



# Red Hat OpenShift Serverless 1.34

## Integrations

Integrating OpenShift Serverless with Service Mesh and with the cost management service



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Integrating OpenShift Serverless with Service Mesh and with the cost management service

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## Abstract

This document provides information on how to integrate Service Mesh with OpenShift Serverless. It also covers using the cost management service to help you understand and track costs and shows you how to use NVIDIA GPU resources with serverless applications.

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# CHAPTER 1. INTEGRATING SERVICE MESH WITH OPENSIFT SERVERLESS

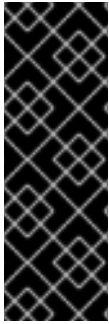
The OpenShift Serverless Operator provides Kourier as the default ingress for Knative. However, you can use Service Mesh with OpenShift Serverless whether Kourier is enabled or not. Integrating with Kourier disabled allows you to configure additional networking and routing options that the Kourier ingress does not support, such as mTLS functionality.

Note the following assumptions and limitations:

- All Knative internal components, as well as Knative Services, are part of the Service Mesh and have sidecars injection enabled. This means that strict mTLS is enforced within the whole mesh. All requests to Knative Services require an mTLS connection, with the client having to send its certificate, except calls coming from OpenShift Routing.
- OpenShift Serverless with Service Mesh integration can only target **one** service mesh. Multiple meshes can be present in the cluster, but OpenShift Serverless is only available on one of them.
- Changing the target **ServiceMeshMemberRoll** that OpenShift Serverless is part of, meaning moving OpenShift Serverless to another mesh, is not supported. The only way to change the targeted Service mesh is to uninstall and reinstall OpenShift Serverless.

## 1.1. PREREQUISITES

- You have access to an Red Hat OpenShift Serverless account with cluster administrator access.
- You have installed the OpenShift CLI (**oc**).
- You have installed the Serverless Operator.
- You have installed the Red Hat OpenShift Service Mesh Operator.
- The examples in the following procedures use the domain **example.com**. The example certificate for this domain is used as a certificate authority (CA) that signs the subdomain certificate.  
To complete and verify these procedures in your deployment, you need either a certificate signed by a widely trusted public CA or a CA provided by your organization. Example commands must be adjusted according to your domain, subdomain, and CA.
- You must configure the wildcard certificate to match the domain of your OpenShift Container Platform cluster. For example, if your OpenShift Container Platform console address is <https://console-openshift-console.apps.openshift.example.com>, you must configure the wildcard certificate so that the domain is **\*.apps.openshift.example.com**. For more information about configuring wildcard certificates, see the following topic about *Creating a certificate to encrypt incoming external traffic*.
- If you want to use any domain name, including those which are not subdomains of the default OpenShift Container Platform cluster domain, you must set up domain mapping for those domains. For more information, see the OpenShift Serverless documentation about [Creating a custom domain mapping](#).



## IMPORTANT

OpenShift Serverless only supports the use of Red Hat OpenShift Service Mesh functionality that is explicitly documented in this guide, and does not support other undocumented features.

Using Serverless 1.31 with Service Mesh is only supported with Service Mesh version 2.2 or later. For details and information on versions other than 1.31, see the "Red Hat OpenShift Serverless Supported Configurations" page.

## 1.2. ADDITIONAL RESOURCES

- [Red Hat OpenShift Serverless Supported Configurations](#)
- [Kourier and Istio ingresses](#)

## 1.3. CREATING A CERTIFICATE TO ENCRYPT INCOMING EXTERNAL TRAFFIC

By default, the Service Mesh mTLS feature only secures traffic inside of the Service Mesh itself, between the ingress gateway and individual pods that have sidecars. To encrypt traffic as it flows into the OpenShift Container Platform cluster, you must generate a certificate before you enable the OpenShift Serverless and Service Mesh integration.

### Prerequisites

- You have cluster administrator permissions on OpenShift Container Platform, or you have cluster or dedicated administrator permissions on Red Hat OpenShift Service on AWS or OpenShift Dedicated.
- You have installed the OpenShift Serverless Operator and Knative Serving.
- Install the OpenShift CLI (**oc**).
- You have created a project or have access to a project with the appropriate roles and permissions to create applications and other workloads.

### Procedure

1. Create a root certificate and private key that signs the certificates for your Knative services:

```
$ openssl req -x509 -sha256 -nodes -days 365 -newkey rsa:2048 \  
-subj '/O=Example Inc./CN=example.com' \  
-keyout root.key \  
-out root.crt
```

2. Create a wildcard certificate:

```
$ openssl req -nodes -newkey rsa:2048 \  
-subj '/CN=*.apps.openshift.example.com/O=Example Inc.' \  
-keyout wildcard.key \  
-out wildcard.csr
```

3. Sign the wildcard certificate:



```
$ openssl x509 -req -days 365 -set_serial 0 \
  -CA root.crt \
  -CAkey root.key \
  -in wildcard.csr \
  -out wildcard.crt
```

4. Create a secret by using the wildcard certificate:

```
$ oc create -n istio-system secret tls wildcard-certs \
  --key=wildcard.key \
  --cert=wildcard.crt
```

This certificate is picked up by the gateways created when you integrate OpenShift Serverless with Service Mesh, so that the ingress gateway serves traffic with this certificate.

## 1.4. INTEGRATING SERVICE MESH WITH OPENSIFT SERVERLESS

### 1.4.1. Verifying installation prerequisites

Before installing and configuring the Service Mesh integration with Serverless, verify that the prerequisites have been met.

#### Procedure

1. Check for conflicting gateways:

#### Example command

```
$ oc get gateway -A -o jsonpath='{range .items[*]}{@.metadata.namespace}/{/}{@.metadata.name}{" "}{@.spec.servers{"\n"}{end}' | column -t
```

#### Example output

```
knative-serving/knative-ingress-gateway [{"hosts":["*"],"port":
{"name":"https","number":443,"protocol":"HTTPS"},"tls":{"credentialName":"wildcard-
certs","mode":"SIMPLE"}}]
knative-serving/knative-local-gateway [{"hosts":["*"],"port":
{"name":"http","number":8081,"protocol":"HTTP"}}]
```

This command should not return a **Gateway** that binds **port: 443** and **hosts: ["\*"]**, except the **Gateways** in **knative-serving** and **Gateways** that are part of another Service Mesh instance.



#### NOTE

The mesh that Serverless is part of must be distinct and preferably reserved only for Serverless workloads. That is because additional configuration, such as **Gateways**, might interfere with the Serverless gateways **knative-local-gateway** and **knative-ingress-gateway**. Red Hat OpenShift Service Mesh only allows one Gateway to claim a wildcard host binding (**hosts: ["\*"]**) on the same port (**port: 443**). If another Gateway is already binding this configuration, a separate mesh has to be created for Serverless workloads.

2. Check whether Red Hat OpenShift Service Mesh **istio-ingressgateway** is exposed as type **NodePort** or **LoadBalancer**:

### Example command

```
$ oc get svc -A | grep istio-ingressgateway
```

### Example output

```
istio-system istio-ingressgateway ClusterIP 172.30.46.146 none>
15021/TCP,80/TCP,443/TCP 9m50s
```

This command should not return a **Service** object of type **NodePort** or **LoadBalancer**.



