Level Up your Kubernetes Scaling with KEDA

Wolfgang Ofner

Agenda

- Architecture in SW projects
- Introduction to KEDA
- Scaling with messages in Azure Service Bus Queue
- KEDA Conclusion
- Q&A

About Me

Senior Software Architect, bbv Software, Zürich

Consultant and Speaker

Focus on Azure, Kubernetes, DevOps and .NET

https://programmingwithwolfgang.com

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

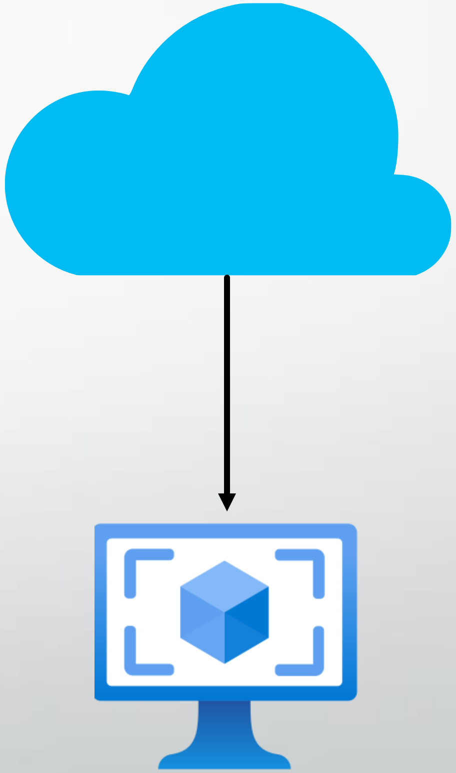
https://twitter.com/wolfgang_ofner

Microsoft CERTIFIED
AZURE SOLUTIONS ARCHITECT
EXPERT

MICROSOFT CERTIFIED TRAINER
Microsoft
MCT
Trainer
2021 - 2022

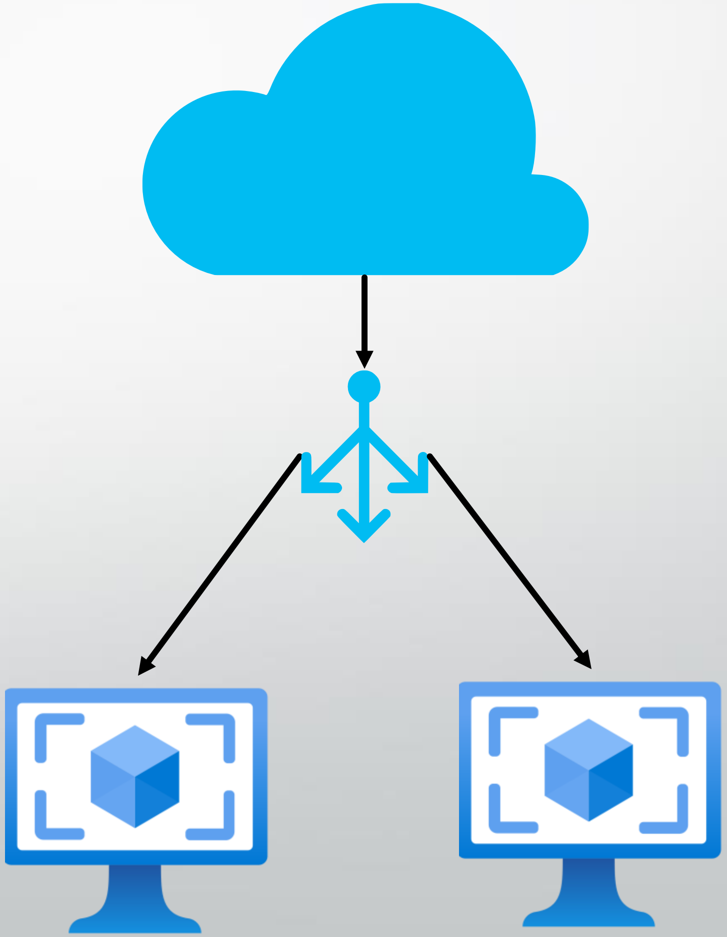
Simplified Architecture History

- Server – Client Architecture
- Only few clients
- No redundancy
- No high availability



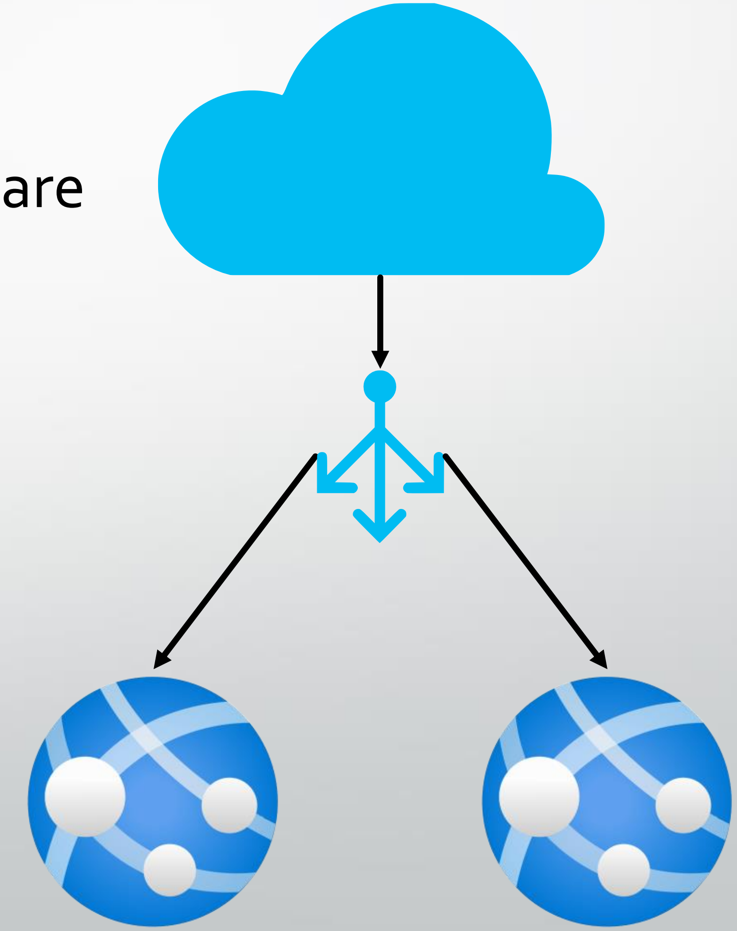
Simplified Architecture History

- Static load balancing
- New VMs need to be added by hand
- Expensive on-premises hardware

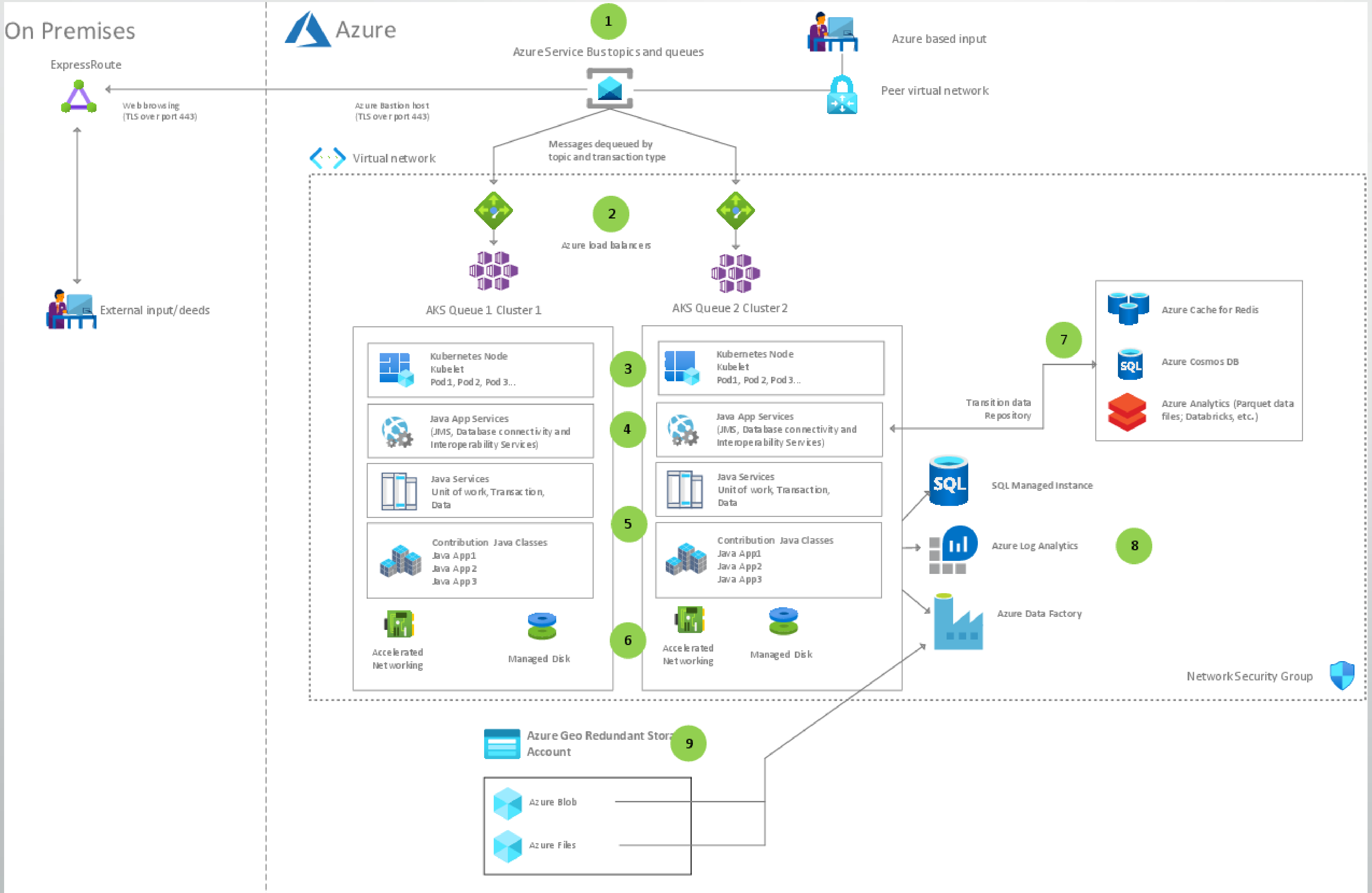


Simplified Architecture History

- Automatically adding additional hardware
- Pay only what you need
- Mostly CPU or RAM based scaling



Modern Architecture



On Premises

ExpressRoute

Web browsing
(TLS over port 443)

External input/deeds

Azure

1

Azure Service Bus topics and queues

Azure Bastion host
(TLS over port 443)

Azure based input

Peer virtual network

Messages dequeued by
topic and transaction type

Virtual network

2

Azure load balancers

AKS Queue 1 Cluster 1

AKS Queue 2 Cluster 2

Kubernetes Node
Kubelet
Pod 1, Pod 2, Pod 3...

