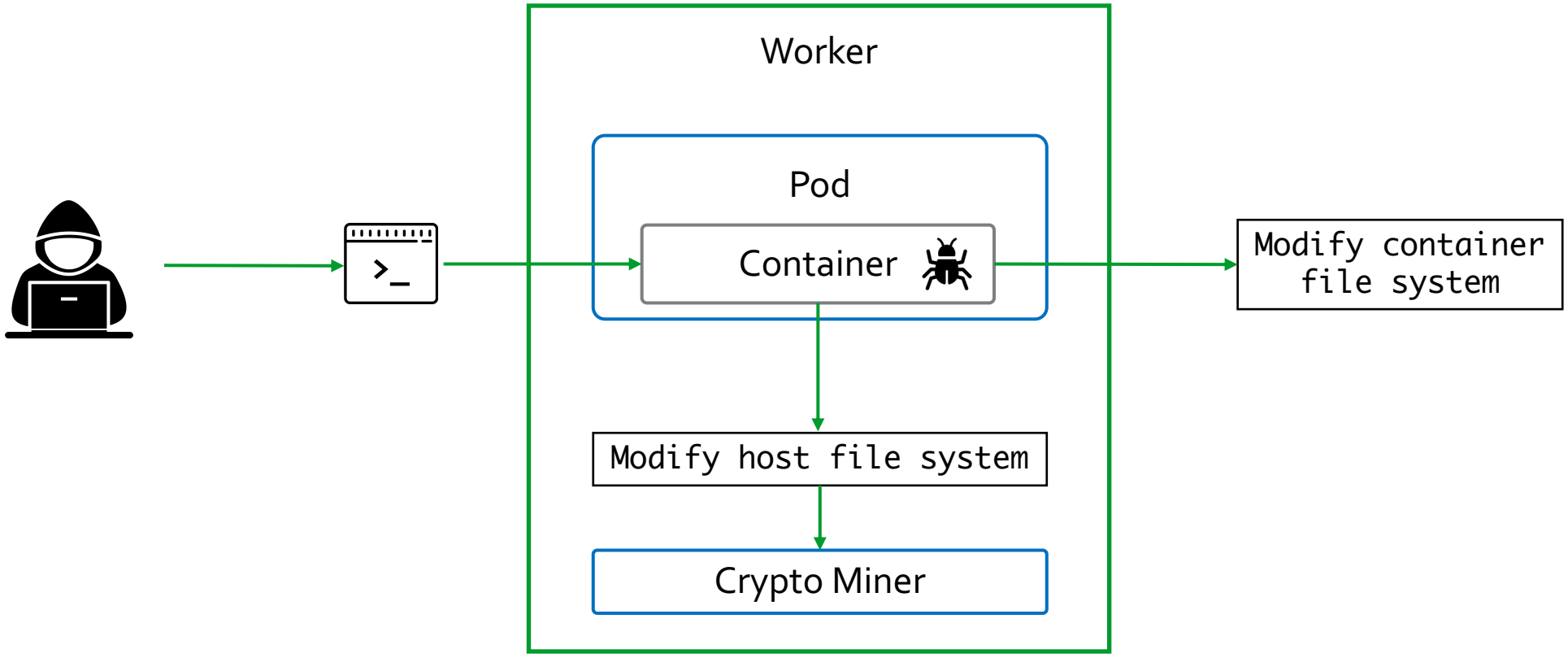


Vulnerability Scanning CI Pipeline Integration



Containers

Privilege Escalation



Hacker icon by karina from the Noun Project

Demo

Privilege Escalation

Security Context

- **RunAsUser**
- **RunAsGroup**

```
securityContext:
    runAsUser: 1000
    runAsGroup: 3000
```

Security Context

- **AllowPrivilegdeEscalation**

```
securityContext:
  allowPrivilegeEscalation: false
```

Security Context

- **ReadOnlyRootFilesystem**

```
securityContext:
  readOnlyRootFilesystem: true
```

Security Context

- RunAsUser
- RunAsGroup
- AllowPrivilegdeEscalation
- ReadOnlyRootFilesystem

```
apiVersion: v1
kind: Pod
metadata:
  name: my-app
spec:
  securityContext:
    runAsUser: 1000
    RunAsGroup: 2000
  containers:
  - name: my-app
    image: my-app
    securityContext:
      allowPrivilegeEscalation: false
      readOnlyRootFilesystem: true
```

Enter *Pod Security Policy*

Pod Security Policy

- A Pod Security Policy is a cluster-level resource that controls the actions that a pod can perform and what it has the ability to access.
- The **PodSecurityPolicy** objects define a set of conditions that a pod must run with in order to be accepted into the system.

