Security and Policies

Authentication, Authorization, and Admission.

Resource Management. Network Policies

kubernetes

SoftUni Team

Technical Trainers

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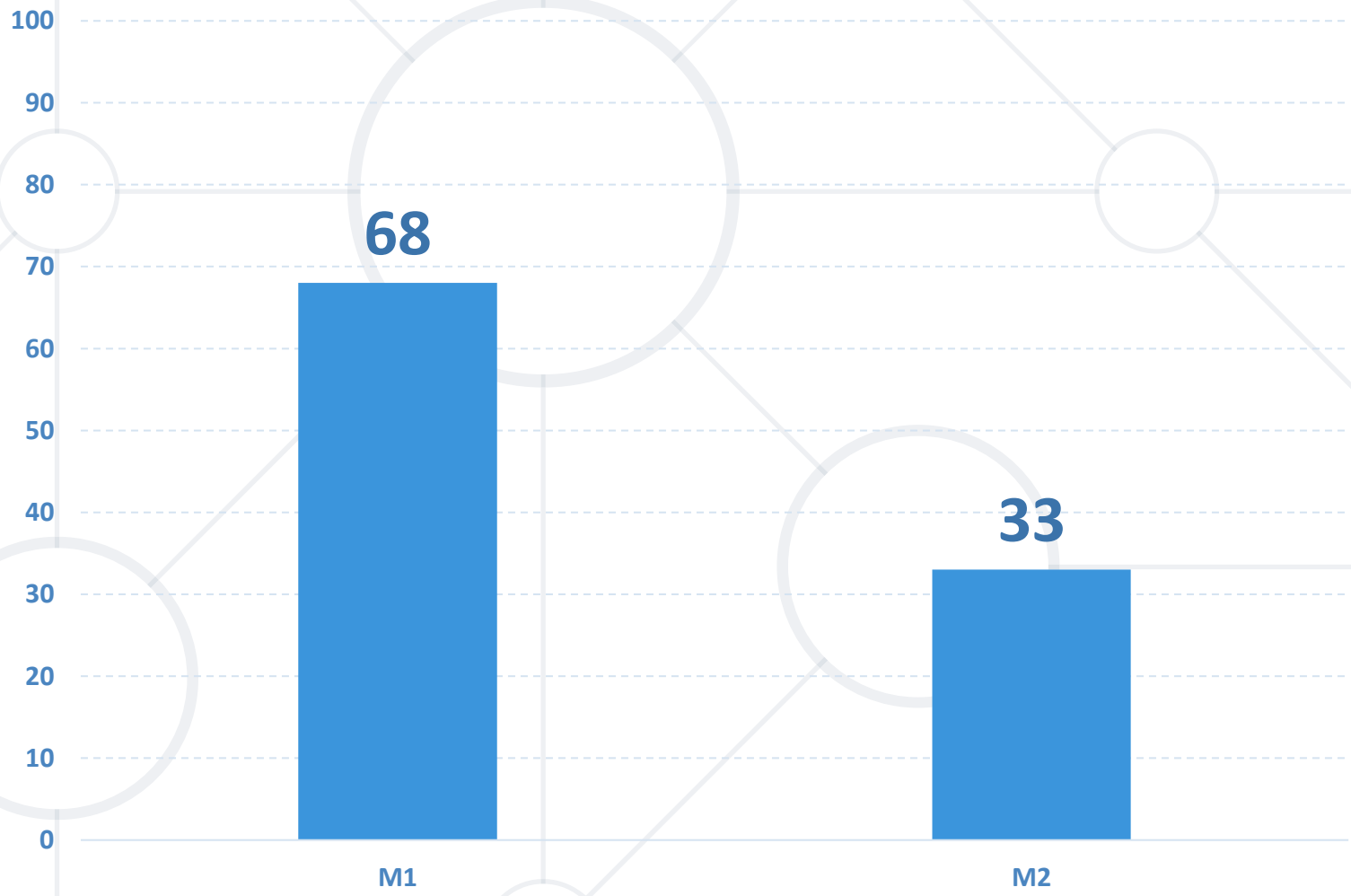
sli.do

#Kubernetes

facebook.com
/groups/kubernetesnovember2025

Homework Progress (as of 17:00)



Submit M2
until 23:59:59
on 18.11.2025

Submit M3
until 23:59:59
on 25.11.2025

Previous Module (M2)

Quick overview

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This Module (M3)