### NOTE

Cluster external Knative Services are expected to be called via OpenShift Ingress using OpenShift Routes. It is not supported to access Service Mesh directly, such as by exposing the **istio-ingressgateway** using a **Service** object with type **NodePort** or **LoadBalancer**.

## 1.4.2. Installing and configuring Service Mesh

To integrate Serverless with Service Mesh, you need to install Service Mesh with a specific configuration.

### Procedure

1. Create a **ServiceMeshControlPlane** resource in the **istio-system** namespace with the following configuration:



### IMPORTANT

If you have an existing **ServiceMeshControlPlane** object, make sure that you have the same configuration applied.

```
apiVersion: maistra.io/v2
kind: ServiceMeshControlPlane
metadata:
  name: basic
  namespace: istio-system
spec:
  profiles:
  - default
  security:
    dataPlane:
      mtls: true 1
  techPreview:
    meshConfig:
      defaultConfig:
        terminationDrainDuration: 35s 2
  gateways:
    ingress:
    service:
```

```

metadata:
  labels:
    knative: ingressgateway 3
proxy:
  networking:
    trafficControl:
      inbound:
        excludedPorts: 4
        - 8444 # metrics
        - 8022 # serving: wait-for-drain k8s pre-stop hook

```

- 1 Enforce strict mTLS in the mesh. Only calls using a valid client certificate are allowed.
  - 2 Serverless has a graceful termination for Knative Services of 30 seconds. **istio-proxy** needs to have a longer termination duration to make sure no requests are dropped.
  - 3 Define a specific selector for the ingress gateway to target only the Knative gateway.
  - 4 These ports are called by Kubernetes and cluster monitoring, which are not part of the mesh and cannot be called using mTLS. Therefore, these ports are excluded from the mesh.
2. Add the namespaces that you would like to integrate with Service Mesh to the **ServiceMeshMemberRoll** object as members:

#### Example `servicemesh-member-roll.yaml` configuration file

```

apiVersion: maistra.io/v1
kind: ServiceMeshMemberRoll
metadata:
  name: default
  namespace: istio-system
spec:
  members: 1
  - knative-serving
  - knative-eventing
  - your-OpenShift-projects

```

- 1 A list of namespaces to be integrated with Service Mesh.



#### IMPORTANT

This list of namespaces must include the **knative-serving** and **knative-eventing** namespaces.

3. Apply the **ServiceMeshMemberRoll** resource:

```
$ oc apply -f servicemesh-member-roll.yaml
```

4. Create the necessary gateways so that Service Mesh can accept traffic. The following example uses the **knative-local-gateway** object with the **ISTIO\_MUTUAL** mode (mTLS):

#### Example `istio-knative-gateways.yaml` configuration file

```
---
apiVersion: networking.istio.io/v1alpha3
kind: Gateway
metadata:
  name: knative-ingress-gateway
  namespace: knative-serving
spec:
  selector:
    knative: ingressgateway
  servers:
  - port:
      number: 443
      name: https
      protocol: HTTPS
    hosts:
    - "*"
    tls:
      mode: SIMPLE
      credentialName: <wildcard_certs> 1
---
apiVersion: networking.istio.io/v1alpha3
kind: Gateway
metadata:
  name: knative-local-gateway
  namespace: knative-serving
spec:
  selector:
    knative: ingressgateway
  servers:
  - port:
      number: 8081
      name: https
      protocol: HTTPS 2
    tls:
      mode: ISTIO_MUTUAL 3
    hosts:
    - "*"
---
apiVersion: v1
kind: Service
metadata:
  name: knative-local-gateway
  namespace: istio-system
labels:
  experimental.istio.io/disable-gateway-port-translation: "true"
spec:
  type: ClusterIP
  selector:
    istio: ingressgateway
  ports:
  - name: http2
    port: 80
    targetPort: 8081
```

1 Name of the secret containing the wildcard certificate.

- 2** **3** The **knative-local-gateway** object serves HTTPS traffic and expects all clients to send requests using mTLS. This means that only traffic coming from within Service Mesh is

5. Apply the **Gateway** resources:

```
$ oc apply -f istio-knative-gateways.yaml
```

### 1.4.3. Installing and configuring Serverless

After installing Service Mesh, you need to install Serverless with a specific configuration.

#### Procedure

1. Install Knative Serving with the following **KnativeServing** custom resource, which enables the Istio integration:

#### Example **knative-serving-config.yaml** configuration file

```
apiVersion: operator.knative.dev/v1beta1
kind: KnativeServing
metadata:
  name: knative-serving
  namespace: knative-serving
spec:
  ingress:
    istio:
      enabled: true 1
  deployments: 2
  - name: activator
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: autoscaler
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  config:
    istio: 3
      gateway.knative-serving.knative-ingress-gateway: istio-ingressgateway.<your-istio-namespace>.svc.cluster.local
      local-gateway.knative-serving.knative-local-gateway: knative-local-gateway.<your-istio-namespace>.svc.cluster.local
```

- 1** Enable Istio integration.
- 2** Enable sidecar injection for Knative Serving data plane pods.
- 3** If your istio is not running in the **istio-system** namespace, you need to set these two flags with the correct namespace.

2. Apply the **KnativeServing** resource:

```
$ oc apply -f knative-serving-config.yaml
```

3. Install Knative Eventing with the following **KnativeEventing** object, which enables the Istio integration:

#### Example `knative-eventing-config.yaml` configuration file

```
apiVersion: operator.knative.dev/v1beta1
kind: KnativeEventing
metadata:
  name: knative-eventing
  namespace: knative-eventing
spec:
  config:
    features:
      istio: enabled 1
  workloads: 2
  - name: pingsource-mt-adapter
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: imc-dispatcher
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: mt-broker-ingress
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: mt-broker-filter
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
```

- 1** Enable Eventing Istio controller to create a **DestinationRule** for each **InMemoryChannel** or **KafkaChannel** service.
- 2** Enable sidecar injection for Knative Eventing pods.

4. Apply the **KnativeEventing** resource:

```
$ oc apply -f knative-eventing-config.yaml
```

5. Install Knative Kafka with the following **KnativeKafka** custom resource, which enables the Istio integration:

#### Example `knative-kafka-config.yaml` configuration file

-

```

apiVersion: operator.serverless.openshift.io/v1alpha1
kind: KnativeKafka
metadata:
  name: knative-kafka
  namespace: knative-eventing
spec:
  channel:
    enabled: true
    bootstrapServers: <bootstrap_servers> ❶
  source:
    enabled: true
  broker:
    enabled: true
    defaultConfig:
      bootstrapServers: <bootstrap_servers> ❷
      numPartitions: <num_partitions>
      replicationFactor: <replication_factor>
    sink:
      enabled: true
  workloads: ❸
  - name: kafka-controller
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: kafka-broker-receiver
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: kafka-broker-dispatcher
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: kafka-channel-receiver
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: kafka-channel-dispatcher
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: kafka-source-dispatcher
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"
  - name: kafka-sink-receiver
    labels:
      "sidecar.istio.io/inject": "true"
    annotations:
      "sidecar.istio.io/rewriteAppHTTPProbers": "true"

```

- 1 2 The Apache Kafka cluster URL, for example **my-cluster-kafka-bootstrap.kafka:9092**.
- 3 Enable sidecar injection for Knative Kafka pods.