3

Kubernetes Node
Kubelet
Pod1, Pod 2, Pod 3...

Java App Services
(JMS, Database connectivity and
Interoperability Services)

4

Java App Services
(JMS, Database connectivity and
Interoperability Services)

Java Services
Unit of work, Transaction,
Data

5

Java Services
Unit of work, Transaction,
Data

Contribution Java Classes
Java App1
Java App2
Java App3

Contribution Java Classes
Java App1
Java App2
Java App3

Accelerated
Networking

Managed Disk

6

Accelerated
Networking

Managed Disk

7

Transition data
Repository

Azure Cache for Redis

Azure Cosmos DB

Azure Analytics (Parquet data
files; Databricks, etc.)

SQL Managed Instance

Azure Log Analytics

8

Azure Data Factory

Network Security Group

Azure Geo Redundant Stora
Account

9

Azure Blob

Azure Files

Kubernetes

- Horizontal Pod Autoscaler (HPA)
  - Scaling according to CPU and/or RAM
- Architectures get more and more complex
- Dependencies on external components
- Applications have to react to events
  - Database
  - Service Bus
  - Streams

Horizontal Pod Autoscaler

- Scales Deployments or StatefulSets
- Adds or removes pods
- Scaling based on CPU or RAM usage
- Scaling on custom metrics
  - Query custom metrics from Kubernetes API
  - Prometheus
  - requests per second

Horizontal Pod Autoscaler Configuration

```yaml
apiVersion: autoscaling/v1
kind: HorizontalPodAutoscaler
metadata:
  name: customerapi
  namespace: customerapi-test
spec:
  maxReplicas: 10
  minReplicas: 1
  averageCpuUtilization: 50
  scaleTargetRef:
    apiVersion: apps/v1
    kind: Deployment
    name: customerapi
```

```yaml
behavior:
  scaleDown:
    policies:
    - type: Pods
      value: 4
      periodSeconds: 60
    - type: Percent
      value: 10
      periodSeconds: 60
    selectPolicy: Min
```

```yaml
scaleUp:
  policies:
  - type: Pods
    value: 5
    periodSeconds: 60
  - type: Percent
    value: 12
    periodSeconds: 60
  selectPolicy: Max
```

Limitation of the HPA

- Black Friday
- Thousands of orders are stored in a queue
- Scaling using CPU or RAM is not sufficient
- No option for scaling in this scenario

KEDA – Kubernetes Event-driven Autoscaling

- Kubernetes Event-driven Autoscaling
- Open source
- CNCF Project
- Maintained by
  - Docplanner Tech
  - Microsoft
  - Red Hat

KEDA

- ~53 built-in Scaler
  - Apache Kafka
  - Azure Blob Storage
  - Azure Monitor
  - Azure Service Bus
  - Elastic Search
  - MongoDB
  - Prometheus
  - Redis Streams

KEDA Use Cases

- Scale according to external events
- Scale to Zero
  - Bring serverless to your datacenter
  - Recreate Azure Functions architecture
  - Better resource usage

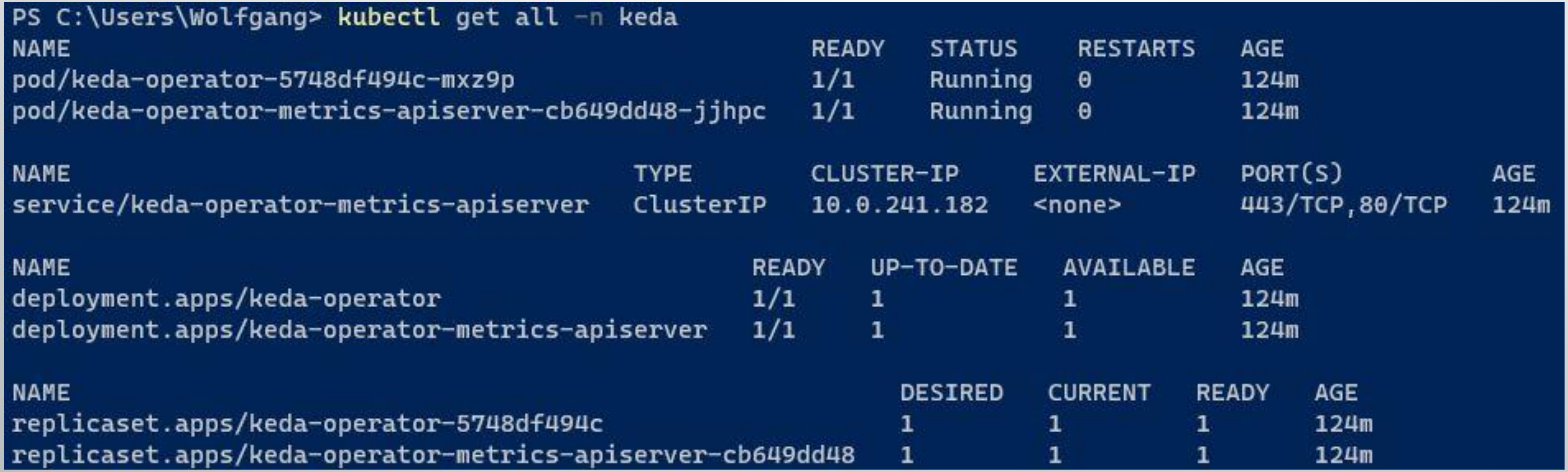
KEDA Installation

- Installation via Helm charts
- Namespace: keda

KEDA Installation

```
kubectl create namespace keda

helm repo add kedacore https://kedacore.github.io/charts
helm repo update
helm install keda kedacore/keda --namespace keda
```

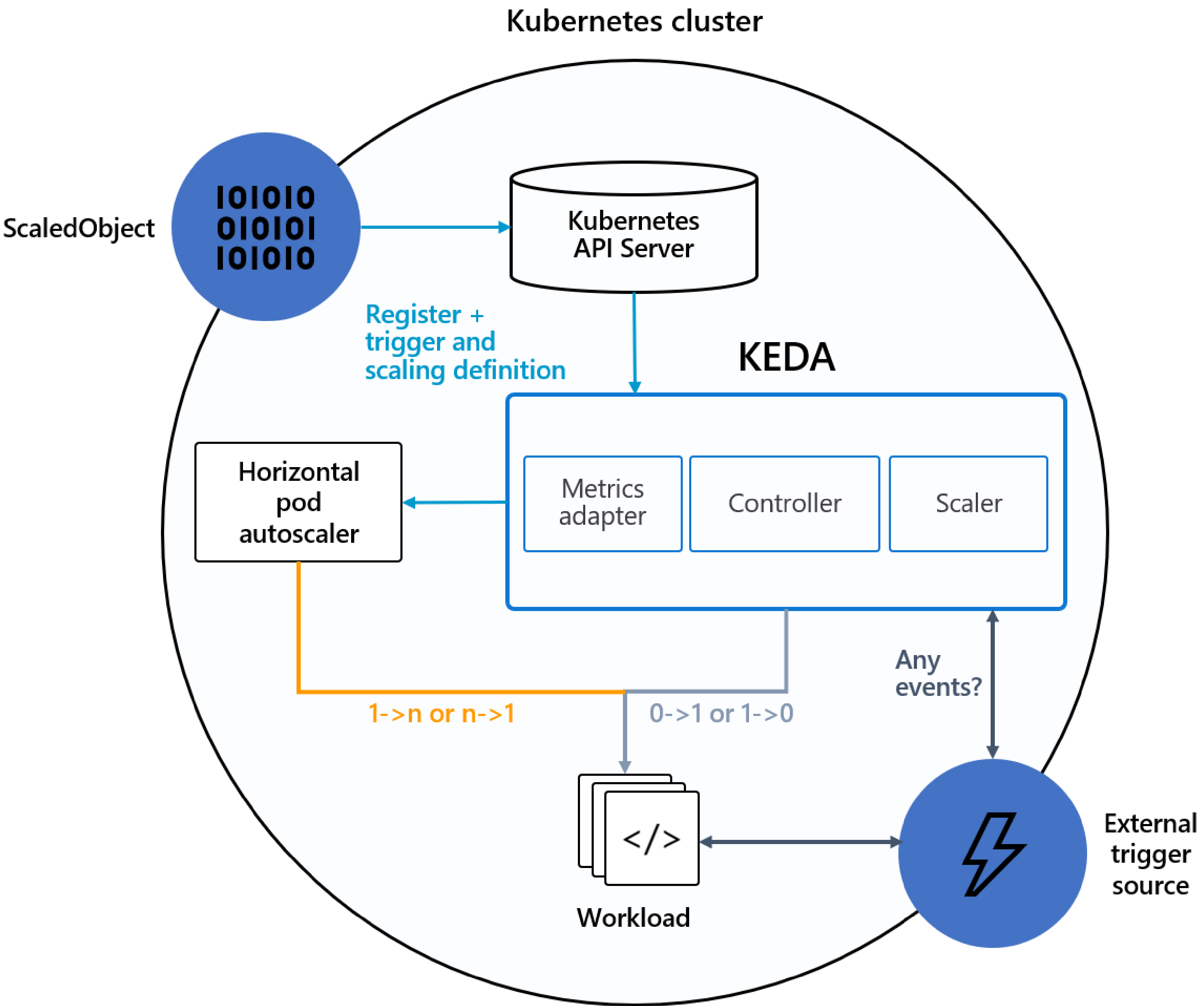
KEDA Resources



```
PS C:\Users\Wolfgang> kubectl get all -n keda
NAME                                                  READY   STATUS    RESTARTS   AGE
pod/keda-operator-5748df494c-mxz9p                    1/1     Running   0          124m
pod/keda-operator-metrics-apiserver-cb649dd48-jjhpc   1/1     Running   0          124m

NAME                                      TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)          AGE
service/keda-operator-metrics-apiserver   ClusterIP   10.0.241.182   <none>        443/TCP,80/TCP   124m

NAME                                              READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/keda-operator                     1/1     1            1           124m
deployment.apps/keda-operator-metrics-apiserver   1/1     1            1           124m

NAME                                                        DESIRED   CURRENT   READY   AGE
replicaset.apps/keda-operator-5748df494c                    1         1         1       124m
replicaset.apps/keda-operator-metrics-apiserver-cb649dd48   1         1         1       124m
```

