

Unleashing the Potential of Hybrid Cloud: Streamlining Multi-Cloud Management and on-Premises Integration

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Focus on Azure, Kubernetes, DevOps, and .NET

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<https://www.youtube.com/@programmingwithwolfgang>



Agenda



Introduction to Hybrid Cloud



Azure Arc and Kubernetes



Integrating On-Premises with Cloud



Real-World Examples



Conclusion





Hybrid Cloud

Hybrid Cloud Definition

Hybrid Cloud is a combination of public and private cloud services, along with on-premises infrastructure, creating a unified computing environment that offers greater flexibility, scalability, and cost-effectiveness.

Types of Hybrid Cloud

Split cloud and on-premise usage

Extend on-premise usage with simple cloud services

- Storage or database services
- VPN or ExpressRoute into the cloud

Unify on-premises and cloud environment

- Run cloud services in your datacenter

Benefits of Hybrid Cloud

Data Sovereignty

Security

Latency

Cost

Resiliency

Challenges of Hybrid Cloud

Complex infrastructure

Security and compliance

Data integration

Skill set

Run Azure Services On-Premises

Azure Stack Edge

Azure Stack Hub

Azure Stack HCI

Azure Arc

Azure Stack HCI

Azure Stack HCI OS is an operating system based on Windows Server

Built on proven technologies such as Hyper-V, Storage Spaces Direct, and Azure-inspired SDN

Each cluster consists of 1 to 16 physical servers

Often used in disconnected scenarios



Azure portal, ARM and bicep templates, Azure CLI and tools

Microsoft
Entra ID



Azure Site Recovery



Azure Backup



Azure File Sync



Azure Update Manager



Additional
Azure services
integration via
Arc



Azure Policy



Azure Monitor



Azure Key Vault



Microsoft Defender for Cloud



Azure Stack HCI solution



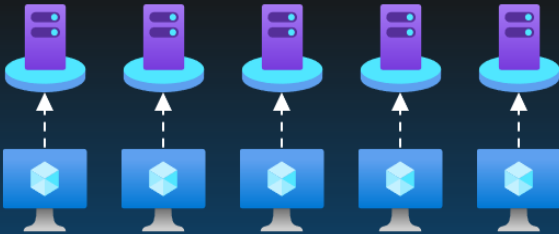
Traditional, non-containerized applications



