OpenShift Container Platform 4.19

Operators

Working with Operators in OpenShift Container Platform

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Legal Notice

Abstract

This document provides information for working with Operators in OpenShift Container Platform. This includes instructions for cluster administrators on how to install and manage Operators, as well as information for developers on how to create applications from installed Operators. This also contains guidance on building your own Operator using the Operator SDK.

Table of Contents

CHAPTER 1. OPERATORS OVERVIEW

Operators are among the most important components of OpenShift Container Platform. They are the preferred method of packaging, deploying, and managing services on the control plane. They can also provide advantages to applications that users run.

Operators integrate with Kubernetes APIs and CLI tools such as **kubectl** and the OpenShift CLI (**oc**). They provide the means of monitoring applications, performing health checks, managing over-the-air (OTA) updates, and ensuring that applications remain in your specified state.

Operators are designed specifically for Kubernetes-native applications to implement and automate common Day 1 operations, such as installation and configuration. Operators can also automate Day 2 operations, such as autoscaling up or down and creating backups. All of these activities are directed by a piece of software running on your cluster.

While both follow similar Operator concepts and goals, Operators in OpenShift Container Platform are managed by two different systems, depending on their purpose:

Cluster Operators

Managed by the Cluster Version Operator (CVO) and installed by default to perform cluster functions.

Optional add-on Operators

Managed by Operator Lifecycle Manager (OLM) and can be made accessible for users to run in their applications. Also known as *OLM-based Operators*.

1.1. FOR DEVELOPERS

As an Operator author, you can perform the following development tasks for OLM-based Operators:

- Install and subscribe an Operator to your namespace .
- Create an application from an installed Operator through the web console .

Additional resources

- Machine deletion lifecycle hook examples for Operator developers

1.2. FOR ADMINISTRATORS

As a cluster administrator, you can perform the following administrative tasks for OLM-based Operators:

- Manage custom catalogs.
- Allow non-cluster administrators to install Operators .
- Install an Operator from OperatorHub .
- View Operator status.
- Manage Operator conditions.
- Upgrade installed Operators.

- Delete installed Operators.
- Configure proxy support.
- Using Operator Lifecycle Manager in disconnected environments .

For information about the cluster Operators that Red Hat provides, see Cluster Operators reference.

1.3. NEXT STEPS

- What are Operators?

CHAPTER 2. UNDERSTANDING OPERATORS

2.1. WHAT ARE OPERATORS?

Conceptually, *Operators* take human operational knowledge and encode it into software that is more easily shared with consumers.

Operators are pieces of software that ease the operational complexity of running another piece of software. They act like an extension of the software vendor's engineering team, monitoring a Kubernetes environment (such as OpenShift Container Platform) and using its current state to make decisions in real time. Advanced Operators are designed to handle upgrades seamlessly, react to failures automatically, and not take shortcuts, like skipping a software backup process to save time.

More technically, Operators are a method of packaging, deploying, and managing a Kubernetes application.

A Kubernetes application is an app that is both deployed on Kubernetes and managed using the Kubernetes APIs and **kubectl** or **oc** tooling. To be able to make the most of Kubernetes, you require a set of cohesive APIs to extend in order to service and manage your apps that run on Kubernetes. Think of Operators as the runtime that manages this type of app on Kubernetes.

2.1.1. Why use Operators?

Operators provide:

- Repeatability of installation and upgrade.
- Constant health checks of every system component.
- Over-the-air (OTA) updates for OpenShift components and ISV content.
- A place to encapsulate knowledge from field engineers and spread it to all users, not just one or two.

Why deploy on Kubernetes?

Kubernetes (and by extension, OpenShift Container Platform) contains all of the primitives needed to build complex distributed systems – secret handling, load balancing, service discovery, autoscaling – that work across on-premise and cloud providers.

Why manage your app with Kubernetes APIs and kubectl tooling?

These APIs are feature rich, have clients for all platforms and plug into the cluster's access control/auditing. An Operator uses the Kubernetes extension mechanism, custom resource definitions (CRDs), so your custom object, for example **MongoDB**, looks and acts just like the built-in, native Kubernetes objects.

How do Operators compare with service brokers?

A service broker is a step towards programmatic discovery and deployment of an app. However, because it is not a long running process, it cannot execute Day 2 operations like upgrade, failover, or scaling. Customizations and parameterization of tunables are provided at install time, versus an Operator that is constantly watching the current state of your cluster. Off-cluster services are a good match for a service broker, although Operators exist for these as well.

2.1.2. Operator Framework

The Operator Framework is a family of tools and capabilities to deliver on the customer experience

described above. It is not just about writing code; testing, delivering, and updating Operators is just as important. The Operator Framework components consist of open source tools to tackle these problems:

Operator Lifecycle Manager

Operator Lifecycle Manager (OLM) controls the installation, upgrade, and role-based access control (RBAC) of Operators in a cluster. It is deployed by default in OpenShift Container Platform 4.19.

Operator Registry

The Operator Registry stores cluster service versions (CSVs) and custom resource definitions (CRDs) for creation in a cluster and stores Operator metadata about packages and channels. It runs in a Kubernetes or OpenShift cluster to provide this Operator catalog data to OLM.

OperatorHub

OperatorHub is a web console for cluster administrators to discover and select Operators to install on their cluster. It is deployed by default in OpenShift Container Platform.

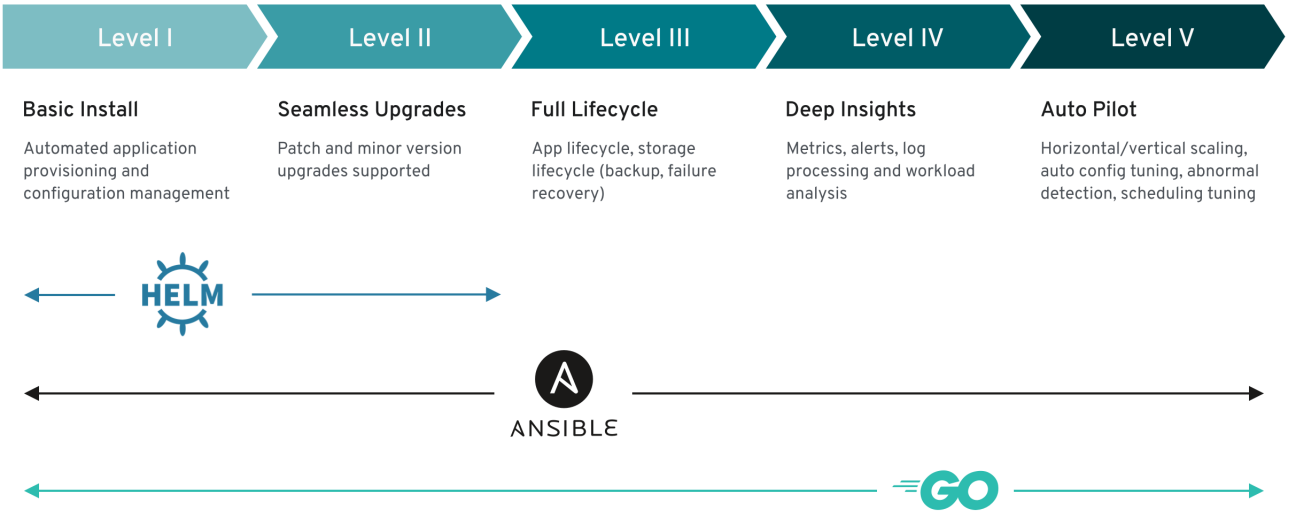
These tools are designed to be composable, so you can use any that are useful to you.

2.1.3. Operator maturity model

The level of sophistication of the management logic encapsulated within an Operator can vary. This logic is also in general highly dependent on the type of the service represented by the Operator.

One can however generalize the scale of the maturity of the encapsulated operations of an Operator for certain set of capabilities that most Operators can include. To this end, the following Operator maturity model defines five phases of maturity for generic Day 2 operations of an Operator:

Figure 2.1. Operator maturity model



2.2. OPERATOR FRAMEWORK PACKAGING FORMAT

This guide outlines the packaging format for Operators supported by Operator Lifecycle Manager (OLM) in OpenShift Container Platform.

2.2.1. Bundle format

The *bundle format* for Operators is a packaging format introduced by the Operator Framework. To improve scalability and to better enable upstream users hosting their own catalogs, the bundle format specification simplifies the distribution of Operator metadata.

An Operator bundle represents a single version of an Operator. On-disk *bundle manifests* are containerized and shipped as a *bundle image*, which is a non-runnable container image that stores the Kubernetes manifests and Operator metadata. Storage and distribution of the bundle image is then managed using existing container tools like **podman** and **docker** and container registries such as Quay.

Operator metadata can include:

- Information that identifies the Operator, for example its name and version.
- Additional information that drives the UI, for example its icon and some example custom resources (CRs).
- Required and provided APIs.
- Related images.

When loading manifests into the Operator Registry database, the following requirements are validated:

- The bundle must have at least one channel defined in the annotations.
- Every bundle has exactly one cluster service version (CSV).
- If a CSV owns a custom resource definition (CRD), that CRD must exist in the bundle.

2.2.1.1. Manifests

Bundle manifests refer to a set of Kubernetes manifests that define the deployment and RBAC model of the Operator.

A bundle includes one CSV per directory and typically the CRDs that define the owned APIs of the CSV in its /**manifests** directory.

Example bundle format layout

```
etcd
 ├──── manifests
 │     ├──── etcdcluster.crd.yaml
 │     └──── etcdoperator.clusterserviceversion.yaml
 │     └──── secret.yaml
 │     └──── configmap.yaml
 └──── metadata
       └──── annotations.yaml
       └──── dependencies.yaml
```

2.2.1.1.1. Additionally supported objects

The following object types can also be optionally included in the /**manifests** directory of a bundle:

Supported optional object types

- **ClusterRole**

- **ClusterRoleBinding**
- **ConfigMap**
- **ConsoleCLIDownload**
- **ConsoleLink**
- **ConsoleQuickStart**
- **ConsoleYamlSample**
- **PodDisruptionBudget**
- **PriorityClass**
- **PrometheusRule**
- **Role**
- **RoleBinding**
- **Secret**
- **Service**
- **ServiceAccount**
- **ServiceMonitor**
- **VerticalPodAutoscaler**

When these optional objects are included in a bundle, Operator Lifecycle Manager (OLM) can create them from the bundle and manage their lifecycle along with the CSV:

Lifecycle for optional objects

- When the CSV is deleted, OLM deletes the optional object.
- When the CSV is upgraded:
  - If the name of the optional object is the same, OLM updates it in place.
  - If the name of the optional object has changed between versions, OLM deletes and recreates it.

2.2.1.2. Annotations

A bundle also includes an **annotations.yaml** file in its /**metadata** directory. This file defines higher level aggregate data that helps describe the format and package information about how the bundle should be added into an index of bundles:

Example annotations.yaml

```
annotations:
```

```
operators.operatorframework.io.bundle.mediatype.v1: "registry+v1" (1)
operators.operatorframework.io.bundle.manifests.v1: "manifests/" (2)
operators.operatorframework.io.bundle.metadata.v1: "metadata/" (3)
operators.operatorframework.io.bundle.package.v1: "test-operator" (4)
operators.operatorframework.io.bundle.channels.v1: "beta,stable" (5)
operators.operatorframework.io.bundle.channel.default.v1: "stable" (6)
```

1. The media type or format of the Operator bundle. The **registry+v1** format means it contains a CSV and its associated Kubernetes objects.
2. The path in the image to the directory that contains the Operator manifests. This label is reserved for future use and currently defaults to **manifests**/. The value **manifests.v1** implies that the bundle contains Operator manifests.
3. The path in the image to the directory that contains metadata files about the bundle. This label is reserved for future use and currently defaults to **metadata**/. The value **metadata.v1** implies that this bundle has Operator metadata.
4. The package name of the bundle.
5. The list of channels the bundle is subscribing to when added into an Operator Registry.
6. The default channel an Operator should be subscribed to when installed from a registry.

NOTE

In case of a mismatch, the **annotations.yaml** file is authoritative because the on-cluster Operator Registry that relies on these annotations only has access to this file.

2.2.1.3. Dependencies

The dependencies of an Operator are listed in a **dependencies.yaml** file in the **metadata**/ folder of a bundle. This file is optional and currently only used to specify explicit Operator-version dependencies.

The dependency list contains a **type** field for each item to specify what kind of dependency this is. The following types of Operator dependencies are supported:

olm.package

This type indicates a dependency for a specific Operator version. The dependency information must include the package name and the version of the package in semver format. For example, you can specify an exact version such as **0.5.2** or a range of versions such as **>0.5.1**.

olm.gvk

With this type, the author can specify a dependency with group/version/kind (GVK) information, similar to existing CRD and API-based usage in a CSV. This is a path to enable Operator authors to consolidate all dependencies, API or explicit versions, to be in the same place.

olm.constraint

This type declares generic constraints on arbitrary Operator properties.

In the following example, dependencies are specified for a Prometheus Operator and etcd CRDs:

Example dependencies.yaml file

```
dependencies:
  - type: olm.package
    value:
      packageName: prometheus
      version: ">0.27.0"
  - type: olm.gvk
    value:
      group: etcd.database.coreos.com
      kind: EtcdCluster
      version: v1beta2
```

Additional resources

- Operator Lifecycle Manager dependency resolution

2.2.1.4. About the opm CLI

The **opm** CLI tool is provided by the Operator Framework for use with the Operator bundle format. This tool allows you to create and maintain catalogs of Operators from a list of Operator bundles that are similar to software repositories. The result is a container image which can be stored in a container registry and then installed on a cluster.

A catalog contains a database of pointers to Operator manifest content that can be queried through an included API that is served when the container image is run. On OpenShift Container Platform, Operator Lifecycle Manager (OLM) can reference the image in a catalog source, defined by a **CatalogSource** object, which polls the image at regular intervals to enable frequent updates to installed Operators on the cluster.

- See CLI tools for steps on installing the **opm** CLI.

2.2.2. Highlights

File-based catalogs are the latest iteration of the catalog format in Operator Lifecycle Manager (OLM). It is a plain text-based (JSON or YAML) and declarative config evolution of the earlier SQLite database format, and it is fully backwards compatible. The goal of this format is to enable Operator catalog editing, composability, and extensibility.

Editing

With file-based catalogs, users interacting with the contents of a catalog are able to make direct changes to the format and verify that their changes are valid. Because this format is plain text JSON or YAML, catalog maintainers can easily manipulate catalog metadata by hand or with widely known and supported JSON or YAML tooling, such as the **jq** CLI.

This editability enables the following features and user-defined extensions:

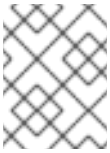
- Promoting an existing bundle to a new channel
- Changing the default channel of a package
- Custom algorithms for adding, updating, and removing upgrade paths

Composability

File-based catalogs are stored in an arbitrary directory hierarchy, which enables catalog composition. For example, consider two separate file-based catalog directories: **catalogA** and **catalogB**. A catalog maintainer can create a new combined catalog by making a new directory **catalogC** and copying

catalogA and **catalogB** into it.

This composability enables decentralized catalogs. The format permits Operator authors to maintain Operator-specific catalogs, and it permits maintainers to trivially build a catalog composed of individual Operator catalogs. File-based catalogs can be composed by combining multiple other catalogs, by extracting subsets of one catalog, or a combination of both of these.



NOTE

Duplicate packages and duplicate bundles within a package are not permitted. The **opm validate** command returns an error if any duplicates are found.

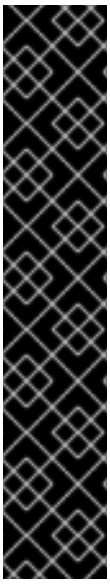
Because Operator authors are most familiar with their Operator, its dependencies, and its upgrade compatibility, they are able to maintain their own Operator-specific catalog and have direct control over its contents. With file-based catalogs, Operator authors own the task of building and maintaining their packages in a catalog. Composite catalog maintainers, however, only own the task of curating the packages in their catalog and publishing the catalog to users.

Extensibility

The file-based catalog specification is a low-level representation of a catalog. While it can be maintained directly in its low-level form, catalog maintainers can build interesting extensions on top that can be used by their own custom tooling to make any number of mutations.

For example, a tool could translate a high-level API, such as **(mode=semver)**, down to the low-level, file-based catalog format for upgrade paths. Or a catalog maintainer might need to customize all of the bundle metadata by adding a new property to bundles that meet a certain criteria.

While this extensibility allows for additional official tooling to be developed on top of the low-level APIs for future OpenShift Container Platform releases, the major benefit is that catalog maintainers have this capability as well.



IMPORTANT

As of OpenShift Container Platform 4.11, the default Red Hat-provided Operator catalog releases in the file-based catalog format. The default Red Hat-provided Operator catalogs for OpenShift Container Platform 4.6 through 4.10 released in the deprecated SQLite database format.

The **opm** subcommands, flags, and functionality related to the SQLite database format are also deprecated and will be removed in a future release. The features are still supported and must be used for catalogs that use the deprecated SQLite database format.

Many of the **opm** subcommands and flags for working with the SQLite database format, such as **opm index prune**, do not work with the file-based catalog format. For more information about working with file-based catalogs, see Managing custom catalogs and Mirroring images for a disconnected installation using the oc-mirror plugin .

2.2.2.1. Directory structure

File-based catalogs can be stored and loaded from directory-based file systems. The **opm** CLI loads the catalog by walking the root directory and recursing into subdirectories. The CLI attempts to load every file it finds and fails if any errors occur.

Non-catalog files can be ignored using **.indexignore** files, which have the same rules for patterns and precedence as **.gitignore** files.

Example .indexignore file

```
# Ignore everything except non-object .json and .yaml files
**/*
!*.json
!*.yaml
**/objects/*.json
**/objects/*.yaml
```

Catalog maintainers have the flexibility to choose their desired layout, but it is recommended to store each package's file-based catalog blobs in separate subdirectories. Each individual file can be either JSON or YAML; it is not necessary for every file in a catalog to use the same format.

Basic recommended structure

```
catalog
├── packageA
│   └── index.yaml
├── packageB
│   ├── .indexignore
│   ├── index.yaml
│   └── objects
│       └── packageB.v0.1.0.clusterserviceversion.yaml
└── packageC
    └── index.json
    └── deprecations.yaml
```

This recommended structure has the property that each subdirectory in the directory hierarchy is a self-contained catalog, which makes catalog composition, discovery, and navigation trivial file system operations. The catalog can also be included in a parent catalog by copying it into the parent catalog's root directory.

2.2.2.2. Schemas

File-based catalogs use a format, based on the CUE language specification, that can be extended with arbitrary schemas. The following **_Meta** CUE schema defines the format that all file-based catalog blobs must adhere to:

_Meta schema

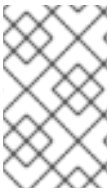
```
_Meta: {
  // schema is required and must be a non-empty string
  schema: string & !=""

  // package is optional, but if it's defined, it must be a non-empty string
  package?: string & !=""

  // properties is optional, but if it's defined, it must be a list of 0 or more properties
  properties?: [... #Property]
}
```

```
#Property: {
  // type is required
  type: string & !=""

  // value is required, and it must not be null
  value: !=null
}
```

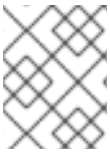


NOTE

No CUE schemas listed in this specification should be considered exhaustive. The **opm validate** command has additional validations that are difficult or impossible to express concisely in CUE.

An Operator Lifecycle Manager (OLM) catalog currently uses three schemas (**olm.package**, **olm.channel**, and **olm.bundle**), which correspond to OLM's existing package and bundle concepts.

Each Operator package in a catalog requires exactly one **olm.package** blob, at least one **olm.channel** blob, and one or more **olm.bundle** blobs.



NOTE

All **olm.*** schemas are reserved for OLM-defined schemas. Custom schemas must use a unique prefix, such as a domain that you own.

2.2.2.2.1. olm.package schema

The **olm.package** schema defines package-level metadata for an Operator. This includes its name, description, default channel, and icon.

Example 2.1. olm.package schema

```
#Package: {
  schema: "olm.package"

  // Package name
  name: string & !=""

  // A description of the package
  description?: string

  // The package's default channel
  defaultChannel: string & !=""

  // An optional icon
  icon?: {
    base64data: string
    mediatype:  string
  }
}
```

2.2.2.2.2. olm.channel schema

The **olm.channel** schema defines a channel within a package, the bundle entries that are members of the channel, and the upgrade paths for those bundles.

If a bundle entry represents an edge in multiple **olm.channel** blobs, it can only appear once per channel.

It is valid for an entry's **replaces** value to reference another bundle name that cannot be found in this catalog or another catalog. However, all other channel invariants must hold true, such as a channel not having multiple heads.

Example 2.2. olm.channel schema

```
#Channel: {
  schema: "olm.channel"
  package: string & !=""
  name: string & !=""
  entries: [...#ChannelEntry]
}

#ChannelEntry: {
  // name is required. It is the name of an `olm.bundle` that
  // is present in the channel.
  name: string & !=""

  // replaces is optional. It is the name of bundle that is replaced
  // by this entry. It does not have to be present in the entry list.
  replaces?: string & !=""

  // skips is optional. It is a list of bundle names that are skipped by
  // this entry. The skipped bundles do not have to be present in the
  // entry list.
  skips?: [...string & !=""]

  // skipRange is optional. It is the semver range of bundle versions
  // that are skipped by this entry.
  skipRange?: string & !=""
}
```

WARNING

When using the **skipRange** field, the skipped Operator versions are pruned from the update graph and are longer installable by users with the **spec.startingCSV** property of **Subscription** objects.

You can update an Operator incrementally while keeping previously installed versions available to users for future installation by using both the **skipRange** and **replaces** field. Ensure that the **replaces** field points to the immediate previous version of the Operator version in question.

2.2.2.2.3. olm.bundle schema

Example 2.3. olm.bundle schema

```
#Bundle: {
  schema: "olm.bundle"
  package: string & !=""
  name: string & !=""
  image: string & !=""
  properties: [...#Property]
  relatedImages?: [...#RelatedImage]
}

#Property: {
  // type is required
  type: string & !=""

  // value is required, and it must not be null
  value: !=null
}

#RelatedImage: {
  // image is the image reference
  image: string & !=""

  // name is an optional descriptive name for an image that
  // helps identify its purpose in the context of the bundle
  name?: string & !=""
}
```

2.2.2.2.4. olm.deprecations schema

The optional **olm.deprecations** schema defines deprecation information for packages, bundles, and channels in a catalog. Operator authors can use this schema to provide relevant messages about their Operators, such as support status and recommended upgrade paths, to users running those Operators from a catalog.

When this schema is defined, the OpenShift Container Platform web console displays warning badges for the affected elements of the Operator, including any custom deprecation messages, on both the pre- and post-installation pages of the OperatorHub.

An **olm.deprecations** schema entry contains one or more of the following **reference** types, which indicates the deprecation scope. After the Operator is installed, any specified messages can be viewed as status conditions on the related **Subscription** object.

Table 2.1. Deprecation reference types

Type	Scope	Status condition
olm.package	Represents the entire package	**PackageDeprecated**
olm.channel	Represents one channel	**ChannelDeprecated**

Type	Scope	Status condition
olm.bundle	Represents one bundle version	**BundleDeprecated**

Each **reference** type has their own requirements, as detailed in the following example.

Example 2.4. Example olm.deprecations schema with eachreference type

```
schema: olm.deprecations
package: my-operator 1
entries:
  - reference:
      schema: olm.package 2
    message: | 3
    The 'my-operator' package is end of life. Please use the
    'my-operator-new' package for support.
  - reference:
      schema: olm.channel
      name: alpha 4
    message: |
    The 'alpha' channel is no longer supported. Please switch to the
    'stable' channel.
  - reference:
      schema: olm.bundle
      name: my-operator.v1.68.0 5
    message: |
    my-operator.v1.68.0 is deprecated. Uninstall my-operator.v1.68.0 and
    install my-operator.v1.72.0 for support.
```

1. Each deprecation schema must have a **package** value, and that package reference must be unique across the catalog. There must not be an associated **name** field.
2. The **olm.package** schema must not include a **name** field, because it is determined by the **package** field defined earlier in the schema.
3. All **message** fields, for any **reference** type, must be a non-zero length and represented as an opaque text blob.
4. The **name** field for the **olm.channel** schema is required.
5. The **name** field for the **olm.bundle** schema is required.

NOTE

The deprecation feature does not consider overlapping deprecation, for example package versus channel versus bundle.

Operator authors can save **olm.deprecations** schema entries as a **deprecations.yaml** file in the same directory as the package's **index.yaml** file:

Example directory structure for a catalog with deprecations

```
my-catalog
└── my-operator
    ├── index.yaml
    └── deprecations.yaml
```

Additional resources

- Updating or filtering a file-based catalog image

2.2.2.3. Properties

Properties are arbitrary pieces of metadata that can be attached to file-based catalog schemas. The **type** field is a string that effectively specifies the semantic and syntactic meaning of the **value** field. The value can be any arbitrary JSON or YAML.

OLM defines a handful of property types, again using the reserved **olm.*** prefix.

2.2.2.3.1. olm.package property

The **olm.package** property defines the package name and version. This is a required property on bundles, and there must be exactly one of these properties. The **packageName** field must match the bundle's first-class **package** field, and the **version** field must be a valid semantic version.

Example 2.5. olm.package property

```
#PropertyPackage: {
  type: "olm.package"
  value: {
    packageName: string & !=""
    version: string & !=""
  }
}
```

2.2.2.3.2. olm.gvk property

The **olm.gvk** property defines the group/version/kind (GVK) of a Kubernetes API that is provided by this bundle. This property is used by OLM to resolve a bundle with this property as a dependency for other bundles that list the same GVK as a required API. The GVK must adhere to Kubernetes GVK validations.

Example 2.6. olm.gvk property

```
#PropertyGVK: {
  type: "olm.gvk"
  value: {
    group: string & !=""
    version: string & !=""
    kind: string & !=""
  }
}
```

2.2.2.3.3. olm.package.required

The **olm.package.required** property defines the package name and version range of another package that this bundle requires. For every required package property a bundle lists, OLM ensures there is an Operator installed on the cluster for the listed package and in the required version range. The **versionRange** field must be a valid semantic version (semver) range.

Example 2.7. olm.package.required property

```
#PropertyPackageRequired: {
  type: "olm.package.required"
  value: {
    packageName: string & !=""
    versionRange: string & !=""
  }
}
```

2.2.2.3.4. olm.gvk.required

The **olm.gvk.required** property defines the group/version/kind (GVK) of a Kubernetes API that this bundle requires. For every required GVK property a bundle lists, OLM ensures there is an Operator installed on the cluster that provides it. The GVK must adhere to Kubernetes GVK validations.

Example 2.8. olm.gvk.required property

```
#PropertyGVKRequired: {
  type: "olm.gvk.required"
  value: {
    group: string & !=""
    version: string & !=""
    kind: string & !=""
  }
}
```

2.2.2.4. Example catalog

With file-based catalogs, catalog maintainers can focus on Operator curation and compatibility. Because Operator authors have already produced Operator-specific catalogs for their Operators, catalog maintainers can build their catalog by rendering each Operator catalog into a subdirectory of the catalog's root directory.

There are many possible ways to build a file-based catalog; the following steps outline a simple approach:

1. Maintain a single configuration file for the catalog, containing image references for each Operator in the catalog:

   Example catalog configuration file

   -

```
name: community-operators
repo: quay.io/community-operators/catalog
tag: latest
references:
- name: etcd-operator
  image: quay.io/etcd-
operator/index@sha256:5891b5b522d5df086d0ff0b110fbd9d21bb4fc7163af34d08286a2e846f
6be03
- name: prometheus-operator
  image: quay.io/prometheus-
operator/index@sha256:e258d248fda94c63753607f7c4494ee0fcbe92f1a76bfdac795c9d84101
eb317
```

2. Run a script that parses the configuration file and creates a new catalog from its references:

Example script

```
name=$(yq eval '.name' catalog.yaml)
mkdir "$name"
yq eval '.name + "/" + .references[].name' catalog.yaml | xargs mkdir
for l in $(yq e '.name as $catalog | .references[] | .image + "|" + $catalog + "/" + .name +
"/index.yaml"' catalog.yaml); do
  image=$(echo $l | cut -d'|' -f1)
  file=$(echo $l | cut -d'|' -f2)
  opm render "$image" > "$file"
done
opm generate dockerfile "$name"
indexImage=$(yq eval '.repo + ":" + .tag' catalog.yaml)
docker build -t "$indexImage" -f "$name.Dockerfile" .
docker push "$indexImage"
```

2.2.2.5. Guidelines

Consider the following guidelines when maintaining file-based catalogs.

2.2.2.5.1. Immutable bundles

The general advice with Operator Lifecycle Manager (OLM) is that bundle images and their metadata should be treated as immutable.

If a broken bundle has been pushed to a catalog, you must assume that at least one of your users has upgraded to that bundle. Based on that assumption, you must release another bundle with an upgrade path from the broken bundle to ensure users with the broken bundle installed receive an upgrade. OLM will not reinstall an installed bundle if the contents of that bundle are updated in the catalog.

However, there are some cases where a change in the catalog metadata is preferred:

- Channel promotion: If you already released a bundle and later decide that you would like to add it to another channel, you can add an entry for your bundle in another **olm.channel** blob.
- New upgrade paths: If you release a new **1.2.z** bundle version, for example **1.2.4**, but **1.3.0** is already released, you can update the catalog metadata for **1.3.0** to skip **1.2.4**.

2.2.2.5.2. Source control

Catalog metadata should be stored in source control and treated as the source of truth. Updates to catalog images should include the following steps:

1. Update the source-controlled catalog directory with a new commit.
2. Build and push the catalog image. Use a consistent tagging taxonomy, such as **:latest** or **:<target_cluster_version>**, so that users can receive updates to a catalog as they become available.

2.2.2.6. CLI usage

For instructions about creating file-based catalogs by using the **opm** CLI, see Managing custom catalogs.

For reference documentation about the **opm** CLI commands related to managing file-based catalogs, see CLI tools.

2.2.2.7. Automation

Operator authors and catalog maintainers are encouraged to automate their catalog maintenance with CI/CD workflows. Catalog maintainers can further improve on this by building GitOps automation to accomplish the following tasks:

- Check that pull request (PR) authors are permitted to make the requested changes, for example by updating their package's image reference.
- Check that the catalog updates pass the **opm validate** command.
- Check that the updated bundle or catalog image references exist, the catalog images run successfully in a cluster, and Operators from that package can be successfully installed.
- Automatically merge PRs that pass the previous checks.
- Automatically rebuild and republish the catalog image.

2.3. OPERATOR FRAMEWORK GLOSSARY OF COMMON TERMS

This topic provides a glossary of common terms related to the Operator Framework, including Operator Lifecycle Manager (OLM).

2.3.1. Bundle

In the bundle format, a *bundle* is a collection of an Operator CSV, manifests, and metadata. Together, they form a unique version of an Operator that can be installed onto the cluster.

2.3.2. Bundle image

In the bundle format, a *bundle image* is a container image that is built from Operator manifests and that contains one bundle. Bundle images are stored and distributed by Open Container Initiative (OCI) spec container registries, such as Quay.io or DockerHub.

2.3.3. Catalog source

A *catalog source* represents a store of metadata that OLM can query to discover and install Operators and their dependencies.

2.3.4. Channel

A *channel* defines a stream of updates for an Operator and is used to roll out updates for subscribers. The head points to the latest version of that channel. For example, a **stable** channel would have all stable versions of an Operator arranged from the earliest to the latest.

An Operator can have several channels, and a subscription binding to a certain channel would only look for updates in that channel.

2.3.5. Channel head

A *channel head* refers to the latest known update in a particular channel.

2.3.6. Cluster service version

A *cluster service version (CSV)* is a YAML manifest created from Operator metadata that assists OLM in running the Operator in a cluster. It is the metadata that accompanies an Operator container image, used to populate user interfaces with information such as its logo, description, and version.

It is also a source of technical information that is required to run the Operator, like the RBAC rules it requires and which custom resources (CRs) it manages or depends on.

2.3.7. Dependency

An Operator may have a *dependency* on another Operator being present in the cluster. For example, the Vault Operator has a dependency on the etcd Operator for its data persistence layer.

OLM resolves dependencies by ensuring that all specified versions of Operators and CRDs are installed on the cluster during the installation phase. This dependency is resolved by finding and installing an Operator in a catalog that satisfies the required CRD API, and is not related to packages or bundles.

2.3.8. Extension

Extensions enable cluster administrators to extend capabilities for users on their OpenShift Container Platform cluster. Extensions are managed by Operator Lifecycle Manager (OLM) v1.

The **ClusterExtension** API streamlines management of installed extensions, which includes Operators via the **registry+v1** bundle format, by consolidating user-facing APIs into a single object. Administrators and SREs can use the API to automate processes and define desired states by using GitOps principles.

2.3.9. Index image

In the bundle format, an *index image* refers to an image of a database (a database snapshot) that contains information about Operator bundles including CSVs and CRDs of all versions. This index can host a history of Operators on a cluster and be maintained by adding or removing Operators using the **opm** CLI tool.

2.3.10. Install plan

An *install plan* is a calculated list of resources to be created to automatically install or upgrade a CSV.

2.3.11. Multitenancy

A *tenant* in OpenShift Container Platform is a user or group of users that share common access and privileges for a set of deployed workloads, typically represented by a namespace or project. You can use tenants to provide a level of isolation between different groups or teams.

When a cluster is shared by multiple users or groups, it is considered a *multitenant* cluster.

2.3.12. Operator

Operators are a method of packaging, deploying, and managing a Kubernetes application. A Kubernetes application is an app that is both deployed on Kubernetes and managed using the Kubernetes APIs and **kubectl** or **oc** tooling.

In Operator Lifecycle Manager (OLM) v1, the **ClusterExtension** API streamlines management of installed extensions, which includes Operators via the **registry+v1** bundle format.

2.3.13. Operator group

An *Operator group* configures all Operators deployed in the same namespace as the **OperatorGroup** object to watch for their CR in a list of namespaces or cluster-wide.

2.3.14. Package

In the bundle format, a *package* is a directory that encloses all released history of an Operator with each version. A released version of an Operator is described in a CSV manifest alongside the CRDs.

2.3.15. Registry

A *registry* is a database that stores bundle images of Operators, each with all of its latest and historical versions in all channels.

2.3.16. Subscription

A *subscription* keeps CSVs up to date by tracking a channel in a package.

2.3.17. Update graph

An *update graph* links versions of CSVs together, similar to the update graph of any other packaged software. Operators can be installed sequentially, or certain versions can be skipped. The update graph is expected to grow only at the head with newer versions being added.

Also known as *update edges* or *update paths*.

2.4. OPERATOR LIFECYCLE MANAGER (OLM)

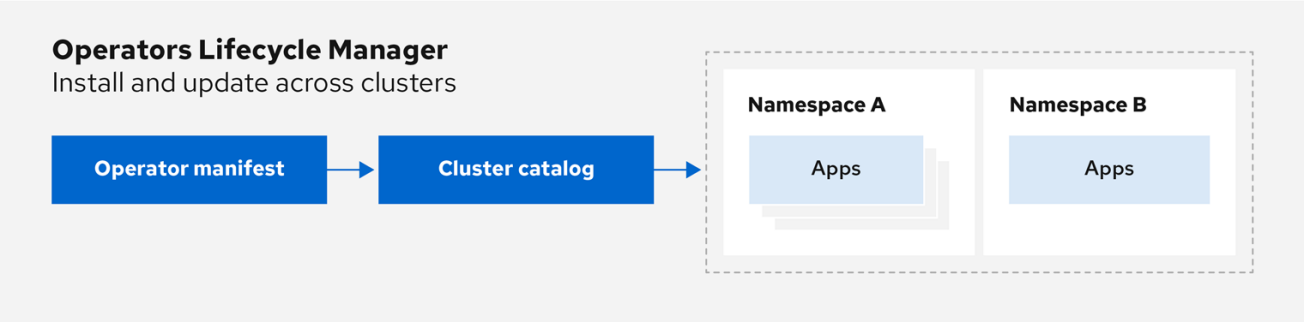
2.4.1. Operator Lifecycle Manager concepts and resources

This guide provides an overview of the concepts that drive Operator Lifecycle Manager (OLM) in OpenShift Container Platform.

2.4.1.1. What is Operator Lifecycle Manager (OLM) Classic?

Operator Lifecycle Manager (OLM) Classic helps users install, update, and manage the lifecycle of Kubernetes native applications (Operators) and their associated services running across their OpenShift Container Platform clusters. It is part of the Operator Framework, an open source toolkit designed to manage Operators in an effective, automated, and scalable way.

Figure 2.2. OLM (Classic) workflow



OLM runs by default in OpenShift Container Platform 4.19, which aids cluster administrators in installing, upgrading, and granting access to Operators running on their cluster. The OpenShift Container Platform web console provides management screens for cluster administrators to install Operators, as well as grant specific projects access to use the catalog of Operators available on the cluster.

For developers, a self-service experience allows provisioning and configuring instances of databases, monitoring, and big data services without having to be subject matter experts, because the Operator has that knowledge baked into it.

2.4.1.2. OLM resources

The following custom resource definitions (CRDs) are defined and managed by Operator Lifecycle Manager (OLM):

Table 2.2. CRDs managed by OLM and Catalog Operators

Resource	Short name	Description
ClusterServiceVersion (CSV)	**csv**	Application metadata. For example: name, version, icon, required resources.
CatalogSource	**catsrc**	A repository of CSVs, CRDs, and packages that define an application.
Subscription	**sub**	Keeps CSVs up to date by tracking a channel in a package.
InstallPlan	**ip**	Calculated list of resources to be created to automatically install or upgrade a CSV.
OperatorGroup	**og**	Configures all Operators deployed in the same namespace as the **OperatorGroup** object to watch for their custom resource (CR) in a list of namespaces or cluster-wide.

Resource	Short name	Description
OperatorConditions	-	Creates a communication channel between OLM and an Operator it manages. Operators can write to the **Status.Conditions** array to communicate complex states to OLM.

2.4.1.2.1. Cluster service version

A *cluster service version* (CSV) represents a specific version of a running Operator on your OpenShift Container Platform cluster. It is a YAML manifest created from Operator metadata that assists Operator Lifecycle Manager (OLM) in running the Operator in the cluster.

OLM requires this metadata about an Operator to ensure that it can be kept running safely on a cluster, and to provide information about how updates should be applied as new versions of the Operator are published. This is similar to packaging software for a traditional operating system; think of the packaging step for OLM as the stage at which you make your **rpm**, **deb**, or **apk** bundle.

A CSV includes the metadata that accompanies an Operator container image, used to populate user interfaces with information such as its name, version, description, labels, repository link, and logo.

A CSV is also a source of technical information required to run the Operator, such as which custom resources (CRs) it manages or depends on, RBAC rules, cluster requirements, and install strategies. This information tells OLM how to create required resources and set up the Operator as a deployment.

2.4.1.2.2. Catalog source

A *catalog source* represents a store of metadata, typically by referencing an *index image* stored in a container registry. Operator Lifecycle Manager (OLM) queries catalog sources to discover and install Operators and their dependencies. OperatorHub in the OpenShift Container Platform web console also displays the Operators provided by catalog sources.

