Red Hat AMQ Streams 2.2

Deploying and Upgrading AMQ Streams on OpenShift

Deploy AMQ Streams 2.2 on OpenShift Container Platform

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Abstract

Deploy AMQ Streams to an OpenShift cluster using the OperatorHub or installation artifacts. Use the AMQ Streams Cluster Operator to deploy and manage Kafka components. Upgrade AMQ Streams to take advantage of new features. As part of the upgrade, upgrade Kafka to the latest supported version.

Table of Contents

MAKING OPEN SOURCE MORE INCLUSIVE 5

CHAPTER 1. DEPLOYMENT OVERVIEW 6
1.1. CONFIGURING A DEPLOYMENT 6
1.1.1. Securing Kafka 6
1.1.2. Monitoring a deployment 6
1.1.3. CPU and memory resource limits and requests 7
1.2. AMQ STREAMS CUSTOM RESOURCES 7
1.2.1. AMQ Streams custom resource example 7
1.3. USING THE KAFKA BRIDGE TO CONNECT WITH A KAFKA CLUSTER 10
1.4. DOCUMENT CONVENTIONS 10
1.5. ADDITIONAL RESOURCES 10

CHAPTER 2. AMQ STREAMS INSTALLATION METHODS 11

CHAPTER 3. WHAT IS DEPLOYED WITH AMQ STREAMS 12
3.1. ORDER OF DEPLOYMENT 12

CHAPTER 4. PREPARING FOR YOUR AMQ STREAMS DEPLOYMENT 13
4.1. DEPLOYMENT PREREQUISITES 13
4.2. DOWNLOADING AMQ STREAMS RELEASE ARTIFACTS 13
4.3. EXAMPLE CONFIGURATION AND DEPLOYMENT FILES 13
4.3.1. Example files location 14
4.3.2. Example files provided with AMQ Streams 14
4.4. PUSHING CONTAINER IMAGES TO YOUR OWN REGISTRY 15
4.5. DESIGNATING AMQ STREAMS ADMINISTRATORS 16

CHAPTER 5. INSTALLING AMQ STREAMS FROM THE OPERATORHUB USING THE WEB CONSOLE 18
5.1. USING THE RED HAT INTEGRATION OPERATOR TO INSTALL THE AMQ STREAMS OPERATOR 18
5.2. INSTALLING THE AMQ STREAMS OPERATOR FROM THE OPERATORHUB 18
5.3. DEPLOYING KAFKA COMPONENTS USING THE AMQ STREAMS OPERATOR 20

CHAPTER 6. DEPLOYING AMQ STREAMS USING INSTALLATION ARTIFACTS 22
6.1. CREATE THE KAFKA CLUSTER 22
6.1.1. Deploying a Kafka cluster with the Topic Operator and User Operator 22
6.1.2. Deploying a standalone Topic Operator and User Operator 23
6.1.3. Deploying the Cluster Operator 23
6.1.3.1. Watch options for a Cluster Operator deployment 23
6.1.3.2. Deploying the Cluster Operator to watch a single namespace 24
6.1.3.3. Deploying the Cluster Operator to watch multiple namespaces 25
6.1.3.4. Deploying the Cluster Operator to watch all namespaces 26
6.1.4. Deploying Kafka 28
6.1.4.1. Deploying the Kafka cluster 28
6.1.4.2. Deploying the Topic Operator using the Cluster Operator 30
6.1.4.3. Deploying the User Operator using the Cluster Operator 32
6.1.5. Alternative standalone deployment options for AMQ Streams Operators 33
6.1.5.1. Deploying the standalone Topic Operator 33
6.1.5.2. Deploying the standalone User Operator 36
6.2. DEPLOY KAFKA CONNECT 39
6.2.1. Deploying Kafka Connect to your OpenShift cluster 40
6.2.2. Kafka Connect configuration for multiple instances 41
6.2.3. Extending Kafka Connect with connector plugins 41
6.2.3.1. Creating a new container image automatically using AMQ Streams 42

6.2.3.2. Creating a Docker image from the Kafka Connect base image 43
6.2.4. Creating and managing connectors 45
6.2.4.1. APIs for creating and managing connectors 46
6.2.4.2. Deploying example KafkaConnector resources 47
Source and sink connector configuration options 49
6.2.4.3. Performing a restart of a Kafka connector 50
6.2.4.4. Performing a restart of a Kafka connector task 51
6.2.4.5. Exposing the Kafka Connect API 51
6.3. DEPLOY KAFKA MIRRORMAKER 53
6.3.1. Deploying Kafka MirrorMaker to your OpenShift cluster 53
6.4. DEPLOY KAFKA BRIDGE 54
6.4.1. Deploying Kafka Bridge to your OpenShift cluster 54
6.4.2. Exposing the Kafka Bridge service to your local machine 55
6.4.3. Accessing the Kafka Bridge outside of OpenShift 56

CHAPTER 7. SETTING UP CLIENT ACCESS TO THE KAFKA CLUSTER 57
7.1. DEPLOYING EXAMPLE CLIENTS 57
7.2. SETTING UP ACCESS FOR CLIENTS OUTSIDE OF OPENSHIFT 57

CHAPTER 8. SETTING UP METRICS AND DASHBOARDS FOR AMQ STREAMS 64
8.1. MONITORING CONSUMER LAG WITH KAFKA EXPORTER 65
The importance of monitoring consumer lag 65
Reducing consumer lag 65
8.2. MONITORING CRUISE CONTROL OPERATIONS 66
8.2.1. Exposing Cruise Control metrics 66
8.2.2. Viewing Cruise Control metrics 67
8.2.2.1. Monitoring balancedness scores 67
8.2.2.2. Alerts on anomaly detection 67
8.3. EXAMPLE METRICS FILES 68
8.3.1. Example Prometheus metrics configuration 69
8.3.2. Example Prometheus rules for alert notifications 69
8.3.2.1. Example altering rules 70
8.3.3. Example Grafana dashboards 70
8.4. DEPLOYING PROMETHEUS METRICS CONFIGURATION 71
8.5. VIEWING KAFKA METRICS AND DASHBOARDS IN OPENSHIFT 74
8.5.1. Prerequisites 75
8.5.2. Additional resources 75
8.5.3. Deploying the Prometheus resources 75
8.5.4. Creating a service account for Grafana 77
8.5.5. Deploying Grafana with a Prometheus datasource 78
8.5.6. Creating a route to the Grafana Service 80
8.5.7. Importing the example Grafana dashboards 80

CHAPTER 9. UPGRADING AMQ STREAMS 82
9.1. AMQ STREAMS UPGRADE PATHS 82
9.1.1. Supported Kafka versions 82
9.1.2. Upgrading from an AMQ Streams version earlier than 1.7 82
9.2. REQUIRED UPGRADE SEQUENCE 83
9.3. UPGRADING OPENSHIFT WITH MINIMAL DOWNTIME 83
9.3.1. Rolling pods using the AMQ Streams Drain Cleaner 84
9.3.2. Rolling pods manually while keeping topics available 85
9.4. UPGRADING THE CLUSTER OPERATOR 85
9.4.1. Upgrading the Cluster Operator returns Kafka version error 86
9.4.2. Upgrading from AMQ Streams 1.7 or earlier using the OperatorHub 86

9.4.3. Upgrading the Cluster Operator using installation files 87
9.5. UPGRADING KAFKA 88
9.5.1. Kafka versions 89
9.5.2. Strategies for upgrading clients 90
9.5.3. Kafka version and image mappings 92
9.5.4. Upgrading Kafka brokers and client applications 92
9.6. UPGRADING CONSUMERS TO COOPERATIVE REBALANCING 95

CHAPTER 10. DOWNGRADING AMQ STREAMS 97
10.1. DOWNGRADING THE CLUSTER OPERATOR TO A PREVIOUS VERSION 97
10.2. DOWNGRADING KAFKA 98
10.2.1. Kafka version compatibility for downgrades 98
10.2.2. Downgrading Kafka brokers and client applications 99

CHAPTER 11. UNINSTALLING AMQ STREAMS 102
11.1. UNINSTALLING AMQ STREAMS FROM THE OPERATORHUB USING THE WEB CONSOLE 102
11.2. UNINSTALLING AMQ STREAMS USING THE CLI 103

CHAPTER 12. USING METERING ON AMQ STREAMS 105
12.1. METERING RESOURCES 105
12.2. METERING LABELS FOR AMQ STREAMS 105

APPENDIX A. USING YOUR SUBSCRIPTION 108
Accessing Your Account 108
Activating a Subscription 108
Downloading Zip and Tar Files 108
Installing packages with DNF 108

MAKING OPEN SOURCE MORE INCLUSIVE

Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see our CTO Chris Wright's message.

CHAPTER 1. DEPLOYMENT OVERVIEW

AMQ Streams simplifies the process of running Apache Kafka in an OpenShift cluster.

This guide provides instructions on all the options available for deploying and upgrading AMQ Streams, describing what is deployed, and the order of deployment required to run Apache Kafka in an OpenShift cluster.

As well as describing the deployment steps, the guide also provides pre- and post-deployment instructions to prepare for and verify a deployment. The guide also describes additional deployment options for introducing metrics.

Upgrade instructions are provided for AMQ Streams and Kafka upgrades.

AMQ Streams is designed to work on all types of OpenShift cluster regardless of distribution, from public and private clouds to local deployments intended for development.

1.1. CONFIGURING A DEPLOYMENT

The deployment procedures in this guide are designed to help you set up the initial structure of your deployment. After setting up the structure, you can use custom resources to configure the deployment to your precise needs. The deployment procedures use the example installation files provided with AMQ Streams. The procedures highlight any important configuration considerations, but they do not describe all the configuration options available.

You might want to review the configuration options available for Kafka components before you deploy AMQ Streams. For more information on the configuration options, see *Configuring AMQ Streams on OpenShift*.

1.1.1. Securing Kafka

On deployment, the Cluster Operator automatically sets up TLS certificates for data encryption and authentication within your cluster.

AMQ Streams provides additional configuration options for *encryption*, *authentication* and *authorization*:

- Secure data exchange between the Kafka cluster and clients by Managing secure access to Kafka.
- Configure your deployment to use an authorization server to provide OAuth 2.0 authentication and OAuth 2.0 authorization.
- Secure Kafka using your own certificates .

1.1.2. Monitoring a deployment

AMQ Streams supports additional deployment options to monitor your deployment.

- Extract metrics and monitor Kafka components by deploying Prometheus and Grafana with your Kafka cluster.
- Extract additional metrics, particularly related to monitoring consumer lag, by deploying Kafka Exporter with your Kafka cluster.
- Track messages end-to-end by setting up distributed tracing.

1.1.3. CPU and memory resource limits and requests

By default, the AMQ Streams Cluster Operator does not specify requests and limits for CPU and memory resources for any operands it deploys.

Having sufficient resources is important for applications like Kafka to be stable and deliver good performance.

The right amount of resources you should use depends on the specific requirements and use-cases.

You should consider configuring the CPU and memory resources. You can set resource requests and limits for each container in the AMQ Streams custom resources.

1.2. AMQ STREAMS CUSTOM RESOURCES

A deployment of Kafka components to an OpenShift cluster using AMQ Streams is highly configurable through the application of custom resources. Custom resources are created as instances of APIs added by Custom resource definitions (CRDs) to extend OpenShift resources.

CRDs act as configuration instructions to describe the custom resources in an OpenShift cluster, and are provided with AMQ Streams for each Kafka component used in a deployment, as well as users and topics. CRDs and custom resources are defined as YAML files. Example YAML files are provided with the AMQ Streams distribution.

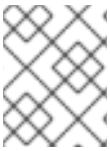
CRDs also allow AMQ Streams resources to benefit from native OpenShift features like CLI accessibility and configuration validation.

1.2.1. AMQ Streams custom resource example

CRDs require a one-time installation in a cluster to define the schemas used to instantiate and manage AMQ Streams-specific resources.

After a new custom resource type is added to your cluster by installing a CRD, you can create instances of the resource based on its specification.

Depending on the cluster setup, installation typically requires cluster admin privileges.



NOTE

Access to manage custom resources is limited to AMQ Streams administrators. For more information, see Designating AMQ Streams administrators .

A CRD defines a new **kind** of resource, such as **kind:Kafka**, within an OpenShift cluster.

The Kubernetes API server allows custom resources to be created based on the **kind** and understands from the CRD how to validate and store the custom resource when it is added to the OpenShift cluster.

WARNING

When CRDs are deleted, custom resources of that type are also deleted. Additionally, the resources created by the custom resource, such as pods and statefulsets are also deleted.

Each AMQ Streams-specific custom resource conforms to the schema defined by the CRD for the resource's **kind**. The custom resources for AMQ Streams components have common configuration properties, which are defined under **spec**.

To understand the relationship between a CRD and a custom resource, let's look at a sample of the CRD for a Kafka topic.

Kafka topic CRD

```
apiVersion: kafka.strimzi.io/v1beta2
kind: CustomResourceDefinition
metadata: 1
  name: kafkatopics.kafka.strimzi.io
  labels:
    app: strimzi
spec: 2
  group: kafka.strimzi.io
  versions:
    v1beta2
  scope: Namespaced
  names:
    # ...
    singular: kafkatopic
    plural: kafkatopics
    shortNames:
    - kt 3
  additionalPrinterColumns: 4
      # ...
  subresources:
    status: {} 5
  validation: 6
    openAPIV3Schema:
      properties:
        spec:
          type: object
          properties:
            partitions:
              type: integer
              minimum: 1
            replicas:
              type: integer
              minimum: 1
              maximum: 32767
      # ...
```

1. The metadata for the topic CRD, its name and a label to identify the CRD.
2. The specification for this CRD, including the group (domain) name, the plural name and the supported schema version, which are used in the URL to access the API of the topic. The other names are used to identify instance resources in the CLI. For example, **oc get kafkatopic my-topic** or **oc get kafkatopics**.
3. The shortname can be used in CLI commands. For example, **oc get kt** can be used as an abbreviation instead of **oc get kafkatopic**.
4. The information presented when using a **get** command on the custom resource.
5. The current status of the CRD as described in the schema reference for the resource.
6. openAPIV3Schema validation provides validation for the creation of topic custom resources. For example, a topic requires at least one partition and one replica.

NOTE

You can identify the CRD YAML files supplied with the AMQ Streams installation files, because the file names contain an index number followed by 'Crd'.

Here is a corresponding example of a **KafkaTopic** custom resource.

Kafka topic custom resource

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic (1)
metadata:
  name: my-topic
  labels:
    strimzi.io/cluster: my-cluster (2)
spec: (3)
  partitions: 1
  replicas: 1
  config:
    retention.ms: 7200000
    segment.bytes: 1073741824
status:
  conditions: (4)
    lastTransitionTime: "2019-08-20T11:37:00.706Z"
    status: "True"
    type: Ready
  observedGeneration: 1
  / ...
```

1. The **kind** and **apiVersion** identify the CRD of which the custom resource is an instance.
2. A label, applicable only to **KafkaTopic** and **KafkaUser** resources, that defines the name of the Kafka cluster (which is same as the name of the **Kafka** resource) to which a topic or user belongs.
3. The spec shows the number of partitions and replicas for the topic as well as the configuration parameters for the topic itself. In this example, the retention period for a message to remain in the topic and the segment file size for the log are specified.

4 Status conditions for the **KafkaTopic** resource. The **type** condition changed to **Ready** at the **lastTransitionTime**.

Custom resources can be applied to a cluster through the platform CLI. When the custom resource is created, it uses the same validation as the built-in resources of the Kubernetes API.

After a **KafkaTopic** custom resource is created, the Topic Operator is notified and corresponding Kafka topics are created in AMQ Streams.

Additional resources

- Extend the Kubernetes API with CustomResourceDefinitions
- Example configuration files provided with AMQ Streams

1.3. USING THE KAFKA BRIDGE TO CONNECT WITH A KAFKA CLUSTER

You can use the AMQ Streams Kafka Bridge API to create and manage consumers and send and receive records over HTTP rather than the native Kafka protocol.

When you set up the Kafka Bridge you configure HTTP access to the Kafka cluster. You can then use the Kafka Bridge to produce and consume messages from the cluster, as well as performing other operations through its REST interface.

Additional resources

- For information on installing and using the Kafka Bridge, see Using the AMQ Streams Kafka Bridge.

1.4. DOCUMENT CONVENTIONS

User-replaced values

User-replaced values, also known as *replaceables*, are shown in *italics* with angle brackets (< >). Underscores (_) are used for multi-word values. If the value refers to code or commands, **monospace** is also used.

For example, in the following code, you will want to replace ***<my_namespace>*** with the name of your namespace:

```
sed -i 's/namespace: .*/namespace: <my_namespace>/' install/cluster-operator/*RoleBinding*.yaml
```

1.5. ADDITIONAL RESOURCES

- AMQ Streams Overview
- Configuring AMQ Streams
- Using the AMQ Streams Kafka Bridge

CHAPTER 2. AMQ STREAMS INSTALLATION METHODS

You can install AMQ Streams on OpenShift 4.8 to 4.11 in two ways.

Installation method	Description
Installation artifacts (YAML files)	Download *Red Hat AMQ Streams 2.2 OpenShift Installation and Example Files* from the AMQ Streams software downloads page. Deploy the YAML installation artifacts to your OpenShift cluster using **oc**. You start by deploying the Cluster Operator from **install/cluster-operator** to a single namespace, multiple namespaces, or all namespaces. You can also use the **install/** artifacts to deploy the following: ● AMQ Streams administrator roles (**strimzi-admin**) ● A standalone Topic Operator (**topic-operator**) ● A standalone User Operator (**user-operator**) ● AMQ Streams Drain Cleaner (**drain-cleaner**)
OperatorHub	Use the **Red Hat Integration - AMQ Streams** in the OperatorHub to deploy AMQ Streams to a single namespace or all namespaces.

For the greatest flexibility, choose the installation artifacts method. The OperatorHub method provides a standard configuration and allows you to take advantage of automatic updates.

CHAPTER 3. WHAT IS DEPLOYED WITH AMQ STREAMS

Apache Kafka components are provided for deployment to OpenShift with the AMQ Streams distribution. The Kafka components are generally run as clusters for availability.

A typical deployment incorporating Kafka components might include:

- **Kafka** cluster of broker nodes
- **ZooKeeper** cluster of replicated ZooKeeper instances
- **Kafka Connect** cluster for external data connections
- **Kafka MirrorMaker** cluster to mirror the Kafka cluster in a secondary cluster
- **Kafka Exporter** to extract additional Kafka metrics data for monitoring
- **Kafka Bridge** to make HTTP-based requests to the Kafka cluster

Not all of these components are mandatory, though you need Kafka and ZooKeeper as a minimum. Some components can be deployed without Kafka, such as MirrorMaker or Kafka Connect.

3.1. ORDER OF DEPLOYMENT

The required order of deployment to an OpenShift cluster is as follows:

1. Deploy the Cluster Operator to manage your Kafka cluster
2. Deploy the Kafka cluster with the ZooKeeper cluster, and include the Topic Operator and User Operator in the deployment
3. Optionally deploy:
    - The Topic Operator and User Operator standalone if you did not deploy them with the Kafka cluster
    - Kafka Connect
    - Kafka MirrorMaker
    - Kafka Bridge
    - Components for the monitoring of metrics

The Cluster Operator creates OpenShift resources for the components, such as **Deployment**, **Service**, and **Pod** resources. The names of the OpenShift resources are appended with the name specified for a component when it's deployed. For example, a Kafka cluster named **my-kafka-cluster** has a service named **my-kafka-cluster-kafka**.

CHAPTER 4. PREPARING FOR YOUR AMQ STREAMS DEPLOYMENT

This section shows how you prepare for a AMQ Streams deployment, describing:

- The prerequisites you need before you can deploy AMQ Streams
- How to download the AMQ Streams release artifacts to use in your deployment
- How to push the AMQ Streams container images into your own registry (if required)
- How to set up *admin* roles for configuration of custom resources used in deployment

NOTE

To run the commands in this guide, your cluster user must have the rights to manage role-based access control (RBAC) and CRDs.

4.1. DEPLOYMENT PREREQUISITES

To deploy AMQ Streams, you will need the following:

- An OpenShift 4.8 to 4.11 cluster.
  AMQ Streams is based on AMQ Streams Strimzi 0.29.x.
- The **oc** command-line tool is installed and configured to connect to the running cluster.

4.2. DOWNLOADING AMQ STREAMS RELEASE ARTIFACTS

To use deployment files to install AMQ Streams, download and extract the files from the AMQ Streams software downloads page.

AMQ Streams release artifacts include sample YAML files to help you deploy the components of AMQ Streams to OpenShift, perform common operations, and configure your Kafka cluster.

Use **oc** to deploy the Cluster Operator from the **install/cluster-operator** folder of the downloaded ZIP file. For more information about deploying and configuring the Cluster Operator, see Section 6.1.3, “Deploying the Cluster Operator”.

In addition, if you want to use standalone installations of the Topic and User Operators with a Kafka cluster that is not managed by the AMQ Streams Cluster Operator, you can deploy them from the **install/topic-operator** and **install/user-operator** folders.

NOTE

Additionally, AMQ Streams container images are available through the Red Hat Ecosystem Catalog. However, we recommend that you use the YAML files provided to deploy AMQ Streams.

4.3. EXAMPLE CONFIGURATION AND DEPLOYMENT FILES

Use the example configuration and deployment files provided with AMQ Streams to deploy Kafka components with different configurations and monitor your deployment. Example configuration files for

custom resources contain important properties and values, which you can extend with additional supported configuration properties for your own deployment.

4.3.1. Example files location

The example files are provided with the downloadable release artifacts from the AMQ Streams software downloads page.

You can download and apply the examples using the **oc** command-line tool. The examples can serve as a starting point when building your own Kafka component configuration for deployment.

NOTE

If you installed AMQ Streams using the Operator, you can still download the example files and use them to upload configuration.

4.3.2. Example files provided with AMQ Streams

The release artifacts include an **examples** directory that contains the configuration examples.

Examples directory