Kubernetes-based
applications



Arc-enabled services



Windows and Linux virtual machines as Arc-enabled servers



Azure Virtual Desktop



AKS enabled by Azure Arc



Hyper-V



Storage Spaces Direct

Azure Stack HCI Operating System



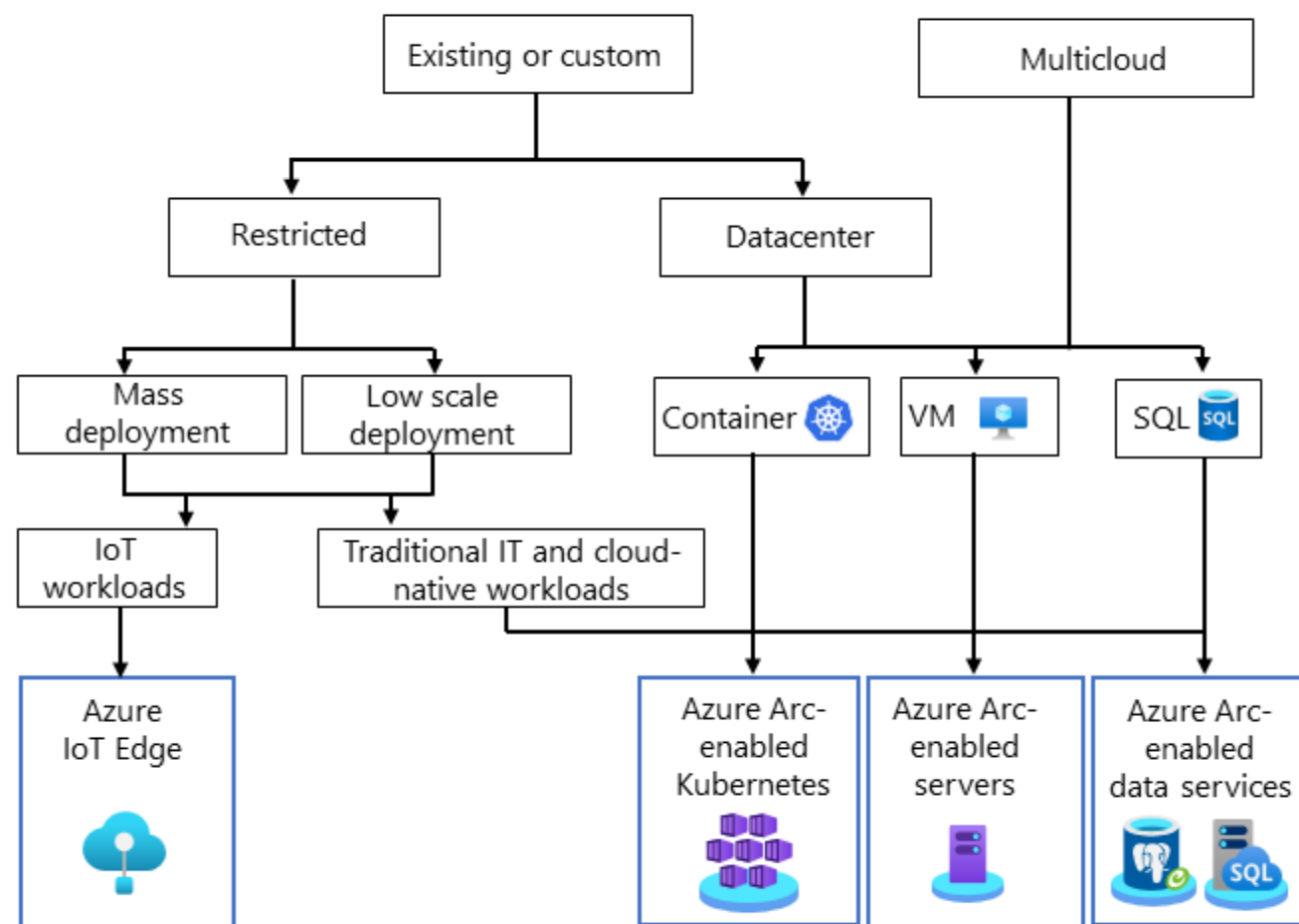
Premier solutions



Validated nodes



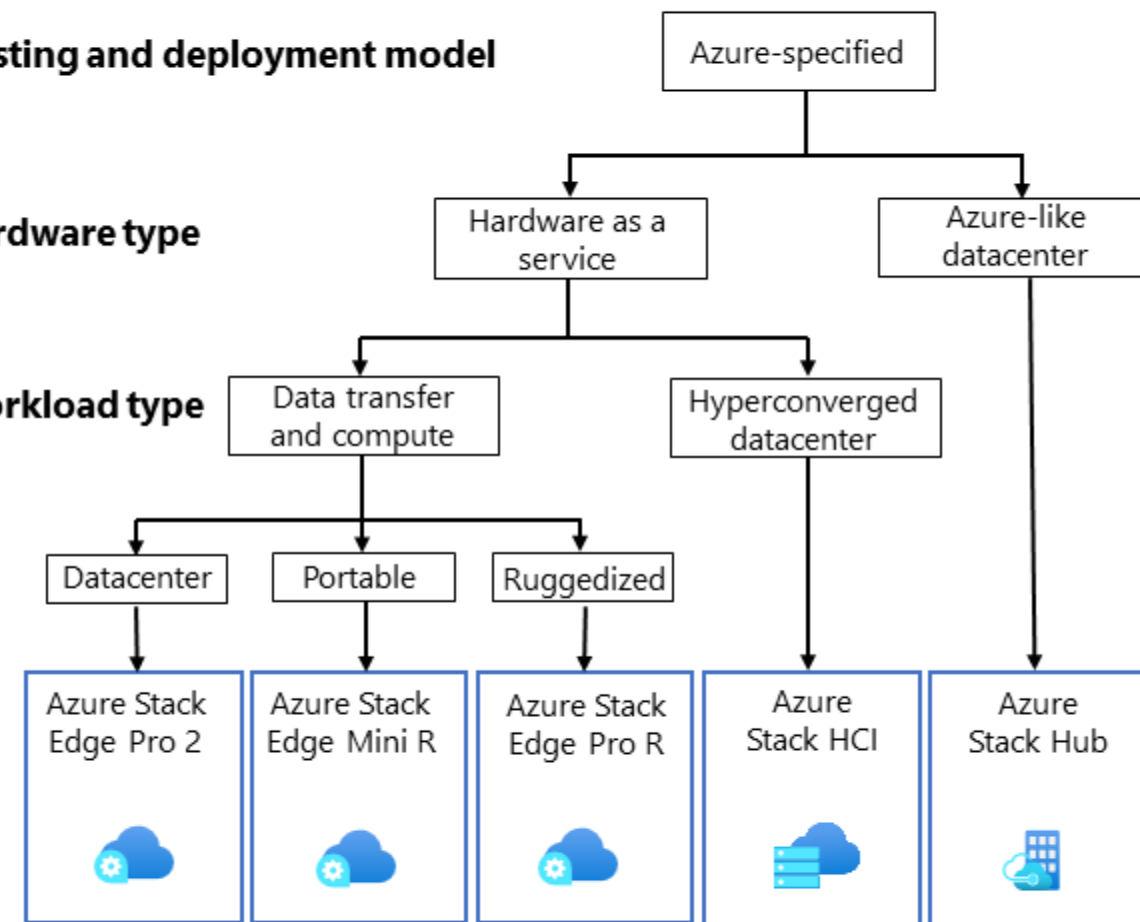
Integrated systems



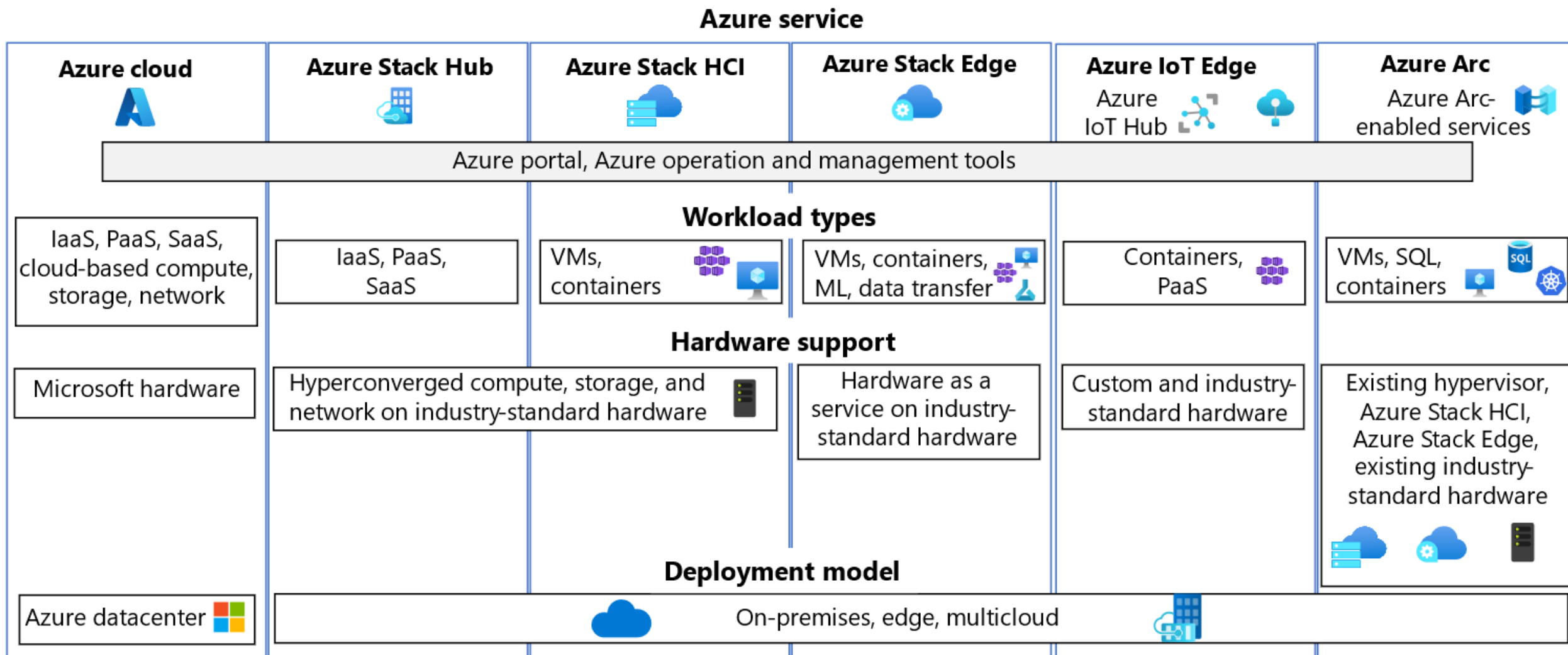
Hosting and deployment model

Hardware type

Workload type



Azure service



A decorative graphic in the bottom-left corner consisting of several overlapping, parallel lines in blue and dark gray, forming a stylized 'L' or corner shape.

Azure Arc







Azure Arc Overview

Project infrastructure running outside of Azure into Azure




- Linux and Windows VMs and bare metal servers
- Any CNCF certified Kubernetes distribution
- SQL Server

<<







[Get started](#)[Infrastructure](#)[Services](#)[Learn more](#)

-  Machines
-  Azure Arc virtual machines (preview)
-  Azure Stack HCI
-  Kubernetes clusters
-  VMware vCenters
-  SCVMM management servers


Data services

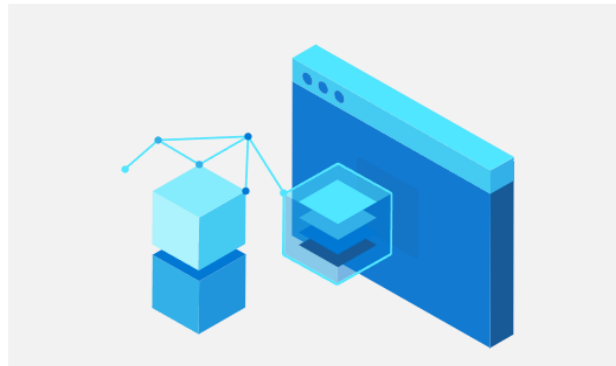
-  SQL Server instances
-  PostgreSQL (preview)
-  SQL managed instances

Application Services


-  API management (preview)
-  App services (preview)
-  Event Grid topics (preview)
-  Functions (preview)
-  Azure IoT Operations (preview)
-  Logic apps (preview)

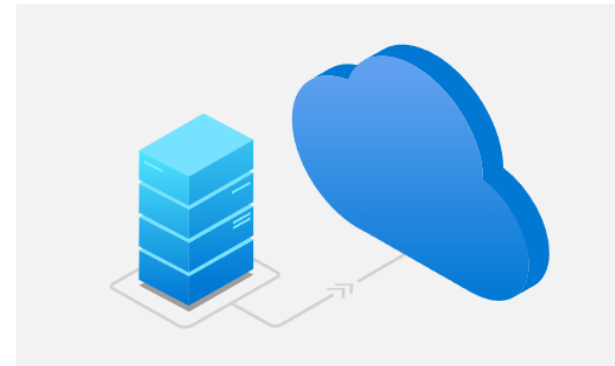
See and manage all your on-prem infrastructure, anywhere. It's free to get started.

