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# Certified Kubernetes Security Associate (KCSA) Crash Course

Curriculum February 2024

# About the Trainer

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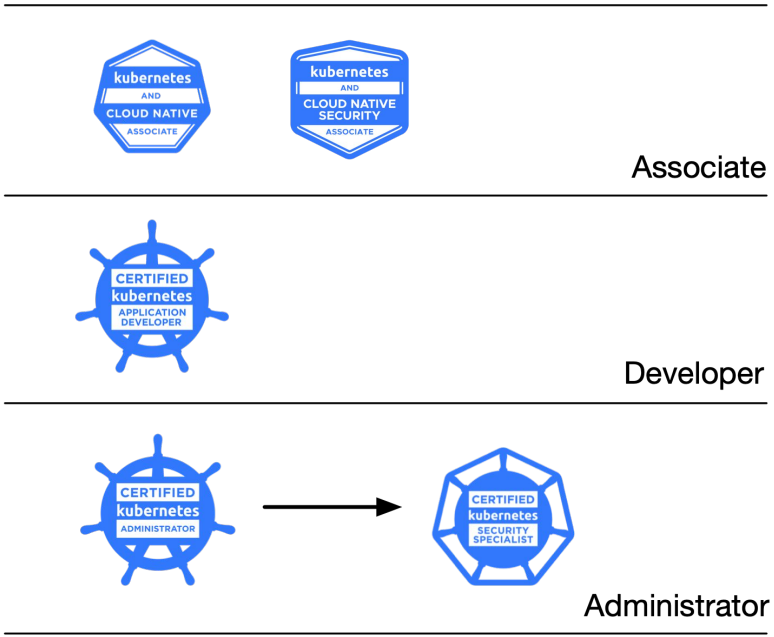
# Exam Objectives and Overview

# Kubernetes Certification Path

Entry level certifications for beginners, hands-on certification for practitioners




Entry Level

Practitioner

Practitioner

# Exam Objectives

"Understand baseline security aspects of Kubernetes and cloud-native apps"

- The certification program allows users to demonstrate their competence as part of a multiple-choice test.
- Test takers **do not** need to solve problems on a real Kubernetes cluster.
- Documentation is not going to be available during the exam.
- While you may think that this is a beginner-level certification from the name, it is **not**. Advanced knowledge is required to pass the exam.

# Exam Domains

High-level topics and their weight that contribute to the total score

| DOMAIN | WEIGHT |
| --- | --- |
| Overview of Cloud Native Security | 14% |
| Kubernetes Cluster Component Security | 22% |
| Kubernetes Security Fundamentals | 22% |
| Kubernetes Threat Model | 16% |
| Platform Security | 16% |
| Compliance and Security Frameworks | 10% |

# Curriculum Details

Each domain is broken up into subtopics (find the latest outline on GitHub)

### 14% - Overview of Cloud Native Security

- The 4Cs of Cloud Native Security
- Cloud Provider and Infrastructure Security
- Controls and Frameworks
- Isolation Techniques
- Artifact Repository and Image Security
- Workload and Application Code Security

### 22% - Kubernetes Cluster Component Security

- API Server
- Controller Manager
- Scheduler
- Kubelet
- Container Runtime
- KubeProxy
- Pod
- Etcd
- Container Networking
- Client Security
- Storage

### 22% - Kubernetes Security Fundamentals

- Pod Security Standards
- Pod Security Admissions
- Authentication
- Secrets
- Isolation and Segmentation
- Audit Logging
- Network Policy

### 16% - Platform Security

- Supply Chain Security
- Image Repository
- Observability
- Service Mesh
- PKI
- Connectivity
- Admission Control

### 16% - Kubernetes Threat Model

- Kubernetes Trust Boundaries and Data Flow
- Persistence
- Denial of Service
- Malicious Code Execution and Compromised Applications in Containers
- Attacker on the Network
- Access to Sensitive Data
- Privilege Escalation

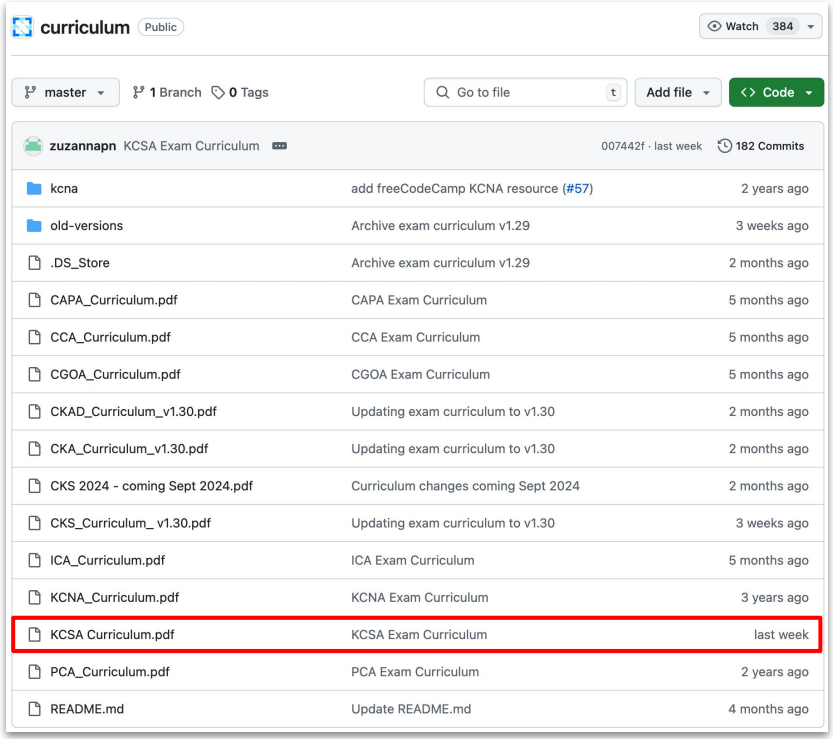
### 10% - Compliance and Security Frameworks

- Compliance Frameworks
- Threat Modeling Frameworks
- Supply Chain Compliance
- Automation and Tooling

Covered along the way as scenarios and examples

# Kubernetes Version Used in Exam

The curriculum file name does not indicate version, assume latest



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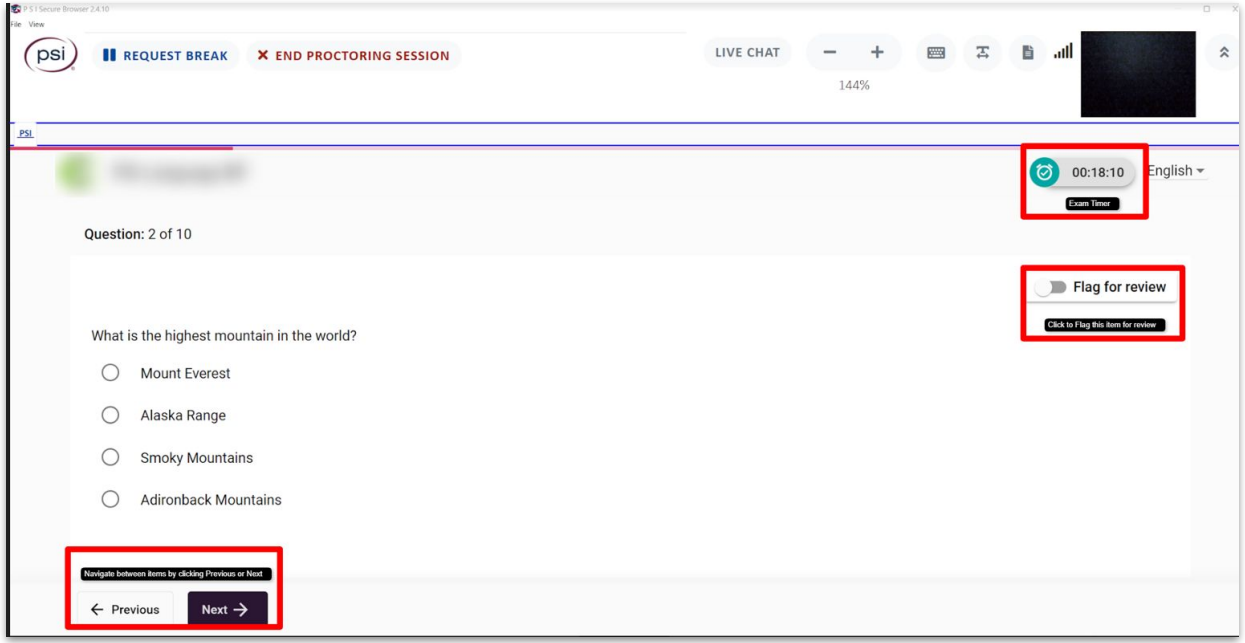
| KCNA_Curriculum.pdf | KCNA Exam Curriculum | 3 years ago |
| KCSA Curriculum.pdf | KCSA Exam Curriculum | last week |
| PCA_Curriculum.pdf | PCA Exam Curriculum | 2 years ago |
| README.md | Update README.md | 4 months ago |

# Exam Environment

PSI Remote desktop, single monitor, no bookmarks (announcement)



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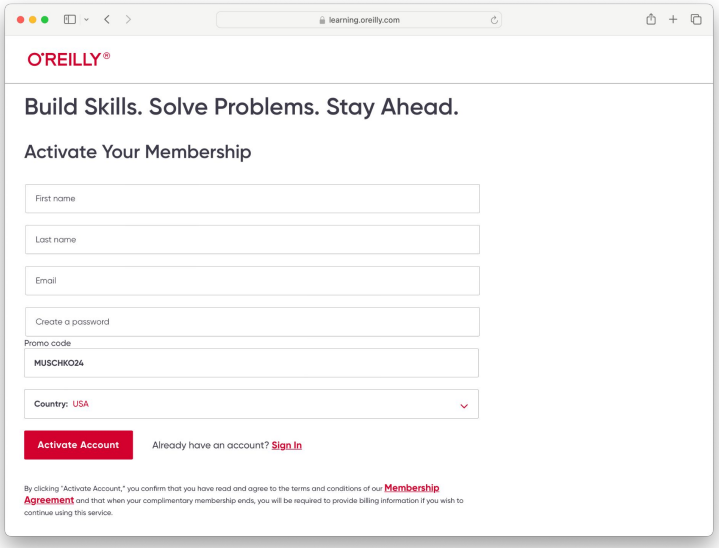


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# Preparing for the Exam

## Supplement theory with practice

- Read through online documentation for relevant topics
- Apply knowledge by getting hands-on with Kubernetes
- Pick the time you are most comfortable with, get enough sleep
- Take it easy on your first attempt, but give it your best effort

# Overview of Cloud Native Security

# Topics We'll Cover

## Cloud-native security features

- Overview
- Cloud providers and on-premise
- Established best practices

## 4Cs of cloud-native security

- The 4 layers
- Security practices for each layer

## Isolation techniques

- Cloud in general
- Kubernetes-specific

## Application/container image security

- Security aspects for code
- Security aspects for container images
- Artifact repositories
- Workload security

# Cloud Provider and Infrastructure Security

Definition and outlook

# Cloud Provider Security

## Many security features and tools are built-in

- Cloud providers like Amazon, Google, and Azure offer Kubernetes hosted in the cloud (EKS, GCP, and AKS).

- Each of the those cloud providers offer security features.
  - Runtime monitoring, e.g. Azure Security Center
  - Identity and access management, e.g. Amazon IAM
  - Container registry, e.g. Google Cloud Registry

- Many cloud providers offer service API endpoints. In most cases, you'll likely not want to expose those endpoints to the internet.

# Infrastructure Security

Guidelines for securing cluster nodes and components

- **Network access to the API server:** Only allow clients to interact with the cluster from within your company network. Set up firewall rules to prevent unauthorized access.

- **Network access to cluster nodes:** Control plane and worker nodes should not be accessible from the public internet. Only those ports should be open that are needed to operate the cluster plus NodePort and LoadBalancer ports.

- **Etcd encryption:** Data-at-rest should not be stored in plain text so that compromised data cannot be read.

- **Access to etcd:** Only the control plane node(s) should be able to access etcd.

# Controls and Frameworks

## Codified security best practices

- **Controls:** Codify security best practices developed by researchers and domain experts. Measures to be taken or avoided to prevent a security breach.

- **Frameworks:** A set of security guidelines, best practices, or standards. Fairly often, tools have been developed to execute the controls in an automated manner. An example of a framework in the Kubernetes space is the CIS Kubernetes Benchmarks.

# Common Security Frameworks

A wide range of options published by research organizations

- Center for Internet Security (CIS) Kubernetes Benchmark: A comprehensive guide for hardening Kubernetes environments.
- MITRE ATT&CK framework: A comprehensive knowledge base built on various hacking mechanisms and tactics based on real-world events.
- PCI DSS Compliance for Kubernetes: A compliance framework outlines the technical and operational requirements to enable security and data protection for the payment industry.
- NIST Application Container Security Framework: A risk management framework for containers and containerized environments.