```
examples
├── user 1
├── topic 2
├── security 3
│   ├── tls-auth
│   ├── scram-sha-512-auth
│   └── keycloak-authorization
├── mirror-maker 4
├── metrics 5
├── kafka 6
├── cruise-control 7
├── connect 8
└── bridge 9
```

1. **KafkaUser** custom resource configuration, which is managed by the User Operator.
2. **KafkaTopic** custom resource configuration, which is managed by Topic Operator.
3. Authentication and authorization configuration for Kafka components. Includes example configuration for TLS and SCRAM-SHA-512 authentication. The Red Hat Single Sign-On example includes **Kafka** custom resource configuration and a Red Hat Single Sign-On realm specification. You can use the example to try Red Hat Single Sign-On authorization services.
4. **Kafka** custom resource configuration for a deployment of Mirror Maker. Includes example configuration for replication policy and synchronization frequency.
5. Metrics configuration, including Prometheus installation and Grafana dashboard files.
6. **Kafka** custom resource configuration for a deployment of Kafka. Includes example configuration for an ephemeral or persistent single or multi-node deployment.

7 **Kafka** custom resource with a deployment configuration for Cruise Control. Includes **KafkaRebalance** custom resources to generate optimizations proposals from Cruise Control, with

8 **KafkaConnect** and **KafkaConnector** custom resource configuration for a deployment of Kafka Connect. Includes example configuration for a single or multi-node deployment.

9 **KafkaBridge** custom resource configuration for a deployment of Kafka Bridge.

Additional resources

- Configuring an AMQ Streams deployment

4.4. PUSHING CONTAINER IMAGES TO YOUR OWN REGISTRY

Container images for AMQ Streams are available in the Red Hat Ecosystem Catalog . The installation YAML files provided by AMQ Streams will pull the images directly from the Red Hat Ecosystem Catalog .

If you do not have access to the Red Hat Ecosystem Catalog or want to use your own container repository:

1. Pull **all** container images listed here
2. Push them into your own registry
3. Update the image names in the installation YAML files

NOTE

Each Kafka version supported for the release has a separate image.

Container image	Namespace/Repository	Description
Kafka	• registry.redhat.io/amq7/amq-streams-kafka-32-rhel8:2.2.2 • registry.redhat.io/amq7/amq-streams-kafka-31-rhel8:2.2.2	AMQ Streams image for running Kafka, including: • Kafka Broker • Kafka Connect • Kafka MirrorMaker • ZooKeeper • TLS Sidecars

Container image	Namespace/Repository	Description
Operator	• registry.redhat.io/amq7/amq-streams-rhel8-operator:2.2.2	AMQ Streams image for running the operators: • Cluster Operator • Topic Operator • User Operator • Kafka Initializer
Kafka Bridge	• registry.redhat.io/amq7/amq-streams-bridge-rhel8:2.2.2	AMQ Streams image for running the AMQ Streams Kafka Bridge
AMQ Streams Drain Cleaner	• registry.redhat.io/amq7/amq-streams-drain-cleaner-rhel8:2.2.2	AMQ Streams image for running the AMQ Streams Drain Cleaner

4.5. DESIGNATING AMQ STREAMS ADMINISTRATORS

AMQ Streams provides custom resources for configuration of your deployment. By default, permission to view, create, edit, and delete these resources is limited to OpenShift cluster administrators. AMQ Streams provides two cluster roles that you can use to assign these rights to other users:

- **strimzi-view** allows users to view and list AMQ Streams resources.
- **strimzi-admin** allows users to also create, edit or delete AMQ Streams resources.

When you install these roles, they will automatically aggregate (add) these rights to the default OpenShift cluster roles. **strimzi-view** aggregates to the **view** role, and **strimzi-admin** aggregates to the **edit** and **admin** roles. Because of the aggregation, you might not need to assign these roles to users who already have similar rights.

The following procedure shows how to assign a **strimzi-admin** role that allows non-cluster administrators to manage AMQ Streams resources.

A system administrator can designate AMQ Streams administrators after the Cluster Operator is deployed.

Prerequisites

- The AMQ Streams Custom Resource Definitions (CRDs) and role-based access control (RBAC) resources to manage the CRDs have been deployed with the Cluster Operator.

Procedure

1. Create the **strimzi-view** and **strimzi-admin** cluster roles in OpenShift.

```
oc create -f install/strimzi-admin
```

2. If needed, assign the roles that provide access rights to users that require them.

```
oc create clusterrolebinding strimzi-admin --clusterrole=strimzi-admin --user=user1 --
user=user2
```

CHAPTER 5. INSTALLING AMQ STREAMS FROM THE OPERATORHUB USING THE WEB CONSOLE

Install the Red Hat Integration - AMQ Streams operator from the OperatorHub in the OpenShift Container Platform web console.

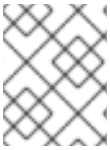
The procedures in this section show how to:

- Install the AMQ Streams operator from the OperatorHub
- Deploy Kafka components using the AMQ Streams operator

5.1. USING THE RED HAT INTEGRATION OPERATOR TO INSTALL THE AMQ STREAMS OPERATOR

The Red Hat Integration operator (deprecated) allows you to choose and install the Operators that manage your Red Hat Integration components. If you have more than one Red Hat Integration subscription, you can use the Red Hat Integration operator to install and update the AMQ Streams operator, as well as the Operators for all subscribed Red Hat Integration components.

As with the AMQ Streams operator, you can use the Operator Lifecycle Manager (OLM) to install the Red Hat Integration operator on an OpenShift Container Platform (OCP) cluster from the OperatorHub in the OCP console.



NOTE

The Red Hat Integration operator has been deprecated and will be removed in the future. It will be available from the OperatorHub in OpenShift 4.6 to 4.10.

Additional resources

For more information on installing and using the Red Hat Integration operator, see Installing the Red Hat Integration Operator

5.2. INSTALLING THE AMQ STREAMS OPERATOR FROM THE OPERATORHUB

You can install and subscribe to the AMQ Streams operator using the OperatorHub in the OpenShift Container Platform web console.

This procedure describes how to create a project and install the AMQ Streams operator to that project. A project is a representation of a namespace. For manageability, it is a good practice to use namespaces to separate functions.

WARNING

Make sure you use the appropriate update channel. If you are on a supported version of OpenShift, installing AMQ Streams from the default stable channel is generally safe. However, we do not recommend enabling automatic updates on the stable channel. An automatic upgrade will skip any necessary steps prior to upgrade. Use automatic upgrades only on version-specific channels.

Prerequisites

- Access to an OpenShift Container Platform web console using an account with **cluster-admin** or **strimzi-admin** permissions.

Procedure

1. Navigate in the OpenShift web console to the **Home > Projects** page and create a project (namespace) for the installation.
   We use a project named **amq-streams-kafka** in this example.
2. Navigate to the **Operators > OperatorHub** page.
3. Scroll or type a keyword into the **Filter by keyword** box to find the **Red Hat Integration - AMQ Streams** operator.
   The operator is located in the **Streaming & Messaging** category.
4. Click **Red Hat Integration - AMQ Streams** to display the operator information.
5. Read the information about the operator and click **Install**.
6. On the **Install Operator** page, choose from the following installation and update options:
   - **Update Channel**: Choose the update channel for the operator.
     - The (default) **stable** channel contains all the latest updates and releases, including major, minor, and micro releases, which are assumed to be well tested and stable.
     - An **amq-streams-*X*.x** channel contains the minor and micro release updates for a major release, where *X* is the major release version number.
     - An **amq-streams-*X.Y*.x** channel contains the micro release updates for a minor release, where *X* is the major release version number and *Y* is the minor release version number.
   - **Installation Mode**: Choose the project you created to install the operator on a specific namespace.
     You can install the AMQ Streams operator to all namespaces in the cluster (the default option) or a specific namespace. We recommend that you dedicate a specific namespace to the Kafka cluster and other AMQ Streams components.
   - **Update approval**: By default, the AMQ Streams operator is automatically upgraded to the latest AMQ Streams version by the Operator Lifecycle Manager (OLM). Optionally, select **Manual** if you want to manually approve future upgrades. For more information, see the Operators guide in the OpenShift documentation.

7. Click **Install** to install the operator to your selected namespace.
   The AMQ Streams operator deploys the Cluster Operator, CRDs, and role-based access control (RBAC) resources to the selected namespace.

8. After the operator is ready for use, navigate to **Operators > Installed Operators** to verify that the operator has installed to the selected namespace.
   The status will show as **Succeeded**.

   You can now use the AMQ Streams operator to deploy Kafka components, starting with a Kafka cluster.

NOTE

If you navigate to **Workloads > Deployments**, you can see the deployment details for the Cluster Operator and Entity Operator. The name of the Cluster Operator includes a version number: **amq-streams-cluster-operator-<version>**. The name is different when deploying the Cluster Operator using the AMQ Streams installation artifacts. In this case, the name is **strimzi-cluster-operator**.

5.3. DEPLOYING KAFKA COMPONENTS USING THE AMQ STREAMS OPERATOR

When installed on Openshift, the AMQ Streams operator makes Kafka components available for installation from the user interface.

The following Kafka components are available for installation:

- Kafka
- Kafka Connect
- Kafka MirrorMaker
- Kafka MirrorMaker 2
- Kafka Topic
- Kafka User
- Kafka Bridge
- Kafka Connector
- Kafka Rebalance

You select the component and create an instance. As a minimum, you create a Kafka instance. This procedure describes how to create a Kafka instance using the default settings. You can configure the default installation specification before you perform the installation.

The process is the same for creating instances of other Kafka components.

Prerequisites

- The AMQ Streams operator is installed on the OpenShift cluster.

Procedure

Procedure

1. Navigate in the web console to the **Operators > Installed Operators** page and click **Red Hat Integration - AMQ Streams** to display the operator details.
   From **Provided APIs**, you can create instances of Kafka components.

2. Click **Create instance** under **Kafka** to create a Kafka instance.
   By default, you'll create a Kafka cluster called **my-cluster** with three Kafka broker nodes and three ZooKeeper nodes. The cluster uses ephemeral storage.

3. Click **Create** to start the installation of Kafka.
   Wait until the status changes to **Ready**.

CHAPTER 6. DEPLOYING AMQ STREAMS USING INSTALLATION ARTIFACTS

Having prepared your environment for a deployment of AMQ Streams , you can deploy AMQ Streams to an OpenShift cluster. You can use the deployment files provided with the release artifacts.

Use the deployment files to create the Kafka cluster.

Optionally, you can deploy the following Kafka components according to your requirements:

- Kafka Connect
- Kafka MirrorMaker
- Kafka Bridge

AMQ Streams is based on Strimzi 0.29.x. You can deploy AMQ Streams 2.2 on OpenShift 4.8 to 4.11.

NOTE

To run the commands in this guide, your cluster user must have the rights to manage role-based access control (RBAC) and CRDs.

6.1. CREATE THE KAFKA CLUSTER

To be able to manage a Kafka cluster with the Cluster Operator, you must deploy it as a **Kafka** resource. AMQ Streams provides example deployment files to do this. You can use these files to deploy the Topic Operator and User Operator at the same time.

If you haven't deployed a Kafka cluster as a **Kafka** resource, you can't use the Cluster Operator to manage it. This applies, for example, to a Kafka cluster running outside of OpenShift. But you can deploy and use the Topic Operator and User Operator as standalone components.

NOTE

The Cluster Operator can watch one, multiple, or all namespaces in an OpenShift cluster. The Topic Operator and User Operator watch for **KafkaTopic** and **KafkaUser** resources in a single namespace. For more information, see Watching namespaces with AMQ Streams operators.

6.1.1. Deploying a Kafka cluster with the Topic Operator and User Operator

Perform these deployment steps if you want to use the Topic Operator and User Operator with a Kafka cluster managed by AMQ Streams.

1. Deploy the Cluster Operator
2. Use the Cluster Operator to deploy the:
   a. Kafka cluster
   b. Topic Operator
   c. User Operator

6.1.2. Deploying a standalone Topic Operator and User Operator

Perform these deployment steps if you want to use the Topic Operator and User Operator with a Kafka cluster that is **not managed** by AMQ Streams.

1. Deploy the standalone Topic Operator
2. Deploy the standalone User Operator

6.1.3. Deploying the Cluster Operator

The Cluster Operator is responsible for deploying and managing Apache Kafka clusters within an OpenShift cluster.

The procedures in this section describe how to deploy the Cluster Operator to watch one of the following:

- A single namespace
- Multiple namespaces
- All namespaces

6.1.3.1. Watch options for a Cluster Operator deployment

When the Cluster Operator is running, it starts to *watch* for updates of Kafka resources.

You can choose to deploy the Cluster Operator to watch Kafka resources from:

- A single namespace (the same namespace containing the Cluster Operator)
- Multiple namespaces
- All namespaces

NOTE

AMQ Streams provides example YAML files to make the deployment process easier.

The Cluster Operator watches for changes to the following resources:

- **Kafka** for the Kafka cluster.
- **KafkaConnect** for the Kafka Connect cluster.
- **KafkaConnector** for creating and managing connectors in a Kafka Connect cluster.
- **KafkaMirrorMaker** for the Kafka MirrorMaker instance.
- **KafkaMirrorMaker2** for the Kafka MirrorMaker 2.0 instance.
- **KafkaBridge** for the Kafka Bridge instance.
- **KafkaRebalance** for the Cruise Control optimization requests.

When one of these resources is created in the OpenShift cluster, the operator gets the cluster description from the resource and starts creating a new cluster for the resource by creating the necessary OpenShift resources, such as StatefulSets, Services and ConfigMaps.

Each time a Kafka resource is updated, the operator performs corresponding updates on the OpenShift resources that make up the cluster for the resource.

Resources are either patched or deleted, and then recreated in order to make the cluster for the resource reflect the desired state of the cluster. This operation might cause a rolling update that might lead to service disruption.

When a resource is deleted, the operator undeploys the cluster and deletes all related OpenShift resources.

6.1.3.2. Deploying the Cluster Operator to watch a single namespace

This procedure shows how to deploy the Cluster Operator to watch AMQ Streams resources in a single namespace in your OpenShift cluster.

Prerequisites

- This procedure requires use of an OpenShift user account which is able to create **CustomResourceDefinitions**, **ClusterRoles** and **ClusterRoleBindings**. Use of Role Base Access Control (RBAC) in the OpenShift cluster usually means that permission to create, edit, and delete these resources is limited to OpenShift cluster administrators, such as **system:admin**.

Procedure

1. Edit the AMQ Streams installation files to use the namespace the Cluster Operator is going to be installed into.
   For example, in this procedure the Cluster Operator is installed into the namespace ***<my_cluster_operator_namespace>***.

   On Linux, use:

   ```
   sed -i 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
   ```

   On MacOS, use:

   ```
   sed -i '' 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
   ```

2. Deploy the Cluster Operator:

   ```
   oc create -f install/cluster-operator -n <my_cluster_operator_namespace>
   ```

3. Check the status of the deployment:

   ```
   oc get deployments -n <my_cluster_operator_namespace>
   ```

   Output shows the deployment name and readiness

```
NAME                      READY  UP-TO-DATE  AVAILABLE
strimzi-cluster-operator  1/1    1           1
```

READY shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows **1**.

6.1.3.3. Deploying the Cluster Operator to watch multiple namespaces

This procedure shows how to deploy the Cluster Operator to watch AMQ Streams resources across multiple namespaces in your OpenShift cluster.

Prerequisites

- This procedure requires use of an OpenShift user account which is able to create **CustomResourceDefinitions**, **ClusterRoles** and **ClusterRoleBindings**. Use of Role Base Access Control (RBAC) in the OpenShift cluster usually means that permission to create, edit, and delete these resources is limited to OpenShift cluster administrators, such as **system:admin**.

Procedure

1. Edit the AMQ Streams installation files to use the namespace the Cluster Operator is going to be installed into.
   For example, in this procedure the Cluster Operator is installed into the namespace ***<my_cluster_operator_namespace>***.

   On Linux, use:

   ```
   sed -i 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
   ```

   On MacOS, use:

   ```
   sed -i '' 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
   ```

2. Edit the **install/cluster-operator/060-Deployment-strimzi-cluster-operator.yaml** file to add a list of all the namespaces the Cluster Operator will watch to the **STRIMZI_NAMESPACE** environment variable.
   For example, in this procedure the Cluster Operator will watch the namespaces **watched-namespace-1**, **watched-namespace-2**, **watched-namespace-3**.

   ```
   apiVersion: apps/v1
   kind: Deployment
   spec:
     # ...
     template:
       spec:
         serviceAccountName: strimzi-cluster-operator
         containers:
         - name: strimzi-cluster-operator
           image: registry.redhat.io/amq7/amq-streams-rhel8-operator:2.2.2
           imagePullPolicy: IfNotPresent
   ```

```
env:
- name: STRIMZI_NAMESPACE
  value: watched-namespace-1,watched-namespace-2,watched-namespace-3
```

3. For each namespace listed, install the **RoleBindings**.
   In this example, we replace ***watched-namespace*** in these commands with the namespaces listed in the previous step, repeating them for **watched-namespace-1**, **watched-namespace-2**, **watched-namespace-3**:

```
oc create -f install/cluster-operator/020-RoleBinding-strimzi-cluster-operator.yaml -n <watched_namespace>
oc create -f install/cluster-operator/031-RoleBinding-strimzi-cluster-operator-entity-operator-delegation.yaml -n <watched_namespace>
```

4. Deploy the Cluster Operator:

```
oc create -f install/cluster-operator -n <my_cluster_operator_namespace>
```

5. Check the status of the deployment:

```
oc get deployments -n <my_cluster_operator_namespace>
```

Output shows the deployment name and readiness

```
NAME                      READY  UP-TO-DATE  AVAILABLE
strimzi-cluster-operator  1/1    1           1
```

READY shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows **1**.

6.1.3.4. Deploying the Cluster Operator to watch all namespaces

This procedure shows how to deploy the Cluster Operator to watch AMQ Streams resources across all namespaces in your OpenShift cluster.

When running in this mode, the Cluster Operator automatically manages clusters in any new namespaces that are created.

Prerequisites

- This procedure requires use of an OpenShift user account which is able to create **CustomResourceDefinitions**, **ClusterRoles** and **ClusterRoleBindings**. Use of Role Base Access Control (RBAC) in the OpenShift cluster usually means that permission to create, edit, and delete these resources is limited to OpenShift cluster administrators, such as **system:admin**.

Procedure

1. Edit the AMQ Streams installation files to use the namespace the Cluster Operator is going to be installed into.
   For example, in this procedure the Cluster Operator is installed into the namespace ***<my_cluster_operator_namespace>***.

On Linux, use:

```
sed -i 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
```

On MacOS, use:

```
sed -i '' 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
```

2. Edit the **install/cluster-operator/060-Deployment-strimzi-cluster-operator.yaml** file to set the value of the **STRIMZI_NAMESPACE** environment variable to ***.

```
apiVersion: apps/v1
kind: Deployment
spec:
  # ...
  template:
    spec:
      # ...
      serviceAccountName: strimzi-cluster-operator
      containers:
      - name: strimzi-cluster-operator
        image: registry.redhat.io/amq7/amq-streams-rhel8-operator:2.2.2
        imagePullPolicy: IfNotPresent
        env:
        - name: STRIMZI_NAMESPACE
          value: "*"
        # ...
```

3. Create **ClusterRoleBindings** that grant cluster-wide access for all namespaces to the Cluster Operator.

```
oc create clusterrolebinding strimzi-cluster-operator-namespaced --clusterrole=strimzi-cluster-operator-namespaced --serviceaccount <my_cluster_operator_namespace>:strimzi-cluster-operator
oc create clusterrolebinding strimzi-cluster-operator-entity-operator-delegation --clusterrole=strimzi-entity-operator --serviceaccount <my_cluster_operator_namespace>:strimzi-cluster-operator
```

Replace ***<my_cluster_operator_namespace>*** with the namespace you want to install the Cluster Operator into.

4. Deploy the Cluster Operator to your OpenShift cluster.

```
oc create -f install/cluster-operator -n <my_cluster_operator_namespace>
```

5. Check the status of the deployment:

```
oc get deployments -n <my_cluster_operator_namespace>
```

Output shows the deployment name and readiness

```
NAME                      READY  UP-TO-DATE  AVAILABLE
strimzi-cluster-operator  1/1    1           1
```

READY shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows **1**.

6.1.4. Deploying Kafka

Apache Kafka is an open-source distributed publish-subscribe messaging system for fault-tolerant real-time data feeds.

The procedures in this section describe the following:

- How to use the Cluster Operator to deploy:
  - An *ephemeral* or *persistent* Kafka cluster
  - The Topic Operator and User Operator by configuring the **Kafka** custom resource:
    - Topic Operator
    - User Operator
- Alternative standalone deployment procedures for the Topic Operator and User Operator:
  - Deploy the standalone Topic Operator
  - Deploy the standalone User Operator

When installing Kafka, AMQ Streams also installs a ZooKeeper cluster and adds the necessary configuration to connect Kafka with ZooKeeper.

6.1.4.1. Deploying the Kafka cluster

This procedure shows how to deploy a Kafka cluster to your OpenShift cluster using the Cluster Operator.

The deployment uses a YAML file to provide the specification to create a **Kafka** resource.

AMQ Streams provides example configuration files. For a Kafka deployment, the following examples are provided:

kafka-persistent.yaml

Deploys a persistent cluster with three ZooKeeper and three Kafka nodes.

kafka-jbod.yaml

Deploys a persistent cluster with three ZooKeeper and three Kafka nodes (each using multiple persistent volumes).

kafka-persistent-single.yaml

Deploys a persistent cluster with a single ZooKeeper node and a single Kafka node.

kafka-ephemeral.yaml

Deploys an ephemeral cluster with three ZooKeeper and three Kafka nodes.

kafka-ephemeral-single.yaml

Deploys an ephemeral cluster with three ZooKeeper nodes and a single Kafka node.

In this procedure, we use the examples for an *ephemeral* and *persistent* Kafka cluster deployment.

Ephemeral cluster

In general, an ephemeral (or temporary) Kafka cluster is suitable for development and testing purposes, not for production. This deployment uses **emptyDir** volumes for storing broker information (for ZooKeeper) and topics or partitions (for Kafka). Using an **emptyDir** volume means that its content is strictly related to the pod life cycle and is deleted when the pod goes down.

Persistent cluster

A persistent Kafka cluster uses persistent volumes to store ZooKeeper and Kafka data. A **PersistentVolume** is acquired using a **PersistentVolumeClaim** to make it independent of the actual type of the **PersistentVolume**. The **PersistentVolumeClaim** can use a **StorageClass** to trigger automatic volume provisioning. When no **StorageClass** is specified, OpenShift will try to use the default **StorageClass**.
The following examples show some common types of persistent volumes:

- If your OpenShift cluster runs on Amazon AWS, OpenShift can provision Amazon EBS volumes
- If your OpenShift cluster runs on Microsoft Azure, OpenShift can provision Azure Disk Storage volumes
- If your OpenShift cluster runs on Google Cloud, OpenShift can provision Persistent Disk volumes
- If your OpenShift cluster runs on bare metal, OpenShift can provision local persistent volumes

The example YAML files specify the latest supported Kafka version, and configuration for its supported log message format version and inter-broker protocol version. The **inter.broker.protocol.version** property for the Kafka **config** must be the version supported by the specified Kafka version (**spec.kafka.version**). The property represents the version of Kafka protocol used in a Kafka cluster.

From Kafka 3.0.0, when the **inter.broker.protocol.version** is set to **3.0** or higher, the **log.message.format.version** option is ignored and doesn't need to be set.

An update to the **inter.broker.protocol.version** is required when upgrading Kafka.

The example clusters are named **my-cluster** by default. The cluster name is defined by the name of the resource and cannot be changed after the cluster has been deployed. To change the cluster name before you deploy the cluster, edit the **Kafka.metadata.name** property of the **Kafka** resource in the relevant YAML file.

Default cluster name and specified Kafka versions

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  kafka:
    version: 3.2.3
    #...
    config:
      #...
```

```
    log.message.format.version: "3.2"
    inter.broker.protocol.version: "3.2"
# ...
```

Prerequisites

- The Cluster Operator must be deployed.