TIP

Cluster administrators can view the full list of Operators provided by an enabled catalog source on a cluster by using the **Administration → Cluster Settings → Configuration → OperatorHub** page in the web console.

The **spec** of a **CatalogSource** object indicates how to construct a pod or how to communicate with a service that serves the Operator Registry gRPC API.

Example 2.9. Example CatalogSource object

```
apiVersion: operators.coreos.com/v1alpha1
kind: CatalogSource
metadata:
  generation: 1
  name: example-catalog 1
  namespace: openshift-marketplace 2
  annotations:
    olm.catalogImageTemplate: 3
      "quay.io/example-org/example-catalog:v{kube_major_version}.{kube_minor_version}.
```

```
{kube_patch_version}"
spec:
  displayName: Example Catalog 4
  image: quay.io/example-org/example-catalog:v1 5
  priority: -400 6
  publisher: Example Org
  sourceType: grpc 7
  grpcPodConfig:
    securityContextConfig: <security_mode> 8
    nodeSelector: 9
      custom_label: <label>
    priorityClassName: system-cluster-critical 10
    tolerations: 11
      - key: "key1"
        operator: "Equal"
        value: "value1"
        effect: "NoSchedule"
  updateStrategy:
    registryPoll: 12
      interval: 30m0s
status:
  connectionState:
    address: example-catalog.openshift-marketplace.svc:50051
    lastConnect: 2021-08-26T18:14:31Z
    lastObservedState: READY 13
  latestImageRegistryPoll: 2021-08-26T18:46:25Z 14
  registryService: 15
    createdAt: 2021-08-26T16:16:37Z
    port: 50051
    protocol: grpc
    serviceName: example-catalog
    serviceNamespace: openshift-marketplace
```

1. Name for the **CatalogSource** object. This value is also used as part of the name for the related pod that is created in the requested namespace.

2. Namespace to create the catalog in. To make the catalog available cluster-wide in all namespaces, set this value to **openshift-marketplace**. The default Red Hat-provided catalog sources also use the **openshift-marketplace** namespace. Otherwise, set the value to a specific namespace to make the Operator only available in that namespace.

3. Optional: To avoid cluster upgrades potentially leaving Operator installations in an unsupported state or without a continued update path, you can enable automatically changing your Operator catalog's index image version as part of cluster upgrades.

   Set the **olm.catalogImageTemplate** annotation to your index image name and use one or more of the Kubernetes cluster version variables as shown when constructing the template for the image tag. The annotation overwrites the **spec.image** field at run time. See the "Image template for custom catalog sources" section for more details.

4. Display name for the catalog in the web console and CLI.

5. Index image for the catalog. Optionally, can be omitted when using the **olm.catalogImageTemplate** annotation, which sets the pull spec at run time.

6 Weight for the catalog source. OLM uses the weight for prioritization during dependency resolution. A higher weight indicates the catalog is preferred over lower-weighted catalogs.

7 Source types include the following:

- **grpc** with an **image** reference: OLM pulls the image and runs the pod, which is expected to serve a compliant API.
- **grpc** with an **address** field: OLM attempts to contact the gRPC API at the given address. This should not be used in most cases.
- **configmap**: OLM parses config map data and runs a pod that can serve the gRPC API over it.

8 Specify the value of **legacy** or **restricted**. If the field is not set, the default value is **legacy**. In a future OpenShift Container Platform release, it is planned that the default value will be **restricted**. If your catalog cannot run with **restricted** permissions, it is recommended that you manually set this field to **legacy**.

9 Optional: For **grpc** type catalog sources, overrides the default node selector for the pod serving the content in **spec.image**, if defined.

10 Optional: For **grpc** type catalog sources, overrides the default priority class name for the pod serving the content in **spec.image**, if defined. Kubernetes provides **system-cluster-critical** and **system-node-critical** priority classes by default. Setting the field to empty (**""**) assigns the pod the default priority. Other priority classes can be defined manually.

11 Optional: For **grpc** type catalog sources, overrides the default tolerations for the pod serving the content in **spec.image**, if defined.

12 Automatically check for new versions at a given interval to stay up-to-date.

13 Last observed state of the catalog connection. For example:

- **READY**: A connection is successfully established.
- **CONNECTING**: A connection is attempting to establish.
- **TRANSIENT_FAILURE**: A temporary problem has occurred while attempting to establish a connection, such as a timeout. The state will eventually switch back to **CONNECTING** and try again.

See States of Connectivity in the gRPC documentation for more details.

14 Latest time the container registry storing the catalog image was polled to ensure the image is up-to-date.

15 Status information for the catalog's Operator Registry service.

Referencing the **name** of a **CatalogSource** object in a subscription instructs OLM where to search to find a requested Operator:

Example 2.10. Example Subscription object referencing a catalog source

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: example-operator
  namespace: example-namespace
spec:
  channel: stable
  name: example-operator
  source: example-catalog
  sourceNamespace: openshift-marketplace
```

Additional resources

- Understanding OperatorHub
- Red Hat-provided Operator catalogs
- Adding a catalog source to a cluster
- Catalog priority
- Viewing Operator catalog source status by using the CLI
- Understanding and managing pod security admission
- Catalog source pod scheduling

2.4.1.2.2.1. Image template for custom catalog sources

Operator compatibility with the underlying cluster can be expressed by a catalog source in various ways. One way, which is used for the default Red Hat-provided catalog sources, is to identify image tags for index images that are specifically created for a particular platform release, for example OpenShift Container Platform 4.19.

During a cluster upgrade, the index image tag for the default Red Hat-provided catalog sources are updated automatically by the Cluster Version Operator (CVO) so that Operator Lifecycle Manager (OLM) pulls the updated version of the catalog. For example during an upgrade from OpenShift Container Platform 4.18 to 4.19, the **spec.image** field in the **CatalogSource** object for the **redhat-operators** catalog is updated from:

```
registry.redhat.io/redhat/redhat-operator-index:v4.19
```

to:

```
registry.redhat.io/redhat/redhat-operator-index:v4.19
```

However, the CVO does not automatically update image tags for custom catalogs. To ensure users are left with a compatible and supported Operator installation after a cluster upgrade, custom catalogs should also be kept updated to reference an updated index image.

Starting in OpenShift Container Platform 4.9, cluster administrators can add the **olm.catalogImageTemplate** annotation in the **CatalogSource** object for custom catalogs to an image reference that includes a template. The following Kubernetes version variables are supported for use in

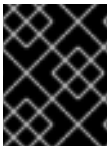
the template:

- **kube_major_version**
- **kube_minor_version**
- **kube_patch_version**

NOTE

You must specify the Kubernetes cluster version and not the OpenShift Container Platform cluster version, as the latter is not currently available for templating.

Provided that you have created and pushed an index image with a tag specifying the updated Kubernetes version, setting this annotation enables the index image versions in custom catalogs to be automatically changed after a cluster upgrade. The annotation value is used to set or update the image reference in the **spec.image** field of the **CatalogSource** object. This helps avoid cluster upgrades leaving Operator installations in unsupported states or without a continued update path.



IMPORTANT

You must ensure that the index image with the updated tag, in whichever registry it is stored in, is accessible by the cluster at the time of the cluster upgrade.

Example 2.11. Example catalog source with an image template

```
apiVersion: operators.coreos.com/v1alpha1
kind: CatalogSource
metadata:
  generation: 1
  name: example-catalog
  namespace: openshift-marketplace
  annotations:
    olm.catalogImageTemplate:
      "quay.io/example-org/example-catalog:v{kube_major_version}.{kube_minor_version}"
spec:
  displayName: Example Catalog
  image: quay.io/example-org/example-catalog:v1.32
  priority: -400
  publisher: Example Org
```

NOTE

If the **spec.image** field and the **olm.catalogImageTemplate** annotation are both set, the **spec.image** field is overwritten by the resolved value from the annotation. If the annotation does not resolve to a usable pull spec, the catalog source falls back to the set **spec.image** value.

If the **spec.image** field is not set and the annotation does not resolve to a usable pull spec, OLM stops reconciliation of the catalog source and sets it into a human-readable error condition.

For an OpenShift Container Platform 4.19 cluster, which uses Kubernetes 1.33, the **olm.catalogImageTemplate** annotation in the preceding example resolves to the following image reference:

```
quay.io/example-org/example-catalog:v1.32
```

For future releases of OpenShift Container Platform, you can create updated index images for your custom catalogs that target the later Kubernetes version that is used by the later OpenShift Container Platform version. With the **olm.catalogImageTemplate** annotation set before the upgrade, upgrading the cluster to the later OpenShift Container Platform version would then automatically update the catalog's index image as well.

2.4.1.2.2.2. Catalog health requirements

Operator catalogs on a cluster are interchangeable from the perspective of installation resolution; a **Subscription** object might reference a specific catalog, but dependencies are resolved using all catalogs on the cluster.

For example, if Catalog A is unhealthy, a subscription referencing Catalog A could resolve a dependency in Catalog B, which the cluster administrator might not have been expecting, because B normally had a lower catalog priority than A.

As a result, OLM requires that all catalogs with a given global namespace (for example, the default **openshift-marketplace** namespace or a custom global namespace) are healthy. When a catalog is unhealthy, all Operator installation or update operations within its shared global namespace will fail with a **CatalogSourcesUnhealthy** condition. If these operations were permitted in an unhealthy state, OLM might make resolution and installation decisions that were unexpected to the cluster administrator.

As a cluster administrator, if you observe an unhealthy catalog and want to consider the catalog as invalid and resume Operator installations, see the "Removing custom catalogs" or "Disabling the default OperatorHub catalog sources" sections for information about removing the unhealthy catalog.

Additional resources

- Removing custom catalogs
- Disabling the default OperatorHub catalog sources

2.4.1.2.3. Subscription

A *subscription*, defined by a **Subscription** object, represents an intention to install an Operator. It is the custom resource that relates an Operator to a catalog source.

Subscriptions describe which channel of an Operator package to subscribe to, and whether to perform updates automatically or manually. If set to automatic, the subscription ensures Operator Lifecycle Manager (OLM) manages and upgrades the Operator to ensure that the latest version is always running in the cluster.

Example Subscription object

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: example-operator
  namespace: example-namespace
```

```
spec:
  channel: stable
  name: example-operator
  source: example-catalog
  sourceNamespace: openshift-marketplace
```

This **Subscription** object defines the name and namespace of the Operator, as well as the catalog from which the Operator data can be found. The channel, such as **alpha**, **beta**, or **stable**, helps determine which Operator stream should be installed from the catalog source.

The names of channels in a subscription can differ between Operators, but the naming scheme should follow a common convention within a given Operator. For example, channel names might follow a minor release update stream for the application provided by the Operator (**1.2**, **1.3**) or a release frequency (**stable**, **fast**).

In addition to being easily visible from the OpenShift Container Platform web console, it is possible to identify when there is a newer version of an Operator available by inspecting the status of the related subscription. The value associated with the **currentCSV** field is the newest version that is known to OLM, and **installedCSV** is the version that is installed on the cluster.

Additional resources

- Multitenancy and Operator colocation
- Viewing Operator subscription status by using the CLI

2.4.1.2.4. Install plan

An *install plan*, defined by an **InstallPlan** object, describes a set of resources that Operator Lifecycle Manager (OLM) creates to install or upgrade to a specific version of an Operator. The version is defined by a cluster service version (CSV).

To install an Operator, a cluster administrator, or a user who has been granted Operator installation permissions, must first create a **Subscription** object. A subscription represents the intent to subscribe to a stream of available versions of an Operator from a catalog source. The subscription then creates an **InstallPlan** object to facilitate the installation of the resources for the Operator.

The install plan must then be approved according to one of the following approval strategies:

- If the subscription's **spec.installPlanApproval** field is set to **Automatic**, the install plan is approved automatically.
- If the subscription's **spec.installPlanApproval** field is set to **Manual**, the install plan must be manually approved by a cluster administrator or user with proper permissions.

After the install plan is approved, OLM creates the specified resources and installs the Operator in the namespace that is specified by the subscription.

Example 2.12. Example InstallPlan object

```
apiVersion: operators.coreos.com/v1alpha1
kind: InstallPlan
metadata:
  name: install-abcde
  namespace: operators
```

```
spec:
  approval: Automatic
  approved: true
  clusterServiceVersionNames:
    - my-operator.v1.0.1
  generation: 1
status:
  ...
  catalogSources: []
  conditions:
    - lastTransitionTime: '2021-01-01T20:17:27Z'
      lastUpdateTime: '2021-01-01T20:17:27Z'
      status: 'True'
      type: Installed
  phase: Complete
  plan:
    - resolving: my-operator.v1.0.1
      resource:
        group: operators.coreos.com
        kind: ClusterServiceVersion
        manifest: >-
        ...
        name: my-operator.v1.0.1
        sourceName: redhat-operators
        sourceNamespace: openshift-marketplace
        version: v1alpha1
      status: Created
    - resolving: my-operator.v1.0.1
      resource:
        group: apiextensions.k8s.io
        kind: CustomResourceDefinition
        manifest: >-
        ...
        name: webservers.web.servers.org
        sourceName: redhat-operators
        sourceNamespace: openshift-marketplace
        version: v1beta1
      status: Created
    - resolving: my-operator.v1.0.1
      resource:
        group: ''
        kind: ServiceAccount
        manifest: >-
        ...
        name: my-operator
        sourceName: redhat-operators
        sourceNamespace: openshift-marketplace
        version: v1
      status: Created
    - resolving: my-operator.v1.0.1
      resource:
        group: rbac.authorization.k8s.io
        kind: Role
        manifest: >-
        ...
        name: my-operator.v1.0.1-my-operator-6d7cbc6f57
```

```
    sourceName: redhat-operators
    sourceNamespace: openshift-marketplace
    version: v1
  status: Created
- resolving: my-operator.v1.0.1
  resource:
    group: rbac.authorization.k8s.io
    kind: RoleBinding
    manifest: >-
    ...
    name: my-operator.v1.0.1-my-operator-6d7cbc6f57
    sourceName: redhat-operators
    sourceNamespace: openshift-marketplace
    version: v1
  status: Created
  ...
```

Additional resources

- Multitenancy and Operator colocation
- Allowing non-cluster administrators to install Operators

2.4.1.2.5. Operator groups

An *Operator group*, defined by the **OperatorGroup** resource, provides multitenant configuration to OLM-installed Operators. An Operator group selects target namespaces in which to generate required RBAC access for its member Operators.

The set of target namespaces is provided by a comma-delimited string stored in the **olm.targetNamespaces** annotation of a cluster service version (CSV). This annotation is applied to the CSV instances of member Operators and is projected into their deployments.

Additional resources

- Operator groups

2.4.1.2.6. Operator conditions

As part of its role in managing the lifecycle of an Operator, Operator Lifecycle Manager (OLM) infers the state of an Operator from the state of Kubernetes resources that define the Operator. While this approach provides some level of assurance that an Operator is in a given state, there are many instances where an Operator might need to communicate information to OLM that could not be inferred otherwise. This information can then be used by OLM to better manage the lifecycle of the Operator.

OLM provides a custom resource definition (CRD) called **OperatorCondition** that allows Operators to communicate conditions to OLM. There are a set of supported conditions that influence management of the Operator by OLM when present in the **Spec.Conditions** array of an **OperatorCondition** resource.

NOTE

By default, the **Spec.Conditions** array is not present in an **OperatorCondition** object until it is either added by a user or as a result of custom Operator logic.

Additional resources

- Operator conditions

2.4.2. Operator Lifecycle Manager architecture

This guide outlines the component architecture of Operator Lifecycle Manager (OLM) in OpenShift Container Platform.

2.4.2.1. Component responsibilities

Operator Lifecycle Manager (OLM) is composed of two Operators: the OLM Operator and the Catalog Operator.

The OLM and Catalog Operators are responsible for managing the custom resource definitions (CRDs) that are the basis for the OLM framework:

Table 2.3. CRDs managed by OLM and Catalog Operators

Resource	Short name	Owner	Description
ClusterServiceVersion (CSV)	**csv**	OLM	Application metadata: name, version, icon, required resources, installation, and so on.
InstallPlan	**ip**	Catalog	Calculated list of resources to be created to automatically install or upgrade a CSV.
CatalogSource	**catsrc**	Catalog	A repository of CSVs, CRDs, and packages that define an application.
Subscription	**sub**	Catalog	Used to keep CSVs up to date by tracking a channel in a package.
OperatorGroup	**og**	OLM	Configures all Operators deployed in the same namespace as the **OperatorGroup** object to watch for their custom resource (CR) in a list of namespaces or cluster-wide.

Each of these Operators is also responsible for creating the following resources:

Table 2.4. Resources created by OLM and Catalog Operators

Resource	Owner
Deployments	OLM
ServiceAccounts	
(Cluster)Roles	
(Cluster)RoleBindings	
CustomResourceDefinitions (CRDs)	Catalog
ClusterServiceVersions	

2.4.2.2. OLM Operator

The OLM Operator is responsible for deploying applications defined by CSV resources after the required resources specified in the CSV are present in the cluster.

The OLM Operator is not concerned with the creation of the required resources; you can choose to manually create these resources using the CLI or using the Catalog Operator. This separation of concern allows users incremental buy-in in terms of how much of the OLM framework they choose to leverage for their application.

The OLM Operator uses the following workflow:

1. Watch for cluster service versions (CSVs) in a namespace and check that requirements are met.
2. If requirements are met, run the install strategy for the CSV.

NOTE

A CSV must be an active member of an Operator group for the install strategy to run.

2.4.2.3. Catalog Operator

The Catalog Operator is responsible for resolving and installing cluster service versions (CSVs) and the required resources they specify. It is also responsible for watching catalog sources for updates to packages in channels and upgrading them, automatically if desired, to the latest available versions.

To track a package in a channel, you can create a **Subscription** object configuring the desired package, channel, and the **CatalogSource** object you want to use for pulling updates. When updates are found, an appropriate **InstallPlan** object is written into the namespace on behalf of the user.

The Catalog Operator uses the following workflow:

1. Connect to each catalog source in the cluster.
2. Watch for unresolved install plans created by a user, and if found:
    a. Find the CSV matching the name requested and add the CSV as a resolved resource.

b. For each managed or required CRD, add the CRD as a resolved resource.

c. For each required CRD, find the CSV that manages it.

3. Watch for resolved install plans and create all of the discovered resources for it, if approved by a user or automatically.

4. Watch for catalog sources and subscriptions and create install plans based on them.

2.4.2.4. Catalog Registry

The Catalog Registry stores CSVs and CRDs for creation in a cluster and stores metadata about packages and channels.

A *package manifest* is an entry in the Catalog Registry that associates a package identity with sets of CSVs. Within a package, channels point to a particular CSV. Because CSVs explicitly reference the CSV that they replace, a package manifest provides the Catalog Operator with all of the information that is required to update a CSV to the latest version in a channel, stepping through each intermediate version.

2.4.3. Operator Lifecycle Manager workflow

This guide outlines the workflow of Operator Lifecycle Manager (OLM) in OpenShift Container Platform.

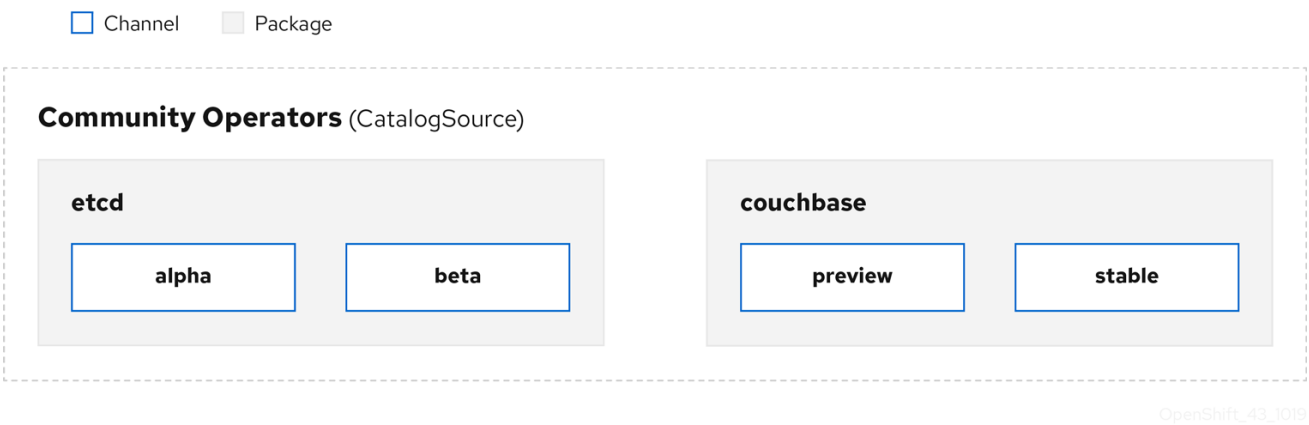
2.4.3.1. Operator installation and upgrade workflow in OLM

In the Operator Lifecycle Manager (OLM) ecosystem, the following resources are used to resolve Operator installations and upgrades:

- **ClusterServiceVersion** (CSV)
- **CatalogSource**
- **Subscription**

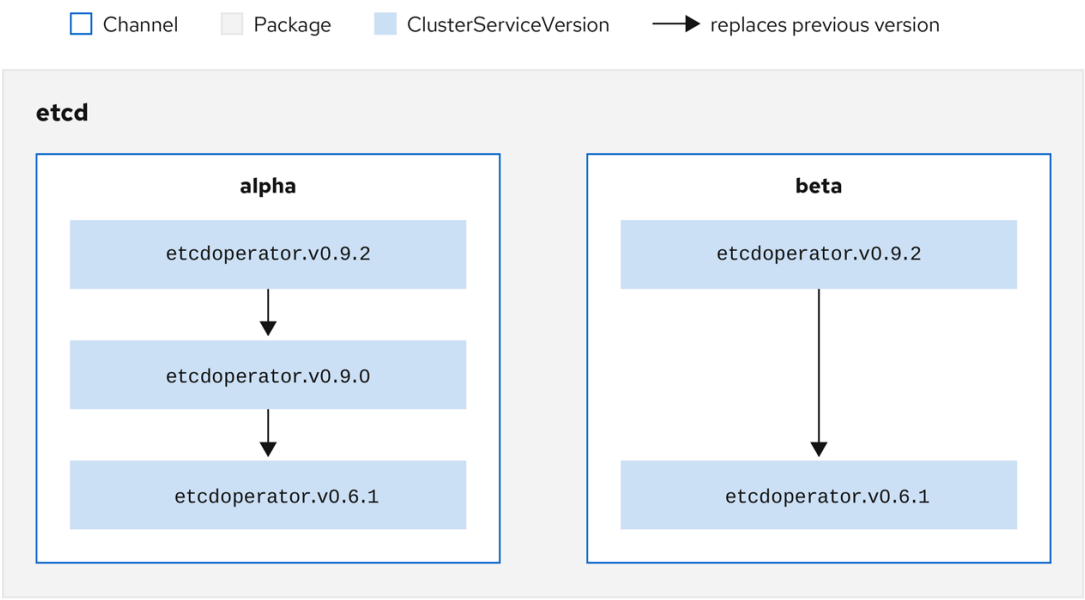
Operator metadata, defined in CSVs, can be stored in a collection called a catalog source. OLM uses catalog sources, which use the Operator Registry API, to query for available Operators as well as upgrades for installed Operators.

Figure 2.3. Catalog source overview

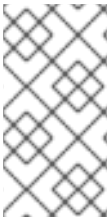


Within a catalog source, Operators are organized into *packages* and streams of updates called *channels*, which should be a familiar update pattern from OpenShift Container Platform or other software on a continuous release cycle like web browsers.

Figure 2.4. Packages and channels in a Catalog source



A user indicates a particular package and channel in a particular catalog source in a *subscription*, for example an **etcd** package and its **alpha** channel. If a subscription is made to a package that has not yet been installed in the namespace, the latest Operator for that package is installed.

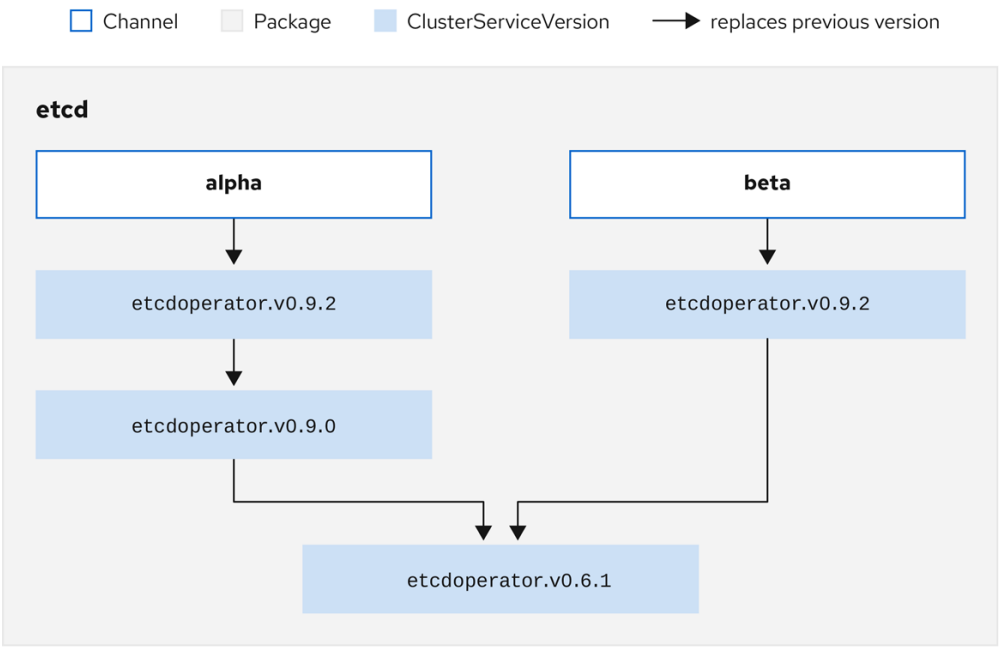


NOTE

OLM deliberately avoids version comparisons, so the "latest" or "newest" Operator available from a given *catalog* → *channel* → *package* path does not necessarily need to be the highest version number. It should be thought of more as the *head* reference of a channel, similar to a Git repository.

Each CSV has a **replaces** parameter that indicates which Operator it replaces. This builds a graph of CSVs that can be queried by OLM, and updates can be shared between channels. Channels can be thought of as entry points into the graph of updates:

Figure 2.5. OLM graph of available channel updates



Example channels in a package

```
packageName: example
channels:
- name: alpha
  currentCSV: example.v0.1.2
- name: beta
  currentCSV: example.v0.1.3
defaultChannel: alpha
```

For OLM to successfully query for updates, given a catalog source, package, channel, and CSV, a catalog must be able to return, unambiguously and deterministically, a single CSV that **replaces** the input CSV.

2.4.3.1.1. Example upgrade path

For an example upgrade scenario, consider an installed Operator corresponding to CSV version **0.1.1**. OLM queries the catalog source and detects an upgrade in the subscribed channel with new CSV version **0.1.3** that replaces an older but not-installed CSV version **0.1.2**, which in turn replaces the older and installed CSV version **0.1.1**.

OLM walks back from the channel head to previous versions via the **replaces** field specified in the CSVs to determine the upgrade path **0.1.3 → 0.1.2 → 0.1.1**; the direction of the arrow indicates that the former replaces the latter. OLM upgrades the Operator one version at the time until it reaches the channel head.

For this given scenario, OLM installs Operator version **0.1.2** to replace the existing Operator version **0.1.1**. Then, it installs Operator version **0.1.3** to replace the previously installed Operator version **0.1.2**. At this point, the installed operator version **0.1.3** matches the channel head and the upgrade is completed.

2.4.3.1.2. Skipping upgrades

The basic path for upgrades in OLM is:

- A catalog source is updated with one or more updates to an Operator.
- OLM traverses every version of the Operator until reaching the latest version the catalog source contains.

However, sometimes this is not a safe operation to perform. There will be cases where a published version of an Operator should never be installed on a cluster if it has not already, for example because a version introduces a serious vulnerability.

In those cases, OLM must consider two cluster states and provide an update graph that supports both:

- The "bad" intermediate Operator has been seen by the cluster and installed.
- The "bad" intermediate Operator has not yet been installed onto the cluster.

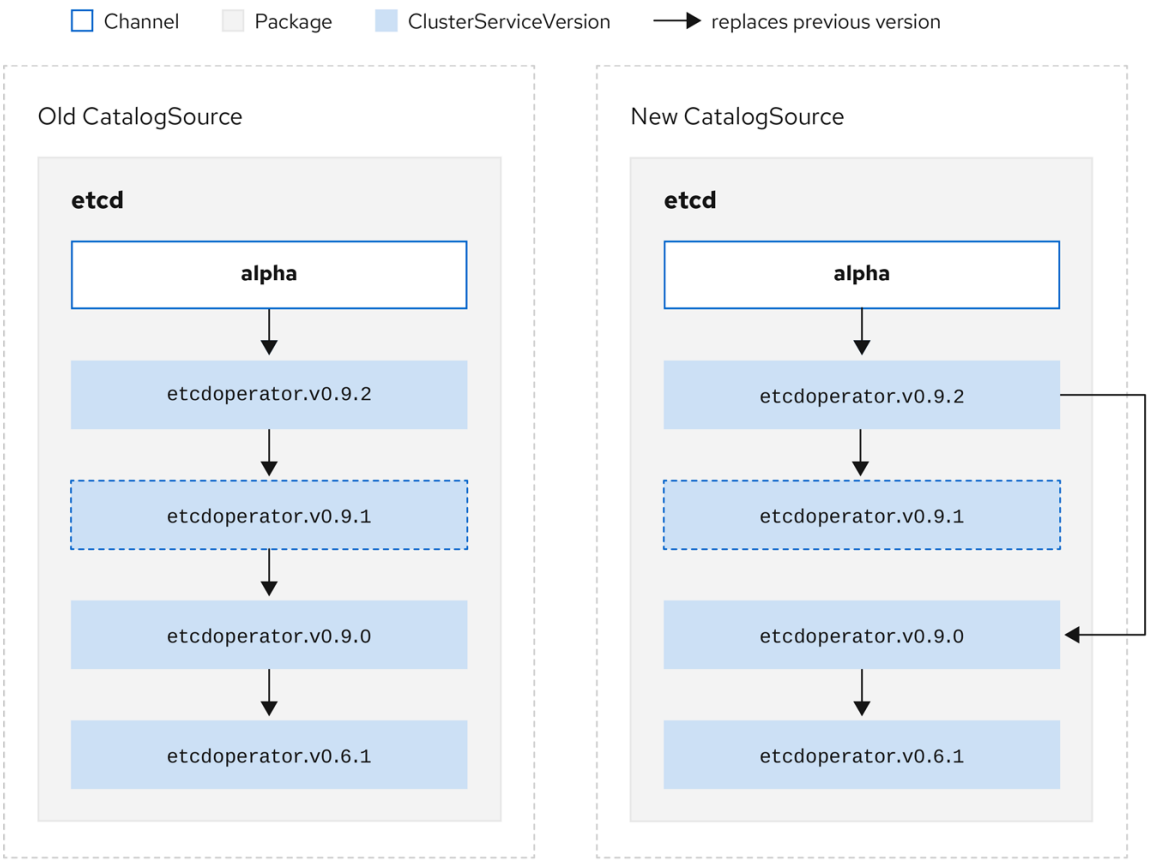
By shipping a new catalog and adding a *skipped* release, OLM is ensured that it can always get a single unique update regardless of the cluster state and whether it has seen the bad update yet.

Example CSV with skipped release

```
apiVersion: operators.coreos.com/v1alpha1
kind: ClusterServiceVersion
metadata:
  name: etcdoperator.v0.9.2
  namespace: placeholder
  annotations:
spec:
    displayName: etcd
    description: Etcd Operator
    replaces: etcdoperator.v0.9.0
    skips:
    - etcdoperator.v0.9.1
```

Consider the following example of **Old CatalogSource** and **New CatalogSource**.

Figure 2.6. Skipping updates



This graph maintains that:

- Any Operator found in **Old CatalogSource** has a single replacement in **New CatalogSource**.
- Any Operator found in **New CatalogSource** has a single replacement in **New CatalogSource**.
- If the bad update has not yet been installed, it will never be.

2.4.3.1.3. Replacing multiple Operators

Creating **New CatalogSource** as described requires publishing CSVs that **replace** one Operator, but can **skip** several. This can be accomplished using the **skipRange** annotation:

```
olm.skipRange: <semver_range>
```

where **<semver_range>** has the version range format supported by the semver library.

When searching catalogs for updates, if the head of a channel has a **skipRange** annotation and the currently installed Operator has a version field that falls in the range, OLM updates to the latest entry in the channel.

The order of precedence is:

1. Channel head in the source specified by **sourceName** on the subscription, if the other criteria for skipping are met.
2. The next Operator that replaces the current one, in the source specified by **sourceName**.

3. Channel head in another source that is visible to the subscription, if the other criteria for skipping are met.

4. The next Operator that replaces the current one in any source visible to the subscription.

Example CSV with skipRange

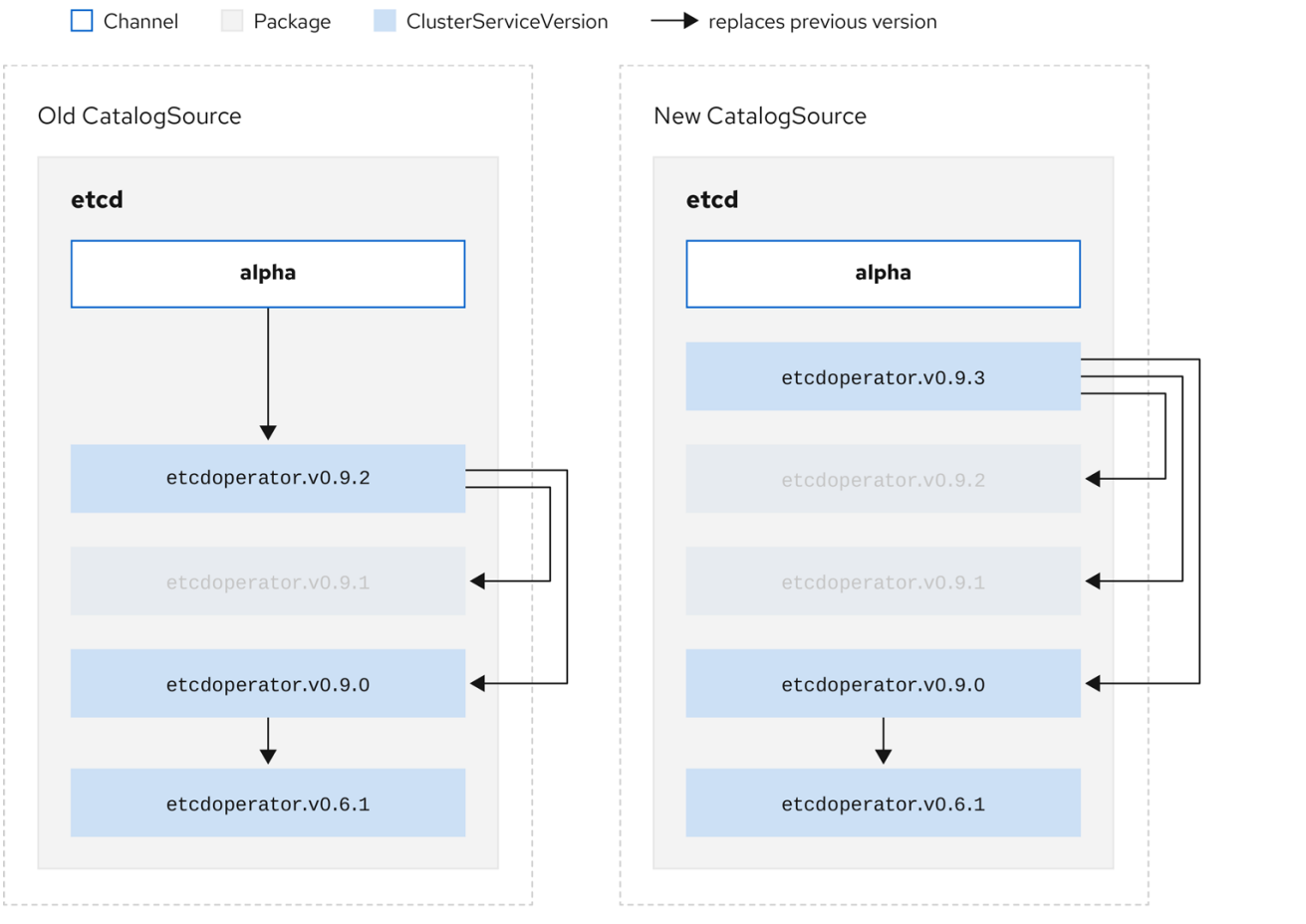
```
apiVersion: operators.coreos.com/v1alpha1
kind: ClusterServiceVersion
metadata:
  name: elasticsearch-operator.v4.1.2
  namespace: <namespace>
  annotations:
    olm.skipRange: '>=4.1.0 <4.1.2'
```

2.4.3.1.4. Z-stream support

A *z-stream*, or patch release, must replace all previous z-stream releases for the same minor version. OLM does not consider major, minor, or patch versions, it just needs to build the correct graph in a catalog.

In other words, OLM must be able to take a graph as in **Old CatalogSource** and, similar to before, generate a graph as in **New CatalogSource**:

Figure 2.7. Replacing several Operators



This graph maintains that:

- Any Operator found in **Old CatalogSource** has a single replacement in **New CatalogSource**.
- Any Operator found in **New CatalogSource** has a single replacement in **New CatalogSource**.
- Any z-stream release in **Old CatalogSource** will update to the latest z-stream release in **New CatalogSource**.
- Unavailable releases can be considered "virtual" graph nodes; their content does not need to exist, the registry just needs to respond as if the graph looks like this.

2.4.4. Operator Lifecycle Manager dependency resolution

This guide outlines dependency resolution and custom resource definition (CRD) upgrade lifecycles with Operator Lifecycle Manager (OLM) in OpenShift Container Platform.

2.4.4.1. About dependency resolution

Operator Lifecycle Manager (OLM) manages the dependency resolution and upgrade lifecycle of running Operators. In many ways, the problems OLM faces are similar to other system or language package managers, such as **yum** and **rpm**.

However, there is one constraint that similar systems do not generally have that OLM does: because Operators are always running, OLM attempts to ensure that you are never left with a set of Operators that do not work with each other.

As a result, OLM must never create the following scenarios:

- Install a set of Operators that require APIs that cannot be provided
- Update an Operator in a way that breaks another that depends upon it

This is made possible with two types of data:

Properties	Typed metadata about the Operator that constitutes the public interface for it in the dependency resolver. Examples include the group/version/kind (GVK) of the APIs provided by the Operator and the semantic version (semver) of the Operator.
Constraints or dependencies	An Operator's requirements that should be satisfied by other Operators that might or might not have already been installed on the target cluster. These act as queries or filters over all available Operators and constrain the selection during dependency resolution and installation. Examples include requiring a specific API to be available on the cluster or expecting a particular Operator with a particular version to be installed.

