



Running Kubernetes in Azure

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About me



Director, Global Microsoft Cloud CoE at Capgemini

Born and brought up in India and based out of Omaha, NE since 2016

Microsoft Azure MVP since 2020

Leader, Omaha Azure User Group(<https://omahaazure.org>)

15+ cloud certifications and counting...



What is Kubernetes?

Kubernetes is a portable, extensible, open-source platform for automating the deployment, scaling, and management of containerized workloads.



*Kubernetes (k(j)u:bər'netɪs)
Greek for “helmsman of a ship”*



Kubernetes History

First announced by Google in 2014

Heavily influenced by Google's **Borg** system.

Original codename for Kubernetes project was Project 7 (a reference to the Star Trek ex-Borg character Seven of Nine)

V1.0 was released on July 21, 2015

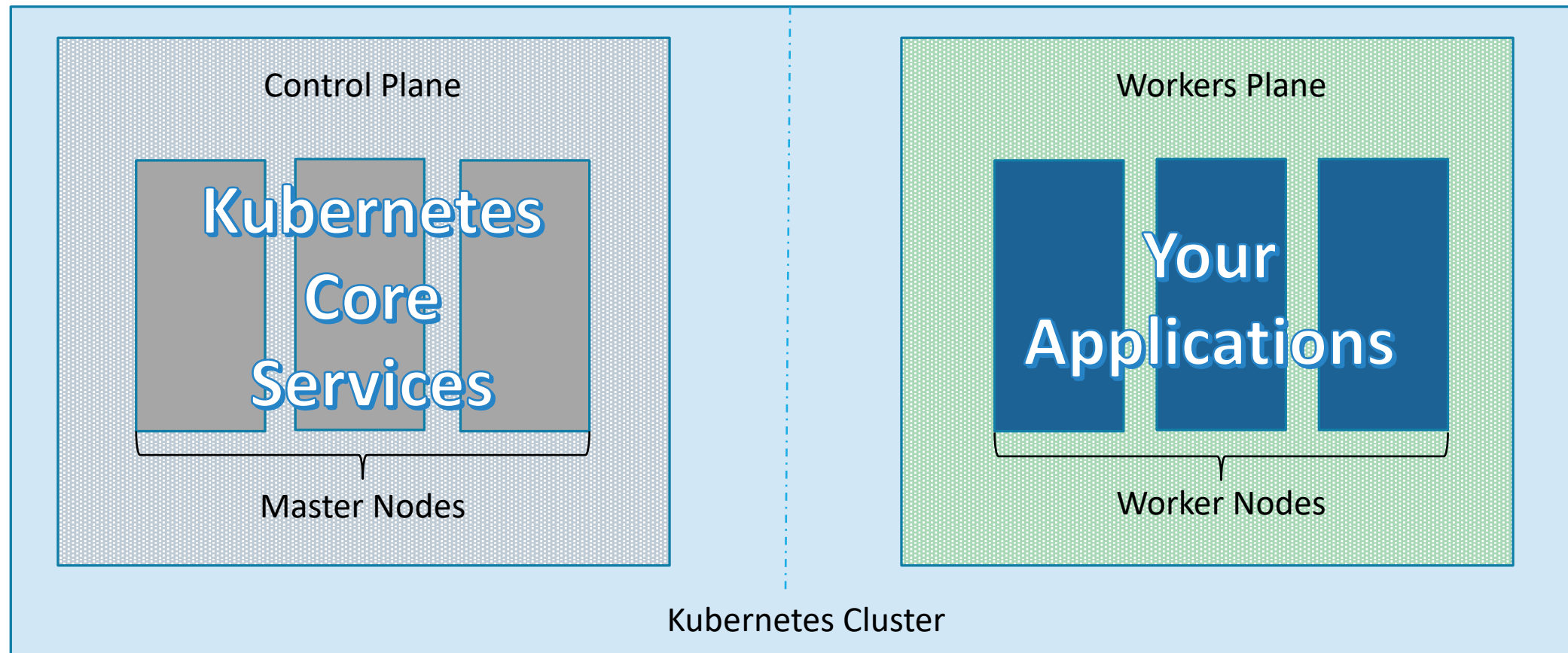
Current version is *1.26.1* (released on 01/18/2023) ([Release History](#))

Version *1.27* will be available 04/11/2023 ([Schedule](#))

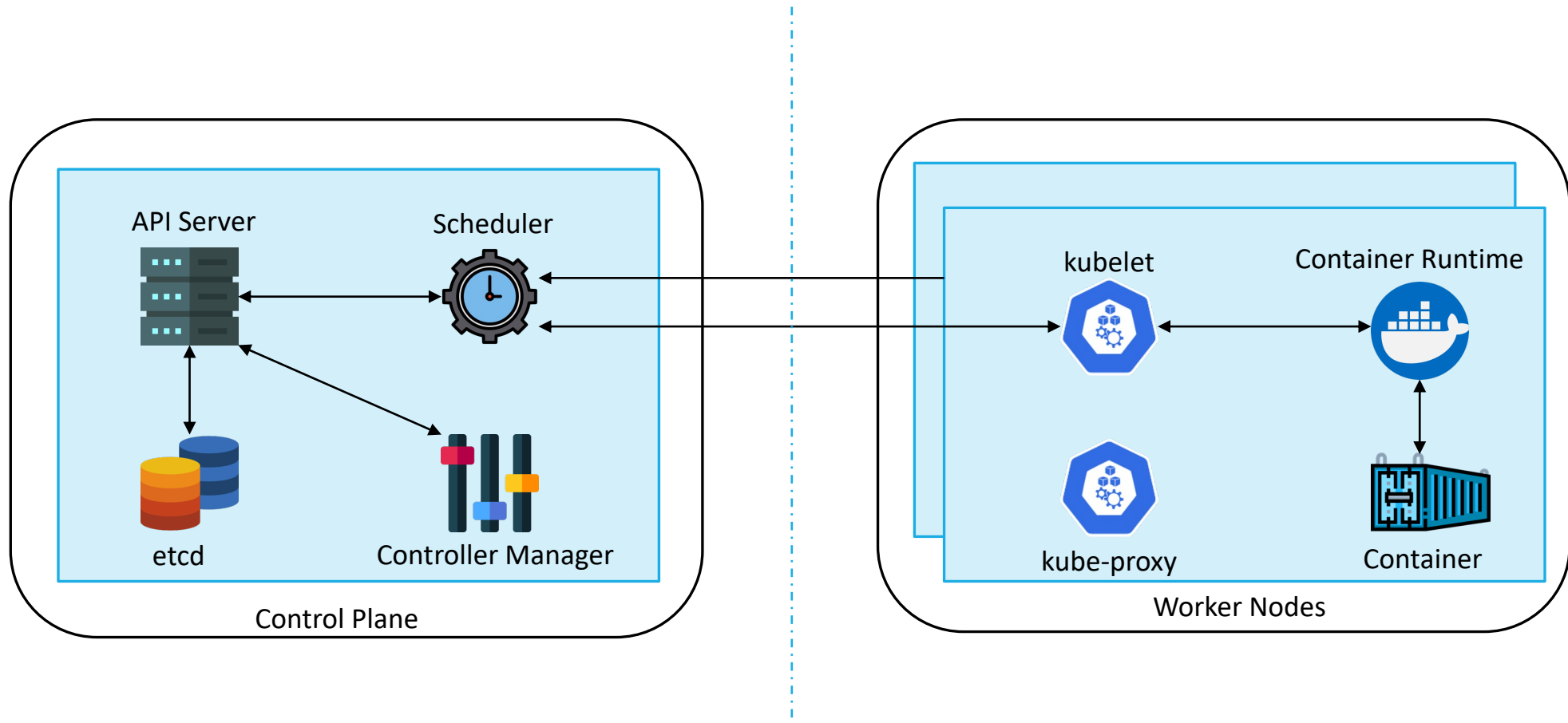
Originally written in C++, the current system is written in Go language.



Kubernetes Architecture – Big Picture



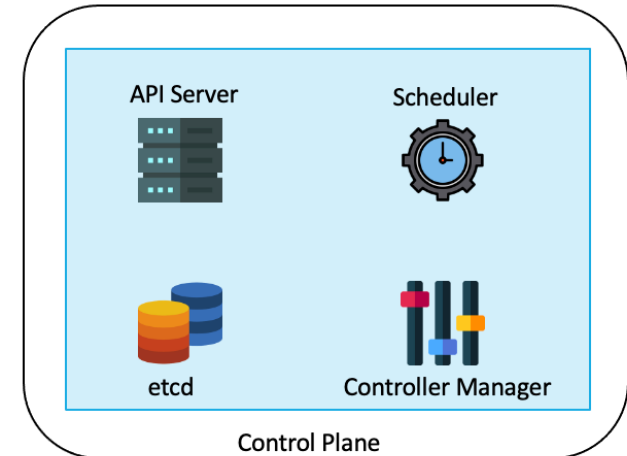
Kubernetes Architecture



Kubernetes Components

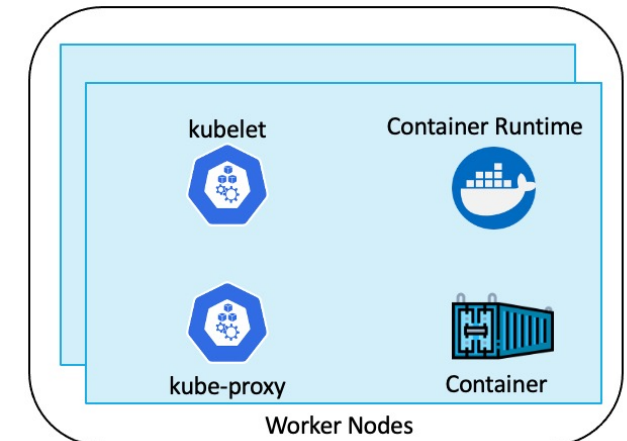
1. Control Plane: manages the agent nodes and the pods in the cluster

- **api-server**: front end of the Kubernetes control plane; exposes Kubernetes API
- **controller-manager**: runs the controller processes
- **scheduler**: tracks newly created pods and selects node to run them on
- **etcd**: stores the state of the cluster (config, running workloads status, etc.)



2. Worker nodes: run your application workloads

- **Pods**: a collection of containers co-located on a single machine
- **kube-proxy**: a network proxy that runs on each node in a cluster
- **kubelet**: agent that runs on each node in a cluster; ensures containers are running in a pod
- **Containers**: software responsible for running containers



Kubernetes Core Concepts

Pods are smallest unit in Kubernetes providing an abstraction over containers. Pods are ephemeral and get their own IP Address.

Services provide a persistent IP Address for a set of pods running an application and acts like a load balancer. The lifecycle of a service is not linked to the lifecycle of a pod.