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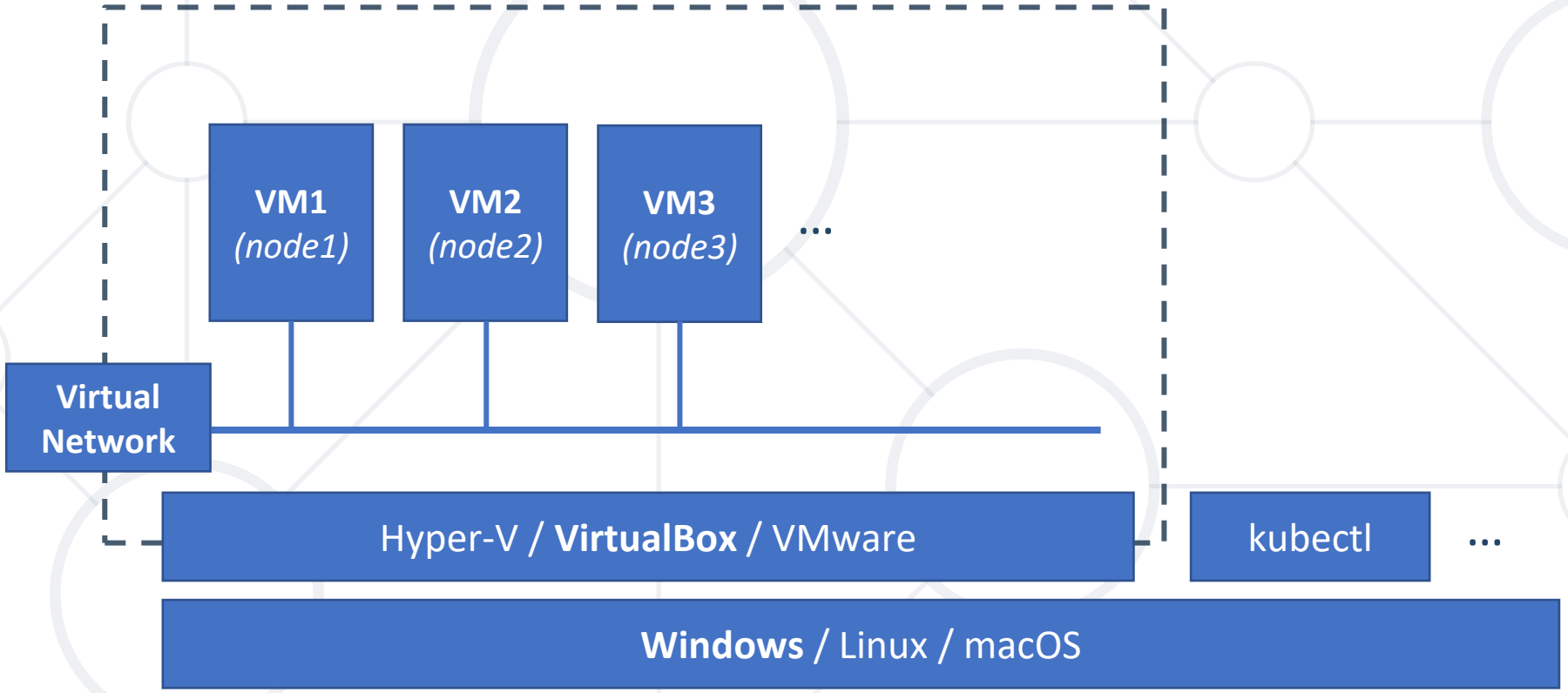
Lab Infrastructure