Pod Security Policy

- privileged
- volumes
- fsGroup
- runAsUser, runAsGroup
- readOnlyRootFilesystem
- allowedHostPaths
- hostNetwork
- Linux capabilities

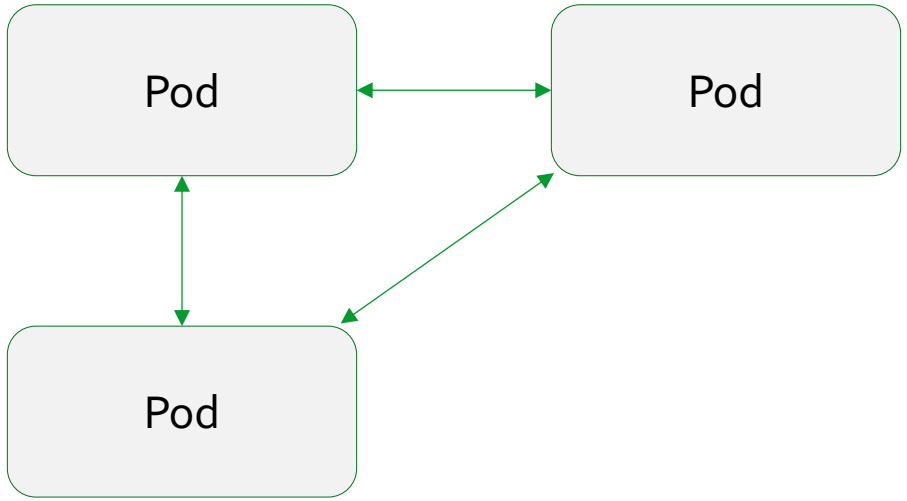
kube-psp-advisor

Command: `./kube-psp-advisor --namespace=psp-test`

```
apiVersion: policy/v1beta1
kind: PodSecurityPolicy
metadata:
  creationTimestamp: null
  name: pod-security-policy-20181130114734
spec:
  allowedCapabilities:
  - SYS_ADMIN
  - NET_ADMIN
  allowedHostPaths:
  - pathPrefix: /bin
  - pathPrefix: /tmp
  - pathPrefix: /usr/sbin
  - pathPrefix: /usr/bin
  fsGroup:
    rule: RunAsAny
  hostIPC: false
  hostNetwork: false
  hostPID: false
  privileged: true
  runAsUser:
    rule: RunAsAny
  seLinux:
    rule: RunAsAny
  supplementalGroups:
    rule: RunAsAny
  volumes:
  - hostPath
  - configMap
  - secret
```