Ingress exposes HTTP and HTTPS routes from outside the cluster to services within the cluster.

ConfigMaps are text-based key-value stores to store the external configuration for your application.

Secrets are base-64 encoded store for confidential data like passwords and secrets.

Volumes offer data storage for persistent data that needs to exist beyond the lifecycle of a pod.

Kubernetes Core Concepts

A **ReplicaSet**'s purpose is to maintain a stable set of replica Pods running at any given time.

A **Deployment** provides declarative updates for Pods and ReplicaSets.

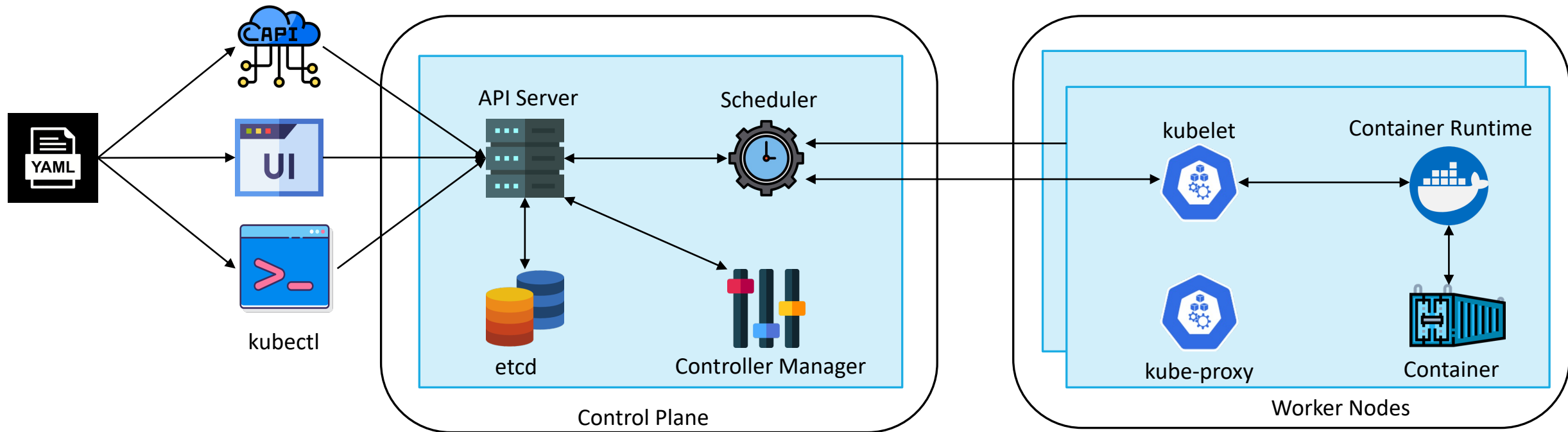
A **StatefulSet** is similar to deployment, but it maintains a sticky identity for each of their Pods.

A **DaemonSet** is used for deploying ongoing background tasks that you need to run on all or certain nodes, and which do not require user intervention.

A **Job** creates one or more Pods and continues to retry execution of the Pods until a specified number of them successfully terminate.

A **CronJob** creates Jobs on a repeating schedule.

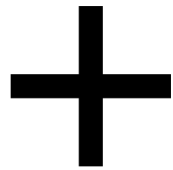
Managing Kubernetes Cluster



[GitHub - kelseyhightower/kubernetes-the-hard-way](https://github.com/kelseyhightower/kubernetes-the-hard-way): Bootstrap Kubernetes the hard way on Google Cloud Platform. No scripts.



Azure



Kubernetes



Azure Kubernetes
Service

Azure Kubernetes service

Hosted Kubernetes service in Azure

Reduces the complexity and operational overhead of managing Kubernetes

The control plane is provided as a managed Azure resource abstracted from the user

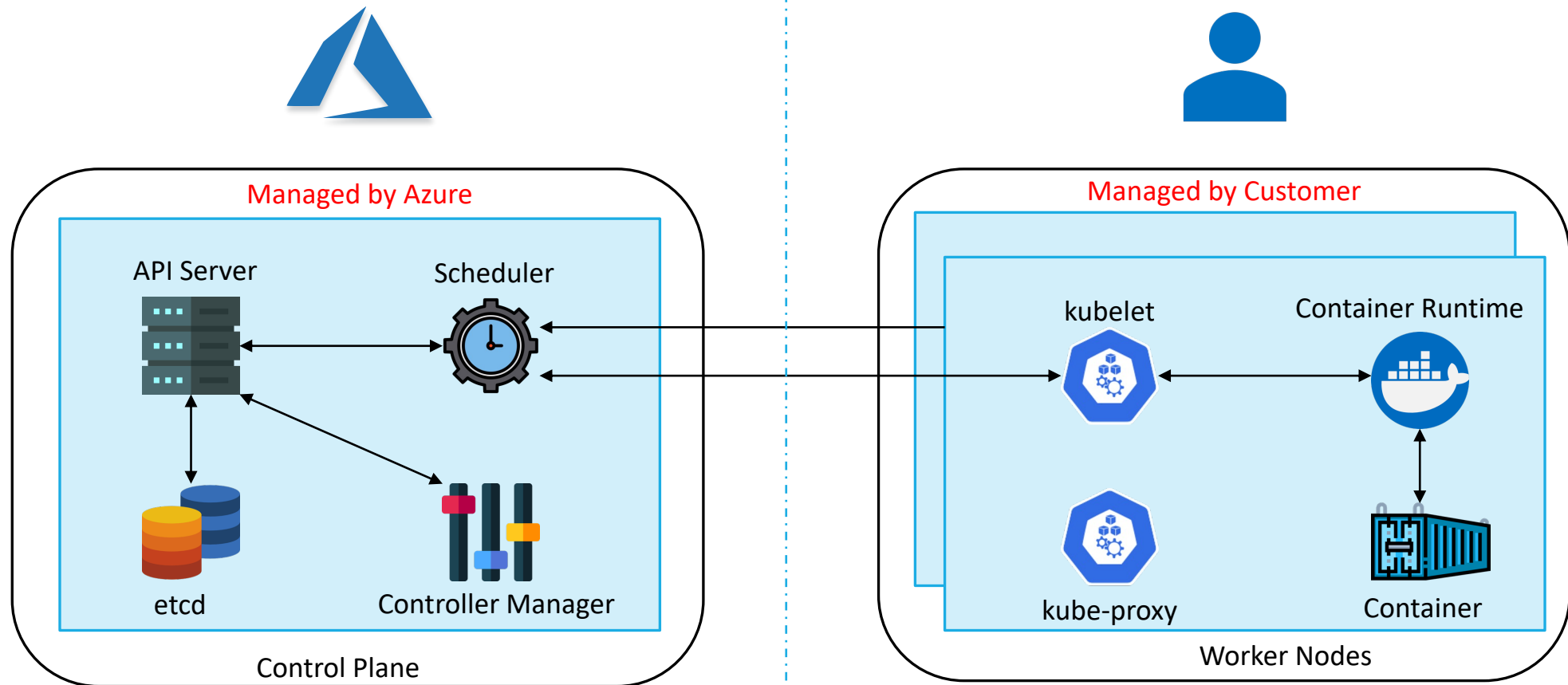
The control plane includes the core Kubernetes components like kube-apiserver, etcd, kube-scheduler and kube-controller-manager

An AKS cluster has one or more worker nodes, which is an Azure virtual machine (VM) that runs the Kubernetes node components and container runtime