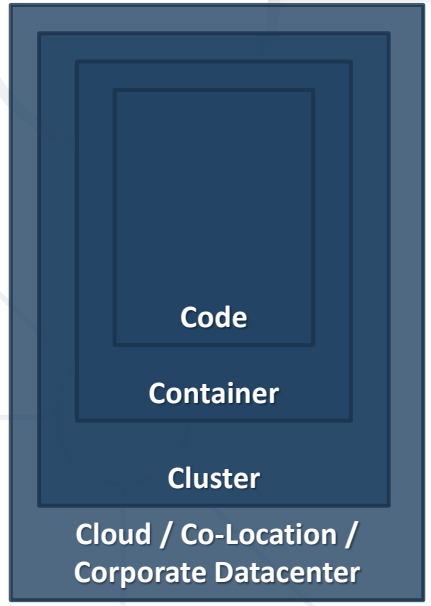


Cloud Native Security

The 4C’s of Cloud Native ***Kubernetes*** Security

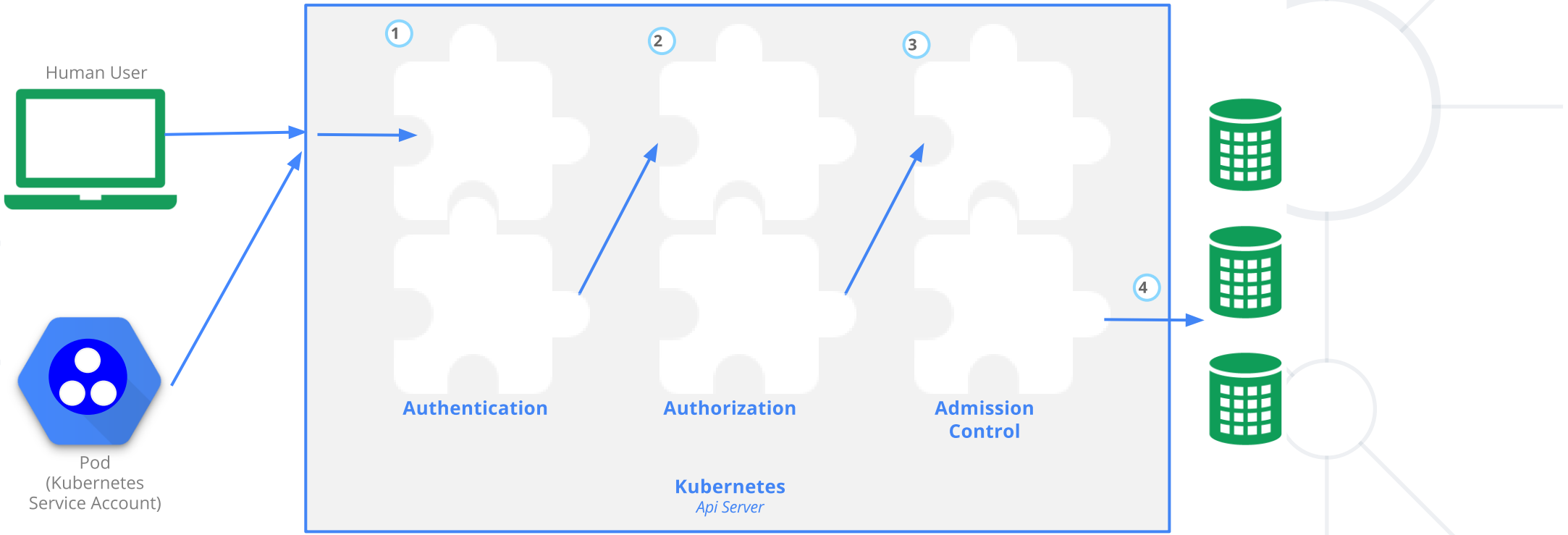
Cloud > Cluster > Container > Code

- **Cloud / Co-Location / Corporate Datacenter**
  - General: Least privilege, network access, encryption, misconfiguration, default settings, etc.
  - Kubernetes: Access to nodes and API server, access and encryption of etcd
- **Cluster**
  - General: Cluster components and applications
  - Kubernetes: RBAC, Authentication, Secrets, Network Policies, etc.
- **Container**
  - Secure base images, image signing, scan for vulnerabilities, container runtime
- **Code**
  - Static code analysis, 3rd party dependencies, access over TLS, exposed ports, hardcoded secrets, etc.