Procedure

1. Create and deploy an *ephemeral* or *persistent* cluster.
   For development or testing, you might prefer to use an ephemeral cluster. You can use a persistent cluster in any situation.

   - To create and deploy an *ephemeral* cluster:

     ```
     oc apply -f examples/kafka/kafka-ephemeral.yaml
     ```

   - To create and deploy a *persistent* cluster:

     ```
     oc apply -f examples/kafka/kafka-persistent.yaml
     ```

2. Check the status of the deployment:

   ```
   oc get pods -n <my_cluster_operator_namespace>
   ```

   Output shows the pod names and readiness

   ```
   NAME                          READY   STATUS    RESTARTS
   my-cluster-entity-operator  3/3     Running   0
   my-cluster-kafka-0          1/1     Running   0
   my-cluster-kafka-1          1/1     Running   0
   my-cluster-kafka-2          1/1     Running   0
   my-cluster-zookeeper-0      1/1     Running   0
   my-cluster-zookeeper-1      1/1     Running   0
   my-cluster-zookeeper-2      1/1     Running   0
   ```

   my-cluster is the name of the Kafka cluster.

   With the default deployment, you install an Entity Operator cluster, 3 Kafka pods, and 3 ZooKeeper pods.

   READY shows the number of replicas that are ready/expected. The deployment is successful when the **STATUS** shows as **Running**.

Additional resources

Kafka cluster configuration

6.1.4.2. Deploying the Topic Operator using the Cluster Operator

This procedure describes how to deploy the Topic Operator using the Cluster Operator.

You configure the **entityOperator** property of the **Kafka** resource to include the **topicOperator**. By default, the Topic Operator watches for **KafkaTopic** resources in the namespace of the Kafka cluster deployed by the Cluster Operator. You can also specify a namespace using **watchedNamespace** in the Topic Operator **spec**. A single Topic Operator can watch a single namespace. One namespace should be watched by only one Topic Operator.

If you use AMQ Streams to deploy multiple Kafka clusters into the same namespace, enable the Topic Operator for only one Kafka cluster or use the **watchedNamespace** property to configure the Topic Operators to watch other namespaces.

If you want to use the Topic Operator with a Kafka cluster that is not managed by AMQ Streams, you must deploy the Topic Operator as a standalone component .

For more information about configuring the **entityOperator** and **topicOperator** properties, see Configuring the Entity Operator.

Prerequisites

- The Cluster Operator must be deployed.

Procedure

1. Edit the **entityOperator** properties of the **Kafka** resource to include **topicOperator**:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  #...
  entityOperator:
    topicOperator: {}
    userOperator: {}
```

2. Configure the Topic Operator **spec** using the properties described in **EntityTopicOperatorSpec** schema reference.
   Use an empty object (**{}**) if you want all properties to use their default values.

3. Create or update the resource:
   Use **oc apply**:

```
oc apply -f <kafka_configuration_file>
```

4. Check the status of the deployment:

```
oc get pods -n <my_cluster_operator_namespace>
```

   Output shows the pod name and readiness

```
NAME                          READY   STATUS    RESTARTS
my-cluster-entity-operator  3/3     Running   0
# ...
```

   my-cluster is the name of the Kafka cluster.

READY shows the number of replicas that are ready/expected. The deployment is successful when the **STATUS** shows as **Running**.

6.1.4.3. Deploying the User Operator using the Cluster Operator

This procedure describes how to deploy the User Operator using the Cluster Operator.

You configure the **entityOperator** property of the **Kafka** resource to include the **userOperator**. By default, the User Operator watches for **KafkaUser** resources in the namespace of the Kafka cluster deployment. You can also specify a namespace using **watchedNamespace** in the User Operator **spec**. A single User Operator can watch a single namespace. One namespace should be watched by only one User Operator.

If you want to use the User Operator with a Kafka cluster that is not managed by AMQ Streams, you must deploy the User Operator as a standalone component .

For more information about configuring the **entityOperator** and **userOperator** properties, see Configuring the Entity Operator.

Prerequisites

- The Cluster Operator must be deployed.

Procedure

1. Edit the **entityOperator** properties of the **Kafka** resource to include **userOperator**:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  #...
  entityOperator:
    topicOperator: {}
    userOperator: {}
```

2. Configure the User Operator **spec** using the properties described in **EntityUserOperatorSpec** schema reference.
   Use an empty object (**{}**) if you want all properties to use their default values.

3. Create or update the resource:

```
oc apply -f <kafka_configuration_file>
```

4. Check the status of the deployment:

```
oc get pods -n <my_cluster_operator_namespace>
```

Output shows the pod name and readiness

```
NAME                          READY   STATUS    RESTARTS
my-cluster-entity-operator  3/3     Running   0
# ...
```

my-cluster is the name of the Kafka cluster.

READY shows the number of replicas that are ready/expected. The deployment is successful when the **STATUS** shows as **Running**.

6.1.5. Alternative standalone deployment options for AMQ Streams Operators

You can perform a standalone deployment of the Topic Operator and User Operator. Consider a standalone deployment of these operators if you are using a Kafka cluster that is not managed by the Cluster Operator.

You deploy the operators to OpenShift. Kafka can be running outside of OpenShift. For example, you might be using a Kafka as a managed service. You adjust the deployment configuration for the standalone operator to match the address of your Kafka cluster.

6.1.5.1. Deploying the standalone Topic Operator

This procedure shows how to deploy the Topic Operator as a standalone component for topic management. You can use a standalone Topic Operator with a Kafka cluster that is not managed by the Cluster Operator.

A standalone deployment can operate with any Kafka cluster.

Standalone deployment files are provided with AMQ Streams. Use the **05-Deployment-strimzi-topic-operator.yaml** deployment file to deploy the Topic Operator. Add or set the environment variables needed to make a connection to a Kafka cluster.

The Topic Operator watches for **KafkaTopic** resources in a single namespace. You specify the namespace to watch, and the connection to the Kafka cluster, in the Topic Operator configuration. A single Topic Operator can watch a single namespace. One namespace should be watched by only one Topic Operator. If you want to use more than one Topic Operator, configure each of them to watch different namespaces. In this way, you can use Topic Operators with multiple Kafka clusters.

Prerequisites

- You are running a Kafka cluster for the Topic Operator to connect to.
  As long as the standalone Topic Operator is correctly configured for connection, the Kafka cluster can be running on a bare-metal environment, a virtual machine, or as a managed cloud application service.

Procedure

1. Edit the **env** properties in the **install/topic-operator/05-Deployment-strimzi-topic-operator.yaml** standalone deployment file.

   Example standalone Topic Operator deployment configuration

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: strimzi-topic-operator
  labels:
    app: strimzi
spec:
  # ...
```

```
template:
  # ...
  spec:
    # ...
    containers:
      - name: strimzi-topic-operator
        # ...
        env:
          - name: STRIMZI_NAMESPACE (1)
            valueFrom:
              fieldRef:
                fieldPath: metadata.namespace
          - name: STRIMZI_KAFKA_BOOTSTRAP_SERVERS (2)
            value: my-kafka-bootstrap-address:9092
          - name: STRIMZI_RESOURCE_LABELS (3)
            value: "strimzi.io/cluster=my-cluster"
          - name: STRIMZI_ZOOKEEPER_CONNECT (4)
            value: my-cluster-zookeeper-client:2181
          - name: STRIMZI_ZOOKEEPER_SESSION_TIMEOUT_MS (5)
            value: "18000"
          - name: STRIMZI_FULL_RECONCILIATION_INTERVAL_MS (6)
            value: "120000"
          - name: STRIMZI_TOPIC_METADATA_MAX_ATTEMPTS (7)
            value: "6"
          - name: STRIMZI_LOG_LEVEL (8)
            value: INFO
          - name: STRIMZI_TLS_ENABLED (9)
            value: "false"
          - name: STRIMZI_JAVA_OPTS (10)
            value: "-Xmx=512M -Xms=256M"
          - name: STRIMZI_JAVA_SYSTEM_PROPERTIES (11)
            value: "-Djavax.net.debug=verbose -DpropertyName=value"
          - name: STRIMZI_PUBLIC_CA (12)
            value: "false"
          - name: STRIMZI_TLS_AUTH_ENABLED (13)
            value: "false"
          - name: STRIMZI_SASL_ENABLED (14)
            value: "false"
          - name: STRIMZI_SASL_USERNAME (15)
            value: "admin"
          - name: STRIMZI_SASL_PASSWORD (16)
            value: "password"
          - name: STRIMZI_SASL_MECHANISM (17)
            value: "scram-sha-512"
          - name: STRIMZI_SECURITY_PROTOCOL (18)
            value: "SSL"
```

(1) The OpenShift namespace for the Topic Operator to watch for **KafkaTopic** resources. Specify the namespace of the Kafka cluster.

(2) The host and port pair of the bootstrap broker address to discover and connect to all brokers in the Kafka cluster. Use a comma-separated list to specify two or three broker addresses in case a server is down.

3. The label to identify the **KafkaTopic** resources managed by the Topic Operator. This does not have to be the name of the Kafka cluster. It can be the label assigned to the
4. The host and port pair of the address to connect to the ZooKeeper cluster. This must be the same ZooKeeper cluster that your Kafka cluster is using.
5. The ZooKeeper session timeout, in milliseconds. The default is **18000** (18 seconds).
6. The interval between periodic reconciliations, in milliseconds. The default is **120000** (2 minutes).
7. The number of attempts at getting topic metadata from Kafka. The time between each attempt is defined as an exponential backoff. Consider increasing this value when topic creation takes more time due to the number of partitions or replicas. The default is **6** attempts.
8. The level for printing logging messages. You can set the level to **ERROR**, **WARNING**, **INFO**, **DEBUG**, or **TRACE**.
9. Enables TLS support for encrypted communication with the Kafka brokers.
10. (Optional) The Java options used by the JVM running the Topic Operator.
11. (Optional) The debugging (**-D**) options set for the Topic Operator.
12. (Optional) Skips the generation of trust store certificates if TLS is enabled through **STRIMZI_TLS_ENABLED**. If this environment variable is enabled, the brokers must use a public trusted certificate authority for their TLS certificates. The default is **false**.
13. (Optional) Generates key store certificates for mutual TLS authentication. Setting this to **false** disables client authentication with TLS to the Kafka brokers. The default is **true**.
14. (Optional) Enables SASL support for client authentication when connecting to Kafka brokers. The default is **false**.
15. (Optional) The SASL username for client authentication. Mandatory only if SASL is enabled through **STRIMZI_SASL_ENABLED**.
16. (Optional) The SASL password for client authentication. Mandatory only if SASL is enabled through **STRIMZI_SASL_ENABLED**.
17. (Optional) The SASL mechanism for client authentication. Mandatory only if SASL is enabled through **STRIMZI_SASL_ENABLED**. You can set the value to **plain**, **scram-sha-256**, or **scram-sha-512**.
18. (Optional) The security protocol used for communication with Kafka brokers. The default value is "PLAINTEXT". You can set the value to **PLAINTEXT**, **SSL**, **SASL_PLAINTEXT**, or **SASL_SSL**.

2. If you want to connect to Kafka brokers that are using certificates from a public certificate authority, set **STRIMZI_PUBLIC_CA** to **true**. Set this property to **true**, for example, if you are using Amazon AWS MSK service.
3. If you enabled TLS with the **STRIMZI_TLS_ENABLED** environment variable, specify the keystore and truststore used to authenticate connection to the Kafka cluster.

Example TLS configuration

```
# ....
env:
  - name: STRIMZI_TRUSTSTORE_LOCATION 1
    value: "/path/to/truststore.p12"
  - name: STRIMZI_TRUSTSTORE_PASSWORD 2
    value: "TRUSTSTORE-PASSWORD"
  - name: STRIMZI_KEYSTORE_LOCATION 3
    value: "/path/to/keystore.p12"
  - name: STRIMZI_KEYSTORE_PASSWORD 4
    value: "KEYSTORE-PASSWORD"
# ...
```

1. The truststore contains the public keys of the Certificate Authorities used to sign the Kafka and ZooKeeper server certificates.
2. The password for accessing the truststore.
3. The keystore contains the private key for TLS client authentication.
4. The password for accessing the keystore.

4. Deploy the Topic Operator.

```
oc create -f install/topic-operator
```

5. Check the status of the deployment:

```
oc get deployments
```

Output shows the deployment name and readiness

```
NAME                      READY  UP-TO-DATE  AVAILABLE
strimzi-topic-operator  1/1    1           1
```

READY shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows **1**.

6.1.5.2. Deploying the standalone User Operator

This procedure shows how to deploy the User Operator as a standalone component for user management. You can use a standalone User Operator with a Kafka cluster that is not managed by the Cluster Operator.

A standalone deployment can operate with any Kafka cluster.

Standalone deployment files are provided with AMQ Streams. Use the **05-Deployment-strimzi-user-operator.yaml** deployment file to deploy the User Operator. Add or set the environment variables needed to make a connection to a Kafka cluster.

The User Operator watches for **KafkaUser** resources in a single namespace. You specify the namespace to watch, and the connection to the Kafka cluster, in the User Operator configuration. A single User Operator can watch a single namespace. One namespace should be watched by only one User Operator.

If you want to use more than one User Operator, configure each of them to watch different namespaces. In this way, you can use the User Operator with multiple Kafka clusters.

Prerequisites

- You are running a Kafka cluster for the User Operator to connect to.
  As long as the standalone User Operator is correctly configured for connection, the Kafka cluster can be running on a bare-metal environment, a virtual machine, or as a managed cloud application service.

Procedure

1. Edit the following **env** properties in the **install/user-operator/05-Deployment-strimzi-user-operator.yaml** standalone deployment file.

   #### Example standalone User Operator deployment configuration

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: strimzi-user-operator
  labels:
    app: strimzi
spec:
  # ...
  template:
    # ...
    spec:
      # ...
      containers:
        - name: strimzi-user-operator
          # ...
          env:
            - name: STRIMZI_NAMESPACE (1)
              valueFrom:
                fieldRef:
                  fieldPath: metadata.namespace
            - name: STRIMZI_KAFKA_BOOTSTRAP_SERVERS (2)
              value: my-kafka-bootstrap-address:9092
            - name: STRIMZI_CA_CERT_NAME (3)
              value: my-cluster-clients-ca-cert
            - name: STRIMZI_CA_KEY_NAME (4)
              value: my-cluster-clients-ca
            - name: STRIMZI_LABELS (5)
              value: "strimzi.io/cluster=my-cluster"
            - name: STRIMZI_FULL_RECONCILIATION_INTERVAL_MS (6)
              value: "120000"
            - name: STRIMZI_LOG_LEVEL (7)
              value: INFO
            - name: STRIMZI_GC_LOG_ENABLED (8)
              value: "true"
            - name: STRIMZI_CA_VALIDITY (9)
              value: "365"
            - name: STRIMZI_CA_RENEWAL (10)
```

```
      value: "30"
    - name: STRIMZI_JAVA_OPTS (11)
      value: "-Xmx=512M -Xms=256M"
    - name: STRIMZI_JAVA_SYSTEM_PROPERTIES (12)
      value: "-Djavax.net.debug=verbose -DpropertyName=value"
    - name: STRIMZI_SECRET_PREFIX (13)
      value: "kafka-"
    - name: STRIMZI_ACLS_ADMIN_API_SUPPORTED (14)
      value: "true"
    - name: STRIMZI_MAINTENANCE_TIME_WINDOWS (15)
      value: '* * 8-10 * * ?;* * 14-15 * * ?'
```

1. The OpenShift namespace for the User Operator to watch for **KafkaUser** resources. Only one namespace can be specified.

2. The host and port pair of the bootstrap broker address to discover and connect to all brokers in the Kafka cluster. Use a comma-separated list to specify two or three broker addresses in case a server is down.

3. The OpenShift **Secret** that contains the public key (**ca.crt**) value of the Certificate Authority that signs new user certificates for TLS client authentication.

4. The OpenShift **Secret** that contains the private key (**ca.key**) value of the Certificate Authority that signs new user certificates for TLS client authentication.

5. The label to identify the **KafkaUser** resources managed by the User Operator. This does not have to be the name of the Kafka cluster. It can be the label assigned to the **KafkaUser** resource. If you deploy more than one User Operator, the labels must be unique for each. That is, the operators cannot manage the same resources.

6. The interval between periodic reconciliations, in milliseconds. The default is **120000** (2 minutes).

7. The level for printing logging messages. You can set the level to **ERROR**, **WARNING**, **INFO**, **DEBUG**, or **TRACE**.

8. Enables garbage collection (GC) logging. The default is **true**.

9. The validity period for the Certificate Authority. The default is **365** days.

10. The renewal period for the Certificate Authority. The renewal period is measured backwards from the expiry date of the current certificate. The default is **30** days to initiate certificate renewal before the old certificates expire.

11. (Optional) The Java options used by the JVM running the User Operator

12. (Optional) The debugging (**-D**) options set for the User Operator

13. (Optional) Prefix for the names of OpenShift secrets created by the User Operator.

14. (Optional) Indicates whether the Kafka cluster supports management of authorization ACL rules using the Kafka Admin API. When set to **false**, the User Operator will reject all resources with **simple** authorization ACL rules. This helps to avoid unnecessary exceptions in the Kafka cluster logs. The default is **true**.

15. (Optional) Semi-colon separated list of Cron Expressions defining the maintenance time

2. If you are using TLS to connect to the Kafka cluster, specify the secrets used to authenticate connection. Otherwise, go to the next step.

   Example TLS configuration

   ```
   # ....
   env:
     - name: STRIMZI_CLUSTER_CA_CERT_SECRET_NAME 1
       value: my-cluster-cluster-ca-cert
     - name: STRIMZI_EO_KEY_SECRET_NAME 2
       value: my-cluster-entity-operator-certs
   # ..."
   ```

   1 The OpenShift **Secret** that contains the public key (**ca.crt**) value of the Certificate Authority that signs Kafka broker certificates for TLS client authentication.

   2 The OpenShift **Secret** that contains the keystore (**entity-operator.p12**) with the private key and certificate for TLS authentication against the Kafka cluster. The **Secret** must also contain the password (**entity-operator.password**) for accessing the keystore.

3. Deploy the User Operator.

   ```
   oc create -f install/user-operator
   ```

4. Check the status of the deployment:

   ```
   oc get deployments
   ```

   Output shows the deployment name and readiness

   ```
   NAME                  READY  UP-TO-DATE  AVAILABLE
   strimzi-user-operator  1/1    1           1
   ```

   READY shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows **1**.

6.2. DEPLOY KAFKA CONNECT

Kafka Connect is a tool for streaming data between Apache Kafka and external systems.

In AMQ Streams, Kafka Connect is deployed in distributed mode. Kafka Connect can also work in standalone mode, but this is not supported by AMQ Streams.

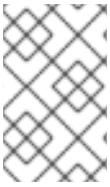
Using the concept of *connectors*, Kafka Connect provides a framework for moving large amounts of data into and out of your Kafka cluster while maintaining scalability and reliability.

Kafka Connect is typically used to integrate Kafka with external databases and storage and messaging systems.

The Cluster Operator manages Kafka Connect clusters deployed using the **KafkaConnect** resource and connectors created using the **KafkaConnector** resource.

The following procedures show how to deploy Kafka Connect and set up connectors for streaming data:

- Section 6.2.1, "Deploying Kafka Connect to your OpenShift cluster"
- Section 6.2.2, "Kafka Connect configuration for multiple instances"
- Section 6.2.3, "Extending Kafka Connect with connector plugins"
- Section 6.2.4, "Creating and managing connectors"
- Section 6.2.4.2, "Deploying example KafkaConnector resources"



NOTE

The term *connector* is used interchangeably to mean a connector instance running within a Kafka Connect cluster, or a connector class. In this guide, the term *connector* is used when the meaning is clear from the context.

6.2.1. Deploying Kafka Connect to your OpenShift cluster

This procedure shows how to deploy a Kafka Connect cluster to your OpenShift cluster using the Cluster Operator.

A Kafka Connect cluster is implemented as a **Deployment** with a configurable number of nodes (also called *workers*) that distribute the workload of connectors as *tasks* so that the message flow is highly scalable and reliable.

The deployment uses a YAML file to provide the specification to create a **KafkaConnect** resource.

AMQ Streams provides example configuration files. In this procedure, we use the following example file:

- **examples/connect/kafka-connect.yaml**

Prerequisites

- The Cluster Operator must be deployed.
- Running Kafka cluster.

Procedure

1. Deploy Kafka Connect to your OpenShift cluster. Use the **examples/connect/kafka-connect.yaml** file to deploy Kafka Connect.

```
oc apply -f examples/connect/kafka-connect.yaml
```

2. Check the status of the deployment:

```
oc get deployments -n <my_cluster_operator_namespace>
```

Output shows the deployment name and readiness

```
NAME                      READY  UP-TO-DATE  AVAILABLE
my-connect-cluster-connect  1/1    1           1
```

my-connect-cluster is the name of the Kafka Connect cluster.