You only pay for worker nodes and control plane comes at no charge to you

<https://docs.microsoft.com/en-us/azure/aks/>

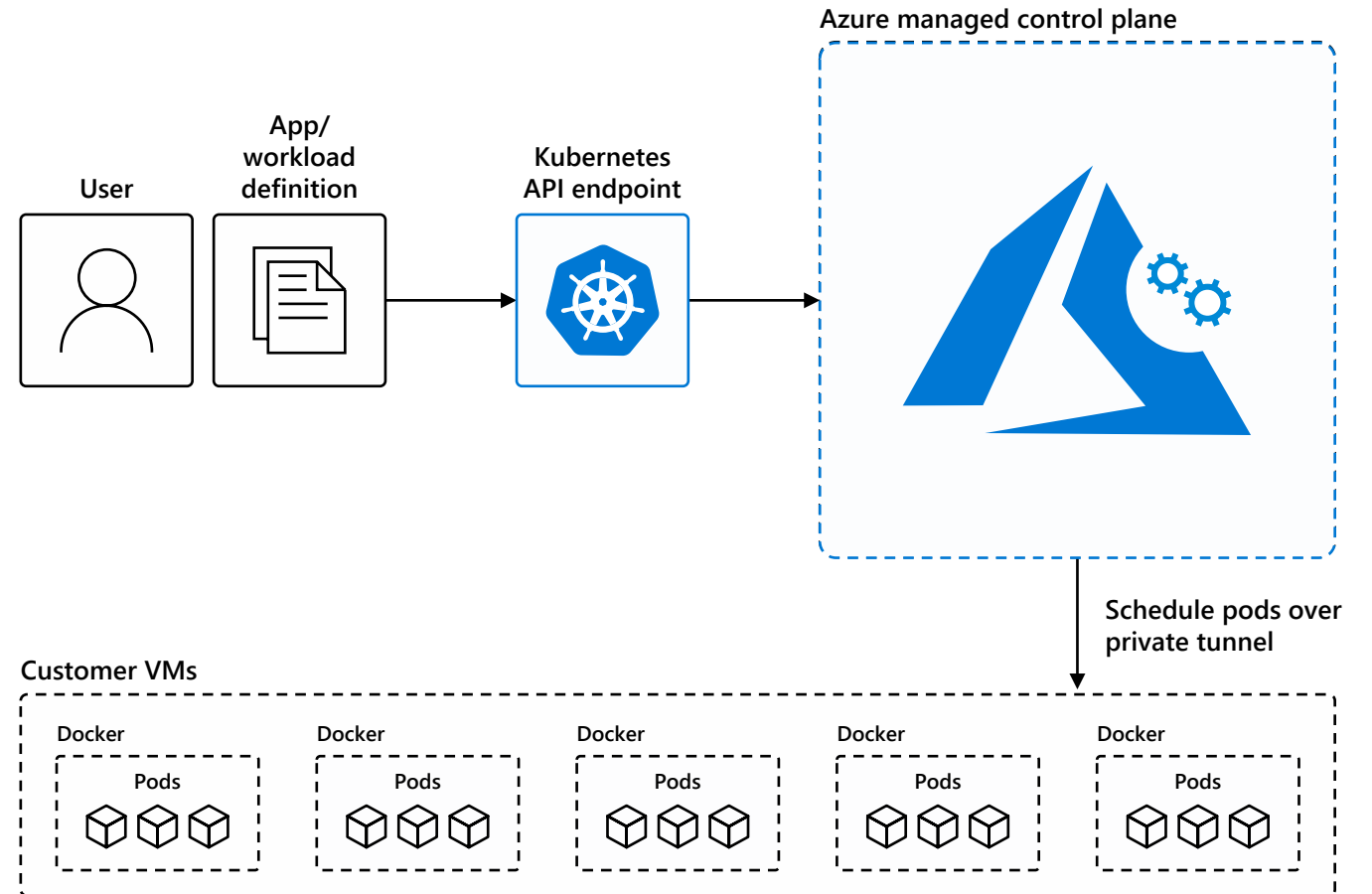
Azure Kubernetes Service



Shared Responsibility

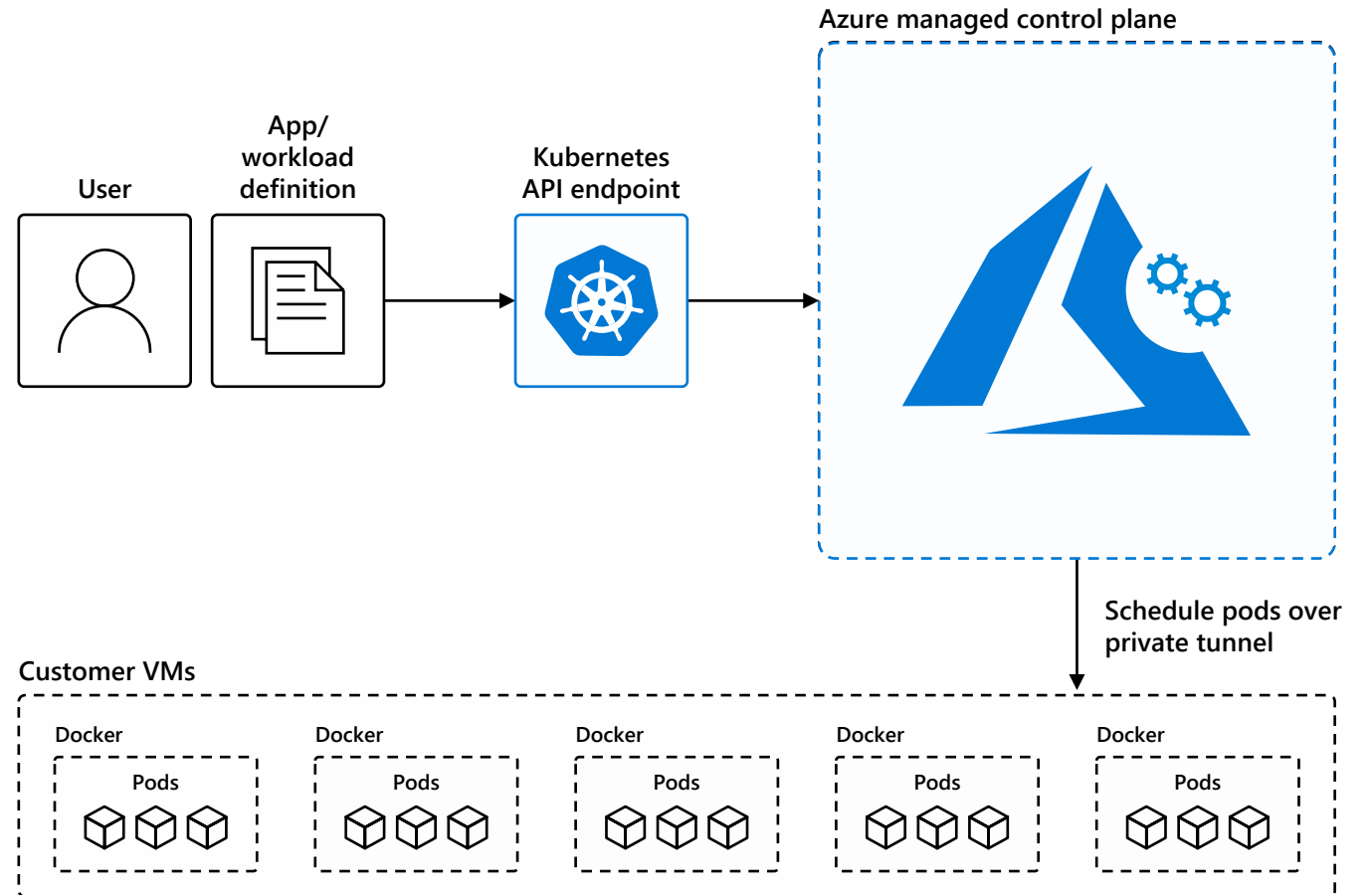
Responsibilities	DIY with Kubernetes	Managed Kubernetes on Azure
Containerization	■	■
Application iteration, debugging	■	■
CI/CD	■	■
Provisioning, upgrades, patches	■	■
Reliability availability	■	■
Scaling	■	■
Monitoring and logging	■	■

■ Customer ■ Microsoft



Benefits of AKS

- Automated upgrades, patches
- High reliability, availability
- Easy, secure cluster scaling
- Self-healing
- API server monitoring
- At no charge



Create/Configure AKS Cluster

1. Using Azure Command Line Interface (CLI)

```
az aks create --resource-group myResourceGroup --name myAKSCluster --node-count 1 --generate-ssh-keys
```

2. Using Azure PowerShell

```
New-AzAksCluster -ResourceGroupName myResourceGroup -Name myAKSCluster -NodeCount 1
```

3. Using Azure Portal




4. Using ARM Templates and Bicep

5. Using Azure REST API

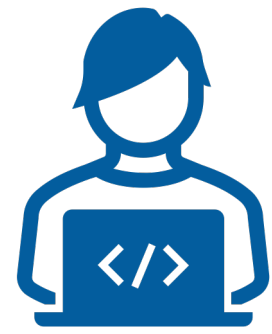
PUT

```
https://management.azure.com/subscriptions/{subscriptionId}/resourceGroups/{resourceGroupName}/  
providers/Microsoft.ContainerService/managedClusters/{resourceName}?api-version=2021-05-01
```


Manage Azure Kubernetes Service

 Task	 The Old Way	 With Azure
Create a cluster	<ul style="list-style-type: none">Provision network and VMsInstall dozens of system components including etcdCreate and install certificatesRegister agent nodes with control plane	<code>az aks create</code>
Upgrade a cluster	<ul style="list-style-type: none">Upgrade your master nodesCordon/drain and upgrade Agent nodes individually	<code>az aks upgrade</code>
Scale a cluster	<ul style="list-style-type: none">Provision new VMsInstall system componentsRegister nodes with API server	<code>az aks scale</code>