# Security Framework Comparison

Automated tools can help with finding misconfiguration and security issues

| Security Frameworks | | | | | |
|---|---|---|---|---|---|
| | **CIS** | **MITRE** | **PCI DSS** | **NIST** | **NSA-CISA** |
| **GOAL** | Provide configuration benchmarks | Enumerate all real-world attack tactics, techniques, and procedures | Protect cardholder data | Issue guidelines for a risk management framework | Enable the hardening of Kubernetes Cluster |
| **WHEN TO USE** | Pre-production | In production | Development, testing, and production | Testing and vulnerability scanning | Pre-production |
| **FOCUS AREAS** | Auditing configuration management | Threat modeling | Access control, vulnerability management | Risk management | Configuration management |
| **HOW TO USE** | Compare CIS standards with system configuration | Use the prescribed techniques for pen tests and threat management | Use guidelines to create policies for data protection | Use the RMF to establish a baseline for security posture | Use example configurations of hardened clusters |
| **TOOLS** | Kubescape | Kubescape | Twistlock | NIST SRE Tools | Kubescape |

Source: https://www.armosec.io/blog/kubernetes-security-frameworks-and-guidance/

Quiz

# Security frameworks

# Exam Essentials

What to focus on for the exam

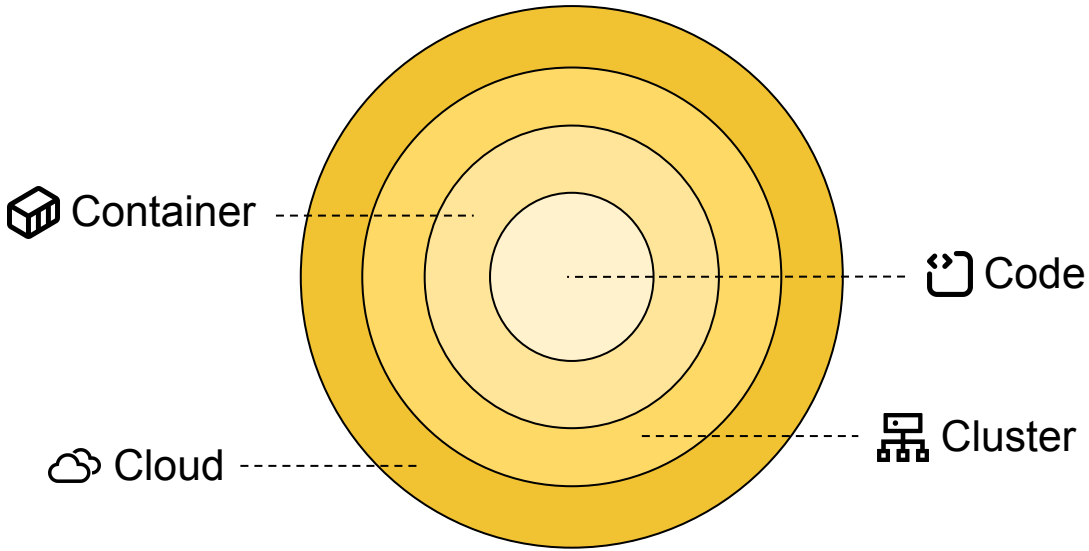
- Cluster components need to be secured by following best practices.
- Best practices have been established by research organizations in the form of security frameworks.
- Read up on common security frameworks and how they can help.

# The 4Cs of Cloud Native Security

Cloud, clusters, containers, and code

# The 4Cs

Each Layer is shielded from the others, and provides unique security capabilities



# The Cloud Layer

Layer includes on-prem and hybrid environments

- The trusted computing base of your Kubernetes cluster.
- If the cloud layer becomes vulnerable, no guarantees can be made about the security of components running on top of this layer.
- Default cloud settings may expose your cluster to outside world.

# Cloud Layer Security Best Practices

Requires experts to configure due to its complexity and variability

- Follow security best practices published by cloud providers to take security measures.
- **Networking:** Configure firewall rules, port access, and encryption.
- **Principle of least privilege:** Only provide access to human users and processes that need to have access. Deny access to anyone/anything else.

# The Cluster Layer

## Cluster components and networking

- Each cluster consists of control plane nodes and worker nodes.
- Control plane nodes and worker nodes run dedicated cluster components (e.g. API server, etcd).
- Secure cluster component settings are well documented (e.g. CIS benchmarks).
- Pod-to-Pod communication can be restricted (network policies) and encrypted (mTLS).

# Cluster Layer Security Best Practices

Typically the responsibility of the Kubernetes administrator

- Verify and adjust secure configuration of cluster components according to CIS benchmark criteria.
- **Authorization:** Only allow stakeholders permissions to cluster operations that they actually need via Role-based access control (RBAC).
- **Encryption:** Encrypt network communication to API server, and between Pods. Encrypt data at rest in etcd (e.g. Secret data).
- **Networking:** Close unnecessary ports.

# The Container Layer

## Containerized workload executed in Kubernetes

- The central Kubernetes resource for executing processes and applications in a container is the Pod.
- A Pod can run a single container (the default) or multiple containers if you need helper functionality.
- The container image should follow best practices when built. Pods can be configured to apply security measures.

# Container Layer Best Practices

Primary responsibility of application developers with governance of admins

- Every container image is built from a base image. The smaller the image and the less functionality included, the smaller the potential security risk. Distroless container images do not provide a shell. Sign container images to ensure their authenticity and integrity.

- Automated tools, e.g. Trivy, Snyk, can help find known security vulnerabilities before they are consumed. Use them as part of your development and automated delivery process.

- Configure Pods with security in mind. For example, do not run the container with the root user, make container immutable (configurable via security context), and govern the creation of Pods via Pod Security Standards rules.

# The Code Layer

## Application implementation written by developers

- Every program starts with the source code used to build it.
- Business application code usually incorporates dependencies in the form of reusable libraries, or external services.
- On the code layer, security issues can arise due to vulnerabilities in dependencies, leaking credentials, or insecure coding practices that allow cross-site scripting or SQL injection.

# Code Layer Best Practices

Responsibility of application developers and their team

- Involve and enforce a code review process (e.g. as part of a pull request) by experienced peers to identify and correct poor coding practices.
- Employ security scanning tools incorporated in automated CI process to detect vulnerabilities.
- Manual QA process: Try to find security holes that feel through the cracks via acceptance testing by humans.

# Exam Essentials

What to focus on for the exam

- The 4Cs of cloud native security cover the layers cloud, clusters, containers, and code.
- The layers build on top of one another. Compromised security on a higher layer is a trickle down effect on lower level layers.
- Each layer can implement its own security aspects.

# Isolation Techniques

Categories supported by Kubernetes

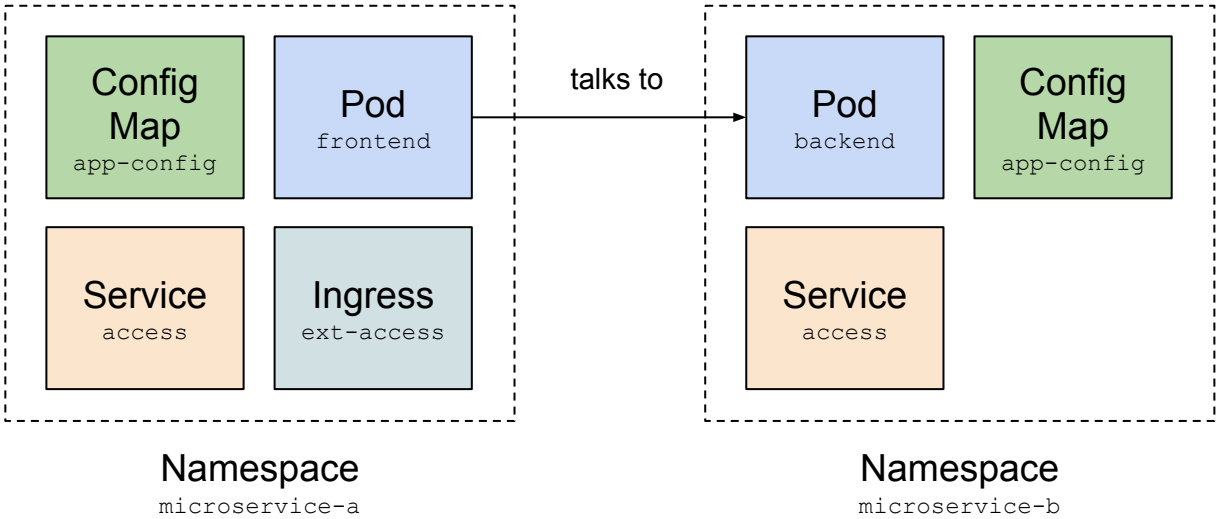
# Kubernetes Isolation Techniques

## Built-in capabilities

| Type | Description |
| --- | --- |
| Namespace | Logical separation of objects into named buckets |
| Role-based access control (RBAC) | Authorization concerns - “Who’s allowed to do what within the cluster?” |
| Network Policies | “Firewall rules” for Pod-to-Pod communication |
| Policy Enforcement | Enforces security settings for data sent with an API request via core Kubernetes concepts or Kubernetes extension mechanism |

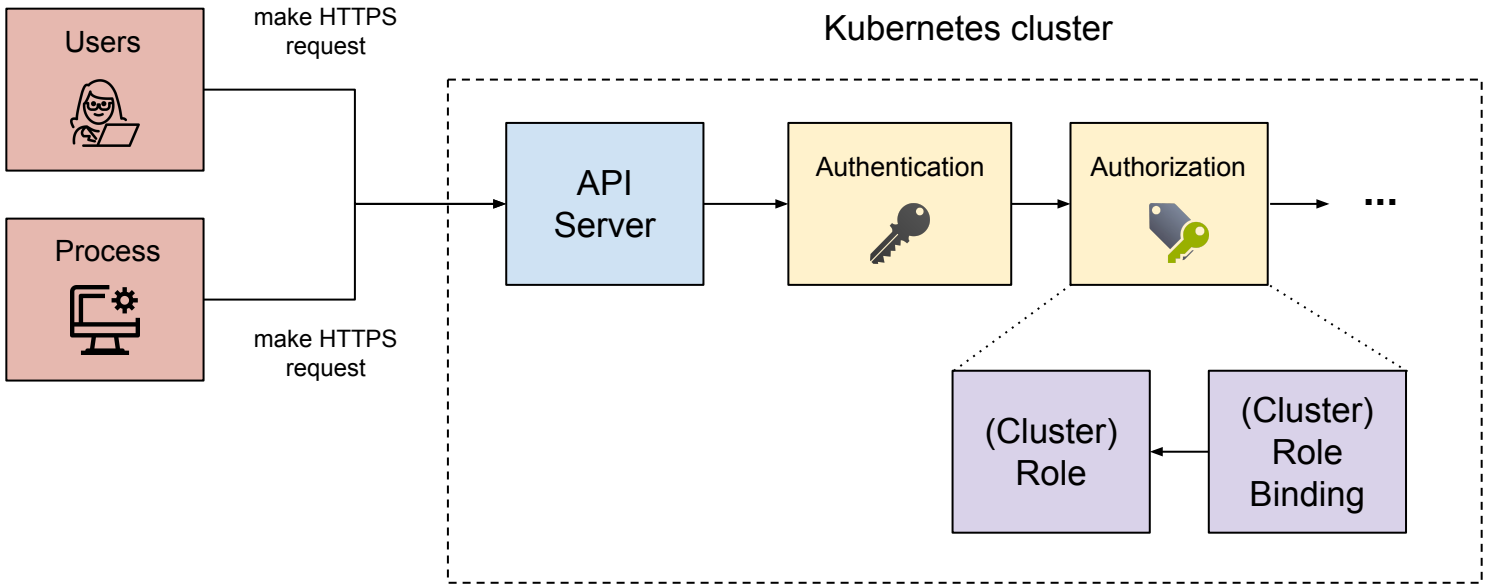
# Namespace

Isolates Kubernetes objects logically



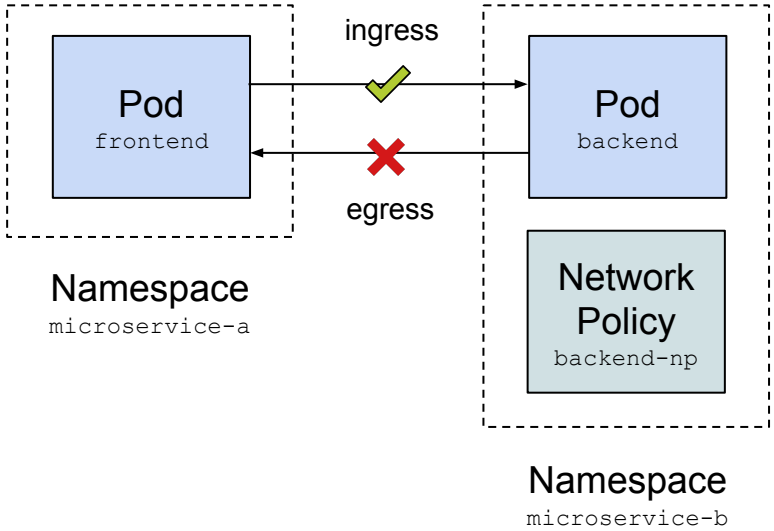
# Role-Based Access Control (RBAC)