READY shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows **1**.

Additional resources

Kafka Connect cluster configuration

6.2.2. Kafka Connect configuration for multiple instances

If you are running multiple instances of Kafka Connect, you have to change the default configuration of the following **config** properties:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect
spec:
  # ...
  config:
    group.id: connect-cluster 1
    offset.storage.topic: connect-cluster-offsets 2
    config.storage.topic: connect-cluster-configs 3
    status.storage.topic: connect-cluster-status 4
    # ...
# ...
```

1. The Kafka Connect cluster ID within Kafka.
2. Kafka topic that stores connector offsets.
3. Kafka topic that stores connector and task status configurations.
4. Kafka topic that stores connector and task status updates.

NOTE

Values for the three topics must be the same for all Kafka Connect instances with the same **group.id**.

Unless you change the default settings, each Kafka Connect instance connecting to the same Kafka cluster is deployed with the same values. What happens, in effect, is all instances are coupled to run in a cluster and use the same topics.

If multiple Kafka Connect clusters try to use the same topics, Kafka Connect will not work as expected and generate errors.

If you wish to run multiple Kafka Connect instances, change the values of these properties for each instance.

6.2.3. Extending Kafka Connect with connector plugins

Kafka Connect uses connector instances to integrate with other systems to stream data. Connectors can be one of the following type:

- Source connectors that push data into Kafka
- Sink connectors that extract data out of Kafka

The procedures in this section describe how you can add connectors by doing one of the following:

- Section 6.2.3.1, "Creating a new container image automatically using AMQ Streams"
- Section 6.2.3.2, "Creating a Docker image from the Kafka Connect base image" (manually or using continuous integration)

IMPORTANT

You create the configuration for connectors directly using the Kafka Connect REST API or **KafkaConnector** custom resources.

You can use your own connectors or try the example **FileStreamSourceConnector** and **FileStreamSinkConnector** connectors for moving file-based data into and out of a Kafka cluster. For information on deploying the example file connectors as **KafkaConnector** resources, see Section 6.2.4.2, "Deploying example KafkaConnector resources".

NOTE

Up until Apache Kafka 3.1.0, the AMQ Streams container images for Kafka Connect included the example file connectors. From Apache Kafka 3.1.1 and 3.2.0, these connectors are no longer included and must be deployed like any connector.

6.2.3.1. Creating a new container image automatically using AMQ Streams

This procedure shows how to configure Kafka Connect so that AMQ Streams automatically builds a new container image with additional connectors. You define the connector plugins using the **.spec.build.plugins** property of the **KafkaConnect** custom resource. AMQ Streams will automatically download and add the connector plugins into a new container image. The container is pushed into the container repository specified in **.spec.build.output** and automatically used in the Kafka Connect deployment.

Prerequisites

- The Cluster Operator must be deployed.
- A container registry.

You need to provide your own container registry where images can be pushed to, stored, and pulled from. AMQ Streams supports private container registries as well as public registries such as Quay or Docker Hub.

Procedure

1. Configure the **KafkaConnect** custom resource by specifying the container registry in **.spec.build.output**, and additional connectors in **.spec.build.plugins**:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
```

```
spec: 1
  #...
  build:
    output: 2
      type: docker
      image: my-registry.io/my-org/my-connect-cluster:latest
      pushSecret: my-registry-credentials
    plugins: 3
      - name: debezium-postgres-connector
        artifacts:
          - type: tgz
            url: https://repo1.maven.org/maven2/io/debezium/debezium-connector-postgres/1.3.1.Final/debezium-connector-postgres-1.3.1.Final-plugin.tar.gz
            sha512sum: 962a12151bdf9a5a30627eebac739955a4fd95a08d373b86bdcea2b4d0c27dd6e1edd5cb548045e115e33a9e69b1b2a352bee24df035a0447cb820077af00c03
      - name: camel-telegram
        artifacts:
          - type: tgz
            url: https://repo.maven.apache.org/maven2/org/apache/camel/kafkaconnector/camel-telegram-kafka-connector/0.7.0/camel-telegram-kafka-connector-0.7.0-package.tar.gz
            sha512sum: a9b1ac63e3284bea7836d7d24d84208c49cdf5600070e6bd1535de654f6920b74ad950d51733e8020bf4187870699819f54ef5859c7846ee4081507f48873479
  #...
```

1. The specification for the Kafka Connect cluster.
2. (Required) Configuration of the container registry where new images are pushed.
3. (Required) List of connector plugins and their artifacts to add to the new container image. Each plugin must be configured with at least one **artifact**.

2. Create or update the resource:

```
$ oc apply -f KAFKA-CONNECT-CONFIG-FILE
```

3. Wait for the new container image to build, and for the Kafka Connect cluster to be deployed.
4. Use the Kafka Connect REST API or the KafkaConnector custom resources to use the connector plugins you added.

Additional resources

See the *Using Strimzi* guide for more information on:

- Kafka Connect **Build** schema reference

6.2.3.2. Creating a Docker image from the Kafka Connect base image

This procedure shows how to create a custom image and add it to the **/opt/kafka/plugins** directory.

You can use the Kafka container image on Red Hat Ecosystem Catalog as a base image for creating your own custom image with additional connector plugins.

At startup, the AMQ Streams version of Kafka Connect loads any third-party connector plugins contained in the **/opt/kafka/plugins** directory.

Prerequisites

- The Cluster Operator must be deployed.

Procedure

1. Create a new **Dockerfile** using **registry.redhat.io/amq7/amq-streams-kafka-32-rhel8:2.2.2** as the base image:

```
FROM registry.redhat.io/amq7/amq-streams-kafka-32-rhel8:2.2.2
USER root:root
COPY ./my-plugins/ /opt/kafka/plugins/
USER 1001
```

Example plug-in file

```
$ tree ./my-plugins/
./my-plugins/
├── debezium-connector-mongodb
│   ├── bson-3.4.2.jar
│   ├── CHANGELOG.md
│   ├── CONTRIBUTE.md
│   ├── COPYRIGHT.txt
│   ├── debezium-connector-mongodb-0.7.1.jar
│   ├── debezium-core-0.7.1.jar
│   ├── LICENSE.txt
│   ├── mongodb-driver-3.4.2.jar
│   ├── mongodb-driver-core-3.4.2.jar
│   └── README.md
├── debezium-connector-mysql
│   ├── CHANGELOG.md
│   ├── CONTRIBUTE.md
│   ├── COPYRIGHT.txt
│   ├── debezium-connector-mysql-0.7.1.jar
│   ├── debezium-core-0.7.1.jar
│   ├── LICENSE.txt
│   ├── mysql-binlog-connector-java-0.13.0.jar
│   ├── mysql-connector-java-5.1.40.jar
│   ├── README.md
│   └── wkb-1.0.2.jar
└── debezium-connector-postgres
    ├── CHANGELOG.md
    ├── CONTRIBUTE.md
    ├── COPYRIGHT.txt
    ├── debezium-connector-postgres-0.7.1.jar
    ├── debezium-core-0.7.1.jar
    ├── LICENSE.txt
    ├── postgresql-42.0.0.jar
    ├── protobuf-java-2.6.1.jar
    └── README.md
```

NOTE

This example uses the Debezium connectors for MongoDB, MySQL, and PostgreSQL. Debezium running in Kafka Connect looks the same as any other Kafka Connect task.

2. Build the container image.
3. Push your custom image to your container registry.
4. Point to the new container image.
   You can either:

   - Edit the **KafkaConnect.spec.image** property of the **KafkaConnect** custom resource. If set, this property overrides the **STRIMZI_KAFKA_CONNECT_IMAGES** variable in the Cluster Operator.

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnect
metadata:
  name: my-connect-cluster
spec: 1
  #...
  image: my-new-container-image 2
  config: 3
    #...
```

   1 The specification for the Kafka Connect cluster.

   2 The docker image for the pods.

   3 Configuration of the Kafka Connect *workers* (not connectors).

   or

   - In the **install/cluster-operator/060-Deployment-strimzi-cluster-operator.yaml** file, edit the **STRIMZI_KAFKA_CONNECT_IMAGES** variable to point to the new container image, and then reinstall the Cluster Operator.

Additional resources

- Container image configuration and the **KafkaConnect.spec.image property**
- Cluster Operator configuration and the **STRIMZI_KAFKA_CONNECT_IMAGES** variable

6.2.4. Creating and managing connectors

When you have created a container image for your connector plug-in, you need to create a connector instance in your Kafka Connect cluster. You can then configure, monitor, and manage a running connector instance.

A connector is an instance of a particular *connector class* that knows how to communicate with the relevant external system in terms of messages. Connectors are available for many external systems, or you can create your own.

You can create *source* and *sink* types of connector.

Source connector

A source connector is a runtime entity that fetches data from an external system and feeds it to Kafka as messages.

Sink connector

A sink connector is a runtime entity that fetches messages from Kafka topics and feeds them to an external system.

6.2.4.1. APIs for creating and managing connectors

AMQ Streams provides two APIs for creating and managing connectors:

- **KafkaConnector** custom resources (referred to as KafkaConnectors)
- The Kafka Connect REST API

Using the APIs, you can:

- Check the status of a connector instance
- Reconfigure a running connector
- Increase or decrease the number of connector tasks for a connector instance
- Restart connectors
- Restart connector tasks, including failed tasks
- Pause a connector instance
- Resume a previously paused connector instance
- Delete a connector instance

KafkaConnector custom resources

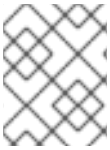
KafkaConnectors allow you to create and manage connector instances for Kafka Connect in an OpenShift-native way, so an HTTP client such as cURL is not required. Like other Kafka resources, you declare a connector's desired state in a **KafkaConnector** YAML file that is deployed to your OpenShift cluster to create the connector instance. **KafkaConnector** resources must be deployed to the same namespace as the Kafka Connect cluster they link to.

You manage a running connector instance by updating its corresponding **KafkaConnector** resource, and then applying the updates. You remove a connector by deleting its corresponding **KafkaConnector**.

To ensure compatibility with earlier versions of AMQ Streams, KafkaConnectors are disabled by default. To enable KafkaConnectors for a Kafka Connect cluster, you set the **strimzi.io/use-connector-resources** annotation to **true** in the **KafkaConnect** resource. For instructions, see Configuring Kafka Connect.

When KafkaConnectors are enabled, the Cluster Operator begins to watch for them. It updates the configurations of running connector instances to match the configurations defined in their KafkaConnectors.

AMQ Streams provides an example **KafkaConnector** configuration file, which you can use to create and manage a **FileStreamSourceConnector** and a **FileStreamSinkConnector**.



NOTE

You can restart a connector or restart a connector task by annotating a **KafkaConnector** resource.

Kafka Connect API

The operations supported by the Kafka Connect REST API are described in the Apache Kafka Connect API documentation.

Switching from using the Kafka Connect API to using KafkaConnectors

You can switch from using the Kafka Connect API to using KafkaConnectors to manage your connectors. To make the switch, do the following in the order shown:

1. Deploy **KafkaConnector** resources with the configuration to create your connector instances.
2. Enable KafkaConnectors in your Kafka Connect configuration by setting the **strimzi.io/use-connector-resources** annotation to **true**.

WARNING

If you enable KafkaConnectors before creating the resources, you will delete all your connectors.

To switch from using KafkaConnectors to using the Kafka Connect API, first remove the annotation that enables the KafkaConnectors from your Kafka Connect configuration. Otherwise, manual changes made directly using the Kafka Connect REST API are reverted by the Cluster Operator.

6.2.4.2. Deploying example KafkaConnector resources

The **KafkaConnector** resource offers a Kubernetes-native approach to management of connectors by the Cluster Operator. AMQ Streams provides example configuration files. In this procedure, we use the **examples/connect/source-connector.yaml** file to create the following connector instances as **KafkaConnector** resources:

- A **FileStreamSourceConnector** instance that reads each line from the Kafka license file (the source) and writes the data as messages to a single Kafka topic.
- A **FileStreamSinkConnector** instance that reads messages from the Kafka topic and writes the messages to a temporary file (the sink).

Alternatively, you can use the **examples/connect/kafka-connect-build.yaml** file to build a new Kafka Connect image with the file connectors.

Up until Apache Kafka 3.1.0, the example file connector plugins were included with Apache Kafka. Starting from the 3.1.1 and 3.2.0 releases of Apache Kafka, the examples need to be added to the plugin path as any other connector. See Extending Kafka Connect with connector plugins for more details.

NOTE

In a production environment, you prepare container images with the required Kafka Connect connectors, as described in Section 6.2.3, "Extending Kafka Connect with connector plugins".

The **FileStreamSourceConnector** and **FileStreamSinkConnector** are provided as examples. Running these connectors in containers as described here is unlikely to be suitable for production use cases.

Prerequisites

- A Kafka Connect deployment
- KafkaConnectors are enabled in the Kafka Connect deployment
- The Cluster Operator is running

Procedure

1. Edit the **examples/connect/source-connector.yaml** file:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnector
metadata:
  name: my-source-connector 1
  labels:
    strimzi.io/cluster: my-connect-cluster 2
spec:
  class: org.apache.kafka.connect.file.FileStreamSourceConnector 3
  tasksMax: 2 4
  config: 5
    file: "/opt/kafka/LICENSE" 6
    topic: my-topic 7
    # ...
```

1. Name of the **KafkaConnector** resource, which is used as the name of the connector. Use any name that is valid for an OpenShift resource.
2. Name of the Kafka Connect cluster to create the connector instance in. Connectors must be deployed to the same namespace as the Kafka Connect cluster they link to.
3. Full name or alias of the connector class. This should be present in the image being used by the Kafka Connect cluster.
4. Maximum number of Kafka Connect **Tasks** that the connector can create.
5. Connector configuration as key-value pairs.
6. This example source connector configuration reads data from the **/opt/kafka/LICENSE** file.
7. Kafka topic to publish the source data to.

2. Create the source **KafkaConnector** in your OpenShift cluster:

```
oc apply -f examples/connect/source-connector.yaml
```

3. Create an **examples/connect/sink-connector.yaml** file:

```
touch examples/connect/sink-connector.yaml
```

4. Paste the following YAML into the **sink-connector.yaml** file:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaConnector
metadata:
  name: my-sink-connector
  labels:
    strimzi.io/cluster: my-connect
spec:
  class: org.apache.kafka.connect.file.FileStreamSinkConnector (1)
  tasksMax: 2
  config: (2)
    file: "/tmp/my-file" (3)
    topics: my-topic (4)
```

(1) Full name or alias of the connector class. This should be present in the image being used by the Kafka Connect cluster.

(2) Connector configuration as key-value pairs.

(3) Temporary file to publish the source data to.

(4) Kafka topic to read the source data from.

5. Create the sink **KafkaConnector** in your OpenShift cluster:

```
oc apply -f examples/connect/sink-connector.yaml
```

6. Check that the connector resources were created:

```
oc get kctr --selector strimzi.io/cluster=MY-CONNECT-CLUSTER -o name

my-source-connector
my-sink-connector
```

Replace *MY-CONNECT-CLUSTER* with your Kafka Connect cluster.

7. In the container, execute **kafka-console-consumer.sh** to read the messages that were written to the topic by the source connector:

```
oc exec MY-CLUSTER-kafka-0 -i -t -- bin/kafka-console-consumer.sh --bootstrap-server MY-CLUSTER-kafka-bootstrap.NAMESPACE.svc:9092 --topic my-topic --from-beginning
```

Source and sink connector configuration options

The connector configuration is defined in the **spec.config** property of the **KafkaConnector** resource.

The **FileStreamSourceConnector** and **FileStreamSinkConnector** classes support the same configuration options as the Kafka Connect REST API. Other connectors support different configuration options.

Table 6.1. Configuration options for the FileStreamSource connector class

Name	Type	Default value	Description
file	String	Null	Source file to write messages to. If not specified, the standard input is used.
topic	List	Null	The Kafka topic to publish data to.

Table 6.2. Configuration options for FileStreamSinkConnector class

Name	Type	Default value	Description
file	String	Null	Destination file to write messages to. If not specified, the standard output is used.
topics	List	Null	One or more Kafka topics to read data from.
topics.regex	String	Null	A regular expression matching one or more Kafka topics to read data from.

6.2.4.3. Performing a restart of a Kafka connector

This procedure describes how to manually trigger a restart of a Kafka connector by using an OpenShift annotation.

Prerequisites

- The Cluster Operator is running.

Procedure

1. Find the name of the **KafkaConnector** custom resource that controls the Kafka connector you want to restart:

```
oc get KafkaConnector
```

2. To restart the connector, annotate the **KafkaConnector** resource in OpenShift. For example, using **oc annotate**:

```
oc annotate KafkaConnector KAFKACONNECTOR-NAME strimzi.io/restart=true
```

3. Wait for the next reconciliation to occur (every two minutes by default).
   The Kafka connector is restarted, as long as the annotation was detected by the reconciliation process. When Kafka Connect accepts the restart request, the annotation is removed from the **KafkaConnector** custom resource.

6.2.4.4. Performing a restart of a Kafka connector task

This procedure describes how to manually trigger a restart of a Kafka connector task by using an OpenShift annotation.

Prerequisites

- The Cluster Operator is running.

Procedure

1. Find the name of the **KafkaConnector** custom resource that controls the Kafka connector task you want to restart:

```
oc get KafkaConnector
```

2. Find the ID of the task to be restarted from the **KafkaConnector** custom resource. Task IDs are non-negative integers, starting from 0.

```
oc describe KafkaConnector KAFKACONNECTOR-NAME
```

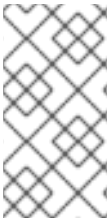
3. To restart the connector task, annotate the **KafkaConnector** resource in OpenShift. For example, using **oc annotate** to restart task 0:

```
oc annotate KafkaConnector KAFKACONNECTOR-NAME strimzi.io/restart-task=0
```

4. Wait for the next reconciliation to occur (every two minutes by default).
   The Kafka connector task is restarted, as long as the annotation was detected by the reconciliation process. When Kafka Connect accepts the restart request, the annotation is removed from the **KafkaConnector** custom resource.

6.2.4.5. Exposing the Kafka Connect API

Use the Kafka Connect REST API as an alternative to using **KafkaConnector** resources to manage connectors. The Kafka Connect REST API is available as a service running on ***<connect_cluster_name>*-connect-api:8083**, where *<connect_cluster_name>* is the name of your Kafka Connect cluster. The service is created when you create a Kafka Connect instance.



NOTE

The **strimzi.io/use-connector-resources** annotation enables KafkaConnectors. If you applied the annotation to your **KafkaConnect** resource configuration, you need to remove it to use the Kafka Connect API. Otherwise, manual changes made directly using the Kafka Connect REST API are reverted by the Cluster Operator.

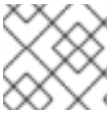
You can add the connector configuration as a JSON object.

Example curl request to add connector configuration

```
curl -X POST \
  http://my-connect-cluster-connect-api:8083/connectors \
  -H 'Content-Type: application/json' \
  -d '{ "name": "my-source-connector",
    "config":
    {
      "connector.class":"org.apache.kafka.connect.file.FileStreamSourceConnector",
      "file": "/opt/kafka/LICENSE",
      "topic":"my-topic",
      "tasksMax": "4",
      "type": "source"
    }
}'
```

The API is only accessible within the OpenShift cluster. If you want to make the Kafka Connect API accessible to applications running outside of the OpenShift cluster, you can expose it manually by creating one of the following features:

- **LoadBalancer** or **NodePort** type services
- **Ingress** resources
- OpenShift routes



NOTE

The connection is insecure, so allow external access advisedly.

If you decide to create services, use the labels from the **selector** of the ***<connect_cluster_name>-connect-api*** service to configure the pods to which the service will route the traffic:

Selector configuration for the service

```
# ...
selector:
  strimzi.io/cluster: my-connect-cluster 1
  strimzi.io/kind: KafkaConnect
  strimzi.io/name: my-connect-cluster-connect 2
#...
```

1. Name of the Kafka Connect custom resource in your OpenShift cluster.
2. Name of the Kafka Connect deployment created by the Cluster Operator.

You must also create a **NetworkPolicy** that allows HTTP requests from external clients.

Example NetworkPolicy to allow requests to the Kafka Connect API

```
apiVersion: networking.k8s.io/v1
```

```
kind: NetworkPolicy
metadata:
  name: my-custom-connect-network-policy
spec:
  ingress:
  - from:
    - podSelector: 1
        matchLabels:
          app: my-connector-manager
    ports:
    - port: 8083
      protocol: TCP
  podSelector:
    matchLabels:
      strimzi.io/cluster: my-connect-cluster
      strimzi.io/kind: KafkaConnect
      strimzi.io/name: my-connect-cluster-connect
  policyTypes:
  - Ingress
```

1 The label of the pod that is allowed to connect to the API.

To add the connector configuration outside the cluster, use the URL of the resource that exposes the API in the curl command.

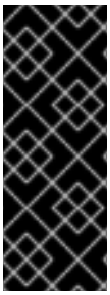
6.3. DEPLOY KAFKA MIRRORMAKER

The Cluster Operator deploys one or more Kafka MirrorMaker replicas to replicate data between Kafka clusters. This process is called mirroring to avoid confusion with the Kafka partitions replication concept. MirrorMaker consumes messages from the source cluster and republishes those messages to the target cluster.

6.3.1. Deploying Kafka MirrorMaker to your OpenShift cluster

This procedure shows how to deploy a Kafka MirrorMaker cluster to your OpenShift cluster using the Cluster Operator.

The deployment uses a YAML file to provide the specification to create a **KafkaMirrorMaker** or **KafkaMirrorMaker2** resource depending on the version of MirrorMaker deployed.



IMPORTANT

Kafka MirrorMaker 1 (referred to as just *MirrorMaker* in the documentation) has been deprecated in Apache Kafka 3.0.0 and will be removed in Apache Kafka 4.0.0. As a result, the **KafkaMirrorMaker** custom resource which is used to deploy Kafka MirrorMaker 1 has been deprecated in AMQ Streams as well. The **KafkaMirrorMaker** resource will be removed from AMQ Streams when we adopt Apache Kafka 4.0.0. As a replacement, use the **KafkaMirrorMaker2** custom resource with the **IdentityReplicationPolicy**.

AMQ Streams provides example configuration files. In this procedure, we use the following example files:

- **examples/mirror-maker/kafka-mirror-maker.yaml**

- **examples/mirror-maker/kafka-mirror-maker-2.yaml**

Prerequisites

- The Cluster Operator must be deployed.

Procedure

1. Deploy Kafka MirrorMaker to your OpenShift cluster:
   For MirrorMaker:

   ```
   oc apply -f examples/mirror-maker/kafka-mirror-maker.yaml
   ```

   For MirrorMaker 2.0:

   ```
   oc apply -f examples/mirror-maker/kafka-mirror-maker-2.yaml
   ```

2. Check the status of the deployment:

   ```
   oc get deployments -n <my_cluster_operator_namespace>
   ```

   Output shows the deployment name and readiness

   ```
   NAME                        READY  UP-TO-DATE  AVAILABLE
   my-mirror-maker-mirror-maker  1/1    1           1
   my-mm2-cluster-mirrormaker2   1/1    1           1
   ```

   my-mirror-maker is the name of the Kafka MirrorMaker cluster. **my-mm2-cluster** is the name of the Kafka MirrorMaker 2.0 cluster.

   READY shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows **1**.

Additional resources

- Kafka MirrorMaker cluster configuration

6.4. DEPLOY KAFKA BRIDGE

The Cluster Operator deploys one or more Kafka bridge replicas to send data between Kafka clusters and clients via HTTP API.

6.4.1. Deploying Kafka Bridge to your OpenShift cluster

This procedure shows how to deploy a Kafka Bridge cluster to your OpenShift cluster using the Cluster Operator.

The deployment uses a YAML file to provide the specification to create a **KafkaBridge** resource.

AMQ Streams provides example configuration files. In this procedure, we use the following example file:

- **examples/bridge/kafka-bridge.yaml**

Prerequisites

- The Cluster Operator must be deployed.

Procedure

1. Deploy Kafka Bridge to your OpenShift cluster:

```
oc apply -f examples/bridge/kafka-bridge.yaml
```

2. Check the status of the deployment:

```
oc get deployments -n <my_cluster_operator_namespace>
```

Output shows the deployment name and readiness

```
NAME             READY  UP-TO-DATE  AVAILABLE
my-bridge-bridge  1/1    1           1
```

my-bridge is the name of the Kafka Bridge cluster.

READY shows the number of replicas that are ready/expected. The deployment is successful when the **AVAILABLE** output shows **1**.

Additional resources

- Kafka Bridge cluster configuration
- Using the AMQ Streams Kafka Bridge

6.4.2. Exposing the Kafka Bridge service to your local machine

Use port forwarding to expose the AMQ Streams Kafka Bridge service to your local machine on http://localhost:8080.

NOTE

Port forwarding is only suitable for development and testing purposes.

Procedure

1. List the names of the pods in your OpenShift cluster:

```
oc get pods -o name

pod/kafka-consumer
# ...
pod/quickstart-bridge-589d78784d-9jcnr
pod/strimzi-cluster-operator-76bcf9bc76-8dnfm
```

2. Connect to the Kafka Bridge pod on port **8080**:

```
oc port-forward pod/quickstart-bridge-589d78784d-9jcnr 8080:8080 &
```

NOTE

If port 8080 on your local machine is already in use, use an alternative HTTP port, such as **8008**.

API requests are now forwarded from port 8080 on your local machine to port 8080 in the Kafka Bridge pod.

6.4.3. Accessing the Kafka Bridge outside of OpenShift

After deployment, the AMQ Streams Kafka Bridge can only be accessed by applications running in the same OpenShift cluster. These applications use the ***<kafka_bridge_name>*-bridge-service** service to access the API.

If you want to make the Kafka Bridge accessible to applications running outside of the OpenShift cluster, you can expose it manually by creating one of the following features:

- **LoadBalancer** or **NodePort** type services
- **Ingress** resources
- OpenShift routes

If you decide to create Services, use the labels from the **selector** of the ***<kafka_bridge_name>*-bridge-service** service to configure the pods to which the service will route the traffic:

```
# ...
selector:
  strimzi.io/cluster: kafka-bridge-name 1
  strimzi.io/kind: KafkaBridge
#...
```

1 Name of the Kafka Bridge custom resource in your OpenShift cluster.

CHAPTER 7. SETTING UP CLIENT ACCESS TO THE KAFKA CLUSTER

After you have deployed AMQ Streams, the procedures in this section explain how to:

- Deploy example producer and consumer clients, which you can use to verify your deployment
- Set up external client access to the Kafka cluster
  The steps to set up access to the Kafka cluster for a client outside OpenShift are more complex, and require familiarity with the Kafka component configuration procedures.

7.1. DEPLOYING EXAMPLE CLIENTS

This procedure shows how to deploy example producer and consumer clients that use the Kafka cluster you created to send and receive messages.

Prerequisites

- The Kafka cluster is available for the clients.

Procedure

1. Deploy a Kafka producer.

```
oc run kafka-producer -ti --image=registry.redhat.io/amq7/amq-streams-kafka-32-rhel8:2.2.2
--rm=true --restart=Never -- bin/kafka-console-producer.sh --bootstrap-server cluster-name-
kafka-bootstrap:9092 --topic my-topic
```

2. Type a message into the console where the producer is running.
3. Press *Enter* to send the message.
4. Deploy a Kafka consumer.

```
oc run kafka-consumer -ti --image=registry.redhat.io/amq7/amq-streams-kafka-32-rhel8:2.2.2
--rm=true --restart=Never -- bin/kafka-console-consumer.sh --bootstrap-server cluster-name-
kafka-bootstrap:9092 --topic my-topic --from-beginning
```

5. Confirm that you see the incoming messages in the consumer console.

7.2. SETTING UP ACCESS FOR CLIENTS OUTSIDE OF OPENSHIFT

This procedure shows how to configure client access to a Kafka cluster from outside OpenShift.

Using the address of the Kafka cluster, you can provide external access to a client on a different OpenShift namespace or outside OpenShift entirely.

You configure an external Kafka listener to provide the access.

The following external listener types are supported:

- **route** to use OpenShift **Route** and the default HAProxy router

- **loadbalancer** to use loadbalancer services
- **nodeport** to use ports on OpenShift nodes
- **ingress** to use OpenShift *Ingress* and the NGINX Ingress Controller for Kubernetes

The type chosen depends on your requirements, and your environment and infrastructure. For example, loadbalancers might not be suitable for certain infrastructure, such as bare metal, where node ports provide a better option.

In this procedure:

1. An external listener is configured for the Kafka cluster, with TLS encryption and authentication, and Kafka *simple authorization* is enabled.
2. A **KafkaUser** is created for the client, with TLS authentication and Access Control Lists (ACLs) defined for *simple authorization*.

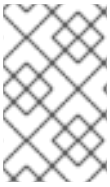
You can configure your listener to use TLS, SCRAM-SHA-512 or OAuth 2.0 authentication. TLS always uses encryption, but it is recommended to also use encryption with SCRAM-SHA-512 and OAuth 2.0 authentication.

You can configure simple, OAuth 2.0, OPA or custom authorization for Kafka brokers. When enabled, authorization is applied to all enabled listeners.

When you configure the **KafkaUser** authentication and authorization mechanisms, ensure they match the equivalent Kafka configuration:

- **KafkaUser.spec.authentication** matches **Kafka.spec.kafka.listeners[*].authentication**
- **KafkaUser.spec.authorization** matches **Kafka.spec.kafka.authorization**

You should have at least one listener supporting the authentication you want to use for the **KafkaUser**.



NOTE

Authentication between Kafka users and Kafka brokers depends on the authentication settings for each. For example, it is not possible to authenticate a user with TLS if it is not also enabled in the Kafka configuration.

AMQ Streams operators automate the configuration process:

- The Cluster Operator creates the listeners and sets up the cluster and client certificate authority (CA) certificates to enable authentication within the Kafka cluster.
- The User Operator creates the user representing the client and the security credentials used for client authentication, based on the chosen authentication type.

In this procedure, the certificates generated by the Cluster Operator are used, but you can replace them by installing your own certificates. You can also configure your listener to use a Kafka listener certificate managed by an external Certificate Authority.

Certificates are available in PKCS #12 (.p12) and PEM (.crt) formats. This procedure shows PKCS #12 certificates.

Prerequisites

- The Kafka cluster is available for the client
- The Cluster Operator and User Operator are running in the cluster
- A client outside the OpenShift cluster to connect to the Kafka cluster

Procedure

1. Configure the Kafka cluster with an **external** Kafka listener.
   - Define the authentication required to access the Kafka broker through the listener
   - Enable authorization on the Kafka broker
     For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
  namespace: myproject
spec:
  kafka:
    # ...
    listeners: 1
    - name: external 2
      port: 9094 3
      type: LISTENER-TYPE 4
      tls: true 5
      authentication:
        type: tls 6
      configuration:
        preferredNodePortAddressType: InternalDNS 7
        bootstrap and broker service overrides 8
        #...
    authorization: 9
      type: simple
      superUsers:
        - super-user-name 10
  # ...
```

1. Configuration options for enabling external listeners are described in the Generic Kafka listener schema reference.
2. Name to identify the listener. Must be unique within the Kafka cluster.
3. Port number used by the listener inside Kafka. The port number has to be unique within a given Kafka cluster. Allowed port numbers are 9092 and higher with the exception of ports 9404 and 9999, which are already used for Prometheus and JMX. Depending on the listener type, the port number might not be the same as the port number that connects Kafka clients.
4. External listener type specified as **route**, **loadbalancer**, **nodeport** or **ingress**. An internal listener is specified as **internal**.

5. Enables TLS encryption on the listener. Default is **false**. TLS encryption is not required for **route** listeners.
6. Authentication specified as **tls**.
7. (Optional, for **nodeport** listeners only) Configuration to specify a preference for the first address type used by AMQ Streams as the node address.
8. (Optional) AMQ Streams automatically determines the addresses to advertise to clients. The addresses are automatically assigned by OpenShift. You can override bootstrap and broker service addresses if the infrastructure on which you are running AMQ Streams does not provide the right address. Validation is not performed on the overrides. The override configuration differs according to the listener type. For example, you can override hosts for **route**, DNS names or IP addresses for **loadbalancer**, and node ports for **nodeport**.
9. Authorization specified as **simple**, which uses the **AclAuthorizer** Kafka plugin.
10. (Optional) Super users can access all brokers regardless of any access restrictions defined in ACLs.

WARNING

An OpenShift Route address comprises the name of the Kafka cluster, the name of the listener, and the name of the namespace it is created in. For example, **my-cluster-kafka-listener1-bootstrap-myproject** (*CLUSTER-NAME*-kafka-*LISTENER-NAME*-bootstrap-*NAMESPACE*). If you are using a **route** listener type, be careful that the whole length of the address does not exceed a maximum limit of 63 characters.

2. Create or update the **Kafka** resource.

```
oc apply -f <kafka_configuration_file>
```

The Kafka cluster is configured with a Kafka broker listener using TLS authentication.

A service is created for each Kafka broker pod.

A service is created to serve as the *bootstrap address* for connection to the Kafka cluster.

A service is also created as the *external bootstrap address* for external connection to the Kafka cluster using **nodeport** listeners.

The cluster CA certificate to verify the identity of the kafka brokers is also created in the secret ***<cluster_name>*-cluster-ca-cert**.

NOTE

If you scale your Kafka cluster while using external listeners, it might trigger a rolling update of all Kafka brokers. This depends on the configuration.

3. Find the bootstrap address and port from the status of the **Kafka** resource.

```
oc get kafka KAFKA-CLUSTER-NAME -o jsonpath='{.status.listeners[?
(@.name=="external")].bootstrapServers}'
```

Use the bootstrap address in your Kafka client to connect to the Kafka cluster.

4. Create or modify a user representing the client that requires access to the Kafka cluster.
   - Specify the same authentication type as the **Kafka** listener.
   - Specify the authorization ACLs for simple authorization.
     For example:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaUser
metadata:
  name: my-user
  labels:
    strimzi.io/cluster: my-cluster (1)
spec:
  authentication:
    type: tls (2)
  authorization:
    type: simple
    acls: (3)
      - resource:
          type: topic
          name: my-topic
          patternType: literal
        operation: Read
      - resource:
          type: topic
          name: my-topic
          patternType: literal
        operation: Describe
      - resource:
          type: group
          name: my-group
          patternType: literal
        operation: Read
```

(1) The label must match the label of the Kafka cluster for the user to be created.

(2) Authentication specified as **tls**.

(3) Simple authorization requires an accompanying list of ACL rules to apply to the user. The rules define the operations allowed on Kafka resources based on the *username* (**my-user**).

5. Create or modify the **KafkaUser** resource.

```
oc apply -f USER-CONFIG-FILE
```

The user is created, as well as a Secret with the same name as the **KafkaUser** resource. The Secret contains a private and public key for TLS client authentication.

For example:

```
apiVersion: v1
kind: Secret
metadata:
  name: my-user
  labels:
    strimzi.io/kind: KafkaUser
    strimzi.io/cluster: my-cluster
type: Opaque
data:
  ca.crt: PUBLIC-KEY-OF-THE-CLIENT-CA
  user.crt: USER-CERTIFICATE-CONTAINING-PUBLIC-KEY-OF-USER
  user.key: PRIVATE-KEY-OF-USER
  user.p12: P12-ARCHIVE-FILE-STORING-CERTIFICATES-AND-KEYS
  user.password: PASSWORD-PROTECTING-P12-ARCHIVE
```

6. Extract the public cluster CA certificate to the desired certificate format:

```
oc get secret KAFKA-CLUSTER-NAME-cluster-ca-cert -o jsonpath='{.data.ca\.p12}' | base64 -d > ca.p12
```

7. Extract the password from the password file:

```
oc get secret KAFKA-CLUSTER-NAME-cluster-ca-cert -o jsonpath='{.data.ca\.password}' | base64 -d > ca.password
```

8. Configure your client with the authentication details for the public cluster certificates:

Sample client code

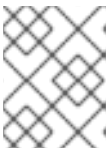
```
properties.put("security.protocol","SSL"); (1)
properties.put(SslConfigs.SSL_TRUSTSTORE_LOCATION_CONFIG,"/path/to/ca.p12"); (2)
properties.put(SslConfigs.SSL_TRUSTSTORE_PASSWORD_CONFIG,CA-PASSWORD); (3)
properties.put(SslConfigs.SSL_TRUSTSTORE_TYPE_CONFIG,"PKCS12"); (4)
```

(1) Enables TLS encryption (with or without TLS client authentication).

(2) Specifies the truststore location where the certificates were imported.

(3) Specifies the password for accessing the truststore. This property can be omitted if it is not needed by the truststore.

(4) Identifies the truststore type.



NOTE

Use **security.protocol: SASL_SSL** when using SCRAM-SHA authentication over TLS.

9. Extract the user CA certificate from the user Secret to the desired certificate format:

```
oc get secret USER-NAME -o jsonpath='{.data.user\.p12}' | base64 -d > user.p12
```

10. Extract the password from the password file:

```
oc get secret USER-NAME -o jsonpath='{.data.user\.password}' | base64 -d > user.password
```

11. Configure your client with the authentication details for the user CA certificate:

Sample client code

```
properties.put(SslConfigs.SSL_KEYSTORE_LOCATION_CONFIG,"/path/to/user.p12"); 1
properties.put(SslConfigs.SSL_KEYSTORE_PASSWORD_CONFIG,"<user.password>"); 2
properties.put(SslConfigs.SSL_KEYSTORE_TYPE_CONFIG,"PKCS12"); 3
```

1. Specifies the keystore location where the certificates were imported.
2. Specifies the password for accessing the keystore. This property can be omitted if it is not needed by the keystore. The public user certificate is signed by the client CA when it is created.
3. Identifies the keystore type.

12. Add the bootstrap address and port for connecting to the Kafka cluster:

```
bootstrap.servers: BOOTSTRAP-ADDRESS:PORT
```

Additional resources

- Listener authentication options
- Kafka authorization options
- If you are using an authorization server, you can use token-based OAuth 2.0 authentication and OAuth 2.0 authorization.

CHAPTER 8. SETTING UP METRICS AND DASHBOARDS FOR AMQ STREAMS

You can use Prometheus and Grafana to monitor your AMQ Streams deployment.

You can monitor your AMQ Streams deployment by viewing key metrics on dashboards and setting up alerts that trigger under certain conditions. Metrics are available for each of the components of AMQ Streams.

To provide metrics information, AMQ Streams uses Prometheus rules and Grafana dashboards.

When configured with a set of rules for each component of AMQ Streams, Prometheus consumes key metrics from the pods that are running in your cluster. Grafana then visualizes those metrics on dashboards. AMQ Streams includes example Grafana dashboards that you can customize to suit your deployment.

AMQ Streams employs *monitoring for user-defined projects* (an OpenShift feature) to simplify the Prometheus setup process.

Depending on your requirements, you can:

- Set up and deploy Prometheus to expose metrics
- Deploy Kafka Exporter to provide additional metrics
- Use Grafana to present the Prometheus metrics

With Prometheus and Grafana set up, you can use the example Grafana dashboards provided by AMQ Streams for monitoring.

Additionally, you can configure your deployment to track messages end-to-end by setting up distributed tracing.

NOTE

AMQ Streams provides example installation files for Prometheus and Grafana. You can use these files as a starting point when trying out monitoring of AMQ Streams. For further support, try engaging with the Prometheus and Grafana developer communities.

Supporting documentation for metrics and monitoring tools

For more information on the metrics and monitoring tools, refer to the supporting documentation:

- Prometheus
- Prometheus configuration
- Kafka Exporter
- Grafana Labs
- Apache Kafka Monitoring describes JMX metrics exposed by Apache Kafka
- ZooKeeper JMX describes JMX metrics exposed by Apache ZooKeeper

8.1. MONITORING CONSUMER LAG WITH KAFKA EXPORTER

Kafka Exporter is an open source project to enhance monitoring of Apache Kafka brokers and clients. You can configure the **Kafka** resource to deploy Kafka Exporter with your Kafka cluster . Kafka Exporter extracts additional metrics data from Kafka brokers related to offsets, consumer groups, consumer lag, and topics. The metrics data is used, for example, to help identify slow consumers. Lag data is exposed as Prometheus metrics, which can then be presented in Grafana for analysis.

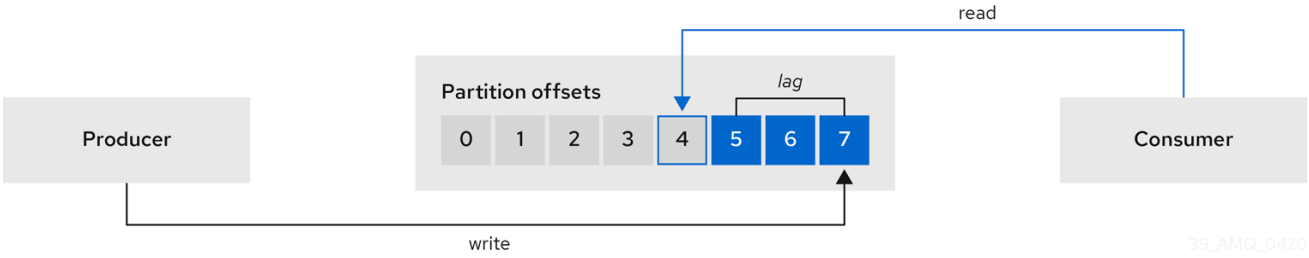
IMPORTANT

Kafka Exporter provides only additional metrics related to consumer lag and consumer offsets. For regular Kafka metrics, you have to configure the Prometheus metrics in Kafka brokers.

Consumer lag indicates the difference in the rate of production and consumption of messages. Specifically, consumer lag for a given consumer group indicates the delay between the last message in the partition and the message being currently picked up by that consumer.

The lag reflects the position of the consumer offset in relation to the end of the partition log.

Consumer lag between the producer and consumer offset



This difference is sometimes referred to as the *delta* between the producer offset and consumer offset: the read and write positions in the Kafka broker topic partitions.

Suppose a topic streams 100 messages a second. A lag of 1000 messages between the producer offset (the topic partition head) and the last offset the consumer has read means a 10-second delay.

The importance of monitoring consumer lag

For applications that rely on the processing of (near) real-time data, it is critical to monitor consumer lag to check that it does not become too big. The greater the lag becomes, the further the process moves from the real-time processing objective.

Consumer lag, for example, might be a result of consuming too much old data that has not been purged, or through unplanned shutdowns.

Reducing consumer lag

Use the Grafana charts to analyze lag and to check if actions to reduce lag are having an impact on an affected consumer group. If, for example, Kafka brokers are adjusted to reduce lag, the dashboard will show the *Lag by consumer group* chart going down and the *Messages consumed per minute* chart going up.

Typical actions to reduce lag include:

- Scaling-up consumer groups by adding new consumers

- Increasing the retention time for a message to remain in a topic
- Adding more disk capacity to increase the message buffer

Actions to reduce consumer lag depend on the underlying infrastructure and the use cases AMQ Streams is supporting. For instance, a lagging consumer is less likely to benefit from the broker being able to service a fetch request from its disk cache. And in certain cases, it might be acceptable to automatically drop messages until a consumer has caught up.

8.2. MONITORING CRUISE CONTROL OPERATIONS

Cruise Control monitors Kafka brokers in order to track the utilization of brokers, topics, and partitions. Cruise Control also provides a set of metrics for monitoring its own performance.

The Cruise Control metrics reporter collects raw metrics data from Kafka brokers. The data is produced to topics that are automatically created by Cruise Control. The metrics are used to generate optimization proposals for Kafka clusters.

Cruise Control metrics are available for real-time monitoring of Cruise Control operations. For example, you can use Cruise Control metrics to monitor the status of rebalancing operations that are running or provide alerts on any anomalies that are detected in an operation's performance.

You expose Cruise Control metrics by enabling the Prometheus JMX Exporter in the Cruise Control configuration.

NOTE

For a full list of available Cruise Control metrics, which are known as *sensors*, see the Cruise Control documentation.

8.2.1. Exposing Cruise Control metrics

If you want to expose metrics on Cruise Control operations, configure the **Kafka** resource to deploy Cruise Control and enable Prometheus metrics in the deployment. You can use your own configuration or use the example **kafka-cruise-control-metrics.yaml** file provided by AMQ Streams.

You add the configuration to the **metricsConfig** of the **CruiseControl** property in the **Kafka** resource. The configuration enables the Prometheus JMX Exporter to expose Cruise Control metrics through an HTTP endpoint. The HTTP endpoint is scraped by the Prometheus server.

Example metrics configuration for Cruise Control

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
Spec:
  # ...
  cruiseControl:
    # ...
    metricsConfig:
      type: jmxPrometheusExporter
      valueFrom:
        configMapKeyRef:
          name: cruise-control-metrics
```

```
        key: metrics-config.yml
---
kind: ConfigMap
apiVersion: v1
metadata:
  name: cruise-control-metrics
  labels:
    app: strimzi
data:
  metrics-config.yml: |
  # metrics configuration...
```

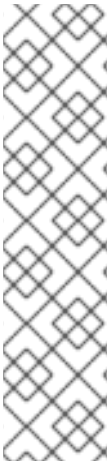
8.2.2. Viewing Cruise Control metrics

After you expose the Cruise Control metrics, you can use Prometheus or another suitable monitoring system to view information on the metrics data. AMQ Streams provides an example Grafana dashboard to display visualizations of Cruise Control metrics. The dashboard is a JSON file called **strimzi-cruise-control.json**. The exposed metrics provide the monitoring data when you enable the Grafana dashboard.