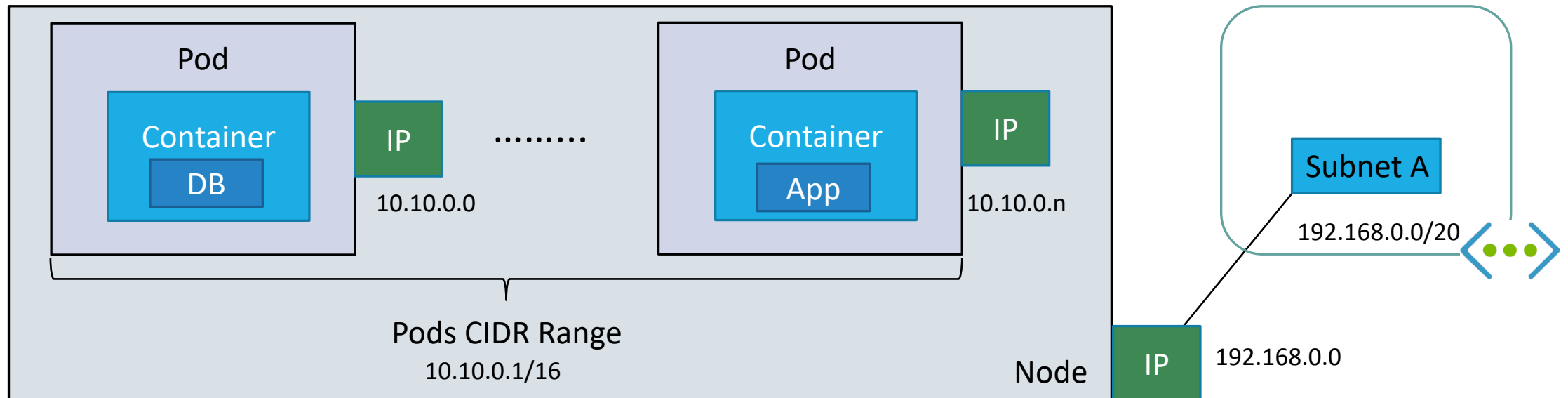
DEMO

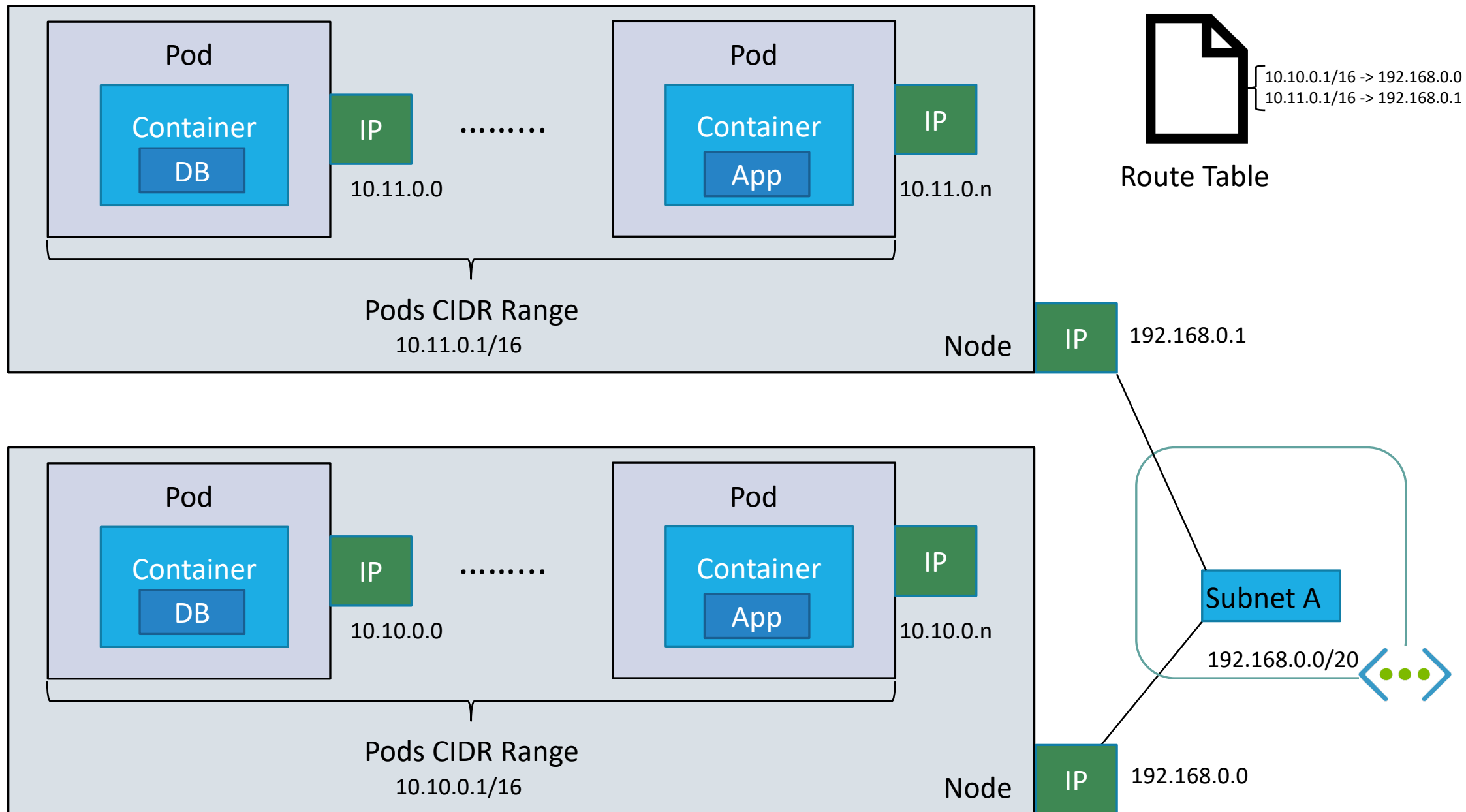


AKS Networking

Two different options -

1. **Kubenet networking** - The network resources are typically created and configured as the AKS cluster is deployed.

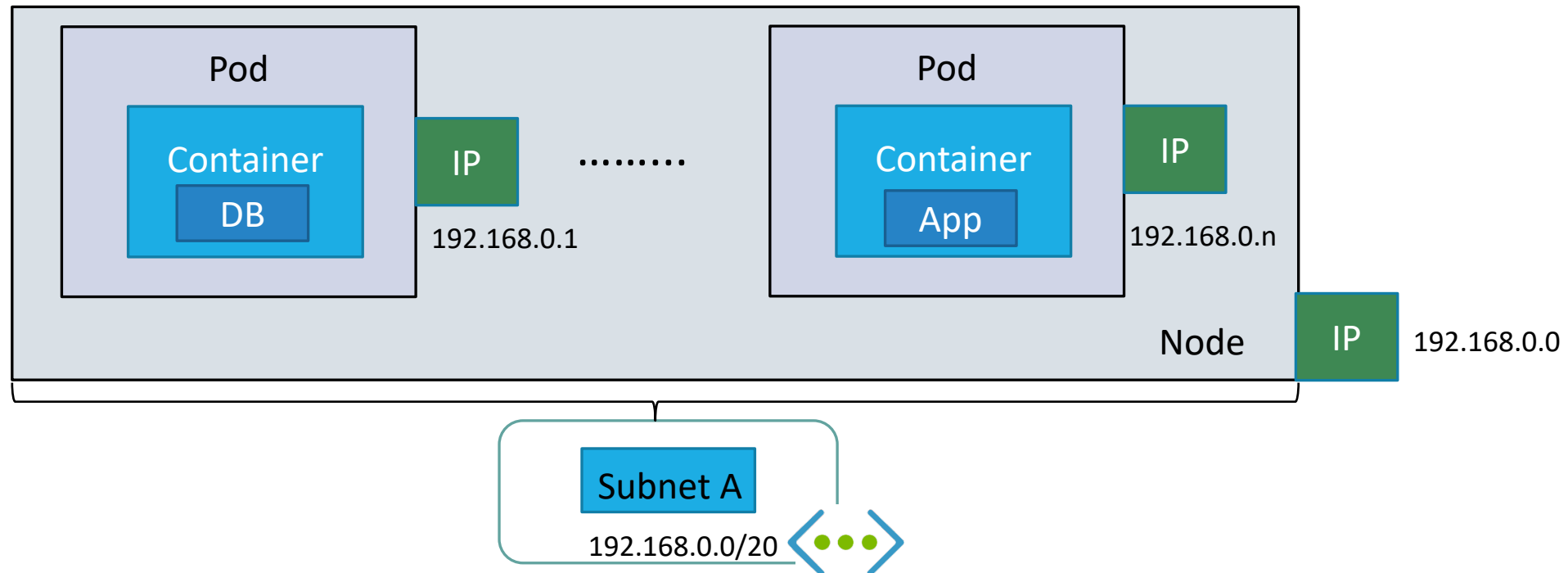




AKS Networking

Two different options -

2. **Azure Container Networking Interface (CNI) networking** - The AKS cluster is connected to existing virtual network resources and configurations.



AKS Security

Enforce compliance rules with Azure Policy

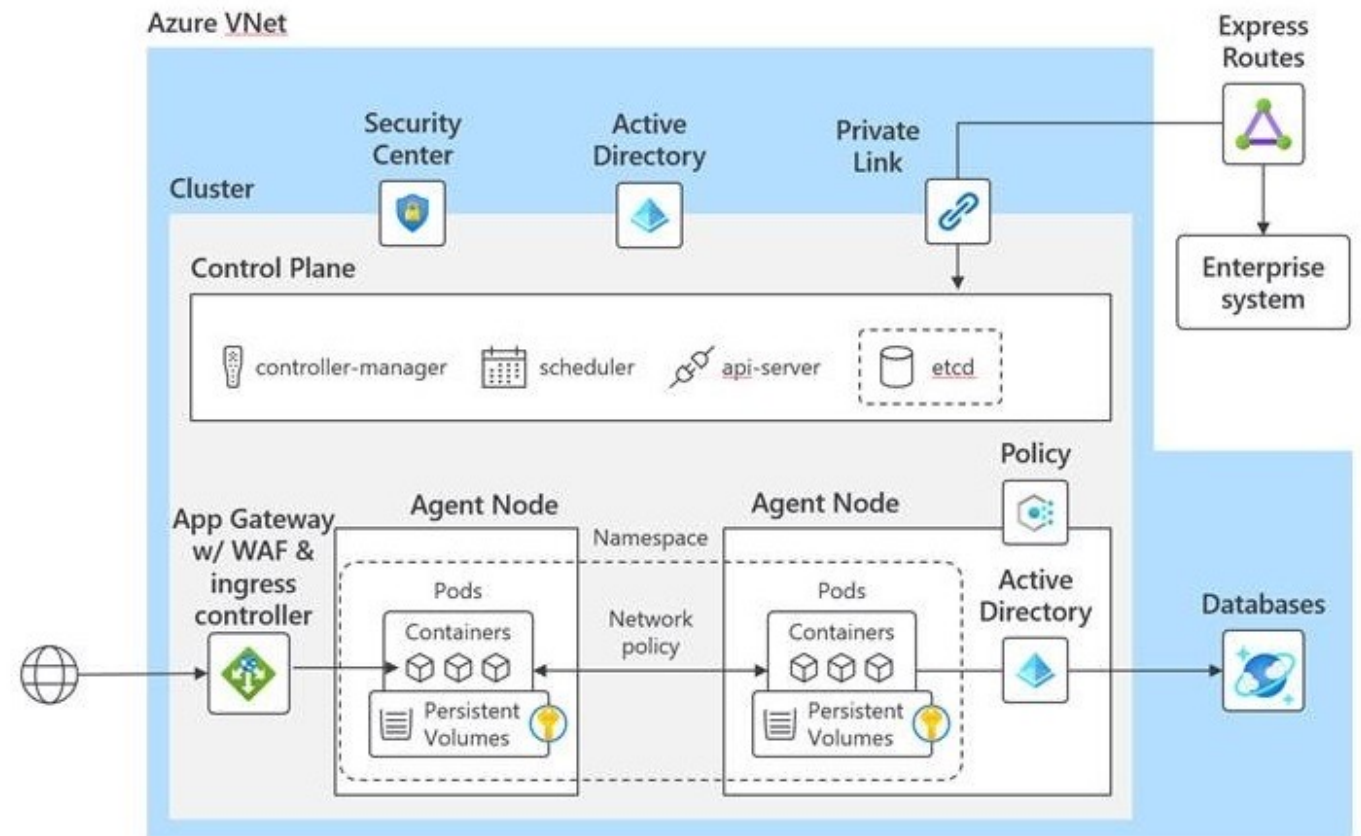
Identity and access control using Azure Active Directory

Encrypt using your own keys, stored in Azure Key Vault

Gain unmatched security management with Azure Security Center integration

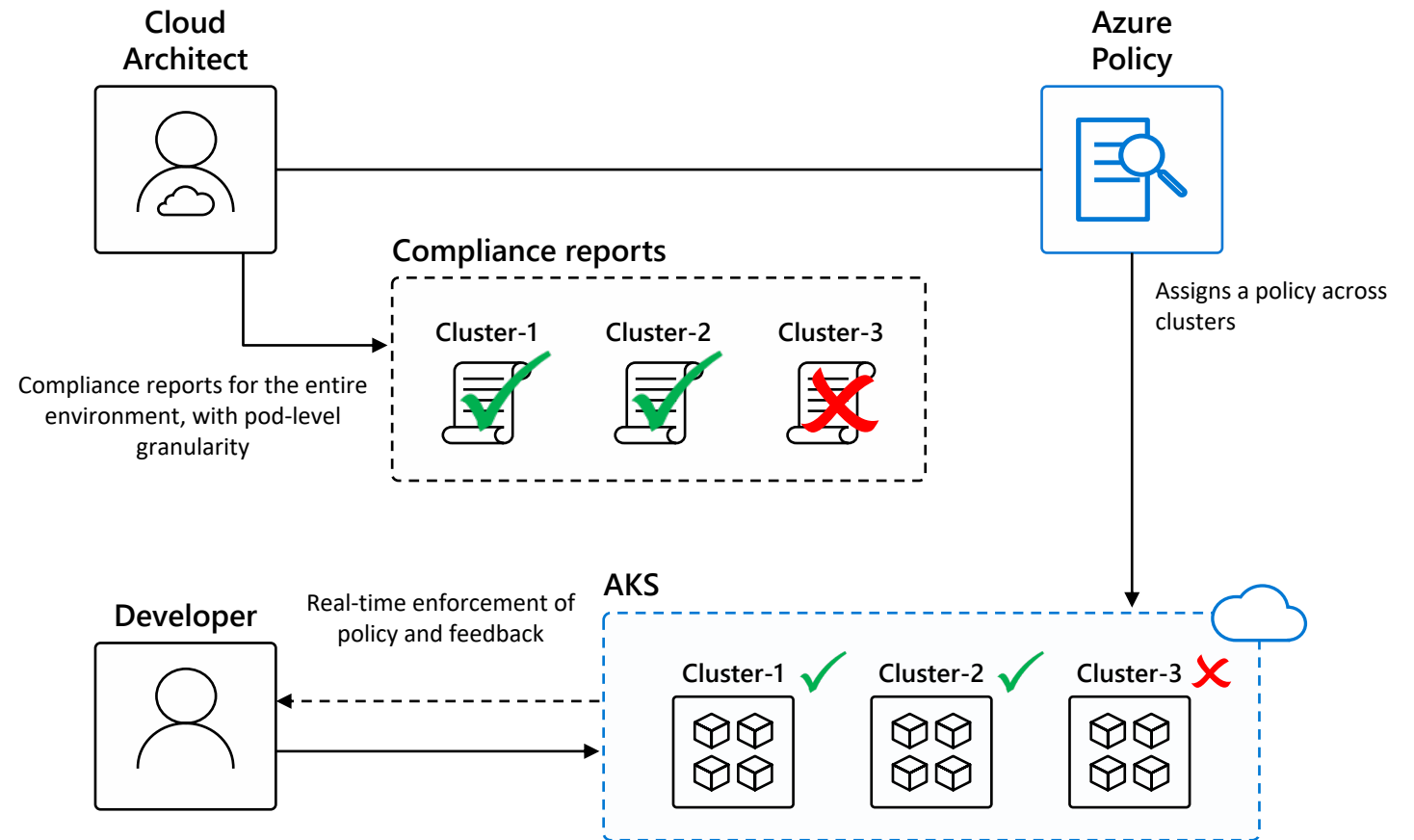
Interact securely with Kubernetes API server using Azure Private Link