With Azure Arc, you can manage your infrastructure in all your environments, including on-premises, other public clouds, and edge devices. There's no charge to start, just add your infrastructure and enjoy the views. [Learn more](#) 




Get hands-on with ArcBox

Use ArcBox to deploy an Azure Arc sandbox in less than an hour. [Learn more](#) 


[Try ArcBox](#)

Add your infrastructure for free

See all your infrastructure in Azure. There's no charge to add and view your existing resources. [Learn more](#) 

[Add](#)

Deploy Azure services

Use Azure Arc to deploy Azure services on your infrastructure. [Learn more](#) 

[Deploy](#)

Azure Arc Overview

Project infrastructure running outside of Azure into Azure

- Linux and Windows VMs and bare metal servers
- Any CNCF certified Kubernetes distribution
- SQL Server

Manage infrastructure as it was running in Azure

- Update Management
- Configuration Management
- Microsoft Cloud Defender

Azure Arc-enabled Kubernetes

Install Azure Arc extensions to manage the cluster

- Azure Monitor
- GitOps with Flux
- Azure Policy
- Azure Key Vault Secrets Provider

Securely access cluster without opening inbound ports

Azure Arc Installation Prerequisites

Azure CLI

Azure CLI Arc extension

```
curl -sL https://aka.ms/InstallAzureCLIDeb | sudo bash  
az extension add --name connectedk8s
```

Azure Arc Installation Prerequisites

Azure CLI

Azure CLI Arc extension

Register Azure Provider

root@Office: /home/wolfgang

```
root@Office:/home/wolfgang# az provider register --namespace Microsoft.Kubernetes
root@Office:/home/wolfgang# az provider register --namespace Microsoft.KubernetesConfiguration
root@Office:/home/wolfgang# az provider register --namespace Microsoft.ExtendedLocation
```

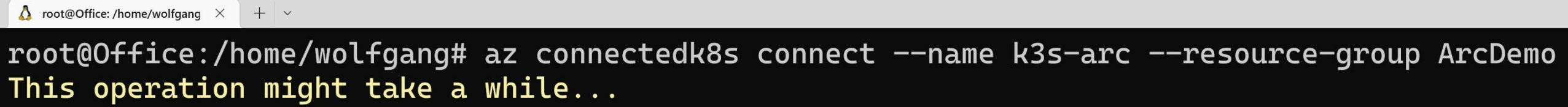
Azure Arc Installation Prerequisites

Register Azure Provider

```
root@Office: /home/wolfgang # az provider show -n Microsoft.Kubernetes -o table
Namespace                RegistrationPolicy      RegistrationState
-----
Microsoft.Kubernetes     RegistrationRequired    Registered
root@Office: /home/wolfgang # az provider show -n Microsoft.KubernetesConfiguration -o table
Namespace                RegistrationPolicy      RegistrationState
-----
Microsoft.KubernetesConfiguration  RegistrationRequired    Registered
root@Office: /home/wolfgang # az provider show -n Microsoft.ExtendedLocation -o table
Namespace                RegistrationPolicy      RegistrationState
-----
Microsoft.ExtendedLocation  RegistrationRequired    Registered
```

Azure Arc Installation

Install with Azure CLI

A terminal window with a title bar showing 'root@Office: /home/wolfgang'. The terminal content shows a command to connect to Azure Arc using the Azure CLI, followed by a message indicating the operation might take some time.

```
root@Office: /home/wolfgang# az connectedk8s connect --name k3s-arc --resource-group ArcDemo  
This operation might take a while...
```

Azure Arc Installation

Install with Azure CLI

Applications are installed in the azure-arc namespace

Azure Arc Applications

```
PS C:\Users\Wolfgang> kubectl get pods -n azure-arc
```

NAME	READY	STATUS	RESTARTS	AGE
cluster-metadata-operator-5dcbb5d97b-k2pwb	2/2	Running	0	14m
clusterconnect-agent-5776f946d9-jchl4	3/3	Running	0	14m
clusteridentityoperator-bf596c845-h8s7s	2/2	Running	0	14m
config-agent-6cd59d5896-d4tvx	2/2	Running	0	14m
controller-manager-59bcd87698-m8jj9	2/2	Running	0	14m
extension-events-collector-55c95b8c4d-m8l5d	2/2	Running	0	14m
extension-manager-75d47f499f-62twm	3/3	Running	0	14m
flux-logs-agent-7d7dc6754f-l24tq	1/1	Running	0	14m
kube-aad-proxy-775476dd6d-bpdl1d	2/2	Running	0	14m
metrics-agent-595bcfdc9-4jpkg	2/2	Running	0	14m
resource-sync-agent-c9559b855-bggcp	2/2	Running	0	14m







Azure Arc in the Azure Portal

“Single pane of glass”




Manage outside infrastructure within Azure

<<







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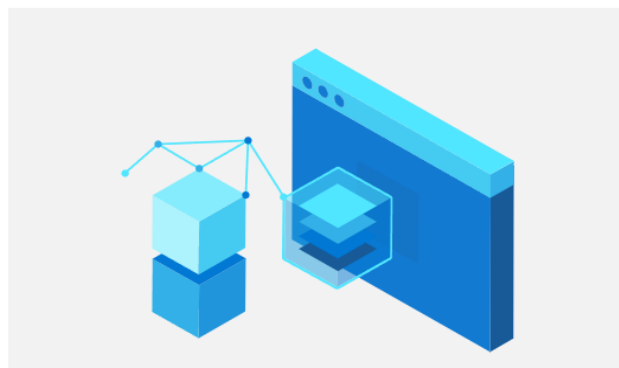
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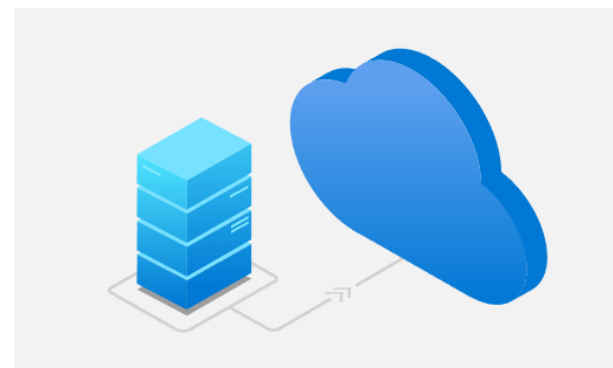
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[Add](#)

Deploy Azure services

Use Azure Arc to deploy Azure services on your infrastructure. [Learn more](#) 

[Deploy](#)

Azure Arc | Kubernetes clusters

Microsoft

Search



+ Add

⚙️ Manage view

🔄 Refresh

📄 Export to CSV

🔗 Open query

🏷️ Assign tags

Infrastructure

- Machines
- Azure Arc virtual machines (preview)
- Azure Stack HCI
- Kubernetes clusters**
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- SCVMM management servers

Data services

- SQL Server instances
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Application Services

- API management (preview)

Filter for any field...

Subscription equals **all**

Type equals **all**

Resource group equals **all** ✕

+🔍 Add filter

Showing 1 to 2 of 2 records.