OLM converts these properties and constraints into a system of Boolean formulas and passes them to a SAT solver, a program that establishes Boolean satisfiability, which does the work of determining what Operators should be installed.

2.4.4.2. Operator properties

All Operators in a catalog have the following properties:

olm.package

Includes the name of the package and the version of the Operator

olm.gvk

A single property for each provided API from the cluster service version (CSV)

Additional properties can also be directly declared by an Operator author by including a **properties.yaml** file in the **metadata/** directory of the Operator bundle.

Example arbitrary property

```
properties:
- type: olm.kubeversion
  value:
    version: "1.16.0"
```

2.4.4.2.1. Arbitrary properties

Operator authors can declare arbitrary properties in a **properties.yaml** file in the **metadata/** directory of the Operator bundle. These properties are translated into a map data structure that is used as an input to the Operator Lifecycle Manager (OLM) resolver at runtime.

These properties are opaque to the resolver as it does not understand the properties, but it can evaluate the generic constraints against those properties to determine if the constraints can be satisfied given the properties list.

Example arbitrary properties

```
properties:
  - property:
      type: color
      value: red
  - property:
      type: shape
      value: square
  - property:
      type: olm.gvk
      value:
        group: olm.coreos.io
        version: v1alpha1
        kind: myresource
```

This structure can be used to construct a Common Expression Language (CEL) expression for generic constraints.

Additional resources

- Common Expression Language (CEL) constraints

2.4.4.3. Operator dependencies

The dependencies of an Operator are listed in a **dependencies.yaml** file in the **metadata/** folder of a bundle. This file is optional and currently only used to specify explicit Operator-version dependencies.

The dependency list contains a **type** field for each item to specify what kind of dependency this is. The following types of Operator dependencies are supported:

olm.package

This type indicates a dependency for a specific Operator version. The dependency information must include the package name and the version of the package in semver format. For example, you can specify an exact version such as **0.5.2** or a range of versions such as **>0.5.1**.

olm.gvk

With this type, the author can specify a dependency with group/version/kind (GVK) information, similar to existing CRD and API-based usage in a CSV. This is a path to enable Operator authors to consolidate all dependencies, API or explicit versions, to be in the same place.

olm.constraint

This type declares generic constraints on arbitrary Operator properties.

In the following example, dependencies are specified for a Prometheus Operator and etcd CRDs:

Example dependencies.yaml file

```
dependencies:
  - type: olm.package
    value:
      packageName: prometheus
      version: ">0.27.0"
  - type: olm.gvk
    value:
      group: etcd.database.coreos.com
      kind: EtcdCluster
      version: v1beta2
```

2.4.4.4. Generic constraints

An **olm.constraint** property declares a dependency constraint of a particular type, differentiating non-constraint and constraint properties. Its **value** field is an object containing a **failureMessage** field holding a string-representation of the constraint message. This message is surfaced as an informative comment to users if the constraint is not satisfiable at runtime.

The following keys denote the available constraint types:

gvk

Type whose value and interpretation is identical to the **olm.gvk** type

package

Type whose value and interpretation is identical to the **olm.package** type

cel

A Common Expression Language (CEL) expression evaluated at runtime by the Operator Lifecycle Manager (OLM) resolver over arbitrary bundle properties and cluster information

all, any, not

Conjunction, disjunction, and negation constraints, respectively, containing one or more concrete constraints, such as **gvk** or a nested compound constraint

2.4.4.4.1. Common Expression Language (CEL) constraints

The **cel** constraint type supports Common Expression Language (CEL) as the expression language. The **cel** struct has a **rule** field which contains the CEL expression string that is evaluated against Operator properties at runtime to determine if the Operator satisfies the constraint.

Example cel constraint

```
type: olm.constraint
value:
  failureMessage: 'require to have "certified"'
  cel:
    rule: 'properties.exists(p, p.type == "certified")'
```

The CEL syntax supports a wide range of logical operators, such as **AND** and **OR**. As a result, a single CEL expression can have multiple rules for multiple conditions that are linked together by these logical operators. These rules are evaluated against a dataset of multiple different properties from a bundle or any given source, and the output is solved into a single bundle or Operator that satisfies all of those rules within a single constraint.

Example cel constraint with multiple rules

```
type: olm.constraint
value:
  failureMessage: 'require to have "certified" and "stable" properties'
  cel:
    rule: 'properties.exists(p, p.type == "certified") && properties.exists(p, p.type == "stable")'
```

2.4.4.4.2. Compound constraints (all, any, not)

Compound constraint types are evaluated following their logical definitions.

The following is an example of a conjunctive constraint (**all**) of two packages and one GVK. That is, they must all be satisfied by installed bundles:

Example all constraint

```
schema: olm.bundle
name: red.v1.0.0
properties:
- type: olm.constraint
  value:
    failureMessage: All are required for Red because...
    all:
      constraints:
      - failureMessage: Package blue is needed for...
        package:
          name: blue
          versionRange: '>=1.0.0'
      - failureMessage: GVK Green/v1 is needed for...
        gvk:
          group: greens.example.com
          version: v1
          kind: Green
```

The following is an example of a disjunctive constraint (**any**) of three versions of the same GVK. That is, at least one must be satisfied by installed bundles:

Example any constraint

```
schema: olm.bundle
name: red.v1.0.0
properties:
- type: olm.constraint
  value:
    failureMessage: Any are required for Red because...
    any:
      constraints:
      - gvk:
          group: blues.example.com
          version: v1beta1
          kind: Blue
      - gvk:
          group: blues.example.com
          version: v1beta2
          kind: Blue
      - gvk:
          group: blues.example.com
          version: v1
          kind: Blue
```

The following is an example of a negation constraint (**not**) of one version of a GVK. That is, this GVK cannot be provided by any bundle in the result set:

Example not constraint

```
schema: olm.bundle
name: red.v1.0.0
properties:
- type: olm.constraint
  value:
  all:
    constraints:
    - failureMessage: Package blue is needed for...
      package:
        name: blue
        versionRange: '>=1.0.0'
    - failureMessage: Cannot be required for Red because...
      not:
        constraints:
        - gvk:
            group: greens.example.com
            version: v1alpha1
            kind: greens
```

The negation semantics might appear unclear in the **not** constraint context. To clarify, the negation is really instructing the resolver to remove any possible solution that includes a particular GVK, package at a version, or satisfies some child compound constraint from the result set.

As a corollary, the **not** compound constraint should only be used within **all** or **any** constraints, because negating without first selecting a possible set of dependencies does not make sense.

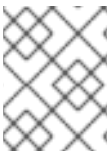
2.4.4.4.3. Nested compound constraints

A nested compound constraint, one that contains at least one child compound constraint along with zero or more simple constraints, is evaluated from the bottom up following the procedures for each previously described constraint type.

The following is an example of a disjunction of conjunctions, where one, the other, or both can satisfy the constraint:

Example nested compound constraint

```
schema: olm.bundle
name: red.v1.0.0
properties:
- type: olm.constraint
  value:
    failureMessage: Required for Red because...
    any:
      constraints:
      - all:
          constraints:
          - package:
              name: blue
              versionRange: '>=1.0.0'
          - gvk:
              group: blues.example.com
              version: v1
              kind: Blue
      - all:
          constraints:
          - package:
              name: blue
              versionRange: '<1.0.0'
          - gvk:
              group: blues.example.com
              version: v1beta1
              kind: Blue
```



NOTE

The maximum raw size of an **olm.constraint** type is 64KB to limit resource exhaustion attacks.

2.4.4.5. Dependency preferences

There can be many options that equally satisfy a dependency of an Operator. The dependency resolver in Operator Lifecycle Manager (OLM) determines which option best fits the requirements of the requested Operator. As an Operator author or user, it can be important to understand how these choices are made so that dependency resolution is clear.

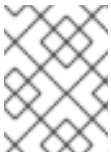
2.4.4.5.1. Catalog priority

On OpenShift Container Platform clusters, OLM reads catalog sources to know which Operators are available for installation.

Example CatalogSource object

```
apiVersion: "operators.coreos.com/v1alpha1"
kind: "CatalogSource"
metadata:
  name: "my-operators"
  namespace: "operators"
spec:
  sourceType: grpc
  grpcPodConfig:
    securityContextConfig: <security_mode> 1
  image: example.com/my/operator-index:v1
  displayName: "My Operators"
  priority: 100
```

1 Specify the value of **legacy** or **restricted**. If the field is not set, the default value is **legacy**. In a future OpenShift Container Platform release, it is planned that the default value will be **restricted**.



NOTE

If your catalog cannot run with **restricted** permissions, it is recommended that you manually set this field to **legacy**.

A **CatalogSource** object has a **priority** field, which is used by the resolver to know how to prefer options for a dependency.

There are two rules that govern catalog preference:

- Options in higher-priority catalogs are preferred to options in lower-priority catalogs.
- Options in the same catalog as the dependent are preferred to any other catalogs.

2.4.4.5.2. Channel ordering

An Operator package in a catalog is a collection of update channels that a user can subscribe to in OpenShift Container Platform clusters. Channels can be used to provide a particular stream of updates for a minor release (**1.2**, **1.3**) or a release frequency (**stable**, **fast**).

It is likely that a dependency might be satisfied by Operators in the same package, but different channels. For example, version **1.2** of an Operator might exist in both the **stable** and **fast** channels.

Each package has a default channel, which is always preferred to non-default channels. If no option in the default channel can satisfy a dependency, options are considered from the remaining channels in lexicographic order of the channel name.

2.4.4.5.3. Order within a channel

There are almost always multiple options to satisfy a dependency within a single channel. For example, Operators in one package and channel provide the same set of APIs.

When a user creates a subscription, they indicate which channel to receive updates from. This immediately reduces the search to just that one channel. But within the channel, it is likely that many Operators satisfy a dependency.

Within a channel, newer Operators that are higher up in the update graph are preferred. If the head of a channel satisfies a dependency, it will be tried first.

2.4.4.5.4. Other constraints

In addition to the constraints supplied by package dependencies, OLM includes additional constraints to represent the desired user state and enforce resolution invariants.

2.4.4.5.4.1. Subscription constraint

A subscription constraint filters the set of Operators that can satisfy a subscription. Subscriptions are user-supplied constraints for the dependency resolver. They declare the intent to either install a new Operator if it is not already on the cluster, or to keep an existing Operator updated.

2.4.4.5.4.2. Package constraint

Within a namespace, no two Operators may come from the same package.

2.4.4.5.5. Additional resources

- Catalog health requirements

2.4.4.6. CRD upgrades

OLM upgrades a custom resource definition (CRD) immediately if it is owned by a singular cluster service version (CSV). If a CRD is owned by multiple CSVs, then the CRD is upgraded when it has satisfied all of the following backward compatible conditions:

- All existing serving versions in the current CRD are present in the new CRD.
- All existing instances, or custom resources, that are associated with the serving versions of the CRD are valid when validated against the validation schema of the new CRD.

2.4.4.7. Dependency best practices

When specifying dependencies, there are best practices you should consider.

Depend on APIs or a specific version range of Operators

Operators can add or remove APIs at any time; always specify an **olm.gvk** dependency on any APIs your Operators requires. The exception to this is if you are specifying **olm.package** constraints instead.

Set a minimum version

The Kubernetes documentation on API changes describes what changes are allowed for Kubernetes-style Operators. These versioning conventions allow an Operator to update an API without bumping the API version, as long as the API is backwards-compatible.
For Operator dependencies, this means that knowing the API version of a dependency might not be enough to ensure the dependent Operator works as intended.

For example:

- TestOperator v1.0.0 provides v1alpha1 API version of the **MyObject** resource.
- TestOperator v1.0.1 adds a new field **spec.newfield** to **MyObject**, but still at v1alpha1.

Your Operator might require the ability to write **spec.newfield** into the **MyObject** resource. An **olm.gvk** constraint alone is not enough for OLM to determine that you need TestOperator v1.0.1 and not TestOperator v1.0.0.

Whenever possible, if a specific Operator that provides an API is known ahead of time, specify an additional **olm.package** constraint to set a minimum.

Omit a maximum version or allow a very wide range

Because Operators provide cluster-scoped resources such as API services and CRDs, an Operator that specifies a small window for a dependency might unnecessarily constrain updates for other consumers of that dependency.
Whenever possible, do not set a maximum version. Alternatively, set a very wide semantic range to prevent conflicts with other Operators. For example, **>1.0.0 <2.0.0**.

Unlike with conventional package managers, Operator authors explicitly encode that updates are safe through channels in OLM. If an update is available for an existing subscription, it is assumed that the Operator author is indicating that it can update from the previous version. Setting a maximum version for a dependency overrides the update stream of the author by unnecessarily truncating it at a particular upper bound.

NOTE

Cluster administrators cannot override dependencies set by an Operator author.

However, maximum versions can and should be set if there are known incompatibilities that must be avoided. Specific versions can be omitted with the version range syntax, for example **> 1.0.0 !1.2.1**.

Additional resources

- Kubernetes documentation: Changing the API

2.4.4.8. Dependency caveats

When specifying dependencies, there are caveats you should consider.

No compound constraints (AND)

There is currently no method for specifying an AND relationship between constraints. In other words, there is no way to specify that one Operator depends on another Operator that both provides a given API and has version **>1.1.0**.
This means that when specifying a dependency such as:

```
dependencies:
- type: olm.package
  value:
    packageName: etcd
    version: ">3.1.0"
- type: olm.gvk
  value:
```

```
group: etcd.database.coreos.com
kind: EtcdCluster
version: v1beta2
```

It would be possible for OLM to satisfy this with two Operators: one that provides EtcdCluster and one that has version **>3.1.0**. Whether that happens, or whether an Operator is selected that satisfies both constraints, depends on the ordering that potential options are visited. Dependency preferences and ordering options are well-defined and can be reasoned about, but to exercise caution, Operators should stick to one mechanism or the other.

Cross-namespace compatibility

OLM performs dependency resolution at the namespace scope. It is possible to get into an update deadlock if updating an Operator in one namespace would be an issue for an Operator in another namespace, and vice-versa.

2.4.4.9. Example dependency resolution scenarios

In the following examples, a *provider* is an Operator which "owns" a CRD or API service.

2.4.4.9.1. Example: Deprecating dependent APIs

A and B are APIs (CRDs):

- The provider of A depends on B.
- The provider of B has a subscription.
- The provider of B updates to provide C but deprecates B.

This results in:

- B no longer has a provider.
- A no longer works.

This is a case OLM prevents with its upgrade strategy.

2.4.4.9.2. Example: Version deadlock

A and B are APIs:

- The provider of A requires B.
- The provider of B requires A.
- The provider of A updates to (provide A2, require B2) and deprecate A.
- The provider of B updates to (provide B2, require A2) and deprecate B.

If OLM attempts to update A without simultaneously updating B, or vice-versa, it is unable to progress to new versions of the Operators, even though a new compatible set can be found.

This is another case OLM prevents with its upgrade strategy.

2.4.5. Operator groups

This guide outlines the use of Operator groups with Operator Lifecycle Manager (OLM) in OpenShift Container Platform.

2.4.5.1. About Operator groups

An *Operator group*, defined by the **OperatorGroup** resource, provides multitenant configuration to OLM-installed Operators. An Operator group selects target namespaces in which to generate required RBAC access for its member Operators.

The set of target namespaces is provided by a comma-delimited string stored in the **olm.targetNamespaces** annotation of a cluster service version (CSV). This annotation is applied to the CSV instances of member Operators and is projected into their deployments.

2.4.5.2. Operator group membership

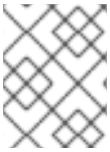
An Operator is considered a *member* of an Operator group if the following conditions are true:

- The CSV of the Operator exists in the same namespace as the Operator group.
- The install modes in the CSV of the Operator support the set of namespaces targeted by the Operator group.

An install mode in a CSV consists of an **InstallModeType** field and a boolean **Supported** field. The spec of a CSV can contain a set of install modes of four distinct **InstallModeTypes**:

Table 2.5. Install modes and supported Operator groups

InstallModeType	Description
OwnNamespace	The Operator can be a member of an Operator group that selects its own namespace.
SingleNamespace	The Operator can be a member of an Operator group that selects one namespace.
MultiNamespace	The Operator can be a member of an Operator group that selects more than one namespace.
AllNamespaces	The Operator can be a member of an Operator group that selects all namespaces (target namespace set is the empty string **""**).



NOTE

If the spec of a CSV omits an entry of **InstallModeType**, then that type is considered unsupported unless support can be inferred by an existing entry that implicitly supports it.

2.4.5.3. Target namespace selection

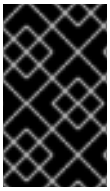
You can explicitly name the target namespace for an Operator group using the **spec.targetNamespaces** parameter:

```
apiVersion: operators.coreos.com/v1
```

```
kind: OperatorGroup
metadata:
  name: my-group
  namespace: my-namespace
spec:
  targetNamespaces:
  - my-namespace
```

You can alternatively specify a namespace using a label selector with the **spec.selector** parameter:

```
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  name: my-group
  namespace: my-namespace
spec:
  selector:
    cool.io/prod: "true"
```



IMPORTANT

Listing multiple namespaces via **spec.targetNamespaces** or use of a label selector via **spec.selector** is not recommended, as the support for more than one target namespace in an Operator group will likely be removed in a future release.

If both **spec.targetNamespaces** and **spec.selector** are defined, **spec.selector** is ignored. Alternatively, you can omit both **spec.selector** and **spec.targetNamespaces** to specify a *global* Operator group, which selects all namespaces:

```
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  name: my-group
  namespace: my-namespace
```

The resolved set of selected namespaces is shown in the **status.namespaces** parameter of an Opeator group. The **status.namespace** of a global Operator group contains the empty string (**""**), which signals to a consuming Operator that it should watch all namespaces.

2.4.5.4. Operator group CSV annotations

Member CSVs of an Operator group have the following annotations:

Annotation	Description
olm.operatorGroup=<group_name>	Contains the name of the Operator group.
olm.operatorNamespace=<group_namespace>	Contains the namespace of the Operator group.

Annotation	Description
olm.targetNamespaces=<target_namespaces>	Contains a comma-delimited string that lists the target namespace selection of the Operator group.

NOTE

All annotations except **olm.targetNamespaces** are included with copied CSVs. Omitting the **olm.targetNamespaces** annotation on copied CSVs prevents the duplication of target namespaces between tenants.

2.4.5.5. Provided APIs annotation

A *group/version/kind (GVK)* is a unique identifier for a Kubernetes API. Information about what GVKs are provided by an Operator group are shown in an **olm.providedAPIs** annotation. The value of the annotation is a string consisting of **<kind>.<version>.<group>** delimited with commas. The GVKs of CRDs and API services provided by all active member CSVs of an Operator group are included.

Review the following example of an **OperatorGroup** object with a single active member CSV that provides the **PackageManifest** resource:

```
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  annotations:
    olm.providedAPIs: PackageManifest.v1alpha1.packages.apps.redhat.com
  name: olm-operators
  namespace: local
  ...
spec:
  selector: {}
  serviceAccountName:
    metadata:
      creationTimestamp: null
  targetNamespaces:
  - local
status:
  lastUpdated: 2019-02-19T16:18:28Z
  namespaces:
  - local
```

2.4.5.6. Role-based access control

When an Operator group is created, three cluster roles are generated. When the cluster roles are generated, they are automatically suffixed with a hash value to ensure that each cluster role is unique. Each Operator group contains a single aggregation rule with a cluster role selector set to match a label, as shown in the following table:

Cluster role	Label to match
olm.og.<operatorgroup_name>-admin-<hash_value>	**olm.opgroup.permissions/aggregate-to-admin: <operatorgroup_name>**
olm.og.<operatorgroup_name>-edit-<hash_value>	**olm.opgroup.permissions/aggregate-to-edit: <operatorgroup_name>**
olm.og.<operatorgroup_name>-view-<hash_value>	**olm.opgroup.permissions/aggregate-to-view: <operatorgroup_name>**

NOTE

To use the cluster role of an Operator group to assign role-based access control (RBAC) to a resource, get the full name of cluster role and hash value by running the following command:

```
$ oc get clusterroles | grep <operatorgroup_name>
```

Because the hash value is generated when the Operator group is created, you must create the Operator group before you can look up the complete name of the cluster role.

The following RBAC resources are generated when a CSV becomes an active member of an Operator group, as long as the CSV is watching all namespaces with the **AllNamespaces** install mode and is not in a failed state with reason **InterOperatorGroupOwnerConflict**:

- Cluster roles for each API resource from a CRD
- Cluster roles for each API resource from an API service
- Additional roles and role bindings

Table 2.6. Cluster roles generated for each API resource from a CRD

Cluster role	Settings
<kind>.<group>-<version>-admin	Verbs on **<kind>**: • ***** Aggregation labels: • **rbac.authorization.k8s.io/aggregate-to-admin: true** • **olm.opgroup.permissions/aggregate-to-admin: <operatorgroup_name>**

Cluster role	Settings
<kind>.<group>-<version>-edit	Verbs on **<kind>**: • **create** • **update** • **patch** • **delete** Aggregation labels: • **rbac.authorization.k8s.io/aggregate-to-edit: true** • **olm.opgroup.permissions/aggregate-to-edit: <operatorgroup_name>**
<kind>.<group>-<version>-view	Verbs on **<kind>**: • **get** • **list** • **watch** Aggregation labels: • **rbac.authorization.k8s.io/aggregate-to-view: true** • **olm.opgroup.permissions/aggregate-to-view: <operatorgroup_name>**
<kind>.<group>-<version>-view-crdview	Verbs on **apiextensions.k8s.io customresourcedefinitions <crd-name>**: • **get** Aggregation labels: • **rbac.authorization.k8s.io/aggregate-to-view: true** • **olm.opgroup.permissions/aggregate-to-view: <operatorgroup_name>**

Table 2.7. Cluster roles generated for each API resource from an API service

Cluster role	Settings
<kind>.<group>-<version>-admin	Verbs on **<kind>**: • ***** Aggregation labels: • **rbac.authorization.k8s.io/aggregate-to-admin: true** • **olm.opgroup.permissions/aggregate-to-admin: <operatorgroup_name>**
<kind>.<group>-<version>-edit	Verbs on **<kind>**: • **create** • **update** • **patch** • **delete** Aggregation labels: • **rbac.authorization.k8s.io/aggregate-to-edit: true** • **olm.opgroup.permissions/aggregate-to-edit: <operatorgroup_name>**
<kind>.<group>-<version>-view	Verbs on **<kind>**: • **get** • **list** • **watch** Aggregation labels: • **rbac.authorization.k8s.io/aggregate-to-view: true** • **olm.opgroup.permissions/aggregate-to-view: <operatorgroup_name>**

Additional roles and role bindings

- If the CSV defines exactly one target namespace that contains *****, then a cluster role and corresponding cluster role binding are generated for each permission defined in the **permissions** field of the CSV. All resources generated are given the **olm.owner: <csv_name>** and **olm.owner.namespace: <csv_namespace>** labels.

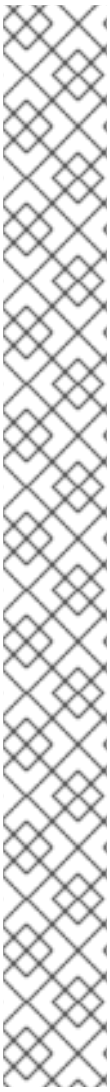
- If the CSV does *not* define exactly one target namespace that contains *, then all roles and role bindings in the Operator namespace with the **olm.owner: <csv_name>** and **olm.owner.namespace: <csv_namespace>** labels are copied into the target namespace.

2.4.5.7. Copied CSVs

OLM creates copies of all active member CSVs of an Operator group in each of the target namespaces of that Operator group. The purpose of a copied CSV is to tell users of a target namespace that a specific Operator is configured to watch resources created there.

Copied CSVs have a status reason **Copied** and are updated to match the status of their source CSV. The **olm.targetNamespaces** annotation is stripped from copied CSVs before they are created on the cluster. Omitting the target namespace selection avoids the duplication of target namespaces between tenants.

Copied CSVs are deleted when their source CSV no longer exists or the Operator group that their source CSV belongs to no longer targets the namespace of the copied CSV.



NOTE

By default, the **disableCopiedCSVs** field is disabled. After enabling a **disableCopiedCSVs** field, the OLM deletes existing copied CSVs on a cluster. When a **disableCopiedCSVs** field is disabled, the OLM adds copied CSVs again.

- Disable the **disableCopiedCSVs** field:

```
$ cat << EOF | oc apply -f -
apiVersion: operators.coreos.com/v1
kind: OLMConfig
metadata:
  name: cluster
spec:
  features:
    disableCopiedCSVs: false
EOF
```

- Enable the **disableCopiedCSVs** field:

```
$ cat << EOF | oc apply -f -
apiVersion: operators.coreos.com/v1
kind: OLMConfig
metadata:
  name: cluster
spec:
  features:
    disableCopiedCSVs: true
EOF
```

2.4.5.8. Static Operator groups

An Operator group is *static* if its **spec.staticProvidedAPIs** field is set to **true**. As a result, OLM does not modify the **olm.providedAPIs** annotation of an Operator group, which means that it can be set in advance. This is useful when a user wants to use an Operator group to prevent resource contention in a set of namespaces but does not have active member CSVs that provide the APIs for those resources.

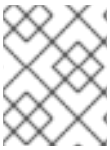
Below is an example of an Operator group that protects **Prometheus** resources in all namespaces with the **something.cool.io/cluster-monitoring: "true"** annotation:

```
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  name: cluster-monitoring
  namespace: cluster-monitoring
  annotations:
    olm.providedAPIs:
Alertmanager.v1.monitoring.coreos.com,Prometheus.v1.monitoring.coreos.com,PrometheusRule.v1.mo
nitoring.coreos.com,ServiceMonitor.v1.monitoring.coreos.com
spec:
  staticProvidedAPIs: true
  selector:
    matchLabels:
      something.cool.io/cluster-monitoring: "true"
```

2.4.5.9. Operator group intersection

Two Operator groups are said to have *intersecting provided APIs* if the intersection of their target namespace sets is not an empty set and the intersection of their provided API sets, defined by **olm.providedAPIs** annotations, is not an empty set.

A potential issue is that Operator groups with intersecting provided APIs can compete for the same resources in the set of intersecting namespaces.



NOTE

When checking intersection rules, an Operator group namespace is always included as part of its selected target namespaces.

2.4.5.9.1. Rules for intersection

Each time an active member CSV synchronizes, OLM queries the cluster for the set of intersecting provided APIs between the Operator group of the CSV and all others. OLM then checks if that set is an empty set:

- If **true** and the CSV's provided APIs are a subset of the Operator group's:
  - Continue transitioning.
- If **true** and the CSV's provided APIs are *not* a subset of the Operator group's:
  - If the Operator group is static:
    - Clean up any deployments that belong to the CSV.
    - Transition the CSV to a failed state with status reason **CannotModifyStaticOperatorGroupProvidedAPIs**.
  - If the Operator group is *not* static:
    - Replace the Operator group's **olm.providedAPIs** annotation with the union of itself and the CSV's provided APIs.

- If **false** and the CSV's provided APIs are *not* a subset of the Operator group's:
  - Clean up any deployments that belong to the CSV.
  - Transition the CSV to a failed state with status reason **InterOperatorGroupOwnerConflict**.
- If **false** and the CSV's provided APIs are a subset of the Operator group's:
  - If the Operator group is static:
    - Clean up any deployments that belong to the CSV.
    - Transition the CSV to a failed state with status reason **CannotModifyStaticOperatorGroupProvidedAPIs**.
  - If the Operator group is *not* static:
    - Replace the Operator group's **olm.providedAPIs** annotation with the difference between itself and the CSV's provided APIs.

NOTE

Failure states caused by Operator groups are non-terminal.

The following actions are performed each time an Operator group synchronizes:

- The set of provided APIs from active member CSVs is calculated from the cluster. Note that copied CSVs are ignored.
- The cluster set is compared to **olm.providedAPIs**, and if **olm.providedAPIs** contains any extra APIs, then those APIs are pruned.
- All CSVs that provide the same APIs across all namespaces are requeued. This notifies conflicting CSVs in intersecting groups that their conflict has possibly been resolved, either through resizing or through deletion of the conflicting CSV.

2.4.5.10. Limitations for multitenant Operator management

OpenShift Container Platform provides limited support for simultaneously installing different versions of an Operator on the same cluster. Operator Lifecycle Manager (OLM) installs Operators multiple times in different namespaces. One constraint of this is that the Operator's API versions must be the same.

Operators are control plane extensions due to their usage of **CustomResourceDefinition** objects (CRDs), which are global resources in Kubernetes. Different major versions of an Operator often have incompatible CRDs. This makes them incompatible to install simultaneously in different namespaces on a cluster.

All tenants, or namespaces, share the same control plane of a cluster. Therefore, tenants in a multitenant cluster also share global CRDs, which limits the scenarios in which different instances of the same Operator can be used in parallel on the same cluster.

The supported scenarios include the following:

- Operators of different versions that ship the exact same CRD definition (in case of versioned CRDs, the exact same set of versions)

- Operators of different versions that do not ship a CRD, and instead have their CRD available in a separate bundle on the OperatorHub

All other scenarios are not supported, because the integrity of the cluster data cannot be guaranteed if there are multiple competing or overlapping CRDs from different Operator versions to be reconciled on the same cluster.

Additional resources

- Operator Lifecycle Manager (OLM) → Multitenancy and Operator colocation
- Operators in multitenant clusters
- Allowing non-cluster administrators to install Operators

2.4.5.11. Troubleshooting Operator groups

2.4.5.11.1. Membership

- An install plan's namespace must contain only one Operator group. When attempting to generate a cluster service version (CSV) in a namespace, an install plan considers an Operator group invalid in the following scenarios:
  - No Operator groups exist in the install plan's namespace.
  - Multiple Operator groups exist in the install plan's namespace.
  - An incorrect or non-existent service account name is specified in the Operator group.

  If an install plan encounters an invalid Operator group, the CSV is not generated and the **InstallPlan** resource continues to install with a relevant message. For example, the following message is provided if more than one Operator group exists in the same namespace:

  > attenuated service account query failed - more than one operator group(s) are managing this namespace count=2

  where **count=** specifies the number of Operator groups in the namespace.

- If the install modes of a CSV do not support the target namespace selection of the Operator group in its namespace, the CSV transitions to a failure state with the reason **UnsupportedOperatorGroup**. CSVs in a failed state for this reason transition to pending after either the target namespace selection of the Operator group changes to a supported configuration, or the install modes of the CSV are modified to support the target namespace selection.

2.4.6. Multitenancy and Operator colocation

This guide outlines multitenancy and Operator colocation in Operator Lifecycle Manager (OLM).

2.4.6.1. Colocation of Operators in a namespace

Operator Lifecycle Manager (OLM) handles OLM-managed Operators that are installed in the same namespace, meaning their **Subscription** resources are colocated in the same namespace, as related Operators. Even if they are not actually related, OLM considers their states, such as their version and update policy, when any one of them is updated.

This default behavior manifests in two ways:

- **InstallPlan** resources of pending updates include **ClusterServiceVersion** (CSV) resources of all other Operators that are in the same namespace.
- All Operators in the same namespace share the same update policy. For example, if one Operator is set to manual updates, all other Operators' update policies are also set to manual.

These scenarios can lead to the following issues:

- It becomes hard to reason about install plans for Operator updates, because there are many more resources defined in them than just the updated Operator.
- It becomes impossible to have some Operators in a namespace update automatically while other are updated manually, which is a common desire for cluster administrators.

These issues usually surface because, when installing Operators with the OpenShift Container Platform web console, the default behavior installs Operators that support the **All namespaces** install mode into the default **openshift-operators** global namespace.

As a cluster administrator, you can bypass this default behavior manually by using the following workflow:

1. Create a namespace for the installation of the Operator.
2. Create a custom *global Operator group*, which is an Operator group that watches all namespaces. By associating this Operator group with the namespace you just created, it makes the installation namespace a global namespace, which makes Operators installed there available in all namespaces.
3. Install the desired Operator in the installation namespace.

If the Operator has dependencies, the dependencies are automatically installed in the pre-created namespace. As a result, it is then valid for the dependency Operators to have the same update policy and shared install plans. For a detailed procedure, see "Installing global Operators in custom namespaces".

Additional resources

- Installing global Operators in custom namespaces
- Operators in multitenant clusters

2.4.7. Operator conditions

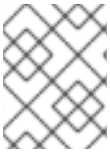
This guide outlines how Operator Lifecycle Manager (OLM) uses Operator conditions.

2.4.7.1. About Operator conditions

As part of its role in managing the lifecycle of an Operator, Operator Lifecycle Manager (OLM) infers the state of an Operator from the state of Kubernetes resources that define the Operator. While this approach provides some level of assurance that an Operator is in a given state, there are many instances where an Operator might need to communicate information to OLM that could not be inferred otherwise. This information can then be used by OLM to better manage the lifecycle of the Operator.

OLM provides a custom resource definition (CRD) called **OperatorCondition** that allows Operators to

communicate conditions to OLM. There are a set of supported conditions that influence management of the Operator by OLM when present in the **Spec.Conditions** array of an **OperatorCondition** resource.



NOTE

By default, the **Spec.Conditions** array is not present in an **OperatorCondition** object until it is either added by a user or as a result of custom Operator logic.

2.4.7.2. Supported conditions

Operator Lifecycle Manager (OLM) supports the following Operator conditions.

2.4.7.2.1. Upgradeable condition

The **Upgradeable** Operator condition prevents an existing cluster service version (CSV) from being replaced by a newer version of the CSV. This condition is useful when:

- An Operator is about to start a critical process and should not be upgraded until the process is completed.
- An Operator is performing a migration of custom resources (CRs) that must be completed before the Operator is ready to be upgraded.

IMPORTANT

Setting the **Upgradeable** Operator condition to the **False** value does not avoid pod disruption. If you must ensure your pods are not disrupted, see "Using pod disruption budgets to specify the number of pods that must be up" and "Graceful termination" in the "Additional resources" section.

Example Upgradeable Operator condition

```
apiVersion: operators.coreos.com/v1
kind: OperatorCondition
metadata:
  name: my-operator
  namespace: operators
spec:
  conditions:
  - type: Upgradeable (1)
    status: "False" (2)
    reason: "migration"
    message: "The Operator is performing a migration."
    lastTransitionTime: "2020-08-24T23:15:55Z"
```

(1) Name of the condition.

(2) A **False** value indicates the Operator is not ready to be upgraded. OLM prevents a CSV that replaces the existing CSV of the Operator from leaving the **Pending** phase. A **False** value does not block cluster upgrades.

2.4.7.3. Additional resources

- Managing Operator conditions
- Using pod disruption budgets to specify the number of pods that must be up
- Graceful termination

2.4.8. Operator Lifecycle Manager metrics

2.4.8.1. Exposed metrics

Operator Lifecycle Manager (OLM) exposes certain OLM-specific resources for use by the Prometheus-based OpenShift Container Platform cluster monitoring stack.

Table 2.8. Metrics exposed by OLM

Name	Description
catalog_source_count	Number of catalog sources.
catalogsource_ready	State of a catalog source. The value **1** indicates that the catalog source is in a**READY** state. The value of **0** indicates that the catalog source is not in a**READY** state.
csv_abnormal	When reconciling a cluster service version (CSV), present whenever a CSV version is in any state other than **Succeeded**, for example when it is not installed. Includes the **name**, **namespace**, **phase**, **reason**, and **version** labels. A Prometheus alert is created when this metric is present.
csv_count	Number of CSVs successfully registered.
csv_succeeded	When reconciling a CSV, represents whether a CSV version is in a **Succeeded** state (value **1**) or not (value **0**). Includes the **name**, **namespace**, and **version** labels.
csv_upgrade_count	Monotonic count of CSV upgrades.
install_plan_count	Number of install plans.
installplan_warnings_total	Monotonic count of warnings generated by resources, such as deprecated resources, included in an install plan.
olm_resolution_duration_seconds	The duration of a dependency resolution attempt.
subscription_count	Number of subscriptions.

Name	Description
subscription_sync_total	Monotonic count of subscription syncs. Includes the **channel**, **installed** CSV, and subscription **name** labels.

2.4.9. Webhook management in Operator Lifecycle Manager

Webhooks allow Operator authors to intercept, modify, and accept or reject resources before they are saved to the object store and handled by the Operator controller. Operator Lifecycle Manager (OLM) can manage the lifecycle of these webhooks when they are shipped alongside your Operator.

2.4.9.1. Additional resources

- Types of webhook admission plugins
- Kubernetes documentation:
  - Validating admission webhooks
  - Mutating admission webhooks
  - Conversion webhooks

2.5. UNDERSTANDING OPERATORHUB

2.5.1. About OperatorHub

OperatorHub is the web console interface in OpenShift Container Platform that cluster administrators use to discover and install Operators. With one click, an Operator can be pulled from its off-cluster source, installed and subscribed on the cluster, and made ready for engineering teams to self-service manage the product across deployment environments using Operator Lifecycle Manager (OLM).

Cluster administrators can choose from catalogs grouped into the following categories:

Category	Description
Red Hat Operators	Red Hat products packaged and shipped by Red Hat. Supported by Red Hat.
Certified Operators	Products from leading independent software vendors (ISVs). Red Hat partners with ISVs to package and ship. Supported by the ISV.
Community Operators	Optionally-visible software maintained by relevant representatives in the redhat-openshift-ecosystem/community-operators-prod/operators GitHub repository. No official support.
Custom Operators	Operators you add to the cluster yourself. If you have not added any custom Operators, the **Custom** category does not appear in the web console on your OperatorHub.

Operators on OperatorHub are packaged to run on OLM. This includes a YAML file called a cluster

service version (CSV) containing all of the CRDs, RBAC rules, deployments, and container images required to install and securely run the Operator. It also contains user-visible information like a description of its features and supported Kubernetes versions.

2.5.2. OperatorHub architecture

The OperatorHub UI component is driven by the Marketplace Operator by default on OpenShift Container Platform in the **openshift-marketplace** namespace.

2.5.2.1. OperatorHub custom resource

The Marketplace Operator manages an **OperatorHub** custom resource (CR) named **cluster** that manages the default **CatalogSource** objects provided with OperatorHub. You can modify this resource to enable or disable the default catalogs, which is useful when configuring OpenShift Container Platform in restricted network environments.

Example OperatorHub custom resource

```
apiVersion: config.openshift.io/v1
kind: OperatorHub
metadata:
  name: cluster
spec:
  disableAllDefaultSources: true (1)
  sources: [ (2)
    {
      name: "community-operators",
      disabled: false
    }
  ]
```

1. **disableAllDefaultSources** is an override that controls availability of all default catalogs that are configured by default during an OpenShift Container Platform installation.
2. Disable default catalogs individually by changing the **disabled** parameter value per source.

2.5.3. Additional resources

- Catalog source
- Operator installation and upgrade workflow in OLM
- Red Hat Partner Connect

2.6. RED HAT-PROVIDED OPERATOR CATALOGS

Red Hat provides several Operator catalogs that are included with OpenShift Container Platform by default.