KEDA Architecture

- 2 components for KEDA
  - Agent or Operator
  - Metrics Server
- Uses HPA for scaling
- Seamless integration into existing architecture


Kubernetes cluster
ScaledObject
101010
010101
101010
Kubernetes API Server
Register + trigger and scaling definition
KEDA
Metrics adapter
Controller
Scaler
Horizontal pod autoscaler
1->n or n->1
0->1 or 1->0
Any events?
</>
Workload
External trigger source

KEDA Architecture

- 2 components for KEDA
  - Agent
  - Metrics Server
- Uses HPA for scaling
- Seamless integration into existing architecture
- 2 custom K8s resources for scaler
  - ScaledObject
  - TriggerAuthentication

ScaledObject

```yaml
apiVersion: keda.sh/v1alpha1
kind: ScaledObject
metadata:
  name: kedademoapi-scaler
```

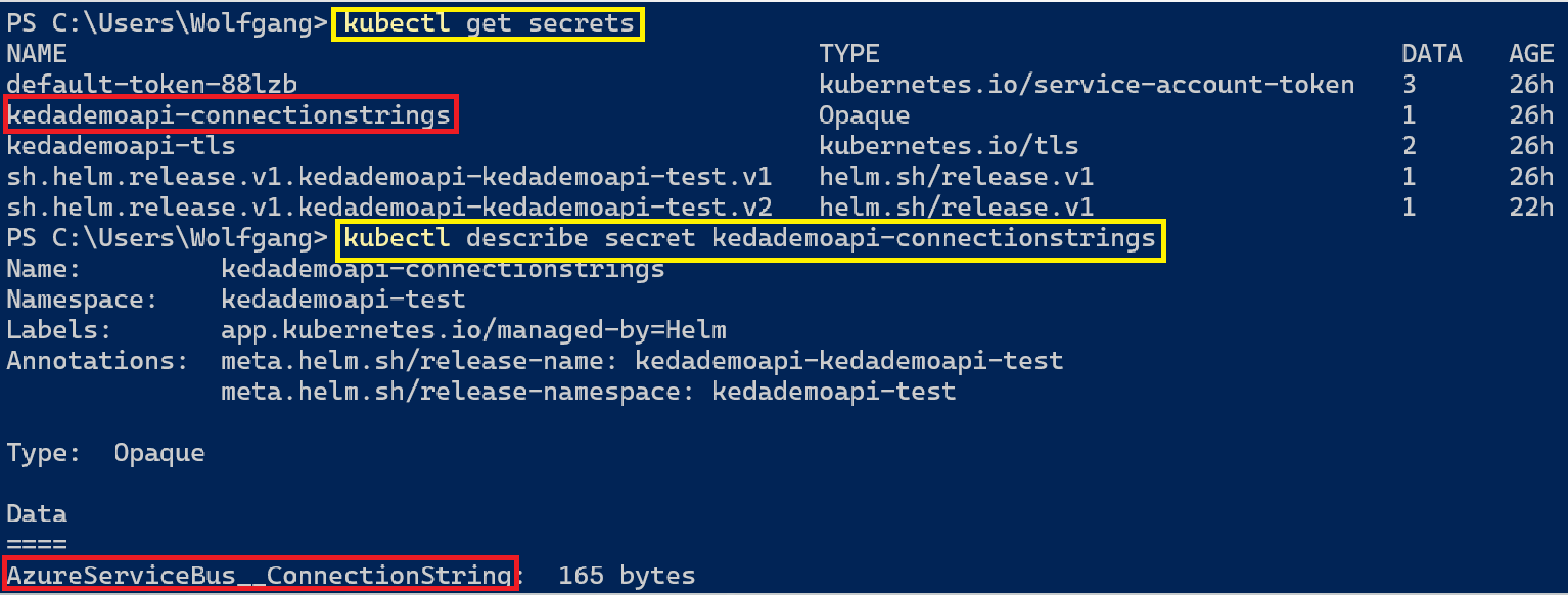
```yaml
spec:
  scaleTargetRef:
    name: kedademoapi
  minReplicaCount: 0
  maxReplicaCount: 10
  pollingInterval: 30
  cooldownPeriod: 30
```

```yaml
triggers:
  - type: azure-servicebus
    metadata:
      queueName: KedaDemo
      queueLength: '5'
    authenticationRef:
      name: trigger-authentication-kedademoapi
```

TriggerAuthentication

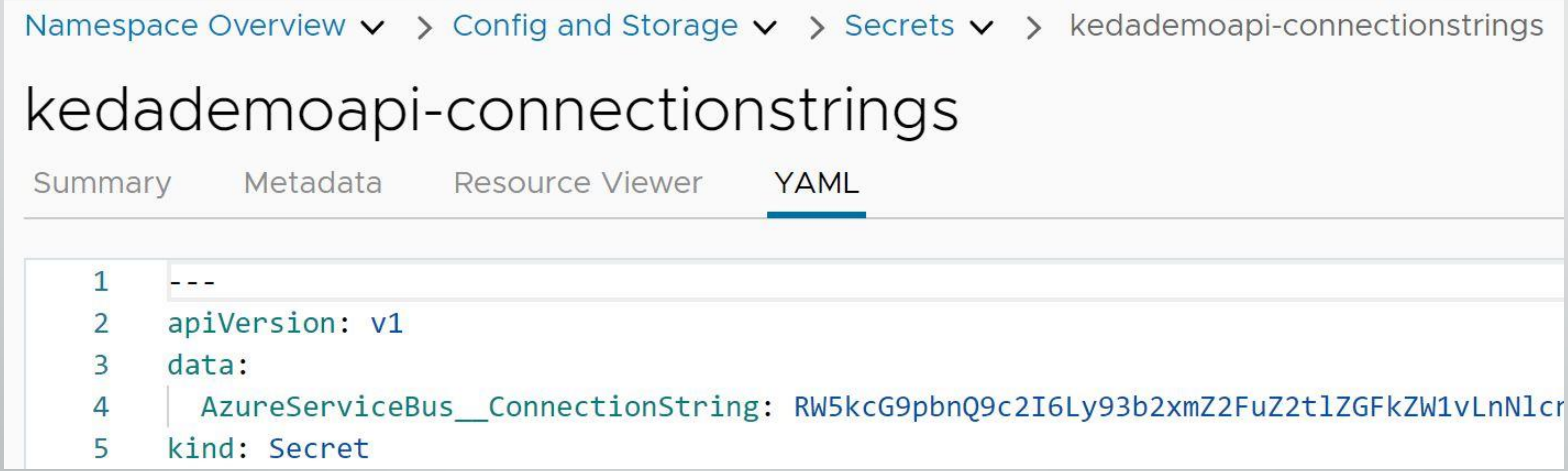
```
apiVersion: keda.sh/v1alpha1
kind: TriggerAuthentication
metadata:
  name: trigger-authentication-kedademoapi
spec:
  secretTargetRef:
  - parameter: connection
    name: kedademoapi-connectionstrings
    key: AzureServiceBus__ConnectionString
```

Kubernetes Secret



```
PS C:\Users\Wolfgang> kubectl get secrets
NAME                                            TYPE                                  DATA   AGE
default-token-88lzb                             kubernetes.io/service-account-token   3      26h
kedademoapi-connectionstrings                   Opaque                                1      26h
kedademoapi-tls                                 kubernetes.io/tls                     2      26h
sh.helm.release.v1.kedademoapi-kedademoapi-test.v1   helm.sh/release.v1               1      26h
sh.helm.release.v1.kedademoapi-kedademoapi-test.v2   helm.sh/release.v1               1      22h
PS C:\Users\Wolfgang> kubectl describe secret kedademoapi-connectionstrings
Name:         kedademoapi-connectionstrings
Namespace:    kedademoapi-test
Labels:       app.kubernetes.io/managed-by=Helm
Annotations:  meta.helm.sh/release-name: kedademoapi-kedademoapi-test
              meta.helm.sh/release-namespace: kedademoapi-test

Type:  Opaque

Data
====
AzureServiceBus__ConnectionString:  165 bytes
```