No grouping

<input type="checkbox"/>	Name ↑↓	Type ↑↓	Resource group ↑↓	Kubernetes version ↑↓	Location ↑↓
<input type="checkbox"/>	dev-cluster-arc	Kubernetes - Azure Arc	ArcDemo	1.27.7	West Europe
<input type="checkbox"/>	k3s-Arc	Kubernetes - Azure Arc	ArcDemo	1.27.7	West Europe



k3s-Arc | Namespaces

Kubernetes - Azure Arc



Search



- Overview
- Activity log
- Access control (IAM)
- Tags
- Diagnose and solve problems

Kubernetes resources (preview)

- Namespaces
- Workloads
- Services and ingresses
- Storage
- Configuration

Settings

- Extensions
- Open Service Mesh
- GitOps
- Policies
- Properties
- Locks



Sign in to view your Kubernetes resources.

A service account bearer token is required to view the Kubernetes resources on this cluster. This can be created using kubectl while connected to your cluster via CLI. [Learn how to create a service account bearer token](#)

Service account bearer token * ⓘ

Sign in



Azure Arc Extensions

Azure Arc extensions

Bring Azure Services to your Kubernetes cluster

- GitOps for deployments
- Azure Monitor
- Azure Key Vault Secrets Provider

Git Ops Extension

Uses Flux as GitOps agent

Can be installed via Azure CLI or Azure Portal

2 repositories

- Application repository
- Configuration repository



Azure
DevOps



Trigger CI



CI Pipeline

Push
Image



Azure
Container
Registry

Pull
Image



Kubernetes



Azure Arc-enabled
Kubernetes cluster

Deploy state change



Flux

Pull desired cluster state

GitOps Connector

Application
Repo

Validate PR



PR Pipeline

Trigger CD



CD Pipeline

Desired State PR

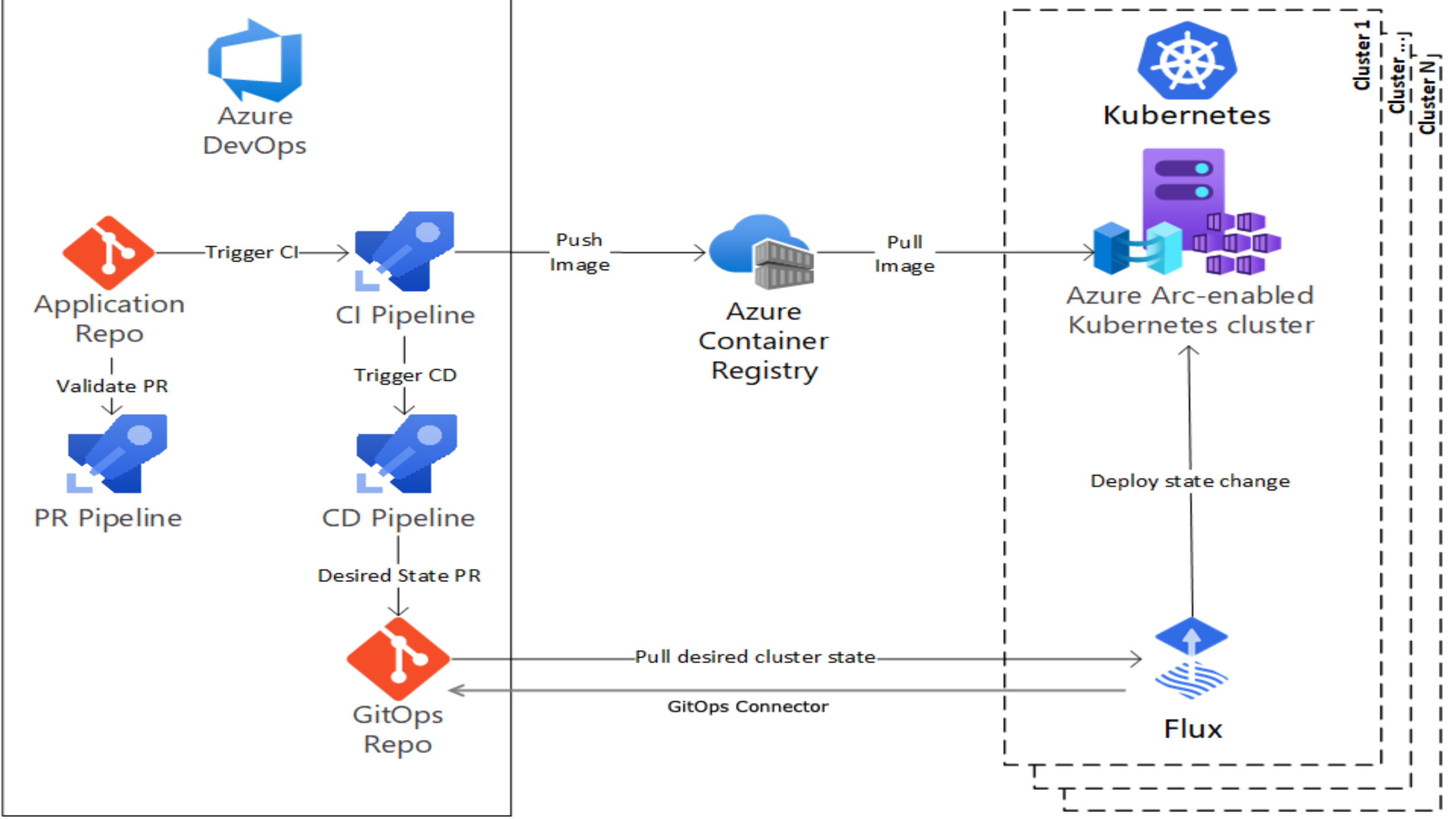


GitOps
Repo

Cluster 1

Cluster ...j

Cluster N



Git Ops Extension Installation

Single Azure CLI command to configure and install GitOps operator

Git Ops Extension Installation

```
PS C:\Users\Wolfgang> az k8s-configuration flux create `
>> --cluster-name k3s-Arc `
>> --resource-group ArcDemo `
>> --name arcdemo-gitops `
>> --namespace azurearcdemo `
>> --cluster-type connectedClusters `
>> --scope cluster `
>> --https-user wolfgang@programmingwithwolfgang.com `
>> --https-key 7ubfok7viuepij24pymxblsekhyjcdjxbsqgcczyp1suo6sv3x5a `
>> --url https://dev.azure.com/ProgrammingWithWolfgang/AzureArcDemo/_git/AzureArcDemoGitOps `
>> --branch master `
>> --kustomization name=app path=./AzureArcDemo prune=true
D:\a\_work\1\s\build_scripts\windows\artifacts\cli\Lib\site-packages\cryptography\hazmat\backends\openssll
/backend.py:27: UserWarning: You are using cryptography on a 32-bit Python on a 64-bit Windows Operating
System. Cryptography will be significantly faster if you switch to using a 64-bit Python.
'Microsoft.Flux' extension not found on the cluster, installing it now. This may take a few minutes...
```

Git Ops Extension Installation

Home > k3s-Arc

 **k3s-Arc | GitOps** ☆ ...
Kubernetes - Azure Arc



 Create  Delete  Refresh

 Configuration

Settings


 Extensions




 Open Service Mesh

 GitOps

 Policies

 Properties

 Flux configurations can now be monitored across clusters, subscriptions, resource groups, etc. [Learn more](#) 

<input type="checkbox"/>	Configuration	Compliance	Namespace	Scope	State	Source last updated
<input type="checkbox"/>	arcdemo-gitops	 Compliant	azurearcdemo	cluster	 Succeeded	Wed Jan 17 2024 03:25:58 GMT-0500 (Eastern Standard Time) 

Git Ops Extension Installation

[Home](#) > [k3s-Arc | GitOps](#) >



k3s-Arc/arcdemo-gitops

GitOps configuration



Delete



Refresh



Give feedback



Overview



Configuration objects



Source



Kustomizations

Status

Compliance state	Compliant
Configuration objects	3 objects
Installation status	Succeeded
Source last sync commit	master@sha1:4ad385bd016dc352ecc0839505f22794c2...
Source last updated	2024-01-17, 3:25:58 a.m.
Status last updated	2024-01-17, 3:47:01 a.m.