IMPORTANT

As of OpenShift Container Platform 4.11, the default Red Hat-provided Operator catalog releases in the file-based catalog format. The default Red Hat-provided Operator catalogs for OpenShift Container Platform 4.6 through 4.10 released in the deprecated SQLite database format.

The **opm** subcommands, flags, and functionality related to the SQLite database format are also deprecated and will be removed in a future release. The features are still supported and must be used for catalogs that use the deprecated SQLite database format.

Many of the **opm** subcommands and flags for working with the SQLite database format, such as **opm index prune**, do not work with the file-based catalog format. For more information about working with file-based catalogs, see Managing custom catalogs, Operator Framework packaging format, and Mirroring images for a disconnected installation using the oc-mirror plugin.

2.6.1. About Operator catalogs

An Operator catalog is a repository of metadata that Operator Lifecycle Manager (OLM) can query to discover and install Operators and their dependencies on a cluster. OLM always installs Operators from the latest version of a catalog.

An index image, based on the Operator bundle format, is a containerized snapshot of a catalog. It is an immutable artifact that contains the database of pointers to a set of Operator manifest content. A catalog can reference an index image to source its content for OLM on the cluster.

As catalogs are updated, the latest versions of Operators change, and older versions may be removed or altered. In addition, when OLM runs on an OpenShift Container Platform cluster in a restricted network environment, it is unable to access the catalogs directly from the internet to pull the latest content.

As a cluster administrator, you can create your own custom index image, either based on a Red Hat-provided catalog or from scratch, which can be used to source the catalog content on the cluster. Creating and updating your own index image provides a method for customizing the set of Operators available on the cluster, while also avoiding the aforementioned restricted network environment issues.

IMPORTANT

Kubernetes periodically deprecates certain APIs that are removed in subsequent releases. As a result, Operators are unable to use removed APIs starting with the version of OpenShift Container Platform that uses the Kubernetes version that removed the API.

NOTE

Support for the legacy *package manifest format* for Operators, including custom catalogs that were using the legacy format, is removed in OpenShift Container Platform 4.8 and later.

When creating custom catalog images, previous versions of OpenShift Container Platform 4 required using the **oc adm catalog build** command, which was deprecated for several releases and is now removed. With the availability of Red Hat-provided index images starting in OpenShift Container Platform 4.6, catalog builders must use the **opm index** command to manage index images.

Additional resources

- Managing custom catalogs
- Packaging format
- Using Operator Lifecycle Manager in disconnected environments

2.6.2. About Red Hat-provided Operator catalogs

The Red Hat-provided catalog sources are installed by default in the **openshift-marketplace** namespace, which makes the catalogs available cluster-wide in all namespaces.

The following Operator catalogs are distributed by Red Hat:

Catalog	Index image	Description
redhat-operators	**registry.redhat.io/redhat/redhat-operator-index:v4.19**	Red Hat products packaged and shipped by Red Hat. Supported by Red Hat.
certified-operators	**registry.redhat.io/redhat/certified-operator-index:v4.19**	Products from leading independent software vendors (ISVs). Red Hat partners with ISVs to package and ship. Supported by the ISV.
community-operators	**registry.redhat.io/redhat/community-operator-index:v4.19**	Software maintained by relevant representatives in the redhat-openshift-ecosystem/community-operators-prod/operators GitHub repository. No official support.

During a cluster upgrade, the index image tag for the default Red Hat-provided catalog sources are updated automatically by the Cluster Version Operator (CVO) so that Operator Lifecycle Manager (OLM) pulls the updated version of the catalog. For example during an upgrade from OpenShift Container Platform 4.8 to 4.9, the **spec.image** field in the **CatalogSource** object for the **redhat-operators** catalog is updated from:

```
registry.redhat.io/redhat/redhat-operator-index:v4.8
```

to:

```
registry.redhat.io/redhat/redhat-operator-index:v4.9
```

2.7. OPERATORS IN MULTITENANT CLUSTERS

The default behavior for Operator Lifecycle Manager (OLM) aims to provide simplicity during Operator installation. However, this behavior can lack flexibility, especially in multitenant clusters. In order for multiple tenants on an OpenShift Container Platform cluster to use an Operator, the default behavior of OLM requires that administrators install the Operator in **All namespaces** mode, which can be considered to violate the principle of least privilege.

Consider the following scenarios to determine which Operator installation workflow works best for your environment and requirements.

Additional resources

- Common terms: Multitenant
- Limitations for multitenant Operator management

2.7.1. Default Operator install modes and behavior

When installing Operators with the web console as an administrator, you typically have two choices for the install mode, depending on the Operator's capabilities:

Single namespace

Installs the Operator in the chosen single namespace, and makes all permissions that the Operator requests available in that namespace.

All namespaces

Installs the Operator in the default **openshift-operators** namespace to watch and be made available to all namespaces in the cluster. Makes all permissions that the Operator requests available in all namespaces. In some cases, an Operator author can define metadata to give the user a second option for that Operator's suggested namespace.

This choice also means that users in the affected namespaces get access to the Operators APIs, which can leverage the custom resources (CRs) they own, depending on their role in the namespace:

- The **namespace-admin** and **namespace-edit** roles can read/write to the Operator APIs, meaning they can use them.
- The **namespace-view** role can read CR objects of that Operator.

For **Single namespace** mode, because the Operator itself installs in the chosen namespace, its pod and service account are also located there. For **All namespaces** mode, the Operator's privileges are all automatically elevated to cluster roles, meaning the Operator has those permissions in all namespaces.

Additional resources

- Adding Operators to a cluster
- Install modes types

2.7.2. Recommended solution for multitenant clusters

While a **Multinamespace** install mode does exist, it is supported by very few Operators. As a middle ground solution between the standard **All namespaces** and **Single namespace** install modes, you can install multiple instances of the same Operator, one for each tenant, by using the following workflow:

1. Create a namespace for the tenant Operator that is separate from the tenant's namespace.

2. Create an Operator group for the tenant Operator scoped only to the tenant's namespace.
3. Install the Operator in the tenant Operator namespace.

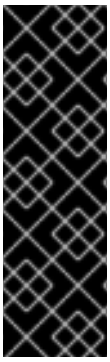
As a result, the Operator resides in the tenant Operator namespace and watches the tenant namespace, but neither the Operator's pod nor its service account are visible or usable by the tenant.

This solution provides better tenant separation, least privilege principle at the cost of resource usage, and additional orchestration to ensure the constraints are met. For a detailed procedure, see "Preparing for multiple instances of an Operator for multitenant clusters".

Limitations and considerations

This solution only works when the following constraints are met:

- All instances of the same Operator must be the same version.
- The Operator cannot have dependencies on other Operators.
- The Operator cannot ship a CRD conversion webhook.



IMPORTANT

You cannot use different versions of the same Operator on the same cluster. Eventually, the installation of another instance of the Operator would be blocked when it meets the following conditions:

- The instance is not the newest version of the Operator.
- The instance ships an older revision of the CRDs that lack information or versions that newer revisions have that are already in use on the cluster.

WARNING

As an administrator, use caution when allowing non-cluster administrators to install Operators self-sufficiently, as explained in "Allowing non-cluster administrators to install Operators". These tenants should only have access to a curated catalog of Operators that are known to not have dependencies. These tenants must also be forced to use the same version line of an Operator, to ensure the CRDs do not change. This requires the use of namespace-scoped catalogs and likely disabling the global default catalogs.

Additional resources

- Preparing for multiple instances of an Operator for multitenant clusters
- Allowing non-cluster administrators to install Operators
- Disabling the default OperatorHub catalog sources

2.7.3. Operator colocation and Operator groups

Operator Lifecycle Manager (OLM) handles OLM-managed Operators that are installed in the same namespace, meaning their **Subscription** resources are colocated in the same namespace, as related Operators. Even if they are not actually related, OLM considers their states, such as their version and update policy, when any one of them is updated.

For more information on Operator colocation and using Operator groups effectively, see Operator Lifecycle Manager (OLM) → Multitenancy and Operator colocation.

2.8. CRDS

2.8.1. Extending the Kubernetes API with custom resource definitions

Operators use the Kubernetes extension mechanism, custom resource definitions (CRDs), so that custom objects managed by the Operator look and act just like the built-in, native Kubernetes objects. This guide describes how cluster administrators can extend their OpenShift Container Platform cluster by creating and managing CRDs.

2.8.1.1. Custom resource definitions

In the Kubernetes API, a *resource* is an endpoint that stores a collection of API objects of a certain kind. For example, the built-in **Pods** resource contains a collection of **Pod** objects.

A *custom resource definition* (CRD) object defines a new, unique object type, called a *kind*, in the cluster and lets the Kubernetes API server handle its entire lifecycle.

Custom resource (CR) objects are created from CRDs that have been added to the cluster by a cluster administrator, allowing all cluster users to add the new resource type into projects.

When a cluster administrator adds a new CRD to the cluster, the Kubernetes API server reacts by creating a new RESTful resource path that can be accessed by the entire cluster or a single project (namespace) and begins serving the specified CR.

Cluster administrators that want to grant access to the CRD to other users can use cluster role aggregation to grant access to users with the **admin**, **edit**, or **view** default cluster roles. Cluster role aggregation allows the insertion of custom policy rules into these cluster roles. This behavior integrates the new resource into the RBAC policy of the cluster as if it was a built-in resource.

Operators in particular make use of CRDs by packaging them with any required RBAC policy and other software-specific logic. Cluster administrators can also add CRDs manually to the cluster outside of the lifecycle of an Operator, making them available to all users.

NOTE

While only cluster administrators can create CRDs, developers can create the CR from an existing CRD if they have read and write permission to it.

2.8.1.2. Creating a custom resource definition

To create custom resource (CR) objects, cluster administrators must first create a custom resource definition (CRD).

Prerequisites

- Access to an OpenShift Container Platform cluster with **cluster-admin** user privileges.

Procedure

To create a CRD:

1. Create a YAML file that contains the following field types:

Example YAML file for a CRD

```
apiVersion: apiextensions.k8s.io/v1 1
kind: CustomResourceDefinition
metadata:
  name: crontabs.stable.example.com 2
spec:
  group: stable.example.com 3
  versions:
    - name: v1 4
      served: true
      storage: true
      schema:
        openAPIV3Schema:
          type: object
          properties:
            spec:
              type: object
              properties:
                cronSpec:
                  type: string
                image:
                  type: string
                replicas:
                  type: integer
  scope: Namespaced 5
  names:
    plural: crontabs 6
    singular: crontab 7
    kind: CronTab 8
    shortNames:
    - ct 9
```

1. Use the **apiextensions.k8s.io/v1** API.

2. Specify a name for the definition. This must be in the **<plural-name>.<group>** format using the values from the **group** and **plural** fields.

3. Specify a group name for the API. An API group is a collection of objects that are logically related. For example, all batch objects like **Job** or **ScheduledJob** could be in the batch API group (such as **batch.api.example.com**). A good practice is to use a fully-qualified-domain name (FQDN) of your organization.

4. Specify a version name to be used in the URL. Each API group can exist in multiple versions, for example **v1alpha**, **v1beta**, **v1**.

5. Specify whether the custom objects are available to a project (**Namespaced**) or all projects in the cluster (**Cluster**).

6 Specify the plural name to use in the URL. The **plural** field is the same as a resource in an API URL.

7 Specify a singular name to use as an alias on the CLI and for display.

8 Specify the kind of objects that can be created. The type can be in CamelCase.

9 Specify a shorter string to match your resource on the CLI.

NOTE

By default, a CRD is cluster-scoped and available to all projects.

2. Create the CRD object:

```
$ oc create -f <file_name>.yaml
```

A new RESTful API endpoint is created at:

```
/apis/<spec:group>/<spec:version>/<scope>/*/<names-plural>/...
```

For example, using the example file, the following endpoint is created:

```
/apis/stable.example.com/v1/namespaces/*/crontabs/...
```

You can now use this endpoint URL to create and manage CRs. The object kind is based on the **spec.kind** field of the CRD object you created.

2.8.1.3. Creating cluster roles for custom resource definitions

Cluster administrators can grant permissions to existing cluster-scoped custom resource definitions (CRDs). If you use the **admin**, **edit**, and **view** default cluster roles, you can take advantage of cluster role aggregation for their rules.

IMPORTANT

You must explicitly assign permissions to each of these roles. The roles with more permissions do not inherit rules from roles with fewer permissions. If you assign a rule to a role, you must also assign that verb to roles that have more permissions. For example, if you grant the **get crontabs** permission to the view role, you must also grant it to the **edit** and **admin** roles. The **admin** or **edit** role is usually assigned to the user that created a project through the project template.

Prerequisites

- Create a CRD.

Procedure

1. Create a cluster role definition file for the CRD. The cluster role definition is a YAML file that contains the rules that apply to each cluster role. An OpenShift Container Platform controller adds the rules that you specify to the default cluster roles.

Example YAML file for a cluster role definition

```
kind: ClusterRole
apiVersion: rbac.authorization.k8s.io/v1 (1)
metadata:
  name: aggregate-cron-tabs-admin-edit (2)
  labels:
    rbac.authorization.k8s.io/aggregate-to-admin: "true" (3)
    rbac.authorization.k8s.io/aggregate-to-edit: "true" (4)
rules:
- apiGroups: ["stable.example.com"] (5)
  resources: ["crontabs"] (6)
  verbs: ["get", "list", "watch", "create", "update", "patch", "delete", "deletecollection"] (7)
---
kind: ClusterRole
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  name: aggregate-cron-tabs-view (8)
  labels:
    # Add these permissions to the "view" default role.
    rbac.authorization.k8s.io/aggregate-to-view: "true" (9)
    rbac.authorization.k8s.io/aggregate-to-cluster-reader: "true" (10)
rules:
- apiGroups: ["stable.example.com"] (11)
  resources: ["crontabs"] (12)
  verbs: ["get", "list", "watch"] (13)
```

(1) Use the **rbac.authorization.k8s.io/v1** API.

(2) (8) Specify a name for the definition.

(3) Specify this label to grant permissions to the admin default role.

(4) Specify this label to grant permissions to the edit default role.

(5) (11) Specify the group name of the CRD.

(6) (12) Specify the plural name of the CRD that these rules apply to.

(7) (13) Specify the verbs that represent the permissions that are granted to the role. For example, apply read and write permissions to the **admin** and **edit** roles and only read permission to the **view** role.

(9) Specify this label to grant permissions to the **view** default role.

(10) Specify this label to grant permissions to the **cluster-reader** default role.

2. Create the cluster role:

```
$ oc create -f <file_name>.yaml
```

2.8.1.4. Creating custom resources from a file

After a custom resource definition (CRD) has been added to the cluster, custom resources (CRs) can be created with the CLI from a file using the CR specification.

Prerequisites

- CRD added to the cluster by a cluster administrator.

Procedure

1. Create a YAML file for the CR. In the following example definition, the **cronSpec** and **image** custom fields are set in a CR of **Kind: CronTab**. The **Kind** comes from the **spec.kind** field of the CRD object:

   Example YAML file for a CR

```
apiVersion: "stable.example.com/v1" 1
kind: CronTab 2
metadata:
  name: my-new-cron-object 3
  finalizers: 4
  - finalizer.stable.example.com
spec: 5
  cronSpec: "* * * * /5"
  image: my-awesome-cron-image
```

   1. Specify the group name and API version (name/version) from the CRD.
   2. Specify the type in the CRD.
   3. Specify a name for the object.
   4. Specify the finalizers for the object, if any. Finalizers allow controllers to implement conditions that must be completed before the object can be deleted.
   5. Specify conditions specific to the type of object.

2. After you create the file, create the object:

```
$ oc create -f <file_name>.yaml
```

2.8.1.5. Inspecting custom resources

You can inspect custom resource (CR) objects that exist in your cluster using the CLI.

Prerequisites

- A CR object exists in a namespace to which you have access.

Procedure

1. To get information on a specific kind of a CR, run:

```
$ oc get <kind>
```

For example:

```
$ oc get crontab
```

Example output

```
NAME                 KIND
my-new-cron-object   CronTab.v1.stable.example.com
```

Resource names are not case-sensitive, and you can use either the singular or plural forms defined in the CRD, as well as any short name. For example:

```
$ oc get crontabs
```

```
$ oc get crontab
```

```
$ oc get ct
```

2. You can also view the raw YAML data for a CR:

```
$ oc get <kind> -o yaml
```

For example:

```
$ oc get ct -o yaml
```

Example output

```
apiVersion: v1
items:
- apiVersion: stable.example.com/v1
  kind: CronTab
  metadata:
    clusterName: ""
    creationTimestamp: 2017-05-31T12:56:35Z
    deletionGracePeriodSeconds: null
    deletionTimestamp: null
    name: my-new-cron-object
    namespace: default
    resourceVersion: "285"
    selfLink: /apis/stable.example.com/v1/namespaces/default/crontabs/my-new-cron-object
    uid: 9423255b-4600-11e7-af6a-28d2447dc82b
  spec:
    cronSpec: '* * * * /5' 1
    image: my-awesome-cron-image 2
```

1 2 Custom data from the YAML that you used to create the object displays.

2.8.2. Managing resources from custom resource definitions

This guide describes how developers can manage custom resources (CRs) that come from custom resource definitions (CRDs).

2.8.2.1. Custom resource definitions

In the Kubernetes API, a *resource* is an endpoint that stores a collection of API objects of a certain kind. For example, the built-in **Pods** resource contains a collection of **Pod** objects.

A *custom resource definition* (CRD) object defines a new, unique object type, called a *kind*, in the cluster and lets the Kubernetes API server handle its entire lifecycle.

Custom resource (CR) objects are created from CRDs that have been added to the cluster by a cluster administrator, allowing all cluster users to add the new resource type into projects.

Operators in particular make use of CRDs by packaging them with any required RBAC policy and other software-specific logic. Cluster administrators can also add CRDs manually to the cluster outside of the lifecycle of an Operator, making them available to all users.

NOTE

While only cluster administrators can create CRDs, developers can create the CR from an existing CRD if they have read and write permission to it.

2.8.2.2. Creating custom resources from a file

After a custom resource definition (CRD) has been added to the cluster, custom resources (CRs) can be created with the CLI from a file using the CR specification.

Prerequisites

- CRD added to the cluster by a cluster administrator.

Procedure

1. Create a YAML file for the CR. In the following example definition, the **cronSpec** and **image** custom fields are set in a CR of **Kind: CronTab**. The **Kind** comes from the **spec.kind** field of the CRD object:

   Example YAML file for a CR

```
apiVersion: "stable.example.com/v1" 1
kind: CronTab 2
metadata:
  name: my-new-cron-object 3
  finalizers: 4
  - finalizer.stable.example.com
spec: 5
  cronSpec: "* * * * /5"
  image: my-awesome-cron-image
```

   1 Specify the group name and API version (name/version) from the CRD.

2 Specify the type in the CRD.

3 Specify a name for the object.

4 Specify the finalizers for the object, if any. Finalizers allow controllers to implement conditions that must be completed before the object can be deleted.

5 Specify conditions specific to the type of object.

2. After you create the file, create the object:

```
$ oc create -f <file_name>.yaml
```

2.8.2.3. Inspecting custom resources

You can inspect custom resource (CR) objects that exist in your cluster using the CLI.

Prerequisites

- A CR object exists in a namespace to which you have access.

Procedure

1. To get information on a specific kind of a CR, run:

```
$ oc get <kind>
```

For example:

```
$ oc get crontab
```

Example output

```
NAME                 KIND
my-new-cron-object   CronTab.v1.stable.example.com
```

Resource names are not case-sensitive, and you can use either the singular or plural forms defined in the CRD, as well as any short name. For example:

```
$ oc get crontabs
```

```
$ oc get crontab
```

```
$ oc get ct
```

2. You can also view the raw YAML data for a CR:

```
$ oc get <kind> -o yaml
```

For example:

```
$ oc get ct -o yaml
```

Example output

```
apiVersion: v1
items:
- apiVersion: stable.example.com/v1
  kind: CronTab
  metadata:
    clusterName: ""
    creationTimestamp: 2017-05-31T12:56:35Z
    deletionGracePeriodSeconds: null
    deletionTimestamp: null
    name: my-new-cron-object
    namespace: default
    resourceVersion: "285"
    selfLink: /apis/stable.example.com/v1/namespaces/default/crontabs/my-new-cron-object
    uid: 9423255b-4600-11e7-af6a-28d2447dc82b
  spec:
    cronSpec: '* * * * /5' 1
    image: my-awesome-cron-image 2
```

1 2 Custom data from the YAML that you used to create the object displays.

CHAPTER 3. USER TASKS

3.1. CREATING APPLICATIONS FROM INSTALLED OPERATORS

This guide walks developers through an example of creating applications from an installed Operator using the OpenShift Container Platform web console.

3.1.1. Creating an etcd cluster using an Operator

This procedure walks through creating a new etcd cluster using the etcd Operator, managed by Operator Lifecycle Manager (OLM).

Prerequisites

- Access to an OpenShift Container Platform 4.19 cluster.
- The etcd Operator already installed cluster-wide by an administrator.

Procedure

1. Create a new project in the OpenShift Container Platform web console for this procedure. This example uses a project called **my-etcd**.
2. Navigate to the **Operators → Installed Operators** page. The Operators that have been installed to the cluster by the cluster administrator and are available for use are shown here as a list of cluster service versions (CSVs). CSVs are used to launch and manage the software provided by the Operator.

   TIP

   You can get this list from the CLI using:

   ```
   $ oc get csv
   ```

3. On the **Installed Operators** page, click the etcd Operator to view more details and available actions.
   As shown under **Provided APIs**, this Operator makes available three new resource types, including one for an **etcd Cluster** (the **EtcdCluster** resource). These objects work similar to the built-in native Kubernetes ones, such as **Deployment** or **ReplicaSet**, but contain logic specific to managing etcd.
4. Create a new etcd cluster:
   a. In the **etcd Cluster** API box, click **Create instance**.
   b. The next page allows you to make any modifications to the minimal starting template of an **EtcdCluster** object, such as the size of the cluster. For now, click **Create** to finalize. This triggers the Operator to start up the pods, services, and other components of the new etcd cluster.
5. Click the **example** etcd cluster, then click the **Resources** tab to see that your project now contains a number of resources created and configured automatically by the Operator.

Verify that a Kubernetes service has been created that allows you to access the database from other pods in your project.

6. All users with the **edit** role in a given project can create, manage, and delete application instances (an etcd cluster, in this example) managed by Operators that have already been created in the project, in a self-service manner, just like a cloud service. If you want to enable additional users with this ability, project administrators can add the role using the following command:

```
$ oc policy add-role-to-user edit <user> -n <target_project>
```

You now have an etcd cluster that will react to failures and rebalance data as pods become unhealthy or are migrated between nodes in the cluster. Most importantly, cluster administrators or developers with proper access can now easily use the database with their applications.

3.2. INSTALLING OPERATORS IN YOUR NAMESPACE

If a cluster administrator has delegated Operator installation permissions to your account, you can install and subscribe an Operator to your namespace in a self-service manner.

3.2.1. Prerequisites

- A cluster administrator must add certain permissions to your OpenShift Container Platform user account to allow self-service Operator installation to a namespace. See Allowing non-cluster administrators to install Operators for details.

3.2.2. About Operator installation with OperatorHub

OperatorHub is a user interface for discovering Operators; it works in conjunction with Operator Lifecycle Manager (OLM), which installs and manages Operators on a cluster.

As a user with the proper permissions, you can install an Operator from OperatorHub by using the OpenShift Container Platform web console or CLI.

During installation, you must determine the following initial settings for the Operator:

Installation Mode

Choose a specific namespace in which to install the Operator.

Update Channel

If an Operator is available through multiple channels, you can choose which channel you want to subscribe to. For example, to deploy from the **stable** channel, if available, select it from the list.

Approval Strategy

You can choose automatic or manual updates.
If you choose automatic updates for an installed Operator, when a new version of that Operator is available in the selected channel, Operator Lifecycle Manager (OLM) automatically upgrades the running instance of your Operator without human intervention.

If you select manual updates, when a newer version of an Operator is available, OLM creates an update request. As a cluster administrator, you must then manually approve that update request to have the Operator updated to the new version.

- Understanding OperatorHub

3.2.3. Installing from OperatorHub by using the web console

You can install and subscribe to an Operator from OperatorHub by using the OpenShift Container Platform web console.

Prerequisites

- Access to an OpenShift Container Platform cluster using an account with Operator installation permissions.

Procedure

1. Navigate in the web console to the **Operators → OperatorHub** page.
2. Scroll or type a keyword into the **Filter by keyword** box to find the Operator you want. For example, type **advanced** to find the Advanced Cluster Management for Kubernetes Operator. You can also filter options by **Infrastructure Features**. For example, select **Disconnected** if you want to see Operators that work in disconnected environments, also known as restricted network environments.
3. Select the Operator to display additional information.

NOTE

Choosing a Community Operator warns that Red Hat does not certify Community Operators; you must acknowledge the warning before continuing.

4. Read the information about the Operator and click **Install**.
5. On the **Install Operator** page, configure your Operator installation:
   a. If you want to install a specific version of an Operator, select an **Update channel** and **Version** from the lists. You can browse the various versions of an Operator across any channels it might have, view the metadata for that channel and version, and select the exact version you want to install.

NOTE

The version selection defaults to the latest version for the channel selected. If the latest version for the channel is selected, the **Automatic** approval strategy is enabled by default. Otherwise, **Manual** approval is required when not installing the latest version for the selected channel.

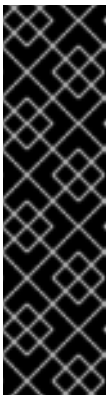
Installing an Operator with **Manual** approval causes all Operators installed within the namespace to function with the **Manual** approval strategy and all Operators are updated together. If you want to update Operators independently, install Operators into separate namespaces.

   b. Choose a specific, single namespace in which to install the Operator. The Operator will only watch and be made available for use in this single namespace.
   c. For clusters on cloud providers with token authentication enabled:
      - If the cluster uses AWS Security Token Service (**STS Mode** in the web console), enter the Amazon Resource Name (ARN) of the AWS IAM role of your service account in the

role ARN field. To create the role's ARN, follow the procedure described in Preparing AWS account.

- If the cluster uses Microsoft Entra Workload ID (**Workload Identity / Federated Identity Mode** in the web console), add the client ID, tenant ID, and subscription ID in the appropriate fields.
- If the cluster uses Google Cloud Platform Workload Identity (**GCP Workload Identity / Federated Identity Mode** in the web console), add the project number, pool ID, provider ID, and service account email in the appropriate fields.

d. For **Update approval**, select either the **Automatic** or **Manual** approval strategy.



IMPORTANT

If the web console shows that the cluster uses AWS STS, Microsoft Entra Workload ID, or GCP Workload Identity, you must set **Update approval** to **Manual**.

Subscriptions with automatic approvals for updates are not recommended because there might be permission changes to make before updating. Subscriptions with manual approvals for updates ensure that administrators have the opportunity to verify the permissions of the later version, take any necessary steps, and then update.

6. Click **Install** to make the Operator available to the selected namespaces on this OpenShift Container Platform cluster:

a. If you selected a **Manual** approval strategy, the upgrade status of the subscription remains **Upgrading** until you review and approve the install plan.
After approving on the **Install Plan** page, the subscription upgrade status moves to **Up to date**.

b. If you selected an **Automatic** approval strategy, the upgrade status should resolve to **Up to date** without intervention.

Verification

- After the upgrade status of the subscription is **Up to date**, select **Operators → Installed Operators** to verify that the cluster service version (CSV) of the installed Operator eventually shows up. The **Status** should eventually resolve to **Succeeded** in the relevant namespace.

NOTE

For the **All namespaces...** installation mode, the status resolves to **Succeeded** in the **openshift-operators** namespace, but the status is **Copied** if you check in other namespaces.

If it does not:

- Check the logs in any pods in the **openshift-operators** project (or other relevant namespace if **A specific namespace...** installation mode was selected) on the **Workloads → Pods** page that are reporting issues to troubleshoot further.

- When the Operator is installed, the metadata indicates which channel and version are installed.

NOTE

The **Channel** and **Version** dropdown menus are still available for viewing other version metadata in this catalog context.

3.2.4. Installing from OperatorHub by using the CLI

Instead of using the OpenShift Container Platform web console, you can install an Operator from OperatorHub by using the CLI. Use the **oc** command to create or update a **Subscription** object.

For **SingleNamespace** install mode, you must also ensure an appropriate Operator group exists in the related namespace. An Operator group, defined by an **OperatorGroup** object, selects target namespaces in which to generate required RBAC access for all Operators in the same namespace as the Operator group.

TIP

In most cases, the web console method of this procedure is preferred because it automates tasks in the background, such as handling the creation of **OperatorGroup** and **Subscription** objects automatically when choosing **SingleNamespace** mode.

Prerequisites

- Access to your OpenShift Container Platform cluster using an account with Operator installation permissions.
- You have installed the OpenShift CLI (**oc**).

Procedure

1. View the list of Operators available to the cluster from OperatorHub:

```
$ oc get packagemanifests -n openshift-marketplace
```

Example 3.1. Example output

```
NAME                               CATALOG               AGE
3scale-operator                    Red Hat Operators     91m
advanced-cluster-management        Red Hat Operators     91m
amq7-cert-manager                  Red Hat Operators     91m
# ...
couchbase-enterprise-certified     Certified Operators   91m
crunchy-postgres-operator          Certified Operators   91m
mongodb-enterprise                 Certified Operators   91m
# ...
etcd                               Community Operators   91m
jaeger                             Community Operators   91m
kubefed                            Community Operators   91m
# ...
```

Note the catalog for your desired Operator.

2. Inspect your desired Operator to verify its supported install modes and available channels:

```
$ oc describe packagemanifests <operator_name> -n openshift-marketplace
```

Example 3.2. Example output

```
# ...
Kind:         PackageManifest
# ...
      Install Modes: (1)
        Supported:  true
        Type:       OwnNamespace
        Supported:  true
        Type:       SingleNamespace
        Supported:  false
        Type:       MultiNamespace
        Supported:  true
        Type:       AllNamespaces
# ...
    Entries:
      Name:       example-operator.v3.7.11
      Version:    3.7.11
      Name:       example-operator.v3.7.10
      Version:    3.7.10
    Name:         stable-3.7 (2)
# ...
    Entries:
      Name:       example-operator.v3.8.5
      Version:    3.8.5
      Name:       example-operator.v3.8.4
      Version:    3.8.4
    Name:         stable-3.8 (3)
  Default Channel:  stable-3.8 (4)
```

(1) Indicates which install modes are supported.

(2) (3) Example channel names.

(4) The channel selected by default if one is not specified.

TIP

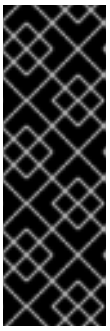
You can print an Operator's version and channel information in YAML format by running the following command:

```
$ oc get packagemanifests <operator_name> -n <catalog_namespace> -o yaml
```

3. If more than one catalog is installed in a namespace, run the following command to look up the available versions and channels of an Operator from a specific catalog:

```
$ oc get packagemanifest \
```

```
--selector=catalog=<catalogsource_name> \
--field-selector metadata.name=<operator_name> \
-n <catalog_namespace> -o yaml
```

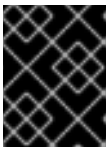


IMPORTANT

If you do not specify the Operator's catalog, running the **oc get packagemanifest** and **oc describe packagemanifest** commands might return a package from an unexpected catalog if the following conditions are met:

- Multiple catalogs are installed in the same namespace.
- The catalogs contain the same Operators or Operators with the same name.

4. If the Operator you intend to install supports the **AllNamespaces** install mode, and you choose to use this mode, skip this step, because the **openshift-operators** namespace already has an appropriate Operator group in place by default, called **global-operators**.
   If the Operator you intend to install supports the **SingleNamespace** install mode, and you choose to use this mode, you must ensure an appropriate Operator group exists in the related namespace. If one does not exist, you can create create one by following these steps:



IMPORTANT

You can only have one Operator group per namespace. For more information, see "Operator groups".

   a. Create an **OperatorGroup** object YAML file, for example **operatorgroup.yaml**, for **SingleNamespace** install mode:

Example OperatorGroup object for SingleNamespace install mode

```
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  name: <operatorgroup_name>
  namespace: <namespace> 1
spec:
  targetNamespaces:
  - <namespace> 2
```

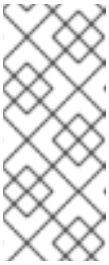
1 2 For **SingleNamespace** install mode, use the same **<namespace>** value for both the **metadata.namespace** and **spec.targetNamespaces** fields.

   b. Create the **OperatorGroup** object:

```
$ oc apply -f operatorgroup.yaml
```

5. Create a **Subscription** object to subscribe a namespace to an Operator:

   a. Create a YAML file for the **Subscription** object, for example **subscription.yaml**:



NOTE

If you want to subscribe to a specific version of an Operator, set the **startingCSV** field to the desired version and set the **installPlanApproval** field to **Manual** to prevent the Operator from automatically upgrading if a later version exists in the catalog. For details, see the following "Example **Subscription** object with a specific starting Operator version".

Example 3.3. Example Subscription object

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: <subscription_name>
  namespace: <namespace_per_install_mode> 1
spec:
  channel: <channel_name> 2
  name: <operator_name> 3
  source: <catalog_name> 4
  sourceNamespace: <catalog_source_namespace> 5
  config:
    env: 6
    - name: ARGS
      value: "-v=10"
    envFrom: 7
    - secretRef:
        name: license-secret
    volumes: 8
    - name: <volume_name>
      configMap:
        name: <configmap_name>
    volumeMounts: 9
    - mountPath: <directory_name>
      name: <volume_name>
    tolerations: 10
    - operator: "Exists"
    resources: 11
      requests:
        memory: "64Mi"
        cpu: "250m"
      limits:
        memory: "128Mi"
        cpu: "500m"
    nodeSelector: 12
      foo: bar
```

1. For default **AllNamespaces** install mode usage, specify the **openshift-operators** namespace. Alternatively, you can specify a custom global namespace, if you have created one. For **SingleNamespace** install mode usage, specify the relevant single namespace.
2. Name of the channel to subscribe to.

3. Name of the Operator to subscribe to.
4. Name of the catalog source that provides the Operator.
5. Namespace of the catalog source. Use **openshift-marketplace** for the default OperatorHub catalog sources.
6. The **env** parameter defines a list of environment variables that must exist in all containers in the pod created by OLM.
7. The **envFrom** parameter defines a list of sources to populate environment variables in the container.
8. The **volumes** parameter defines a list of volumes that must exist on the pod created by OLM.
9. The **volumeMounts** parameter defines a list of volume mounts that must exist in all containers in the pod created by OLM. If a **volumeMount** references a **volume** that does not exist, OLM fails to deploy the Operator.
10. The **tolerations** parameter defines a list of tolerations for the pod created by OLM.
11. The **resources** parameter defines resource constraints for all the containers in the pod created by OLM.
12. The **nodeSelector** parameter defines a **NodeSelector** for the pod created by OLM.

Example 3.4. Example Subscription object with a specific starting Operator version

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: example-operator
  namespace: example-operator
spec:
  channel: stable-3.7
  installPlanApproval: Manual (1)
  name: example-operator
  source: custom-operators
  sourceNamespace: openshift-marketplace
  startingCSV: example-operator.v3.7.10 (2)
```

1. Set the approval strategy to **Manual** in case your specified version is superseded by a later version in the catalog. This plan prevents an automatic upgrade to a later version and requires manual approval before the starting CSV can complete the installation.
2. Set a specific version of an Operator CSV.

b. For clusters on cloud providers with token authentication enabled, such as Amazon Web

Services (AWS) Security Token Service (STS), Microsoft Entra Workload ID, or Google Cloud Platform Workload Identity, configure your **Subscription** object by following these steps:

i. Ensure the **Subscription** object is set to manual update approvals:

Example 3.5. Example Subscription object with manual update approvals

```
kind: Subscription
# ...
spec:
  installPlanApproval: Manual (1)
```

(1) Subscriptions with automatic approvals for updates are not recommended because there might be permission changes to make before updating. Subscriptions with manual approvals for updates ensure that administrators have the opportunity to verify the permissions of the later version, take any necessary steps, and then update.

ii. Include the relevant cloud provider-specific fields in the **Subscription** object's **config** section:
If the cluster is in AWS STS mode, include the following fields:

Example 3.6. Example Subscription object with AWS STS variables

```
kind: Subscription
# ...
spec:
  config:
    env:
    - name: ROLEARN
      value: "<role_arn>" (1)
```

(1) Include the role ARN details.

If the cluster is in Workload ID mode, include the following fields:

Example 3.7. Example Subscription object with Workload ID variables

```
kind: Subscription
# ...
spec:
 config:
   env:
   - name: CLIENTID
     value: "<client_id>" (1)
   - name: TENANTID
     value: "<tenant_id>" (2)
   - name: SUBSCRIPTIONID
     value: "<subscription_id>" (3)
```

1. Include the client ID.
2. Include the tenant ID.
3. Include the subscription ID.

If the cluster is in GCP Workload Identity mode, include the following fields:

Example 3.8. Example Subscription object with GCP Workload Identity variables

```
kind: Subscription
# ...
spec:
 config:
   env:
   - name: AUDIENCE
     value: "<audience_url>" 1
   - name: SERVICE_ACCOUNT_EMAIL
     value: "<service_account_email>" 2
```

where:

<audience>

Created in Google Cloud by the administrator when they set up GCP Workload Identity, the **AUDIENCE** value must be a preformatted URL in the following format:

```
//iam.googleapis.com/projects/<project_number>/locations/global/workloadIdentityPools/<pool_id>/providers/<provider_id>
```

<service_account_email>

The **SERVICE_ACCOUNT_EMAIL** value is a Google Cloud service account email that is impersonated during Operator operation, for example:

```
<service_account_name>@<project_id>.iam.gserviceaccount.com
```

c. Create the **Subscription** object by running the following command:

```
$ oc apply -f subscription.yaml
```

6. If you set the **installPlanApproval** field to **Manual**, manually approve the pending install plan to complete the Operator installation. For more information, see "Manually approving a pending Operator update".

At this point, OLM is now aware of the selected Operator. A cluster service version (CSV) for the Operator should appear in the target namespace, and APIs provided by the Operator should be available for creation.

Verification

1. Check the status of the **Subscription** object for your installed Operator by running the following command:

```
$ oc describe subscription <subscription_name> -n <namespace>
```

2. If you created an Operator group for **SingleNamespace** install mode, check the status of the **OperatorGroup** object by running the following command:

```
$ oc describe operatorgroup <operatorgroup_name> -n <namespace>
```

Additional resources

- Operator groups
- Channel names

Additional resources

- Manually approving a pending Operator update

CHAPTER 4. ADMINISTRATOR TASKS

4.1. ADDING OPERATORS TO A CLUSTER

Using Operator Lifecycle Manager (OLM), cluster administrators can install OLM-based Operators to an OpenShift Container Platform cluster.