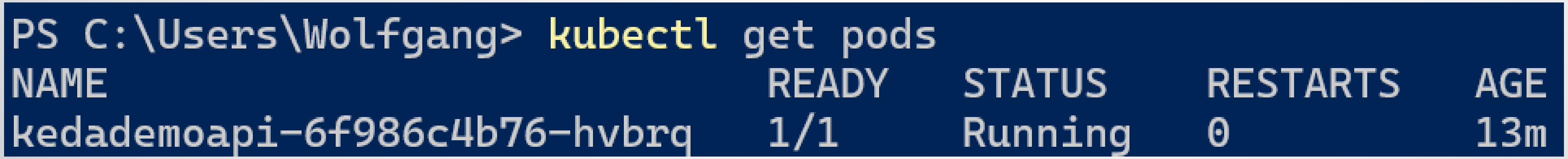
Kubernetes Secret



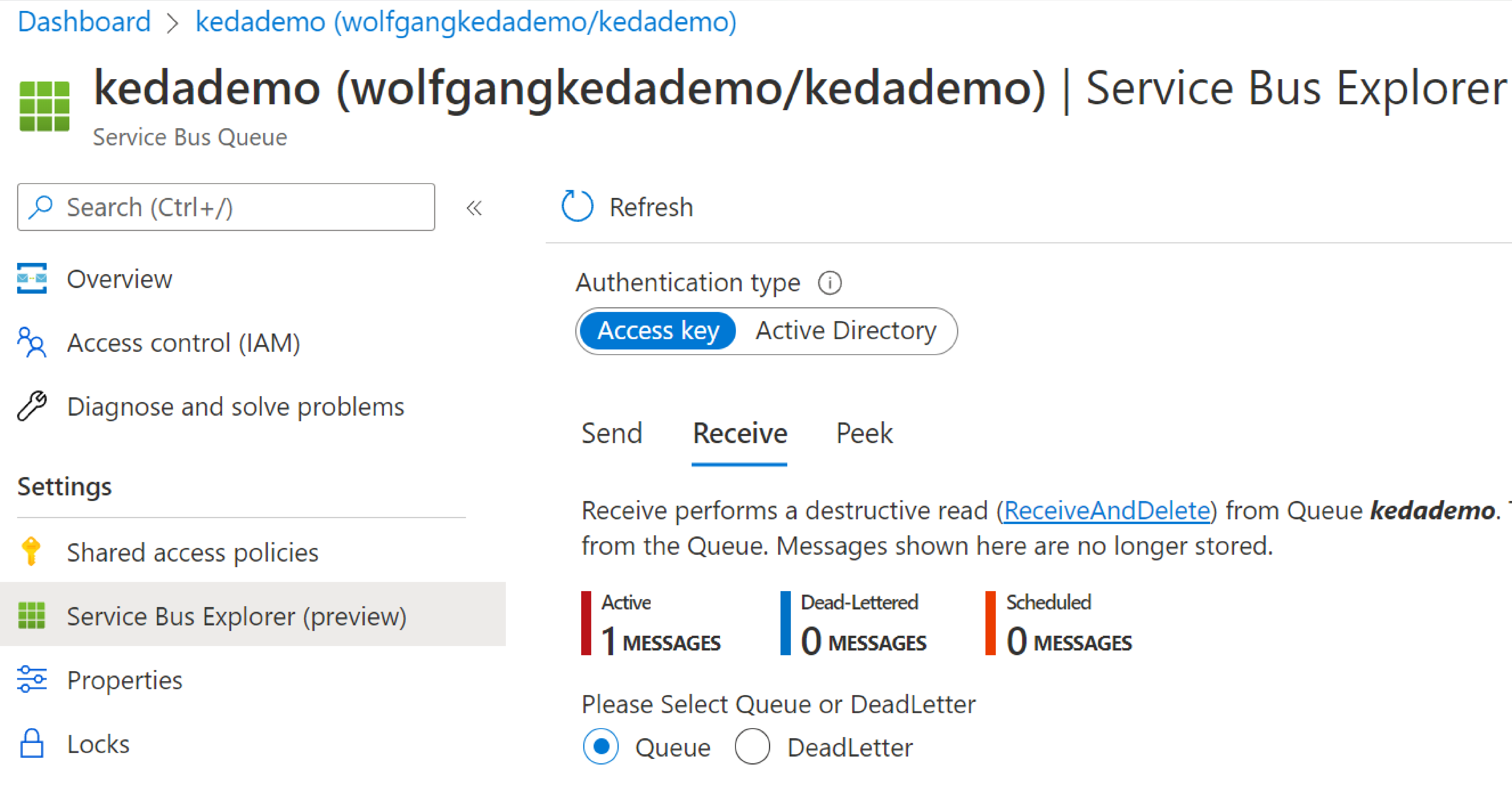
```yaml
---
apiVersion: v1
data:
  AzureServiceBus__ConnectionString: RW5kcG9pbnQ9c2I6Ly93b2xmZ2FuZ2tlZGFkZW1vLnNlcr
kind: Secret
```

Demo

- Scale with messages in an Azure Service Bus Queue
- Scale to 0
- Scale to 1



```
PS C:\Users\Wolfgang> kubectl get pods
NAME                            READY   STATUS    RESTARTS   AGE
kedademoapi-6f986c4b76-hvbrq    1/1     Running   0          13m
```


Dashboard > kedademo (wolfgangkedademo/kedademo)
kedademo (wolfgangkedademo/kedademo) | Service Bus Explorer
Service Bus Queue
Search (Ctrl+/)
«
Refresh
Overview
Access control (IAM)
Diagnose and solve problems
Settings
Shared access policies
Service Bus Explorer (preview)
Properties
Locks
Send
Receive
Peek

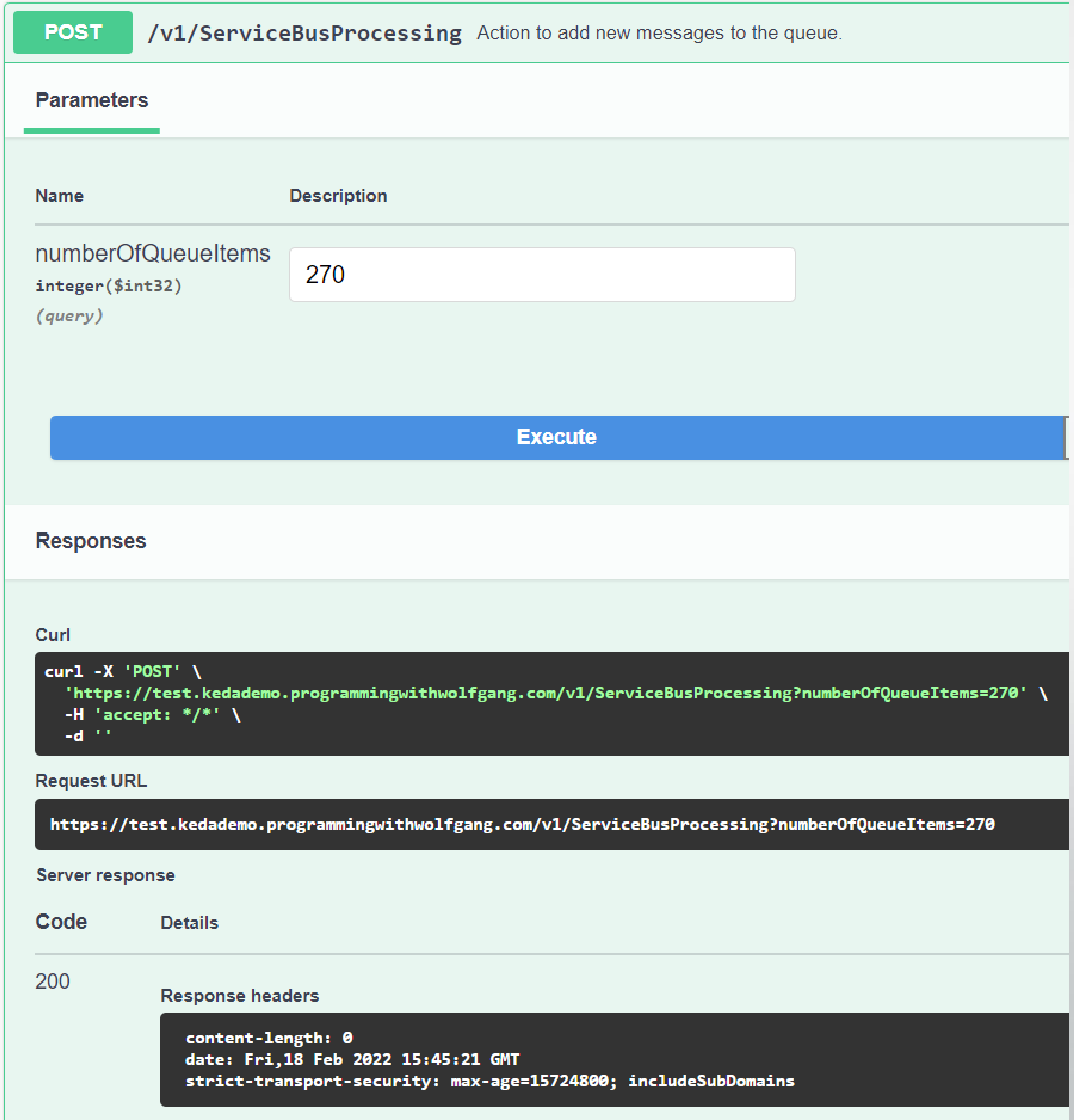
Authentication type ⓘ [✓ Access key] Active Directory

Receive performs a destructive read (ReceiveAndDelete) from Queue ***kedademo***.
from the Queue. Messages shown here are no longer stored.