Properties

Namespace	azurearcdemo
Scope	cluster
Type	Flux v2
Kustomizations	1 Kustomizations

Source

Source kind	GitRepository
Repository URL	https://dev.azure.com/ProgrammingWithWolfgang/Az...
Repository reference type	Branch
Branch	master
Repository public key	---
Sync interval	1 mins
Sync timeout	1 mins

GitOps Deployment

```
PS C:\Users\Wolfgang> kubectl get pods -n azurearcdemo
```

NAME	READY	STATUS	RESTARTS	AGE
azurearcdemo-64fbd7fcfc-4v6qr	1/1	Running	0	28m

GitOps Repository

Kustomize file referencing all release files

GitOps Repository

```
apiVersion: kustomize.config.k8s.io/v1  
kind: Kustomization  
resources:  
- HelmRelease.yaml
```

GitOps Repository

Kustomize file referencing all release files

HelmRelease YAML file containing information about the Helm chart

apiVersion: helm.toolkit.fluxcd.io/v2beta1

kind: HelmRelease

metadata:

name: azurearcdemo

namespace: azurearcdemo

annotations:

clusterconfig.azure.com/use-managed-source: "true"

spec:

interval: 1m

releaseName: azurearcdemo

chart:

spec:

chart: ./AzureArcDemo/charts/azurearcdemo

GitOps Pipeline

CD Pipeline reads newest tag from Azure Container Registry

Replace tag in values.yaml file

Commit changes to master branch

GitOps Agent sees changes and applies them to the K8s cluster

Tag can be set manually when starting the pipeline

Azure Key Vault Secrets Provider Extension

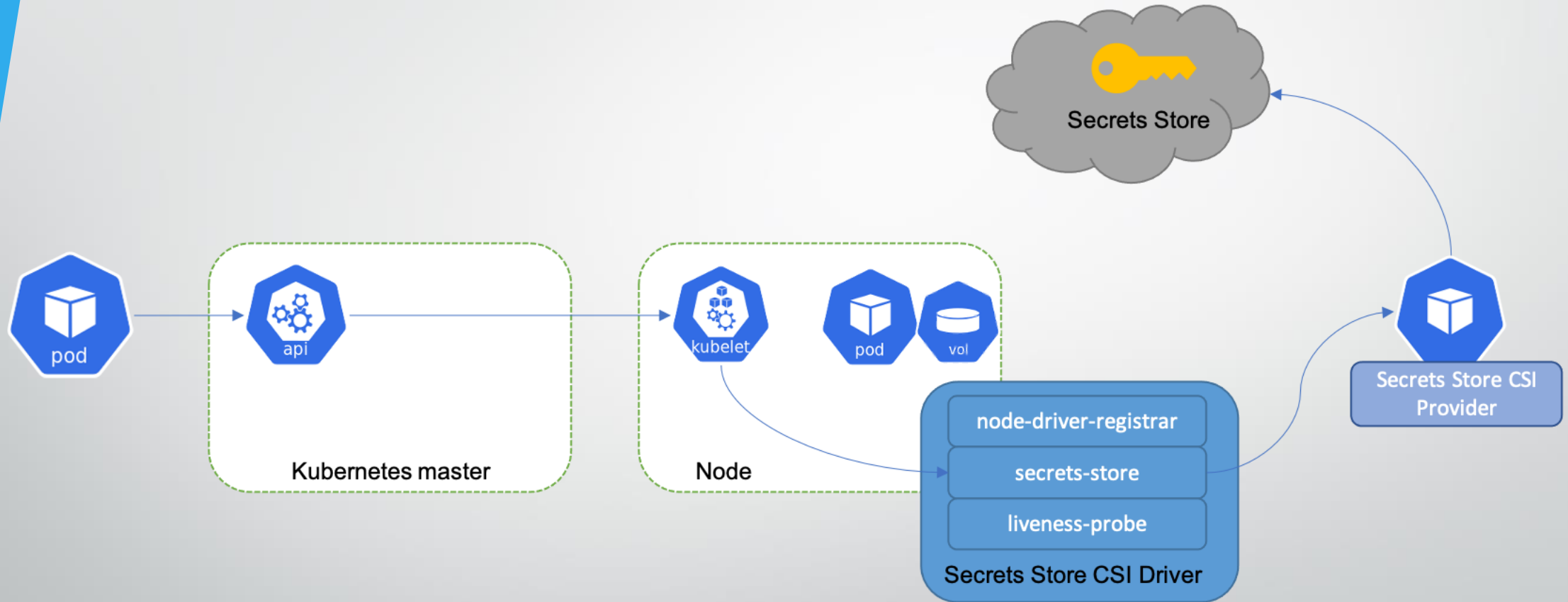
Mount secrets from Azure Key Vault into Kubernetes