NOTE

For information on how OLM handles updates for installed Operators colocated in the same namespace, as well as an alternative method for installing Operators with custom global Operator groups, see Multitenancy and Operator colocation.

4.1.1. About Operator installation with OperatorHub

OperatorHub is a user interface for discovering Operators; it works in conjunction with Operator Lifecycle Manager (OLM), which installs and manages Operators on a cluster.

As a cluster administrator, you can install an Operator from OperatorHub by using the OpenShift Container Platform web console or CLI. Subscribing an Operator to one or more namespaces makes the Operator available to developers on your cluster.

During installation, you must determine the following initial settings for the Operator:

Installation Mode

Choose **All namespaces on the cluster (default)**to have the Operator installed on all namespaces or choose individual namespaces, if available, to only install the Operator on selected namespaces. This example chooses **All namespaces...** to make the Operator available to all users and projects.

Update Channel

If an Operator is available through multiple channels, you can choose which channel you want to subscribe to. For example, to deploy from the **stable** channel, if available, select it from the list.

Approval Strategy

You can choose automatic or manual updates.
If you choose automatic updates for an installed Operator, when a new version of that Operator is available in the selected channel, Operator Lifecycle Manager (OLM) automatically upgrades the running instance of your Operator without human intervention.

If you select manual updates, when a newer version of an Operator is available, OLM creates an update request. As a cluster administrator, you must then manually approve that update request to have the Operator updated to the new version.

Additional resources

- Understanding OperatorHub

4.1.2. Installing from OperatorHub by using the web console

You can install and subscribe to an Operator from OperatorHub by using the OpenShift Container Platform web console.

Prerequisites

- Access to an OpenShift Container Platform cluster using an account with **cluster-admin** permissions.

Procedure

1. Navigate in the web console to the **Operators → OperatorHub** page.
2. Scroll or type a keyword into the **Filter by keyword** box to find the Operator you want. For example, type **advanced** to find the Advanced Cluster Management for Kubernetes Operator. You can also filter options by **Infrastructure Features**. For example, select **Disconnected** if you want to see Operators that work in disconnected environments, also known as restricted network environments.
3. Select the Operator to display additional information.

NOTE

Choosing a Community Operator warns that Red Hat does not certify Community Operators; you must acknowledge the warning before continuing.

4. Read the information about the Operator and click **Install**.
5. On the **Install Operator** page, configure your Operator installation:
   a. If you want to install a specific version of an Operator, select an **Update channel** and **Version** from the lists. You can browse the various versions of an Operator across any channels it might have, view the metadata for that channel and version, and select the exact version you want to install.

NOTE

The version selection defaults to the latest version for the channel selected. If the latest version for the channel is selected, the **Automatic** approval strategy is enabled by default. Otherwise, **Manual** approval is required when not installing the latest version for the selected channel.

Installing an Operator with **Manual** approval causes all Operators installed within the namespace to function with the **Manual** approval strategy and all Operators are updated together. If you want to update Operators independently, install Operators into separate namespaces.

   b. Confirm the installation mode for the Operator:
      - **All namespaces on the cluster (default)**installs the Operator in the default **openshift-operators** namespace to watch and be made available to all namespaces in the cluster. This option is not always available.
      - **A specific namespace on the cluster**allows you to choose a specific, single namespace in which to install the Operator. The Operator will only watch and be made available for use in this single namespace.
   c. For clusters on cloud providers with token authentication enabled:
      - If the cluster uses AWS Security Token Service (**STS Mode** in the web console), enter the Amazon Resource Name (ARN) of the AWS IAM role of your service account in the

role ARN field. To create the role's ARN, follow the procedure described in Preparing AWS account.

- If the cluster uses Microsoft Entra Workload ID (**Workload Identity / Federated Identity Mode** in the web console), add the client ID, tenant ID, and subscription ID in the appropriate fields.
- If the cluster uses Google Cloud Platform Workload Identity (**GCP Workload Identity / Federated Identity Mode** in the web console), add the project number, pool ID, provider ID, and service account email in the appropriate fields.

d. For **Update approval**, select either the **Automatic** or **Manual** approval strategy.

IMPORTANT

If the web console shows that the cluster uses AWS STS, Microsoft Entra Workload ID, or GCP Workload Identity, you must set **Update approval** to **Manual**.

Subscriptions with automatic approvals for updates are not recommended because there might be permission changes to make before updating. Subscriptions with manual approvals for updates ensure that administrators have the opportunity to verify the permissions of the later version, take any necessary steps, and then update.

6. Click **Install** to make the Operator available to the selected namespaces on this OpenShift Container Platform cluster:

a. If you selected a **Manual** approval strategy, the upgrade status of the subscription remains **Upgrading** until you review and approve the install plan.
After approving on the **Install Plan** page, the subscription upgrade status moves to **Up to date**.

b. If you selected an **Automatic** approval strategy, the upgrade status should resolve to **Up to date** without intervention.

Verification

- After the upgrade status of the subscription is **Up to date**, select **Operators → Installed Operators** to verify that the cluster service version (CSV) of the installed Operator eventually shows up. The **Status** should eventually resolve to **Succeeded** in the relevant namespace.

NOTE

For the **All namespaces...** installation mode, the status resolves to **Succeeded** in the **openshift-operators** namespace, but the status is **Copied** if you check in other namespaces.

If it does not:

- Check the logs in any pods in the **openshift-operators** project (or other relevant namespace if **A specific namespace...** installation mode was selected) on the **Workloads → Pods** page that are reporting issues to troubleshoot further.

- When the Operator is installed, the metadata indicates which channel and version are installed.

NOTE

The **Channel** and **Version** dropdown menus are still available for viewing other version metadata in this catalog context.

Additional resources

- Manually approving a pending Operator update

4.1.3. Installing from OperatorHub by using the CLI

Instead of using the OpenShift Container Platform web console, you can install an Operator from OperatorHub by using the CLI. Use the **oc** command to create or update a **Subscription** object.

For **SingleNamespace** install mode, you must also ensure an appropriate Operator group exists in the related namespace. An Operator group, defined by an **OperatorGroup** object, selects target namespaces in which to generate required RBAC access for all Operators in the same namespace as the Operator group.

TIP

In most cases, the web console method of this procedure is preferred because it automates tasks in the background, such as handling the creation of **OperatorGroup** and **Subscription** objects automatically when choosing **SingleNamespace** mode.

Prerequisites

- Access to your OpenShift Container Platform cluster using an account with **cluster-admin** permissions.
- You have installed the OpenShift CLI (**oc**).

Procedure

1. View the list of Operators available to the cluster from OperatorHub:

```
$ oc get packagemanifests -n openshift-marketplace
```

Example 4.1. Example output

```
NAME                              CATALOG               AGE
3scale-operator                   Red Hat Operators     91m
advanced-cluster-management       Red Hat Operators     91m
amq7-cert-manager                 Red Hat Operators     91m
# ...
couchbase-enterprise-certified    Certified Operators   91m
crunchy-postgres-operator         Certified Operators   91m
mongodb-enterprise                Certified Operators   91m
# ...
etcd                              Community Operators   91m
jaeger                            Community Operators   91m
kubefed                           Community Operators   91m
# ...
```

Note the catalog for your desired Operator.

2. Inspect your desired Operator to verify its supported install modes and available channels:

```
$ oc describe packagemanifests <operator_name> -n openshift-marketplace
```

Example 4.2. Example output

```
# ...
Kind:         PackageManifest
# ...
      Install Modes: (1)
        Supported:  true
        Type:       OwnNamespace
        Supported:  true
        Type:       SingleNamespace
        Supported:  false
        Type:       MultiNamespace
        Supported:  true
        Type:       AllNamespaces
# ...
    Entries:
      Name:       example-operator.v3.7.11
      Version:    3.7.11
      Name:       example-operator.v3.7.10
      Version:    3.7.10
    Name:         stable-3.7 (2)
# ...
   Entries:
      Name:         example-operator.v3.8.5
      Version:      3.8.5
      Name:         example-operator.v3.8.4
      Version:      3.8.4
    Name:           stable-3.8 (3)
  Default Channel:  stable-3.8 (4)
```

(1) (1) Indicates which install modes are supported.

(2) (2) (3) Example channel names.

(4) The channel selected by default if one is not specified.

TIP

You can print an Operator's version and channel information in YAML format by running the following command:

```
$ oc get packagemanifests <operator_name> -n <catalog_namespace> -o yaml
```

3. If more than one catalog is installed in a namespace, run the following command to look up the available versions and channels of an Operator from a specific catalog:

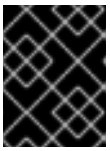
```
$ oc get packagemanifest \
  --selector=catalog=<catalogsource_name> \
  --field-selector metadata.name=<operator_name> \
  -n <catalog_namespace> -o yaml
```

IMPORTANT

If you do not specify the Operator's catalog, running the **oc get packagemanifest** and **oc describe packagemanifest** commands might return a package from an unexpected catalog if the following conditions are met:

- Multiple catalogs are installed in the same namespace.
- The catalogs contain the same Operators or Operators with the same name.

4. If the Operator you intend to install supports the **AllNamespaces** install mode, and you choose to use this mode, skip this step, because the **openshift-operators** namespace already has an appropriate Operator group in place by default, called **global-operators**.
If the Operator you intend to install supports the **SingleNamespace** install mode, and you choose to use this mode, you must ensure an appropriate Operator group exists in the related namespace. If one does not exist, you can create create one by following these steps:



IMPORTANT

You can only have one Operator group per namespace. For more information, see "Operator groups".

a. Create an **OperatorGroup** object YAML file, for example **operatorgroup.yaml**, for **SingleNamespace** install mode:

Example OperatorGroup object for SingleNamespace install mode

```
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  name: <operatorgroup_name>
  namespace: <namespace> 1
spec:
  targetNamespaces:
  - <namespace> 2
```

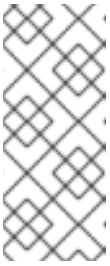
1 2 For **SingleNamespace** install mode, use the same **<namespace>** value for both the **metadata.namespace** and **spec.targetNamespaces** fields.

b. Create the **OperatorGroup** object:

```
$ oc apply -f operatorgroup.yaml
```

5. Create a **Subscription** object to subscribe a namespace to an Operator:

   a. Create a YAML file for the **Subscription** object, for example **subscription.yaml**:



NOTE

If you want to subscribe to a specific version of an Operator, set the **startingCSV** field to the desired version and set the **installPlanApproval** field to **Manual** to prevent the Operator from automatically upgrading if a later version exists in the catalog. For details, see the following "Example **Subscription** object with a specific starting Operator version".

Example 4.3. Example Subscription object

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: <subscription_name>
  namespace: <namespace_per_install_mode> 1
spec:
  channel: <channel_name> 2
  name: <operator_name> 3
  source: <catalog_name> 4
  sourceNamespace: <catalog_source_namespace> 5
  config:
    env: 6
    - name: ARGS
      value: "-v=10"
    envFrom: 7
    - secretRef:
        name: license-secret
    volumes: 8
    - name: <volume_name>
      configMap:
        name: <configmap_name>
    volumeMounts: 9
    - mountPath: <directory_name>
      name: <volume_name>
    tolerations: 10
    - operator: "Exists"
    resources: 11
      requests:
        memory: "64Mi"
        cpu: "250m"
      limits:
        memory: "128Mi"
        cpu: "500m"
    nodeSelector: 12
      foo: bar
```

1 For default **AllNamespaces** install mode usage, specify the **openshift-operators** namespace. Alternatively, you can specify a custom global namespace, if you have created one. For **SingleNamespace** install mode usage, specify the relevant single

namespace.

2 Name of the channel to subscribe to.

3 Name of the Operator to subscribe to.

4 Name of the catalog source that provides the Operator.

5 Namespace of the catalog source. Use **openshift-marketplace** for the default OperatorHub catalog sources.

6 The **env** parameter defines a list of environment variables that must exist in all containers in the pod created by OLM.

7 The **envFrom** parameter defines a list of sources to populate environment variables in the container.

8 The **volumes** parameter defines a list of volumes that must exist on the pod created by OLM.

9 The **volumeMounts** parameter defines a list of volume mounts that must exist in all containers in the pod created by OLM. If a **volumeMount** references a **volume** that does not exist, OLM fails to deploy the Operator.

10 The **tolerations** parameter defines a list of tolerations for the pod created by OLM.

11 The **resources** parameter defines resource constraints for all the containers in the pod created by OLM.

12 The **nodeSelector** parameter defines a **NodeSelector** for the pod created by OLM.

Example 4.4. Example Subscription object with a specific starting Operator version

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: example-operator
  namespace: example-operator
spec:
  channel: stable-3.7
  installPlanApproval: Manual 1
  name: example-operator
  source: custom-operators
  sourceNamespace: openshift-marketplace
  startingCSV: example-operator.v3.7.10 2
```

1 Set the approval strategy to **Manual** in case your specified version is superseded by a later version in the catalog. This plan prevents an automatic upgrade to a later version and requires manual approval before the starting CSV can complete the installation.

2 Set a specific version of an Operator CSV.

b. For clusters on cloud providers with token authentication enabled, such as Amazon Web Services (AWS) Security Token Service (STS), Microsoft Entra Workload ID, or Google Cloud Platform Workload Identity, configure your **Subscription** object by following these steps:

i. Ensure the **Subscription** object is set to manual update approvals:

Example 4.5. Example Subscription object with manual update approvals

```
kind: Subscription
# ...
spec:
  installPlanApproval: Manual (1)
```

(1) Subscriptions with automatic approvals for updates are not recommended because there might be permission changes to make before updating. Subscriptions with manual approvals for updates ensure that administrators have the opportunity to verify the permissions of the later version, take any necessary steps, and then update.

ii. Include the relevant cloud provider-specific fields in the **Subscription** object's **config** section:
If the cluster is in AWS STS mode, include the following fields:

Example 4.6. Example Subscription object with AWS STS variables

```
kind: Subscription
# ...
spec:
  config:
    env:
    - name: ROLEARN
      value: "<role_arn>" (1)
```

(1) Include the role ARN details.

If the cluster is in Workload ID mode, include the following fields:

Example 4.7. Example Subscription object with Workload ID variables

```
kind: Subscription
# ...
spec:
 config:
   env:
   - name: CLIENTID
     value: "<client_id>" (1)
   - name: TENANTID
```

```
      value: "<tenant_id>" 2
    - name: SUBSCRIPTIONID
      value: "<subscription_id>" 3
```

1 Include the client ID.

2 Include the tenant ID.

3 Include the subscription ID.

If the cluster is in GCP Workload Identity mode, include the following fields:

Example 4.8. Example Subscription object with GCP Workload Identity variables

```
kind: Subscription
# ...
spec:
 config:
   env:
   - name: AUDIENCE
     value: "<audience_url>" 1
   - name: SERVICE_ACCOUNT_EMAIL
     value: "<service_account_email>" 2
```

where:

<audience>

Created in Google Cloud by the administrator when they set up GCP Workload Identity, the **AUDIENCE** value must be a preformatted URL in the following format:

```
//iam.googleapis.com/projects/<project_number>/locations/global/workloadIdentityPools/<pool_id>/providers/<provider_id>
```

<service_account_email>

The **SERVICE_ACCOUNT_EMAIL** value is a Google Cloud service account email that is impersonated during Operator operation, for example:

```
<service_account_name>@<project_id>.iam.gserviceaccount.com
```

c. Create the **Subscription** object by running the following command:

```
$ oc apply -f subscription.yaml
```

6. If you set the **installPlanApproval** field to **Manual**, manually approve the pending install plan to complete the Operator installation. For more information, see "Manually approving a pending Operator update".

At this point, OLM is now aware of the selected Operator. A cluster service version (CSV) for the Operator should appear in the target namespace, and APIs provided by the Operator should be available for creation.

Verification

1. Check the status of the **Subscription** object for your installed Operator by running the following command:

```
$ oc describe subscription <subscription_name> -n <namespace>
```

2. If you created an Operator group for **SingleNamespace** install mode, check the status of the **OperatorGroup** object by running the following command:

```
$ oc describe operatorgroup <operatorgroup_name> -n <namespace>
```

Additional resources

- About Operator groups
- Installing global Operators in custom namespaces
- Manually approving a pending Operator update

4.1.4. Preparing for multiple instances of an Operator for multitenant clusters

As a cluster administrator, you can add multiple instances of an Operator for use in multitenant clusters. This is an alternative solution to either using the standard **All namespaces** install mode, which can be considered to violate the principle of least privilege, or the **Multinamespace** mode, which is not widely adopted. For more information, see "Operators in multitenant clusters".

In the following procedure, the *tenant* is a user or group of users that share common access and privileges for a set of deployed workloads. The *tenant Operator* is the instance of an Operator that is intended for use by only that tenant.

Prerequisites

- All instances of the Operator you want to install must be the same version across a given cluster.

IMPORTANT

For more information on this and other limitations, see "Operators in multitenant clusters".

Procedure

1. Before installing the Operator, create a namespace for the tenant Operator that is separate from the tenant's namespace. For example, if the tenant's namespace is **team1**, you might create a **team1-operator** namespace:

   a. Define a **Namespace** resource and save the YAML file, for example, **team1-operator.yaml**:

```
apiVersion: v1
kind: Namespace
```

```
metadata:
  name: team1-operator
```

b. Create the namespace by running the following command:

```
$ oc create -f team1-operator.yaml
```

2. Create an Operator group for the tenant Operator scoped to the tenant's namespace, with only that one namespace entry in the **spec.targetNamespaces** list:

a. Define an **OperatorGroup** resource and save the YAML file, for example, **team1-operatorgroup.yaml**:

```
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  name: team1-operatorgroup
  namespace: team1-operator
spec:
  targetNamespaces:
  - team1 1
```

1 1 Define only the tenant's namespace in the **spec.targetNamespaces** list.

b. Create the Operator group by running the following command:

```
$ oc create -f team1-operatorgroup.yaml
```

Next steps

- Install the Operator in the tenant Operator namespace. This task is more easily performed by using the OperatorHub in the web console instead of the CLI; for a detailed procedure, "Installing from OperatorHub using the web console".

NOTE

After completing the Operator installation, the Operator resides in the tenant Operator namespace and watches the tenant namespace, but neither the Operator's pod nor its service account are visible or usable by the tenant.

Additional resources

- Operators in multitenant clusters

4.1.5. Installing global Operators in custom namespaces

When installing Operators with the OpenShift Container Platform web console, the default behavior installs Operators that support the **All namespaces** install mode into the default **openshift-operators** global namespace. This can cause issues related to shared install plans and update policies between all Operators in the namespace. For more details on these limitations, see "Multitenancy and Operator colocation".

As a cluster administrator, you can bypass this default behavior manually by creating a custom global namespace and using that namespace to install your individual or scoped set of Operators and their dependencies.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.

Procedure

1. Before installing the Operator, create a namespace for the installation of your desired Operator. This installation namespace will become the custom global namespace:

   a. Define a **Namespace** resource and save the YAML file, for example, **global-operators.yaml**:

   ```
   apiVersion: v1
   kind: Namespace
   metadata:
     name: global-operators
   ```

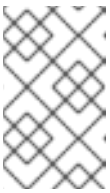
   b. Create the namespace by running the following command:

   ```
   $ oc create -f global-operators.yaml
   ```

2. Create a custom *global Operator group*, which is an Operator group that watches all namespaces:

   a. Define an **OperatorGroup** resource and save the YAML file, for example, **global-operatorgroup.yaml**. Omit both the **spec.selector** and **spec.targetNamespaces** fields to make it a *global Operator group*, which selects all namespaces:

   ```
   apiVersion: operators.coreos.com/v1
   kind: OperatorGroup
   metadata:
     name: global-operatorgroup
     namespace: global-operators
   ```

   NOTE

   The **status.namespaces** of a created global Operator group contains the empty string (**""**), which signals to a consuming Operator that it should watch all namespaces.

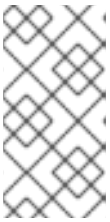
   b. Create the Operator group by running the following command:

   ```
   $ oc create -f global-operatorgroup.yaml
   ```

Next steps

- Install the desired Operator in your custom global namespace. Because the web console does not populate the **Installed Namespace** menu during Operator installation with custom global namespaces, the install task can only be performed with the OpenShift CLI (**oc**). For a detailed

installation procedure, see "Installing from OperatorHub by using the CLI".



NOTE

When you initiate the Operator installation, if the Operator has dependencies, the dependencies are also automatically installed in the custom global namespace. As a result, it is then valid for the dependency Operators to have the same update policy and shared install plans.

Additional resources

- Multitenancy and Operator colocation

4.1.6. Pod placement of Operator workloads

By default, Operator Lifecycle Manager (OLM) places pods on arbitrary worker nodes when installing an Operator or deploying Operand workloads. As an administrator, you can use projects with a combination of node selectors, taints, and tolerations to control the placement of Operators and Operands to specific nodes.

Controlling pod placement of Operator and Operand workloads has the following prerequisites:

1. Determine a node or set of nodes to target for the pods per your requirements. If available, note an existing label, such as **node-role.kubernetes.io/app**, that identifies the node or nodes. Otherwise, add a label, such as **myoperator**, by using a compute machine set or editing the node directly. You will use this label in a later step as the node selector on your project.

2. If you want to ensure that only pods with a certain label are allowed to run on the nodes, while steering unrelated workloads to other nodes, add a taint to the node or nodes by using a compute machine set or editing the node directly. Use an effect that ensures that new pods that do not match the taint cannot be scheduled on the nodes. For example, a **myoperator:NoSchedule** taint ensures that new pods that do not match the taint are not scheduled onto that node, but existing pods on the node are allowed to remain.

3. Create a project that is configured with a default node selector and, if you added a taint, a matching toleration.

At this point, the project you created can be used to steer pods towards the specified nodes in the following scenarios:

For Operator pods

Administrators can create a **Subscription** object in the project as described in the following section. As a result, the Operator pods are placed on the specified nodes.

For Operand pods

Using an installed Operator, users can create an application in the project, which places the custom resource (CR) owned by the Operator in the project. As a result, the Operand pods are placed on the specified nodes, unless the Operator is deploying cluster-wide objects or resources in other namespaces, in which case this customized pod placement does not apply.

Additional resources

- Adding taints and tolerations manually to nodes or with compute machine sets
- Creating project-wide node selectors

- Creating a project with a node selector and toleration

4.1.7. Controlling where an Operator is installed

By default, when you install an Operator, OpenShift Container Platform installs the Operator pod to one of your worker nodes randomly. However, there might be situations where you want that pod scheduled on a specific node or set of nodes.

The following examples describe situations where you might want to schedule an Operator pod to a specific node or set of nodes:

- If an Operator requires a particular platform, such as **amd64** or **arm64**
- If an Operator requires a particular operating system, such as Linux or Windows
- If you want Operators that work together scheduled on the same host or on hosts located on the same rack
- If you want Operators dispersed throughout the infrastructure to avoid downtime due to network or hardware issues

You can control where an Operator pod is installed by adding node affinity, pod affinity, or pod anti-affinity constraints to the Operator's **Subscription** object. Node affinity is a set of rules used by the scheduler to determine where a pod can be placed. Pod affinity enables you to ensure that related pods are scheduled to the same node. Pod anti-affinity allows you to prevent a pod from being scheduled on a node.

The following examples show how to use node affinity or pod anti-affinity to install an instance of the Custom Metrics Autoscaler Operator to a specific node in the cluster:

Node affinity example that places the Operator pod on a specific node

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: openshift-custom-metrics-autoscaler-operator
  namespace: openshift-keda
spec:
  name: my-package
  source: my-operators
  sourceNamespace: operator-registries
  config:
    affinity:
      nodeAffinity: 1
        requiredDuringSchedulingIgnoredDuringExecution:
          nodeSelectorTerms:
          - matchExpressions:
            - key: kubernetes.io/hostname
              operator: In
              values:
              - ip-10-0-163-94.us-west-2.compute.internal
#...
```

1 A node affinity that requires the Operator's pod to be scheduled on a node named **ip-10-0-163-94.us-west-2.compute.internal**.

Node affinity example that places the Operator pod on a node with a specific platform

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: openshift-custom-metrics-autoscaler-operator
  namespace: openshift-keda
spec:
  name: my-package
  source: my-operators
  sourceNamespace: operator-registries
  config:
    affinity:
      nodeAffinity: 1
        requiredDuringSchedulingIgnoredDuringExecution:
          nodeSelectorTerms:
          - matchExpressions:
            - key: kubernetes.io/arch
              operator: In
              values:
              - arm64
            - key: kubernetes.io/os
              operator: In
              values:
              - linux
#...
```

1 A node affinity that requires the Operator's pod to be scheduled on a node with the **kubernetes.io/arch=arm64** and **kubernetes.io/os=linux** labels.

Pod affinity example that places the Operator pod on one or more specific nodes

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: openshift-custom-metrics-autoscaler-operator
  namespace: openshift-keda
spec:
  name: my-package
  source: my-operators
  sourceNamespace: operator-registries
  config:
    affinity:
      podAffinity: 1
        requiredDuringSchedulingIgnoredDuringExecution:
        - labelSelector:
            matchExpressions:
            - key: app
              operator: In
              values:
              - test
          topologyKey: kubernetes.io/hostname
#...
```

1 A pod affinity that places the Operator's pod on a node that has pods with the **app=test** label.

Pod anti-affinity example that prevents the Operator pod from one or more specific nodes

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: openshift-custom-metrics-autoscaler-operator
  namespace: openshift-keda
spec:
  name: my-package
  source: my-operators
  sourceNamespace: operator-registries
  config:
    affinity:
      podAntiAffinity: 1
        requiredDuringSchedulingIgnoredDuringExecution:
        - labelSelector:
            matchExpressions:
            - key: cpu
              operator: In
              values:
              - high
          topologyKey: kubernetes.io/hostname
#...
```

1 A pod anti-affinity that prevents the Operator's pod from being scheduled on a node that has pods with the **cpu=high** label.

Procedure

To control the placement of an Operator pod, complete the following steps:

1. Install the Operator as usual.
2. If needed, ensure that your nodes are labeled to properly respond to the affinity.
3. Edit the Operator **Subscription** object to add an affinity:

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: openshift-custom-metrics-autoscaler-operator
  namespace: openshift-keda
spec:
  name: my-package
  source: my-operators
  sourceNamespace: operator-registries
  config:
    affinity: 1
      nodeAffinity:
        requiredDuringSchedulingIgnoredDuringExecution:
          nodeSelectorTerms:
          - matchExpressions:
```

```
            - key: kubernetes.io/hostname
              operator: In
              values:
              - ip-10-0-185-229.ec2.internal
#...
```

1 Add a **nodeAffinity**, **podAffinity**, or **podAntiAffinity**. See the Additional resources section that follows for information about creating the affinity.

Verification

- To ensure that the pod is deployed on the specific node, run the following command:

```
$ oc get pods -o wide
```

Example output

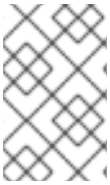
```
NAME                                    READY   STATUS    RESTARTS   AGE   IP
NODE                          NOMINATED NODE   READINESS GATES
custom-metrics-autoscaler-operator-5dcc45d656-bhshg   1/1     Running   0          50s
10.131.0.20   ip-10-0-185-229.ec2.internal   <none>           <none>
```

Additional resources

- Understanding pod affinity
- Understanding node affinity
- Understanding how to update labels on nodes

4.2. UPDATING INSTALLED OPERATORS

As a cluster administrator, you can update Operators that have been previously installed using Operator Lifecycle Manager (OLM) on your OpenShift Container Platform cluster.



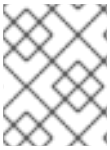
NOTE

For information on how OLM handles updates for installed Operators colocated in the same namespace, as well as an alternative method for installing Operators with custom global Operator groups, see Multitenancy and Operator colocation.

4.2.1. Preparing for an Operator update

The subscription of an installed Operator specifies an update channel that tracks and receives updates for the Operator. You can change the update channel to start tracking and receiving updates from a newer channel.

The names of update channels in a subscription can differ between Operators, but the naming scheme typically follows a common convention within a given Operator. For example, channel names might follow a minor release update stream for the application provided by the Operator (**1.2**, **1.3**) or a release frequency (**stable**, **fast**).



NOTE

You cannot change installed Operators to a channel that is older than the current channel.

Red Hat Customer Portal Labs include the following application that helps administrators prepare to update their Operators:

- Red Hat OpenShift Container Platform Operator Update Information Checker

You can use the application to search for Operator Lifecycle Manager-based Operators and verify the available Operator version per update channel across different versions of OpenShift Container Platform. Cluster Version Operator-based Operators are not included.

4.2.2. Changing the update channel for an Operator

You can change the update channel for an Operator by using the OpenShift Container Platform web console.

TIP

If the approval strategy in the subscription is set to **Automatic**, the update process initiates as soon as a new Operator version is available in the selected channel. If the approval strategy is set to **Manual**, you must manually approve pending updates.

Prerequisites

- An Operator previously installed using Operator Lifecycle Manager (OLM).

Procedure

1. In the **Administrator** perspective of the web console, navigate to **Operators → Installed Operators**.
2. Click the name of the Operator you want to change the update channel for.
3. Click the **Subscription** tab.
4. Click the name of the update channel under **Update channel**.
5. Click the newer update channel that you want to change to, then click **Save**.
6. For subscriptions with an **Automatic** approval strategy, the update begins automatically. Navigate back to the **Operators → Installed Operators** page to monitor the progress of the update. When complete, the status changes to **Succeeded** and **Up to date**.
   For subscriptions with a **Manual** approval strategy, you can manually approve the update from the **Subscription** tab.

4.2.3. Manually approving a pending Operator update

If an installed Operator has the approval strategy in its subscription set to **Manual**, when new updates are released in its current update channel, the update must be manually approved before installation can begin.

Prerequisites

- An Operator previously installed using Operator Lifecycle Manager (OLM).

Procedure

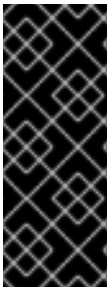
1. In the **Administrator** perspective of the OpenShift Container Platform web console, navigate to **Operators → Installed Operators**.
2. Operators that have a pending update display a status with **Upgrade available**. Click the name of the Operator you want to update.
3. Click the **Subscription** tab. Any updates requiring approval are displayed next to **Upgrade status**. For example, it might display **1 requires approval**.
4. Click **1 requires approval**, then click **Preview Install Plan**.
5. Review the resources that are listed as available for update. When satisfied, click **Approve**.
6. Navigate back to the **Operators → Installed Operators** page to monitor the progress of the update. When complete, the status changes to **Succeeded** and **Up to date**.

4.2.4. Additional resources

- Using Operator Lifecycle Manager in disconnected environments

4.3. DELETING OPERATORS FROM A CLUSTER

The following describes how to delete, or uninstall, Operators that were previously installed using Operator Lifecycle Manager (OLM) on your OpenShift Container Platform cluster.



IMPORTANT

You must successfully and completely uninstall an Operator prior to attempting to reinstall the same Operator. Failure to fully uninstall the Operator properly can leave resources, such as a project or namespace, stuck in a "Terminating" state and cause "error resolving resource" messages to be observed when trying to reinstall the Operator.

For more information, see Reinstalling Operators after failed uninstallation.

4.3.1. Deleting Operators from a cluster using the web console

Cluster administrators can delete installed Operators from a selected namespace by using the web console.

Prerequisites

- You have access to the OpenShift Container Platform cluster web console using an account with **cluster-admin** permissions.

Procedure

1. Navigate to the **Operators → Installed Operators** page.

2. Scroll or enter a keyword into the **Filter by name** field to find the Operator that you want to remove. Then, click on it.

3. On the right side of the **Operator Details** page, select **Uninstall Operator** from the **Actions** list. An **Uninstall Operator?** dialog box is displayed.

4. Select **Uninstall** to remove the Operator, Operator deployments, and pods. Following this action, the Operator stops running and no longer receives updates.

NOTE

This action does not remove resources managed by the Operator, including custom resource definitions (CRDs) and custom resources (CRs). Dashboards and navigation items enabled by the web console and off-cluster resources that continue to run might need manual clean up. To remove these after uninstalling the Operator, you might need to manually delete the Operator CRDs.

4.3.2. Deleting Operators from a cluster using the CLI

Cluster administrators can delete installed Operators from a selected namespace by using the CLI.

Prerequisites

- You have access to the OpenShift Container Platform cluster using an account with **cluster-admin** permissions.
- The OpenShift CLI (**oc**) is installed on your workstation.

Procedure

1. Ensure the latest version of the subscribed operator (for example, **serverless-operator**) is identified in the **currentCSV** field.

```
$ oc get subscription.operators.coreos.com serverless-operator -n openshift-serverless -o yaml | grep currentCSV
```

Example output

```
  currentCSV: serverless-operator.v1.28.0
```

2. Delete the subscription (for example, **serverless-operator**):

```
$ oc delete subscription.operators.coreos.com serverless-operator -n openshift-serverless
```

Example output

```
subscription.operators.coreos.com "serverless-operator" deleted
```

3. Delete the CSV for the Operator in the target namespace using the **currentCSV** value from the previous step:

```
$ oc delete clusterserviceversion serverless-operator.v1.28.0 -n openshift-serverless
```

Example output

```
clusterserviceversion.operators.coreos.com "serverless-operator.v1.28.0" deleted
```

4.3.3. Refreshing failing subscriptions

In Operator Lifecycle Manager (OLM), if you subscribe to an Operator that references images that are not accessible on your network, you can find jobs in the **openshift-marketplace** namespace that are failing with the following errors:

Example output

```
ImagePullBackOff for
Back-off pulling image "example.com/openshift4/ose-elasticsearch-operator-
bundle@sha256:6d2587129c846ec28d384540322b40b05833e7e00b25cca584e004af9a1d292e"
```

Example output

```
rpc error: code = Unknown desc = error pinging docker registry example.com: Get
"https://example.com/v2/": dial tcp: lookup example.com on 10.0.0.1:53: no such host
```

As a result, the subscription is stuck in this failing state and the Operator is unable to install or upgrade.

You can refresh a failing subscription by deleting the subscription, cluster service version (CSV), and other related objects. After recreating the subscription, OLM then reinstalls the correct version of the Operator.

Prerequisites

- You have a failing subscription that is unable to pull an inaccessible bundle image.
- You have confirmed that the correct bundle image is accessible.

Procedure

1. Get the names of the **Subscription** and **ClusterServiceVersion** objects from the namespace where the Operator is installed:

   ```
   $ oc get sub,csv -n <namespace>
   ```

   Example output

   ```
   NAME                                         PACKAGE                  SOURCE            CHANNEL
   subscription.operators.coreos.com/elasticsearch-operator   elasticsearch-operator   redhat-
   operators   5.0

   NAME                                                  DISPLAY                  VERSION
   REPLACES   PHASE
   clusterserviceversion.operators.coreos.com/elasticsearch-operator.5.0.0-65   OpenShift
   Elasticsearch Operator   5.0.0-65              Succeeded
   ```

2. Delete the subscription:

   ```
   -
   ```

```
$ oc delete subscription <subscription_name> -n <namespace>
```

3. Delete the cluster service version:

```
$ oc delete csv <csv_name> -n <namespace>
```

4. Get the names of any failing jobs and related config maps in the **openshift-marketplace** namespace:

```
$ oc get job,configmap -n openshift-marketplace
```

Example output

```
NAME                                                                COMPLETIONS   DURATION   AGE
job.batch/1de9443b6324e629ddf31fed0a853a121275806170e34c926d69e53a7fcbccb   1/1
26s        9m30s

NAME                                                                DATA   AGE
configmap/1de9443b6324e629ddf31fed0a853a121275806170e34c926d69e53a7fcbccb   3
9m30s
```

5. Delete the job:

```
$ oc delete job <job_name> -n openshift-marketplace
```

This ensures pods that try to pull the inaccessible image are not recreated.

6. Delete the config map:

```
$ oc delete configmap <configmap_name> -n openshift-marketplace
```

7. Reinstall the Operator using OperatorHub in the web console.

Verification

- Check that the Operator has been reinstalled successfully:

```
$ oc get sub,csv,installplan -n <namespace>
```

4.4. CONFIGURING OPERATOR LIFECYCLE MANAGER FEATURES

The Operator Lifecycle Manager (OLM) controller is configured by an **OLMConfig** custom resource (CR) named **cluster**. Cluster administrators can modify this resource to enable or disable certain features.

This document outlines the features currently supported by OLM that are configured by the **OLMConfig** resource.

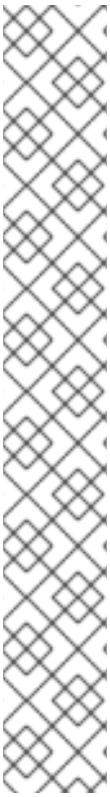
4.4.1. Disabling copied CSVs

When an Operator is installed by Operator Lifecycle Manager (OLM), a simplified copy of its cluster service version (CSV) is created by default in every namespace that the Operator is configured to

watch. These CSVs are known as *copied CSVs* and communicate to users which controllers are actively reconciling resource events in a given namespace.

When an Operator is configured to use the **AllNamespaces** install mode, versus targeting a single or specified set of namespaces, a copied CSV for the Operator is created in every namespace on the cluster. On especially large clusters, with namespaces and installed Operators potentially in the hundreds or thousands, copied CSVs consume an untenable amount of resources, such as OLM's memory usage, cluster etcd limits, and networking.

To support these larger clusters, cluster administrators can disable copied CSVs for Operators globally installed with the **AllNamespaces** mode.



NOTE

If you disable copied CSVs, an Operator installed in **AllNamespaces** mode has their CSV copied only to the **openshift** namespace, instead of every namespace on the cluster. In disabled copied CSVs mode, the behavior differs between the web console and CLI:

- In the web console, the default behavior is modified to show copied CSVs from the **openshift** namespace in every namespace, even though the CSVs are not actually copied to every namespace. This allows regular users to still be able to view the details of these Operators in their namespaces and create related custom resources (CRs).
- In the OpenShift CLI (**oc**), regular users can view Operators installed directly in their namespaces by using the **oc get csvs** command, but the copied CSVs from the **openshift** namespace are not visible in their namespaces. Operators affected by this limitation are still available and continue to reconcile events in the user's namespace.
  To view a full list of installed global Operators, similar to the web console behavior, all authenticated users can run the following command:

  ```
  $ oc get csvs -n openshift
  ```

Procedure

- Edit the **OLMConfig** object named **cluster** and set the **spec.features.disableCopiedCSVs** field to **true**:

```
$ oc apply -f - <<EOF
apiVersion: operators.coreos.com/v1
kind: OLMConfig
metadata:
  name: cluster
spec:
  features:
    disableCopiedCSVs: true (1)
EOF
```

(1) Disabled copied CSVs for **AllNamespaces** install mode Operators

Verification

- When copied CSVs are disabled, OLM captures this information in an event in the Operator's namespace:

```
$ oc get events
```

Example output

```
LAST SEEN   TYPE      REASON              OBJECT                                MESSAGE
85s         Warning   DisabledCopiedCSVs  clusterserviceversion/my-csv.v1.0.0   CSV
copying disabled for operators/my-csv.v1.0.0
```

When the **spec.features.disableCopiedCSVs** field is missing or set to **false**, OLM recreates the copied CSVs for all Operators installed with the **AllNamespaces** mode and deletes the previously mentioned events.

Additional resources

- Install modes

4.5. CONFIGURING PROXY SUPPORT IN OPERATOR LIFECYCLE MANAGER

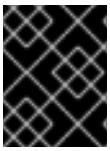
If a global proxy is configured on your OpenShift Container Platform cluster, Operator Lifecycle Manager (OLM) automatically configures Operators that it manages with the cluster-wide proxy. However, you can also configure installed Operators to override the global proxy or inject a custom CA certificate.

Additional resources

- Configuring the cluster-wide proxy
- Configuring a custom PKI (custom CA certificate)

4.5.1. Overriding proxy settings of an Operator

If a cluster-wide egress proxy is configured, Operators running with Operator Lifecycle Manager (OLM) inherit the cluster-wide proxy settings on their deployments. Cluster administrators can also override these proxy settings by configuring the subscription of an Operator.



IMPORTANT

Operators must handle setting environment variables for proxy settings in the pods for any managed Operands.

Prerequisites

- Access to an OpenShift Container Platform cluster using an account with **cluster-admin** permissions.

Procedure

1. Navigate in the web console to the **Operators → OperatorHub** page.

2. Select the Operator and click **Install**.

3. On the **Install Operator** page, modify the **Subscription** object to include one or more of the following environment variables in the **spec** section:

   - **HTTP_PROXY**
   - **HTTPS_PROXY**
   - **NO_PROXY**

   For example:

   Subscription object with proxy setting overrides

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: etcd-config-test
  namespace: openshift-operators
spec:
  config:
    env:
    - name: HTTP_PROXY
      value: test_http
    - name: HTTPS_PROXY
      value: test_https
    - name: NO_PROXY
      value: test
  channel: clusterwide-alpha
  installPlanApproval: Automatic
  name: etcd
  source: community-operators
  sourceNamespace: openshift-marketplace
  startingCSV: etcdoperator.v0.9.4-clusterwide
```

NOTE

These environment variables can also be unset using an empty value to remove any previously set cluster-wide or custom proxy settings.