Active	Dead-Lettered	Scheduled
1 MESSAGES	0 MESSAGES	0 MESSAGES

Please Select Queue or DeadLetter

● Queue ○ DeadLetter



`/v1/ServiceBusProcessing` Action to add new messages to the queue.

Parameters

Name	Description
numberOfQueueItems integer($int32) *(query)*	270

Responses

Curl

```
curl -X 'POST' \
  'https://test.kedademo.programmingwithwolfgang.com/v1/ServiceBusProcessing?numberOfQueueItems=270' \
  -H 'accept: */*' \
  -d ''
```

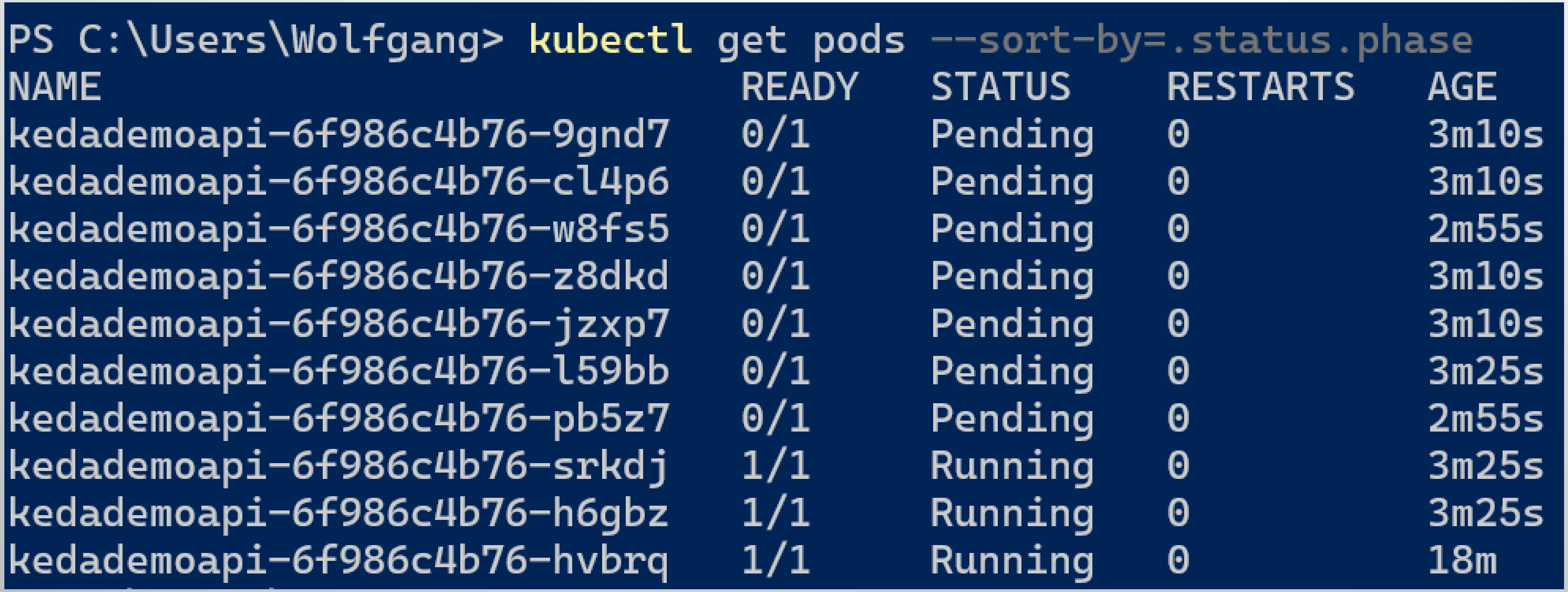
Request URL

```
https://test.kedademo.programmingwithwolfgang.com/v1/ServiceBusProcessing?numberOfQueueItems=270
```

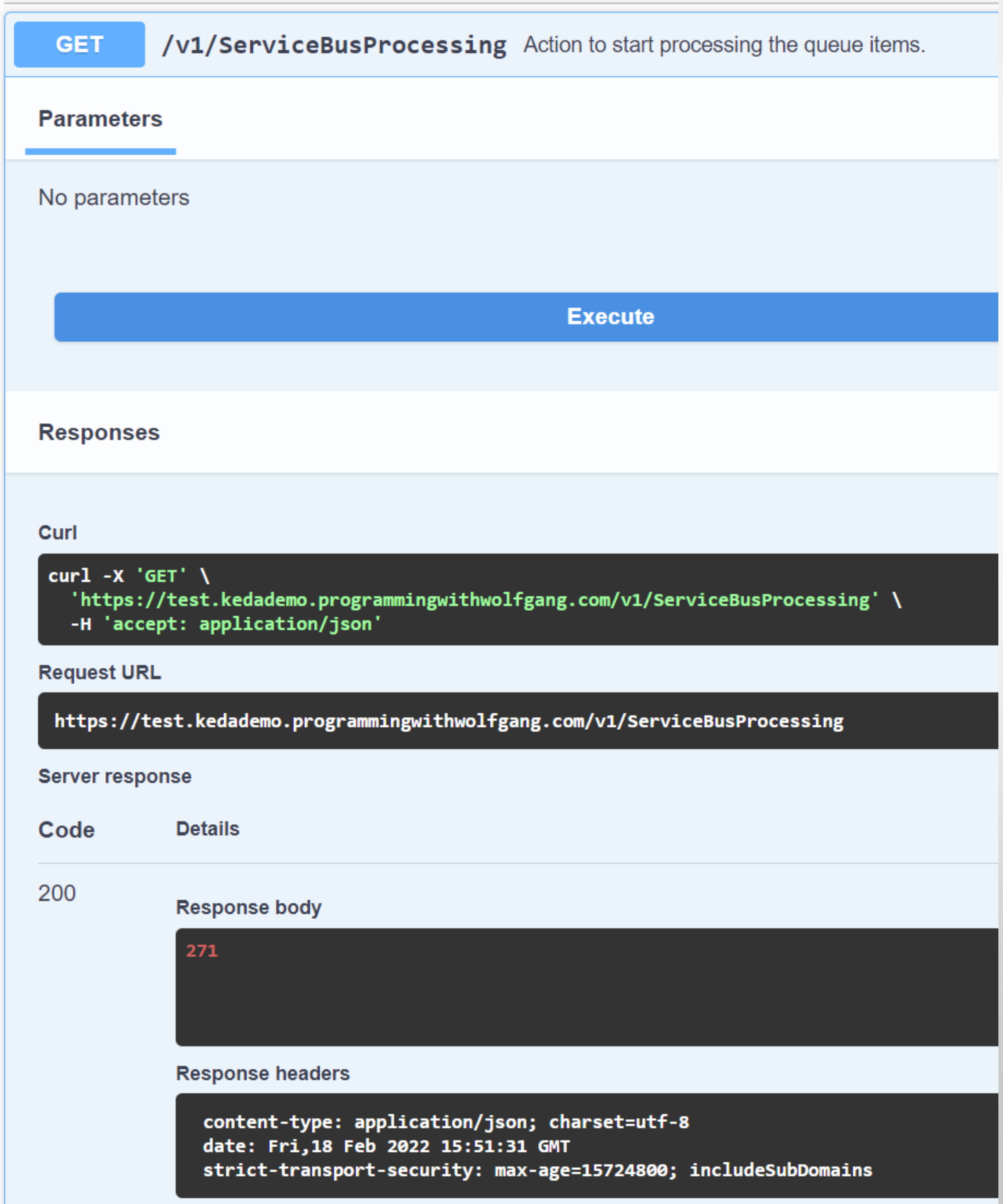
Server response

Code	Details
200	Response headers

```
content-length: 0
date: Fri,18 Feb 2022 15:45:21 GMT
strict-transport-security: max-age=15724800; includeSubDomains
```



```
PS C:\Users\Wolfgang> kubectl get pods --sort-by=.status.phase
NAME                           READY   STATUS    RESTARTS   AGE
kedademoapi-6f986c4b76-9gnd7   0/1     Pending   0          3m10s
kedademoapi-6f986c4b76-cl4p6   0/1     Pending   0          3m10s
kedademoapi-6f986c4b76-w8fs5   0/1     Pending   0          2m55s
kedademoapi-6f986c4b76-z8dkd   0/1     Pending   0          3m10s
kedademoapi-6f986c4b76-jzxp7   0/1     Pending   0          3m10s
kedademoapi-6f986c4b76-l59bb   0/1     Pending   0          3m25s
kedademoapi-6f986c4b76-pb5z7   0/1     Pending   0          2m55s
kedademoapi-6f986c4b76-srkdj   1/1     Running   0          3m25s
kedademoapi-6f986c4b76-h6gbz   1/1     Running   0          3m25s
kedademoapi-6f986c4b76-hvbrq   1/1     Running   0          18m
```



/v1/ServiceBusProcessing Action to start processing the queue items.