Use application gateway (and WAF) with Ingress Controller

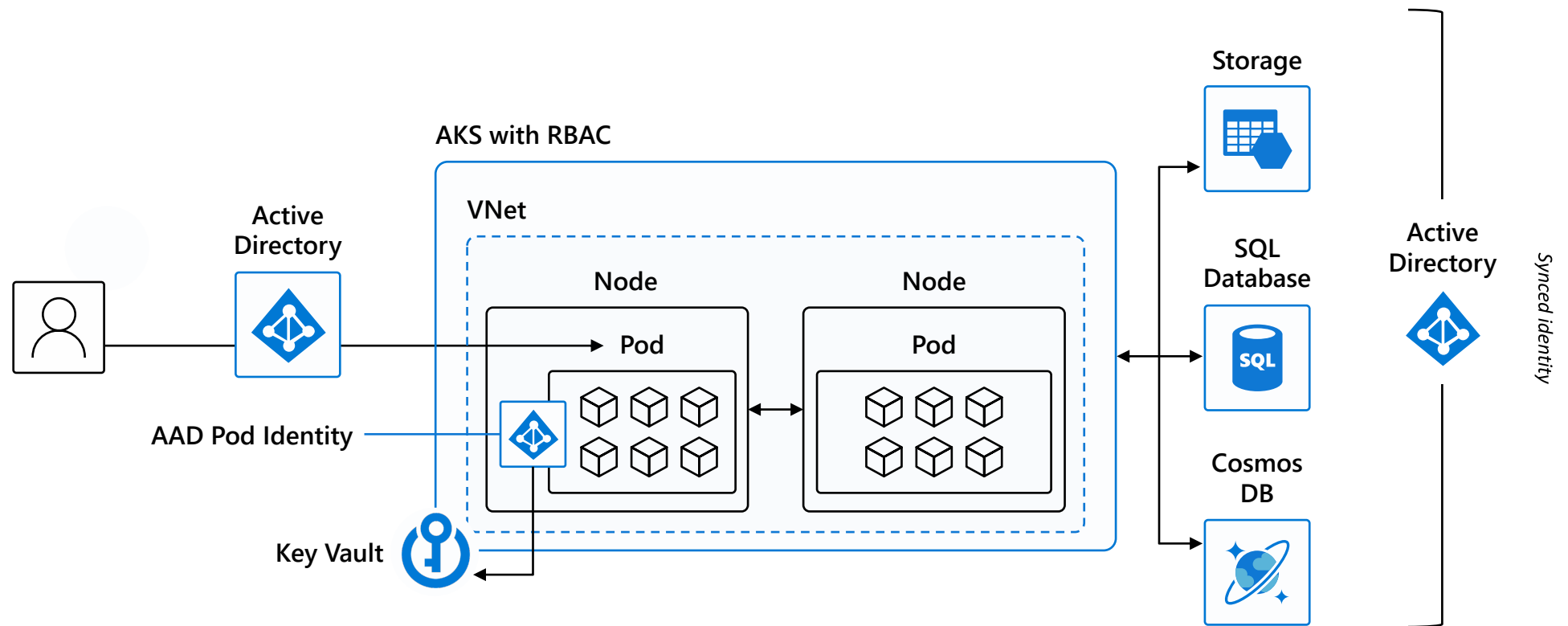


AKS Governance with Azure Policies

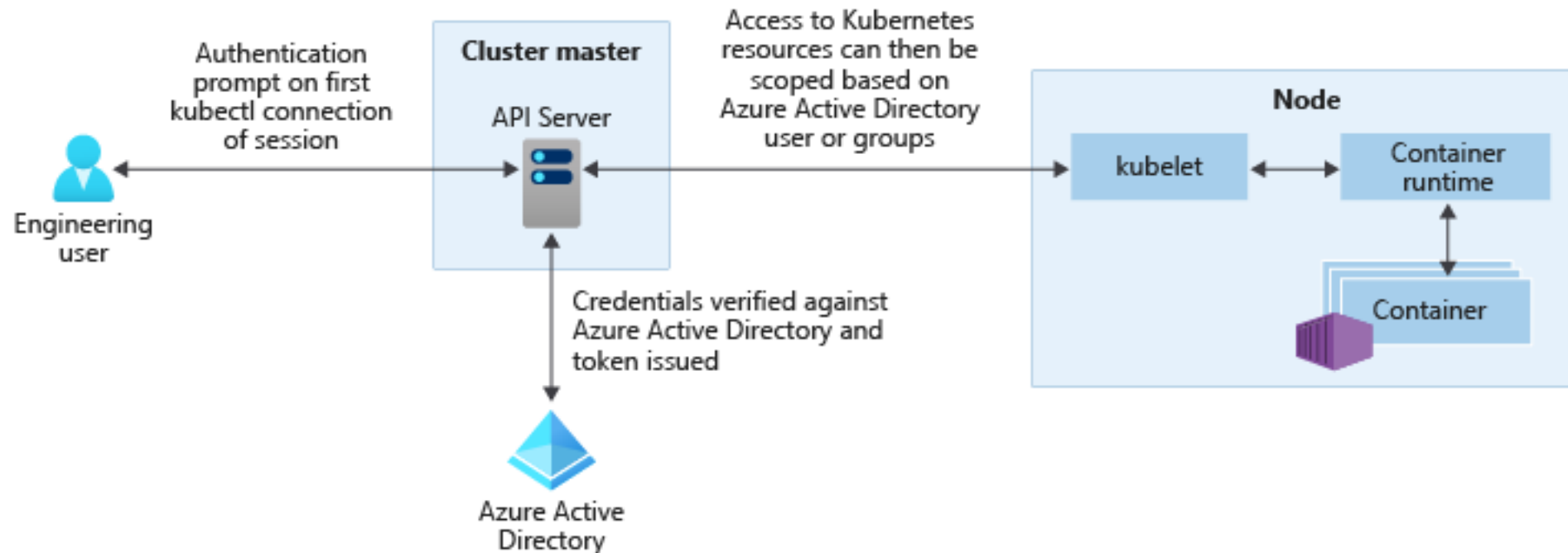
1. Cloud architect assigns a deployment policy across cluster(s)
2. Developer uses standard Kubernetes API to deploy to the cluster
3. Real-time deployment enforcement (acceptance/denial) provided to developer based on policy
4. Cloud architect obtains compliance report for the entire environment and can drill down to individual pod level



AKS Identity and Management



AKS Identity and Management

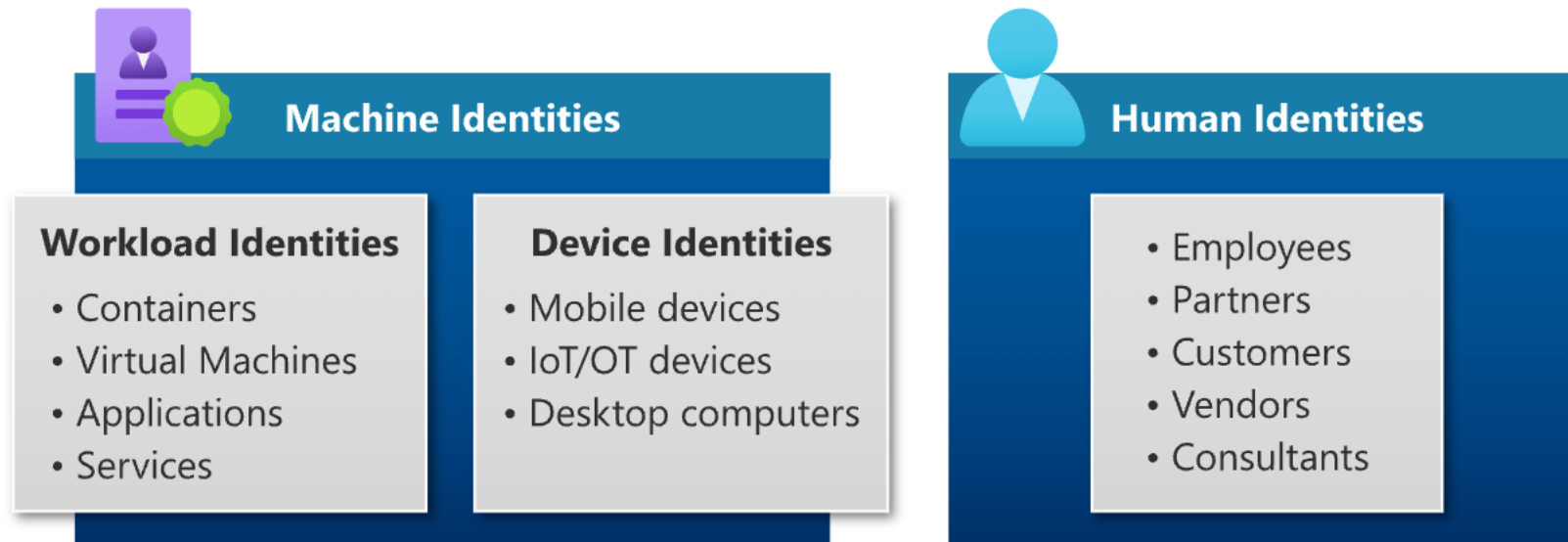


<https://docs.microsoft.com/en-us/azure/aks/concepts-identity#azure-ad-integration>

Azure AD Workload Identities

Used by a software workload (such as an application, service, script, or container) to authenticate and access other services and resources.