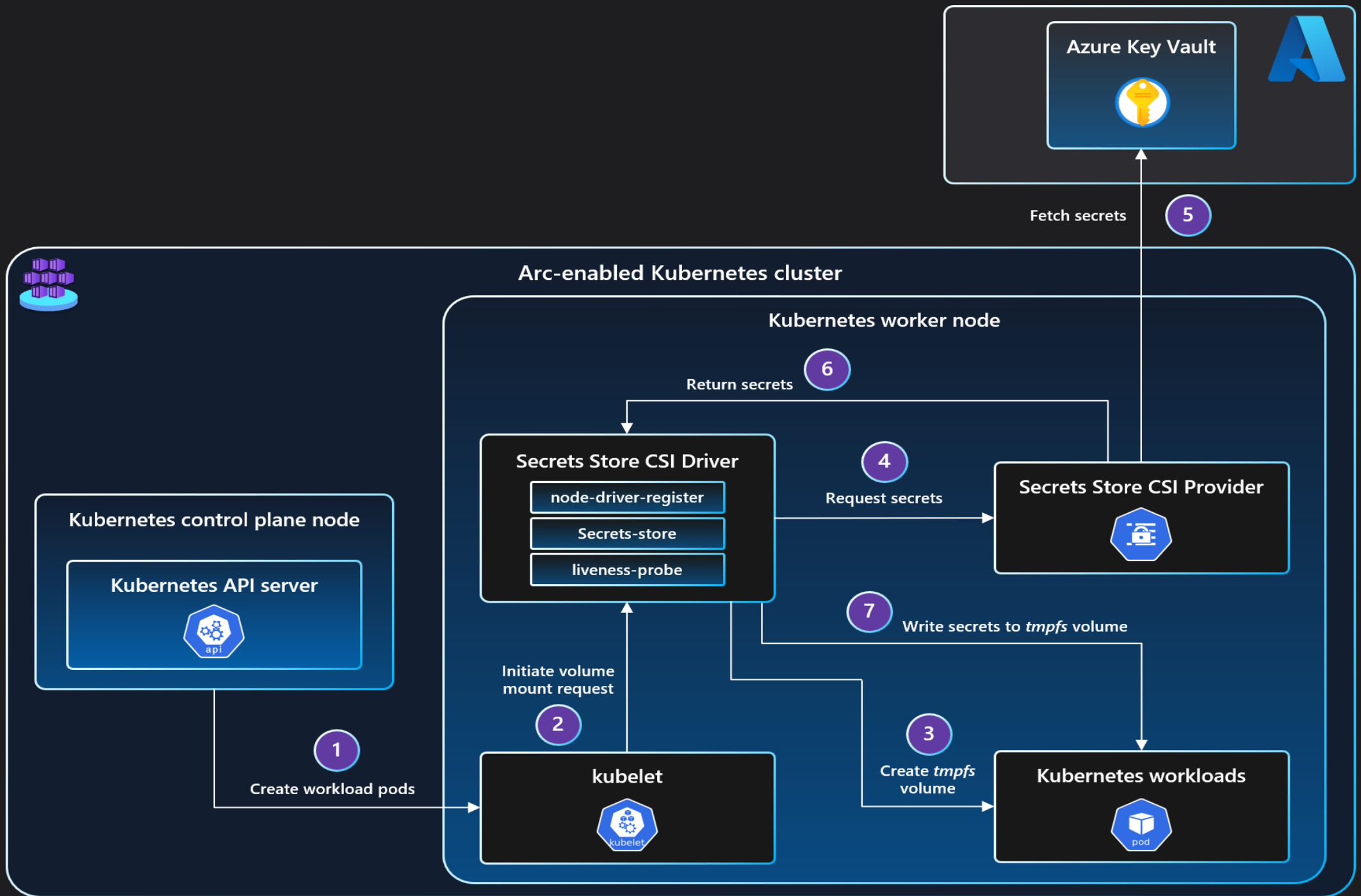
Secrets are retrieved using gRPC

Get all advantages from Azure Key Vault

Use pipeline to write/rotate secrets in Key Vault

Azure Key Vault Secrets Provider Extension





Azure Monitor Extension

Azure Monitor agent is installed in its own namespace

Agent sends information to Log Analytics Workspace

Azure Monitor:

- Dashboards
- Alerting
- Container Insights

Search (Ctrl+/) << Refresh View All Clusters Recommended alerts (Preview) View Workbooks ? Help Feedback

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

Security (preview)

Kubernetes resources (preview)

Namespaces

Workloads

Services and ingresses

Storage

Configuration

Settings

Extensions

GitOps (preview)

Policies

Properties

Locks

Monitoring

Insights

Alerts

Metrics

Logs

Time range = Last 30 minutes

+ Add Filter

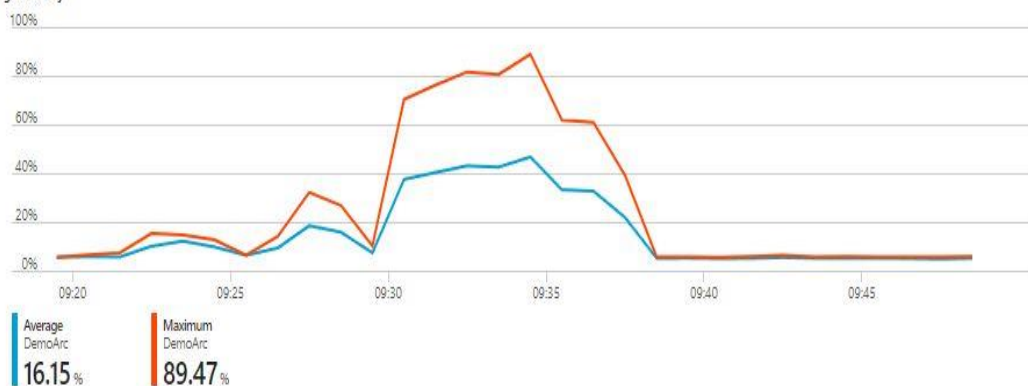
What's new Cluster Reports Nodes Controllers Containers

Node CPU Utilization %

Percentage of Total capacity

Avg Min 50th 90th 95th Max

1m granularity

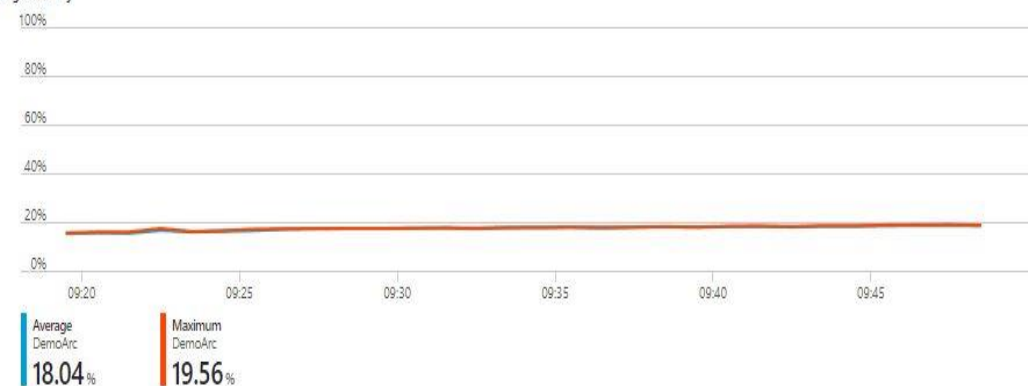


Node Memory Utilization %

Percentage of Total capacity (memory rss)