Defines permissions for authenticated users and processes



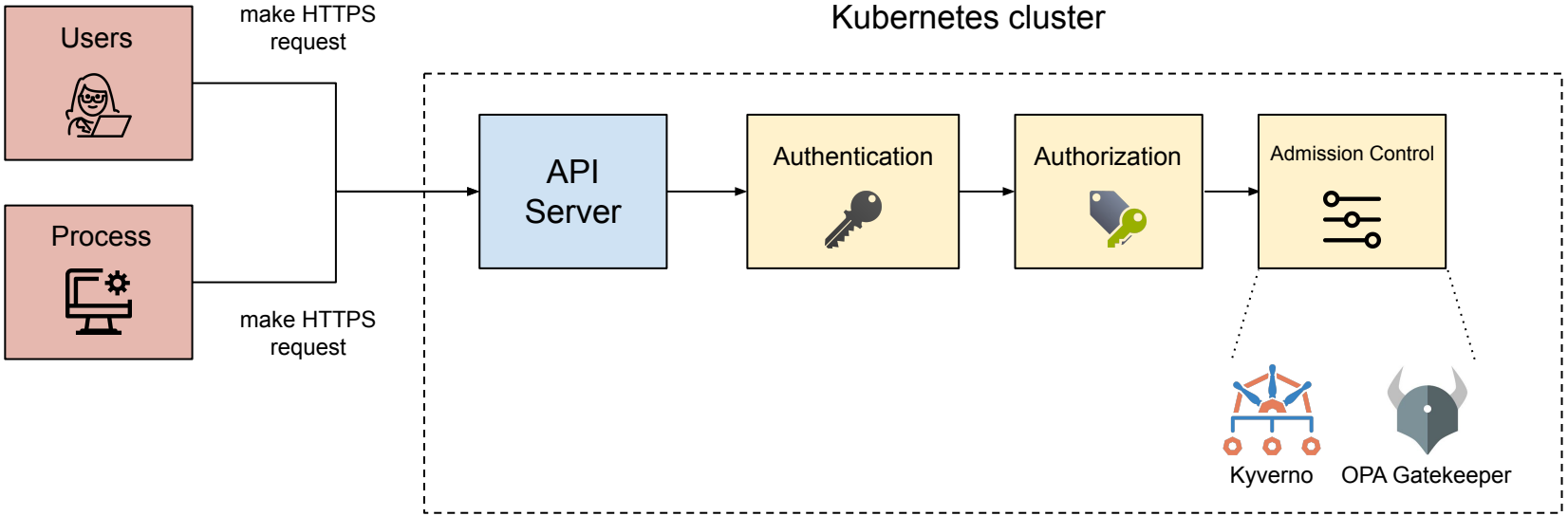
# Network Policies

By default, Pod-to-Pod network communication is not restricted



# Policy Enforcement

Admission Controllers can reject or manipulate configuration sent with request



# Exam Essentials

What to focus on for the exam

- Kubernetes offers isolation techniques with built-in capabilities.
- Each capability addresses a different concern.
- You will not need to understand all capabilities in details. Understand their purpose and how they enforce isolation.

# Artifact Repository and Image Security

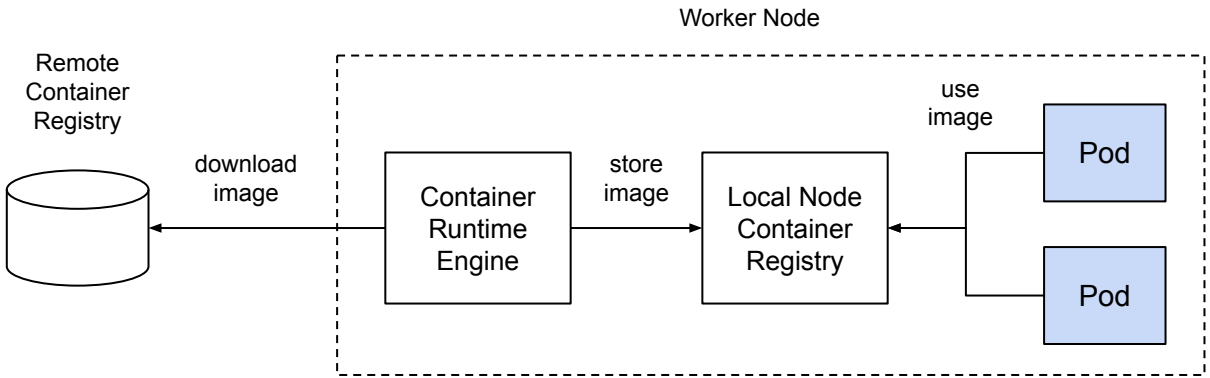
Controlling container image storage and vulnerability scanning

# Artifact Repositories

## Remote container image storage location

- Application developers build container images and share them for consumption in an artifact repository.

- Examples for artifact repositories are Docker Hub, Google Cloud Registry (GCR), Amazon Elastic Container Registry (ECR), and JFrog Artifactory.



# Using Private Artifact Repositories

Do not use public artifact repositories to safeguard from potential security risks

- To ensure that container images aren't tampered with, you should host a private artifact repository for your company-internal container images.

- You can configure Kubernetes to only pull images from private artifact repositories. Tools like Kyverno and OPA Gatekeeper can further govern the behavior.

# Container Image Security

## Consumers shouldn’t blindly use container images

- Container images, their base image, and used dependencies can contain security vulnerabilities.
- Commercial artifact repositories provide built-in feature for scanning container images to detect known vulnerabilities published in CVE database.
- You can prevent consumers from pulling container images containing detected vulnerabilities based on CVSS score.

# Exam Essentials

What to focus on for the exam

- Artifact repositories can host container images as one of its supported artifact types.
- Do not rely on public artifact repositories. Use one that is internal to your company which helps with controlling access management, security, and versioning.
- Container images can contain security vulnerabilities. Scan existing images for vulnerabilities and prevent access to them if they contain critical issues.

# Workload and Application Code Security

Runtime and code security

# Workload vs. Application Code Security

Runtime security and the code executed by the runtime

- **Workload security:** Configuring and maintaining monitoring, logging, and networking tools to ensure workload security. For example, you will want to enable audit logging in your cluster, and employ monitoring tools like Falco to watch for abnormal behavior, potential security threats, and compliance violations in containers by inspecting kernel events.

- **Application code security:** This security concern is less about Kubernetes itself. It focuses on security best practices used by the code itself. You will want to employ automated tools scanning for issues as part of your delivery process even before the container image is built and beyond.

# Application Code & Workload Security

## Automated scanning tools can help a lot

- **Scan the application code:** Use code reviews and run automated security tools like SonarQube.
- **Scan the container image:** Run automated tools like JFrog XRay to find vulnerabilities and configuration issues.
- **Scan Pod configuration:** Ensure that containers stick to principle of least privilege via tools by inspecting manifests via tools like Kubesec.
- **Only allow required operations:** Pods running processes that need to interact with the Kubernetes API need to restricted by RBAC bound to the assigned ServiceAccount.

# Exam Essentials

What to focus on for the exam

- Security already starts on the level of application code. Make security an important part of the development process.
- Become familiar with techniques for building container images (e.g. choosing a small base image, multi-stage builds).
- Implement container image scanning for vulnerabilities by using automated scanning tools.

# Kubernetes Cluster Component Security

# Topics We'll Cover

## High-level architecture

- Overview
- Node types
- Cluster components

## Securing cluster components

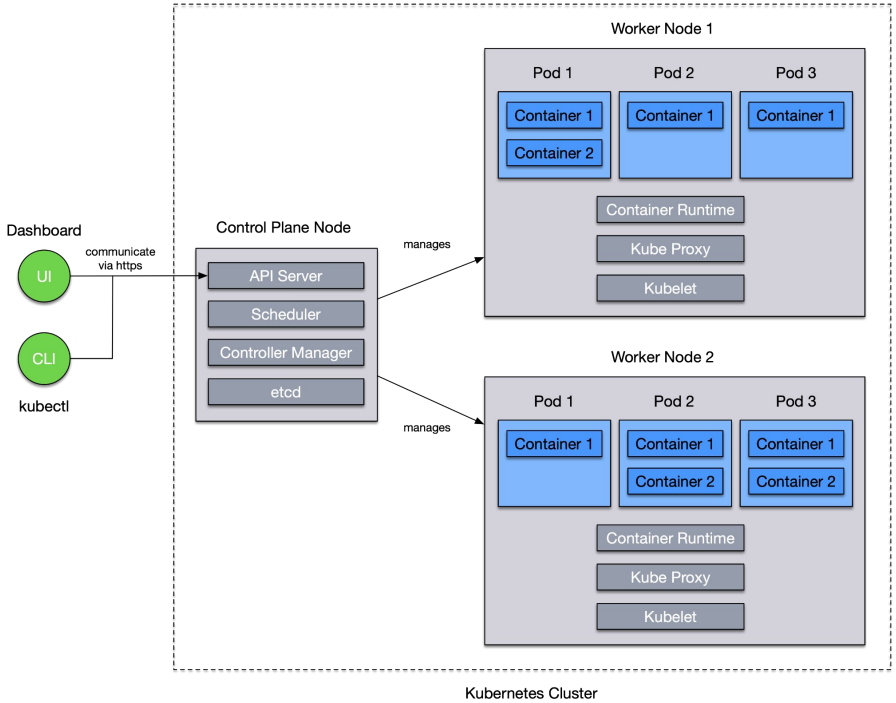
- Responsibility of components
- How to secure the components

## Securing workload

- Pod security settings
- Container networking
- Storage security

# Kubernetes Architecture

## Cluster components in control plane node and worker nodes



# Scanning Cluster Component Configuration

Use automation tools to identify deficiencies and fix them

- Research organizations publish recommendations for cluster configuration. The most prominent example is the CIS Kubernetes benchmark.

- You can use the tool kube-bench to check Kubernetes cluster components against the CIS Benchmark best practices in an automated fashion.

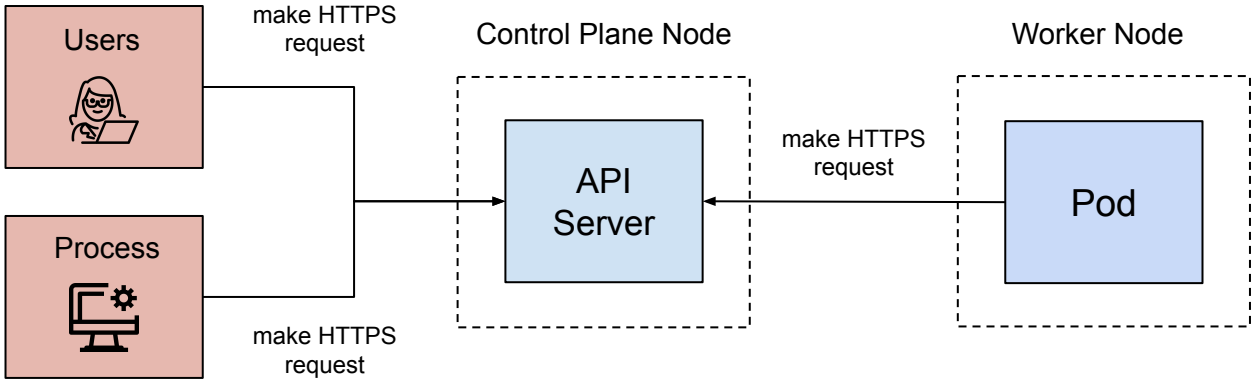
```
[INFO] 1 Master Node Security Configuration
[INFO] 1.1 API Server
[FAIL] 1.1.1 Ensure that the --allow-privileged argument is set to false (Scored)
[FAIL] 1.1.2 Ensure that the --anonymous-auth argument is set to false (Scored)
[PASS] 1.1.3 Ensure that the --basic-auth-file argument is not set (Scored)
[PASS] 1.1.4 Ensure that the --insecure-allow-any-token argument is not set (Scored)
[FAIL] 1.1.5 Ensure that the --kubelet-https argument is set to true (Scored)
[PASS] 1.1.6 Ensure that the --insecure-bind-address argument is not set (Scored)
[PASS] 1.1.7 Ensure that the --insecure-port argument is set to 0 (Scored)
[PASS] 1.1.8 Ensure that the --secure-port argument is not set to 0 (Scored)
[FAIL] 1.1.9 Ensure that the --profiling argument is set to false (Scored)
[FAIL] 1.1.10 Ensure that the --repair-malformed-updates argument is set to false (Scored)
[PASS] 1.1.11 Ensure that the admission control policy is not set to AlwaysAdmit (Scored)
[FAIL] 1.1.12 Ensure that the admission control policy is set to AlwaysPullImages (Scored)
[FAIL] 1.1.13 Ensure that the admission control policy is set to DenyEscalatingExec (Scored)
[FAIL] 1.1.14 Ensure that the admission control policy is set to SecurityContextDeny (Scored)
[PASS] 1.1.15 Ensure that the admission control policy is set to NamespaceLifecycle (Scored)
[FAIL] 1.1.16 Ensure that the --audit-log-path argument is set as appropriate (Scored)
[FAIL] 1.1.17 Ensure that the --audit-log-maxage argument is set to 30 or as appropriate (Scored)
[FAIL] 1.1.18 Ensure that the --audit-log-maxbackup argument is set to 10 or as appropriate (Scored)
[FAIL] 1.1.19 Ensure that the --audit-log-maxsize argument is set to 100 or as appropriate (Scored)
[PASS] 1.1.20 Ensure that the --authorization-mode argument is not set to AlwaysAllow (Scored)
[PASS] 1.1.21 Ensure that the --token-auth-file parameter is not set (Scored)
[FAIL] 1.1.22 Ensure that the --kubelet-certificate-authority argument is set as appropriate (Scored)
```

# API Server

Securing the cluster component

# API Server

Exposes the API endpoints clients use to communicate with cluster



# Securing the API Server

## Configurable in dedicated configuration file

- The `kube-apiserver` process running in a Pod allows for configuring a variety of security-related settings.
- Configurable through the file `/etc/kubernetes/manifests/kube-apiserver.yaml` on control plane node.
- **Configuration example:** “Make sure that anonymous requests to the secure port of the API server are disabled by setting `--anonymous-auth` to `false`.”
- Automatically restarts the API server Pod in the `kube-system` namespaces after making a change to configuration file.