   OLM handles these environment variables as a unit; if at least one of them is set, all three are considered overridden and the cluster-wide defaults are not used for the deployments of the subscribed Operator.

4. Click **Install** to make the Operator available to the selected namespaces.

5. After the CSV for the Operator appears in the relevant namespace, you can verify that custom proxy environment variables are set in the deployment. For example, using the CLI:

```
$ oc get deployment -n openshift-operators \
    etcd-operator -o yaml \
    | grep -i "PROXY" -A 2
```

Example output

```
        - name: HTTP_PROXY
          value: test_http
        - name: HTTPS_PROXY
          value: test_https
        - name: NO_PROXY
          value: test
        image: quay.io/coreos/etcd-
operator@sha256:66a37fd61a06a43969854ee6d3e21088a98b93838e284a6086b13917f96b0
d9c
...
```

4.5.2. Injecting a custom CA certificate

When a cluster administrator adds a custom CA certificate to a cluster using a config map, the Cluster Network Operator merges the user-provided certificates and system CA certificates into a single bundle. You can inject this merged bundle into your Operator running on Operator Lifecycle Manager (OLM), which is useful if you have a man-in-the-middle HTTPS proxy.

Prerequisites

- Access to an OpenShift Container Platform cluster using an account with **cluster-admin** permissions.
- Custom CA certificate added to the cluster using a config map.
- Desired Operator installed and running on OLM.

Procedure

1. Create an empty config map in the namespace where the subscription for your Operator exists and include the following label:

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: trusted-ca 1
  labels:
    config.openshift.io/inject-trusted-cabundle: "true" 2
```

1. Name of the config map.
2. Requests the Cluster Network Operator to inject the merged bundle.

After creating this config map, it is immediately populated with the certificate contents of the merged bundle.

2. Update the **Subscription** object to include a **spec.config** section that mounts the **trusted-ca** config map as a volume to each container within a pod that requires a custom CA:

```
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
```

```
metadata:
  name: my-operator
spec:
  package: etcd
  channel: alpha
  config: 1
    selector:
      matchLabels:
        <labels_for_pods> 2
    volumes: 3
    - name: trusted-ca
      configMap:
        name: trusted-ca
        items:
          - key: ca-bundle.crt 4
            path: tls-ca-bundle.pem 5
    volumeMounts: 6
    - name: trusted-ca
      mountPath: /etc/pki/ca-trust/extracted/pem
      readOnly: true
```

1. Add a **config** section if it does not exist.
2. Specify labels to match pods that are owned by the Operator.
3. Create a **trusted-ca** volume.
4. **ca-bundle.crt** is required as the config map key.
5. **tls-ca-bundle.pem** is required as the config map path.
6. Create a **trusted-ca** volume mount.

NOTE

Deployments of an Operator can fail to validate the authority and display a **x509 certificate signed by unknown authority** error. This error can occur even after injecting a custom CA when using the subscription of an Operator. In this case, you can set the **mountPath** as **/etc/ssl/certs** for trusted-ca by using the subscription of an Operator.

4.5.3. Additional resources

- Proxy certificates
- Replacing the default ingress certificate
- Updating the CA bundle

4.6. VIEWING OPERATOR STATUS

Understanding the state of the system in Operator Lifecycle Manager (OLM) is important for making decisions about and debugging problems with installed Operators. OLM provides insight into

subscriptions and related catalog sources regarding their state and actions performed. This helps users better understand the healthiness of their Operators.

4.6.1. Operator subscription condition types

Subscriptions can report the following condition types:

Table 4.1. Subscription condition types

Condition	Description
CatalogSourcesUnhealthy	Some or all of the catalog sources to be used in resolution are unhealthy.
InstallPlanMissing	An install plan for a subscription is missing.
InstallPlanPending	An install plan for a subscription is pending installation.
InstallPlanFailed	An install plan for a subscription has failed.
ResolutionFailed	The dependency resolution for a subscription has failed.

NOTE

Default OpenShift Container Platform cluster Operators are managed by the Cluster Version Operator (CVO) and they do not have a **Subscription** object. Application Operators are managed by Operator Lifecycle Manager (OLM) and they have a **Subscription** object.

Additional resources

- Refreshing failing subscriptions

4.6.2. Viewing Operator subscription status by using the CLI

You can view Operator subscription status by using the CLI.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- You have installed the OpenShift CLI (**oc**).

Procedure

1. List Operator subscriptions:

```
$ oc get subs -n <operator_namespace>
```

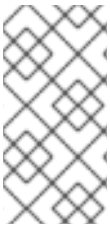
2. Use the **oc describe** command to inspect a **Subscription** resource:

```
$ oc describe sub <subscription_name> -n <operator_namespace>
```

3. In the command output, find the **Conditions** section for the status of Operator subscription condition types. In the following example, the **CatalogSourcesUnhealthy** condition type has a status of **false** because all available catalog sources are healthy:

Example output

```
Name:         cluster-logging
Namespace:    openshift-logging
Labels:       operators.coreos.com/cluster-logging.openshift-logging=
Annotations:  <none>
API Version:  operators.coreos.com/v1alpha1
Kind:         Subscription
# ...
Conditions:
  Last Transition Time:  2019-07-29T13:42:57Z
  Message:               all available catalogsources are healthy
  Reason:                AllCatalogSourcesHealthy
  Status:                False
  Type:                  CatalogSourcesUnhealthy
# ...
```



NOTE

Default OpenShift Container Platform cluster Operators are managed by the Cluster Version Operator (CVO) and they do not have a **Subscription** object. Application Operators are managed by Operator Lifecycle Manager (OLM) and they have a **Subscription** object.

4.6.3. Viewing Operator catalog source status by using the CLI

You can view the status of an Operator catalog source by using the CLI.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- You have installed the OpenShift CLI (**oc**).

Procedure

1. List the catalog sources in a namespace. For example, you can check the **openshift-marketplace** namespace, which is used for cluster-wide catalog sources:

```
$ oc get catalogsources -n openshift-marketplace
```

Example output

```
NAME                  DISPLAY               TYPE   PUBLISHER   AGE
certified-operators   Certified Operators   grpc   Red Hat     55m
community-operators   Community Operators   grpc   Red Hat     55m
example-catalog       Example Catalog       grpc   Example Org 2m25s
```

```
redhat-operators      Red Hat Operators     grpc   Red Hat     55m
```

2. Use the **oc describe** command to get more details and status about a catalog source:

```
$ oc describe catalogsource example-catalog -n openshift-marketplace
```

Example output

```
Name:         example-catalog
Namespace:    openshift-marketplace
Labels:       <none>
Annotations:  operatorframework.io/managed-by: marketplace-operator
              target.workload.openshift.io/management: {"effect": "PreferredDuringScheduling"}
API Version:  operators.coreos.com/v1alpha1
Kind:         CatalogSource
# ...
Status:
  Connection State:
    Address:              example-catalog.openshift-marketplace.svc:50051
    Last Connect:         2021-09-09T17:07:35Z
    Last Observed State:  TRANSIENT_FAILURE
  Registry Service:
    Created At:         2021-09-09T17:05:45Z
    Port:               50051
    Protocol:           grpc
    Service Name:       example-catalog
    Service Namespace:  openshift-marketplace
# ...
```

In the preceding example output, the last observed state is **TRANSIENT_FAILURE**. This state indicates that there is a problem establishing a connection for the catalog source.

3. List the pods in the namespace where your catalog source was created:

```
$ oc get pods -n openshift-marketplace
```

Example output

```
NAME                                  READY   STATUS             RESTARTS   AGE
certified-operators-cv9nn             1/1     Running            0          36m
community-operators-6v8lp             1/1     Running            0          36m
marketplace-operator-86bfc75f9b-jkgbc 1/1     Running            0          42m
example-catalog-bwt8z                 0/1     ImagePullBackOff   0          3m55s
redhat-operators-smxx8                1/1     Running            0          36m
```

When a catalog source is created in a namespace, a pod for the catalog source is created in that namespace. In the preceding example output, the status for the **example-catalog-bwt8z** pod is **ImagePullBackOff**. This status indicates that there is an issue pulling the catalog source's index image.

4. Use the **oc describe** command to inspect a pod for more detailed information:

```
$ oc describe pod example-catalog-bwt8z -n openshift-marketplace
```

Example output

```
Name:         example-catalog-bwt8z
Namespace:    openshift-marketplace
Priority:     0
Node:         ci-ln-jyryyg2-f76d1-ggdbq-worker-b-vsxjd/10.0.128.2
...
Events:
  Type     Reason          Age                From               Message
  ----     ------          ----               ----               -------
  Normal   Scheduled       48s                default-scheduler  Successfully assigned openshift-marketplace/example-catalog-bwt8z to ci-ln-jyryyf2-f76d1-fgdbq-worker-b-vsxjd
  Normal   AddedInterface  47s                multus             Add eth0 [10.131.0.40/23] from openshift-sdn
  Normal   BackOff         20s (x2 over 46s)  kubelet            Back-off pulling image "quay.io/example-org/example-catalog:v1"
  Warning  Failed          20s (x2 over 46s)  kubelet            Error: ImagePullBackOff
  Normal   Pulling         8s (x3 over 47s)   kubelet            Pulling image "quay.io/example-org/example-catalog:v1"
  Warning  Failed          8s (x3 over 47s)   kubelet            Failed to pull image "quay.io/example-org/example-catalog:v1": rpc error: code = Unknown desc = reading manifest v1 in quay.io/example-org/example-catalog: unauthorized: access to the requested resource is not authorized
  Warning  Failed          8s (x3 over 47s)   kubelet            Error: ErrImagePull
```

In the preceding example output, the error messages indicate that the catalog source's index image is failing to pull successfully because of an authorization issue. For example, the index image might be stored in a registry that requires login credentials.

Additional resources

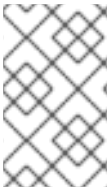
- Operator Lifecycle Manager concepts and resources → Catalog source
- gRPC documentation: States of Connectivity
- Accessing images for Operators from private registries

4.7. MANAGING OPERATOR CONDITIONS

As a cluster administrator, you can manage Operator conditions by using Operator Lifecycle Manager (OLM).

4.7.1. Overriding Operator conditions

As a cluster administrator, you might want to ignore a supported Operator condition reported by an Operator. When present, Operator conditions in the **Spec.Overrides** array override the conditions in the **Spec.Conditions** array, allowing cluster administrators to deal with situations where an Operator is incorrectly reporting a state to Operator Lifecycle Manager (OLM).



NOTE

By default, the **Spec.Overrides** array is not present in an **OperatorCondition** object until it is added by a cluster administrator . The **Spec.Conditions** array is also not present until it is either added by a user or as a result of custom Operator logic.

For example, consider a known version of an Operator that always communicates that it is not upgradeable. In this instance, you might want to upgrade the Operator despite the Operator communicating that it is not upgradeable. This could be accomplished by overriding the Operator condition by adding the condition **type** and **status** to the **Spec.Overrides** array in the **OperatorCondition** object.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- An Operator with an **OperatorCondition** object, installed using OLM.

Procedure

1. Edit the **OperatorCondition** object for the Operator:

```
$ oc edit operatorcondition <name>
```

2. Add a **Spec.Overrides** array to the object:

Example Operator condition override

```
apiVersion: operators.coreos.com/v2
kind: OperatorCondition
metadata:
  name: my-operator
  namespace: operators
spec:
  overrides:
  - type: Upgradeable (1)
    status: "True"
    reason: "upgradeIsSafe"
    message: "This is a known issue with the Operator where it always reports that it cannot be upgraded."
  conditions:
  - type: Upgradeable
    status: "False"
    reason: "migration"
    message: "The operator is performing a migration."
    lastTransitionTime: "2020-08-24T23:15:55Z"
```

(1) Allows the cluster administrator to change the upgrade readiness to **True**.

4.7.2. Updating your Operator to use Operator conditions

Operator Lifecycle Manager (OLM) automatically creates an **OperatorCondition** resource for each **ClusterServiceVersion** resource that it reconciles. All service accounts in the CSV are granted the RBAC to interact with the **OperatorCondition** owned by the Operator.

An Operator author can develop their Operator to use the **operator-lib** library such that, after the Operator has been deployed by OLM, it can set its own conditions. For more resources about setting Operator conditions as an Operator author, see the Enabling Operator conditions page.

4.7.2.1. Setting defaults

In an effort to remain backwards compatible, OLM treats the absence of an **OperatorCondition** resource as opting out of the condition. Therefore, an Operator that opts in to using Operator conditions should set default conditions before the ready probe for the pod is set to **true**. This provides the Operator with a grace period to update the condition to the correct state.

4.7.3. Additional resources

- Operator conditions

4.8. ALLOWING NON-CLUSTER ADMINISTRATORS TO INSTALL OPERATORS

Cluster administrators can use *Operator groups* to allow regular users to install Operators.

Additional resources

- Operator groups

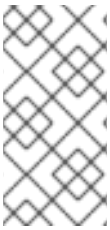
4.8.1. Understanding Operator installation policy

Operators can require wide privileges to run, and the required privileges can change between versions. Operator Lifecycle Manager (OLM) runs with **cluster-admin** privileges. By default, Operator authors can specify any set of permissions in the cluster service version (CSV), and OLM consequently grants it to the Operator.

To ensure that an Operator cannot achieve cluster-scoped privileges and that users cannot escalate privileges using OLM, Cluster administrators can manually audit Operators before they are added to the cluster. Cluster administrators are also provided tools for determining and constraining which actions are allowed during an Operator installation or upgrade using service accounts.

Cluster administrators can associate an Operator group with a service account that has a set of privileges granted to it. The service account sets policy on Operators to ensure they only run within predetermined boundaries by using role-based access control (RBAC) rules. As a result, the Operator is unable to do anything that is not explicitly permitted by those rules.

By employing Operator groups, users with enough privileges can install Operators with a limited scope. As a result, more of the Operator Framework tools can safely be made available to more users, providing a richer experience for building applications with Operators.



NOTE

Role-based access control (RBAC) for **Subscription** objects is automatically granted to every user with the **edit** or **admin** role in a namespace. However, RBAC does not exist on **OperatorGroup** objects; this absence is what prevents regular users from installing Operators. Preinstalling Operator groups is effectively what gives installation privileges.

Keep the following points in mind when associating an Operator group with a service account:

- The **APIService** and **CustomResourceDefinition** resources are always created by OLM using the **cluster-admin** role. A service account associated with an Operator group should never be granted privileges to write these resources.

- Any Operator tied to this Operator group is now confined to the permissions granted to the specified service account. If the Operator asks for permissions that are outside the scope of the service account, the install fails with appropriate errors so the cluster administrator can troubleshoot and resolve the issue.

4.8.1.1. Installation scenarios

When determining whether an Operator can be installed or upgraded on a cluster, Operator Lifecycle Manager (OLM) considers the following scenarios:

- A cluster administrator creates a new Operator group and specifies a service account. All Operator(s) associated with this Operator group are installed and run against the privileges granted to the service account.
- A cluster administrator creates a new Operator group and does not specify any service account. OpenShift Container Platform maintains backward compatibility, so the default behavior remains and Operator installs and upgrades are permitted.
- For existing Operator groups that do not specify a service account, the default behavior remains and Operator installs and upgrades are permitted.
- A cluster administrator updates an existing Operator group and specifies a service account. OLM allows the existing Operator to continue to run with their current privileges. When such an existing Operator is going through an upgrade, it is reinstalled and run against the privileges granted to the service account like any new Operator.
- A service account specified by an Operator group changes by adding or removing permissions, or the existing service account is swapped with a new one. When existing Operators go through an upgrade, it is reinstalled and run against the privileges granted to the updated service account like any new Operator.
- A cluster administrator removes the service account from an Operator group. The default behavior remains and Operator installs and upgrades are permitted.

4.8.1.2. Installation workflow

When an Operator group is tied to a service account and an Operator is installed or upgraded, Operator Lifecycle Manager (OLM) uses the following workflow:

1. The given **Subscription** object is picked up by OLM.
2. OLM fetches the Operator group tied to this subscription.
3. OLM determines that the Operator group has a service account specified.
4. OLM creates a client scoped to the service account and uses the scoped client to install the Operator. This ensures that any permission requested by the Operator is always confined to that of the service account in the Operator group.
5. OLM creates a new service account with the set of permissions specified in the CSV and assigns it to the Operator. The Operator runs as the assigned service account.

4.8.2. Scoping Operator installations

To provide scoping rules to Operator installations and upgrades on Operator Lifecycle Manager (OLM), associate a service account with an Operator group.

Using this example, a cluster administrator can confine a set of Operators to a designated namespace.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- You have installed the OpenShift CLI (**oc**).

Procedure

1. Create a new namespace:

   Example 4.9. Example command that creates a Namespace object

   ```
   $ cat <<EOF | oc create -f -
   apiVersion: v1
   kind: Namespace
   metadata:
     name: scoped
   EOF
   ```

2. Allocate permissions that you want the Operator(s) to be confined to. This involves creating a new service account, relevant role(s), and role binding(s) in the newly created, designated namespace:

   a. Create a service account by running the following command:

      Example 4.10. Example command that creates a ServiceAccount object

      ```
      $ cat <<EOF | oc create -f -
      apiVersion: v1
      kind: ServiceAccount
      metadata:
        name: scoped
        namespace: scoped
      EOF
      ```

   b. Create a secret by running the following command:

      Example 4.11. Example command that creates a long-lived API token Secret object

      ```
      $ cat <<EOF | oc create -f -
      apiVersion: v1
      kind: Secret
      type: kubernetes.io/service-account-token (1)
      metadata:
        name: scoped
        namespace: scoped
        annotations:
          kubernetes.io/service-account.name: scoped
      EOF
      ```

      (1) The secret must be a long-lived API token, which is used by the service account.

c. Create a role by running the following command.

WARNING

In this example, the role grants the service account permissions to do anything in the designated namespace for demonostration purposes only. In a production environment, you should create a more fine-grained set of permissions. For more information, see "Fine-grained permissions".

Example 4.12. Example command that creates Role and RoleBinding objects

```
$ cat <<EOF | oc create -f -
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  name: scoped
  namespace: scoped
rules:
- apiGroups: ["*"]
  resources: ["*"]
  verbs: ["*"]
---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  name: scoped-bindings
  namespace: scoped
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: scoped
subjects:
- kind: ServiceAccount
  name: scoped
  namespace: scoped
EOF
```

3. Create an **OperatorGroup** object in the designated namespace by running the following command. This Operator group targets the designated namespace to ensure that its tenancy is confined to it. In addition, Operator groups allow a user to specify a service account.

Example 4.13. Example command that creates an OperatorGroup object

```
$ cat <<EOF | oc create -f -
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
```

```
metadata:
  name: scoped
  namespace: scoped
spec:
  serviceAccountName: scoped 1
  targetNamespaces:
  - scoped
EOF
```

1 Specify the service account created in the previous step. Any Operator installed in the designated namespace is tied to this Operator group and therefore to the service account specified.

4. Create a **Subscription** object in the designated namespace to install an Operator:

Example 4.14. Example command that creates a Subscription object

```
$ cat <<EOF | oc create -f -
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: openshift-cert-manager-operator
  namespace: scoped
spec:
  channel: stable-v1
  name: openshift-cert-manager-operator
  source: <catalog_source_name> 1
  sourceNamespace: <catalog_source_namespace> 2
EOF
```

1 Specify a catalog source that already exists in the designated namespace or one that is in the global catalog namespace, for example **redhat-operators**.

2 Specify a namespace where the catalog source was created, for example **openshift-marketplace** for the **redhat-operators** catalog.

Any Operator tied to this Operator group is confined to the permissions granted to the specified service account. If the Operator requests permissions that are outside the scope of the service account, the installation fails with relevant errors.

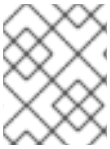
4.8.2.1. Fine-grained permissions

Operator Lifecycle Manager (OLM) uses the service account specified in an Operator group to create or update the following resources related to the Operator being installed:

- **ClusterServiceVersion**
- **Subscription**
- **Secret**

- **ServiceAccount**
- **Service**
- **ClusterRole** and **ClusterRoleBinding**
- **Role** and **RoleBinding**

To confine Operators to a designated namespace, cluster administrators can start by granting the following permissions to the service account:



NOTE

The following role is a generic example and additional rules might be required based on the specific Operator.

```
kind: Role
rules:
- apiGroups: ["operators.coreos.com"]
  resources: ["subscriptions", "clusterserviceversions"]
  verbs: ["get", "create", "update", "patch"]
- apiGroups: [""]
  resources: ["services", "serviceaccounts"]
  verbs: ["get", "create", "update", "patch"]
- apiGroups: ["rbac.authorization.k8s.io"]
  resources: ["roles", "rolebindings"]
  verbs: ["get", "create", "update", "patch"]
- apiGroups: ["apps"] 1
  resources: ["deployments"]
  verbs: ["list", "watch", "get", "create", "update", "patch", "delete"]
- apiGroups: [""] 2
  resources: ["pods"]
  verbs: ["list", "watch", "get", "create", "update", "patch", "delete"]
```

1 2 Add permissions to create other resources, such as deployments and pods shown here.

In addition, if any Operator specifies a pull secret, the following permissions must also be added:

```
kind: ClusterRole 1
rules:
- apiGroups: [""]
  resources: ["secrets"]
  verbs: ["get"]
---
kind: Role
rules:
- apiGroups: [""]
  resources: ["secrets"]
  verbs: ["create", "update", "patch"]
```

1 Required to get the secret from the OLM namespace.

4.8.3. Operator catalog access control

When an Operator catalog is created in the global catalog namespace **openshift-marketplace**, the catalog's Operators are made available cluster-wide to all namespaces. A catalog created in other namespaces only makes its Operators available in that same namespace of the catalog.

On clusters where non-cluster administrator users have been delegated Operator installation privileges, cluster administrators might want to further control or restrict the set of Operators those users are allowed to install. This can be achieved with the following actions:

1. Disable all of the default global catalogs.
2. Enable custom, curated catalogs in the same namespace where the relevant Operator groups have been preinstalled.

Additional resources

- Disabling the default OperatorHub catalog sources
- Adding a catalog source to a cluster

4.8.4. Troubleshooting permission failures

If an Operator installation fails due to lack of permissions, identify the errors using the following procedure.

Procedure

1. Review the **Subscription** object. Its status has an object reference **installPlanRef** that points to the **InstallPlan** object that attempted to create the necessary **[Cluster]Role[Binding]** object(s) for the Operator:

```
apiVersion: operators.coreos.com/v1
kind: Subscription
metadata:
  name: etcd
  namespace: scoped
status:
  installPlanRef:
    apiVersion: operators.coreos.com/v1
    kind: InstallPlan
    name: install-4plp8
    namespace: scoped
    resourceVersion: "117359"
    uid: 2c1df80e-afea-11e9-bce3-5254009c9c23
```

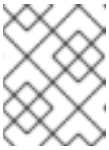
2. Check the status of the **InstallPlan** object for any errors:

```
apiVersion: operators.coreos.com/v1
kind: InstallPlan
status:
  conditions:
  - lastTransitionTime: "2019-07-26T21:13:10Z"
    lastUpdateTime: "2019-07-26T21:13:10Z"
    message: 'error creating clusterrole etcdoperator.v0.9.4-clusterwide-dsfx4:
```

```
clusterroles.rbac.authorization.k8s.io
    is forbidden: User "system:serviceaccount:scoped:scoped" cannot create resource
    "clusterroles" in API group "rbac.authorization.k8s.io" at the cluster scope'
  reason: InstallComponentFailed
  status: "False"
  type: Installed
phase: Failed
```

The error message tells you:

- The type of resource it failed to create, including the API group of the resource. In this case, it was **clusterroles** in the **rbac.authorization.k8s.io** group.
- The name of the resource.
- The type of error: **is forbidden** tells you that the user does not have enough permission to do the operation.
- The name of the user who attempted to create or update the resource. In this case, it refers to the service account specified in the Operator group.
- The scope of the operation: **cluster scope** or not.
  The user can add the missing permission to the service account and then iterate.



NOTE

Operator Lifecycle Manager (OLM) does not currently provide the complete list of errors on the first try.

4.9. MANAGING CUSTOM CATALOGS

Cluster administrators and Operator catalog maintainers can create and manage custom catalogs packaged using the bundle format on Operator Lifecycle Manager (OLM) in OpenShift Container Platform.

IMPORTANT

Kubernetes periodically deprecates certain APIs that are removed in subsequent releases. As a result, Operators are unable to use removed APIs starting with the version of OpenShift Container Platform that uses the Kubernetes version that removed the API.

Additional resources

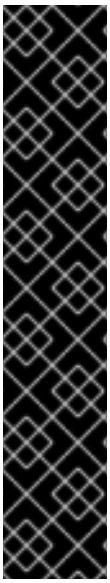
- Red Hat-provided Operator catalogs

4.9.1. Prerequisites

- You have installed the **opm** CLI.

4.9.2. File-based catalogs

File-based catalogs are the latest iteration of the catalog format in Operator Lifecycle Manager (OLM). It is a plain text-based (JSON or YAML) and declarative config evolution of the earlier SQLite database format, and it is fully backwards compatible.



IMPORTANT

As of OpenShift Container Platform 4.11, the default Red Hat-provided Operator catalog releases in the file-based catalog format. The default Red Hat-provided Operator catalogs for OpenShift Container Platform 4.6 through 4.10 released in the deprecated SQLite database format.

The **opm** subcommands, flags, and functionality related to the SQLite database format are also deprecated and will be removed in a future release. The features are still supported and must be used for catalogs that use the deprecated SQLite database format.

Many of the **opm** subcommands and flags for working with the SQLite database format, such as **opm index prune**, do not work with the file-based catalog format. For more information about working with file-based catalogs, see Operator Framework packaging format and Mirroring images for a disconnected installation using the oc-mirror plugin .

4.9.2.1. Creating a file-based catalog image

You can use the **opm** CLI to create a catalog image that uses the plain text *file-based catalog* format (JSON or YAML), which replaces the deprecated SQLite database format.

Prerequisites

- You have installed the **opm** CLI.
- You have **podman** version 1.9.3+.
- A bundle image is built and pushed to a registry that supports Docker v2-2.

Procedure

1. Initialize the catalog:

   a. Create a directory for the catalog by running the following command:

   ```
   $ mkdir <catalog_dir>
   ```

   b. Generate a Dockerfile that can build a catalog image by running the **opm generate dockerfile** command:

   ```
   $ opm generate dockerfile <catalog_dir> \
     -i registry.redhat.io/openshift4/ose-operator-registry-rhel9:v4.19 1
   ```

   1 Specify the official Red Hat base image by using the **-i** flag, otherwise the Dockerfile uses the default upstream image.

   The Dockerfile must be in the same parent directory as the catalog directory that you created in the previous step:

   Example directory structure

```
. 1
├── <catalog_dir> 2
└── <catalog_dir>.Dockerfile 3
```

1. Parent directory
2. Catalog directory
3. Dockerfile generated by the **opm generate dockerfile** command

c. Populate the catalog with the package definition for your Operator by running the **opm init** command:

```
$ opm init <operator_name> \ 1
    --default-channel=preview \ 2
    --description=./README.md \ 3
    --icon=./operator-icon.svg \ 4
    --output yaml \ 5
    > <catalog_dir>/index.yaml 6
```

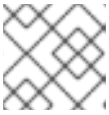
1. Operator, or package, name
2. Channel that subscriptions default to if unspecified
3. Path to the Operator's **README.md** or other documentation
4. Path to the Operator's icon
5. Output format: JSON or YAML
6. Path for creating the catalog configuration file

This command generates an **olm.package** declarative config blob in the specified catalog configuration file.

2. Add a bundle to the catalog by running the **opm render** command:

```
$ opm render <registry>/<namespace>/<bundle_image_name>:<tag> \ 1
    --output=yaml \
    >> <catalog_dir>/index.yaml 2
```

1. Pull spec for the bundle image
2. Path to the catalog configuration file



NOTE

Channels must contain at least one bundle.

3. Add a channel entry for the bundle. For example, modify the following example to your specifications, and add it to your **<catalog_dir>/index.yaml** file:

   Example channel entry

   ```
   ---
   schema: olm.channel
   package: <operator_name>
   name: preview
   entries:
     - name: <operator_name>.v0.1.0 (1)
   ```

   (1) Ensure that you include the period (**.**) after **<operator_name>** but before the **v** in the version. Otherwise, the entry fails to pass the **opm validate** command.

4. Validate the file-based catalog:

   a. Run the **opm validate** command against the catalog directory:

   ```
   $ opm validate <catalog_dir>
   ```

   b. Check that the error code is **0**:

   ```
   $ echo $?
   ```

   Example output

   ```
   0
   ```

5. Build the catalog image by running the **podman build** command:

   ```
   $ podman build . \
      -f <catalog_dir>.Dockerfile \
      -t <registry>/<namespace>/<catalog_image_name>:<tag>
   ```

6. Push the catalog image to a registry:

   a. If required, authenticate with your target registry by running the **podman login** command:

   ```
   $ podman login <registry>
   ```

   b. Push the catalog image by running the **podman push** command:

   ```
   $ podman push <registry>/<namespace>/<catalog_image_name>:<tag>
   ```

Additional resources

- **opm** CLI reference

4.9.2.2. Updating or filtering a file-based catalog image

You can use the **opm** CLI to update or filter a catalog image that uses the file-based catalog format. By extracting the contents of an existing catalog image, you can modify the catalog as needed, for example:

- Adding packages
- Removing packages
- Updating existing package entries
- Detailing deprecation messages per package, channel, and bundle

You can then rebuild the image as an updated version of the catalog.

NOTE

Alternatively, if you already have a catalog image on a mirror registry, you can use the oc-mirror CLI plugin to automatically prune any removed images from an updated source version of that catalog image while mirroring it to the target registry.

For more information about the oc-mirror plugin and this use case, see the "Keeping your mirror registry content updated" section, and specifically the "Pruning images" subsection, of "Mirroring images for a disconnected installation using the oc-mirror plugin".

Prerequisites

- You have the following on your workstation:
  - The **opm** CLI.
  - **podman** version 1.9.3+.
  - A file-based catalog image.
  - A catalog directory structure recently initialized on your workstation related to this catalog. If you do not have an initialized catalog directory, create the directory and generate the Dockerfile. For more information, see the "Initialize the catalog" step from the "Creating a file-based catalog image" procedure.

Procedure

1. Extract the contents of the catalog image in YAML format to an **index.yaml** file in your catalog directory:

```
$ opm render <registry>/<namespace>/<catalog_image_name>:<tag> \
    -o yaml > <catalog_dir>/index.yaml
```

NOTE

Alternatively, you can use the **-o json** flag to output in JSON format.

2. Modify the contents of the resulting **index.yaml** file to your specifications:

IMPORTANT

After a bundle has been published in a catalog, assume that one of your users has installed it. Ensure that all previously published bundles in a catalog have an update path to the current or newer channel head to avoid stranding users that have that version installed.

- To add an Operator, follow the steps for creating package, bundle, and channel entries in the "Creating a file-based catalog image" procedure.
- To remove an Operator, delete the set of **olm.package**, **olm.channel**, and **olm.bundle** blobs that relate to the package. The following example shows a set that must be deleted to remove the **example-operator** package from the catalog:

Example 4.15. Example removed entries

```
---
defaultChannel: release-2.7
icon:
  base64data: <base64_string>
  mediatype: image/svg+xml
name: example-operator
schema: olm.package
---
entries:
- name: example-operator.v2.7.0
  skipRange: '>=2.6.0 <2.7.0'
- name: example-operator.v2.7.1
  replaces: example-operator.v2.7.0
  skipRange: '>=2.6.0 <2.7.1'
- name: example-operator.v2.7.2
  replaces: example-operator.v2.7.1
  skipRange: '>=2.6.0 <2.7.2'
- name: example-operator.v2.7.3
  replaces: example-operator.v2.7.2
  skipRange: '>=2.6.0 <2.7.3'
- name: example-operator.v2.7.4
  replaces: example-operator.v2.7.3
  skipRange: '>=2.6.0 <2.7.4'
name: release-2.7
package: example-operator
schema: olm.channel
---
image: example.com/example-inc/example-operator-bundle@sha256:<digest>
name: example-operator.v2.7.0
package: example-operator
properties:
- type: olm.gvk
  value:
    group: example-group.example.io
    kind: MyObject
    version: v1alpha1
- type: olm.gvk
  value:
    group: example-group.example.io
    kind: MyOtherObject
```

```
    version: v1beta1
- type: olm.package
  value:
    packageName: example-operator
    version: 2.7.0
- type: olm.bundle.object
  value:
    data: <base64_string>
- type: olm.bundle.object
  value:
    data: <base64_string>
relatedImages:
- image: example.com/example-inc/example-related-image@sha256:<digest>
  name: example-related-image
schema: olm.bundle
---
```

- To add or update deprecation messages for an Operator, ensure there is a **deprecations.yaml** file in the same directory as the package's **index.yaml** file. For information on the **deprecations.yaml** file format, see "olm.deprecations schema".

3. Save your changes.

4. Validate the catalog:

```
$ opm validate <catalog_dir>
```

5. Rebuild the catalog:

```
$ podman build . \
    -f <catalog_dir>.Dockerfile \
    -t <registry>/<namespace>/<catalog_image_name>:<tag>
```

6. Push the updated catalog image to a registry:

```
$ podman push <registry>/<namespace>/<catalog_image_name>:<tag>
```

Verification

1. In the web console, navigate to the OperatorHub configuration resource in the **Administration → Cluster Settings → Configuration** page.

2. Add the catalog source or update the existing catalog source to use the pull spec for your updated catalog image.
   For more information, see "Adding a catalog source to a cluster" in the "Additional resources" of this section.

3. After the catalog source is in a **READY** state, navigate to the **Operators → OperatorHub** page and check that the changes you made are reflected in the list of Operators.

Additional resources

- Packaging format → Schemas → olm.deprecations schema

- Mirroring images for a disconnected installation using the oc-mirror plugin → Keeping your mirror registry content updated
- Adding a catalog source to a cluster

4.9.3. SQLite-based catalogs

IMPORTANT

The SQLite database format for Operator catalogs is a deprecated feature. Deprecated functionality is still included in OpenShift Container Platform and continues to be supported; however, it will be removed in a future release of this product and is not recommended for new deployments.

For the most recent list of major functionality that has been deprecated or removed within OpenShift Container Platform, refer to the *Deprecated and removed features* section of the OpenShift Container Platform release notes.

4.9.3.1. Creating a SQLite-based index image

You can create an index image based on the SQLite database format by using the **opm** CLI.

Prerequisites

- You have installed the **opm** CLI.
- You have **podman** version 1.9.3+.
- A bundle image is built and pushed to a registry that supports Docker v2-2.

Procedure

1. Start a new index:

```
$ opm index add \
    --bundles <registry>/<namespace>/<bundle_image_name>:<tag> \ 1
    --tag <registry>/<namespace>/<index_image_name>:<tag> \ 2
    [--binary-image <registry_base_image>] 3
```

1. Comma-separated list of bundle images to add to the index.
2. The image tag that you want the index image to have.
3. Optional: An alternative registry base image to use for serving the catalog.

2. Push the index image to a registry.
   a. If required, authenticate with your target registry:

```
$ podman login <registry>
```

   b. Push the index image:

```
$ podman push <registry>/<namespace>/<index_image_name>:<tag>
```

4.9.3.2. Updating a SQLite-based index image

After configuring OperatorHub to use a catalog source that references a custom index image, cluster administrators can keep the available Operators on their cluster up-to-date by adding bundle images to the index image.

You can update an existing index image using the **opm index add** command.

Prerequisites

- You have installed the **opm** CLI.
- You have **podman** version 1.9.3+.
- An index image is built and pushed to a registry.
- You have an existing catalog source referencing the index image.

Procedure

1. Update the existing index by adding bundle images:

```
$ opm index add \
    --bundles <registry>/<namespace>/<new_bundle_image>@sha256:<digest> \ 1
    --from-index <registry>/<namespace>/<existing_index_image>:<existing_tag> \ 2
    --tag <registry>/<namespace>/<existing_index_image>:<updated_tag> \ 3
    --pull-tool podman 4
```

1. The **--bundles** flag specifies a comma-separated list of additional bundle images to add to the index.
2. The **--from-index** flag specifies the previously pushed index.
3. The **--tag** flag specifies the image tag to apply to the updated index image.
4. The **--pull-tool** flag specifies the tool used to pull container images.

where:

<registry>

Specifies the hostname of the registry, such as **quay.io** or **mirror.example.com**.

<namespace>

Specifies the namespace of the registry, such as **ocs-dev** or **abc**.

<new_bundle_image>

Specifies the new bundle image to add to the registry, such as **ocs-operator**.

<digest>

Specifies the SHA image ID, or digest, of the bundle image, such as **c7f11097a628f092d8bad148406aa0e0951094a03445fd4bc0775431ef683a41**.

<existing_index_image>

Specifies the previously pushed image, such as **abc-redhat-operator-index**.

<existing_tag>

Specifies a previously pushed image tag, such as **4.19**.

<updated_tag>

Specifies the image tag to apply to the updated index image, such as **4.19.1**.

Example command