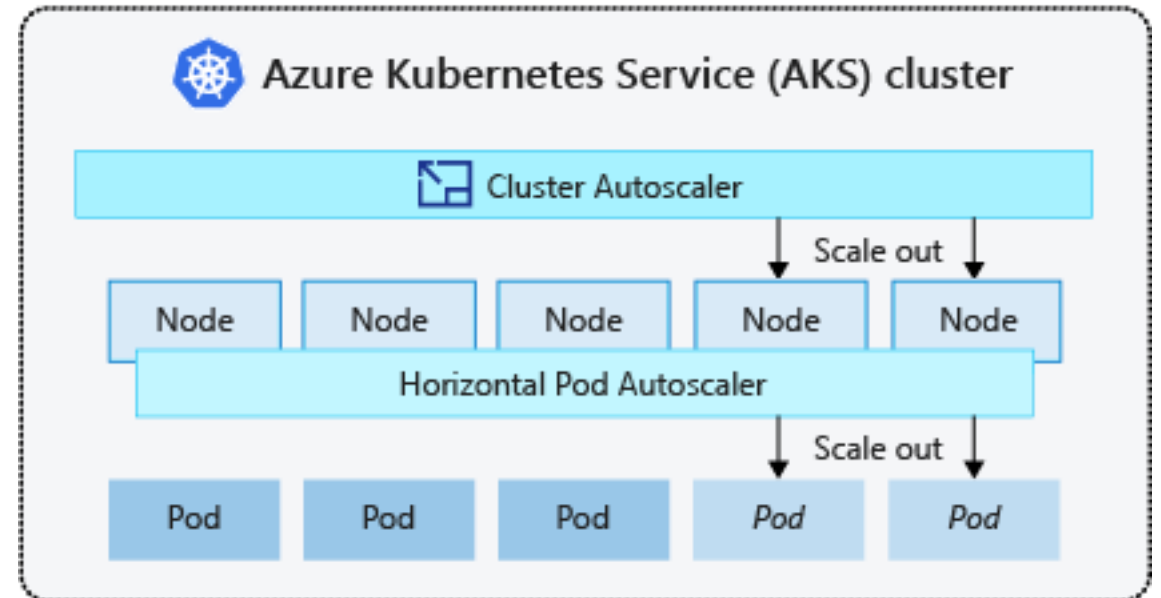
In Azure Active Directory (Azure AD), workload identities are applications, service principals, and managed identities.



AKS Auto-scaling

The **cluster autoscaler** watches for pods that can't be scheduled on nodes because of resource constraints. The cluster then automatically increases the number of nodes.

The **horizontal pod autoscaler** uses the Metrics Server in a Kubernetes cluster to monitor the resource demand of pods. If an application needs more resources, the number of pods is automatically increased to meet the demand.



Kubernetes-based event-driven auto-scaling (KEDA)

Open-source component jointly built by Microsoft and RedHat

Event-driven container creation & scaling

Allows containers to “scale to zero” until an event comes in, which will then create the container and process the event, resulting in more efficient utilization and reduced costs

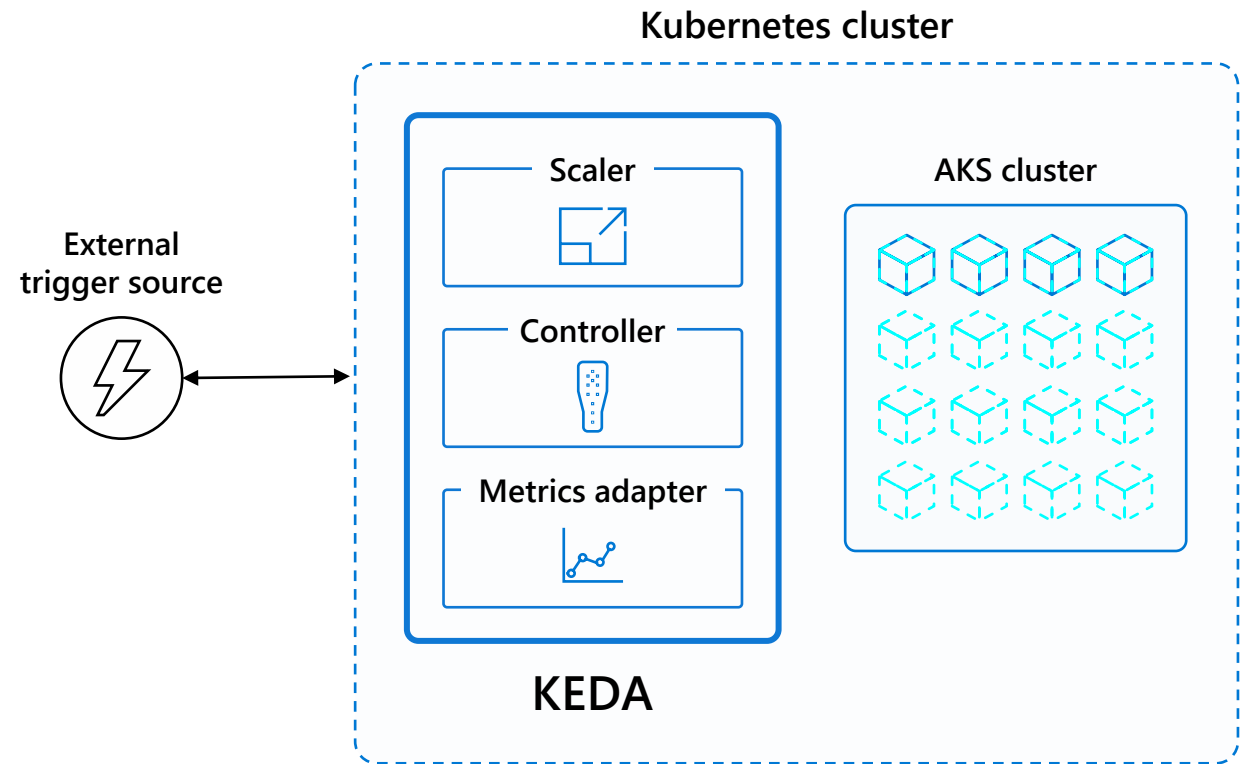
Native triggers support

Containers can consume events directly from the event source, instead of routing events through HTTP

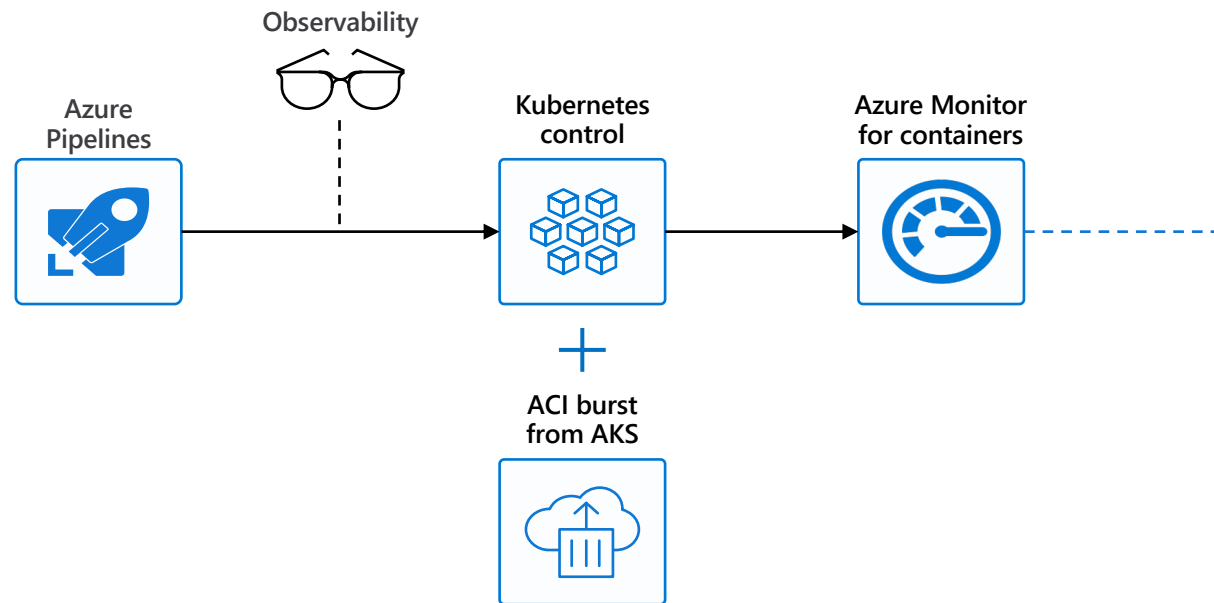
Can be used in any Kubernetes service

This includes in the cloud (e.g., AKS, EKS, GKE, etc.) or on-premises with OpenShift—any Kubernetes workload that requires scaling by events instead of traditional CPU or memory scaling can leverage this component.