6. Apply the **KnativeEventing** object:

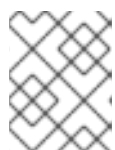
```
$ oc apply -f knative-kafka-config.yaml
```

7. Install **ServiceEntry** to inform Service Mesh of the communication between **KnativeKafka** components and an Apache Kafka cluster:

#### Example **kafka-cluster-serviceentry.yaml** configuration file

```
apiVersion: networking.istio.io/v1alpha3
kind: ServiceEntry
metadata:
  name: kafka-cluster
  namespace: knative-eventing
spec:
  hosts: 1
  - <bootstrap_servers_without_port>
  exportTo:
  - "*"
  ports: 2
  - number: 9092
    name: tcp-plain
    protocol: TCP
  - number: 9093
    name: tcp-tls
    protocol: TCP
  - number: 9094
    name: tcp-sasl-tls
    protocol: TCP
  - number: 9095
    name: tcp-sasl-tls
    protocol: TCP
  - number: 9096
    name: tcp-tls
    protocol: TCP
  location: MESH_EXTERNAL
  resolution: NONE
```

- 1 The list of Apache Kafka cluster hosts, for example **my-cluster-kafka-bootstrap.kafka**.
- 2 Apache Kafka cluster listeners ports.



#### NOTE

The listed ports in **spec.ports** are example TPC ports. The actual values depend on how the Apache Kafka cluster is configured.

8. Apply the **ServiceEntry** resource:

-



```
$ oc apply -f kafka-cluster-serviceentry.yaml
```

### 1.4.4. Verifying the integration

After installing Service Mesh and Serverless with Istio enabled, you can verify that the integration works.

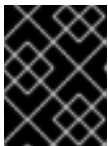
#### Procedure

1. Create a Knative Service that has sidecar injection enabled and uses a pass-through route:

#### Example knative-service.yaml configuration file

```
apiVersion: serving.knative.dev/v1
kind: Service
metadata:
  name: <service_name>
  namespace: <namespace> 1
  annotations:
    serving.knative.openshift.io/enablePassthrough: "true" 2
spec:
  template:
    metadata:
      annotations:
        sidecar.istio.io/inject: "true" 3
        sidecar.istio.io/rewriteAppHTTPProbers: "true"
    spec:
      containers:
        - image: <image_url>
```

- 1** A namespace that is part of the service mesh member roll.
- 2** Instruct Knative Serving to generate a pass-through enabled route, so that the certificates you have generated are served through the ingress gateway directly.
- 3** Inject Service Mesh sidecars into the Knative service pods.



#### IMPORTANT

Always add the annotation from this example to all of your Knative Service to make them work with Service Mesh.

2. Apply the **Service** resource:

```
$ oc apply -f knative-service.yaml
```

3. Access your serverless application by using a secure connection that is now trusted by the CA:

```
$ curl --cacert root.crt <service_url>
```

For example, run:

#### Example command

```
$ curl --cacert root.crt https://hello-default.apps.openshift.example.com
```

### Example output

```
Hello Openshift!
```

## 1.5. ENABLING KNATIVE SERVING AND KNATIVE EVENTING METRICS WHEN USING SERVICE MESH WITH MTLS

If Service Mesh is enabled with Mutual Transport Layer Security (mTLS), metrics for Knative Serving and Knative Eventing are disabled by default, because Service Mesh prevents Prometheus from scraping metrics. You can enable Knative Serving and Knative Eventing metrics when using Service Mesh and mTLS.

### Prerequisites

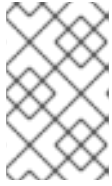
- You have one of the following permissions to access the cluster:
  - Cluster administrator permissions on OpenShift Container Platform
  - Cluster administrator permissions on Red Hat OpenShift Service on AWS
  - Dedicated administrator permissions on OpenShift Dedicated
- You have installed the OpenShift CLI (**oc**).
- You have access to a project with the appropriate roles and permissions to create applications and other workloads.
- You have installed the OpenShift Serverless Operator, Knative Serving, and Knative Eventing on your cluster.
- You have installed Red Hat OpenShift Service Mesh with the mTLS functionality enabled.

### Procedure

1. Specify **prometheus** as the **metrics.backend-destination** in the **observability** spec of the Knative Serving custom resource (CR):

```
apiVersion: operator.knative.dev/v1beta1
kind: KnativeServing
metadata:
  name: knative-serving
  namespace: knative-serving
spec:
  config:
    observability:
      metrics.backend-destination: "prometheus"
  ...
```

This step prevents metrics from being disabled by default.



## NOTE

When you configure **ServiceMeshControlPlane** with **manageNetworkPolicy: false**, you must use the annotation on KnativeEventing to ensure proper event delivery.

The same mechanism is used for Knative Eventing. To enable metrics for Knative Eventing, you need to specify **prometheus** as the **metrics.backend-destination** in the **observability** spec of the Knative Eventing custom resource (CR) as follows:

```
apiVersion: operator.knative.dev/v1beta1
kind: KnativeEventing
metadata:
  name: knative-eventing
  namespace: knative-eventing
spec:
  config:
    observability:
      metrics.backend-destination: "prometheus"
  ...
```

2. Modify and reapply the default Service Mesh control plane in the **istio-system** namespace, so that it includes the following spec:

```
...
spec:
  proxy:
    networking:
      trafficControl:
        inbound:
          excludedPorts:
            - 8444
  ...
```

## 1.6. DISABLING THE DEFAULT NETWORK POLICIES

The OpenShift Serverless Operator generates the network policies by default. To disable the default network policy generation, you can add the **serverless.openshift.io/disable-istio-net-policies-generation** annotation in the **KnativeEventing** and **KnativeServing** custom resources (CRs).

### Prerequisites

- You have one of the following permissions to access the cluster:
  - Cluster administrator permissions on OpenShift Container Platform
  - Cluster administrator permissions on Red Hat OpenShift Service on AWS
  - Dedicated administrator permissions on OpenShift Dedicated
- You have installed the OpenShift CLI (**oc**).
- You have access to a project with the appropriate roles and permissions to create applications and other workloads.

- You have installed the OpenShift Serverless Operator, Knative Serving, and Knative Eventing on your cluster.
- You have installed Red Hat OpenShift Service Mesh with the mTLS functionality enabled.

## Procedure

- Add the **serverless.openshift.io/disable-istio-net-policies-generation: "true"** annotation to your Knative custom resources.



### NOTE

The OpenShift Serverless Operator generates the required network policies by default. When you configure **ServiceMeshControlPlane** with **manageNetworkPolicy: false**, you must disable the default network policy generation to ensure proper event delivery. To disable the default network policy generation, you can add the **serverless.openshift.io/disable-istio-net-policies-generation** annotation in the **KnativeEventing** and **KnativeServing** custom resources (CRs).