Authentication, Authorization and Admission Control

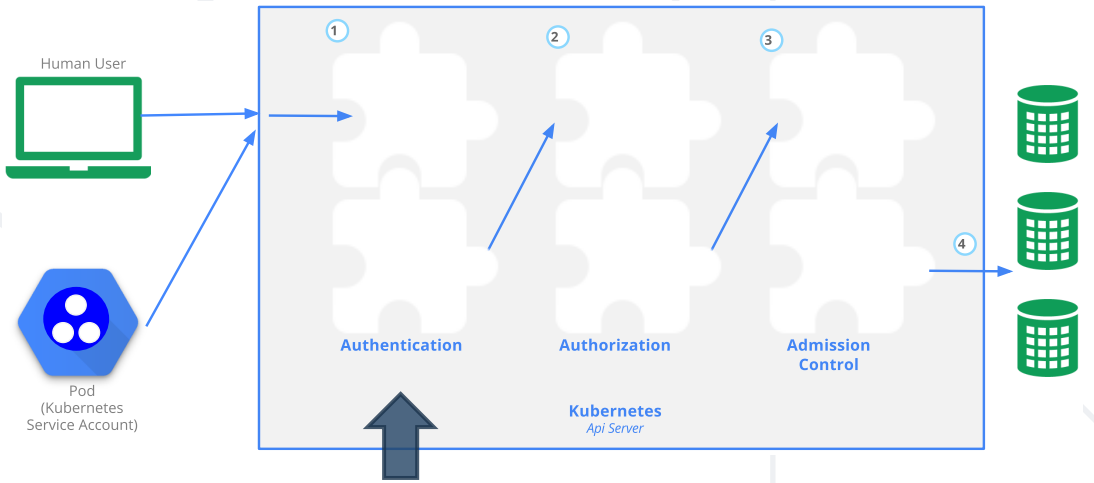
Access Control Overview



https://kubernetes.io/docs/concepts/security/controlling-access/

Authentication

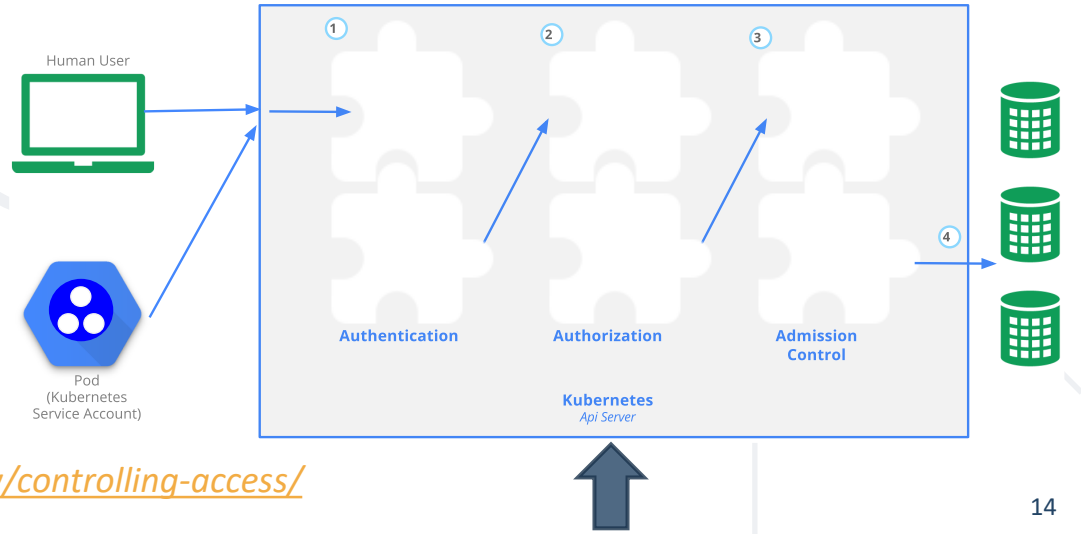
- Authentication modules include **client certificates**, **password**, and **plain tokens**, **bootstrap tokens**, and **JSON Web Tokens**
- Multiple authentication modules can be specified. Each one is tried in sequence, until one of them succeeds
- If the request cannot be authenticated, it is rejected with HTTP status **code 401**
- If process succeeds, the user is authenticated as a specific **username**, and it is available to subsequent steps to use in their decisions