No parameters

Curl

```
curl -X 'GET' \
  'https://test.kedademo.programmingwithwolfgang.com/v1/ServiceBusProcessing' \
  -H 'accept: application/json'
```

Request URL

```
https://test.kedademo.programmingwithwolfgang.com/v1/ServiceBusProcessing
```

Server response

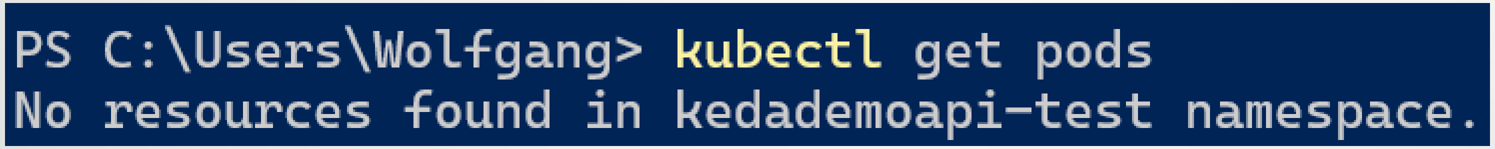
200

Response body

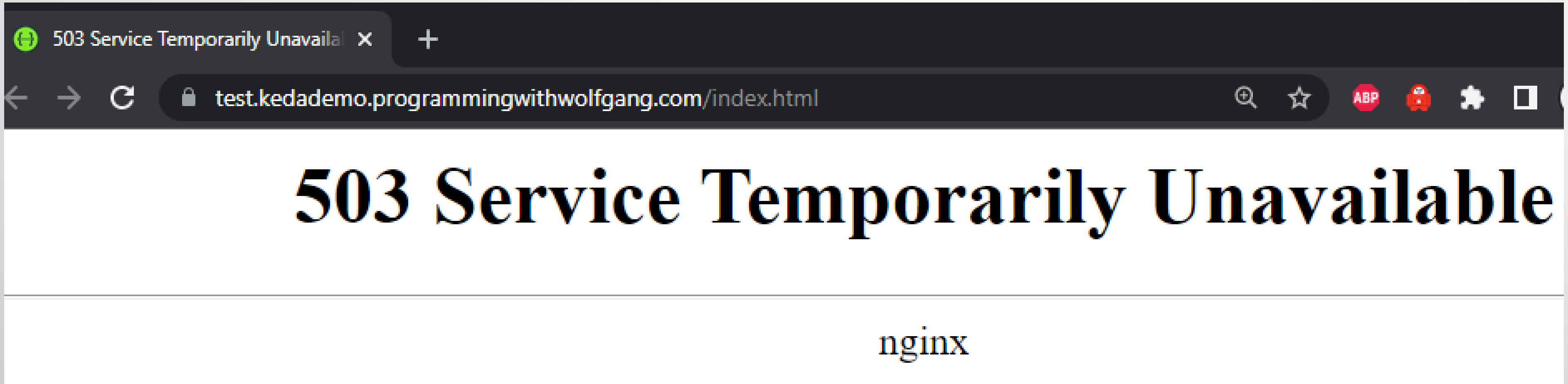
```
271
```

Response headers

```
 content-type: application/json; charset=utf-8
 date: Fri,18 Feb 2022 15:51:31 GMT
 strict-transport-security: max-age=15724800; includeSubDomains
```



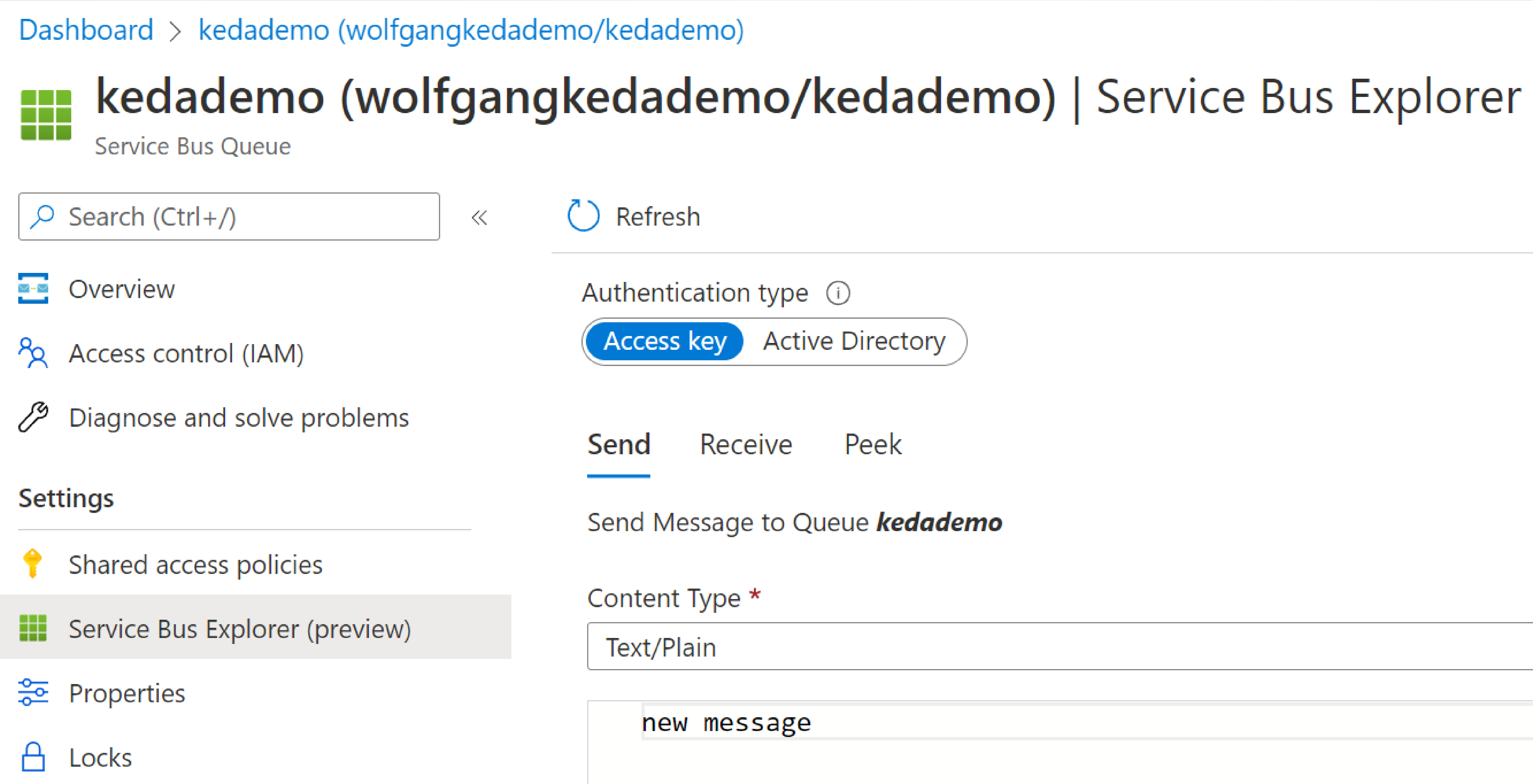
```
PS C:\Users\Wolfgang> kubectl get pods
No resources found in kedademoapi-test namespace.
```



503 Service Temporarily Unavaila
test.kedademo.programmingwithwolfgang.com/index.html

503 Service Temporarily Unavailable

nginx



kedademo (wolfgangkedademo/kedademo) | Service Bus Explorer

Service Bus Queue

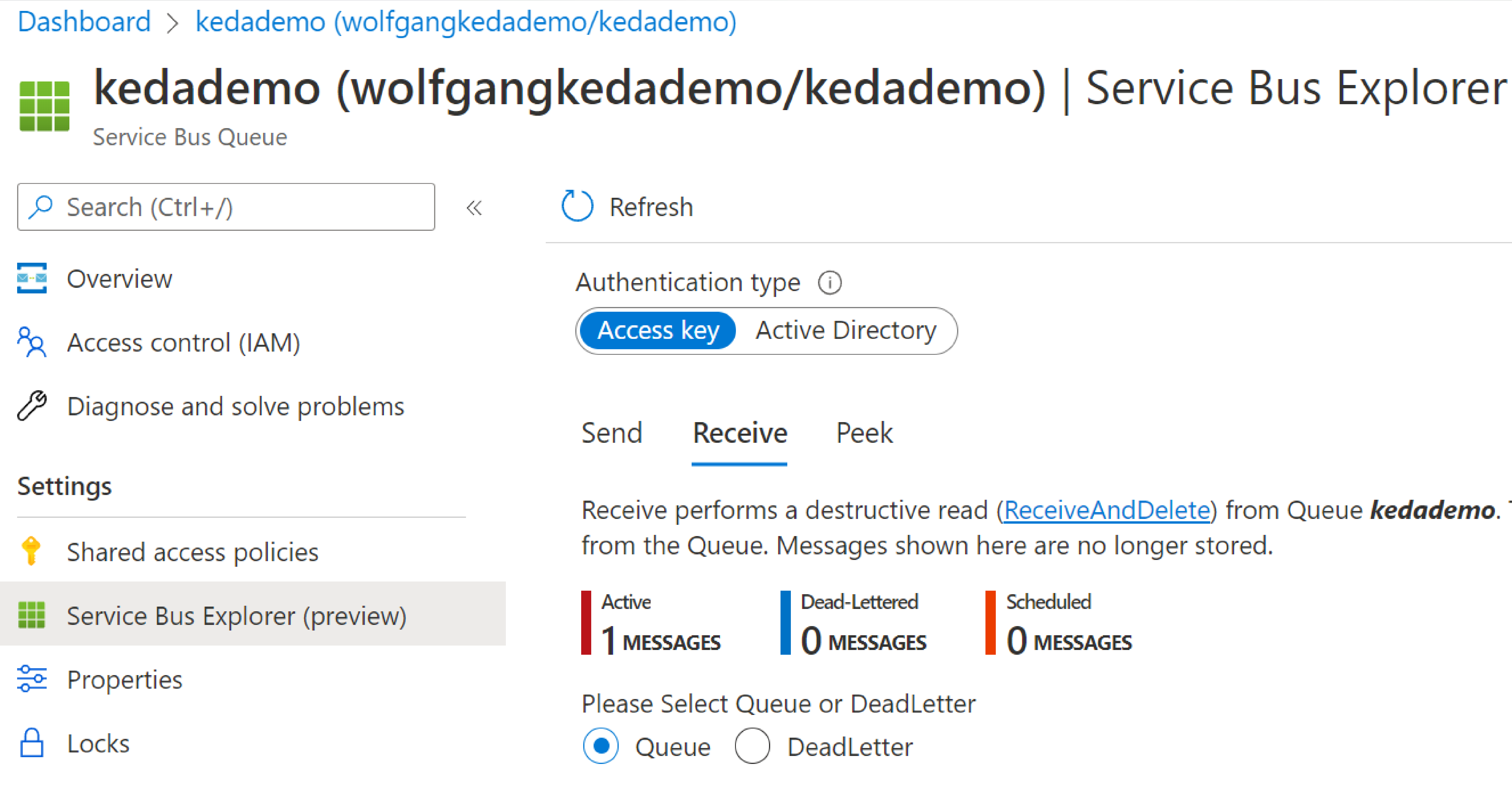
Authentication type: **Access key** | Active Directory