- Annotate the **KnativeEventing** CR by running the following command:

```
$ oc edit KnativeEventing -n knative-eventing
```

#### Example KnativeEventing CR

```
apiVersion: operator.knative.dev/v1beta1
kind: KnativeEventing
metadata:
  name: knative-eventing
  namespace: knative-eventing
  annotations:
    serverless.openshift.io/disable-istio-net-policies-generation: "true"
```

- Annotate the **KnativeServing** CR by running the following command:

```
$ oc edit KnativeServing -n knative-serving
```

#### Example KnativeServing CR

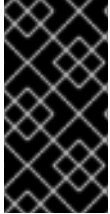
```
apiVersion: operator.knative.dev/v1beta1
kind: KnativeServing
metadata:
  name: knative-serving
  namespace: knative-serving
  annotations:
    serverless.openshift.io/disable-istio-net-policies-generation: "true"
```

## 1.7. IMPROVING NET-ISTIO MEMORY USAGE BY USING SECRET FILTERING FOR SERVICE MESH

By default, the [informers](#) implementation for the Kubernetes **client-go** library fetches all resources of a

particular type. This can lead to a substantial overhead when many resources are available, which can cause the Knative **net-istio** ingress controller to fail on large clusters due to memory leaking. However, a filtering mechanism is available for the Knative **net-istio** ingress controller, which enables the controllers to only fetch Knative related secrets.

The secret filtering is enabled by default on the OpenShift Serverless Operator side. An environment variable, **ENABLE\_SECRET\_INFORMER\_FILTERING\_BY\_CERT\_UID=true**, is added by default to the **net-istio** controller pods.



## IMPORTANT

If you enable secret filtering, you must label all of your secrets with **networking.internal.knative.dev/certificate-uid: "<id>"**. Otherwise, Knative Serving does not detect them, which leads to failures. You must label both new and existing secrets.

## Prerequisites

- You have cluster administrator permissions on OpenShift Container Platform, or you have cluster or dedicated administrator permissions on Red Hat OpenShift Service on AWS or OpenShift Dedicated.
- You have created a project or have access to a project with the appropriate roles and permissions to create applications and other workloads.
- Install Red Hat OpenShift Service Mesh. OpenShift Serverless with Service Mesh only is supported for use with Red Hat OpenShift Service Mesh version 2.0.5 or later.
- Install the OpenShift Serverless Operator and Knative Serving.
- Install the OpenShift CLI (**oc**).

You can disable the secret filtering by setting the **ENABLE\_SECRET\_INFORMER\_FILTERING\_BY\_CERT\_UID** variable to **false** by using the **workloads** field in the **KnativeServing** custom resource (CR).

## Example KnativeServing CR

```
apiVersion: operator.knative.dev/v1beta1
kind: KnativeServing
metadata:
  name: knative-serving
  namespace: knative-serving
spec:
  ...
  workloads:
    - env:
      - container: controller
        envVars:
          - name: ENABLE_SECRET_INFORMER_FILTERING_BY_CERT_UID
            value: 'false'
      name: net-istio-controller
```

## CHAPTER 2. USING SERVICE MESH TO ISOLATE NETWORK TRAFFIC WITH OPENSIFT SERVERLESS



### IMPORTANT

Using Service Mesh to isolate network traffic with OpenShift Serverless is a Technology Preview feature only. Technology Preview features are not supported with Red Hat production service level agreements (SLAs) and might not be functionally complete. Red Hat does not recommend using them in production. These features provide early access to upcoming product features, enabling customers to test functionality and provide feedback during the development process.

For more information about the support scope of Red Hat Technology Preview features, see [Technology Preview Features Support Scope](#).

Service Mesh can be used to isolate network traffic between tenants on a shared Red Hat OpenShift Serverless cluster using Service Mesh **AuthorizationPolicy** resources. Serverless can also leverage this, using several Service Mesh resources. A tenant is a group of one or multiple projects that can access each other over the network on a shared cluster.

### 2.1. PREREQUISITES

- You have access to an Red Hat OpenShift Serverless account with cluster administrator access.
- You have set up the Service Mesh and Serverless integration.
- You have created one or more OpenShift projects for each tenant.

### 2.2. HIGH-LEVEL ARCHITECTURE

The high-level architecture of Serverless traffic isolation provided by Service Mesh consists of **AuthorizationPolicy** objects in the **knative-serving**, **knative-eventing**, and the tenants' namespaces, with all the components being part of the Service Mesh. The injected Service Mesh sidecars enforce those rules to isolate network traffic between tenants.

### 2.3. SECURING THE SERVICE MESH

Authorization policies and mTLS allow you to secure Service Mesh.

#### Procedure

1. Make sure that all Red Hat OpenShift Serverless projects of your tenant are part of the same **ServiceMeshMemberRoll** object as members:

```
apiVersion: maistra.io/v1
kind: ServiceMeshMemberRoll
metadata:
  name: default
  namespace: istio-system
spec:
  members:
    - knative-serving # static value, needs to be here, see setup page
```

```

- knative-eventing # static value, needs to be here, see setup page
- team-alpha-1     # example OpenShift project that belongs to the team-alpha tenant
- team-alpha-2     # example OpenShift project that belongs th the team-alpha tenant
- team-bravo-1     # example OpenShift project that belongs to the team-bravo tenant
- team-bravo-2     # example OpenShift project that belongs th the team-bravo tenant

```

All projects that are part of the mesh must enforce mTLS in strict mode. This forces Istio to only accept connections with a client-certificate present and allows the Service Mesh sidecar to validate the origin using an **AuthorizationPolicy** object.

2. Create the configuration with **AuthorizationPolicy** objects in the **knative-serving** and **knative-eventing** namespaces:

### Example knative-default-authz-policies.yaml configuration file

```

apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: deny-all-by-default
  namespace: knative-eventing
spec: { }
---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: deny-all-by-default
  namespace: knative-serving
spec: { }
---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-mt-channel-based-broker-ingress-to-imc-dispatcher
  namespace: knative-eventing
spec:
  action: ALLOW
  selector:
    matchLabels:
      app.kubernetes.io/component: "imc-dispatcher"
  rules:
    - from:
      - source:
          namespaces: [ "knative-eventing" ]
          principals: [ "cluster.local/ns/knative-eventing/sa/mt-broker-ingress" ]
      to:
        - operation:
            methods: [ "POST" ]
---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-mt-channel-based-broker-ingress-to-kafka-channel
  namespace: knative-eventing
spec:
  action: ALLOW
  selector:

```

```

    matchLabels:
      app.kubernetes.io/component: "kafka-channel-receiver"
  rules:
  - from:
    - source:
      namespaces: [ "knative-eventing" ]
      principals: [ "cluster.local/ns/knative-eventing/sa/mt-broker-ingress" ]
    to:
    - operation:
      methods: [ "POST" ]
  ---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-kafka-channel-to-mt-channel-based-broker-filter
  namespace: knative-eventing
spec:
  action: ALLOW
  selector:
    matchLabels:
      app.kubernetes.io/component: "broker-filter"
  rules:
  - from:
    - source:
      namespaces: [ "knative-eventing" ]
      principals: [ "cluster.local/ns/knative-eventing/sa/knative-kafka-channel-data-plane" ]
    to:
    - operation:
      methods: [ "POST" ]
  ---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-imc-to-mt-channel-based-broker-filter
  namespace: knative-eventing
spec:
  action: ALLOW
  selector:
    matchLabels:
      app.kubernetes.io/component: "broker-filter"
  rules:
  - from:
    - source:
      namespaces: [ "knative-eventing" ]
      principals: [ "cluster.local/ns/knative-eventing/sa/imc-dispatcher" ]
    to:
    - operation:
      methods: [ "POST" ]
  ---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-probe-kafka-broker-receiver
  namespace: knative-eventing
spec:
  action: ALLOW

```



```

selector:
  matchLabels:
    app.kubernetes.io/component: "kafka-broker-receiver"
rules:
  - from:
    - source:
      namespaces: [ "knative-eventing" ]
      principals: [ "cluster.local/ns/knative-eventing/sa/kafka-controller" ]
    to:
    - operation:
      methods: [ "GET" ]
---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-probe-kafka-sink-receiver
  namespace: knative-eventing
spec:
  action: ALLOW
  selector:
    matchLabels:
      app.kubernetes.io/component: "kafka-sink-receiver"
  rules:
    - from:
      - source:
        namespaces: [ "knative-eventing" ]
        principals: [ "cluster.local/ns/knative-eventing/sa/kafka-controller" ]
      to:
      - operation:
        methods: [ "GET" ]
---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-probe-kafka-channel-receiver
  namespace: knative-eventing
spec:
  action: ALLOW
  selector:
    matchLabels:
      app.kubernetes.io/component: "kafka-channel-receiver"
  rules:
    - from:
      - source:
        namespaces: [ "knative-eventing" ]
        principals: [ "cluster.local/ns/knative-eventing/sa/kafka-controller" ]
      to:
      - operation:
        methods: [ "GET" ]
---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-traffic-to-activator
  namespace: knative-serving
spec:

```

```

selector:
  matchLabels:
    app: activator
action: ALLOW
rules:
  - from:
    - source:
      namespaces: [ "knative-serving", "istio-system" ]
---
apiVersion: security.istio.io/v1beta1
kind: AuthorizationPolicy
metadata:
  name: allow-traffic-to-autoscaler
  namespace: knative-serving
spec:
  selector:
    matchLabels:
      app: autoscaler
  action: ALLOW
  rules:
    - from:
      - source:
        namespaces: [ "knative-serving" ]

```

These policies restrict the access rules for the network communication between Serverless system components. Specifically, they enforce the following rules:

- Deny all traffic that is not explicitly allowed in the **knative-serving** and **knative-eventing** namespaces
  - Allow traffic from the **istio-system** and **knative-serving** namespaces to activator
  - Allow traffic from the **knative-serving** namespace to autoscaler
  - Allow health probes for Apache Kafka components in the **knative-eventing** namespace
  - Allow internal traffic for channel-based brokers in the **knative-eventing** namespace
3. Apply the authorization policy configuration:

```
$ oc apply -f knative-default-authz-policies.yaml
```

4. Define which OpenShift projects can communicate with each other. For this communication, every OpenShift project of a tenant requires the following:
- One **AuthorizationPolicy** object limiting directly incoming traffic to the tenant's project
  - One **AuthorizationPolicy** object limiting incoming traffic using the activator component of Serverless that runs in the **knative-serving** project
  - One **AuthorizationPolicy** object allowing Kubernetes to call **PreStopHooks** on Knative Services

Instead of creating these policies manually, install the **helm** utility and create the necessary resources for each tenant:

## Installing the helm utility

```
$ helm repo add openshift-helm-charts https://charts.openshift.io/
```

## Creating example configuration for team alpha

```
$ helm template openshift-helm-charts/redhat-knative-istio-authz --version 1.33.0 --set "name=team-alpha" --set "namespaces={team-alpha-1,team-alpha-2}" > team-alpha.yaml
```

## Creating example configuration for team bravo

```
$ helm template openshift-helm-charts/redhat-knative-istio-authz --version 1.31.0 --set "name=team-bravo" --set "namespaces={team-bravo-1,team-bravo-2}" > team-bravo.yaml
```

5. Apply the authorization policy configuration:

```
$ oc apply -f team-alpha.yaml team-bravo.yaml
```

## 2.4. VERIFYING THE CONFIGURATION

You can use the **curl** command to verify the configuration for network traffic isolation.



### NOTE

The following examples assume having two tenants, each having one namespace, and all part of the **ServiceMeshMemberRoll** object, configured with the resources in the **team-alpha.yaml** and **team-bravo.yaml** files.

### Procedure

1. Deploy Knative Services in the namespaces of both of the tenants:

### Example command for team-alpha

```
$ kn service create test-webapp -n team-alpha-1 \
  --annotation-service serving.knative.openshift.io/enablePassthrough=true \
  --annotation-revision sidecar.istio.io/inject=true \
  --env RESPONSE="Hello Serverless" \
  --image docker.io/openshift/hello-openshift
```

### Example command for team-bravo

```
$ kn service create test-webapp -n team-bravo-1 \
  --annotation-service serving.knative.openshift.io/enablePassthrough=true \
  --annotation-revision sidecar.istio.io/inject=true \
  --env RESPONSE="Hello Serverless" \
  --image docker.io/openshift/hello-openshift
```

Alternatively, use the following YAML configuration:

```
apiVersion: serving.knative.dev/v1
```

```

kind: Service
metadata:
  name: test-webapp
  namespace: team-alpha-1
  annotations:
    serving.knative.openshift.io/enablePassthrough: "true"
spec:
  template:
    metadata:
      annotations:
        sidecar.istio.io/inject: 'true'
    spec:
      containers:
        - image: docker.io/openshift/hello-openshift
          env:
            - name: RESPONSE
              value: "Hello Serverless!"
---
apiVersion: serving.knative.dev/v1
kind: Service
metadata:
  name: test-webapp
  namespace: team-bravo-1
  annotations:
    serving.knative.openshift.io/enablePassthrough: "true"
spec:
  template:
    metadata:
      annotations:
        sidecar.istio.io/inject: 'true'
    spec:
      containers:
        - image: docker.io/openshift/hello-openshift
          env:
            - name: RESPONSE
              value: "Hello Serverless!"