8.2.2.1. Monitoring balancedness scores

Cruise Control metrics include a balancedness score. Balancedness is the measure of how evenly a workload is distributed in a Kafka cluster.

The Cruise Control metric for balancedness score (**balancedness-score**) might differ from the balancedness score in the **KafkaRebalance** resource. Cruise Control calculates each score using **anomaly.detection.goals** which might not be the same as the **default.goals** used in the **KafkaRebalance** resource. The **anomaly.detection.goals** are specified in the **spec.cruiseControl.config** of the **Kafka** custom resource.



NOTE

Refreshing the **KafkaRebalance** resource fetches an optimization proposal. The latest cached optimization proposal is fetched if one of the following conditions applies:

- KafkaRebalance **goals** match the goals configured in the **default.goals** section of the **Kafka** resource
- KafkaRebalance **goals** are not specified

Otherwise, Cruise Control generates a new optimization proposal based on KafkaRebalance **goals**. If new proposals are generated with each refresh, this can impact performance monitoring.

8.2.2.2. Alerts on anomaly detection

Cruise control's *anomaly detector* provides metrics data for conditions that block the generation of optimization goals, such as broker failures. If you want more visibility, you can use the metrics provided by the anomaly detector to set up alerts and send out notifications. You can set up Cruise Control's *anomaly notifier* to route alerts based on these metrics through a specified notification channel. Alternatively, you can set up Prometheus to scrape the metrics data provided by the anomaly detector and generate alerts. Prometheus Alertmanager can then route the alerts generated by Prometheus.

The Cruise Control documentation provides information on **AnomalyDetector** metrics and the anomaly notifier.

8.3. EXAMPLE METRICS FILES

You can find example Grafana dashboards and other metrics configuration files in the example configuration files provided by AMQ Streams.

Example metrics files provided with AMQ Streams

```
metrics
├── grafana-dashboards 1
│   ├── strimzi-cruise-control.json
│   ├── strimzi-kafka-bridge.json
│   ├── strimzi-kafka-connect.json
│   ├── strimzi-kafka-exporter.json
│   ├── strimzi-kafka-mirror-maker-2.json
│   ├── strimzi-kafka.json
│   ├── strimzi-operators.json
│   └── strimzi-zookeeper.json
├── grafana-install
│   └── grafana.yaml 2
├── prometheus-additional-properties
│   └── prometheus-additional.yaml 3
├── prometheus-alertmanager-config
│   └── alert-manager-config.yaml 4
├── prometheus-install
│   ├── alert-manager.yaml 5
│   ├── prometheus-rules.yaml 6
│   ├── prometheus.yaml 7
│   └── strimzi-pod-monitor.yaml 8
├── kafka-bridge-metrics.yaml 9
├── kafka-connect-metrics.yaml 10
├── kafka-cruise-control-metrics.yaml 11
├── kafka-metrics.yaml 12
└── kafka-mirror-maker-2-metrics.yaml 13
```

1. Example Grafana dashboards for the different AMQ Streams components.
2. Installation file for the Grafana image.
3. Additional configuration to scrape metrics for CPU, memory and disk volume usage, which comes directly from the OpenShift cAdvisor agent and kubelet on the nodes.
4. Hook definitions for sending notifications through Alertmanager.
5. Resources for deploying and configuring Alertmanager.
6. Alerting rules examples for use with Prometheus Alertmanager (deployed with Prometheus).
7. Installation resource file for the Prometheus image.
8. PodMonitor definitions translated by the Prometheus Operator into jobs for the Prometheus server to be able to scrape metrics data directly from pods.

9 Kafka Bridge resource with metrics enabled.

10 Metrics configuration that defines Prometheus JMX Exporter relabeling rules for Kafka Connect.

11 Metrics configuration that defines Prometheus JMX Exporter relabeling rules for Cruise Control.

12 Metrics configuration that defines Prometheus JMX Exporter relabeling rules for Kafka and ZooKeeper.

13 Metrics configuration that defines Prometheus JMX Exporter relabeling rules for Kafka Mirror Maker 2.0.

8.3.1. Example Prometheus metrics configuration

AMQ Streams uses the Prometheus JMX Exporter to expose metrics through an HTTP endpoint, which can be scraped by the Prometheus server.

Grafana dashboards are dependent on Prometheus JMX Exporter relabeling rules, which are defined for AMQ Streams components in the custom resource configuration.

A label is a name-value pair. Relabeling is the process of writing a label dynamically. For example, the value of a label may be derived from the name of a Kafka server and client ID.

AMQ Streams provides example custom resource configuration YAML files with relabeling rules. When deploying Prometheus metrics configuration, you can can deploy the example custom resource or copy the metrics configuration to your own custom resource definition.

Table 8.1. Example custom resources with metrics configuration

Component	Custom resource	Example YAML file
Kafka and ZooKeeper	**Kafka**	**kafka-metrics.yaml**
Kafka Connect	**KafkaConnect**	**kafka-connect-metrics.yaml**
Kafka MirrorMaker 2.0	**KafkaMirrorMaker2**	**kafka-mirror-maker-2-metrics.yaml**
Kafka Bridge	**KafkaBridge**	**kafka-bridge-metrics.yaml**
Cruise Control	**Kafka**	**kafka-cruise-control-metrics.yaml**

8.3.2. Example Prometheus rules for alert notifications

Example Prometheus rules for alert notifications are provided with the example metrics configuration files provided by AMQ Streams. The rules are specified in the example **prometheus-rules.yaml** file for use in a Prometheus deployment.

Alerting rules provide notifications about specific conditions observed in metrics. Rules are declared on the Prometheus server, but Prometheus Alertmanager is responsible for alert notifications.

Prometheus alerting rules describe conditions using PromQL expressions that are continuously evaluated.

When an alert expression becomes true, the condition is met and the Prometheus server sends alert data to the Alertmanager. Alertmanager then sends out a notification using the communication method configured for its deployment.

General points about the alerting rule definitions:

- A **for** property is used with the rules to determine the period of time a condition must persist before an alert is triggered.
- A tick is a basic ZooKeeper time unit, which is measured in milliseconds and configured using the **tickTime** parameter of **Kafka.spec.zookeeper.config**. For example, if ZooKeeper **tickTime=3000**, 3 ticks (3 x 3000) equals 9000 milliseconds.
- The availability of the **ZookeeperRunningOutOfSpace** metric and alert is dependent on the OpenShift configuration and storage implementation used. Storage implementations for certain platforms may not be able to supply the information on available space required for the metric to provide an alert.

Alertmanager can be configured to use email, chat messages or other notification methods. Adapt the default configuration of the example rules according to your specific needs.

8.3.2.1. Example altering rules

The **prometheus-rules.yaml** file contains example rules for the following components:

- Kafka
- ZooKeeper
- Entity Operator
- Kafka Connect
- Kafka Bridge
- MirrorMaker
- Kafka Exporter

A description of each of the example rules is provided in the file.

8.3.3. Example Grafana dashboards

If you deploy Prometheus to provide metrics, you can use the example Grafana dashboards provided with AMQ Streams to monitor AMQ Streams components.

Example dashboards are provided in the **examples/metrics/grafana-dashboards** directory as JSON files.

All dashboards provide JVM metrics, as well as metrics specific to the component. For example, the Grafana dashboard for AMQ Streams operators provides information on the number of reconciliations or custom resources they are processing.

The example dashboards don't show all the metrics supported by Kafka. The dashboards are populated with a representative set of metrics for monitoring.

Table 8.2. Example Grafana dashboard files

Component	Example JSON file
AMQ Streams operators	**strimzi-operators.json**
Kafka	**strimzi-kafka.json**
ZooKeeper	**strimzi-zookeeper.json**
Kafka Connect	**strimzi-kafka-connect.json**
Kafka MirrorMaker 2.0	**strimzi-kafka-mirror-maker-2.json**
Kafka Bridge	**strimzi-kafka-bridge.json**
Cruise Control	**strimzi-cruise-control.json**
Kafka Exporter	**strimzi-kafka-exporter.json**

8.4. DEPLOYING PROMETHEUS METRICS CONFIGURATION

Deploy Prometheus metrics configuration to use Prometheus with AMQ Streams. Use the **metricsConfig** property to enable and configure Prometheus metrics.

You can use your own configuration or the example custom resource configuration files provided with AMQ Streams.

- **kafka-metrics.yaml**
- **kafka-connect-metrics.yaml**
- **kafka-mirror-maker-2-metrics.yaml**
- **kafka-bridge-metrics.yaml**
- **kafka-cruise-control-metrics.yaml**

The example configuration files have relabeling rules and the configuration required to enable Prometheus metrics. Prometheus scrapes metrics from target HTTP endpoints. The example files are a good way to try Prometheus with AMQ Streams.

To apply the relabeling rules and metrics configuration, do one of the following:

- Copy the example configuration to your own custom resources
- Deploy the custom resource with the metrics configuration

If you want to include Kafka Exporter metrics, add **kafkaExporter** configuration to your **Kafka** resource.

IMPORTANT

Kafka Exporter provides only additional metrics related to consumer lag and consumer offsets. For regular Kafka metrics, you have to configure the Prometheus metrics in Kafka brokers.

This procedure shows how to deploy Prometheus metrics configuration in the **Kafka** resource. The process is the same when using the example files for other resources.

Procedure

1. Deploy the example custom resource with the Prometheus configuration.
   For example, for each **Kafka** resource you apply the **kafka-metrics.yaml** file.

   Deploying the example configuration

   ```
   oc apply -f kafka-metrics.yaml
   ```

   Alternatively, you can copy the example configuration in **kafka-metrics.yaml** to your own **Kafka** resource.

   Copying the example configuration

   ```
   oc edit kafka <kafka-configuration-file>
   ```

   Copy the **metricsConfig** property and the **ConfigMap** it references to your **Kafka** resource.

   Example metrics configuration for Kafka

   ```
   apiVersion: kafka.strimzi.io/v1beta2
   kind: Kafka
   metadata:
     name: my-cluster
   spec:
     kafka:
       # ...
       metricsConfig: 1
         type: jmxPrometheusExporter
         valueFrom:
           configMapKeyRef:
             name: my-config-map
             key: my-key
   ---
   kind: ConfigMap 2
   apiVersion: v1
   metadata:
     name: kafka-metrics
     labels:
       app: strimzi
   data:
     kafka-metrics-config.yml: |
     # metrics configuration...
   ```

1. Copy the **metricsConfig** property that references the ConfigMap that contains metrics configuration.
2. Copy the whole **ConfigMap** that specifies the metrics configuration.

NOTE

For Kafka Bridge, you specify the **enableMetrics** property and set it to **true**.

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaBridge
metadata:
  name: my-bridge
spec:
  # ...
  bootstrapServers: my-cluster-kafka:9092
  http:
    # ...
  enableMetrics: true
  # ...
```

2. To deploy Kafka Exporter, add **kafkaExporter** configuration. **kafkaExporter** configuration is only specified in the **Kafka** resource.

Example configuration for deploying Kafka Exporter

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
spec:
  # ...
  kafkaExporter:
    image: my-registry.io/my-org/my-exporter-cluster:latest 1
    groupRegex: ".*" 2
    topicRegex: ".*" 3
    resources: 4
      requests:
        cpu: 200m
        memory: 64Mi
      limits:
        cpu: 500m
        memory: 128Mi
    logging: debug 5
    enableSaramaLogging: true 6
    template: 7
      pod:
        metadata:
          labels:
            label1: value1
        imagePullSecrets:
          - name: my-docker-credentials
```

```
      securityContext:
        runAsUser: 1000001
        fsGroup: 0
      terminationGracePeriodSeconds: 120
    readinessProbe: 8
      initialDelaySeconds: 15
      timeoutSeconds: 5
    livenessProbe: 9
      initialDelaySeconds: 15
      timeoutSeconds: 5
# ...
```

1. ADVANCED OPTION: Container image configuration, which is recommended only in special situations.
2. A regular expression to specify the consumer groups to include in the metrics.
3. A regular expression to specify the topics to include in the metrics.
4. CPU and memory resources to reserve .
5. Logging configuration, to log messages with a given severity (debug, info, warn, error, fatal) or above.
6. Boolean to enable Sarama logging, a Go client library used by Kafka Exporter.
7. Customization of deployment templates and pods.
8. Healthcheck readiness probes.
9. Healthcheck liveness probes.

Additional resources

- **KafkaExporterTemplate** schema reference
- **metricsConfig** schema reference

8.5. VIEWING KAFKA METRICS AND DASHBOARDS IN OPENSHIFT

When AMQ Streams is deployed to OpenShift Container Platform, metrics are provided through *monitoring for user-defined projects*. This OpenShift feature gives developers access to a separate Prometheus instance for monitoring their own projects (for example, a **Kafka** project).

If monitoring for user-defined projects is enabled, the **openshift-user-workload-monitoring** project contains the following components:

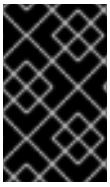
- A Prometheus Operator
- A Prometheus instance (automatically deployed by the Prometheus Operator)
- A Thanos Ruler instance

AMQ Streams uses these components to consume metrics.

A cluster administrator must enable monitoring for user-defined projects and then grant developers and other users permission to monitor applications within their own projects.

Grafana deployment

You can deploy a Grafana instance to the project containing your Kafka cluster. The example Grafana dashboards can then be used to visualize Prometheus metrics for AMQ Streams in the Grafana user interface.



IMPORTANT

The **openshift-monitoring** project provides monitoring for core platform components. Do *not* use the Prometheus and Grafana components in this project to configure monitoring for AMQ Streams on OpenShift Container Platform 4.x.

Procedure outline

To set up AMQ Streams monitoring in OpenShift Container Platform, follow these procedures in order:

1. Prerequisite: Deploy the Prometheus metrics configuration
2. Deploy the Prometheus resources
3. Create a service account for Grafana
4. Deploy Grafana with a Prometheus datasource
5. Create a Route to the Grafana Service
6. Import the example Grafana dashboards

8.5.1. Prerequisites

- You have deployed the Prometheus metrics configuration using the example YAML files.
- *Monitoring for user-defined projects* is enabled. A cluster administrator has created a **cluster-monitoring-config** config map in your OpenShift cluster.
- A cluster administrator has assigned you a **monitoring-rules-edit** or **monitoring-edit** role.

For more information on creating a **cluster-monitoring-config** config map and granting users permission to monitor user-defined projects, see OpenShift Container Platform Monitoring.

8.5.2. Additional resources

- OpenShift Container Platform Monitoring

8.5.3. Deploying the Prometheus resources

Use Prometheus to obtain monitoring data in your Kafka cluster.

You can use your own Prometheus deployment or deploy Prometheus using the example metrics configuration files provided by AMQ Streams. To use the example files, you configure and deploy the **PodMonitor** resources. The **PodMonitors** scrape data directly from pods for Apache Kafka, ZooKeeper, Operators, the Kafka Bridge, and Cruise Control.

Then, you deploy the example alerting rules for Alertmanager.

Prerequisites

- A running Kafka cluster.
- Check the example alerting rules provided with AMQ Streams.

Procedure

1. Check that monitoring for user-defined projects is enabled:

```
oc get pods -n openshift-user-workload-monitoring
```

If enabled, pods for the monitoring components are returned. For example:

```
NAME                                  READY   STATUS    RESTARTS   AGE
prometheus-operator-5cc59f9bc6-kgcq8   1/1     Running   0          25s
prometheus-user-workload-0             5/5     Running   1          14s
prometheus-user-workload-1             5/5     Running   1          14s
thanos-ruler-user-workload-0           3/3     Running   0          14s
thanos-ruler-user-workload-1           3/3     Running   0          14s
```

If no pods are returned, monitoring for user-defined projects is disabled. See the Prerequisites in Section 8.5, "Viewing Kafka metrics and dashboards in OpenShift" .

2. Multiple **PodMonitor** resources are defined in **examples/metrics/prometheus-install/strimzi-pod-monitor.yaml**.
For each **PodMonitor** resource, edit the **spec.namespaceSelector.matchNames** property:

```
apiVersion: monitoring.coreos.com/v1
kind: PodMonitor
metadata:
  name: cluster-operator-metrics
  labels:
    app: strimzi
spec:
  selector:
    matchLabels:
      strimzi.io/kind: cluster-operator
  namespaceSelector:
    matchNames:
      - <project-name> 1
  podMetricsEndpoints:
  - path: /metrics
    port: http
# ...
```

1 The project where the pods to scrape the metrics from are running, for example, **Kafka**.

3. Deploy the **strimzi-pod-monitor.yaml** file to the project where your Kafka cluster is running:

```
oc apply -f strimzi-pod-monitor.yaml -n MY-PROJECT
```

4. Deploy the example Prometheus rules to the same project:

```
oc apply -f prometheus-rules.yaml -n MY-PROJECT
```

8.5.4. Creating a service account for Grafana

A Grafana instance for AMQ Streams needs to run with a service account that is assigned the **cluster-monitoring-view** role.

Create a service account if you are using Grafana to present metrics for monitoring.

Prerequisites

- Deploy the Prometheus resources

Procedure

1. Create a **ServiceAccount** for Grafana. Here the resource is named **grafana-serviceaccount**.

```
apiVersion: v1
kind: ServiceAccount
metadata:
  name: grafana-serviceaccount
  labels:
    app: strimzi
```

2. Deploy the **ServiceAccount** to the project containing your Kafka cluster:

```
oc apply -f GRAFANA-SERVICEACCOUNT -n MY-PROJECT
```

3. Create a **ClusterRoleBinding** resource that assigns the **cluster-monitoring-view** role to the Grafana **ServiceAccount**. Here the resource is named **grafana-cluster-monitoring-binding**.

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  name: grafana-cluster-monitoring-binding
  labels:
    app: strimzi
subjects:
  - kind: ServiceAccount
    name: grafana-serviceaccount
    namespace: <my-project> 1
roleRef:
  kind: ClusterRole
  name: cluster-monitoring-view
  apiGroup: rbac.authorization.k8s.io
```

1 Name of your project.

4. Deploy the **ClusterRoleBinding** to the project containing your Kafka cluster:

```
oc apply -f <grafana-cluster-monitoring-binding> -n <my-project>
```

8.5.5. Deploying Grafana with a Prometheus datasource

Deploy Grafana to present Prometheus metrics. A Grafana application requires configuration for the OpenShift Container Platform monitoring stack.

OpenShift Container Platform includes a *Thanos Querier* instance in the **openshift-monitoring** project. Thanos Querier is used to aggregate platform metrics.

To consume the required platform metrics, your Grafana instance requires a Prometheus data source that can connect to Thanos Querier. To configure this connection, you create a config map that authenticates, by using a token, to the **oauth-proxy** sidecar that runs alongside Thanos Querier. A **datasource.yaml** file is used as the source of the config map.

Finally, you deploy the Grafana application with the config map mounted as a volume to the project containing your Kafka cluster.

Prerequisites

- Deploy the Prometheus resources
- Create a service account for Grafana

Procedure

1. Get the access token of the Grafana **ServiceAccount**:

```
oc serviceaccounts get-token grafana-serviceaccount -n MY-PROJECT
```

   Copy the access token to use in the next step.

2. Create a **datasource.yaml** file containing the Thanos Querier configuration for Grafana. Paste the access token into the **httpHeaderValue1** property as indicated.

```
apiVersion: 1

datasources:
- name: Prometheus
  type: prometheus
  url: https://thanos-querier.openshift-monitoring.svc.cluster.local:9091
  access: proxy
  basicAuth: false
  withCredentials: false
  isDefault: true
  jsonData:
    timeInterval: 5s
    tlsSkipVerify: true
    httpHeaderName1: "Authorization"
  secureJsonData:
    httpHeaderValue1: "Bearer ${GRAFANA-ACCESS-TOKEN}" (1)
  editable: true
```

(1) ***GRAFANA-ACCESS-TOKEN***: The value of the access token for the Grafana **ServiceAccount**.

3. Create a config map named **grafana-config** from the **datasource.yaml** file:

```
oc create configmap grafana-config --from-file=datasource.yaml -n MY-PROJECT
```

4. Create a Grafana application consisting of a **Deployment** and a **Service**.
The **grafana-config** config map is mounted as a volume for the datasource configuration.

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: grafana
  labels:
    app: strimzi
spec:
  replicas: 1
  selector:
    matchLabels:
      name: grafana
  template:
    metadata:
      labels:
        name: grafana
    spec:
      serviceAccountName: grafana-serviceaccount
      containers:
      - name: grafana
        image: grafana/grafana:7.5.15
        ports:
        - name: grafana
          containerPort: 3000
          protocol: TCP
        volumeMounts:
        - name: grafana-data
          mountPath: /var/lib/grafana
        - name: grafana-logs
          mountPath: /var/log/grafana
        - name: grafana-config
          mountPath: /etc/grafana/provisioning/datasources/datasource.yaml
          readOnly: true
          subPath: datasource.yaml
        readinessProbe:
          httpGet:
            path: /api/health
            port: 3000
          initialDelaySeconds: 5
          periodSeconds: 10
        livenessProbe:
          httpGet:
            path: /api/health
            port: 3000
          initialDelaySeconds: 15
          periodSeconds: 20
      volumes:
      - name: grafana-data
        emptyDir: {}
```

```
      - name: grafana-logs
        emptyDir: {}
      - name: grafana-config
        configMap:
          name: grafana-config
---
apiVersion: v1
kind: Service
metadata:
  name: grafana
  labels:
    app: strimzi
spec:
  ports:
  - name: grafana
    port: 3000
    targetPort: 3000
    protocol: TCP
  selector:
    name: grafana
  type: ClusterIP
```

5. Deploy the Grafana application to the project containing your Kafka cluster:

```
oc apply -f <grafana-application> -n <my-project>
```

8.5.6. Creating a route to the Grafana Service

You can access the Grafana user interface through a Route that exposes the Grafana service.