Send Message to Queue ***kedademo***

Content Type *

Text/Plain

```
new message
```



Dashboard > kedademo (wolfgangkedademo/kedademo)

kedademo (wolfgangkedademo/kedademo) | Service Bus Explorer

Service Bus Queue

Authentication type ⓘ

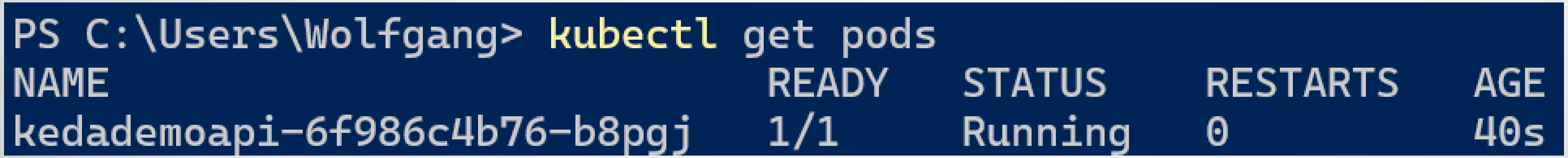
[✓ Access key] Active Directory

Receive performs a destructive read (ReceiveAndDelete) from Queue ***kedademo***. T
from the Queue. Messages shown here are no longer stored.

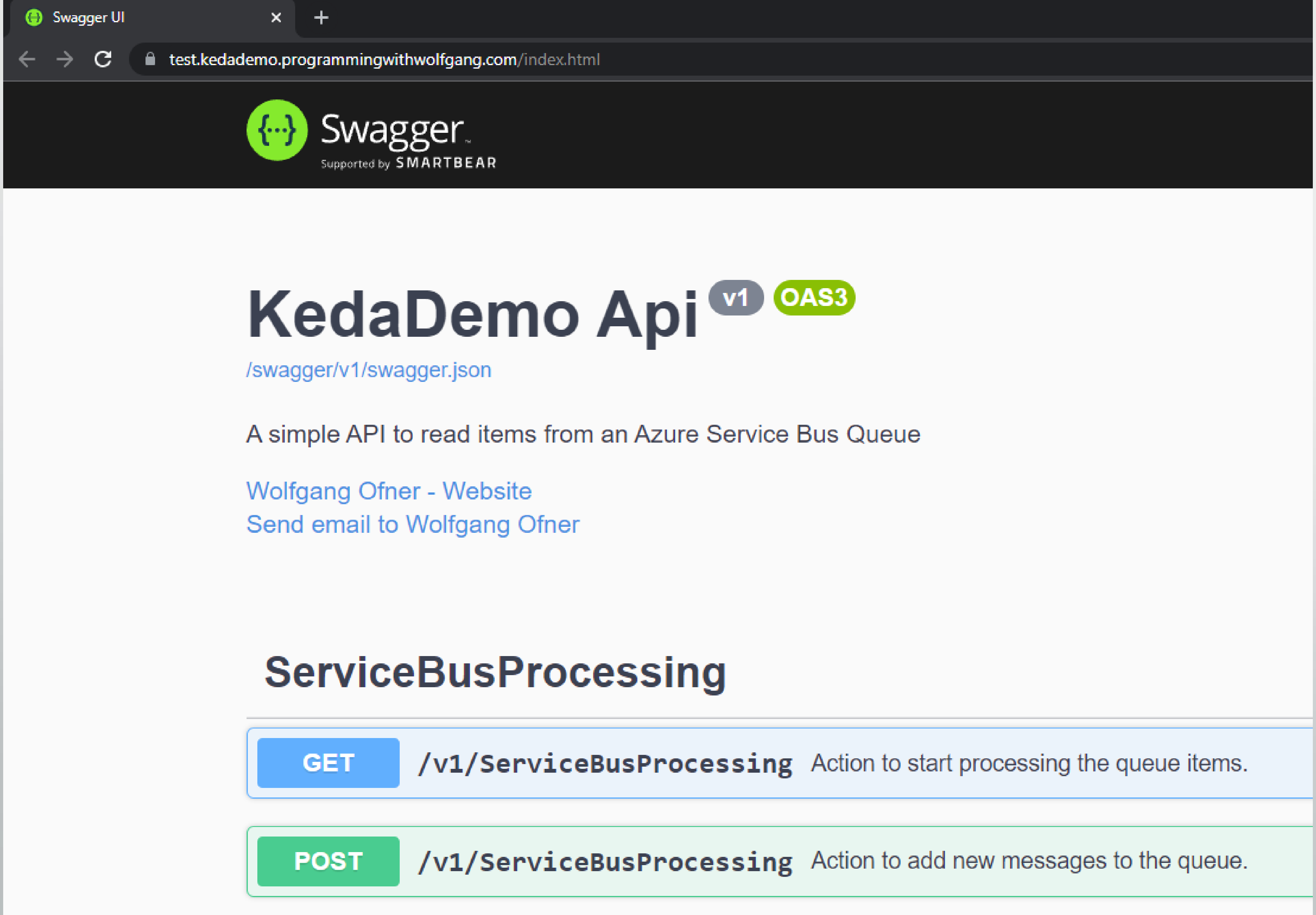
Active	Dead-Lettered	Scheduled
1 MESSAGES	0 MESSAGES	0 MESSAGES

Please Select Queue or DeadLetter

● Queue ○ DeadLetter



```
PS C:\Users\Wolfgang> kubectl get pods
NAME                            READY   STATUS    RESTARTS   AGE
kedademoapi-6f986c4b76-b8pgj    1/1     Running   0          40s
```



KedaDemo Api v1 OAS3

/swagger/v1/swagger.json

A simple API to read items from an Azure Service Bus Queue

Wolfgang Ofner - Website
Send email to Wolfgang Ofner

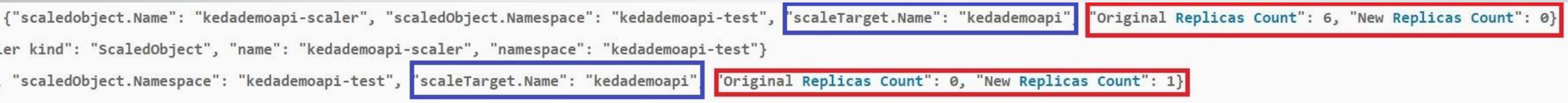
ServiceBusProcessing

GET `/v1/ServiceBusProcessing` Action to start processing the queue items.

POST `/v1/ServiceBusProcessing` Action to add new messages to the queue.

KEDA Scaling Logs

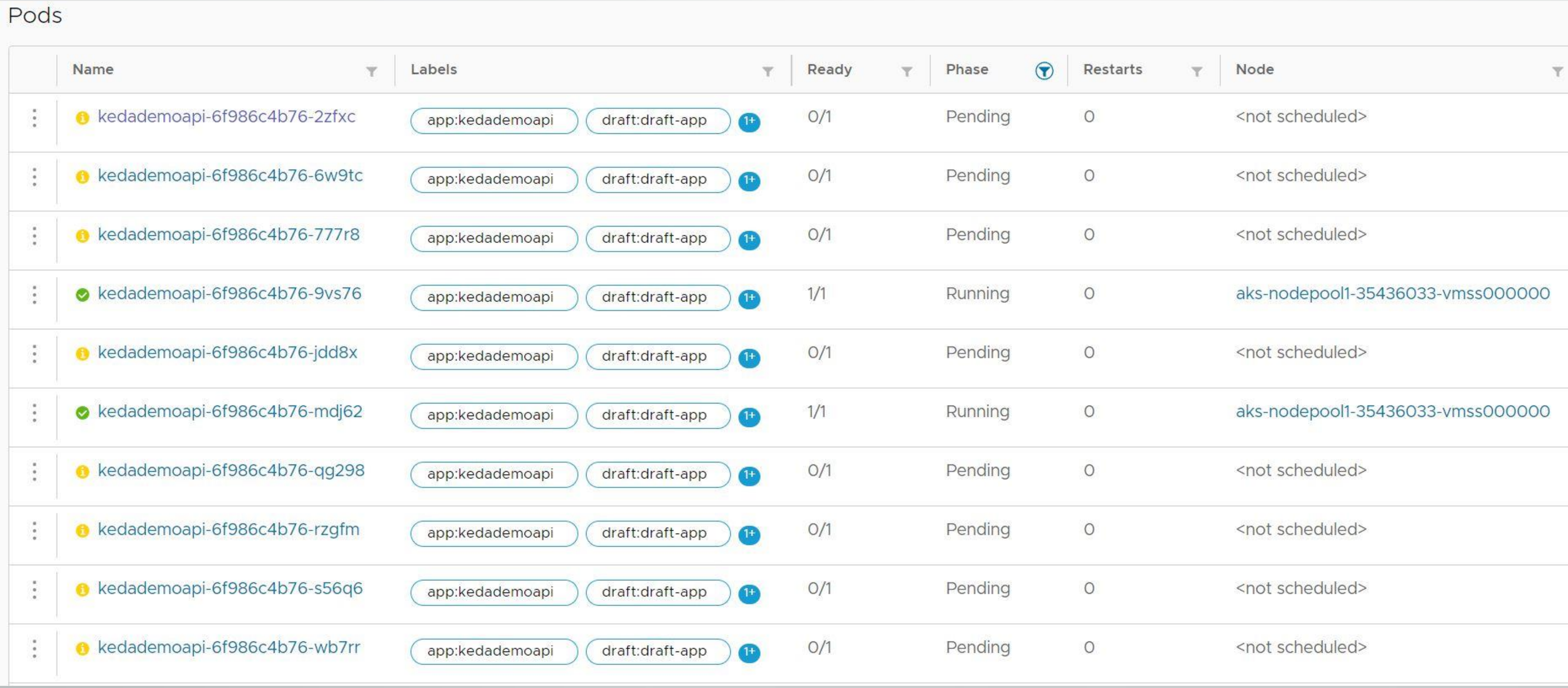
- keda-operator pod writes logs during scaling events



```
{"scaledobject.Name": "kedademoapi-scaler", "scaledObject.Namespace": "kedademoapi-test", "scaleTarget.Name": "kedademoapi" "Original Replicas Count": 6, "New Replicas Count": 0}
er kind": "ScaledObject", "name": "kedademoapi-scaler", "namespace": "kedademoapi-test"}
 "scaledObject.Namespace": "kedademoapi-test", "scaleTarget.Name": "kedademoapi" "Original Replicas Count": 0, "New Replicas Count": 1}
```