```

2. Deploy a **curl** pod for testing the connections:

```

$ cat <<EOF | oc apply -f -
apiVersion: apps/v1
kind: Deployment
metadata:
  name: curl
  namespace: team-alpha-1
  labels:
    app: curl
spec:
  replicas: 1
  selector:
    matchLabels:
      app: curl
  template:
    metadata:
      labels:
        app: curl

```

```

    annotations:
      sidecar.istio.io/inject: 'true'
  spec:
    containers:
      - name: curl
        image: curlimages/curl
        command:
          - sleep
          - "3600"
EOF

```

3. Verify the configuration by using the **curl** command.

Test **team-alpha-1** → **team-alpha-1** through cluster local domain, which is allowed:

#### Example command

```
$ oc exec deployment/curl -n team-alpha-1 -it -- curl -v http://test-webapp.team-alpha-1:80
```

#### Example output

```

HTTP/1.1 200 OK
content-length: 18
content-type: text/plain; charset=utf-8
date: Wed, 26 Jul 2023 12:49:59 GMT
server: envoy
x-envoy-upstream-service-time: 9

Hello Serverless!

```

Test the **team-alpha-1** to **team-alpha-1** connection through an external domain, which is allowed:

#### Example command

```
$ EXTERNAL_URL=$(oc get ksvc -n team-alpha-1 test-webapp -o custom-
columns=:status.url --no-headers) && \
oc exec deployment/curl -n team-alpha-1 -it -- curl -ik $EXTERNAL_URL
```

#### Example output

```

HTTP/2 200
content-length: 18
content-type: text/plain; charset=utf-8
date: Wed, 26 Jul 2023 12:55:30 GMT
server: istio-envoy
x-envoy-upstream-service-time: 3629

Hello Serverless!

```

Test the **team-alpha-1** to **team-bravo-1** connection through the cluster's local domain, which is not allowed:

#### Example command

```
$ oc exec deployment/curl -n team-alpha-1 -it -- curl -v http://test-webapp.team-bravo-1:80
```

### Example output

```
* processing: http://test-webapp.team-bravo-1:80
* Trying 172.30.73.216:80...
* Connected to test-webapp.team-bravo-1 (172.30.73.216) port 80
> GET / HTTP/1.1
> Host: test-webapp.team-bravo-1
> User-Agent: curl/8.2.0
> Accept: */*
>
< HTTP/1.1 403 Forbidden
< content-length: 19
< content-type: text/plain
< date: Wed, 26 Jul 2023 12:55:49 GMT
< server: envoy
< x-envoy-upstream-service-time: 6
<
* Connection #0 to host test-webapp.team-bravo-1 left intact
RBAC: access denied
```

Test the **team-alpha-1** to **team-bravo-1** connection through an external domain, which is allowed:

### Example command

```
$ EXTERNAL_URL=$(oc get ksvc -n team-bravo-1 test-webapp -o custom-
columns=:.status.url --no-headers) && \
oc exec deployment/curl -n team-alpha-1 -it -- curl -ik $EXTERNAL_URL
```

### Example output

```
HTTP/2 200
content-length: 18
content-type: text/plain; charset=utf-8
date: Wed, 26 Jul 2023 12:56:22 GMT
server: istio-envoy
x-envoy-upstream-service-time: 2856

Hello Serverless!
```

4. Delete the resources that were created for verification:

```
$ oc delete deployment/curl -n team-alpha-1 && \
oc delete ksvc/test-webapp -n team-alpha-1 && \
oc delete ksvc/test-webapp -n team-bravo-1
```

### Additional resources for OpenShift Container Platform

- [The Helm utility](#)
- [Option reference for the Helm utility](#)

## CHAPTER 3. INTEGRATING SERVERLESS WITH THE COST MANAGEMENT SERVICE

[Cost management](#) is an OpenShift Container Platform service that enables you to better understand and track costs for clouds and containers. It is based on the open source [Koku](#) project.

### 3.1. PREREQUISITES

- You have cluster administrator permissions.
- You have set up cost management and added an [OpenShift Container Platform source](#).

### 3.2. LABELS FOR COST MANAGEMENT QUERIES

Labels, also known as *tags* in cost management, can be applied for nodes, namespaces or pods. Each label is a key and value pair. You can use a combination of multiple labels to generate reports. You can access reports about costs by using the [Red Hat hybrid console](#).

Labels are inherited from nodes to namespaces, and from namespaces to pods. However, labels are not overridden if they already exist on a resource. For example, Knative services have a default **app=<revision\_name>** label:

#### Example Knative service default label

```
apiVersion: serving.knative.dev/v1
kind: Service
metadata:
  name: showcase
spec:
  ...
  labels:
    app: <revision_name>
  ...
```

If you define a label for a namespace, such as **app=my-domain**, the cost management service does not take into account costs coming from a Knative service with the tag **app=<revision\_name>** when querying the application using the **app=my-domain** tag. Costs for Knative services that have this tag must be queried under the **app=<revision\_name>** tag.

### 3.3. ADDITIONAL RESOURCES

- [Managing cost data using tagging](#)
- [Visualizing your costs using cost explorer](#)

## CHAPTER 4. INTEGRATING SERVERLESS WITH OPENSHIFT PIPELINES

Integrating Serverless with OpenShift Pipelines enables CI/CD pipeline management for Serverless services. Using this integration, you can automate the deployment of your Serverless services.

### 4.1. PREREQUISITES

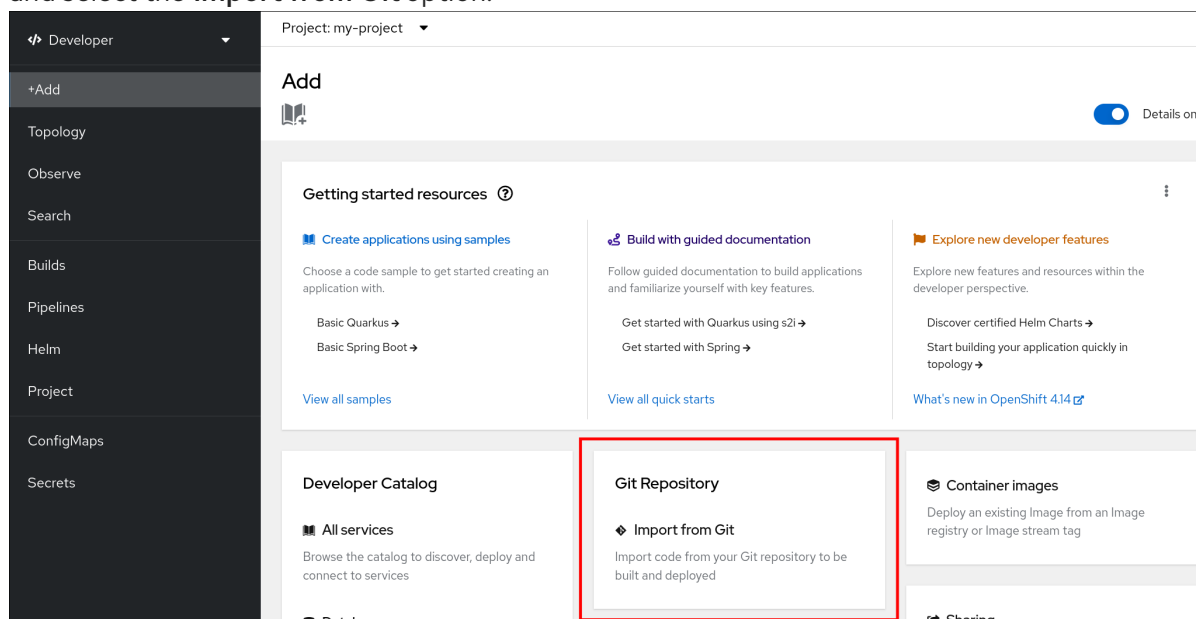
- You have access to the cluster with **cluster-admin** privileges.
- The OpenShift Serverless Operator and Knative Serving are installed on the cluster.
- You have installed the OpenShift Pipelines Operator on the cluster.