<https://docs.microsoft.com/en-us/azure/azure-functions/functions-kubernetes-keda>



Azure Monitor for Containers



Visualization

Visualize overall health and performance from clusters to containers with drill downs and filters

Insights

Provide insights with multi-cluster health roll up view

Monitor & Analyze

Monitor and analyze Kubernetes and container deployment performance, events, health, and logs

Response

Native alerting with integration to issue managements and ITSM tools

Observability

Observe live container logs on container deployment status

AKS Diagnostics


Faster resolution of common issues with an intelligent, self-diagnostic experience right in the portal


Cluster-specific observations






Recommended actions for troubleshooting





AKS diagnostics

Sample diagnostics web portal

 **Cluster Node Issues** Node Issues Detected
One or more **Node based Issues** have been detected.

 **Successful Checks (15)**
Tests that succeeded

Checks	Description
 Cluster Management	Our analysis did not find any issues in this category. Please click for recom
 CoreDNS Upgrade Breaking Change	CoreDNS is not using the proxy plugin
 Cluster Certificates	No cluster certificate issues detected.
 Node Drain Failures	We found no obvious issues with Node Drain Failures
 AKS-managed AAD Integration Issues	Your cluster is not configured to use AKS-managed AAD integration

-  Zero configuration and zero cost
-  Intelligent detectors based on AKS-specific telemetry
-  Cluster-specific observations
-  Recommended actions for troubleshooting

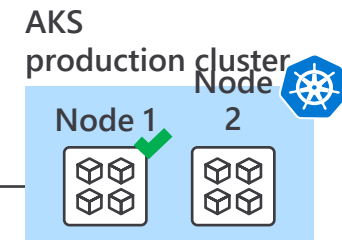
Azure portal



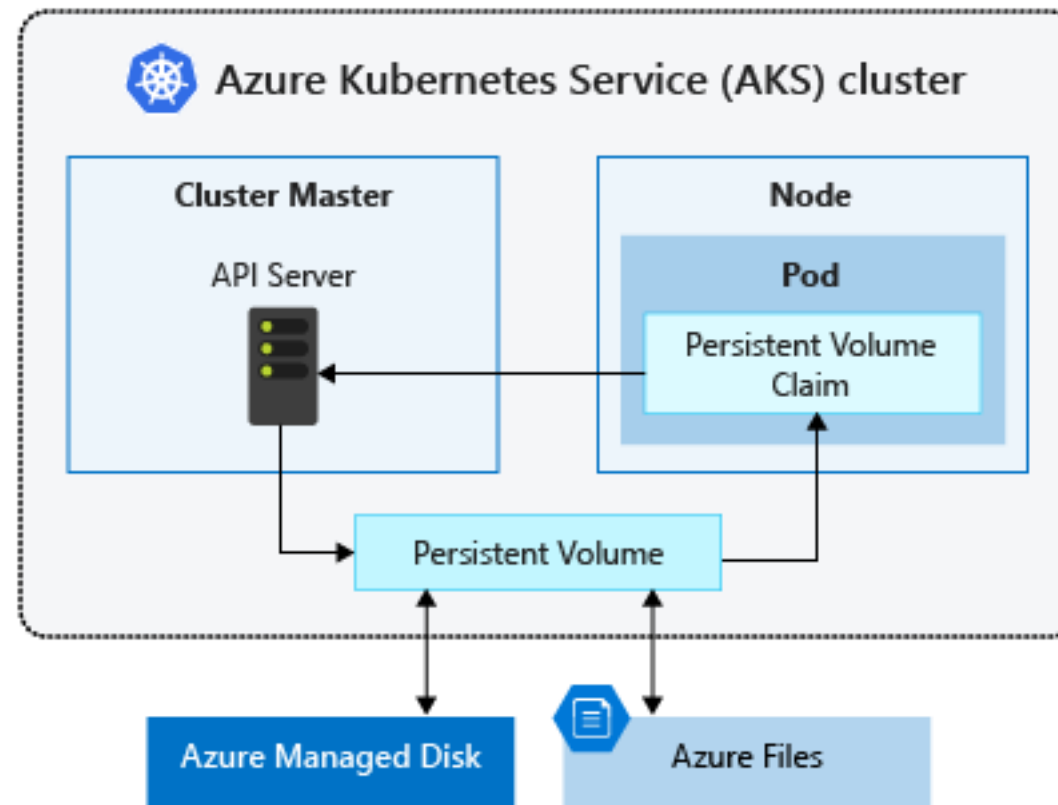
User



Azure backend telemetry



AKS Storage Options



Azure Container registry

First-class Azure resource

Managed, private Docker registry service based on the open-source Docker Registry 2.0.

Can be used with existing container development and deployment pipelines

Use Azure Container Registry Tasks to build container images in Azure

Three pricing tiers:

1. Basic
2. Standard
3. Premium

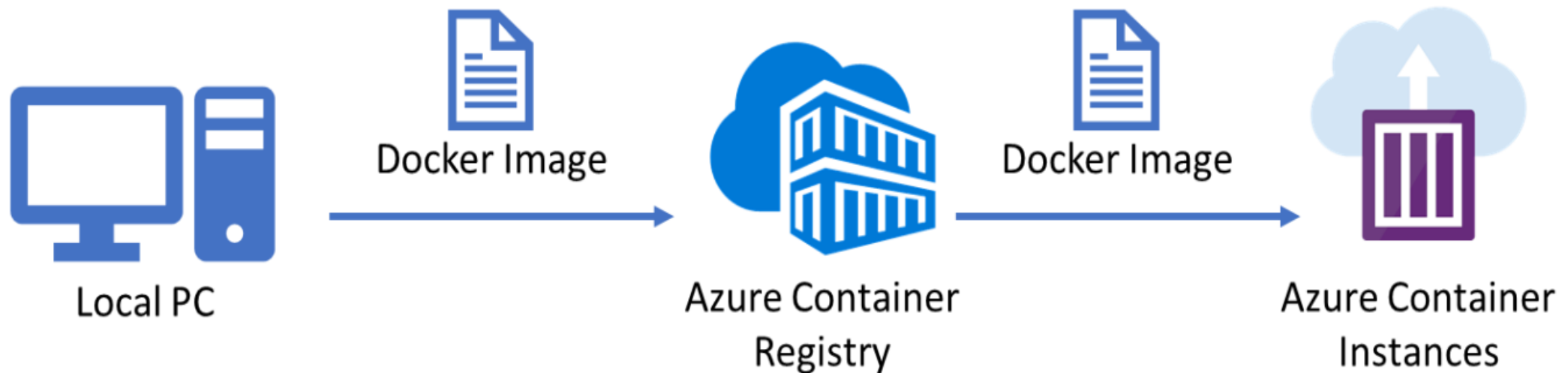
<https://azure.microsoft.com/en-us/pricing/details/container-registry/>

<https://docs.microsoft.com/en-us/azure/container-registry/container-registry-skus>

Azure container instances

Fastest and simplest way to run a container in Azure

<https://docs.microsoft.com/en-us/azure/container-instances/>

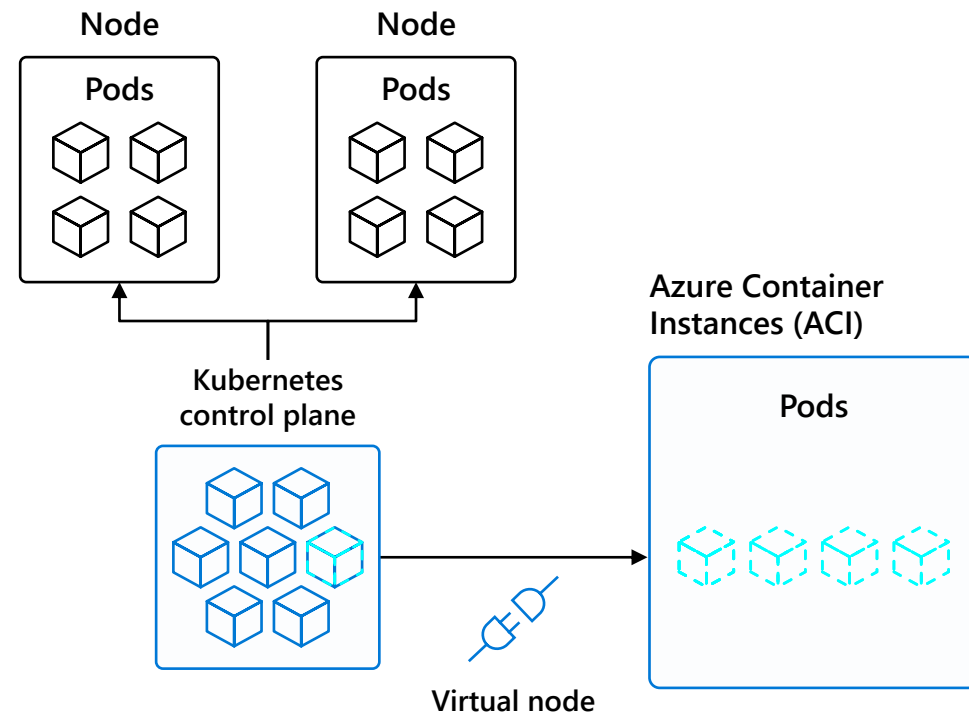


Serverless Kubernetes with Virtual Nodes

Elastically provision compute capacity in seconds

No infrastructure to manage

Built on open sourced Virtual Kubelet technology, donated to the Cloud Native Computing Foundation (CNCF)

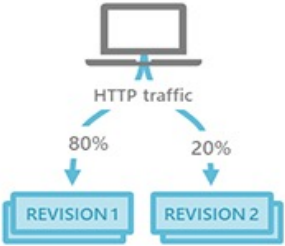


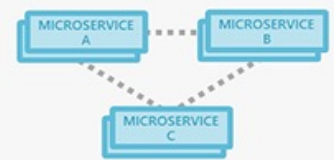


Azure Container Apps

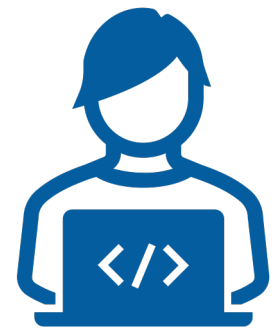
Azure Container Apps enables you to run microservices and containerized applications on a serverless platform.