# Demo

## Configuring kube-bench suggestion in API server

https://learning.oreilly.com/interactive-lab/fixing-issues-discovered/9781098149659/

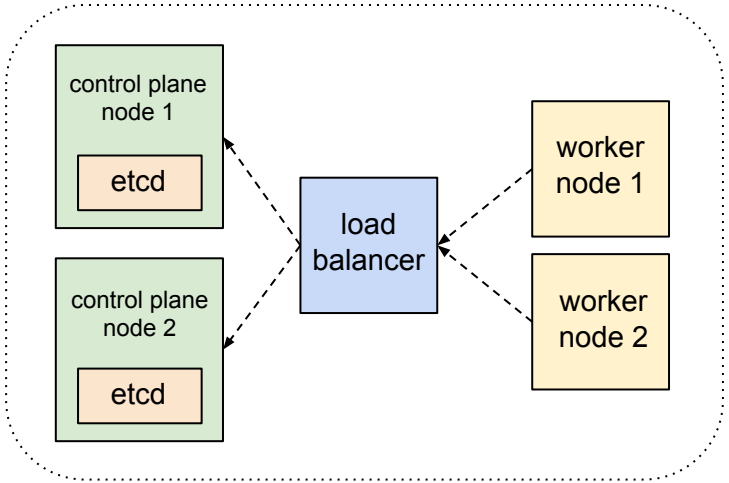
# Etcd

Securing the cluster component

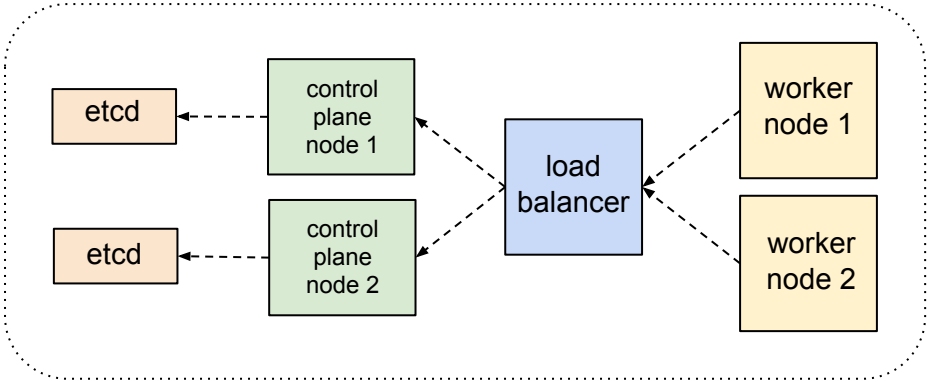
# Etcd

Persists the cluster state in plain-text

## Stacked etcd topology




## External etcd topology




Detailed installation instructions

# Securing Etcd

## Configurable in dedicated configuration file

- The `etcd` process allows for configuring a variety of security-related settings.
- Configurable through the file `/etc/kubernetes/manifests/etcd.yaml`on the host that runs etcd.
- **Configuration example:** “Ensure TLS communication with flags like `--cert-file`, `--key-file`, `--client-cert-auth`, and `--trusted-ca-file`.”

# Encrypting and Backing Up Etcd Data

Stored in plain-text by default

- Sensitive data like Secrets stored in etcd should be encrypted. You'd do so by assigning the encryption configuration via the API server configuration flag `--encryption-provider-config`

- Alternatively, you can integrate external secrets manager like HashiCorp Vault or AWS Secrets Manager using the External Secrets Operator.

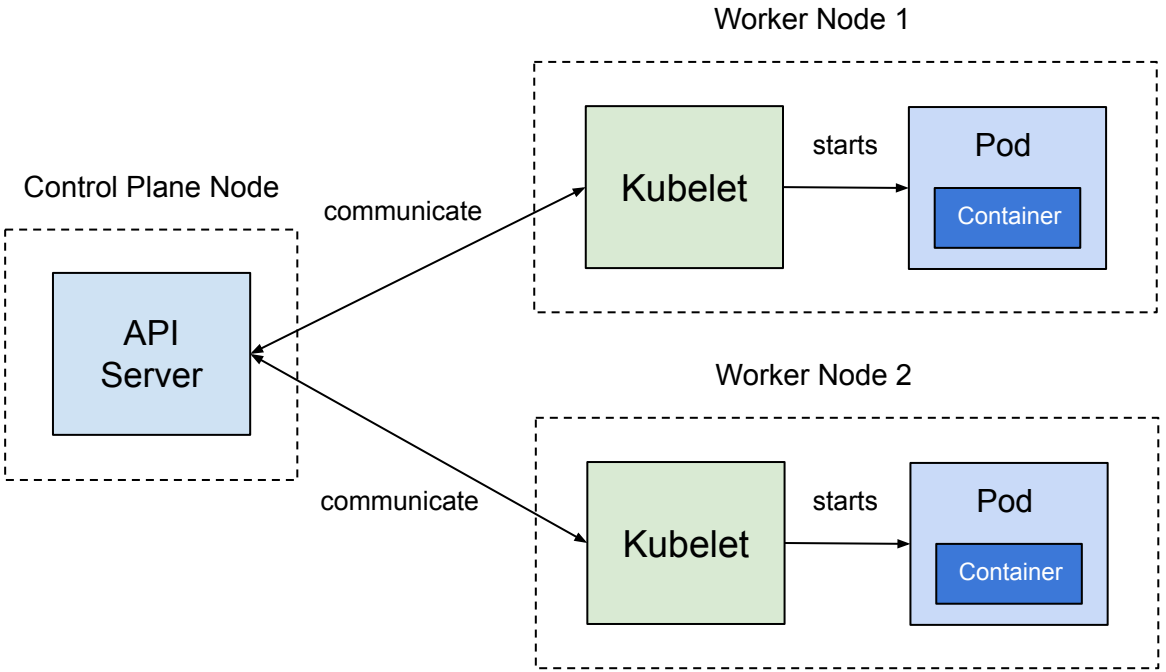
- Make sure to back up etcd periodically in case the data gets compromised or corrupted. One way to do this is with the help of `etcdctl`.

# Kubelet

Securing the cluster component

# Kubelet

Manages and coordinates Pods and nodes



# Securing the Kubelet

## Configurable in dedicated configuration file

- The `kubelet` process allows for configuring a variety of security-related settings.
- Configurable through the file `/var/lib/kubelet/config.yaml` on the node that runs a kubelet Pod.
- **Configuration example:** “Set `--authorization` mode to a value other than `AlwaysAllow` to verify that requests are authorized.”

# Workload

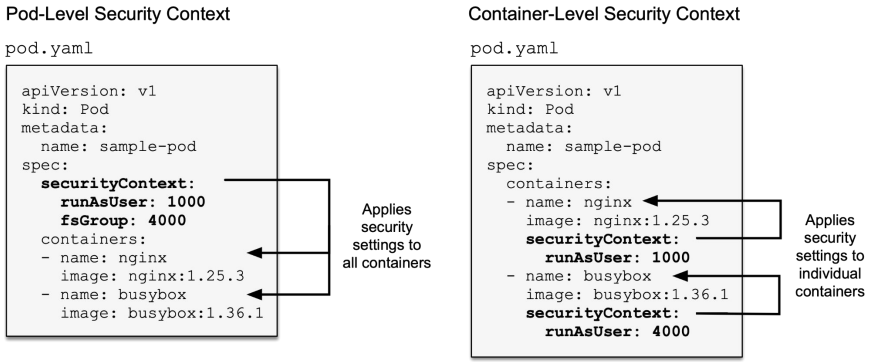
Securing Pods, network communication, and storage

# Securing Pods

## Securing settings are available through the Pod spec

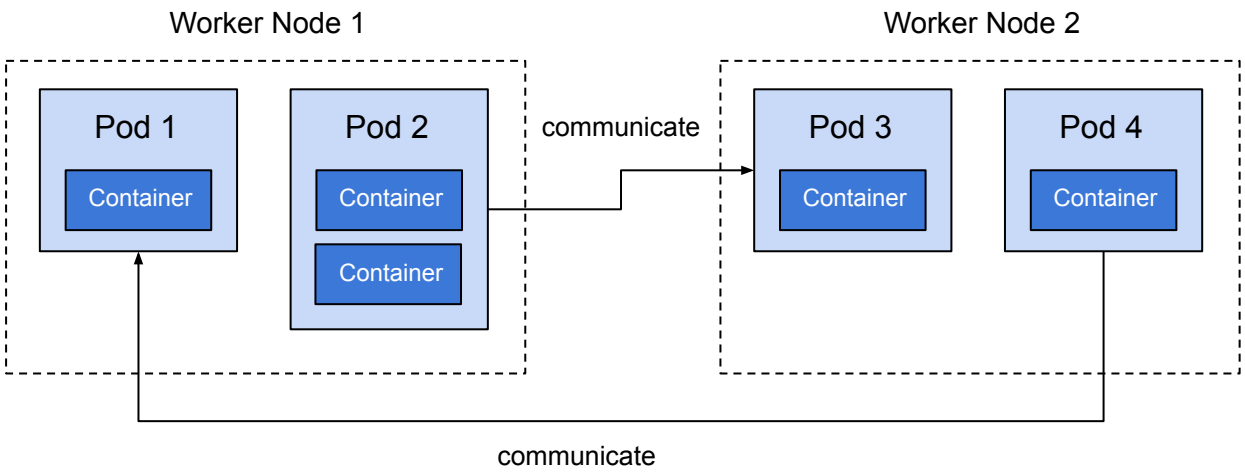
- The Pod spec offers the security context concept to enforce access and privilege control.

- **Configuration example:** “Set the `runAsNonRoot` attribute to `true` to prevent executing the container with the root user.”



# Pods

Runs an application or process inside of one or many containers



# Securing Pod-to-Pod Communication

CNI assigns virtual IP address to Pods and doesn't restrict communication

- A Network Policy defines ingress and egress traffic for Pods. You can also restrict access to ports with Network Policy rules.

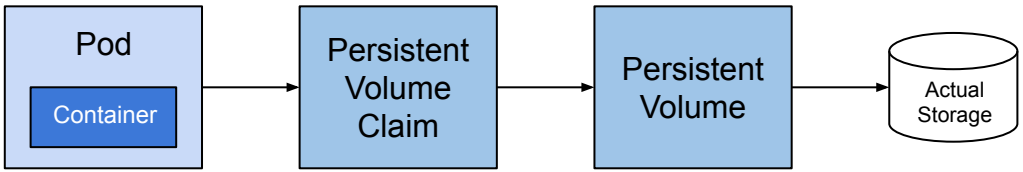
- **Configuration example:** "The `frontend` Pod should be allowed to talk to the `backend` Pod on port 8080. All other network traffic should be denied."

# Securing Storage

Volumes can be mounted to containers to provide persistent data storage

- The Persistent Volume is a primitive that allows for storing data beyond a Pod, node, or even cluster restart.

- Data is usually stored unencrypted. Make sure to back up data in case you need to restore it. Encrypt the data to prevent intruders from reading sensitive information.



# Quiz

## Etcd

# Exam Essentials

What to focus on for the exam

- Understand the role of each cluster component and know how to configure them. I would recommend reading through the configuration options as well.
- Certain cluster components need to talk to each other. You will have to understand how to secure the network communication between them.
- Dive deeper into how etcd stores data and how to configure encryption of data-at-rest.
- Learn about Pod spec security options like the security context, as well as privilege mode, and access to the host namespace.

# Kubernetes Security Fundamentals

# Topics We'll Cover

## Pod Security Standards and Admission

- Overview
- Policy profiles
- Governing Pod security settings

## Authentication and Authorization

- Overview
- Authentication with `kubectl`
- High-level RBAC

## Secrets and Network Policies

- Defining and consuming sensitive configuration data
- Restricting Pod-to-Pod communication

## Audit Logging

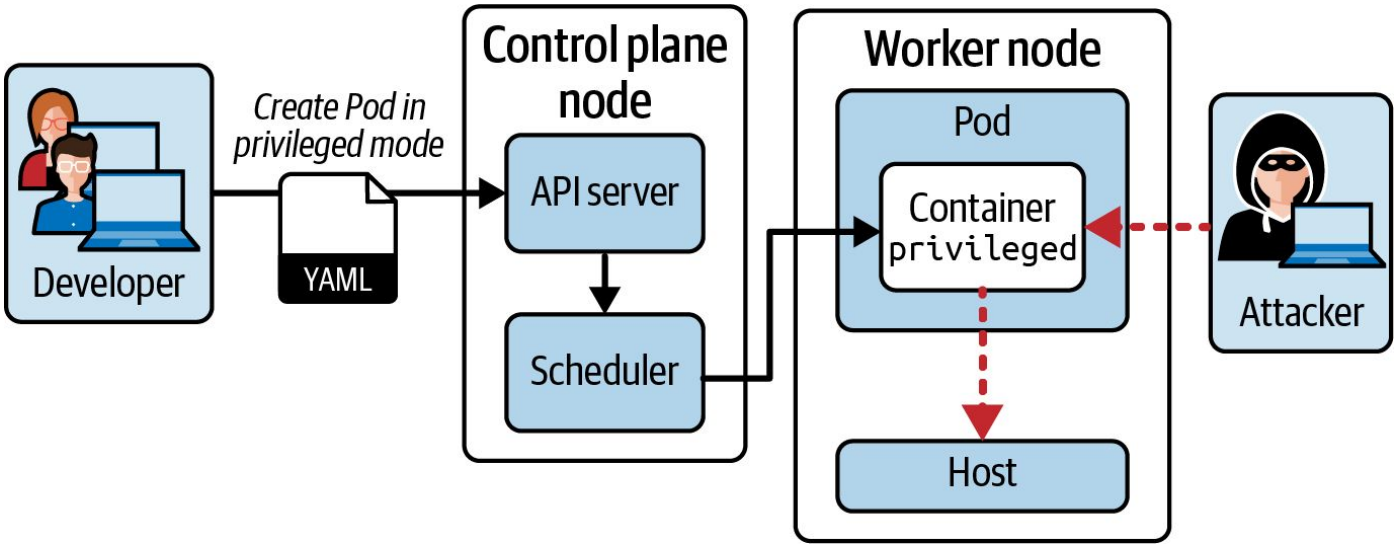
- Information captured by audit logging
- Configuring audit logging
- Example audit logging output

# Pod Security Standards and Admission

Governing Pod security settings

# Why Pod Security Standards?

Governing poor security practices in Pods



# Pod Security Standard (PSS)

Pod-specific security policies

- A PSS defines a range of security policies from highly restrictive to highly permissive.
- Most security policies describe desired security context configurations applicable to Pods.
- The different levels of policies help with gradually introducing security standards within an organization without being too disruptive.