Avg Min 50th 90th 95th Max

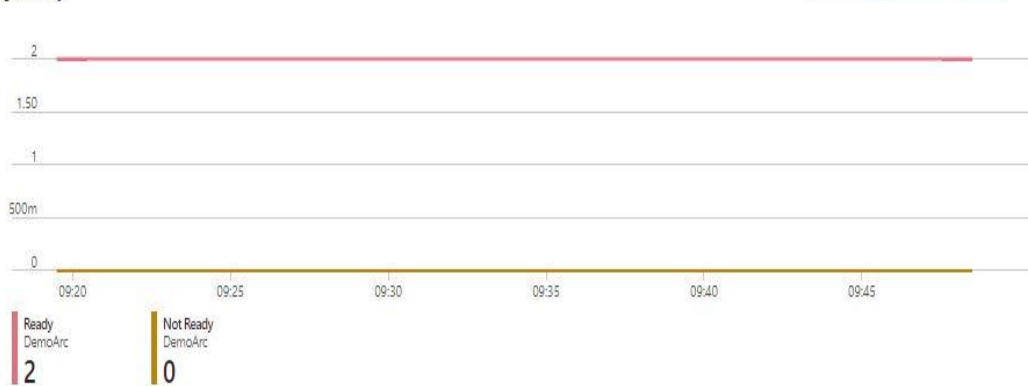
1m granularity



Node Count

1m granularity

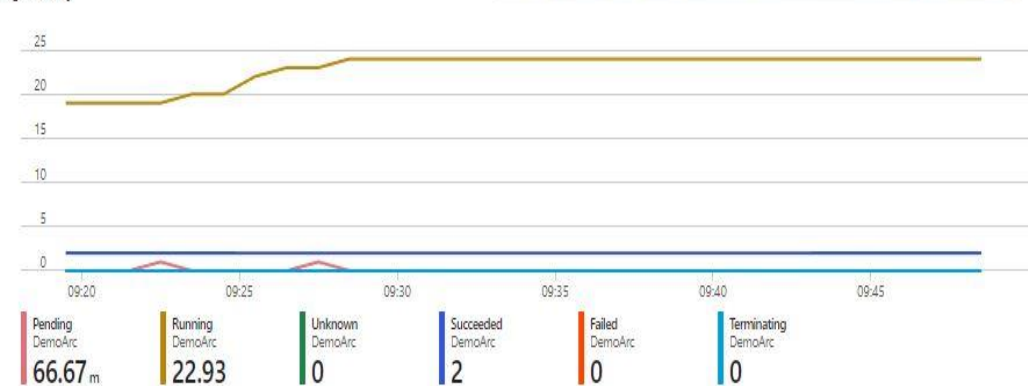
Total Ready Not Ready



Active Pod Count

1m granularity

Total Pending Running Unknown Succeeded Failed Terminating



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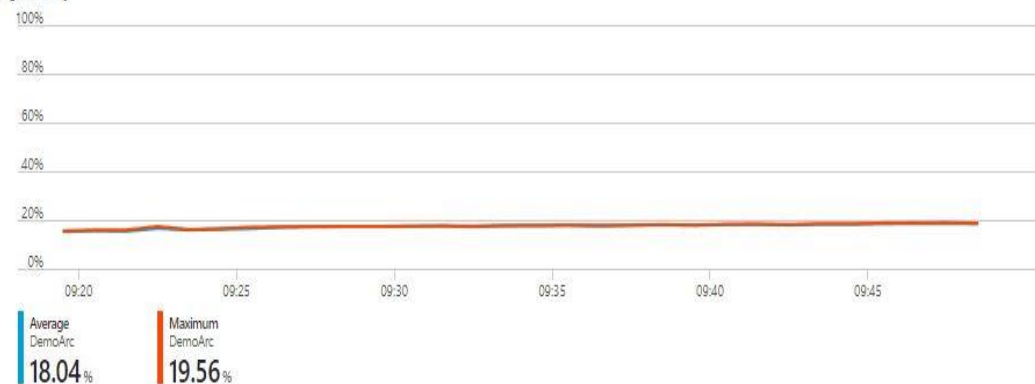


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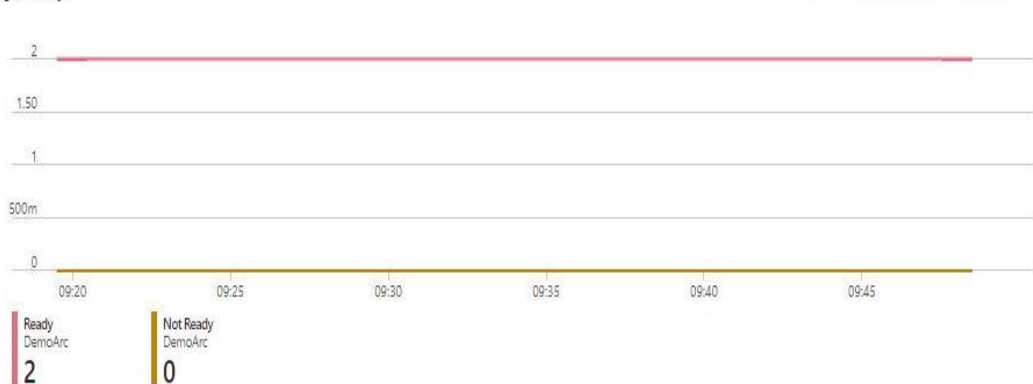
1m granularity



Node Count

1m granularity

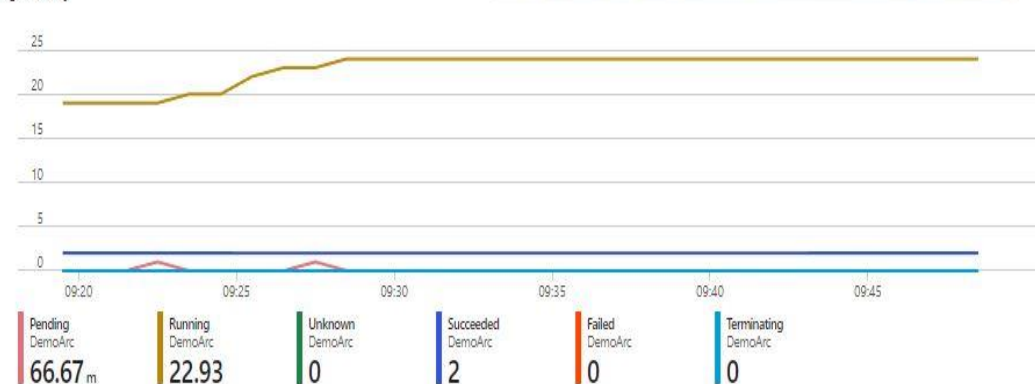
Total Ready Not Ready



Active Pod Count

1m granularity

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«  Refresh

 View All Clusters

 Recommended alerts (Preview)

 View Workbooks

 Help

 Feedback


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- Kubernetes resources (preview)
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- Settings
- Extensions
 - GitOps (preview)
 - Policies
 - Properties
 - Locks
- Monitoring
- Insights
 - Alerts

Time range = Last 30 minutes  Add Filter

What's new Cluster Reports Nodes Controllers Containers

Metric: CPU Usage (millicores) 

Min

















Avg

50th

90th

95th

Max

Name	Status	95th % ↓	95th	Pod	Node	Restarts	UpTime	Trend 95th % (1 bar = 1m)
 customerapi	✓ Ok	91%	1810 mc	customerapi-5d5f8d96c5-v8nt7	master	0	25 mins	
 mqtt	✓ Ok	64%	322 mc	mqtt-58b75468c-zcnzx	master	0	27 mins	
 kube-aad-proxy	✓ Ok	17%	17 mc	kube-aad-proxy-8564d4dd5d-qqcby	worker1	0	54 mins	
 omsagent	✓ Ok	7%	10 mc	omsagent-727fd	worker1	0	31 mins	
 omsagent	✓ Ok	4%	6 mc	omsagent-4pftj	master	0	32 mins	
 fluent-bit	✓ Ok	4%	0.8 mc	config-agent-69dccb554d-7swhm	worker1	0	57 mins	
 fluent-bit	✓ Ok	4%	0.8 mc	cluster-metadata-operator-9945b897c-nxcwr	worker1	0	57 mins	
 cluster-metadata-operator	✓ Ok	4%	2 mc	cluster-metadata-operator-9945b897c-nxcwr	worker1	0	58 mins	
 fluent-bit	✓ Ok	3%	0.7 mc	controller-manager-5494575977-rfc6g	worker1	0	57 mins	
 flux-logs-agent	✓ Ok	3%	1 mc	flux-logs-agent-86cf4f7b7d-55fld	worker1	0	58 mins	
 fluent-bit	✓ Ok	3%	0.6 mc	extension-manager-7dc84fb6d7-sfznl	worker1	0	57 mins	
 resource-sync-agent	✓ Ok	3%	1 mc	resource-sync-agent-56f777f6b6-7zj9n	worker1	0	58 mins	



Azure Arc Services

Azure Arc Services

Azure Arc-enabled infrastructure

- Azure Arc-enabled servers
- Azure Arc-enabled Kubernetes
- Azure Stack HCI

Azure Arc Services

Azure Arc-enabled services

- Azure App Service
- Azure Logic Apps
- Azure Event Grid
- Azure Functions
- Azure API Management
- Azure Container Apps