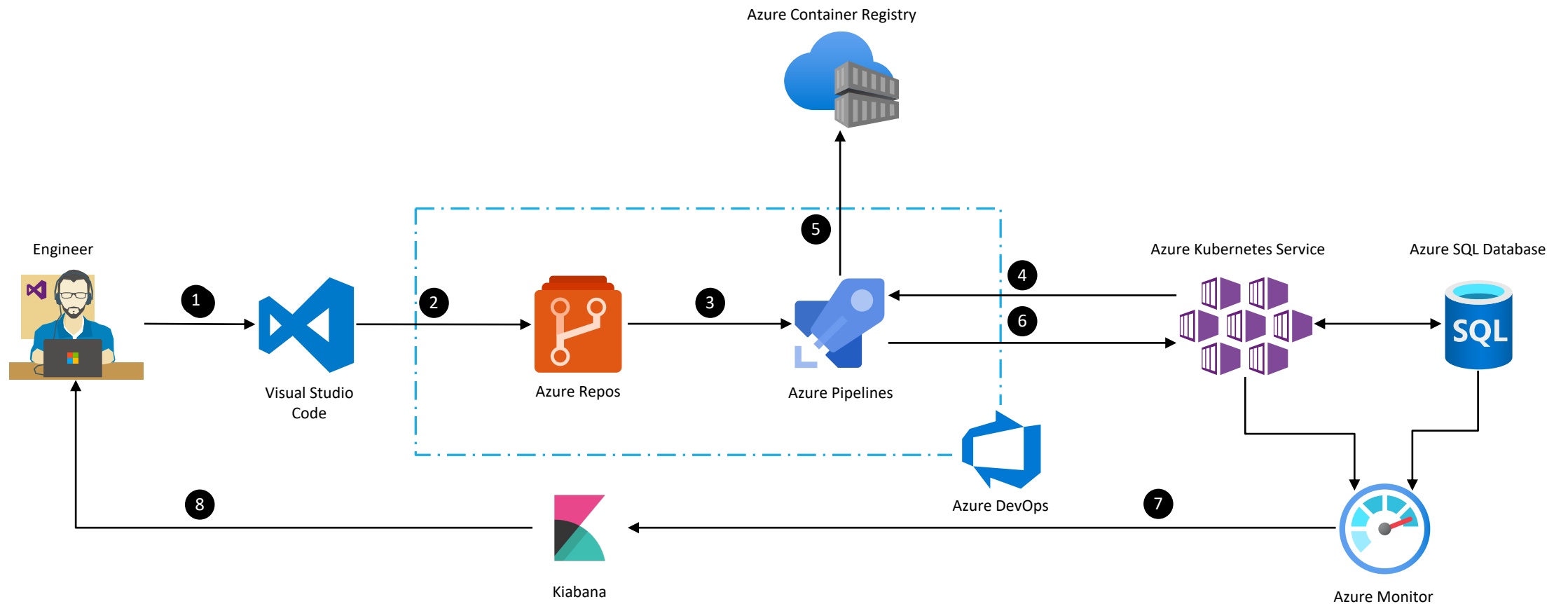
Azure Container Apps: Example scenarios

PUBLIC API ENDPOINTS	BACKGROUND PROCESSING	EVENT-DRIVEN PROCESSING	MICROSERVICES
			
HTTP requests are split between two versions of the container app where the first revision gets 80% of the traffic, while a new revision receives the remaining 20%.	A continuously-running background process that transforms data in a database.	A queue reader application that processes messages as they arrive in a queue.	Deploy and manage a microservices architecture with the option to integrate with Dapr.
AUTO-SCALE CRITERIA	AUTO-SCALE CRITERIA	AUTO-SCALE CRITERIA	AUTO-SCALE CRITERIA
Scaling is determined by the number of concurrent HTTP requests.	Scaling is determined by the level of CPU or memory load.	Scaling is determined by the number of messages in the queue.	Individual microservices can scale according to any KEDA scale triggers.

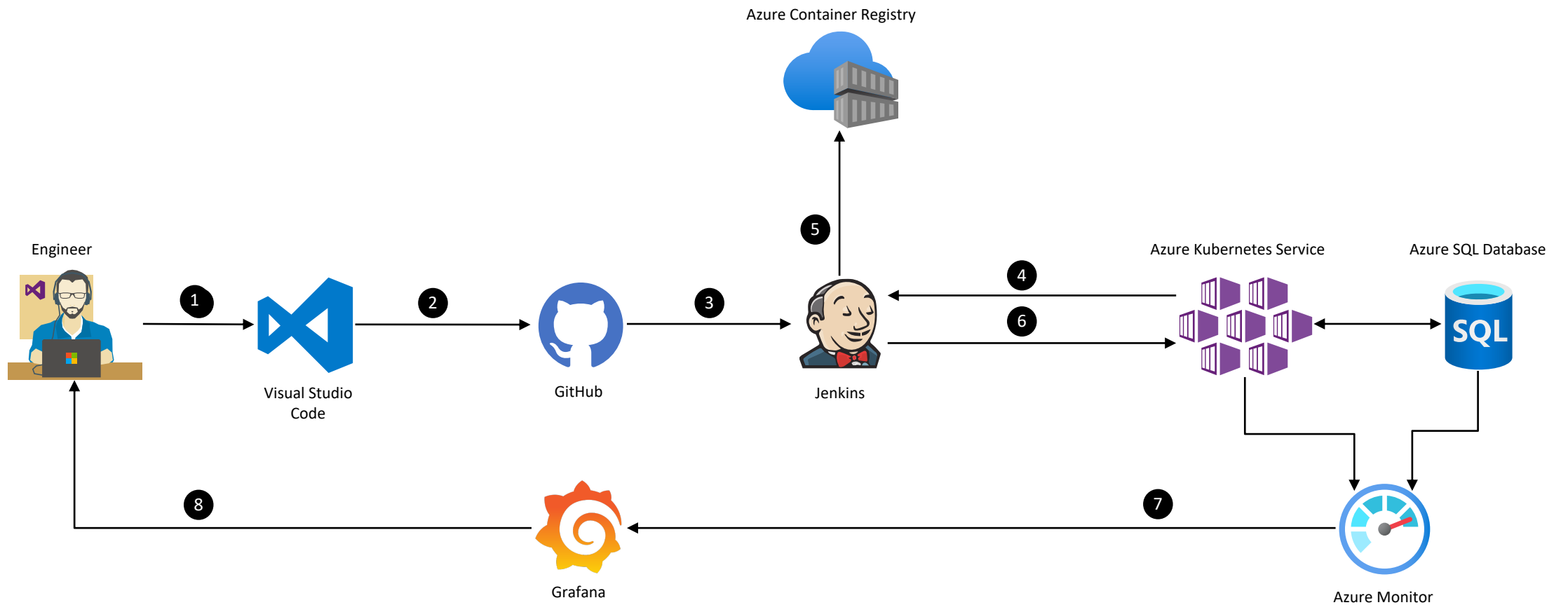
DEMO



CI/CD using Azure DevOps

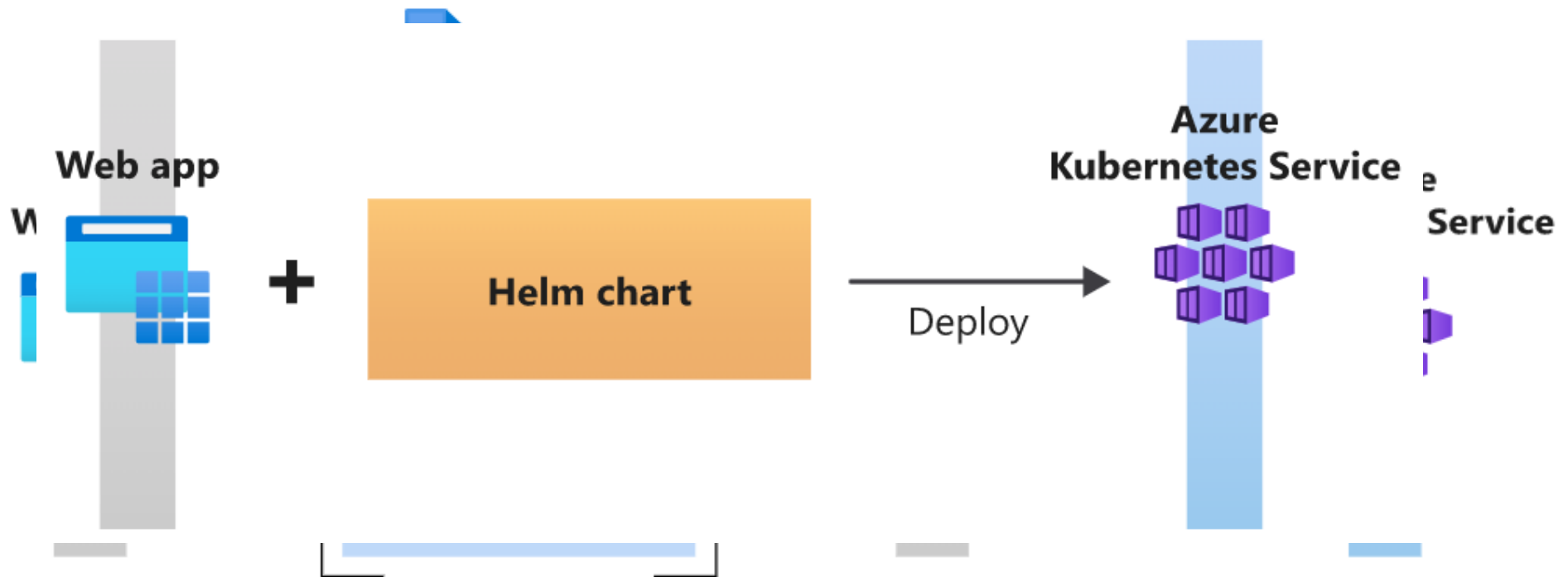


CI/CD using GitHub and Jenkins



Helm Package Manager

Helm is a package manager for Kubernetes that combines all your application's resources and deployment information into a single deployment package.



AKS – Best Practices



Networking configuration

- Network topology
- Plan the IP addresses
- Deploy Ingress resources



Cluster compute

- Compute for the base cluster
- Container image reference
- Policy management



Identity management

- Integrate Azure AD for the cluster
- Integrate Azure AD for the workload



Secure data flow

- Secure the network flow
- Add secret management



Business continuity

- Scalability
- Cluster and node availability
- Availability and multi-region support



Operations

- Cluster and workload CI/CD pipelines
- Cluster health and metrics
- Cost management and reporting

<https://docs.microsoft.com/en-us/azure/aks/best-practices>

Further Reading

Kubernetes on Azure - <https://aka.ms/K8sonAzure>

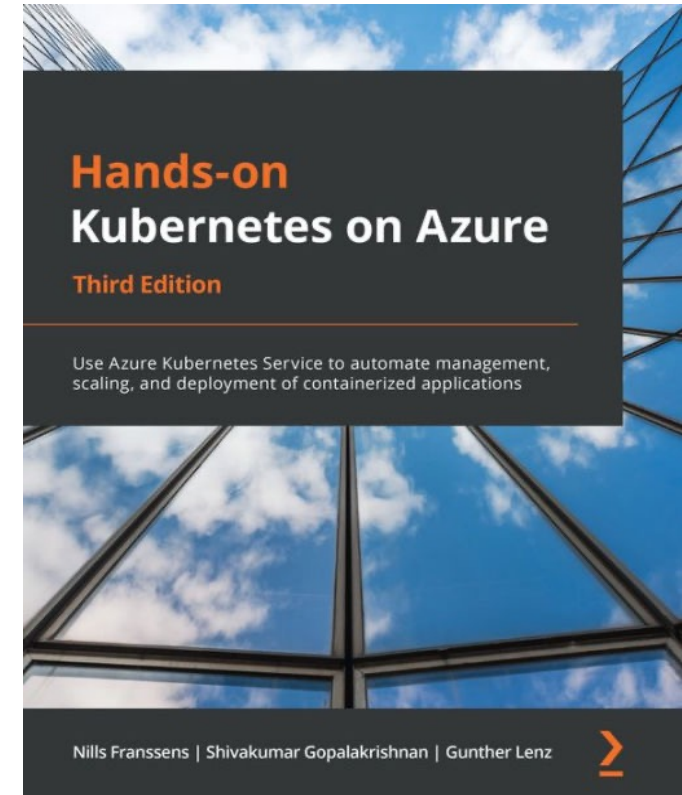
Microsoft Learn - <https://aka.ms/LearnKubernetes>

What is Kubernetes - <https://aka.ms/k8sLearning>

AKS Case Studies - <https://aka.ms/AKS/casestudy>

AKS Roadmap - <https://aka.ms/k8sroadmap>

Getting started for free - <https://aka.ms/AKS/trial>



Q&A

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