# Policy Profiles

What level of security standards do you want to apply?

| Profile | Description |
| --- | --- |
| `privileged` | Fully unrestricted policy. |
| `baseline` | Minimally restrictive policy that covers crucial standards. |
| `restricted` | Heavily restricted policy following best practices for hardening Pods from a security perspective. |

The Kubernetes documentation describe the settings per level in more detail.

# Pod Security Admission (PSA)

A admission controller that governs Pods upon creation

- The PSA determines which Pod Security Standard (PSS) to follow.
- It does so by assigning the desired PSS to a namespace and the runtime treatment for Pods created in the namespace if they don't follow the standards.

> **Removed feature**
>
> PodSecurityPolicy was deprecated in Kubernetes v1.21, and removed from Kubernetes in v1.25.

# PSA Modes

## How should a violation be handled

| Profile | Description |
| --- | --- |
| `enforce` | Violations will cause the Pod to be rejected. |
| `audit` | Pod creation will be allowed. Violations will be appended to the audit log. |
| `warn` | Pod creation will be allowed. Violations will be rendered on the console. |

# Pod Security Admission (PSA)

A admission controller that governs Pods upon creation

- The PSA functionality is enabled by default.
- As a developer, you just have to assign a reserved label to the namespace for the PSA to kick in.

```yaml
apiVersion: v1
kind: Namespace
metadata:
  name: psa
  labels:
    pod-security.kubernetes.io/enforce: restricted
```

Reserved label | Mode | Policy profile

# A Pod Violating Security Standards

Does not define the expected security context configuration

```yaml
apiVersion: v1
kind: Pod
metadata:
  name: busybox
  namespace: psa
spec:
  containers:
  - image: busybox:1.35.0
    name: busybox
    command: ["sh", "-c", "sleep 1h"]
```

# A Pod Violating Security Standards

Error message is rendered, Pod creation is denied

```
$ kubectl create -f psa-namespace.yaml
namespace/psa created
$ kubectl apply -f psa-violating-pod.yaml
Error from server (Forbidden): error when creating "psa-pod.yaml": pods \
"busybox" is forbidden: violates PodSecurity "restricted:latest": \
allowPrivilegeEscalation != false (container "busybox" must set \
securityContext.allowPrivilegeEscalation=false), unrestricted \
capabilities (container "busybox" must set securityContext. \
capabilities.drop=["ALL"]), runAsNonRoot != true (pod or container \
"busybox" must set securityContext.runAsNonRoot=true), seccompProfile \
(pod or container "busybox" must set securityContext.seccompProfile. \
type to "RuntimeDefault" or "Localhost")
$ kubectl get pod -n psa
No resources found in psa namespace.
```

Demo

# Enforcing a Pod Security Standard

https://learning.oreilly.com/interactive-lab/creating-a-pod/9781098149871/

# Exam Essentials

What to focus on for the exam

- Pod Security Standards define best practice security settings for Pods. Introduce them gradually to avoid disrupting workload.

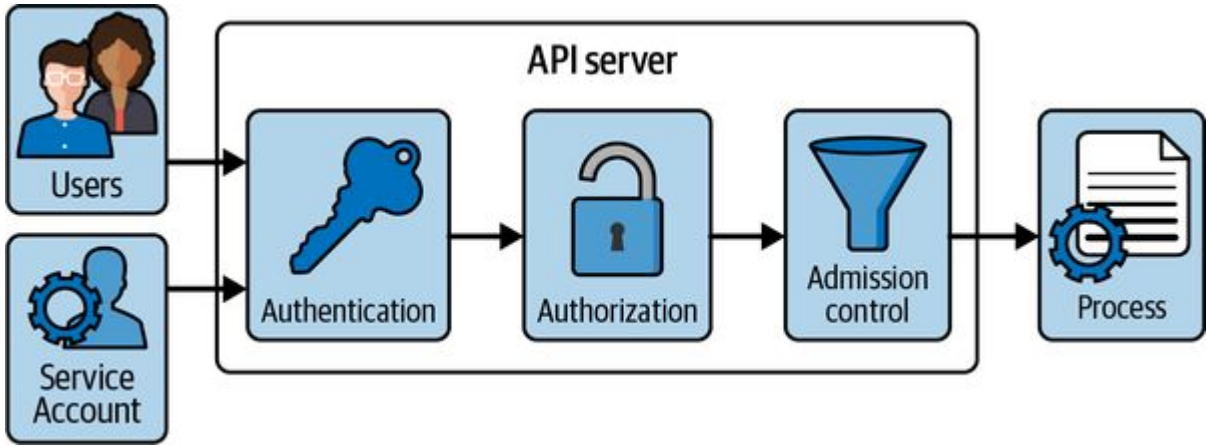
- Read up on the different levels for Pod Security Standards in the Kubernetes documentation and what security settings they apply.

# Authentication and Authorization

Processing a request to the Kubernetes API

# Processing a Request to the Kubernetes API

Multi-phases approach which includes authentication and authorization



# Why Authentication and Authorization?

Prevent authorized access to cluster operations

- **Authentication:** Authentication validates the identity of the caller by inspecting the client certificates or bearer tokens. If the bearer token is associated with a service account, then it will be verified here.

  *Prevent anonymous requests and only allow identifies with proper credentials.*

- **Authorization:** Verifies if authenticated client should be allowed to execute requested operation via RBAC. For example, is the request allowed to list Pods or create a new Service object.

  *Do not allow any authenticated client to run all operations.*

# Authentication

## User management + credentials

- User management is handled by the cluster administrator. The administrator creates a user representing the developer and hands the relevant information (username and credentials) to the human wanting to interact with the cluster via `kubectl`.

- Alternatively, it is also possible to integrate with external identity providers for authentication purposes, e.g., via OpenID Connect.

# Authenticating with kubectl

Command line tool automatically sends credentials with every request

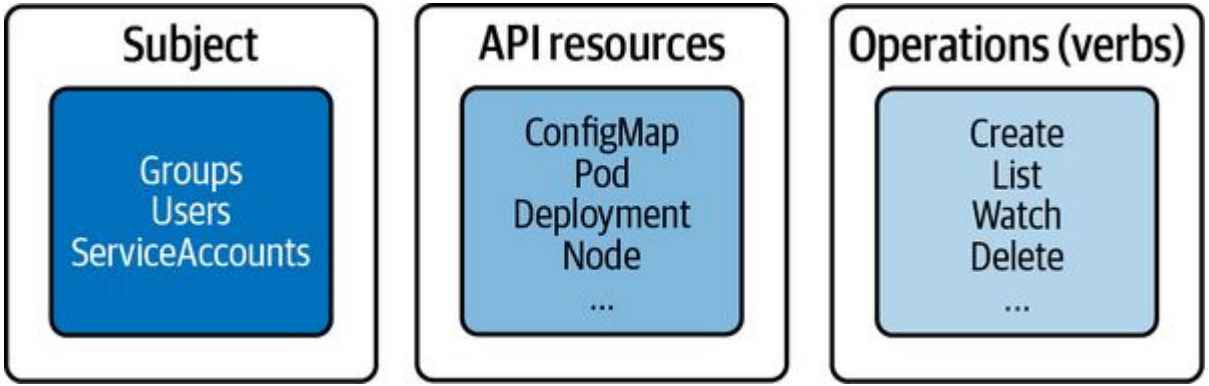
- Whenever you execute a command with `kubectl`, the underlying HTTPS call to the API server needs to authenticate.
- Credentials for the use of kubectl are stored in the file `$HOME/.kube/config`, also known as the `kubeconfig` file.
- `Kubectl` uses the currently selected context to know which cluster to talk to and which credentials to use.

# Quiz

## Authentication with kubectl

# RBAC Overview

Three key building blocks for understanding the concept



# RBAC API Primitives

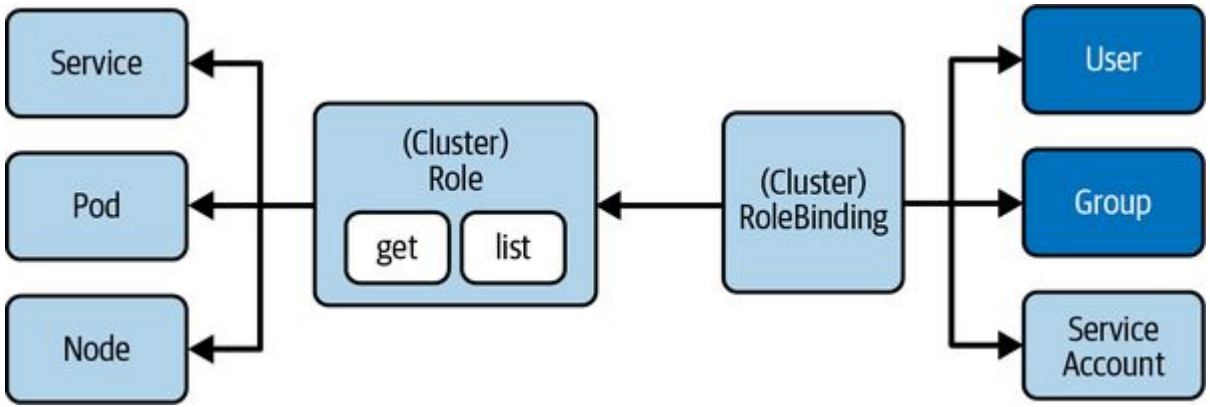
## Role and RoleBinding

- **Role:** The Role API primitive declares the API resources and their operations this rule should operate on in a specific namespace. For example, you may want to say “allow listing and deleting of Pods,” or you may express “allow watching the logs of Pods,” or even both with the same Role. Any operation that is not spelled out explicitly is disallowed as soon as it is bound to the subject.

- **RoleBinding:** The RoleBinding API primitive binds the Role object to the subject(s) in a specific namespace. It is the glue for making the rules active. For example, you may want to say “bind the Role that permits updating Services to the user John Doe.”

# Relationships between RBAC API Primitives

A Role is bound by a RoleBinding



# Role YAML Manifest

Can define a list of rules in an array

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  name: read-only
rules:
- apiGroups: [""]
  resources: ["pods", "services"]
  verbs: ["list", "get", "watch"]
- apiGroups: ["apps"]
  resources: ["deployments"]
  verbs: ["list", "get", "watch"]
```

Resources with groups need to be spelled out explicitly (in this case `apps/Deployment`)

# RoleBinding YAML Manifest

Roles can be mapped to multiple subjects if needed

```yaml
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: read-only-binding
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: read-only
subjects:
- apiGroup: rbac.authorization.k8s.io
  kind: User
  name: johndoe
```


# Working with Service Accounts

Service Accounts by default have very little permissions

- Some applications running inside of a Pod may have to communicate with the API server as well. For example, the application may ask for specific cluster node information or available namespaces.

- Pods can use a service account to authenticate with the API server through an authentication token. A Kubernetes administrator assigns rules to a service account via RBAC to authorize access to specific resources and actions.

# Exam Essentials

What to focus on for the exam

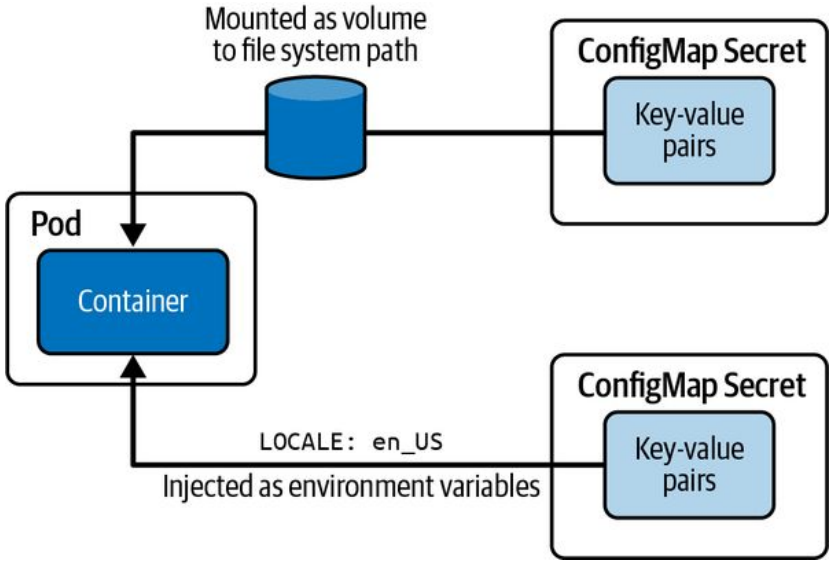
- All clients will make a call to the API server which will take care of authentication and authorization.
- Role-Based Access Control (RBAC) defines the permissions for permitted operations on specific API resources. RBAC kicks in everything the API server receives a request.
- A Role and RoleBinding define permissions for objects in a namespace. ClusterRole and ClusterRoleBinding define permissions across all namespaces.
- Processes that need access to the Kubernetes API use a Service Account. The Service Account is subject that can be tied in with RBAC.

# Secrets

Defining and consuming sensitive configuration data

# Why do Pods need Sensitive Configuration Data?

Controlling runtime behavior for applications running in the container



# Secrets

## A Secret is meant for storing sensitive data

- The Secret is a Kubernetes primitive for storing key-value pairs with a lifecycle decoupled from the consuming Pod.
- Syntactically meant storing sensitive data like passwords, API keys, or SSL certificates
- Values are only base64-encoded values, not encrypted!

# Secret YAML Manifest

Assigned values need to be provided in base64-encoded form