Azure Arc Services

Azure Arc-enabled services

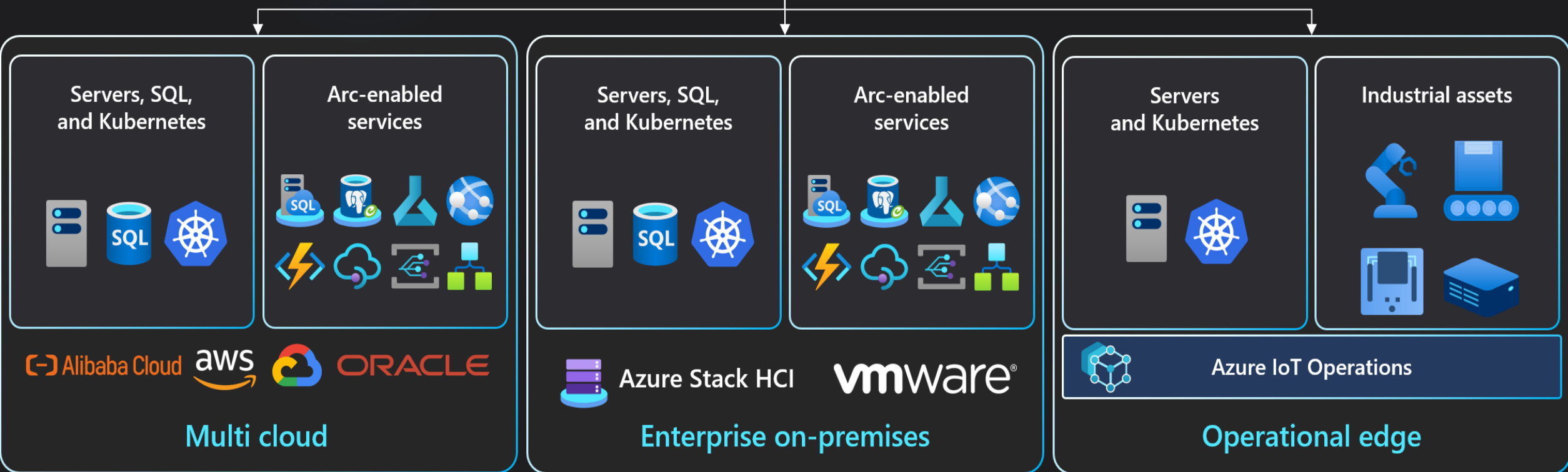
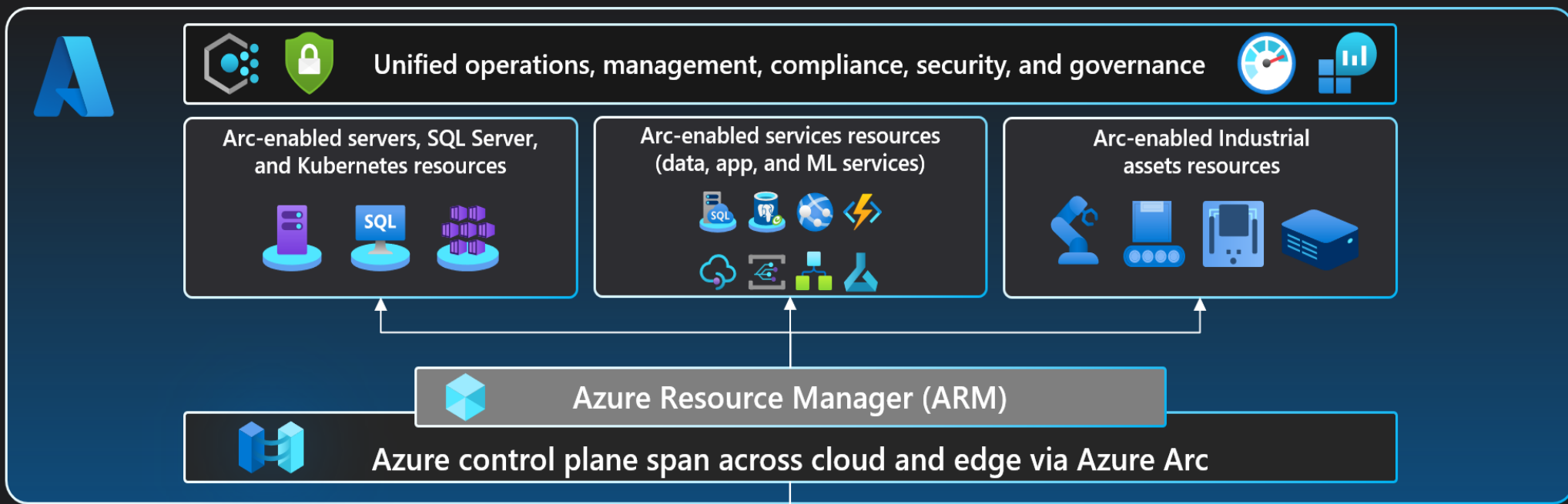
- Azure SQL Managed Instance
- PostgreSQL Hyperscale
- Azure Machine Learning

Azure Arc Services

Azure Arc-enabled services run inside a Kubernetes cluster

Bring Azure services to your on-prem datacenter

Developers can continue using their tools



Real-World Examples

Project “Autonomous Ropeway System”

Project “Smart Machine Factory”



Project “Autonomous Ropeway System”

Ropeway vehicle comes out of the garage automatically

Routing possible → ropeway vehicle can find its way

Saves costs due to better usage of resources and less wear and tear

Running 24/7 with minimum human interaction

Challenges

Use existing hardware

No inbound traffic allowed

- No connection from Azure DevOps
- No possibility to use cloud services like Azure Monitor
- How to collect logs from the Kubernetes cluster?
- No VPN or ExpressRoute allowed



Smart Machine Factory

Run Azure Stack HCI AKS in factories around the globe

Use Azure Arc to manage AKS cluster

- Azure Monitor for monitoring and alerting
- GitOps for deployments without access to the factory
- Microsoft Entra integration for user authentication

Run additional service in AKS such as managed PostgreSQL



Hybrid Cloud Conclusion

Hybrid Cloud Conclusion

Powerful tool to combine on-premises requirements with cloud services

Manage on-premises infrastructure from the cloud

- Data never leaves your datacenter
- Combine cloud services with low latency

Broad technical knowledge necessary

Too many applications to talk about them in just one hour

Azure Arc Conclusion

Possibly the most powerful Azure service

Major focus from Microsoft

Deep technical knowledge required

Can be buggy

Documentation needs improvement

Resources

[Slides](#)

[Azure Arc Series – Blog Posts](#)

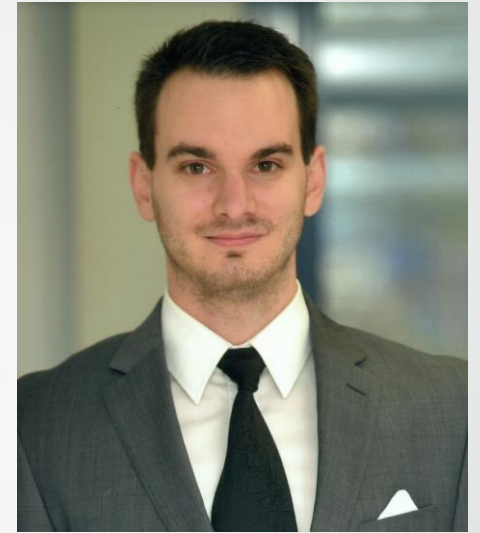
[Azure Arc - Youtube Playlist](#)

[Azure Arc Documentation](#)

[Azure Stack HCI](#)

[Flux CD](#)





Q&A

Unleashing the Potential of Hybrid Cloud: Streamlining Multi-Cloud Management and On-Premises Integration

Wolfgang Ofner

<https://programmingwithwolfgang.com>

<https://www.linkedin.com/in/wolfgangofner>

<https://www.youtube.com/@programmingwithwolfgang>