### 4.2. CREATING A SERVICE DEPLOYED BY OPENSHIFT PIPELINES

Using the OpenShift Container Platform web console, you can create a service that the OpenShift Pipelines deploys.

#### Procedure

1. In the OpenShift Container Platform web console **Developer** perspective, navigate to **+Add** and select the **Import from Git** option.



2. In the **Import from Git** dialog, specify project metadata by doing the following:
  - Specify the Git repository URL.
  - If necessary, specify the context directory. This is the subdirectory inside the repository that contains the root of application source code.
  - Optional: Specify the application name. By default, the repository name is used.
  - Select the **Serverless Deployment** resource type.
  - Select the **Add pipeline** checkbox. The pipeline is automatically selected based on the source code and its visualization is shown on the scheme.



- Specify any other relevant settings.

Project: my-project    Application: All applications

## Import from Git

### Git

**Git Repo URL \***

✓

Validated

▼ Hide advanced Git options

**Git reference**

Optional branch, tag, or commit.


**Context dir**

Optional subdirectory for the source code, used as a context directory for build.

**Source Secret**

Secret with credentials for pulling your source code.

✓ **Builder Image detected.**  
A Builder Image is recommended.

 **Python 3.9 (UBI 8)** Edit Import Strategy

BUILDER PYTHON

Build and run Python 3.9 applications on UBI 8. For more information about using this builder image, including OpenShift considerations, see <https://github.com/sclorg/s2i-python-container/blob/master/3.9/README.md>.  
Sample repository: <https://github.com/sclorg/django-ex.git>

### General

**Application name**

A unique name given to the application grouping to label your resources.

**Name \***

A unique name given to the component that will be used to name associated resources.

**Resource type**

Serverless Deployment

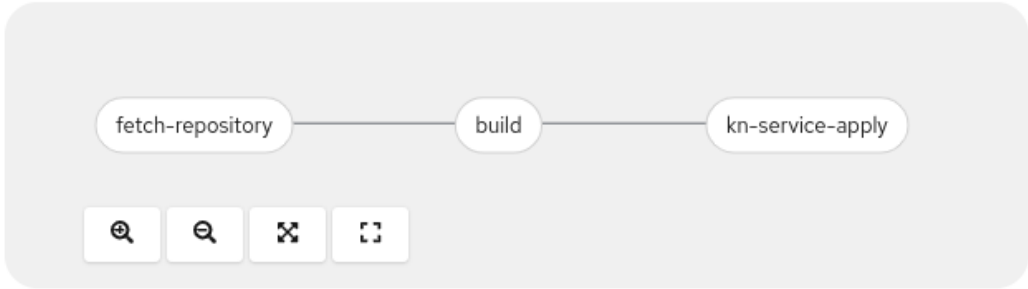
Resource type to generate. The default can be set in [User Preferences](#).

**Pipelines**

Add pipeline

s2i-python-knative

Hide pipeline visualization



```

graph LR
    A(fetch-repository) --> B(build)
    B --> C(kn-service-apply)
  
```

**Advanced options**

**Target port**

8080

Target port for traffic.

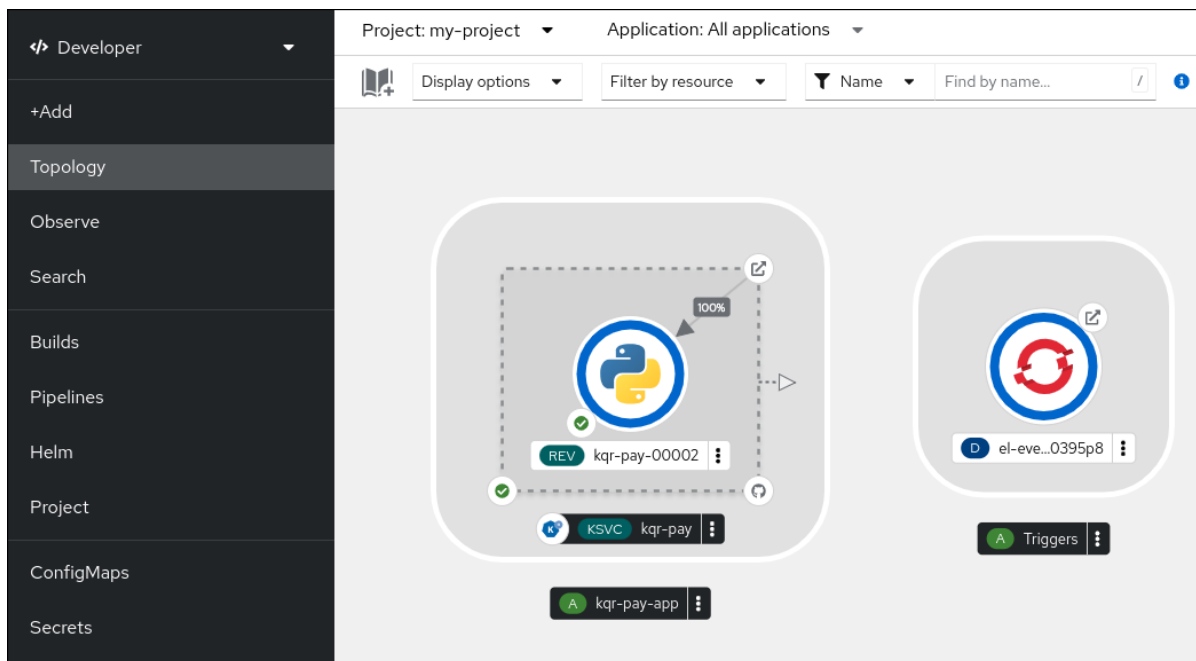
Create a route  
Exposes your component at a public URL

[Show advanced Routing options](#)