```
$ echo -n 's3cre!' | base64
czNjcmUh
```

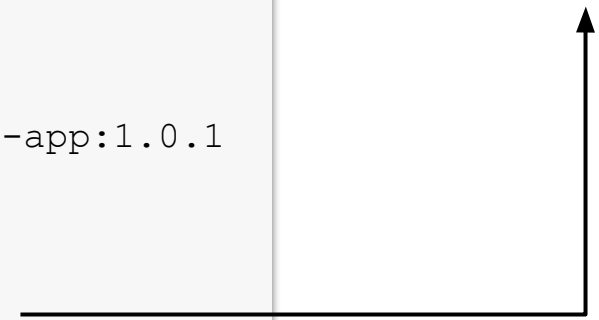
```
apiVersion: v1
kind: Secret
metadata:
  name: mysecret
type: Opaque
data:
  pwd: czNjcmUh
```

# Consuming a Secret as Environment Variables

Accessed values are base64-decoded

```
apiVersion: v1
kind: Pod
metadata:
  name: backend
spec:
  containers:
  - image: bmuschko/web-app:1.0.1
    name: backend
    envFrom:
    - secretRef:
        name: mysecret
```

```
$ kubectl exec -it backend -- env
pwd=s3cre!
```



# Consuming a Secret as a Volume

A good choice for processing a machine-readable configuration file

```
apiVersion: v1
kind: Pod
metadata:
  name: backend
spec:
  containers:
    - name: backend
      image:
bmuschko/web-app:1.0.1
      volumeMounts:
      - name: ssh-volume
        mountPath: /var/app
        readOnly: true
  volumes:
    - name: ssh-volume
      secret:
        secretName:
secret-ssh-auth
```

```
$ kubectl exec -it backend -- /bin/sh
# ls -l /var/app
ssh-privatekey
# cat /var/app/ssh-privatekey
-----BEGIN RSA PRIVATE KEY-----
Proc-Type: 4,ENCRYPTED
DEK-Info:
AES-128-CBC,8734C9153079F2E8497C8075289E
BBF1
...
-----END RSA PRIVATE KEY-----
```

# Plain-Text Secret Values

The `stringData` attribute allows for plain-text values

*secret.yaml*

```yaml
apiVersion: v1
kind: Secret
metadata:
  name: secret-basic-auth
type: kubernetes.io/basic-auth
stringData:
  username: admin
  password: t0p-Secret
```

```
kubectl create -f
secret.yaml
```

*Live object*

```yaml
apiVersion: v1
kind: Secret
metadata:
  name: secret-basic-auth
type: kubernetes.io/basic-auth
data:
  username: YWRtaW4=
  password: dDBwLVNlY3JldA==
```

# Secrets Are Not Really Secret

Techniques that help with making Secrets more secure

- Secret objects are stored in etcd in unencrypted form by default. Encryption of data in etcd is configurable.

- Define RBAC permissions to only allow developers to create, view, and modify Secret objects in dedicated namespaces. An even stricter policy could only allow administrators to manage Secrets.

- Use Kubernetes-external, third-party Secrets services for managing sensitive data, e.g. AWS Secrets Manager or HashiCorp Vault. You can consume the data with the help of the External Secrets Operator.

# Exam Essentials

What to focus on for the exam

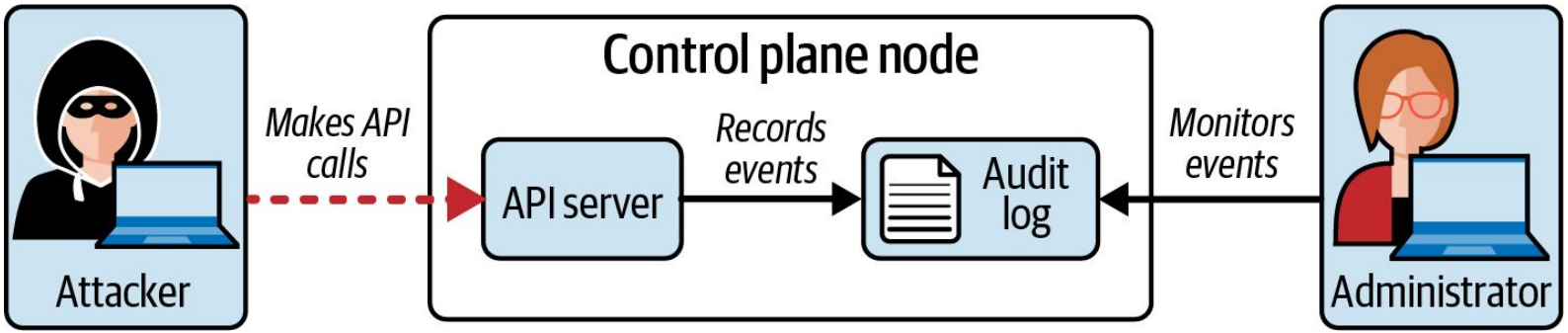
- ConfigMaps store plain-text key-value pairs. They are a good fit for simple strings, e.g. connection URLs, and theme names.
- Secrets are meant to represent sensitive data, however, they are not encrypted and therefore not “secret”. The values of the key-value pairs are only base64-encoded.
- ConfigMaps and Secrets can be consumed by Pods as environment variables or Volumes. Choose the appropriate method based on your application’s implementation.

# Audit Logging

Logging API server events

# Why Audit Logging?

Observing unauthorized access and historical tracking of API requests



# Information Captured by Audit Logging

Events emitted by API server or by client requests to the API server

- What event occurred?
- Who triggered the event?
- When was it triggered?
- Which Kubernetes component handled the request?

# Audit Logging Terminology

Events emitted by API server or by client requests to the API server

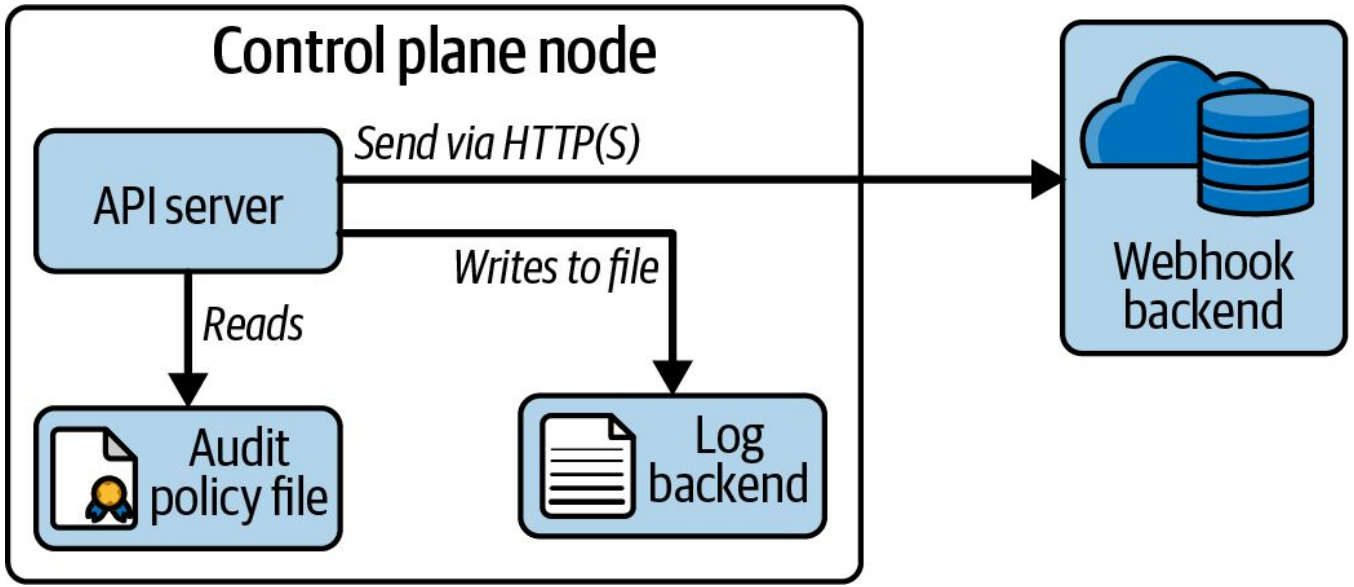
- **Audit policy:** Defines the type of event and the corresponding request data to be recorded. The audit policy is a YAML manifest specifying those rules and has to be provided to the API server process.

- **Audit backend:** Responsible for storing the recorded audit events, as defined by the audit policy.

- You have two configurable options for a backend:
  - A log backend, which write the events to a file.
  - A webhook backend, which sends the events to an external service via HTTP(S) - for example, for the purpose of integrating a centralized logging and monitoring system

# Audit Logging Architecture

Involved components



# Example Audit Policy File

Events emitted by API server or by client requests to the API server

```
apiVersion: audit.k8s.io/v1
kind: Policy
omitStages:
  - "RequestReceived"
rules:
  - level: RequestResponse
    resources:
    - group: ""
      resources: ["pods"]
  - level: Metadata
    resources:
    - group: ""
      resources: ["pods/log", "pods/status"]
```

Prevents generating logs for all requests in the `RequestReceived` stage

Logs Pod changes at `RequestResponse` level

Logs specialized Pod events, e.g., log and status requests, at the `Metadata` level

# Audit Levels

Logging on a high level requires more storage space

| Level | Description |
| --- | --- |
| `None` | Omit log events. |
| `Metadata` | Log request metadata (requesting user, timestamp, resource, verb, etc.) but not request or response body. |
| `Request` | Log event metadata and request body but not response body. |
| `RequestResponse` | Log event metadata, request and response bodies. |

# Configuring Audit Logging

## Modify the API server configuration file

```
spec:
  containers:
  - command:
    - kube-apiserver
    - --audit-policy-file=/etc/kubernetes/audit-policy.yaml
    - --audit-log-path=/var/log/kubernetes/audit/audit.log
    ...
    volumeMounts:
    - mountPath: /etc/kubernetes/audit-policy.yaml
      name: audit
      readOnly: true
    - mountPath: /var/log/kubernetes/audit/
      name: audit-log
      readOnly: false
  ...
  volumes:
  - name: audit
    hostPath:
      path: /etc/kubernetes/audit-policy.yaml
      type: File
  - name: audit-log
    hostPath:
      path: /var/log/kubernetes/audit/
      type: DirectoryOrCreate
```

Provides the location of the policy file and log file to the API server process.

Mounts the policy file and the audit log directory to the given paths.

Defines the Volumes for the policy file and the audit log directory.

# Example Audit Logging File Output

Produces log entries in JSON format