https://kubernetes.io/docs/concepts/security/controlling-access/

Authorization

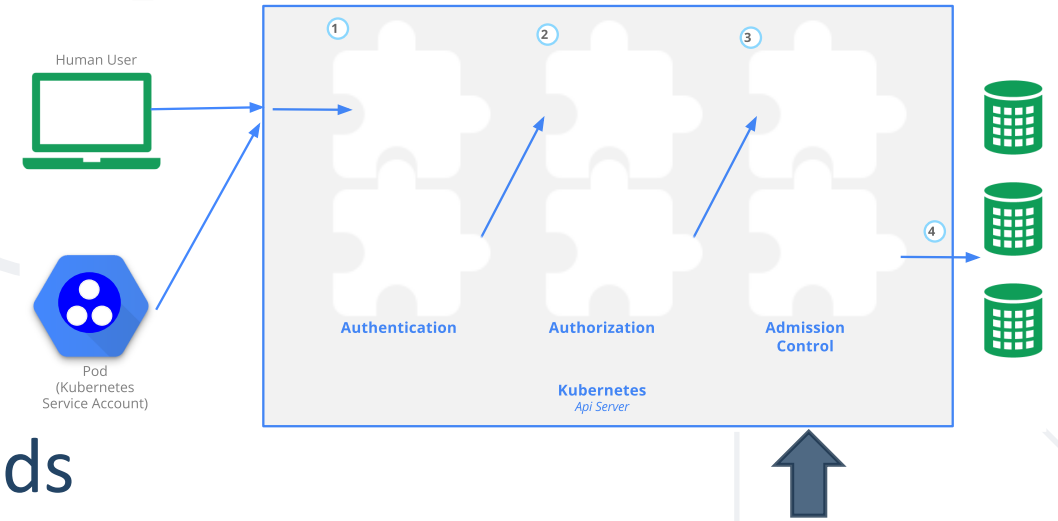
- After a successful authentication, the request must be authorized
- It must include the **username**, the **action**, and the **target object**
- It is authorized if an existing policy confirms that the user has the right to complete the requested action
- Multiple authorization modules are supported, such as **ABAC**, **RBAC**, and **Webhook**
- They are configured during the cluster creation
- More than one may be specified
- All are evaluated until one authorizes the request
- If all deny it, then the request is denied (**403**)



https://kubernetes.io/docs/concepts/security/controlling-access/

Admission Control

- Software modules that can **modify** or **reject** requests
- In addition to the attributes available to Authorization modules, Admission Control modules can access the **contents of the object** that is being created or modified
- **Multiple controllers** may be configured. In this case they are **called in order**
- If any admission controller module rejects, then the request is immediately rejected
- They act on requests that **create**, **modify**, **delete**, or **connect to** (proxy) an object
- They **ignore** requests that merely **read objects**
- They can also set complex defaults for fields



https://kubernetes.io/docs/concepts/security/controlling-access/

User Accounts vs Service Accounts

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- When we (humans) access the cluster (for example with kubectl), we are authenticated by the **apiserver** as a particular **User Account** (usually **admin**)
- Processes in containers inside pods can also contact the **apiserver**. When they do, they are authenticated as a particular **Service Account** (for example, **default**)

https://kubernetes.io/docs/tasks/configure-pod-container/configure-service-account/

Service Accounts

- Each namespace gets one by default named **default**
- During pod creation we can specify a service account
- If we omit it, the default one is assigned
- Service account names are formatted like this:
  system:serviceaccount:<namespace>:<service account name>
- We can create additional ones to further adjust pods' rights
- Pods can use service accounts from the same namespace
- Each pod is attached to only one service account
- One service account may be shared by multiple pods

https://kubernetes.io/docs/tasks/configure-pod-container/configure-service-account/

Role-based Access Control (RBAC)

- Controls who can do what with which type of resources
- **Roles** contain rules that represent a set of permissions
- Permissions are purely additive (there are no "deny" rules)
- A **role binding** grants the permissions defined in a role to a user or set of users
- Role bindings hold a list of **subjects** (users, groups, or service accounts), and a **reference to the role** being granted

https://kubernetes.io/docs/reference/access-authn-authz/rbac/

Roles and Bindings

- **Roles** set permissions within a namespace
- **ClusterRoles** are non-namespaced resources. They are used to
  - Grant permissions on namespaced resources within individual namespaces
  - Grant permissions on namespaced resources across all namespaces
  - Grant permissions on cluster-scoped resources

https://kubernetes.io/docs/reference/access-authn-authz/rbac/

Roles and Bindings

- **RoleBinding** grants permissions within a specific namespace whereas a **ClusterRoleBinding** grants that access cluster-wide
- RoleBinding may reference any Role in the same namespace or a ClusterRole
- If we want to bind a ClusterRole to all namespaces, we must use ClusterRoleBinding

https://kubernetes.io/docs/reference/access-authn-authz/rbac/

Practice

Live Exercise in Class (Lab)