Prerequisites

- Deploy the Prometheus resources
- Create a service account for Grafana
- Deploy Grafana with a Prometheus datasource

Procedure

- Create an edge route to the **grafana** service:

```
oc create route edge <my-grafana-route> --service=grafana --namespace=KAFKA-NAMESPACE
```

8.5.7. Importing the example Grafana dashboards

Use Grafana to provide visualizations of Prometheus metrics on customizable dashboards.

AMQ Streams provides example dashboard configuration files for Grafana in JSON format.

- **examples/metrics/grafana-dashboards**

This procedure uses the example Grafana dashboards.

The example dashboards are a good starting point for monitoring key metrics, but they don't show all the metrics supported by Kafka. You can modify the example dashboards or add other metrics, depending on your infrastructure.

Prerequisites

- Deploy the Prometheus resources
- Create a service account for Grafana
- Deploy Grafana with a Prometheus datasource
- Create a Route to the Grafana Service

Procedure

1. Get the details of the Route to the Grafana Service. For example:

```
oc get routes

NAME              HOST/PORT                        PATH  SERVICES
MY-GRAFANA-ROUTE  MY-GRAFANA-ROUTE-amq-streams.net        grafana
```

2. In a web browser, access the Grafana login screen using the URL for the Route host and port.
3. Enter your user name and password, and then click **Log In**.
   The default Grafana user name and password are both **admin**. After logging in for the first time, you can change the password.
4. In **Configuration > Data Sources**, check that the **Prometheus** data source was created. The data source was created in Section 8.5.5, "Deploying Grafana with a Prometheus datasource" .
5. Click the **+** icon and then click **Import**.
6. In **examples/metrics/grafana-dashboards**, copy the JSON of the dashboard to import.
7. Paste the JSON into the text box, and then click **Load**.
8. Repeat steps 5-7 for the other example Grafana dashboards.

The imported Grafana dashboards are available to view from the **Dashboards** home page.

CHAPTER 9. UPGRADING AMQ STREAMS

AMQ Streams can be upgraded to version 2.2 to take advantage of new features and enhancements, performance improvements, and security options.

As part of the upgrade, you upgrade Kafka to the latest supported version. Each Kafka release introduces new features, improvements, and bug fixes to your AMQ Streams deployment.

AMQ Streams can be downgraded to the previous version if you encounter issues with the newer version.

Released versions of AMQ Streams are available from the AMQ Streams software downloads page .

Downtime and availability

If topics are configured for high availability, upgrading AMQ Streams should not cause any downtime for consumers and producers that publish and read data from those topics. Highly available topics have a replication factor of at least 3 and partitions distributed evenly among the brokers.

Upgrading AMQ Streams triggers rolling updates, where all brokers are restarted in turn, at different stages of the process. During rolling updates, not all brokers are online, so overall *cluster availability* is temporarily reduced. A reduction in cluster availability increases the chance that a broker failure will result in lost messages.

9.1. AMQ STREAMS UPGRADE PATHS

Two upgrade paths are possible.

Incremental upgrade

Upgrading AMQ Streams from the previous minor version to version 2.2.

Multi-version upgrade

Upgrading AMQ Streams from an old version to version 2.2 within a single upgrade (skipping one or more intermediate versions).
For example, upgrading from AMQ Streams 1.8 directly to AMQ Streams 2.2.

9.1.1. Supported Kafka versions

Decide which Kafka version to upgrade to before starting the AMQ Streams upgrade process. You can review supported Kafka versions in the AMQ Streams Supported Configurations .

- Kafka 3.2.3 is supported for production use.
- Kafka 3.1.0 is supported only for the purpose of upgrading to AMQ Streams 2.2.

You can only use a Kafka version supported by the version of AMQ Streams you are using. You can upgrade to a higher Kafka version as long as it is supported by your version of AMQ Streams. In some cases, you can also downgrade to a previous supported Kafka version.

9.1.2. Upgrading from an AMQ Streams version earlier than 1.7

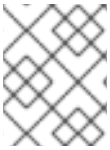
When upgrading AMQ Streams to 2.2 from 1.7 or earlier, you must ensure that your custom resources are using API version **v1beta2**. You must upgrade the Custom Resource Definitions and the custom resources **before** upgrading to AMQ Streams 1.8 or newer. To perform the upgrade, you can use the *API*

conversion tool provided with AMQ Streams 1.7. For more information, see the AMQ Streams 1.7 upgrade documentation.

The **v1beta2** API version for all custom resources was introduced with AMQ Streams 1.7. For AMQ Streams 1.8 and newer, the **v1alpha1** and **v1beta1** API versions were removed from all AMQ Streams custom resources apart from **KafkaTopic** and **KafkaUser**.

If you are upgrading from a AMQ Streams version prior to version 1.7:

1. Upgrade AMQ Streams to 1.7
2. Convert the custom resources to **v1beta2**
3. Upgrade AMQ Streams to 1.8 or newer



NOTE

As an alternative, you can install the custom resources from version 1.7, convert the resources, and then upgrade to 1.8 or newer.

9.2. REQUIRED UPGRADE SEQUENCE

To upgrade brokers and clients without downtime, you *must* complete the AMQ Streams upgrade procedures in the following order:

1. Make sure your OpenShift cluster version is supported.
   AMQ Streams 2.2 is supported by OpenShift 4.8 to 4.11.

   You can upgrade OpenShift with minimal downtime .
2. When upgrading AMQ Streams from 1.7 or earlier, update existing custom resources to support the **v1beta2** API version.
3. Update your Cluster Operator to a new AMQ Streams version.
4. Upgrade all Kafka brokers and client applications to the latest supported Kafka version.
5. Optional: Upgrade consumers and Kafka Streams applications to use the *incremental cooperative rebalance* protocol for partition rebalances.

9.3. UPGRADING OPENSHIFT WITH MINIMAL DOWNTIME

If you are upgrading OpenShift, refer to the OpenShift upgrade documentation to check the upgrade path and the steps to upgrade your nodes correctly. Before upgrading OpenShift, check the supported versions for your version of AMQ Streams.

When performing your upgrade, you'll want to keep your Kafka clusters available.

You can employ one of the following strategies:

1. Configuring pod disruption budgets
2. Rolling pods by one of these methods:
   a. Using the AMQ Streams Drain Cleaner

b. Manually by applying an annotation to your pod

You have to configure the pod disruption budget before using one of the methods to roll your pods.

For Kafka to stay operational, topics must also be replicated for high availability. This requires topic configuration that specifies a replication factor of at least 3 and a minimum number of in-sync replicas to 1 less than the replication factor.

Kafka topic replicated for high availability

```
apiVersion: kafka.strimzi.io/v1beta2
kind: KafkaTopic
metadata:
  name: my-topic
  labels:
    strimzi.io/cluster: my-cluster
spec:
  partitions: 1
  replicas: 3
  config:
    # ...
    min.insync.replicas: 2
    # ...
```

In a highly available environment, the Cluster Operator maintains a minimum number of in-sync replicas for topics during the upgrade process so that there is no downtime.

9.3.1. Rolling pods using the AMQ Streams Drain Cleaner

You can use the AMQ Streams Drain Cleaner tool to evict nodes during an upgrade. The AMQ Streams Drain Cleaner annotates pods with a rolling update pod annotation. This informs the Cluster Operator to perform a rolling update of an evicted pod.

A pod disruption budget allows only a specified number of pods to be unavailable at a given time. During planned maintenance of Kafka broker pods, a pod disruption budget ensures Kafka continues to run in a highly available environment.

You specify a pod disruption budget using a **template** customization for a Kafka component. By default, pod disruption budgets allow only a single pod to be unavailable at a given time.

To do this, you set **maxUnavailable** to **0** (zero). Reducing the maximum pod disruption budget to zero prevents voluntary disruptions, so pods must be evicted manually.

Specifying a pod disruption budget

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
metadata:
  name: my-cluster
  namespace: myproject
spec:
  kafka:
    # ...
    template:
```

```
    podDisruptionBudget:
      maxUnavailable: 0
# ...
```

9.3.2. Rolling pods manually while keeping topics available

During an upgrade, you can trigger a manual rolling update of pods through the Cluster Operator. Using **Pod** resources, rolling updates restart the pods of resources with new pods. As with using the AMQ Streams Drain Cleaner, you'll need to set the **maxUnavailable** value to zero for the pod disruption budget.

You need to watch the pods that need to be drained. You then add a pod annotation to make the update.

Here, the annotation updates a Kafka broker.

Performing a manual rolling update on a Kafka broker pod

```
oc annotate pod <cluster_name>-kafka-<index> strimzi.io/manual-rolling-update=true
```

You replace *<cluster_name>* with the name of the cluster. Kafka broker pods are named *<cluster-name>*-kafka-*<index>*, where *<index>* starts at zero and ends at the total number of replicas minus one. For example, **my-cluster-kafka-0**.

Additional resources

- OpenShift documentation
- Draining pods using the AMQ Streams Drain Cleaner
- Replicating topics for high availability
- PodDisruptionBudgetTemplate schema reference
- Performing a rolling update using a pod annotation

9.4. UPGRADING THE CLUSTER OPERATOR

Use the same method to upgrade the Cluster Operator as the initial method of deployment.

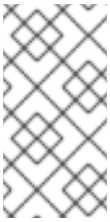
Using installation files

If you deployed the Cluster Operator using the installation YAML files, perform your upgrade by modifying the Operator installation files, as described in Upgrading the Cluster Operator using installation files.

Using the OperatorHub

If you deployed AMQ Streams from the OperatorHub, use the Operator Lifecycle Manager (OLM) to change the update channel for the AMQ Streams operators to a new AMQ Streams version. Updating the channel starts one of the following types of upgrade, depending on your chosen upgrade strategy:

- An automatic upgrade is initiated
- A manual upgrade that requires approval before installation begins



NOTE

If you subscribe to the *stable* channel, you can get automatic updates without changing channels. However, enabling automatic updates is not recommended because of the potential for missing any pre-installation upgrade steps. Use automatic upgrades only on version-specific channels.

For more information on using the OperatorHub to upgrade Operators, see Upgrading installed Operators (OpenShift documentation).

9.4.1. Upgrading the Cluster Operator returns Kafka version error

If you upgrade the Cluster Operator and get an *unsupported Kafka version* error, your Kafka cluster deployment has an older Kafka version that is not supported by the new operator version. This error applies to all installation methods.

If this error occurs, upgrade Kafka to a supported Kafka version. Change the **spec.kafka.version** in the **Kafka** resource to the supported version.

You can use **oc** to check for error messages like this in the **status** of the **Kafka** resource.

Checking the Kafka status for errors

```
oc get kafka <kafka_cluster_name> -n <namespace> -o jsonpath='{.status.conditions}'
```

Replace ***<kafka_cluster_name>*** with the name of your Kafka cluster and ***<namespace>*** with the OpenShift namespace where the pod is running.

9.4.2. Upgrading from AMQ Streams 1.7 or earlier using the OperatorHub

Action required if upgrading from AMQ Streams 1.7 or earlier using the OperatorHub

The **Red Hat Integration - AMQ Streams Operator** supports **v1beta2** custom resources only. **Before** you upgrade the AMQ Streams Operator to version 2.2 in the OperatorHub, custom resources must be upgraded to **v1beta2**.

If you are upgrading from an AMQ Streams version prior to version 1.7:

1. Upgrade to AMQ Streams 1.7.
2. Download the **Red Hat AMQ Streams API Conversion Tool** provided with AMQ Streams 1.8 from the AMQ Streams software downloads page .
3. Convert custom resources and CRDs to **v1beta2**.
   For more information, see the AMQ Streams 1.7 upgrade documentation .
4. In the OperatorHub, delete version 1.7.0 of the **Red Hat Integration - AMQ Streams Operator**.
5. If it also exists, delete version 2.1.0 of the **Red Hat Integration - AMQ Streams Operator**.
   If it does not exist, go to the next step.

   If the **Approval Strategy** for the AMQ Streams Operator was set to **Automatic**, version 2.1.0 of the operator might already exist in your cluster. If you did *not* convert custom resources and CRDs to the **v1beta2** API version before release, the operator-managed custom resources and

CRDs will be using the old API version. As a result, the 2.1.0 Operator is stuck in *Pending* status. In this situation, you need to delete version 2.1.0 of the **Red Hat Integration - AMQ Streams Operator** as well as version 1.7.0.

If you delete both operators, reconciliations are paused until the new operator version is installed. Follow the next step immediately so that any changes to custom resources are not delayed.

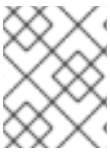
6. In the OperatorHub, install version 2.1.0 of the **Red Hat Integration - AMQ Streams Operator** immediately.
The installed 2.1.0 operator begins to watch the cluster and performs rolling updates. You might notice a temporary decrease in cluster performance during this process.

9.4.3. Upgrading the Cluster Operator using installation files

This procedure describes how to upgrade a Cluster Operator deployment to use AMQ Streams 2.2.

Follow this procedure if you deployed the Cluster Operator using the installation YAML files.

The availability of Kafka clusters managed by the Cluster Operator is not affected by the upgrade operation.



NOTE

Refer to the documentation supporting a specific version of AMQ Streams for information on how to upgrade to that version.

Prerequisites

- An existing Cluster Operator deployment is available.
- You have downloaded the release artifacts for AMQ Streams 2.2 .

Procedure

1. Take note of any configuration changes made to the existing Cluster Operator resources (in the **/install/cluster-operator** directory). Any changes will be **overwritten** by the new version of the Cluster Operator.
2. Update your custom resources to reflect the supported configuration options available for AMQ Streams version 2.2.
3. Update the Cluster Operator.
    a. Modify the installation files for the new Cluster Operator version according to the namespace the Cluster Operator is running in.
    On Linux, use:

```
sed -i 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
```

    On MacOS, use:

```
sed -i '' 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
```

b. If you modified one or more environment variables in your existing Cluster Operator **Deployment**, edit the **install/cluster-operator/060-Deployment-strimzi-cluster-operator.yaml** file to use those environment variables.

4. When you have an updated configuration, deploy it along with the rest of the installation resources:

```
oc replace -f install/cluster-operator
```

Wait for the rolling updates to complete.

5. If the new Operator version no longer supports the Kafka version you are upgrading from, the Cluster Operator returns an error message to say the version is not supported. Otherwise, no error message is returned.

- If the error message is returned, upgrade to a Kafka version that is supported by the new Cluster Operator version:

a. Edit the **Kafka** custom resource.

b. Change the **spec.kafka.version** property to a supported Kafka version.

- If the error message is *not* returned, go to the next step. You will upgrade the Kafka version later.

6. Get the image for the Kafka pod to ensure the upgrade was successful:

```
oc get pods my-cluster-kafka-0 -o jsonpath='{.spec.containers[0].image}'
```

The image tag shows the new Operator version. For example:

```
registry.redhat.io/amq7/amq-streams-kafka-32-rhel8:2.2.2
```

Your Cluster Operator was upgraded to version 2.2 but the version of Kafka running in the cluster it manages is unchanged.

Following the Cluster Operator upgrade, you must perform a Kafka upgrade.

9.5. UPGRADING KAFKA

After you have upgraded your Cluster Operator to 2.2, the next step is to upgrade all Kafka brokers to the latest supported version of Kafka.

Kafka upgrades are performed by the Cluster Operator through rolling updates of the Kafka brokers.

The Cluster Operator initiates rolling updates based on the Kafka cluster configuration.

If **Kafka.spec.kafka.config** contains...	The Cluster Operator initiates...
Both the **inter.broker.protocol.version** and the **log.message.format.version**.	A single rolling update. After the update, the **inter.broker.protocol.version** must be updated manually, followed by **log.message.format.version**. Changing each will trigger a further rolling update.

If **Kafka.spec.kafka.config** contains...	The Cluster Operator initiates...
Either the **inter.broker.protocol.version** or the **log.message.format.version**.	Two rolling updates.
No configuration for the **inter.broker.protocol.version** or the **log.message.format.version**.	Two rolling updates.

IMPORTANT

From Kafka 3.0.0, when the **inter.broker.protocol.version** is set to **3.0** or higher, the **log.message.format.version** option is ignored and doesn't need to be set. The **log.message.format.version** property for brokers and the **message.format.version** property for topics are deprecated and will be removed in a future release of Kafka.

As part of the Kafka upgrade, the Cluster Operator initiates rolling updates for ZooKeeper.

- A single rolling update occurs even if the ZooKeeper version is unchanged.
- Additional rolling updates occur if the new version of Kafka requires a new ZooKeeper version.

9.5.1. Kafka versions

Kafka's log message format version and inter-broker protocol version specify, respectively, the log format version appended to messages and the version of the Kafka protocol used in a cluster. To ensure the correct versions are used, the upgrade process involves making configuration changes to existing Kafka brokers and code changes to client applications (consumers and producers).

The following table shows the differences between Kafka versions:

Table 9.1. Kafka version differences

Kafka version	Inter-broker protocol version	Log message format version	ZooKeeper version
3.2.3	3.2	3.2	3.6.3
3.1.0	3.1	3.1	3.6.3

Inter-broker protocol version

In Kafka, the network protocol used for inter-broker communication is called the *inter-broker protocol*. Each version of Kafka has a compatible version of the inter-broker protocol. The minor version of the protocol typically increases to match the minor version of Kafka, as shown in the preceding table.

The inter-broker protocol version is set cluster wide in the **Kafka** resource. To change it, you edit the **inter.broker.protocol.version** property in **Kafka.spec.kafka.config**.

Log message format version

When a producer sends a message to a Kafka broker, the message is encoded using a specific format. The format can change between Kafka releases, so messages specify which version of the message format they were encoded with.

The properties used to set a specific message format version are as follows:

- **message.format.version** property for topics
- **log.message.format.version** property for Kafka brokers

From Kafka 3.0.0, the message format version values are assumed to match the **inter.broker.protocol.version** and don't need to be set. The values reflect the Kafka version used.

When upgrading to Kafka 3.0.0 or higher, you can remove these settings when you update the **inter.broker.protocol.version**. Otherwise, set the message format version based on the Kafka version you are upgrading to.

The default value of **message.format.version** for a topic is defined by the **log.message.format.version** that is set on the Kafka broker. You can manually set the **message.format.version** of a topic by modifying its topic configuration.

9.5.2. Strategies for upgrading clients

The right approach to upgrading your client applications (including Kafka Connect connectors) depends on your particular circumstances.

Consuming applications need to receive messages in a message format that they understand. You can ensure that this is the case in one of two ways:

- By upgrading all the consumers for a topic *before* upgrading any of the producers.
- By having the brokers down-convert messages to an older format.

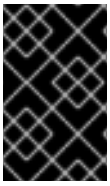
Using broker down-conversion puts extra load on the brokers, so it is not ideal to rely on down-conversion for all topics for a prolonged period of time. For brokers to perform optimally they should not be down converting messages at all.

Broker down-conversion is configured in two ways:

- The topic-level **message.format.version** configures it for a single topic.
- The broker-level **log.message.format.version** is the default for topics that do not have the topic-level **message.format.version** configured.

Messages published to a topic in a new-version format will be visible to consumers, because brokers perform down-conversion when they receive messages from producers, not when they are sent to consumers.

Common strategies you can use to upgrade your clients are described as follows. Other strategies for upgrading client applications are also possible.



IMPORTANT

The steps outlined in each strategy change slightly when upgrading to Kafka 3.0.0 or later. From Kafka 3.0.0, the message format version values are assumed to match the **inter.broker.protocol.version** and don't need to be set.

Broker-level consumers first strategy

1. Upgrade all the consuming applications.
2. Change the broker-level **log.message.format.version** to the new version.
3. Upgrade all the producing applications.

This strategy is straightforward, and avoids any broker down-conversion. However, it assumes that all consumers in your organization can be upgraded in a coordinated way, and it does not work for applications that are both consumers and producers. There is also a risk that, if there is a problem with the upgraded clients, new-format messages might get added to the message log so that you cannot revert to the previous consumer version.

Topic-level consumers first strategy

For each topic:

1. Upgrade all the consuming applications.
2. Change the topic-level **message.format.version** to the new version.
3. Upgrade all the producing applications.

This strategy avoids any broker down-conversion, and means you can proceed on a topic-by-topic basis. It does not work for applications that are both consumers and producers of the same topic. Again, it has the risk that, if there is a problem with the upgraded clients, new-format messages might get added to the message log.

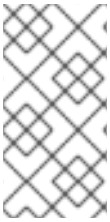
Topic-level consumers first strategy with down conversion

For each topic:

1. Change the topic-level **message.format.version** to the old version (or rely on the topic defaulting to the broker-level **log.message.format.version**).
2. Upgrade all the consuming and producing applications.
3. Verify that the upgraded applications function correctly.
4. Change the topic-level **message.format.version** to the new version.

This strategy requires broker down-conversion, but the load on the brokers is minimized because it is only required for a single topic (or small group of topics) at a time. It also works for applications that are both consumers and producers of the same topic. This approach ensures that the upgraded producers and consumers are working correctly before you commit to using the new message format version.

The main drawback of this approach is that it can be complicated to manage in a cluster with many topics and applications.



NOTE

It is also possible to apply multiple strategies. For example, for the first few applications and topics the "per-topic consumers first, with down conversion" strategy can be used. When this has proved successful another, more efficient strategy can be considered acceptable to use instead.

9.5.3. Kafka version and image mappings

When upgrading Kafka, consider your settings for the **STRIMZI_KAFKA_IMAGES** environment variable and the **Kafka.spec.kafka.version** property.

- Each **Kafka** resource can be configured with a **Kafka.spec.kafka.version**.
- The Cluster Operator's **STRIMZI_KAFKA_IMAGES** environment variable provides a mapping between the Kafka version and the image to be used when that version is requested in a given **Kafka** resource.
  - If **Kafka.spec.kafka.image** is not configured, the default image for the given version is used.
  - If **Kafka.spec.kafka.image** is configured, the default image is overridden.

WARNING

The Cluster Operator cannot validate that an image actually contains a Kafka broker of the expected version. Take care to ensure that the given image corresponds to the given Kafka version.

9.5.4. Upgrading Kafka brokers and client applications

This procedure describes how to upgrade an AMQ Streams Kafka cluster to the latest supported Kafka version.

Compared to your current Kafka version, the new version might support a higher *log message format version* or *inter-broker protocol version*, or both. Follow the steps to upgrade these versions, if required. For more information, see Section 9.5.1, "Kafka versions".

You should also choose a strategy for upgrading clients. Kafka clients are upgraded in step 6 of this procedure.

Prerequisites

For the **Kafka** resource to be upgraded, check that:

- The Cluster Operator, which supports both versions of Kafka, is up and running.
- The **Kafka.spec.kafka.config** does *not* contain options that are not supported in the new Kafka version.

Procedure

1. Update the Kafka cluster configuration:

```
oc edit kafka my-cluster
```

2. If configured, ensure that **Kafka.spec.kafka.config** has the **log.message.format.version** and **inter.broker.protocol.version** set to the defaults for the *current* Kafka version.

For example, if upgrading from Kafka version 3.1.0 to 3.2.3:

```
kind: Kafka
spec:
  # ...
  kafka:
    version: 3.1.0
    config:
      log.message.format.version: "3.1"
      inter.broker.protocol.version: "3.1"
      # ...
```

If **log.message.format.version** and **inter.broker.protocol.version** are not configured, AMQ Streams automatically updates these versions to the current defaults after the update to the Kafka version in the next step.

NOTE

The value of **log.message.format.version** and **inter.broker.protocol.version** must be strings to prevent them from being interpreted as floating point numbers.

3. Change the **Kafka.spec.kafka.version** to specify the new Kafka version; leave the **log.message.format.version** and **inter.broker.protocol.version** at the defaults for the *current* Kafka version.

NOTE

Changing the **kafka.version** ensures that all brokers in the cluster will be upgraded to start using the new broker binaries. During this process, some brokers are using the old binaries while others have already upgraded to the new ones. Leaving the **inter.broker.protocol.version** unchanged ensures that the brokers can continue to communicate with each other throughout the upgrade.

For example, if upgrading from Kafka 3.1.0 to 3.2.3:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # ...
  kafka:
    version: 3.2.3 (1)
    config:
      log.message.format.version: "3.1" (2)
      inter.broker.protocol.version: "3.1" (3)
      # ...
```

(1) Kafka version is changed to the new version.