```
$ sudo grep 'audit.k8s.io/v1' /var/log/kubernetes/audit/audit.log
...
{"kind":"Event","apiVersion":"audit.k8s.io/v1","level":"RequestResponse", \
"auditID":"285f4b99-951e-405b-b5de-6b66295074f4","stage":"ResponseComplete", \
"requestURI":"/api/v1/namespaces/default/pods/nginx","verb":"get", \
"user":{"username":"system:node:node01","groups":["system:nodes", \
"system:authenticated"]},"sourceIPs":["172.28.116.6"],"userAgent": \
"kubelet/v1.26.0 (linux/amd64) kubernetes/b46a3f8","objectRef": \
{"resource":"pods","namespace":"default","name":"nginx","apiVersion":"v1"}, \
"responseStatus":{"metadata":{},"code":200},"responseObject":{"kind":"Pod", \
"apiVersion":"v1","metadata":{"name":"nginx","namespace":"default", \
...
```

# Quiz

## Audit logging

# Exam Essentials

What to focus on for the exam

- Audit logging helps with observing unauthorized access and historical tracking of API requests.

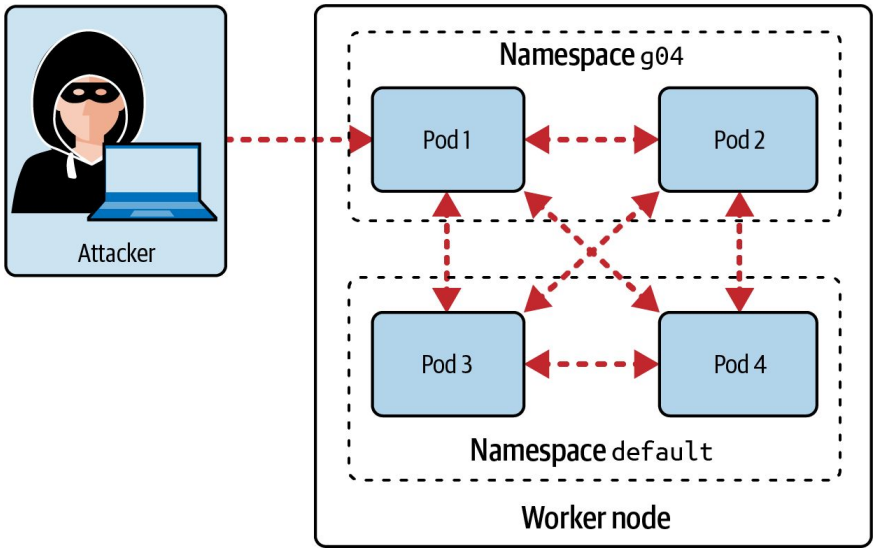
- Setting up audit logging consists of two steps. For one, you need to understand the syntax and structure of an audit policy file. The other aspect is how to configure the API server to consume the audit policy file, provide a reference to a backend, and mount the relevant file system Volumes.

# Network Policies

Restricting Pod-to-Pod communication

# Why Network Policies?

Unrestricted Pod-to-Pod communication opens new attack vectors for intruders

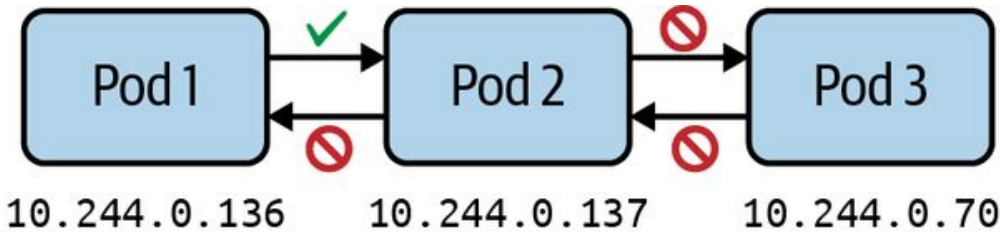


# Pod-to-Pod Communication

Microservices running in Pods need to be able to communicate

- Pod-to-Pod communication is unrestricted by default, even across namespaces. Any Pod can talk to any other Pod in the cluster via the virtual IP address.

- The Network Policy is a Kubernetes primitive for restricting the network communication.



# General Principles of Network Policies

Restrict as much as possible, only open up necessary communication

- You will want to start by establishing the principle of least privilege. That means instantiating a network policy that disallows all communication.

- Network policies are additive. You will want to open up network communication between Pods based on your communication requirements. For example, you can may want a frontend microservice to talk to a backend microservice.

# Installing an Network Policy Controller

A network policy cannot work without a network policy controller

- The network policy controller evaluates the collection of rules defined by a network policy. You can find instructions for a wide range of network policy controllers in the Kubernetes documentation.

- Cilium is a CNI that implements a network policy controller. You can install Cilium on cloud provider and on-prem Kubernetes clusters. Refer to the installation instructions for detailed information.

# Denying Directional Traffic

The Kubernetes documentation offers a list of default policies

```yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: default-deny-ingress
  namespace: g04
spec:
  podSelector: {}
  policyTypes:
  - Ingress
```

# Opening up Directional Traffic

You can define ingress and egress traffic, as well as ports

```yaml
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: backend-ingress
  namespace: g04
spec:
  podSelector:
    matchLabels:
      tier: backend
  policyTypes:
  - Ingress
  ingress:
  - from:
    - podSelector:
        matchLabels:
          tier: frontend
    ports:
    - protocol: TCP
      port: 3000
```

Quiz

# Network policies

# Exam Essentials

What to focus on for the exam

- Understand the following Kubernetes primitives and their spec in detail: Namespace, Pod, NetworkPolicy, Secret, Role, RoleBinding. It's not enough to know responsibilities of those primitives.

- Deepen your knowledge by understanding use cases and scenarios. For example, "What's the impact of using base64-encoding in a Secret for security?"

- Audit Logging is a cluster-level configuration option. Learn about its purpose and its configuration options.

# Platform Security

# Topics We'll Cover

## Supply Chain Security

- Scenarios
- Tools and approaches

## Observability

- Overview
- A quick tour on common tooling

## Service Mesh and PKI

- Drivers for using a service mesh
- Service mesh implementation
- Usage of PKI in Kubernetes

## Admission Control

- The purpose of admission control
- Admission controller plugins
- CNCF projects

# Supply Chain Security

Reduce security risks in creation and delivery process of your software

# What is Supply Chain Security?

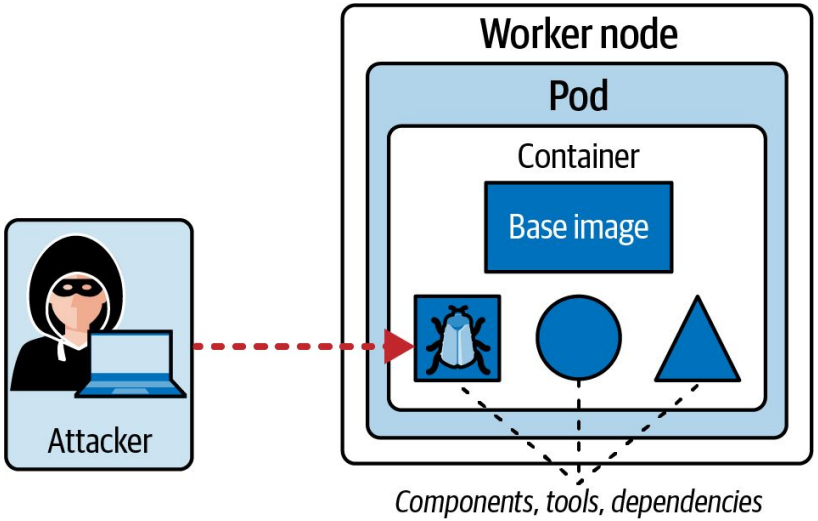
Security as an important aspect of your automation pipelines

- The creation and delivery of software is optimally automated by employing CI/CD pipelines, as well as the consumption of the software in the runtime environment.

- Some best practices include in the context of containerized applications include:
  - Minimizing base image footprint
  - Scanning images for known vulnerabilities
  - Signing container images and software bill of materials (SBOM) attestation
  - Governing the use of public container registries
  - Performing static analysis of user workload

# Why Minimize Container Image Footprint?

Reducing security risk by including less




Example: https://docs.docker.com/build/building/best-practices/

# Picking a Base Image Small in Size

Start by looking at the size before deciding to use it

- It is recommended to use a base image with a minimal set of functionality and dependencies. The less is included, the less potential vulnerabilities do you ship. Upgrade to newer base image versions to pull in security vulnerability fixes.

- Many container producers upload a wide range of variations of their container images for the same release. One of those variations is an `alpine` image, a small, lightweight, and less vulnerable Linux distribution.

- You can further reduce the container image size and the attack surface by using a distroless image offered by Google, an image without a shell.

# Building Multi-Stage Container Images

## Stripping tools used to build binary from container image

- Some developers prefer building the application binary directly as part of the container image creation process.
- Separate the build stage from the runtime stage. As a result, all dependencies needed in the build stage will be discarded after the process has been performed and therefore do not end up in the final container image.
- This approach automatically leads to a much smaller container image size by removing all the unnecessary cruft.

# Example Multi-Stage Dockerfile

Output of named stage is copied to final container image

```
FROM golang:1.19.4-alpine AS build
RUN apk add --no-cache git
WORKDIR /tmp/go-sample-app
COPY go.mod .
COPY go.sum .
RUN go mod download
COPY . .

RUN CGO_ENABLED=0 go test -v
RUN go build -o ./out/go-sample-app .

FROM alpine:3.17.0
RUN apk add ca-certificates
COPY --from=build /tmp/go-sample-app/out/go-sample-app /app/go-sample-app
CMD ["/app/go-sample-app"]
```

# Reducing the Number of Layers

## Roll multiple commands into one line of instruction

- Every Dockerfile consists of an ordered list of instructions. Only some instructions create a read-only layer in the resulting container image. Those instructions are `FROM`, `COPY`, `RUN`, and `CMD`.

- All other instructions will not create a layer as they create temporary intermediate images.

- It’s common practice to execute multiple commands in a row to avoid creating extra layers.

# Example Combining Commands

Use `&&` to execute multiple commands in a single layer

```
FROM ubuntu:22.10
RUN apt-get update -y
RUN apt-get upgrade -y
RUN apt-get install -y curl
```

vs.

```
FROM ubuntu:22.10
RUN apt-get update -y && apt-get upgrade -y && apt-get install -y curl
```

# Container Image Optimization Tools

Inspecting a produced container image for further optimization potential

- *DockerSlim* will optimize and secure your container image by analyzing your application and its dependencies. You can find more information in the tool's GitHub repository.

- *Dive* is a tool for exploring the layers baked into a container image. It makes it easy to identify unnecessary layers, which you can further optimize on. The code and documentation for Dive are available in a GitHub repository.

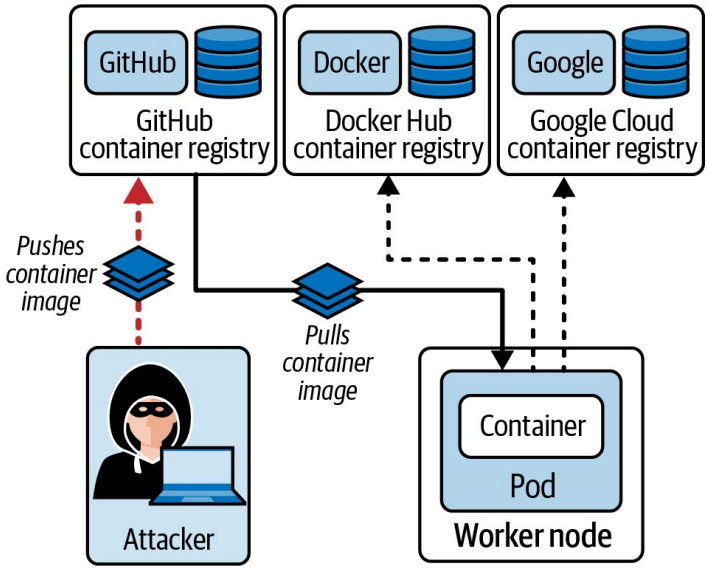
# Demo

## Applying security best practices to a Dockerfile

https://learning.oreilly.com/interactive-lab/applying-security-best/9781098149970/

# Why avoid the use of Public Registries?

Only rely on a private registry you can control and govern




Examples: OPA Gatekeeper, Kyverno

# Only Allow the Use of Internal Image Registries

Set up and control your own registry without the risk of pulling public images

- On an enterprise level, you need to control which container registries you trust. It's recommended to set up your own container registry within your company's network, which you can fully control and govern. Alternatively, you can set up a private container registry in a cloud provider environment, not accessible by anyone else.

- One of the prominent binary repository managers you can choose from is JFrog Artifactory. The product fully supports storing, scanning, and serving container images.

- One way to govern container registry usage is with Kyverno and OPA Gatekeeper, or an admission controller plugin.

# Example Pod With Registry Reference

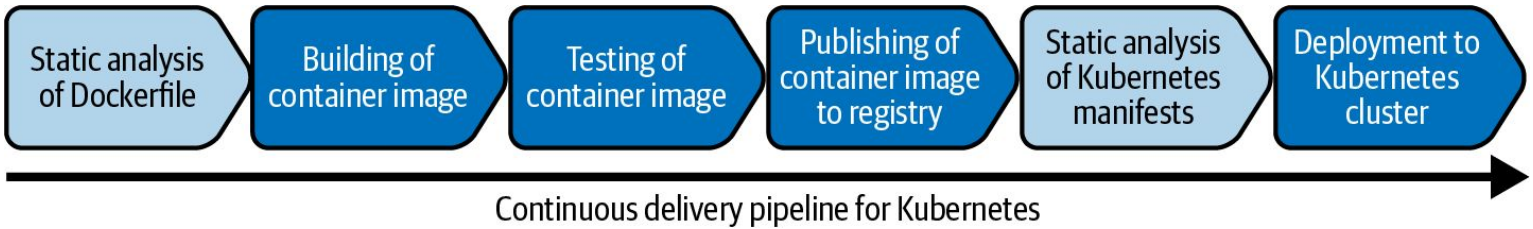
The registry will very likely want you to authenticate

```
apiVersion: v1
kind: Pod
metadata:
  name: alpine
spec:
  containers:
  - name: alpine
    image: my-company-docker-local.jfrog.io/my-app:1.0.0
  imagePullSecrets:
  - name: regcred
```

Put credentials into a Secret
and reference it here

# Why use Static Analysis of Workload?

Use tools to enforce the use of best practices




Examples: Haskell Dockerfile Linter, Kubesec

# Using Kubesec for Analyzing Kubernetes Manifests

## Check against best practices

Kubesec is a tool for analyzing Kubernetes manifests. It can be executed as a binary, Docker container, admission controller plugin, and even as a plugin for `kubectl`.