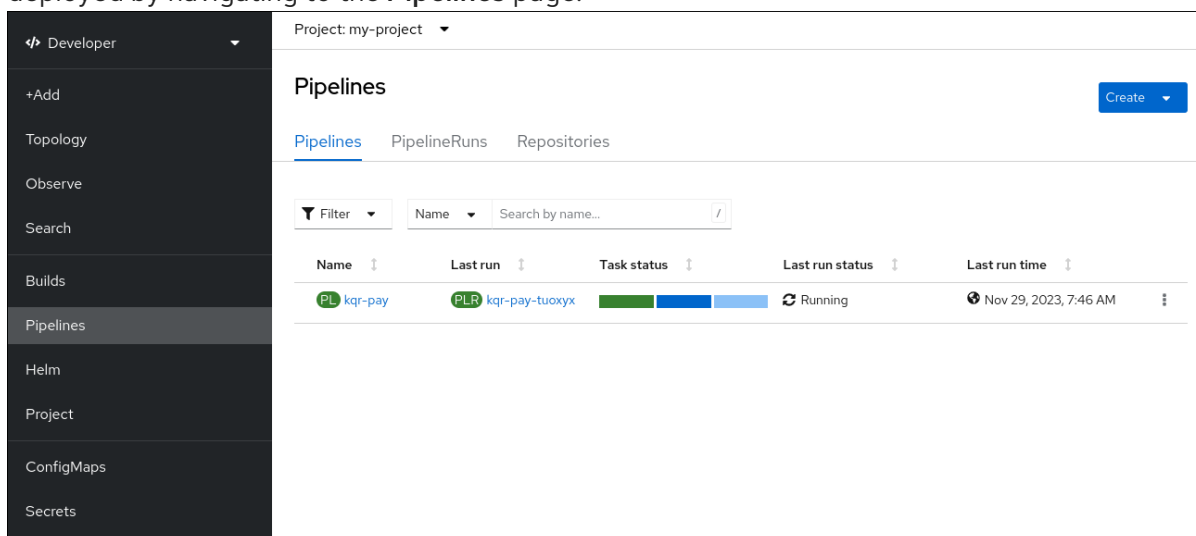
Click on the names to access advanced options for [Health checks](#), [Deployment](#), [Scaling](#), [Resource limits](#), and [Labels](#).

[Create](#) [Cancel](#)

3. Click **Create** to create the service.
4. After the service creation starts, you are navigated to the **Topology** screen, where your service and the related trigger are visualized and where you can interact with them.



- Optional: Verify that the pipeline has been created and that the service is being built and deployed by navigating to the **Pipelines** page:



- To see the details of the pipeline, click the pipeline on the **Pipelines** page.

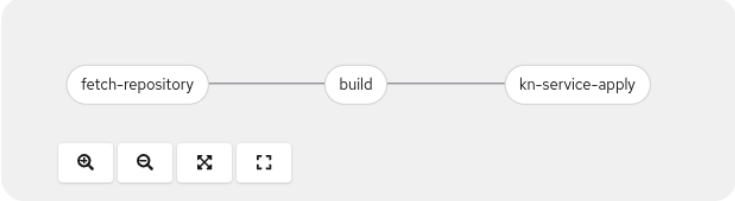
Project: my-project ▾

Pipelines > Pipeline details

**PL** kqr-pay Actions ▾

[Details](#) [Metrics](#) [YAML](#) [PipelineRuns](#) [Parameters](#)

### Pipeline details



```

graph LR
    A(fetch-repository) --> B(build)
    B --> C(kn-service-apply)
  
```

**Name**  
kqr-pay

**Namespace**  
**NS** my-project

**Labels** Edit ✎

- app.kubernetes.io/instance=kqr-pay
- app.kubernetes.io/name=kqr-pay
- operator.tekton.dev/operand-name=openshift-pipelines-addons
- pipeline.openshift.io/runtime=python
- pipeline.openshift.io/runtime-version=3.9-ubi8
- pipeline.openshift.io/type=knative

**Annotations**  
0 annotations ✎

**Created at**  
🕒 Nov 29, 2023, 5:51 AM

**Owner**  
No owner

**TriggerTemplates**

- TT** trigger-template-kqr-pay-dt7gw9  
http://el-event-listener-0395p8-my-project.apps.rosa.kpkfe-0a8da-dzu.x6pc.p3.openshiftapps.com 📄

**Tasks**

- CT** git-clone (fetch-repository)
- CT** s2i-python (build)
- CT** kn (kn-service-apply)

**Workspaces**  
workspace

- To see the details about the current pipeline run, click the name of the run on the **Pipelines** page.


Project: my-project ▾

PipelineRuns > PipelineRun details

**PLR** kqr-pay-6v9twr ✔ Succeeded Actions ▾

[Details](#) [YAML](#) [TaskRuns](#) [Parameters](#) [Logs](#) [Events](#)

### PipelineRun details



**Name**  
kqr-pay-6v9twr

**Namespace**  
**NS** my-project

**Labels** Edit ✎

- app.kubernetes.io/instance=kqr-pay
- app.kubernetes.io/name=kqr-pay
- operator.tekton.dev/operand-name=openshift-pipelines-addons
- pipeline.openshift.io/runtime=python
- pipeline.openshift.io/runtime-version=3.9-ubi8
- pipeline.openshift.io/type=knative
- tekton.dev/pipeline=kqr-pay

**Annotations**  
[2 annotations](#) ✎

**Created at**  
🕒 Nov 29, 2023, 5:51 AM

**Owner**  
No owner

**Status**  
✔ Succeeded

**Pipeline**  
**PL** kqr-pay

**Start time**  
🕒 Nov 29, 2023, 5:51 AM

**Completion time**  
🕒 Nov 29, 2023, 5:54 AM

**Duration**  
3 minutes 13 seconds

**Triggered by:**  
cluster-admin

**VolumeClaimTemplate Resources**  
**PVC** pvc-adf55f0b4f

## 4.3. ADDITIONAL RESOURCES

- [Documentation for Red Hat OpenShift Pipelines](#)

## CHAPTER 5. USING NVIDIA GPU RESOURCES WITH SERVERLESS APPLICATIONS

NVIDIA supports using GPU resources on OpenShift Container Platform. See [GPU Operator on OpenShift](#) for more information about setting up GPU resources on OpenShift Container Platform.

### 5.1. SPECIFYING GPU REQUIREMENTS FOR A SERVICE

After GPU resources are enabled for your OpenShift Container Platform cluster, you can specify GPU requirements for a Knative service using the Knative (**kn**) CLI.

#### Prerequisites

- The OpenShift Serverless Operator, Knative Serving and Knative Eventing are installed on the cluster.
- You have installed the Knative (**kn**) CLI.
- GPU resources are enabled for your OpenShift Container Platform cluster.
- You have created a project or have access to a project with the appropriate roles and permissions to create applications and other workloads in OpenShift Container Platform.



#### NOTE

Using NVIDIA GPU resources is not supported for IBM zSystems and IBM Power on OpenShift Container Platform or OpenShift Dedicated.

#### Procedure

1. Create a Knative service and set the GPU resource requirement limit to **1** by using the **--limit nvidia.com/gpu=1** flag:

```
$ kn service create hello --image <service-image> --limit nvidia.com/gpu=1
```

A GPU resource requirement limit of **1** means that the service has 1 GPU resource dedicated. Services do not share GPU resources. Any other services that require GPU resources must wait until the GPU resource is no longer in use.

A limit of 1 GPU also means that applications exceeding usage of 1 GPU resource are restricted. If a service requests more than 1 GPU resource, it is deployed on a node where the GPU resource requirements can be met.

2. Optional. For an existing service, you can change the GPU resource requirement limit to **3** by using the **--limit nvidia.com/gpu=3** flag:

```
$ kn service update hello --limit nvidia.com/gpu=3
```

### 5.2. ADDITIONAL RESOURCES FOR OPENSIFT CONTAINER PLATFORM

- [Setting resource quotas for extended resources](#)