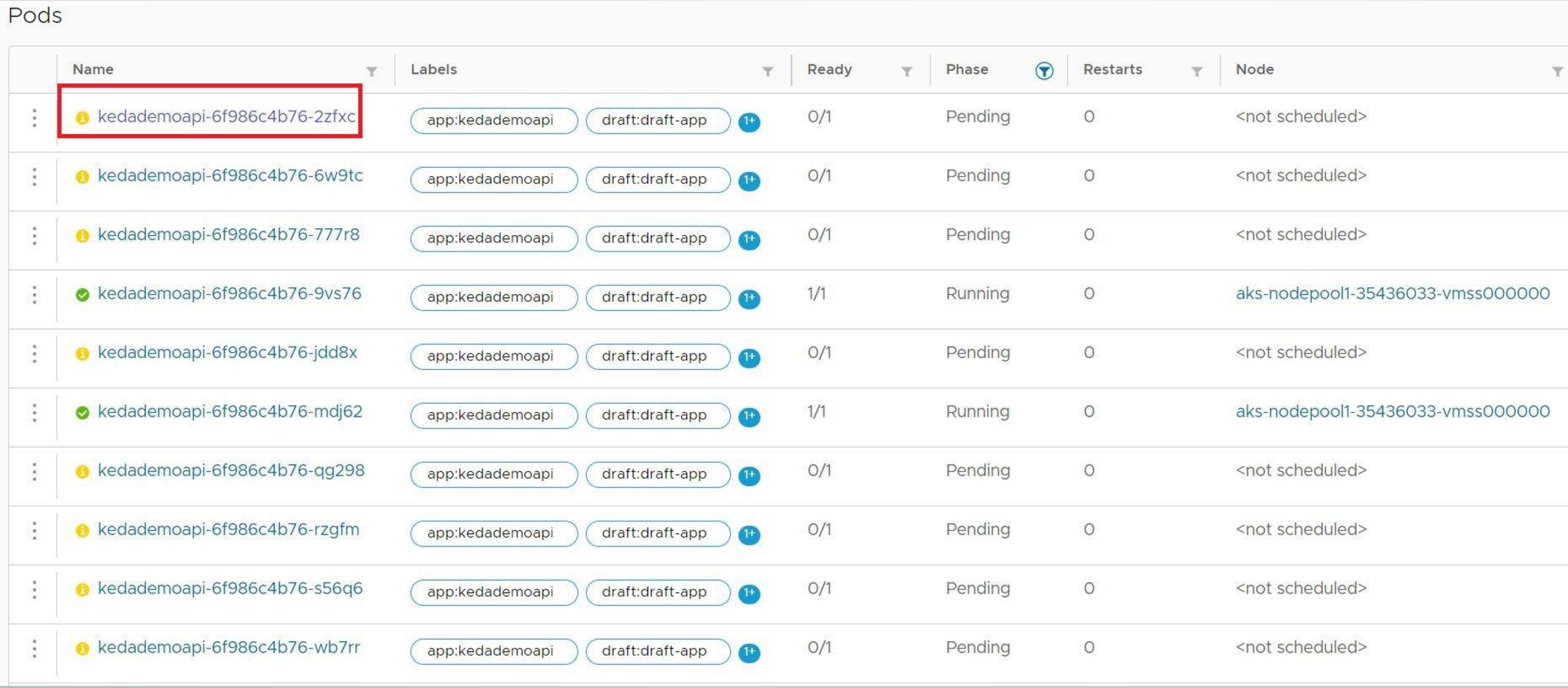
Limitations

- Scaler not available for used technology
- Cluster runs out of resources



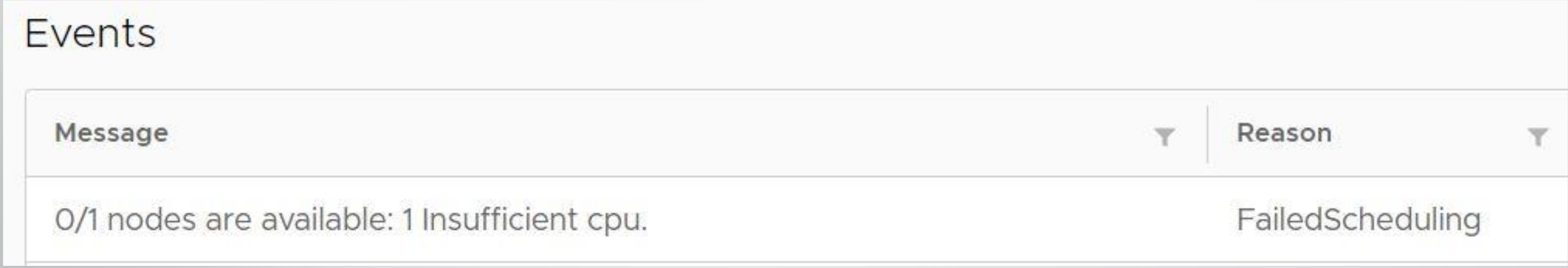
Pods

	Name	Labels	Ready	Phase	Restarts	Node
⋮	ⓘ kedademoapi-6f986c4b76-2zfxc	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ⓘ kedademoapi-6f986c4b76-6w9tc	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ⓘ kedademoapi-6f986c4b76-777r8	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	✓ kedademoapi-6f986c4b76-9vs76	app:kedademoapi draft:draft-app 1+	1/1	Running	0	aks-nodepool1-35436033-vmss000000
⋮	ⓘ kedademoapi-6f986c4b76-jdd8x	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	✓ kedademoapi-6f986c4b76-mdj62	app:kedademoapi draft:draft-app 1+	1/1	Running	0	aks-nodepool1-35436033-vmss000000
⋮	ⓘ kedademoapi-6f986c4b76-qg298	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ⓘ kedademoapi-6f986c4b76-rzgfm	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ⓘ kedademoapi-6f986c4b76-s56q6	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ⓘ kedademoapi-6f986c4b76-wb7rr	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>



Pods

	Name	Labels	Ready	Phase	Restarts	Node
⋮	ℹ kedademoapi-6f986c4b76-2zfxc	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ℹ kedademoapi-6f986c4b76-6w9tc	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ℹ kedademoapi-6f986c4b76-777r8	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	✓ kedademoapi-6f986c4b76-9vs76	app:kedademoapi draft:draft-app 1+	1/1	Running	0	aks-nodepool1-35436033-vmss000000
⋮	ℹ kedademoapi-6f986c4b76-jdd8x	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	✓ kedademoapi-6f986c4b76-mdj62	app:kedademoapi draft:draft-app 1+	1/1	Running	0	aks-nodepool1-35436033-vmss000000
⋮	ℹ kedademoapi-6f986c4b76-qg298	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ℹ kedademoapi-6f986c4b76-rzgfm	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ℹ kedademoapi-6f986c4b76-s56q6	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>
⋮	ℹ kedademoapi-6f986c4b76-wb7rr	app:kedademoapi draft:draft-app 1+	0/1	Pending	0	<not scheduled>



Events

Message	Reason
0/1 nodes are available: 1 Insufficient cpu.	FailedScheduling

Limitations

- Scaler not available for used technology
- Cluster runs out of resources
  - Azure Cluster Autoscaler
  - Define replica limit
  - Monitor cluster usage

KEDA in Production

- Azure Container Apps use KEDA for scaling
  - Serverless containers
- KEDA 1.0.0 → 17. Nov 2019
- Currently 2.7.1
- Over 5k GitHub stars

Resources

- Demo Application
  - https://github.com/WolfgangOfner/MicroserviceDemo/tree/master/KedaDemoApi
- Slides
  - https://github.com/WolfgangOfner/Presentation
- KEDA
  - https://keda.sh
- KEDA GitHub
  - https://github.com/kedacore/keda
- KEDA Architecture Screenshot
  - https://keda.sh/docs/2.6/concepts/#architecture

Q&A

Level Up your Kubernetes Scaling with KEDA

Wolfgang Ofner

https://programmingwithwolfgang.com

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

https://twitter.com/wolfgang_ofner