(2) Message format version is unchanged.

(3) Inter-broker protocol version is unchanged.

WARNING

You cannot downgrade Kafka if the **inter.broker.protocol.version** for the new Kafka version changes. The inter-broker protocol version determines the schemas used for persistent metadata stored by the broker, including messages written to **__consumer_offsets**. The downgraded cluster will not understand the messages.

4. If the image for the Kafka cluster is defined in the Kafka custom resource, in **Kafka.spec.kafka.image**, update the **image** to point to a container image with the new Kafka version.
   See Kafka version and image mappings

5. Save and exit the editor, then wait for rolling updates to complete.
   Check the progress of the rolling updates by watching the pod state transitions:

   ```
   oc get pods my-cluster-kafka-0 -o jsonpath='{.spec.containers[0].image}'
   ```

   The rolling updates ensure that each pod is using the broker binaries for the new version of Kafka.

6. Depending on your chosen strategy for upgrading clients, upgrade all client applications to use the new version of the client binaries.
   If required, set the **version** property for Kafka Connect and MirrorMaker as the new version of Kafka:

   a. For Kafka Connect, update **KafkaConnect.spec.version**.

   b. For MirrorMaker, update **KafkaMirrorMaker.spec.version**.

   c. For MirrorMaker 2.0, update **KafkaMirrorMaker2.spec.version**.

7. If configured, update the Kafka resource to use the new **inter.broker.protocol.version** version.
   Otherwise, go to step 9.
   For example, if upgrading to Kafka 3.2.3:

   ```
   apiVersion: kafka.strimzi.io/v1beta2
   kind: Kafka
   spec:
     # ...
     kafka:
       version: 3.2.3
       config:
         log.message.format.version: "3.1"
         inter.broker.protocol.version: "3.2"
         # ...
   ```

8. Wait for the Cluster Operator to update the cluster.

9. If configured, update the Kafka resource to use the new **log.message.format.version** version.
   Otherwise, go to step 10.

For example, if upgrading to Kafka 3.2.3:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # ...
  kafka:
    version: 3.2.3
    config:
      log.message.format.version: "3.2"
      inter.broker.protocol.version: "3.2"
      # ...
```

IMPORTANT

From Kafka 3.0.0, when the **inter.broker.protocol.version** is set to **3.0** or higher, the **log.message.format.version** option is ignored and doesn't need to be set.

10. Wait for the Cluster Operator to update the cluster.

- The Kafka cluster and clients are now using the new Kafka version.
- The brokers are configured to send messages using the inter-broker protocol version and message format version of the new version of Kafka.

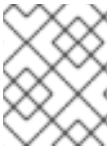
Following the Kafka upgrade, if required, you can:

- Upgrade consumers to use the incremental cooperative rebalance protocol

9.6. UPGRADING CONSUMERS TO COOPERATIVE REBALANCING

You can upgrade Kafka consumers and Kafka Streams applications to use the *incremental cooperative rebalance* protocol for partition rebalances instead of the default *eager rebalance* protocol. The new protocol was added in Kafka 2.4.0.

Consumers keep their partition assignments in a cooperative rebalance and only revoke them at the end of the process, if needed to achieve a balanced cluster. This reduces the unavailability of the consumer group or Kafka Streams application.



NOTE

Upgrading to the incremental cooperative rebalance protocol is optional. The eager rebalance protocol is still supported.

Prerequisites

- You have upgraded Kafka brokers and client applications to Kafka 3.2.3.

Procedure

To upgrade a Kafka consumer to use the incremental cooperative rebalance protocol:

1. Replace the Kafka clients **.jar** file with the new version.

2. In the consumer configuration, append **cooperative-sticky** to the **partition.assignment.strategy**. For example, if the **range** strategy is set, change the configuration to **range, cooperative-sticky**.

3. Restart each consumer in the group in turn, waiting for the consumer to rejoin the group after each restart.

4. Reconfigure each consumer in the group by removing the earlier **partition.assignment.strategy** from the consumer configuration, leaving only the **cooperative-sticky** strategy.

5. Restart each consumer in the group in turn, waiting for the consumer to rejoin the group after each restart.

To upgrade a Kafka Streams application to use the incremental cooperative rebalance protocol:

1. Replace the Kafka Streams **.jar** file with the new version.

2. In the Kafka Streams configuration, set the **upgrade.from** configuration parameter to the Kafka version you are upgrading from (for example, 2.3).

3. Restart each of the stream processors (nodes) in turn.

4. Remove the **upgrade.from** configuration parameter from the Kafka Streams configuration.

5. Restart each consumer in the group in turn.

CHAPTER 10. DOWNGRADING AMQ STREAMS

If you are encountering issues with the version of AMQ Streams you upgraded to, you can revert your installation to the previous version.

If you used the YAML installation files to install AMQ Streams, you can use the YAML installation files from the previous release to perform the following downgrade procedures:

1. Section 10.1, "Downgrading the Cluster Operator to a previous version"
2. Section 10.2, "Downgrading Kafka"

If the previous version of AMQ Streams does not support the version of Kafka you are using, you can also downgrade Kafka as long as the log message format versions appended to messages match.

WARNING

If you deployed AMQ Streams using another installation method, use a supported approach to downgrade AMQ Streams. Do not use the downgrade instructions provided here. For example, if you installed AMQ Streams using the Operator Lifecycle Manager (OLM), you can downgrade by changing the deployment channel to an earlier version of AMQ Streams.

10.1. DOWNGRADING THE CLUSTER OPERATOR TO A PREVIOUS VERSION

If you are encountering issues with AMQ Streams, you can revert your installation.

This procedure describes how to downgrade a Cluster Operator deployment to a previous version.

Prerequisites

- An existing Cluster Operator deployment is available.
- You have downloaded the installation files for the previous version .

Procedure

1. Take note of any configuration changes made to the existing Cluster Operator resources (in the **/install/cluster-operator** directory). Any changes will be **overwritten** by the previous version of the Cluster Operator.
2. Revert your custom resources to reflect the supported configuration options available for the version of AMQ Streams you are downgrading to.
3. Update the Cluster Operator.
   a. Modify the installation files for the previous version according to the namespace the Cluster Operator is running in.
   On Linux, use:

```
sed -i 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
```

On MacOS, use:

```
sed -i '' 's/namespace: .*/namespace: <my_cluster_operator_namespace>/' install/cluster-operator/*RoleBinding*.yaml
```

b. If you modified one or more environment variables in your existing Cluster Operator **Deployment**, edit the **install/cluster-operator/060-Deployment-strimzi-cluster-operator.yaml** file to use those environment variables.

4. When you have an updated configuration, deploy it along with the rest of the installation resources:

```
oc replace -f install/cluster-operator
```

Wait for the rolling updates to complete.

5. Get the image for the Kafka pod to ensure the downgrade was successful:

```
oc get pod my-cluster-kafka-0 -o jsonpath='{.spec.containers[0].image}'
```

The image tag shows the new AMQ Streams version followed by the Kafka version. For example, ***NEW-STRIMZI-VERSION*-kafka-*CURRENT-KAFKA-VERSION***.

Your Cluster Operator was downgraded to the previous version.

10.2. DOWNGRADING KAFKA

Kafka version downgrades are performed by the Cluster Operator.

10.2.1. Kafka version compatibility for downgrades

Kafka downgrades are dependent on compatible current and target Kafka versions, and the state at which messages have been logged.

You cannot revert to the previous Kafka version if that version does not support any of the **inter.broker.protocol.version** settings which have *ever been used* in that cluster, or messages have been added to message logs that use a newer **log.message.format.version**.

The **inter.broker.protocol.version** determines the schemas used for persistent metadata stored by the broker, such as the schema for messages written to **__consumer_offsets**. If you downgrade to a version of Kafka that does not understand an **inter.broker.protocol.version** that has ever been previously used in the cluster the broker will encounter data it cannot understand.

If the target downgrade version of Kafka has:

- The *same* **log.message.format.version** as the current version, the Cluster Operator downgrades by performing a single rolling restart of the brokers.
- A *different* **log.message.format.version**, downgrading is only possible if the running cluster has *always* had **log.message.format.version** set to the version used by the downgraded version. This is typically only the case if the upgrade procedure was aborted before the

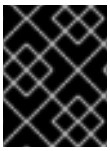
log.message.format.version was changed. In this case, the downgrade requires:

- Two rolling restarts of the brokers if the interbroker protocol of the two versions is different
- A single rolling restart if they are the same

Downgrading is *not possible* if the new version has ever used a **log.message.format.version** that is not supported by the previous version, including when the default value for **log.message.format.version** is used. For example, this resource can be downgraded to Kafka version 3.1.0 because the **log.message.format.version** has not been changed:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # ...
  kafka:
    version: 3.2.3
    config:
      log.message.format.version: "3.1"
      # ...
```

The downgrade would not be possible if the **log.message.format.version** was set at **"3.2"** or a value was absent, so that the parameter took the default value for a 3.2.3 broker of 3.2.



IMPORTANT

From Kafka 3.0.0, when the **inter.broker.protocol.version** is set to **3.0** or higher, the **log.message.format.version** option is ignored and doesn't need to be set.

10.2.2. Downgrading Kafka brokers and client applications

This procedure describes how you can downgrade an AMQ Streams Kafka cluster to a lower (previous) version of Kafka, such as downgrading from 3.2.3 to 3.1.0.

Prerequisites

Before you downgrade the AMQ Streams Kafka cluster, check the following for the **Kafka** resource:

- IMPORTANT: Compatibility of Kafka versions.
- The Cluster Operator, which supports both versions of Kafka, is up and running.
- The **Kafka.spec.kafka.config** does not contain options that are not supported by the Kafka version being downgraded to.
- The **Kafka.spec.kafka.config** has a **log.message.format.version** and **inter.broker.protocol.version** that is supported by the Kafka version being downgraded to. From Kafka 3.0.0, when the **inter.broker.protocol.version** is set to **3.0** or higher, the **log.message.format.version** option is ignored and doesn't need to be set.

Procedure

1. Update the Kafka cluster configuration.

```
oc edit kafka KAFKA-CONFIGURATION-FILE
```

2. Change the **Kafka.spec.kafka.version** to specify the previous version.
   For example, if downgrading from Kafka 3.2.3 to 3.1.0:

```
apiVersion: kafka.strimzi.io/v1beta2
kind: Kafka
spec:
  # ...
  kafka:
    version: 3.1.0 (1)
    config:
      log.message.format.version: "3.1" (2)
      inter.broker.protocol.version: "3.1" (3)
      # ...
```

(1) Kafka version is changed to the previous version.

(2) Message format version is unchanged.

(3) Inter-broker protocol version is unchanged.

NOTE

The value of **log.message.format.version** and **inter.broker.protocol.version** must be strings to prevent them from being interpreted as floating point numbers.

3. If the image for the Kafka version is different from the image defined in **STRIMZI_KAFKA_IMAGES** for the Cluster Operator, update **Kafka.spec.kafka.image**.
   See Section 9.5.3, "Kafka version and image mappings"

4. Save and exit the editor, then wait for rolling updates to complete.
   Check the update in the logs or by watching the pod state transitions:

```
oc logs -f CLUSTER-OPERATOR-POD-NAME | grep -E "Kafka version downgrade from [0-9.]+ to [0-9.]+, phase ([0-9]+) of \1 completed"
```

```
oc get pod -w
```

   Check the Cluster Operator logs for an **INFO** level message:

```
Reconciliation #NUM(watch) Kafka(NAMESPACE/NAME): Kafka version downgrade from FROM-VERSION to TO-VERSION, phase 1 of 1 completed
```

5. Downgrade all client applications (consumers) to use the previous version of the client binaries.
   The Kafka cluster and clients are now using the previous Kafka version.

6. If you are reverting back to a version of AMQ Streams earlier than 1.7, which uses ZooKeeper for the storage of topic metadata, delete the internal topic store topics from the Kafka cluster.

```
oc run kafka-admin -ti --image=registry.redhat.io/amq7/amq-streams-kafka-32-rhel8:2.2.2 --rm=true --restart=Never -- ./bin/kafka-topics.sh --bootstrap-server localhost:9092 --topic __strimzi-topic-operator-kstreams-topic-store-changelog --delete && ./bin/kafka-topics.sh --
```

```
bootstrap-server localhost:9092 --topic __strimzi_store_topic --delete
```

Additional resources

- Topic Operator topic store

CHAPTER 11. UNINSTALLING AMQ STREAMS

You can uninstall AMQ Streams on OpenShift 4.8 to 4.11 from the OperatorHub using the OpenShift Container Platform web console or CLI.

Use the same approach you used to install AMQ Streams.

When you uninstall AMQ Streams, you will need to identify resources created specifically for a deployment and referenced from the AMQ Streams resource.

Such resources include:

- Secrets (Custom CAs and certificates, Kafka Connect secrets, and other Kafka secrets)
- Logging **ConfigMaps** (of type **external**)

These are resources referenced by **Kafka**, **KafkaConnect**, **KafkaMirrorMaker**, or **KafkaBridge** configuration.

WARNING

Deleting **CustomResourceDefinitions** results in the garbage collection of the corresponding custom resources (**Kafka**, **KafkaConnect**, **KafkaMirrorMaker**, or **KafkaBridge**) and the resources dependent on them (Deployments, StatefulSets, and other dependent resources).

11.1. UNINSTALLING AMQ STREAMS FROM THE OPERATORHUB USING THE WEB CONSOLE

This procedure describes how to uninstall AMQ Streams from the OperatorHub and remove resources related to the deployment.

You can perform the steps from the console or use alternative CLI commands.

Prerequisites

- Access to an OpenShift Container Platform web console using an account with **cluster-admin** or **strimzi-admin** permissions.
- You have identified the resources to be deleted.
  You can use the following **oc** CLI command to find resources and also verify that they have been removed when you have uninstalled AMQ Streams.

  Command to find resources related to an AMQ Streams deployment

  ```
  oc get <resource_type> --all-namespaces | grep <kafka_cluster_name>
  ```

  Replace *<resource_type>* with the type of the resource you are checking, such as **secret** or **configmap**.

Procedure

1. Navigate in the OpenShift web console to **Operators > Installed Operators**.
2. For the installed **Red Hat Integration - AMQ Streams**operator, select the options icon (three vertical dots) and click **Uninstall Operator**.
   The operator is removed from **Installed Operators**.
3. Navigate to **Home** > **Projects** and select the project where you installed AMQ Streams and the Kafka components.
4. Click the options under **Inventory** to delete related resources.
   Resources include the following:
   - Deployments
   - StatefulSets
   - Pods
   - Services
   - ConfigMaps
   - Secrets

   TIP

   Use the search to find related resources that begin with the name of the Kafka cluster. You can also find the resources under **Workloads**.

Alternative CLI commands

You can use CLI commands to uninstall AMQ Streams from the OperatorHub.

1. Delete the AMQ Streams subscription.

```
oc delete subscription amq-streams -n openshift-operators
```

2. Delete the cluster service version (CSV).

```
oc delete csv amqstreams.<version>  -n openshift-operators
```

3. Remove related CRDs.

```
oc get crd -l app=strimzi -o name | xargs oc delete
```

11.2. UNINSTALLING AMQ STREAMS USING THE CLI

This procedure describes how to use the **oc** command-line tool to uninstall AMQ Streams and remove resources related to the deployment.

Prerequisites

- Access to an OpenShift cluster using an account with **cluster-admin** or **strimzi-admin** permissions.
- You have identified the resources to be deleted.
  You can use the following **oc** CLI command to find resources and also verify that they have been removed when you have uninstalled AMQ Streams.

  Command to find resources related to an AMQ Streams deployment

  ```
  oc get <resource_type> --all-namespaces | grep <kafka_cluster_name>
  ```

  Replace *<resource_type>* with the type of the resource you are checking, such as **secret** or **configmap**.

Procedure

1. Delete the Cluster Operator **Deployment**, related **CustomResourceDefinitions**, and **RBAC** resources.
   Specify the installation files used to deploy the Cluster Operator.

   ```
   oc delete -f install/cluster-operator
   ```

2. Delete the resources you identified in the prerequisites.

   ```
   oc delete <resource_type> <resource_name> -n <namespace>
   ```

   Replace *<resource_type>* with the type of resource you are deleting and *<resource_name>* with the name of the resource.

   Example to delete a secret

   ```
   oc delete secret my-cluster-clients-ca -n my-project
   ```

CHAPTER 12. USING METERING ON AMQ STREAMS

You can use the Metering tool that is available on OpenShift to generate metering reports from different data sources. As a cluster administrator, you can use metering to analyze what is happening in your cluster. You can either write your own, or use predefined SQL queries to define how you want to process data from the different data sources you have available. Using Prometheus as a default data source, you can generate reports on pods, namespaces, and most other OpenShift resources.

You can also use the OpenShift Metering operator to analyze your installed AMQ Streams components to determine whether you are in compliance with your Red Hat subscription.

To use metering with AMQ Streams, you must first install and configure the Metering operator on OpenShift Container Platform.

12.1. METERING RESOURCES

Metering has many resources which can be used to manage the deployment and installation of metering, as well as the reporting functionality metering provides. Metering is managed using the following CRDs:

Table 12.1. Metering resources

Name	Description
MeteringConfig	Configures the metering stack for deployment. Contains customizations and configuration options to control each component that makes up the metering stack.
Reports	Controls what query to use, when, and how often the query should be run, and where to store the results.
ReportQueries	Contains the SQL queries used to perform analysis on the data contained within **ReportDataSources**.
ReportDataSources	Controls the data available to ReportQueries and Reports. Allows configuring access to different databases for use within metering.

12.2. METERING LABELS FOR AMQ STREAMS

The following table lists the metering labels for AMQ Streams infrastructure components and integrations.

Table 12.2. Metering Labels

Label	Possible values
com.company	**Red_Hat**
rht.prod_name	**Red_Hat_Integration**
rht.prod_ver	**2022.Q3**

Label	Possible values
rht.comp	**AMQ_Streams**
rht.comp_ver	**2.2**
rht.subcomp	Infrastructure **cluster-operator** **entity-operator** **zookeeper**
	Application **kafka-broker** **kafka-connect** **kafka-connect-build** **kafka-mirror-maker2** **kafka-mirror-maker** **cruise-control** **kafka-bridge** **kafka-exporter** **drain-cleaner**
rht.subcomp_t	**infrastructure** **application**

Examples

- Infrastructure example (where the infrastructure component is **entity-operator**)

```
com.company=Red_Hat
rht.prod_name=Red_Hat_Integration
rht.prod_ver=2022.Q3
rht.comp=AMQ_Streams
rht.comp_ver=2.2
rht.subcomp=entity-operator
rht.comp_t=infrastructure
```

- Application example (where the integration deployment name is **kafka-bridge**)

```
com.company=Red_Hat
rht.prod_name=Red_Hat_Integration
```

```
rht.prod_ver=2022.Q3
rht.comp=AMQ_Streams
rht.comp_ver=2.2
rht.subcomp=kafka-bridge
rht.comp_t=application
```

APPENDIX A. USING YOUR SUBSCRIPTION

AMQ Streams is provided through a software subscription. To manage your subscriptions, access your account at the Red Hat Customer Portal.

Accessing Your Account

1. Go to access.redhat.com.
2. If you do not already have an account, create one.
3. Log in to your account.

Activating a Subscription

1. Go to access.redhat.com.
2. Navigate to **My Subscriptions**.
3. Navigate to **Activate a subscription** and enter your 16-digit activation number.

Downloading Zip and Tar Files

To access zip or tar files, use the customer portal to find the relevant files for download. If you are using RPM packages, this step is not required.

1. Open a browser and log in to the Red Hat Customer Portal **Product Downloads** page at access.redhat.com/downloads.
2. Locate the **AMQ Streams for Apache Kafka** entries in the **INTEGRATION AND AUTOMATION** category.
3. Select the desired AMQ Streams product. The **Software Downloads** page opens.
4. Click the **Download** link for your component.

Installing packages with DNF

To install a package and all the package dependencies, use:

```
dnf install <package_name>
```

To install a previously-downloaded package from a local directory, use:

```
dnf install <path_to_download_package>
```

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