```
$ docker run -i kubesec/kubesec:512c5e0 scan /dev/stdin < pod-initial-kubesec-test.yaml
[
  {
    "object": "Pod/kubesec-demo.default",
    "valid": true,
    "message": "Passed with a score of 1 points",
    "score": 1,
    "scoring": {
      "advise": [
        {
          "selector": ".spec .serviceAccountName",
          "reason": "Service accounts restrict Kubernetes API access and \
                     should be configured with least privilege"
        },
 ...
```

# Scanning Images for Known Vulnerabilities

## Finding embedded security vulnerabilities

- One of the top sources for logging and discovering security vulnerabilities is CVE Details. The page lists and ranks known vulnerabilities (CVEs) by score. One of the open source tools with this capability explicitly mentioned in the CKS curriculum is Trivy.

- Trivy can run in different modes of operation: as a command line tool, in a container, as a GitHub Action configurable in a continuous integration workflow, as a plugin for the IDE VSCode, and as a Kubernetes operator.

# Example Trivy

Renders detailed information on vulnerabilities in container images

# Exam Essentials

What to focus on for the exam

- Follow best practices when defining and building container images. The smaller the size, the lower the risk of potential security vulnerabilities. Distroless images eliminate the risk of attacks through a shell vulnerability.

- Only trust container images you host in an non-public container image registry. Scan the stored images for vulnerabilities as part of your supply chain CI pipeline.

# Observability

Monitoring and visualizing the health of your cluster and applications

# What is Observability?

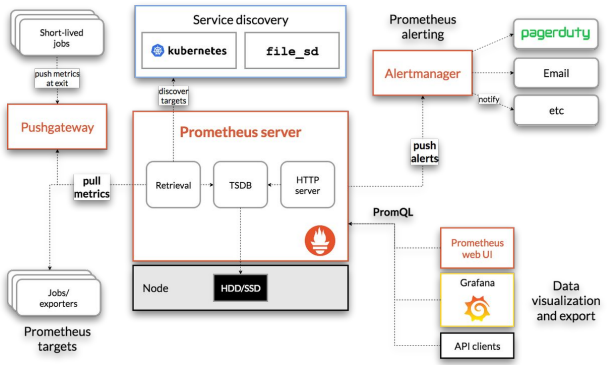
Insights into the real-time performance of Kubernetes clusters and applications

- Infrastructure monitoring for your cluster nodes.
- Application resource monitoring (e.g. CPU, memory, storage, networking metrics).
- Service component metrics for discovering failures.
- Alerting and notifications based on events.
- Support for capturing custom metrics.

# Prometheus

## Open-source monitoring and alerting tool

- Cloud-native time-series data store with a built-in query language for metrics.
- Built-in support for Kubernetes and containers.
- Can be installed as Kubernetes operator.

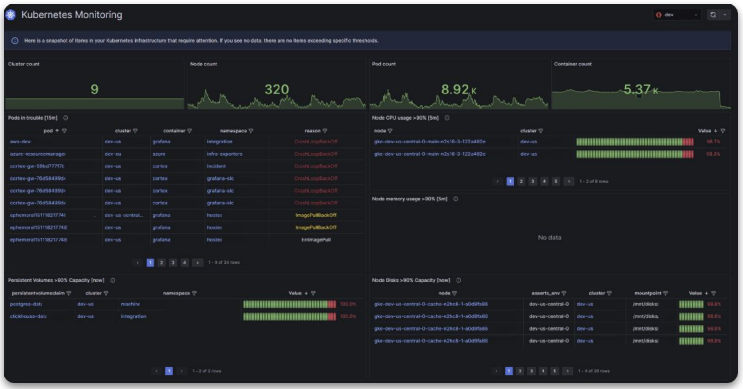


# Grafana

## Open-source tool to visualize observability data

- Data visualization and analytics tool that supports alerting and notifications.

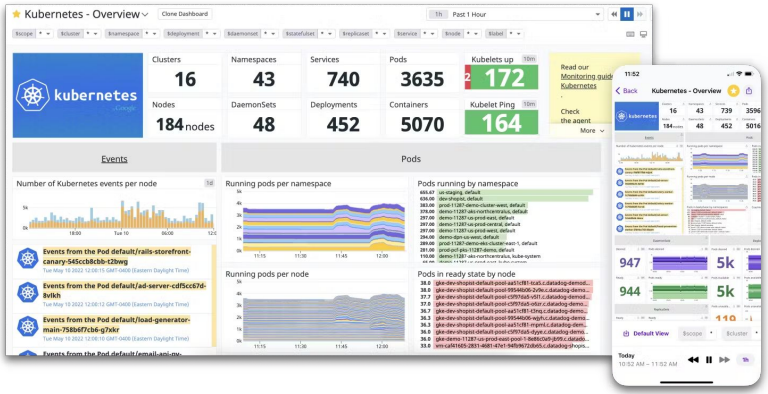
- Integrates with major time-series databases (Prometheus, InfluxDB), Elasticsearch, SQL databases, cloud monitoring service.



# Datadog

## Commercial observability tool

- Cloud-based monitoring and analytics platform.
- Can be used to visualize data, explore metrics, manage logs, and perform various other tasks.



# Exam Essentials

What to focus on for the exam

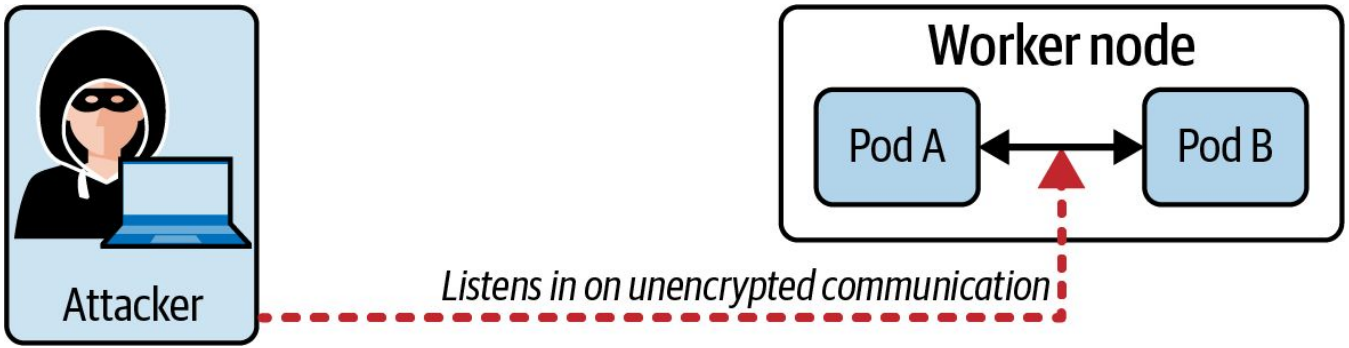
- Every production Kubernetes cluster should keep track of real-time performance metrics, commonly referred to as observability.
- Observability can be implemented using open source and commercially available tools. Prometheus is time-series data store. Grafana is a data visualization tool that can tap into the time-series data store.
- You will not need to understand the intricacies and terminology of both tools.

# Service Mesh

Encrypted network communication between cluster components via TLS

# Scenario: Attacker Listens to Pod Communication

Impersonating the sending or the receiving side to extract sensitive data



# What is a Service Mesh?

Simplify and abstract microservices communication

- Organizations that build their system in a microservices fashion break down their business functionality into distinct, decoupled pieces of software. Each part of the system can be developed and deployment independently.

- In Kubernetes, each microservice would live in a Pod, often times scaled out by a ReplicaSet. Pods need to talk to each other to be able to fulfill the business needs.

- A service mesh is a dedicated infrastructure layer designed to manage, observe, and control communication between microservices within a Kubernetes cluster.

# Benefits of Using a Service Mesh

Microservices communication, management, and security

- **Traffic management:** Ensuring that application traffic is routed efficiently and reliably.
- **Security:** Providing end-to-end encryption via mutual TLS.
- **Service-level observability:** Monitor and analyze the performance and behavior of services in real time to diagnose issue.
- **Policy enforcement:** Support access controls, rate limits, and quotas.

# Examples for Service Mesh Implementation

Compare feature lists when deciding for a product

- Istio: Provides features such as load balancing, authentication, authorization, rate limiting, and observability.
- Linkerd: Provides features such as load balancing, automatic retries, circuit breaking, and observability.
- Consul service mesh: Provide features such as service segmentation, mutual TLS encryption, and fine-grained access control for microservices. Developed by HashiCorp that can be integrated with Kubernetes.

# Exam Essentials

What to focus on for the exam

- Organization install a service mesh into the Kubernetes cluster to better manage and control network communication between microservices.
- Depending on the service mesh product, it can provide benefits like security, traffic management, and policy enforcement.
- Popular service meshes include Istio and Linkerd.

# PKI

Encrypted network communication between cluster components via TLS

# What is Public key infrastructure (PKI)?

Responsible for generating TLS certificates

- Refers to tools used to create and manage public keys for encryption, which is a common method of securing data transfers on the internet.
- When you install Kubernetes using `kubeadm`, certificates used by cluster components are generated automatically.
- You can also generate your own certificates.
- Most certificates are stored in `/etc/kubernetes/pki`.
- `kubeadm` places user account certificates in `/etc/kubernetes`.

# What does Kubernetes use PKI for?

## Primarily for cluster component communication

Kubernetes requires PKI for the following operations:

- Client certificates for the kubelet to authenticate to the API server
- Kubelet server certificates for the API server to talk to the kubelets
- Server certificate for the API server endpoint
- Client certificates for administrators of the cluster to authenticate to the API server
- Client certificates for the API server to talk to the kubelets
- Client certificate for the API server to talk to etcd
- Client certificate/kubeconfig for the controller manager to talk to the API server
- Client certificate/kubeconfig for the scheduler to talk to the API server.
- Client and server certificates for the front-proxy

https://kubernetes.io/docs/setup/best-practices/certificates/#how-certificates-are-used-by-your-cluster

# Exam Essentials

What to focus on for the exam

- PKI refers to the tools used to create and manage public keys for encryption.
- When initializing a cluster using `kubeadm`, it uses PKI to generate certificates for cluster component communication.
- You will not need to understand how to generate your own certificates.

# Admission Control

Validation and mutations of request to the API server

# What is an Admission Controller?

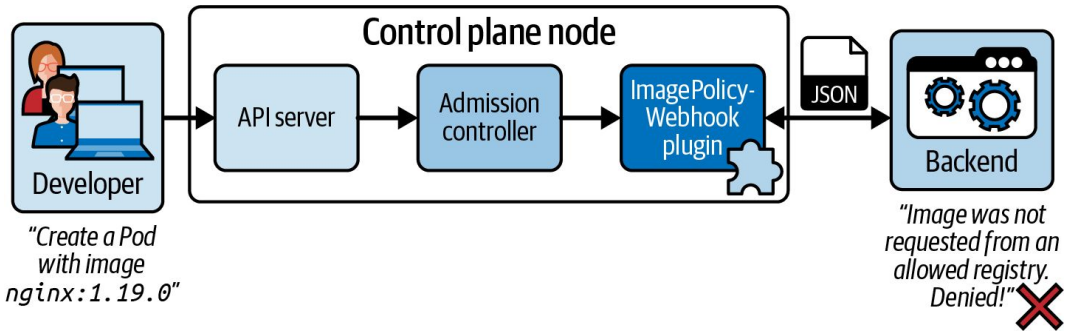
Piece of code that intercepts requests to the Kubernetes API server

- Admission control is the third phase when processing a Kubernetes API request.
- Authentication and authorization needs to pass before admission control comes into play.
- An admission controller provides a way to approve, deny, or mutate a request before the request takes effect.

# Admission Controller Plugins

You can choose from a wide range of built-in plugins

- You can configure different admission controller plugins in the API server.
- For example, the `ImagePolicyWebhook` admission controller plugin defines a policy for all container images used by Pod upon creation of the object.



# Admission Control Phases

If any of the phases fails, then the whole request will be rejected

- The admission control process proceeds in two phases. In the first phase, mutating admission controllers are run. In the second phase, validating admission controllers are run.

- **Mutation:** Runs the `MutatingAdmissionWebhook`plugin. Modifies the data for the object requested. This may confuse end users if functionality isn't communicated properly.

- **Validation:** Runs the `ValidatingAdmissionWebhook`plugin. Validates the data for the object requested.

# Default Admission Controller Plugins

Configured in the API server via `--enable-admission-plugins` option

```
$ kubectl get pod kube-apiserver -n kube-system -o yaml | grep
enable-admission-plugins
    - --enable-admission-plugins=CertificateApproval, CertificateSigning,
CertificateSubjectRestriction, DefaultIngressClass, DefaultStorageClass,
DefaultTolerationSeconds, LimitRanger, MutatingAdmissionWebhook,
NamespaceLifecycle, PersistentVolumeClaimResize, PodSecurity, Priority,
ResourceQuota, RuntimeClass, ServiceAccount, StorageObjectInUseProtection,
TaintNodesByCondition, ValidatingAdmissionPolicy, ValidatingAdmissionWebhook
```

Those are the default plugins enabled in Kubernetes 1.30.

# Cloud-Native Governance Projects

CNCF projects that help with rolling out governance on an enterprise level

- Implementing custom solutions in Kubernetes is not necessarily easy.
- You can choose from official CNCF that solve the project declaratively, e.g. OPA Gatekeeper or Kyverno.

# Exam Essentials

What to focus on for the exam

- Understand that processing a Kubernetes API request will invoke admission control. An admission controller provides a way to approve, deny, or mutate a request before the request takes effect.

- The admission controller distinguishes two phases executed in a predetermined order. In the first phase, mutating admission controller plugins are run. The second phase executes validating admission controller plugins.

- Get a high-level overview of existing admission controller plugins. Know where and how to enable or disable a plugin.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