Resource Requirements, Limits and Quotas

Resource Requests and Limits

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- By default, containers run with unbounded resources on a cluster
- We can control how much of a resource is granted to a Container
- Most common resources are the CPU and memory
- We specify how much resources a Container needs to operate via the **request** option. This information is accumulated on a Pod level and a decision for scheduling of the Pod is made
- We restrict how much of a resource a Container can use via the **limit** option

https://kubernetes.io/docs/concepts/configuration/manage-resources-containers/

CPU

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- The CPU resource is measured in **CPU units**
- One CPU, in Kubernetes, is equivalent to **1 AWS vCPU** or **1 GCP Core** or **1 Azure vCore** or **1 Hyperthread on a bare-metal Intel processor with Hyperthreading**
- We can specify fractional values, for example **0.5** which is the half of 1 CPU
- The above can be stated as **500m** (milicpu) units

https://kubernetes.io/docs/tasks/configure-pod-container/assign-cpu-resource/

Memory

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- Memory requests and limits are measured in **bytes**
- We can specify it using **integer** values or **fixed-point** numbers
- We may use the standard suffixes **k**, **M**, **G**, **T**, etc. or the power-of-two ones **Ki**, **Mi**, **Gi**, **Ti**, etc.
- For example, to set **128 MiB** of memory, we must use **128Mi**

https://kubernetes.io/docs/tasks/configure-pod-container/assign-memory-resource/

Quotas

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- Resource quotas are a tool for administrators to address the need of sharing cluster resources between teams of users
- They are defined by the **ResourceQuota** object
- Provide constraints that **limit aggregate resource consumption per namespace**
- Limit the **quantity of objects** that can be created in a namespace by type
- Limit the **total amount of compute resources** that may be consumed by resources

https://kubernetes.io/docs/concepts/policy/resource-quotas/

Limit Ranges

- A **LimitRange** is a policy to constrain resource allocations (to **Pods** or **Containers**) in a namespace
- Enforce **minimum** and **maximum** compute resources usage per Pod or Container in a namespace
- Enforce minimum and maximum storage request per PersistentVolumeClaim in a namespace
- Enforce a ratio between request and limit for a resource in a namespace
- Set **default request/limit** for compute resources in a namespace and automatically inject them to Containers at runtime

https://kubernetes.io/docs/concepts/policy/limit-range/

Practice

Live Exercise in Class (Lab)

Network Policies

Network Policies

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- Control traffic flow at the IP address or port level for particular applications in the cluster
- Allow control if and how a pod is allowed to communicate with various network entities over the network
- The entities are identified by a combination of
  - Other pods that are allowed
  - Namespaces that are allowed
  - IP blocks

https://kubernetes.io/docs/concepts/services-networking/network-policies/

Prerequisites

- They are **implemented by the network plugin**
- **Flannel** does not support Network Policies
- Plugins like **Antrea**, **Calico**, and **Cilium** do support them
- Creating a NetworkPolicy resource without a plugin that supports it won't have any effect

https://kubernetes.io/docs/concepts/services-networking/network-policies/

Main Elements

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- **podSelector** selects a pod or group of pods. If an empty one is used this matches all pods in the namespace
- **policyTypes** can include either **Ingress** or **Egress** or both. It specifies which traffic for the selected pods is being regulated
- **ingress** includes a list of allowed ingress rules. Each rule consists of **from** and **ports** sections
- **egress** includes a list of allowed egress rules. Each ruleconsists of **to** and **ports** sections

```
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: test-network-policy
  namespace: default
spec:
  podSelector:
    matchLabels:
      role: db
  policyTypes:
  - Ingress
  ingress:
  - from:
    - ipBlock:
        cidr: 172.17.0.0/16
        except:
        - 172.17.1.0/24
    - namespaceSelector:
        matchLabels:
          project: myproject
    - podSelector:
        matchLabels:
          role: frontend
    ports:
    - protocol: TCP
      port: 6379
```

https://kubernetes.io/docs/concepts/services-networking/network-policies/

Default Policies

- By default, no policies exist in a namespace, so all ingress and egress traffic is allowed
- Should we want, we can create the following **default network policies**

Deny all ingress traffic

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

Allow all ingress traffic

```
---
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: allow-all-ingress
spec:
  podSelector: {}
  ingress:
  - {}
  policyTypes:
  - Ingress
```

Deny all egress traffic

```
---
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: default-deny-egress
spec:
  podSelector: {}
  policyTypes:
  - Egress
```

Allow all egress traffic

```
---
apiVersion: networking.k8s.io/v1
kind: NetworkPolicy
metadata:
  name: allow-all-egress
spec:
  podSelector: {}
  egress:
  - {}
  policyTypes:
  - Egress
```

https://kubernetes.io/docs/concepts/services-networking/network-policies/

Practice

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