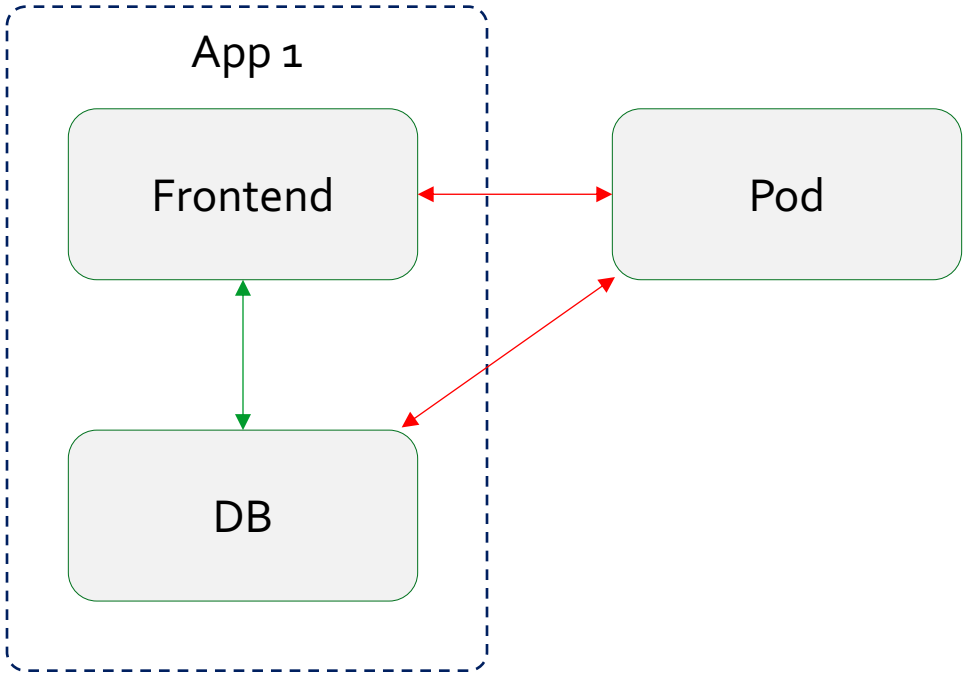
Network Communication

» All pods can communicate with each other



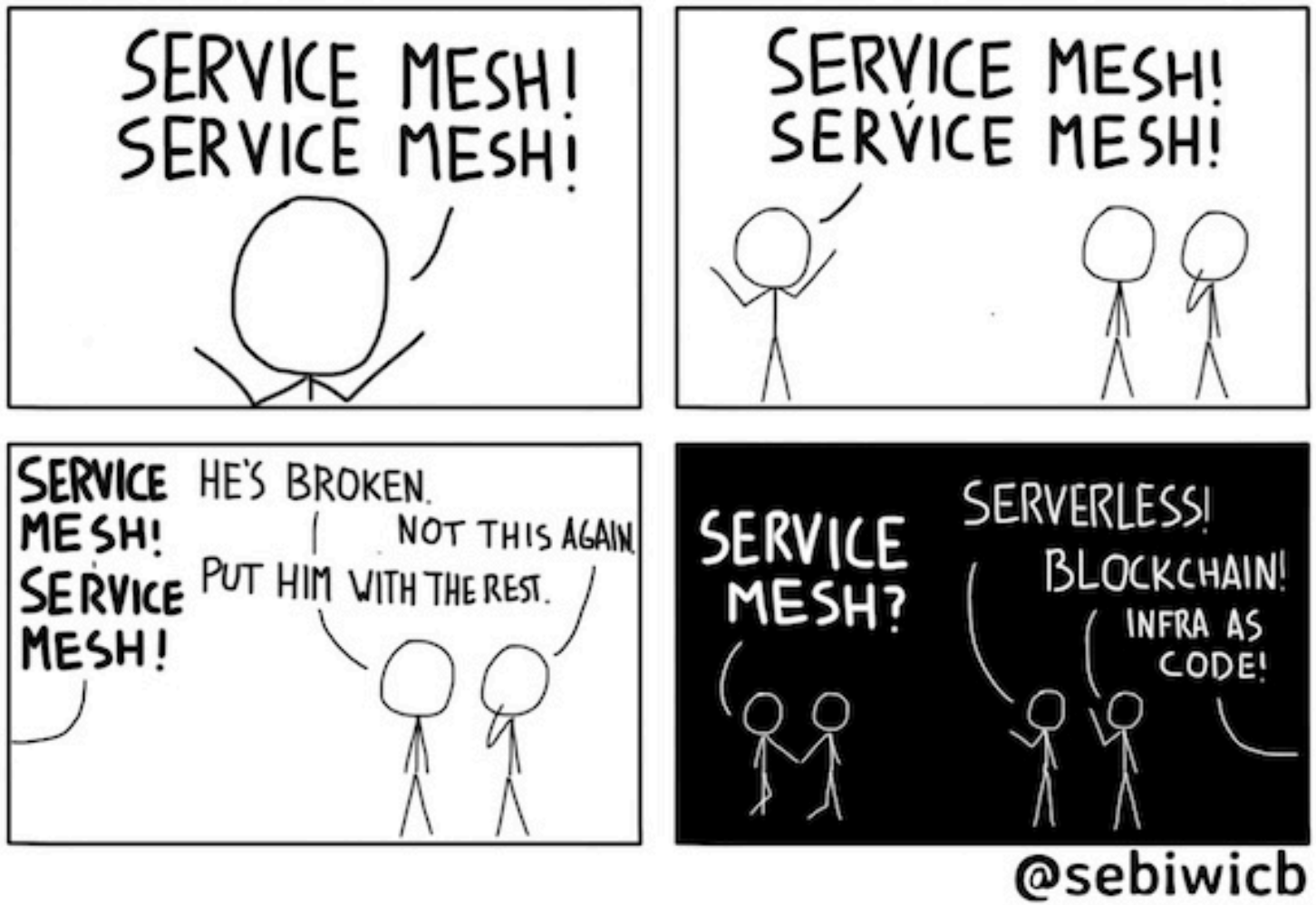
Network Communication

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: my-frontend-policy
spec:
  podSelector:
    matchLabels:
      app: db
  ingress:
  - from:
    - podSelector:
        matchLabels:
          app: frontend
```



Network Plugin

- Calico
- Cilium
- Kube-Router
- Weave Net
- ...


SERVICE MESH!
SERVICE MESH!
SERVICE MESH!
SERVICE MESH!
SERVICE MESH!
SERVICE MESH!
HE'S BROKEN.
NOT THIS AGAIN.
PUT HIM WITH THE REST.
SERVICE MESH?
SERVERLESS!
BLOCKCHAIN!
INFRA AS CODE!
@sebiwicb

Service Mesh

- Security specific policy enforcement
- End-to-end encryption
- Rolling certificates

Summary

Kubernetes Cluster

- Bootstrap TLS
- Authentication
- Enable RBAC
- CIS Benchmark

Container Images

- No root user
- Small images
- Do NOT use latest
- Private Image Registry
- Vulnerability Scans

Containers

- Pod Security Context
- Pod Security Policy
- Network Policy
- Service Mesh

Resources

- https://kubernetes-security.info
- Demos: http://github.com/hossambarakat/secure-k8s-containers

Questions?

#2019addo-devsecops

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Thank You

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