```
$ opm index add \
    --bundles quay.io/ocs-dev/ocs-
operator@sha256:c7f11097a628f092d8bad148406aa0e0951094a03445fd4bc0775431ef683a
41 \
    --from-index mirror.example.com/abc/abc-redhat-operator-index:4.19 \
    --tag mirror.example.com/abc/abc-redhat-operator-index:4.19.1 \
    --pull-tool podman
```

2. Push the updated index image:

```
$ podman push <registry>/<namespace>/<existing_index_image>:<updated_tag>
```

3. After Operator Lifecycle Manager (OLM) automatically polls the index image referenced in the catalog source at its regular interval, verify that the new packages are successfully added:

```
$ oc get packagemanifests -n openshift-marketplace
```

4.9.3.3. Filtering a SQLite-based index image

An index image, based on the Operator bundle format, is a containerized snapshot of an Operator catalog. You can filter, or *prune*, an index of all but a specified list of packages, which creates a copy of the source index containing only the Operators that you want.

Prerequisites

- You have **podman** version 1.9.3+.
- You have **grpcurl** (third-party command-line tool).
- You have installed the **opm** CLI.
- You have access to a registry that supports Docker v2-2.

Procedure

1. Authenticate with your target registry:

```
$ podman login <target_registry>
```

2. Determine the list of packages you want to include in your pruned index.

   a. Run the source index image that you want to prune in a container. For example:

```
$ podman run -p50051:50051 \
    -it registry.redhat.io/redhat/redhat-operator-index:v4.19
```

Example output

```
Trying to pull registry.redhat.io/redhat/redhat-operator-index:v4.19...
Getting image source signatures
Copying blob ae8a0c23f5b1 done
...
INFO[0000] serving registry                 database=/database/index.db port=50051
```

b. In a separate terminal session, use the **grpcurl** command to get a list of the packages provided by the index:

```
$ grpcurl -plaintext localhost:50051 api.Registry/ListPackages > packages.out
```

c. Inspect the **packages.out** file and identify which package names from this list you want to keep in your pruned index. For example:

Example snippets of packages list

```
...
{
  "name": "advanced-cluster-management"
}
...
{
  "name": "jaeger-product"
}
...
{
{
  "name": "quay-operator"
}
...
```

d. In the terminal session where you executed the **podman run** command, press **Ctrl** and **C** to stop the container process.

3. Run the following command to prune the source index of all but the specified packages:

```
$ opm index prune \
    -f registry.redhat.io/redhat/redhat-operator-index:v4.19 \ 1
    -p advanced-cluster-management,jaeger-product,quay-operator \ 2
    [-i registry.redhat.io/openshift4/ose-operator-registry-rhel9:v4.19] \ 3
    -t <target_registry>:<port>/<namespace>/redhat-operator-index:v4.19 4
```

1 Index to prune.

2 Comma-separated list of packages to keep.

3 Required only for IBM Power® and IBM Z® images: Operator Registry base image with the

4 Custom tag for new index image being built.

4. Run the following command to push the new index image to your target registry:

```
$ podman push <target_registry>:<port>/<namespace>/redhat-operator-index:v4.19
```

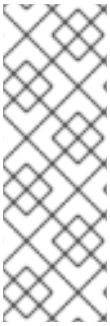
where **<namespace>** is any existing namespace on the registry.

4.9.4. Catalog sources and pod security admission

Pod security admission was introduced in OpenShift Container Platform 4.11 to ensure pod security standards. Catalog sources built using the SQLite-based catalog format and a version of the **opm** CLI tool released before OpenShift Container Platform 4.11 cannot run under restricted pod security enforcement.

In OpenShift Container Platform 4.19, namespaces do not have restricted pod security enforcement by default and the default catalog source security mode is set to **legacy**.

Default restricted enforcement for all namespaces is planned for inclusion in a future OpenShift Container Platform release. When restricted enforcement occurs, the security context of the pod specification for catalog source pods must match the restricted pod security standard. If your catalog source image requires a different pod security standard, the pod security admissions label for the namespace must be explicitly set.



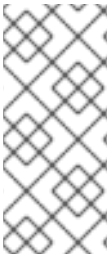
NOTE

If you do not want to run your SQLite-based catalog source pods as restricted, you do not need to update your catalog source in OpenShift Container Platform 4.19.

However, it is recommended that you take action now to ensure your catalog sources run under restricted pod security enforcement. If you do not take action to ensure your catalog sources run under restricted pod security enforcement, your catalog sources might not run in future OpenShift Container Platform releases.

As a catalog author, you can enable compatibility with restricted pod security enforcement by completing either of the following actions:

- Migrate your catalog to the file-based catalog format.
- Update your catalog image with a version of the **opm** CLI tool released with OpenShift Container Platform 4.11 or later.



NOTE

The SQLite database catalog format is deprecated, but still supported by Red Hat. In a future release, the SQLite database format will not be supported, and catalogs will need to migrate to the file-based catalog format. As of OpenShift Container Platform 4.11, the default Red Hat-provided Operator catalog is released in the file-based catalog format. File-based catalogs are compatible with restricted pod security enforcement.

If you do not want to update your SQLite database catalog image or migrate your catalog to the file-based catalog format, you can configure your catalog to run with elevated permissions.

Additional resources

- Understanding and managing pod security admission

4.9.4.1. Migrating SQLite database catalogs to the file-based catalog format

You can update your deprecated SQLite database format catalogs to the file-based catalog format.

Prerequisites

- You have a SQLite database catalog source.
- You have access to the cluster as a user with the **cluster-admin** role.
- You have the latest version of the **opm** CLI tool released with OpenShift Container Platform 4.19 on your workstation.

Procedure

1. Migrate your SQLite database catalog to a file-based catalog by running the following command:

```
$ opm migrate <registry_image> <fbc_directory>
```

2. Generate a Dockerfile for your file-based catalog by running the following command:

```
$ opm generate dockerfile <fbc_directory> \
  --binary-image \
  registry.redhat.io/openshift4/ose-operator-registry-rhel9:v4.19
```

Next steps

- The generated Dockerfile can be built, tagged, and pushed to your registry.

Additional resources

- Adding a catalog source to a cluster

4.9.4.2. Rebuilding SQLite database catalog images

You can rebuild your SQLite database catalog image with the latest version of the **opm** CLI tool that is released with your version of OpenShift Container Platform.

Prerequisites

- You have a SQLite database catalog source.
- You have access to the cluster as a user with the **cluster-admin** role.
- You have the latest version of the **opm** CLI tool released with OpenShift Container Platform 4.19 on your workstation.

Procedure

- Run the following command to rebuild your catalog with a more recent version of the **opm** CLI tool:

```
$ opm index add --binary-image \
  registry.redhat.io/openshift4/ose-operator-registry-rhel9:v4.19 \
  --from-index <your_registry_image> \
  --bundles "" -t \<your_registry_image>
```

4.9.4.3. Configuring catalogs to run with elevated permissions

If you do not want to update your SQLite database catalog image or migrate your catalog to the file-based catalog format, you can perform the following actions to ensure your catalog source runs when the default pod security enforcement changes to restricted:

- Manually set the catalog security mode to legacy in your catalog source definition. This action ensures your catalog runs with legacy permissions even if the default catalog security mode changes to restricted.
- Label the catalog source namespace for baseline or privileged pod security enforcement.

NOTE

The SQLite database catalog format is deprecated, but still supported by Red Hat. In a future release, the SQLite database format will not be supported, and catalogs will need to migrate to the file-based catalog format. File-based catalogs are compatible with restricted pod security enforcement.

Prerequisites

- You have a SQLite database catalog source.
- You have access to the cluster as a user with the **cluster-admin** role.
- You have a target namespace that supports running pods with the elevated pod security admission standard of **baseline** or **privileged**.

Procedure

1. Edit the **CatalogSource** definition by setting the **spec.grpcPodConfig.securityContextConfig** label to **legacy**, as shown in the following example:

   Example CatalogSource definition

```
apiVersion: operators.coreos.com/v1alpha1
kind: CatalogSource
metadata:
  name: my-catsrc
  namespace: my-ns
spec:
  sourceType: grpc
  grpcPodConfig:
    securityContextConfig: legacy
  image: my-image:latest
```

TIP

In OpenShift Container Platform 4.19, the **spec.grpcPodConfig.securityContextConfig** field is set to **legacy** by default. In a future release of OpenShift Container Platform, it is planned that the default setting will change to **restricted**. If your catalog cannot run under restricted enforcement, it is recommended that you manually set this field to **legacy**.

2. Edit your **<namespace>.yaml** file to add elevated pod security admission standards to your catalog source namespace, as shown in the following example:

Example <namespace>.yaml file

```
apiVersion: v1
kind: Namespace
metadata:
...
  labels:
    security.openshift.io/scc.podSecurityLabelSync: "false" 1
    openshift.io/cluster-monitoring: "true"
    pod-security.kubernetes.io/enforce: baseline 2
  name: "<namespace_name>"
```

1. Turn off pod security label synchronization by adding the **security.openshift.io/scc.podSecurityLabelSync=false** label to the namespace.

2. Apply the pod security admission **pod-security.kubernetes.io/enforce** label. Set the label to **baseline** or **privileged**. Use the **baseline** pod security profile unless other workloads in the namespace require a **privileged** profile.

4.9.5. Adding a catalog source to a cluster

Adding a catalog source to an OpenShift Container Platform cluster enables the discovery and installation of Operators for users. Cluster administrators can create a **CatalogSource** object that references an index image. OperatorHub uses catalog sources to populate the user interface.

TIP

Alternatively, you can use the web console to manage catalog sources. From the **Administration → Cluster Settings → Configuration → OperatorHub** page, click the **Sources** tab, where you can create, update, delete, disable, and enable individual sources.

Prerequisites

- You built and pushed an index image to a registry.
- You have access to the cluster as a user with the **cluster-admin** role.

Procedure

1. Create a **CatalogSource** object that references your index image.
   a. Modify the following to your specifications and save it as a **catalogSource.yaml** file:

```
apiVersion: operators.coreos.com/v1alpha1
kind: CatalogSource
metadata:
  name: my-operator-catalog
  namespace: openshift-marketplace (1)
  annotations:
    olm.catalogImageTemplate: (2)
      "<registry>/<namespace>/<index_image_name>:v{kube_major_version}.
{kube_minor_version}.{kube_patch_version}"
spec:
  sourceType: grpc
  grpcPodConfig:
    securityContextConfig: <security_mode> (3)
  image: <registry>/<namespace>/<index_image_name>:<tag> (4)
  displayName: My Operator Catalog
  publisher: <publisher_name> (5)
  updateStrategy:
    registryPoll: (6)
      interval: 30m
```

(1) If you want the catalog source to be available globally to users in all namespaces, specify the **openshift-marketplace** namespace. Otherwise, you can specify a different namespace for the catalog to be scoped and available only for that namespace.

(2) Optional: Set the **olm.catalogImageTemplate** annotation to your index image name and use one or more of the Kubernetes cluster version variables as shown when constructing the template for the image tag.

(3) Specify the value of **legacy** or **restricted**. If the field is not set, the default value is **legacy**. In a future OpenShift Container Platform release, it is planned that the default value will be **restricted**.

NOTE

If your catalog cannot run with **restricted** permissions, it is recommended that you manually set this field to **legacy**.

(4) Specify your index image. If you specify a tag after the image name, for example **:v4.19**, the catalog source pod uses an image pull policy of **Always**, meaning the pod always pulls the image prior to starting the container. If you specify a digest, for example **@sha256:<id>**, the image pull policy is **IfNotPresent**, meaning the pod pulls the image only if it does not already exist on the node.

(5) Specify your name or an organization name publishing the catalog.

(6) Catalog sources can automatically check for new versions to keep up to date.

b. Use the file to create the **CatalogSource** object:

```
$ oc apply -f catalogSource.yaml
```

2. Verify the following resources are created successfully.

a. Check the pods:

```
$ oc get pods -n openshift-marketplace
```

Example output

```
NAME                                READY   STATUS    RESTARTS  AGE
my-operator-catalog-6njx6           1/1     Running   0         28s
marketplace-operator-d9f549946-96sgr  1/1     Running   0         26h
```

b. Check the catalog source:

```
$ oc get catalogsource -n openshift-marketplace
```

Example output

```
NAME                  DISPLAY               TYPE PUBLISHER  AGE
my-operator-catalog   My Operator Catalog   grpc           5s
```

c. Check the package manifest:

```
$ oc get packagemanifest -n openshift-marketplace
```

Example output

```
NAME                      CATALOG               AGE
jaeger-product            My Operator Catalog   93s
```

You can now install the Operators from the **OperatorHub** page on your OpenShift Container Platform web console.

Additional resources

- Operator Lifecycle Manager concepts and resources → Catalog source
- Accessing images for Operators from private registries
- Image pull policy

4.9.6. Accessing images for Operators from private registries

If certain images relevant to Operators managed by Operator Lifecycle Manager (OLM) are hosted in an authenticated container image registry, also known as a private registry, OLM and OperatorHub are unable to pull the images by default. To enable access, you can create a pull secret that contains the authentication credentials for the registry. By referencing one or more pull secrets in a catalog source, OLM can handle placing the secrets in the Operator and catalog namespace to allow installation.

Other images required by an Operator or its Operands might require access to private registries as well. OLM does not handle placing the secrets in target tenant namespaces for this scenario, but authentication credentials can be added to the global cluster pull secret or individual namespace service accounts to enable the required access.

The following types of images should be considered when determining whether Operators managed by OLM have appropriate pull access:

Index images

A **CatalogSource** object can reference an index image, which use the Operator bundle format and are catalog sources packaged as container images hosted in images registries. If an index image is hosted in a private registry, a secret can be used to enable pull access.

Bundle images

Operator bundle images are metadata and manifests packaged as container images that represent a unique version of an Operator. If any bundle images referenced in a catalog source are hosted in one or more private registries, a secret can be used to enable pull access.

Operator and Operand images

If an Operator installed from a catalog source uses a private image, either for the Operator image itself or one of the Operand images it watches, the Operator will fail to install because the deployment will not have access to the required registry authentication. Referencing secrets in a catalog source does not enable OLM to place the secrets in target tenant namespaces in which Operands are installed.

Instead, the authentication details can be added to the global cluster pull secret in the **openshift-config** namespace, which provides access to all namespaces on the cluster. Alternatively, if providing access to the entire cluster is not permissible, the pull secret can be added to the **default** service accounts of the target tenant namespaces.

You can access images from Operator from private registries by creating a secret for your registry credentials and adding the secret for use with relevant catalogs.

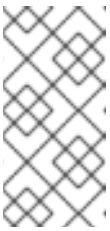
Prerequisites

- You have at least one of the following hosted in a private registry:
  - An index image or catalog image.
  - An Operator bundle image.
  - An Operator or Operand image.
- You have access to the cluster as a user with the **cluster-admin** role.

Procedure

1. Create a secret for each required private registry.
   a. Log in to the private registry to create or update your registry credentials file:

```
$ podman login <registry>:<port>
```



NOTE

The file path of your registry credentials can be different depending on the container tool used to log in to the registry. For the **podman** CLI, the default location is **${XDG_RUNTIME_DIR}/containers/auth.json**. For the **docker** CLI, the default location is **/root/.docker/config.json**.

b. It is recommended to include credentials for only one registry per secret, and manage credentials for multiple registries in separate secrets. Multiple secrets can be included in a **CatalogSource** object in later steps, and OpenShift Container Platform will merge the secrets into a single virtual credentials file for use during an image pull.
A registry credentials file can, by default, store details for more than one registry or for multiple repositories in one registry. Verify the current contents of your file. For example:

File storing credentials for multiple registries

```
{
  "auths": {
    "registry.redhat.io": {
      "auth": "FrNHNydQXdzclNqdg=="
    },
    "quay.io": {
      "auth": "fegdsRib21iMQ=="
    },
    "https://quay.io/my-namespace/my-user/my-image": {
      "auth": "eWfjwsDdfsa221=="
    },
    "https://quay.io/my-namespace/my-user": {
      "auth": "feFweDdscw34rR=="
    },
    "https://quay.io/my-namespace": {
      "auth": "frwEews4fescyq=="
    }
  }
}
```

Because this file is used to create secrets in later steps, ensure that you are storing details for only one registry per file. This can be accomplished by using either of the following methods:

- Use the **podman logout <registry>** command to remove credentials for additional registries until only the one registry you want remains.
- Edit your registry credentials file and separate the registry details to be stored in multiple files. For example:

File storing credentials for one registry

```
{
	"auths": {
		"registry.redhat.io": {
			"auth": "FrNHNydQXdzclNqdg=="
		}
	}
}
```

File storing credentials for another registry

```
{
	"auths": {
		"quay.io": {
			"auth": "Xd2lhdsbnRib21iMQ=="
```

```
            }
        }
}
```

c. Create a secret in the **openshift-marketplace** namespace that contains the authentication credentials for a private registry:

```
$ oc create secret generic <secret_name> \
    -n openshift-marketplace \
    --from-file=.dockerconfigjson=<path/to/registry/credentials> \
    --type=kubernetes.io/dockerconfigjson
```

Repeat this step to create additional secrets for any other required private registries, updating the **--from-file** flag to specify another registry credentials file path.

2. Create or update an existing **CatalogSource** object to reference one or more secrets:

```
apiVersion: operators.coreos.com/v1alpha1
kind: CatalogSource
metadata:
  name: my-operator-catalog
  namespace: openshift-marketplace
spec:
  sourceType: grpc
  secrets: 1
  - "<secret_name_1>"
  - "<secret_name_2>"
  grpcPodConfig:
    securityContextConfig: <security_mode> 2
  image: <registry>:<port>/<namespace>/<image>:<tag>
  displayName: My Operator Catalog
  publisher: <publisher_name>
  updateStrategy:
    registryPoll:
      interval: 30m
```

1 Add a **spec.secrets** section and specify any required secrets.

2 Specify the value of **legacy** or **restricted**. If the field is not set, the default value is **legacy**. In a future OpenShift Container Platform release, it is planned that the default value will be **restricted**.

NOTE

If your catalog cannot run with **restricted** permissions, it is recommended that you manually set this field to **legacy**.

3. If any Operator or Operand images that are referenced by a subscribed Operator require access to a private registry, you can either provide access to all namespaces in the cluster, or individual target tenant namespaces.

- To provide access to all namespaces in the cluster, add authentication details to the global cluster pull secret in the **openshift-config** namespace.

WARNING

Cluster resources must adjust to the new global pull secret, which can temporarily limit the usability of the cluster.

a. Extract the **.dockerconfigjson** file from the global pull secret:

```
$ oc extract secret/pull-secret -n openshift-config --confirm
```

b. Update the **.dockerconfigjson** file with your authentication credentials for the required private registry or registries and save it as a new file:

```
$ cat .dockerconfigjson | \
    jq --compact-output '.auths["<registry>:<port>/<namespace>/"] |= . + {"auth":"
<token>"}' \ 1
    > new_dockerconfigjson
```

1 Replace **<registry>:<port>/<namespace>** with the private registry details and **<token>** with your authentication credentials.

c. Update the global pull secret with the new file:

```
$ oc set data secret/pull-secret -n openshift-config \
    --from-file=.dockerconfigjson=new_dockerconfigjson
```

- To update an individual namespace, add a pull secret to the service account for the Operator that requires access in the target tenant namespace.

a. Recreate the secret that you created for the **openshift-marketplace** in the tenant namespace:

```
$ oc create secret generic <secret_name> \
    -n <tenant_namespace> \
    --from-file=.dockerconfigjson=<path/to/registry/credentials> \
    --type=kubernetes.io/dockerconfigjson
```

b. Verify the name of the service account for the Operator by searching the tenant namespace:

```
$ oc get sa -n <tenant_namespace> 1
```

1 If the Operator was installed in an individual namespace, search that namespace. If the Operator was installed for all namespaces, search the **openshift-operators** namespace.

Example output

```
NAME          SECRETS   AGE
builder       2         6m1s
default       2         6m1s
deployer      2         6m1s
etcd-operator 2         5m18s 1
```

1 Service account for an installed etcd Operator.

c. Link the secret to the service account for the Operator:

```
$ oc secrets link <operator_sa> \
    -n <tenant_namespace> \
     <secret_name> \
    --for=pull
```

Additional resources

- See What is a secret? for more information on the types of secrets, including those used for registry credentials.
- See Updating the global cluster pull secret for more details on the impact of changing this secret.
- See Allowing pods to reference images from other secured registries for more details on linking pull secrets to service accounts per namespace.

4.9.7. Disabling the default OperatorHub catalog sources

Operator catalogs that source content provided by Red Hat and community projects are configured for OperatorHub by default during an OpenShift Container Platform installation. As a cluster administrator, you can disable the set of default catalogs.

Procedure

- Disable the sources for the default catalogs by adding **disableAllDefaultSources: true** to the **OperatorHub** object:

```
$ oc patch OperatorHub cluster --type json \
    -p '[{"op": "add", "path": "/spec/disableAllDefaultSources", "value": true}]'
```

TIP

Alternatively, you can use the web console to manage catalog sources. From the **Administration → Cluster Settings → Configuration → OperatorHub** page, click the **Sources** tab, where you can create, update, delete, disable, and enable individual sources.

4.9.8. Removing custom catalogs

As a cluster administrator, you can remove custom Operator catalogs that have been previously added to your cluster by deleting the related catalog source.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.

Procedure

1. In the **Administrator** perspective of the web console, navigate to **Administration → Cluster Settings**.
2. Click the **Configuration** tab, and then click **OperatorHub**.
3. Click the **Sources** tab.
4. Select the Options menu  for the catalog that you want to remove, and then click **Delete CatalogSource**.

4.10. USING OPERATOR LIFECYCLE MANAGER IN DISCONNECTED ENVIRONMENTS

For OpenShift Container Platform clusters in disconnected environments, Operator Lifecycle Manager (OLM) by default cannot access the Red Hat-provided OperatorHub sources hosted on remote registries because those remote sources require full internet connectivity.

However, as a cluster administrator you can still enable your cluster to use OLM in a disconnected environment if you have a workstation that has full internet access. The workstation, which requires full internet access to pull the remote OperatorHub content, is used to prepare local mirrors of the remote sources, and push the content to a mirror registry.

The mirror registry can be located on a bastion host, which requires connectivity to both your workstation and the disconnected cluster, or a completely disconnected, or *airgapped*, host, which requires removable media to physically move the mirrored content to the disconnected environment.

This guide describes the following process that is required to enable OLM in disconnected environments:

- Disable the default remote OperatorHub sources for OLM.
- Use a workstation with full internet access to create and push local mirrors of the OperatorHub content to a mirror registry.
- Configure OLM to install and manage Operators from local sources on the mirror registry instead of the default remote sources.

After enabling OLM in a disconnected environment, you can continue to use your unrestricted workstation to keep your local OperatorHub sources updated as newer versions of Operators are released.

For more information, see Using Operator Lifecycle Manager in disconnected environments in the Disconnected environments section.

4.11. CATALOG SOURCE POD SCHEDULING

When an Operator Lifecycle Manager (OLM) catalog source of source type **grpc** defines a **spec.image**, the Catalog Operator creates a pod that serves the defined image content. By default, this pod defines the following in its specification:

- Only the **kubernetes.io/os=linux** node selector.
- The default priority class name: **system-cluster-critical**.
- No tolerations.

As an administrator, you can override these values by modifying fields in the **CatalogSource** object's optional **spec.grpcPodConfig** section.

IMPORTANT

The Marketplace Operator, **openshift-marketplace**, manages the default **OperatorHub** custom resource's (CR). This CR manages **CatalogSource** objects. If you attempt to modify fields in the **CatalogSource** object's **spec.grpcPodConfig** section, the Marketplace Operator automatically reverts these modifications. By default, if you modify fields in the **spec.grpcPodConfig** section of the **CatalogSource** object, the Marketplace Operator automatically reverts these changes.

To apply persistent changes to **CatalogSource** object, you must first disable a default **CatalogSource** object.

Additional resources

- OLM concepts and resources → Catalog source

4.11.1. Disabling default CatalogSource objects at a local level

You can apply persistent changes to a **CatalogSource** object, such as catalog source pods, at a local level, by disabling a default **CatalogSource** object. Consider the default configuration in situations where the default **CatalogSource** object's configuration does not meet your organization's needs. By default, if you modify fields in the **spec.grpcPodConfig** section of the **CatalogSource** object, the Marketplace Operator automatically reverts these changes.

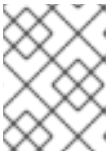
The Marketplace Operator, **openshift-marketplace**, manages the default custom resources (CRs) of the **OperatorHub**. The **OperatorHub** manages **CatalogSource** objects.

To apply persistent changes to **CatalogSource** object, you must first disable a default **CatalogSource** object.

Procedure

- To disable all the default **CatalogSource** objects at a local level, enter the following command:

```
$ oc patch operatorhub cluster -p '{"spec": {"disableAllDefaultSources": true}}' --type=merge
```



NOTE

You can also configure the default **OperatorHub** CR to either disable all **CatalogSource** objects or disable a specific object.

Additional resources

- OperatorHub custom resource

- Disabling the default OperatorHub catalog sources

4.11.2. Overriding the node selector for catalog source pods

Prerequisites

- A **CatalogSource** object of source type **grpc** with **spec.image** is defined.

Procedure

- Edit the **CatalogSource** object and add or modify the **spec.grpcPodConfig** section to include the following:

```
grpcPodConfig:
  nodeSelector:
    custom_label: <label>
```

where **<label>** is the label for the node selector that you want catalog source pods to use for scheduling.

Additional resources

- Placing pods on specific nodes using node selectors

4.11.3. Overriding the priority class name for catalog source pods

Prerequisites

- A **CatalogSource** object of source type **grpc** with **spec.image** is defined.

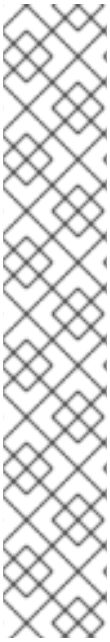
Procedure

- Edit the **CatalogSource** object and add or modify the **spec.grpcPodConfig** section to include the following:

```
grpcPodConfig:
  priorityClassName: <priority_class>
```

where **<priority_class>** is one of the following:

  - One of the default priority classes provided by Kubernetes: **system-cluster-critical** or **system-node-critical**
  - An empty set (**""**) to assign the default priority
  - A pre-existing and custom defined priority class



NOTE

Previously, the only pod scheduling parameter that could be overriden was **priorityClassName**. This was done by adding the **operatorframework.io/priorityclass** annotation to the **CatalogSource** object. For example:

```
apiVersion: operators.coreos.com/v1alpha1
kind: CatalogSource
metadata:
  name: example-catalog
  namespace: openshift-marketplace
  annotations:
    operatorframework.io/priorityclass: system-cluster-critical
```

If a **CatalogSource** object defines both the annotation and **spec.grpcPodConfig.priorityClassName**, the annotation takes precedence over the configuration parameter.

Additional resources

- Pod priority classes

4.11.4. Overriding tolerations for catalog source pods

Prerequisites

- A **CatalogSource** object of source type **grpc** with **spec.image** is defined.

Procedure

- Edit the **CatalogSource** object and add or modify the **spec.grpcPodConfig** section to include the following:

```
grpcPodConfig:
  tolerations:
    - key: "<key_name>"
      operator: "<operator_type>"
      value: "<value>"
      effect: "<effect>"
```

Additional resources

- Understanding taints and tolerations

4.12. TROUBLESHOOTING OPERATOR ISSUES

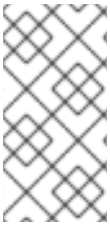
If you experience Operator issues, verify Operator subscription status. Check Operator pod health across the cluster and gather Operator logs for diagnosis.

4.12.1. Operator subscription condition types

Subscriptions can report the following condition types:

Table 4.2. Subscription condition types

Condition	Description
CatalogSourcesUnhealthy	Some or all of the catalog sources to be used in resolution are unhealthy.
InstallPlanMissing	An install plan for a subscription is missing.
InstallPlanPending	An install plan for a subscription is pending installation.
InstallPlanFailed	An install plan for a subscription has failed.
ResolutionFailed	The dependency resolution for a subscription has failed.



NOTE

Default OpenShift Container Platform cluster Operators are managed by the Cluster Version Operator (CVO) and they do not have a **Subscription** object. Application Operators are managed by Operator Lifecycle Manager (OLM) and they have a **Subscription** object.

Additional resources

- Catalog health requirements

4.12.2. Viewing Operator subscription status by using the CLI

You can view Operator subscription status by using the CLI.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- You have installed the OpenShift CLI (**oc**).

Procedure

1. List Operator subscriptions:

```
$ oc get subs -n <operator_namespace>
```

2. Use the **oc describe** command to inspect a **Subscription** resource:

```
$ oc describe sub <subscription_name> -n <operator_namespace>
```

3. In the command output, find the **Conditions** section for the status of Operator subscription condition types. In the following example, the **CatalogSourcesUnhealthy** condition type has a status of **false** because all available catalog sources are healthy:

Example output

```
Name:         cluster-logging
Namespace:    openshift-logging
Labels:       operators.coreos.com/cluster-logging.openshift-logging=
Annotations:  <none>
API Version:  operators.coreos.com/v1alpha1
Kind:         Subscription
# ...
Conditions:
  Last Transition Time:  2019-07-29T13:42:57Z
  Message:               all available catalogsources are healthy
  Reason:                AllCatalogSourcesHealthy
  Status:                False
  Type:                  CatalogSourcesUnhealthy
# ...
```

NOTE

Default OpenShift Container Platform cluster Operators are managed by the Cluster Version Operator (CVO) and they do not have a **Subscription** object. Application Operators are managed by Operator Lifecycle Manager (OLM) and they have a **Subscription** object.

4.12.3. Viewing Operator catalog source status by using the CLI

You can view the status of an Operator catalog source by using the CLI.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- You have installed the OpenShift CLI (**oc**).

Procedure

1. List the catalog sources in a namespace. For example, you can check the **openshift-marketplace** namespace, which is used for cluster-wide catalog sources:

```
$ oc get catalogsources -n openshift-marketplace
```

Example output

```
NAME                  DISPLAY               TYPE   PUBLISHER   AGE
certified-operators   Certified Operators   grpc   Red Hat     55m
community-operators   Community Operators   grpc   Red Hat     55m
example-catalog       Example Catalog       grpc   Example Org 2m25s
redhat-operators      Red Hat Operators     grpc   Red Hat     55m
```

2. Use the **oc describe** command to get more details and status about a catalog source:

```
$ oc describe catalogsource example-catalog -n openshift-marketplace
```

Example output

```
Name:         example-catalog
Namespace:    openshift-marketplace
Labels:       <none>
Annotations:  operatorframework.io/managed-by: marketplace-operator
              target.workload.openshift.io/management: {"effect": "PreferredDuringScheduling"}
API Version:  operators.coreos.com/v1alpha1
Kind:         CatalogSource
# ...
Status:
  Connection State:
    Address:              example-catalog.openshift-marketplace.svc:50051
    Last Connect:         2021-09-09T17:07:35Z
    Last Observed State:  TRANSIENT_FAILURE
  Registry Service:
    Created At:         2021-09-09T17:05:45Z
    Port:               50051
    Protocol:           grpc
    Service Name:       example-catalog
    Service Namespace:  openshift-marketplace
# ...
```

In the preceding example output, the last observed state is **TRANSIENT_FAILURE**. This state indicates that there is a problem establishing a connection for the catalog source.

3. List the pods in the namespace where your catalog source was created:

```
$ oc get pods -n openshift-marketplace
```

Example output

```
NAME                                  READY   STATUS             RESTARTS   AGE
certified-operators-cv9nn             1/1     Running            0          36m
community-operators-6v8lp             1/1     Running            0          36m
marketplace-operator-86bfc75f9b-jkgbc 1/1     Running            0          42m
example-catalog-bwt8z                 0/1     ImagePullBackOff   0          3m55s
redhat-operators-smxx8                1/1     Running            0          36m
```

When a catalog source is created in a namespace, a pod for the catalog source is created in that namespace. In the preceding example output, the status for the **example-catalog-bwt8z** pod is **ImagePullBackOff**. This status indicates that there is an issue pulling the catalog source's index image.

4. Use the **oc describe** command to inspect a pod for more detailed information:

```
$ oc describe pod example-catalog-bwt8z -n openshift-marketplace
```

Example output

```
Name:         example-catalog-bwt8z
Namespace:    openshift-marketplace
Priority:     0
Node:         ci-ln-jyryyg2-f76d1-ggdbq-worker-b-vsxjd/10.0.128.2
```

```
...
Events:
  Type     Reason          Age                From               Message
  ----     ------          ----               ----               -------
  Normal   Scheduled       48s                default-scheduler  Successfully assigned openshift-
marketplace/example-catalog-bwt8z to ci-ln-jyryyf2-f76d1-fgdbq-worker-b-vsxjd
  Normal   AddedInterface  47s                multus             Add eth0 [10.131.0.40/23] from
openshift-sdn
  Normal   BackOff         20s (x2 over 46s)  kubelet            Back-off pulling image
"quay.io/example-org/example-catalog:v1"
  Warning  Failed          20s (x2 over 46s)  kubelet            Error: ImagePullBackOff
  Normal   Pulling         8s (x3 over 47s)   kubelet            Pulling image "quay.io/example-
org/example-catalog:v1"
  Warning  Failed          8s (x3 over 47s)   kubelet            Failed to pull image
"quay.io/example-org/example-catalog:v1": rpc error: code = Unknown desc = reading
manifest v1 in quay.io/example-org/example-catalog: unauthorized: access to the requested
resource is not authorized
  Warning  Failed          8s (x3 over 47s)   kubelet            Error: ErrImagePull
```

In the preceding example output, the error messages indicate that the catalog source's index image is failing to pull successfully because of an authorization issue. For example, the index image might be stored in a registry that requires login credentials.

Additional resources

- Operator Lifecycle Manager concepts and resources → Catalog source
- gRPC documentation: States of Connectivity
- Accessing images for Operators from private registries

4.12.4. Querying Operator pod status

You can list Operator pods within a cluster and their status. You can also collect a detailed Operator pod summary.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- Your API service is still functional.
- You have installed the OpenShift CLI (**oc**).

Procedure

1. List Operators running in the cluster. The output includes Operator version, availability, and up-time information:

```
$ oc get clusteroperators
```

2. List Operator pods running in the Operator's namespace, plus pod status, restarts, and age:

```
$ oc get pod -n <operator_namespace>
```

3. Output a detailed Operator pod summary:

```
$ oc describe pod <operator_pod_name> -n <operator_namespace>
```

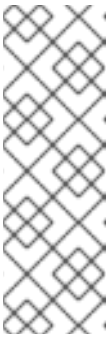
4. If an Operator issue is node-specific, query Operator container status on that node.

   a. Start a debug pod for the node:

```
$ oc debug node/my-node
```

   b. Set **/host** as the root directory within the debug shell. The debug pod mounts the host's root file system in **/host** within the pod. By changing the root directory to **/host**, you can run binaries contained in the host's executable paths:

```
# chroot /host
```



NOTE

OpenShift Container Platform 4.19 cluster nodes running Red Hat Enterprise Linux CoreOS (RHCOS) are immutable and rely on Operators to apply cluster changes. Accessing cluster nodes by using SSH is not recommended. However, if the OpenShift Container Platform API is not available, or the kubelet is not properly functioning on the target node, **oc** operations will be impacted. In such situations, it is possible to access nodes using **ssh core@<node>.<cluster_name>.<base_domain>** instead.

   c. List details about the node's containers, including state and associated pod IDs:

```
# crictl ps
```

   d. List information about a specific Operator container on the node. The following example lists information about the **network-operator** container:

```
# crictl ps --name network-operator
```

   e. Exit from the debug shell.

4.12.5. Gathering Operator logs

If you experience Operator issues, you can gather detailed diagnostic information from Operator pod logs.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- Your API service is still functional.
- You have installed the OpenShift CLI (**oc**).
- You have the fully qualified domain names of the control plane or control plane machines.

Procedure

Procedure

1. List the Operator pods that are running in the Operator's namespace, plus the pod status, restarts, and age:

```
$ oc get pods -n <operator_namespace>
```

2. Review logs for an Operator pod:

```
$ oc logs pod/<pod_name> -n <operator_namespace>
```

If an Operator pod has multiple containers, the preceding command will produce an error that includes the name of each container. Query logs from an individual container:

```
$ oc logs pod/<operator_pod_name> -c <container_name> -n <operator_namespace>
```

3. If the API is not functional, review Operator pod and container logs on each control plane node by using SSH instead. Replace **<master-node>.<cluster_name>.<base_domain>** with appropriate values.

   a. List pods on each control plane node:

```
$ ssh core@<master-node>.<cluster_name>.<base_domain> sudo crictl pods
```

   b. For any Operator pods not showing a **Ready** status, inspect the pod's status in detail. Replace **<operator_pod_id>** with the Operator pod's ID listed in the output of the preceding command:

```
$ ssh core@<master-node>.<cluster_name>.<base_domain> sudo crictl inspectp
<operator_pod_id>
```

   c. List containers related to an Operator pod:

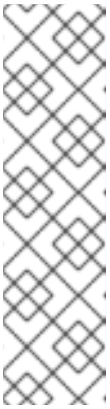
```
$ ssh core@<master-node>.<cluster_name>.<base_domain> sudo crictl ps --pod=
<operator_pod_id>
```

   d. For any Operator container not showing a **Ready** status, inspect the container's status in detail. Replace **<container_id>** with a container ID listed in the output of the preceding command:

```
$ ssh core@<master-node>.<cluster_name>.<base_domain> sudo crictl inspect
<container_id>
```

   e. Review the logs for any Operator containers not showing a **Ready** status. Replace **<container_id>** with a container ID listed in the output of the preceding command:

```
$ ssh core@<master-node>.<cluster_name>.<base_domain> sudo crictl logs -f
<container_id>
```

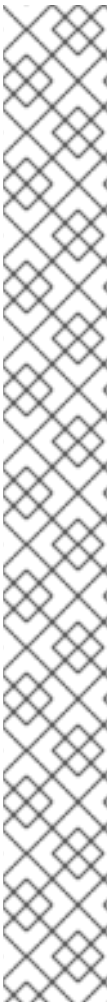


NOTE

OpenShift Container Platform 4.19 cluster nodes running Red Hat Enterprise Linux CoreOS (RHCOS) are immutable and rely on Operators to apply cluster changes. Accessing cluster nodes by using SSH is not recommended. Before attempting to collect diagnostic data over SSH, review whether the data collected by running **oc adm must gather** and other **oc** commands is sufficient instead. However, if the OpenShift Container Platform API is not available, or the kubelet is not properly functioning on the target node, **oc** operations will be impacted. In such situations, it is possible to access nodes using **ssh core@<node>.<cluster_name>.<base_domain>**.

4.12.6. Disabling the Machine Config Operator from automatically rebooting

When configuration changes are made by the Machine Config Operator (MCO), Red Hat Enterprise Linux CoreOS (RHCOS) must reboot for the changes to take effect. Whether the configuration change is automatic or manual, an RHCOS node reboots automatically unless it is paused.



NOTE

- When the MCO detects any of the following changes, it applies the update without draining or rebooting the node:
  - Changes to the SSH key in the **spec.config.passwd.users.sshAuthorizedKeys** parameter of a machine config.
  - Changes to the global pull secret or pull secret in the **openshift-config** namespace.
  - Automatic rotation of the **/etc/kubernetes/kubelet-ca.crt** certificate authority (CA) by the Kubernetes API Server Operator.
- When the MCO detects changes to the **/etc/containers/registries.conf** file, such as editing an **ImageDigestMirrorSet**, **ImageTagMirrorSet**, or **ImageContentSourcePolicy** object, it drains the corresponding nodes, applies the changes, and uncordons the nodes. The node drain does not happen for the following changes:
  - The addition of a registry with the **pull-from-mirror = "digest-only"** parameter set for each mirror.
  - The addition of a mirror with the **pull-from-mirror = "digest-only"** parameter set in a registry.
  - The addition of items to the **unqualified-search-registries** list.

To avoid unwanted disruptions, you can modify the machine config pool (MCP) to prevent automatic rebooting after the Operator makes changes to the machine config.

4.12.6.1. Disabling the Machine Config Operator from automatically rebooting by using the console

To avoid unwanted disruptions from changes made by the Machine Config Operator (MCO), you can use the OpenShift Container Platform web console to modify the machine config pool (MCP) to

prevent the MCO from making any changes to nodes in that pool. This prevents any reboots that would normally be part of the MCO update process.

NOTE

See second **NOTE** in Disabling the Machine Config Operator from automatically rebooting.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.

Procedure

To pause or unpause automatic MCO update rebooting:

- Pause the autoreboot process:

  1. Log in to the OpenShift Container Platform web console as a user with the **cluster-admin** role.
  2. Click **Compute → MachineConfigPools**.
  3. On the **MachineConfigPools** page, click either **master** or **worker**, depending upon which nodes you want to pause rebooting for.
  4. On the **master** or **worker** page, click **YAML**.
  5. In the YAML, update the **spec.paused** field to **true**.

     #### Sample MachineConfigPool object

     ```
     apiVersion: machineconfiguration.openshift.io/v1
     kind: MachineConfigPool
     # ...
     spec:
     # ...
       paused: true (1)
     # ...
     ```

     (1) Update the **spec.paused** field to **true** to pause rebooting.

  6. To verify that the MCP is paused, return to the **MachineConfigPools** page.
     On the **MachineConfigPools** page, the **Paused** column reports **True** for the MCP you modified.

     If the MCP has pending changes while paused, the **Updated** column is **False** and **Updating** is **False**. When **Updated** is **True** and **Updating** is **False**, there are no pending changes.

IMPORTANT

If there are pending changes (where both the **Updated** and **Updating** columns are **False**), it is recommended to schedule a maintenance window for a reboot as early as possible. Use the following steps for unpausing the autoreboot process to apply the changes that were queued since the last reboot.

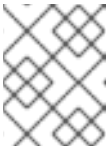
- Unpause the autoreboot process:

  1. Log in to the OpenShift Container Platform web console as a user with the **cluster-admin** role.
  2. Click **Compute → MachineConfigPools**.
  3. On the **MachineConfigPools** page, click either **master** or **worker**, depending upon which nodes you want to pause rebooting for.
  4. On the **master** or **worker** page, click **YAML**.
  5. In the YAML, update the **spec.paused** field to **false**.

     Sample MachineConfigPool object

     ```
     apiVersion: machineconfiguration.openshift.io/v1
     kind: MachineConfigPool
     # ...
     spec:
     # ...
       paused: false (1)
     # ...
     ```

     (1) Update the **spec.paused** field to **false** to allow rebooting.

     NOTE

     By unpausing an MCP, the MCO applies all paused changes reboots Red Hat Enterprise Linux CoreOS (RHCOS) as needed.

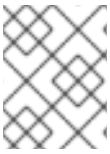
  6. To verify that the MCP is paused, return to the **MachineConfigPools** page.
     On the **MachineConfigPools** page, the **Paused** column reports **False** for the MCP you modified.

     If the MCP is applying any pending changes, the **Updated** column is **False** and the **Updating** column is **True**. When **Updated** is **True** and **Updating** is **False**, there are no further changes being made.

4.12.6.2. Disabling the Machine Config Operator from automatically rebooting by using the CLI

To avoid unwanted disruptions from changes made by the Machine Config Operator (MCO), you can modify the machine config pool (MCP) using the OpenShift CLI (oc) to prevent the MCO from making any changes to nodes in that pool. This prevents any reboots that would normally be part of the MCO

update process.



NOTE

See second **NOTE** in Disabling the Machine Config Operator from automatically rebooting.

Prerequisites

- You have access to the cluster as a user with the **cluster-admin** role.
- You have installed the OpenShift CLI (**oc**).

Procedure

To pause or unpause automatic MCO update rebooting:

- Pause the autoreboot process:
  1. Update the **MachineConfigPool** custom resource to set the **spec.paused** field to **true**.

     Control plane (master) nodes

     ```
     $ oc patch --type=merge --patch='{"spec":{"paused":true}}' machineconfigpool/master
     ```

     Worker nodes

     ```
     $ oc patch --type=merge --patch='{"spec":{"paused":true}}' machineconfigpool/worker
     ```

  2. Verify that the MCP is paused:

     Control plane (master) nodes

     ```
     $ oc get machineconfigpool/master --template='{{.spec.paused}}'
     ```

     Worker nodes

     ```
     $ oc get machineconfigpool/worker --template='{{.spec.paused}}'
     ```

     Example output

     ```
     true
     ```

     The **spec.paused** field is **true** and the MCP is paused.

  3. Determine if the MCP has pending changes:

     ```
     # oc get machineconfigpool
     ```

     Example output

```
NAME     CONFIG                                             UPDATED   UPDATING
master   rendered-master-33cf0a1254318755d7b48002c597bf91   True      False
worker   rendered-worker-e405a5bdb0db1295acea08bcca33fa60   False     False
```

If the **UPDATED** column is **False** and **UPDATING** is **False**, there are pending changes. When **UPDATED** is **True** and **UPDATING** is **False**, there are no pending changes. In the previous example, the worker node has pending changes. The control plane node does not have any pending changes.

IMPORTANT

If there are pending changes (where both the **Updated** and **Updating** columns are **False**), it is recommended to schedule a maintenance window for a reboot as early as possible. Use the following steps for unpausing the autoreboot process to apply the changes that were queued since the last reboot.

- Unpause the autoreboot process:

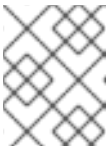
1. Update the **MachineConfigPool** custom resource to set the **spec.paused** field to **false**.

Control plane (master) nodes

```
$ oc patch --type=merge --patch='{"spec":{"paused":false}}' machineconfigpool/master
```

Worker nodes

```
$ oc patch --type=merge --patch='{"spec":{"paused":false}}' machineconfigpool/worker
```



NOTE

By unpausing an MCP, the MCO applies all paused changes and reboots Red Hat Enterprise Linux CoreOS (RHCOS) as needed.

2. Verify that the MCP is unpaused:

Control plane (master) nodes

```
$ oc get machineconfigpool/master --template='{{.spec.paused}}'
```

Worker nodes

```
$ oc get machineconfigpool/worker --template='{{.spec.paused}}'
```

Example output

```
false
```

The **spec.paused** field is **false** and the MCP is unpaused.

3. Determine if the MCP has pending changes:

```
$ oc get machineconfigpool
```

Example output

```
NAME     CONFIG                                UPDATED  UPDATING
master   rendered-master-546383f80705bd5aeaba93   True     False
worker   rendered-worker-b4c51bb33ccaae6fc4a6a5   False    True
```

If the MCP is applying any pending changes, the **UPDATED** column is **False** and the **UPDATING** column is **True**. When **UPDATED** is **True** and **UPDATING** is **False**, there are no further changes being made. In the previous example, the MCO is updating the worker node.

4.12.7. Refreshing failing subscriptions

In Operator Lifecycle Manager (OLM), if you subscribe to an Operator that references images that are not accessible on your network, you can find jobs in the **openshift-marketplace** namespace that are failing with the following errors:

Example output

```
ImagePullBackOff for
Back-off pulling image "example.com/openshift4/ose-elasticsearch-operator-
bundle@sha256:6d2587129c846ec28d384540322b40b05833e7e00b25cca584e004af9a1d292e"
```

Example output

```
rpc error: code = Unknown desc = error pinging docker registry example.com: Get
"https://example.com/v2/": dial tcp: lookup example.com on 10.0.0.1:53: no such host
```

As a result, the subscription is stuck in this failing state and the Operator is unable to install or upgrade.

You can refresh a failing subscription by deleting the subscription, cluster service version (CSV), and other related objects. After recreating the subscription, OLM then reinstalls the correct version of the Operator.

Prerequisites

- You have a failing subscription that is unable to pull an inaccessible bundle image.
- You have confirmed that the correct bundle image is accessible.

Procedure

1. Get the names of the **Subscription** and **ClusterServiceVersion** objects from the namespace where the Operator is installed:

```
$ oc get sub,csv -n <namespace>
```

Example output

```
NAME                         PACKAGE          SOURCE          CHANNEL
```

```
subscription.operators.coreos.com/elasticsearch-operator   elasticsearch-operator   redhat-operators   5.0

NAME                                                         DISPLAY                  VERSION   REPLACES   PHASE
clusterserviceversion.operators.coreos.com/elasticsearch-operator.5.0.0-65   OpenShift Elasticsearch Operator   5.0.0-65              Succeeded
```

2. Delete the subscription:

```
$ oc delete subscription <subscription_name> -n <namespace>
```

3. Delete the cluster service version:

```
$ oc delete csv <csv_name> -n <namespace>
```

4. Get the names of any failing jobs and related config maps in the **openshift-marketplace** namespace:

```
$ oc get job,configmap -n openshift-marketplace
```

Example output

```
NAME                                                                COMPLETIONS   DURATION   AGE
job.batch/1de9443b6324e629ddf31fed0a853a121275806170e34c926d69e53a7fcbccb   1/1           26s        9m30s

NAME                                                                DATA   AGE
configmap/1de9443b6324e629ddf31fed0a853a121275806170e34c926d69e53a7fcbccb   3      9m30s
```

5. Delete the job:

```
$ oc delete job <job_name> -n openshift-marketplace
```

This ensures pods that try to pull the inaccessible image are not recreated.

6. Delete the config map:

```
$ oc delete configmap <configmap_name> -n openshift-marketplace
```

7. Reinstall the Operator using OperatorHub in the web console.

Verification

- Check that the Operator has been reinstalled successfully:

```
$ oc get sub,csv,installplan -n <namespace>
```

4.12.8. Reinstalling Operators after failed uninstallation

You must successfully and completely uninstall an Operator prior to attempting to reinstall the same Operator. Failure to fully uninstall the Operator properly can leave resources, such as a project or namespace, stuck in a "Terminating" state and cause "error resolving resource" messages. For example:

Example Project resource description

```
...
  message: 'Failed to delete all resource types, 1 remaining: Internal error occurred:
    error resolving resource'
...
```

These types of issues can prevent an Operator from being reinstalled successfully.

WARNING

Forced deletion of a namespace is not likely to resolve "Terminating" state issues and can lead to unstable or unpredictable cluster behavior, so it is better to try to find related resources that might be preventing the namespace from being deleted. For more information, see the Red Hat Knowledgebase Solution #4165791 , paying careful attention to the cautions and warnings.

The following procedure shows how to troubleshoot when an Operator cannot be reinstalled because an existing custom resource definition (CRD) from a previous installation of the Operator is preventing a related namespace from deleting successfully.

Procedure

1. Check if there are any namespaces related to the Operator that are stuck in "Terminating" state:

```
$ oc get namespaces
```

Example output

```
operator-ns-1                                      Terminating
```

2. Check if there are any CRDs related to the Operator that are still present after the failed uninstallation:

```
$ oc get crds
```

NOTE

CRDs are global cluster definitions; the actual custom resource (CR) instances related to the CRDs could be in other namespaces or be global cluster instances.

3. If there are any CRDs that you know were provided or managed by the Operator and that should have been deleted after uninstallation, delete the CRD:

```
$ oc delete crd <crd_name>
```

4. Check if there are any remaining CR instances related to the Operator that are still present after uninstallation, and if so, delete the CRs:

   a. The type of CRs to search for can be difficult to determine after uninstallation and can require knowing what CRDs the Operator manages. For example, if you are troubleshooting an uninstallation of the etcd Operator, which provides the **EtcdCluster** CRD, you can search for remaining **EtcdCluster** CRs in a namespace:

   ```
   $ oc get EtcdCluster -n <namespace_name>
   ```

   Alternatively, you can search across all namespaces:

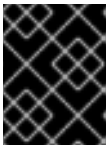
   ```
   $ oc get EtcdCluster --all-namespaces
   ```

   b. If there are any remaining CRs that should be removed, delete the instances:

   ```
   $ oc delete <cr_name> <cr_instance_name> -n <namespace_name>
   ```

5. Check that the namespace deletion has successfully resolved:

   ```
   $ oc get namespace <namespace_name>
   ```

   IMPORTANT

   If the namespace or other Operator resources are still not uninstalled cleanly, contact Red Hat Support.

6. Reinstall the Operator using OperatorHub in the web console.

Verification

- Check that the Operator has been reinstalled successfully:

  ```
  $ oc get sub,csv,installplan -n <namespace>
  ```

Additional resources

- Deleting Operators from a cluster
- Adding Operators to a cluster

CHAPTER 5. DEVELOPING OPERATORS

5.1. TOKEN AUTHENTICATION

5.1.1. Token authentication for Operators on cloud providers

Many cloud providers can enable authentication by using account tokens that provide short-term, limited-privilege security credentials.

OpenShift Container Platform includes the Cloud Credential Operator (CCO) to manage cloud provider credentials as custom resource definitions (CRDs). The CCO syncs on **CredentialsRequest** custom resources (CRs) to allow OpenShift Container Platform components to request cloud provider credentials with any specific permissions required.

Previously, on clusters where the CCO is in *manual mode*, Operators managed by Operator Lifecycle Manager (OLM) often provided detailed instructions in the OperatorHub for how users could manually provision any required cloud credentials.

Starting in OpenShift Container Platform 4.14, the CCO can detect when it is running on clusters enabled to use short-term credentials on certain cloud providers. It can then semi-automate provisioning certain credentials, provided that the Operator author has enabled their Operator to support the updated CCO.

Additional resources

- About the Cloud Credential Operator
- CCO-based workflow for OLM-managed Operators with AWS STS
- CCO-based workflow for OLM-managed Operators with Microsoft Entra Workload ID
- CCO-based workflow for OLM-managed Operators with GCP Workload Identity

5.1.2. CCO-based workflow for OLM-managed Operators with AWS STS

When an OpenShift Container Platform cluster running on AWS is in Security Token Service (STS) mode, it means the cluster is utilizing features of AWS and OpenShift Container Platform to use IAM roles at an application level. STS enables applications to provide a JSON Web Token (JWT) that can assume an IAM role.

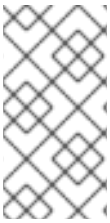
The JWT includes an Amazon Resource Name (ARN) for the **sts:AssumeRoleWithWebIdentity** IAM action to allow temporarily-granted permission for the service account. The JWT contains the signing keys for the **ProjectedServiceAccountToken** that AWS IAM can validate. The service account token itself, which is signed, is used as the JWT required for assuming the AWS role.

The Cloud Credential Operator (CCO) is a cluster Operator installed by default in OpenShift Container Platform clusters running on cloud providers. For the purposes of STS, the CCO provides the following functions:

- Detects when it is running on an STS-enabled cluster
- Checks the **CredentialsRequest** object for the presence of fields that provide the required information for granting Operators access to AWS resources

The CCO performs this detection even when in manual mode. When properly configured, the CCO projects a **Secret** object with the required access information into the Operator namespace.

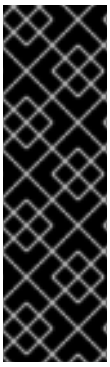
Starting in OpenShift Container Platform 4.14, the CCO can semi-automate this task through an expanded use of **CredentialsRequest** objects, which can request the creation of **Secrets** that contain the information required for STS workflows. Users can provide a role ARN when installing the Operator from either the web console or CLI.



NOTE

Subscriptions with automatic approvals for updates are not recommended because there might be permission changes to make before updating. Subscriptions with manual approvals for updates ensure that administrators have the opportunity to verify the permissions of the later version, take any necessary steps, and then update.

As an Operator author preparing an Operator for use alongside the updated CCO in OpenShift Container Platform 4.14 or later, you should instruct users and add code to handle the divergence from earlier CCO versions, in addition to handling STS token authentication (if your Operator is not already STS-enabled). The recommended method is to provide a **CredentialsRequest** object with the correctly filled STS fields and let the CCO create the **Secret** for you.



IMPORTANT

If you plan to support OpenShift Container Platform clusters earlier than version 4.14, consider providing users with instructions on how to manually create a secret with the STS-enabling information by using the CCO utility (**ccoctl**). Earlier CCO versions are unaware of STS mode on the cluster and cannot create secrets for you.

Your code should check for secrets that never appear and warn users to follow the fallback instructions you have provided. For more information, see the "Alternative method" subsection.

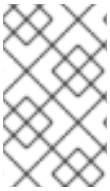
Additional resources

- OLM-managed Operator support for authentication with AWS STS
- Installing from OperatorHub using the web console
- Installing from OperatorHub using the CLI

5.1.2.1. Enabling Operators to support CCO-based workflows with AWS STS

As an Operator author designing your project to run on Operator Lifecycle Manager (OLM), you can enable your Operator to authenticate against AWS on STS-enabled OpenShift Container Platform clusters by customizing your project to support the Cloud Credential Operator (CCO).

With this method, the Operator is responsible for and requires RBAC permissions for creating the **CredentialsRequest** object and reading the resulting **Secret** object.



NOTE

By default, pods related to the Operator deployment mount a **serviceAccountToken** volume so that the service account token can be referenced in the resulting **Secret** object.

Prerequisities

- OpenShift Container Platform 4.14 or later
- Cluster in STS mode
- OLM-based Operator project

Procedure

1. Update your Operator project's **ClusterServiceVersion** (CSV) object:
   a. Ensure your Operator has RBAC permission to create **CredentialsRequests** objects:

      Example 5.1. Example clusterPermissions list

      ```
      # ...
      install:
        spec:
          clusterPermissions:
          - rules:
            - apiGroups:
              - "cloudcredential.openshift.io"
              resources:
              - credentialsrequests
              verbs:
              - create
              - delete
              - get
              - list
              - patch
              - update
              - watch
      ```

   b. Add the following annotation to claim support for this method of CCO-based workflow with AWS STS:

      ```
      # ...
      metadata:
       annotations:
         features.operators.openshift.io/token-auth-aws: "true"
      ```

2. Update your Operator project code:
   a. Get the role ARN from the environment variable set on the pod by the **Subscription** object. For example:

      ```
      // Get ENV var
      roleARN := os.Getenv("ROLEARN")
      setupLog.Info("getting role ARN", "role ARN = ", roleARN)
      webIdentityTokenPath := "/var/run/secrets/openshift/serviceaccount/token"
      ```

   b. Ensure you have a **CredentialsRequest** object ready to be patched and applied. For example:

Example 5.2. Example CredentialsRequest object creation

```
import (
  minterv1 "github.com/openshift/cloud-credential-
operator/pkg/apis/cloudcredential/v1"
  corev1 "k8s.io/api/core/v1"
  metav1 "k8s.io/apimachinery/pkg/apis/meta/v1"
)

var in = minterv1.AWSProviderSpec{
  StatementEntries: []minterv1.StatementEntry{
    {
      Action: []string{
        "s3:*",
      },
      Effect:   "Allow",
      Resource: "arn:aws:s3:*:*:*",
    },
  },
 STSIAMRoleARN: "<role_arn>",
}

var codec = minterv1.Codec
var ProviderSpec, _ = codec.EncodeProviderSpec(in.DeepCopyObject())

const (
  name      = "<credential_request_name>"
  namespace = "<namespace_name>"
)

var CredentialsRequestTemplate = &minterv1.CredentialsRequest{
  ObjectMeta: metav1.ObjectMeta{
      Name:      name,
      Namespace: "openshift-cloud-credential-operator",
  },
  Spec: minterv1.CredentialsRequestSpec{
    ProviderSpec: ProviderSpec,
    SecretRef: corev1.ObjectReference{
      Name:      "<secret_name>",
      Namespace: namespace,
    },
    ServiceAccountNames: []string{
      "<service_account_name>",
    },
    CloudTokenPath:   "",
  },
}
```

Alternatively, if you are starting from a **CredentialsRequest** object in YAML form (for example, as part of your Operator project code), you can handle it differently:

Example 5.3. Example CredentialsRequest object creation in YAML form

```
// CredentialsRequest is a struct that represents a request for credentials
```

```
type CredentialsRequest struct {
  APIVersion string `yaml:"apiVersion"`
  Kind       string `yaml:"kind"`
  Metadata   struct {
    Name      string `yaml:"name"`
    Namespace string `yaml:"namespace"`
  } `yaml:"metadata"`
  Spec struct {
    SecretRef struct {
      Name      string `yaml:"name"`
      Namespace string `yaml:"namespace"`
    } `yaml:"secretRef"`
    ProviderSpec struct {
      APIVersion     string `yaml:"apiVersion"`
      Kind           string `yaml:"kind"`
      StatementEntries []struct {
        Effect   string   `yaml:"effect"`
        Action   []string `yaml:"action"`
        Resource string   `yaml:"resource"`
      } `yaml:"statementEntries"`
      STSIAMRoleARN   string `yaml:"stsIAMRoleARN"`
    } `yaml:"providerSpec"`

    // added new field
     CloudTokenPath   string `yaml:"cloudTokenPath"`
  } `yaml:"spec"`
}

// ConsumeCredsRequestAddingTokenInfo is a function that takes a YAML filename
and two strings as arguments
// It unmarshals the YAML file to a CredentialsRequest object and adds the token
information.
func ConsumeCredsRequestAddingTokenInfo(fileName, tokenString, tokenPath
string) (*CredentialsRequest, error) {
  // open a file containing YAML form of a CredentialsRequest
  file, err := os.Open(fileName)
  if err != nil {
    return nil, err
  }
  defer file.Close()

  // create a new CredentialsRequest object
  cr := &CredentialsRequest{}

  // decode the yaml file to the object
  decoder := yaml.NewDecoder(file)
  err = decoder.Decode(cr)
  if err != nil {
    return nil, err
  }

  // assign the string to the existing field in the object
  cr.Spec.CloudTokenPath = tokenPath
```

```
  // return the modified object
  return cr, nil
}
```

NOTE

Adding a **CredentialsRequest** object to the Operator bundle is not currently supported.

c. Add the role ARN and web identity token path to the credentials request and apply it during Operator initialization:

Example 5.4. Example applying CredentialsRequest object during Operator initialization

```
// apply CredentialsRequest on install
credReq := credreq.CredentialsRequestTemplate
credReq.Spec.CloudTokenPath = webIdentityTokenPath

c := mgr.GetClient()
if err := c.Create(context.TODO(), credReq); err != nil {
  if !errors.IsAlreadyExists(err) {
    setupLog.Error(err, "unable to create CredRequest")
    os.Exit(1)
  }
}
```

d. Ensure your Operator can wait for a **Secret** object to show up from the CCO, as shown in the following example, which is called along with the other items you are reconciling in your Operator:

Example 5.5. Example wait forSecret object

```
// WaitForSecret is a function that takes a Kubernetes client, a namespace, and a v1
"k8s.io/api/core/v1" name as arguments
// It waits until the secret object with the given name exists in the given namespace
// It returns the secret object or an error if the timeout is exceeded
func WaitForSecret(client kubernetes.Interface, namespace, name string)
(*v1.Secret, error) {
  // set a timeout of 10 minutes
  timeout := time.After(10 * time.Minute) (1)

  // set a polling interval of 10 seconds
  ticker := time.NewTicker(10 * time.Second)

  // loop until the timeout or the secret is found
  for {
    select {
    case <-timeout:
      // timeout is exceeded, return an error
      return nil, fmt.Errorf("timed out waiting for secret %s in namespace %s", name,
namespace)
        // add to this error with a pointer to instructions for following a manual path to a
```

```
Secret that will work on STS
    case <-ticker.C:
      // polling interval is reached, try to get the secret
      secret, err := client.CoreV1().Secrets(namespace).Get(context.Background(),
name, metav1.GetOptions{})
      if err != nil {
        if errors.IsNotFound(err) {
          // secret does not exist yet, continue waiting
          continue
        } else {
          // some other error occurred, return it
          return nil, err
        }
      } else {
        // secret is found, return it
        return secret, nil
      }
    }
  }
}
```

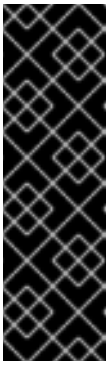
1 The **timeout** value is based on an estimate of how fast the CCO might detect an added **CredentialsRequest** object and generate a **Secret** object. You might consider lowering the time or creating custom feedback for cluster administrators that could be wondering why the Operator is not yet accessing the cloud resources.

e. Set up the AWS configuration by reading the secret created by the CCO from the credentials request and creating the AWS config file containing the data from that secret:

Example 5.6. Example AWS configuration creation

```
func SharedCredentialsFileFromSecret(secret *corev1.Secret) (string, error) {
  var data []byte
  switch {
  case len(secret.Data["credentials"]) > 0:
     data = secret.Data["credentials"]
  default:
     return "", errors.New("invalid secret for aws credentials")
  }


  f, err := ioutil.TempFile("", "aws-shared-credentials")
  if err != nil {
     return "", errors.Wrap(err, "failed to create file for shared credentials")
  }
  defer f.Close()
  if _, err := f.Write(data); err != nil {
     return "", errors.Wrapf(err, "failed to write credentials to %s", f.Name())
  }
  return f.Name(), nil
}
```



IMPORTANT

The secret is assumed to exist, but your Operator code should wait and retry when using this secret to give time to the CCO to create the secret.

Additionally, the wait period should eventually time out and warn users that the OpenShift Container Platform cluster version, and therefore the CCO, might be an earlier version that does not support the **CredentialsRequest** object workflow with STS detection. In such cases, instruct users that they must add a secret by using another method.

f. Configure the AWS SDK session, for example:

Example 5.7. Example AWS SDK session configuration

```
sharedCredentialsFile, err := SharedCredentialsFileFromSecret(secret)
if err != nil {
   // handle error
}
options := session.Options{
   SharedConfigState: session.SharedConfigEnable,
   SharedConfigFiles: []string{sharedCredentialsFile},
}
```

5.1.2.2. Role specification

The Operator description should contain the specifics of the role required to be created before installation, ideally in the form of a script that the administrator can run. For example:

Example 5.8. Example role creation script

```
#!/bin/bash
set -x

AWS_ACCOUNT_ID=$(aws sts get-caller-identity --query "Account" --output text)
OIDC_PROVIDER=$(oc get authentication cluster -ojson | jq -r .spec.serviceAccountIssuer | sed -
e "s/^https:\/\///")
NAMESPACE=my-namespace
SERVICE_ACCOUNT_NAME="my-service-account"
POLICY_ARN_STRINGS="arn:aws:iam::aws:policy/AmazonS3FullAccess"


read -r -d '' TRUST_RELATIONSHIP <<EOF
{
 "Version": "2012-10-17",
 "Statement": [
   {
     "Effect": "Allow",
     "Principal": {
       "Federated": "arn:aws:iam::${AWS_ACCOUNT_ID}:oidc-provider/${OIDC_PROVIDER}"
     },
     "Action": "sts:AssumeRoleWithWebIdentity",
     "Condition": {
       "StringEquals": {
```

```
        "${OIDC_PROVIDER}:sub":
"system:serviceaccount:${NAMESPACE}:${SERVICE_ACCOUNT_NAME}"
        }
      }
    }
  ]
}
EOF

echo "${TRUST_RELATIONSHIP}" > trust.json

aws iam create-role --role-name "$SERVICE_ACCOUNT_NAME" --assume-role-policy-document
file://trust.json --description "role for demo"

while IFS= read -r POLICY_ARN; do
    echo -n "Attaching $POLICY_ARN ... "
    aws iam attach-role-policy \
        --role-name "$SERVICE_ACCOUNT_NAME" \
        --policy-arn "${POLICY_ARN}"
    echo "ok."
done <<< "$POLICY_ARN_STRINGS"
```

5.1.2.3. Troubleshooting

5.1.2.3.1. Authentication failure

If authentication was not successful, ensure you can assume the role with web identity by using the token provided to the Operator.

Procedure

1. Extract the token from the pod:

```
$ oc exec operator-pod -n <namespace_name> \
    -- cat /var/run/secrets/openshift/serviceaccount/token
```

2. Extract the role ARN from the pod:

```
$ oc exec operator-pod -n <namespace_name> \
    -- cat /<path>/<to>/<secret_name> 1
```

1 Do not use root for the path.

3. Try assuming the role with the web identity token:

```
$ aws sts assume-role-with-web-identity \
    --role-arn $ROLEARN \
    --role-session-name <session_name> \
    --web-identity-token $TOKEN
```

5.1.2.3.2. Secret not mounting correctly

Pods that run as non-root users cannot write to the /**root** directory where the AWS shared credentials file is expected to exist by default. If the secret is not mounting correctly to the AWS credentials file path, consider mounting the secret to a different location and enabling the shared credentials file option in the AWS SDK.

5.1.2.4. Alternative method

As an alternative method for Operator authors, you can indicate that the user is responsible for creating the **CredentialsRequest** object for the Cloud Credential Operator (CCO) before installing the Operator.

The Operator instructions must indicate the following to users:

- Provide a YAML version of a **CredentialsRequest** object, either by providing the YAML inline in the instructions or pointing users to a download location
- Instruct the user to create the **CredentialsRequest** object

In OpenShift Container Platform 4.14 and later, after the **CredentialsRequest** object appears on the cluster with the appropriate STS information added, the Operator can then read the CCO-generated **Secret** or mount it, having defined the mount in the cluster service version (CSV).

For earlier versions of OpenShift Container Platform, the Operator instructions must also indicate the following to users:

- Use the CCO utility (**ccoctl**) to generate the **Secret** YAML object from the **CredentialsRequest** object
- Apply the **Secret** object to the cluster in the appropriate namespace

The Operator still must be able to consume the resulting secret to communicate with cloud APIs. Because in this case the secret is created by the user before the Operator is installed, the Operator can do either of the following:

- Define an explicit mount in the **Deployment** object within the CSV
- Programmatically read the **Secret** object from the API server, as shown in the recommended "Enabling Operators to support CCO-based workflows with AWS STS" method

5.1.3. CCO-based workflow for OLM-managed Operators with Microsoft Entra Workload ID

When an OpenShift Container Platform cluster running on Azure is in **Workload Identity / Federated Identity** mode, it means the cluster is utilizing features of Azure and OpenShift Container Platform to apply *user-assigned managed identities* or *app registrations* in Microsoft Entra Workload ID at an application level.

The Cloud Credential Operator (CCO) is a cluster Operator installed by default in OpenShift Container Platform clusters running on cloud providers. Starting in OpenShift Container Platform 4.14.8, the CCO supports workflows for OLM-managed Operators with Workload ID.

For the purposes of Workload ID, the CCO provides the following functions:

- Detects when it is running on an Workload ID-enabled cluster

- Checks the **CredentialsRequest** object for the presence of fields that provide the required information for granting Operators access to Azure resources

The CCO can semi-automate this process through an expanded use of **CredentialsRequest** objects, which can request the creation of **Secrets** that contain the information required for Workload ID workflows.

NOTE

Subscriptions with automatic approvals for updates are not recommended because there might be permission changes to make before updating. Subscriptions with manual approvals for updates ensure that administrators have the opportunity to verify the permissions of the later version, take any necessary steps, and then update.

As an Operator author preparing an Operator for use alongside the updated CCO in OpenShift Container Platform 4.14 and later, you should instruct users and add code to handle the divergence from earlier CCO versions, in addition to handling Workload ID token authentication (if your Operator is not already enabled). The recommended method is to provide a **CredentialsRequest** object with the correctly filled Workload ID fields and let the CCO create the **Secret** object for you.

IMPORTANT

If you plan to support OpenShift Container Platform clusters earlier than version 4.14, consider providing users with instructions on how to manually create a secret with the Workload ID-enabling information by using the CCO utility (**ccoctl**). Earlier CCO versions are unaware of Workload ID mode on the cluster and cannot create secrets for you.

Your code should check for secrets that never appear and warn users to follow the fallback instructions you have provided.

Authentication with Workload ID requires the following information:

- **azure_client_id**
- **azure_tenant_id**
- **azure_region**
- **azure_subscription_id**
- **azure_federated_token_file**

The **Install Operator** page in the web console allows cluster administrators to provide this information at installation time. This information is then propagated to the **Subscription** object as environment variables on the Operator pod.

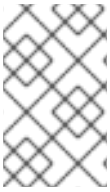
Additional resources

- OLM-managed Operator support for authentication with Microsoft Entra Workload ID
- Installing from OperatorHub using the web console
- Installing from OperatorHub using the CLI

5.1.3.1. Enabling Operators to support CCO-based workflows with Microsoft Entra Workload ID

As an Operator author designing your project to run on Operator Lifecycle Manager (OLM), you can enable your Operator to authenticate against Microsoft Entra Workload ID-enabled OpenShift Container Platform clusters by customizing your project to support the Cloud Credential Operator (CCO).

With this method, the Operator is responsible for and requires RBAC permissions for creating the **CredentialsRequest** object and reading the resulting **Secret** object.



NOTE

By default, pods related to the Operator deployment mount a **serviceAccountToken** volume so that the service account token can be referenced in the resulting **Secret** object.

Prerequisities

- OpenShift Container Platform 4.14 or later
- Cluster in Workload ID mode
- OLM-based Operator project

Procedure

1. Update your Operator project's **ClusterServiceVersion** (CSV) object:
   a. Ensure your Operator has RBAC permission to create **CredentialsRequests** objects:

Example 5.9. Example clusterPermissions list

```
# ...
install:
  spec:
    clusterPermissions:
    - rules:
      - apiGroups:
        - "cloudcredential.openshift.io"
        resources:
        - credentialsrequests
        verbs:
        - create
        - delete
        - get
        - list
        - patch
        - update
        - watch
```

   b. Add the following annotation to claim support for this method of CCO-based workflow with Workload ID:

```
# ...
metadata:
 annotations:
   features.operators.openshift.io/token-auth-azure: "true"
```

2. Update your Operator project code:

   a. Get the client ID, tenant ID, and subscription ID from the environment variables set on the pod by the **Subscription** object. For example:

```
// Get ENV var
clientID := os.Getenv("CLIENTID")
tenantID := os.Getenv("TENANTID")
subscriptionID := os.Getenv("SUBSCRIPTIONID")
azureFederatedTokenFile := "/var/run/secrets/openshift/serviceaccount/token"
```

   b. Ensure you have a **CredentialsRequest** object ready to be patched and applied.

NOTE

Adding a **CredentialsRequest** object to the Operator bundle is not currently supported.

   c. Add the Azure credentials information and web identity token path to the credentials request and apply it during Operator initialization:

Example 5.10. Example applying CredentialsRequest object during Operator initialization

```
// apply CredentialsRequest on install
credReqTemplate.Spec.AzureProviderSpec.AzureClientID = clientID
credReqTemplate.Spec.AzureProviderSpec.AzureTenantID = tenantID
credReqTemplate.Spec.AzureProviderSpec.AzureRegion = "centralus"
credReqTemplate.Spec.AzureProviderSpec.AzureSubscriptionID = subscriptionID
credReqTemplate.CloudTokenPath = azureFederatedTokenFile

c := mgr.GetClient()
if err := c.Create(context.TODO(), credReq); err != nil {
    if !errors.IsAlreadyExists(err) {
        setupLog.Error(err, "unable to create CredRequest")
        os.Exit(1)
    }
}
```

   d. Ensure your Operator can wait for a **Secret** object to show up from the CCO, as shown in the following example, which is called along with the other items you are reconciling in your Operator:

Example 5.11. Example wait forSecret object

```
// WaitForSecret is a function that takes a Kubernetes client, a namespace, and a v1 "k8s.io/api/core/v1" name as arguments
// It waits until the secret object with the given name exists in the given namespace
// It returns the secret object or an error if the timeout is exceeded
```

```
func WaitForSecret(client kubernetes.Interface, namespace, name string)
(*v1.Secret, error) {
  // set a timeout of 10 minutes
  timeout := time.After(10 * time.Minute) (1)

  // set a polling interval of 10 seconds
  ticker := time.NewTicker(10 * time.Second)

  // loop until the timeout or the secret is found
  for {
    select {
    case <-timeout:
      // timeout is exceeded, return an error
      return nil, fmt.Errorf("timed out waiting for secret %s in namespace %s", name,
namespace)
        // add to this error with a pointer to instructions for following a manual path to a
Secret that will work on STS
    case <-ticker.C:
      // polling interval is reached, try to get the secret
      secret, err := client.CoreV1().Secrets(namespace).Get(context.Background(),
name, metav1.GetOptions{})
      if err != nil {
        if errors.IsNotFound(err) {
          // secret does not exist yet, continue waiting
          continue
        } else {
          // some other error occurred, return it
          return nil, err
        }
      } else {
        // secret is found, return it
        return secret, nil
      }
    }
  }
}
```

(1) The **timeout** value is based on an estimate of how fast the CCO might detect an added **CredentialsRequest** object and generate a **Secret** object. You might consider lowering the time or creating custom feedback for cluster administrators that could be wondering why the Operator is not yet accessing the cloud resources.

e. Read the secret created by the CCO from the **CredentialsRequest** object to authenticate with Azure and receive the necessary credentials.

5.1.4. CCO-based workflow for OLM-managed Operators with GCP Workload Identity

When an OpenShift Container Platform cluster running on Google Cloud is in **GCP Workload Identity / Federated Identity** mode, it means the cluster is utilizing features of Google Cloud and OpenShift Container Platform to apply permissions in GCP Workload Identity at an application level.

The Cloud Credential Operator (CCO) is a cluster Operator installed by default in OpenShift Container Platform clusters running on cloud providers. Starting in OpenShift Container Platform 4.17, the CCO supports workflows for OLM-managed Operators with GCP Workload Identity.

For the purposes of GCP Workload Identity, the CCO provides the following functions:

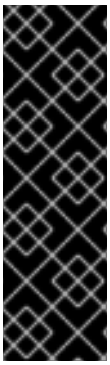
- Detects when it is running on an GCP Workload Identity-enabled cluster
- Checks the **CredentialsRequest** object for the presence of fields that provide the required information for granting Operators access to Google Cloud resources

The CCO can semi-automate this process through an expanded use of **CredentialsRequest** objects, which can request the creation of **Secrets** that contain the information required for GCP Workload Identity workflows.

NOTE

Subscriptions with automatic approvals for updates are not recommended because there might be permission changes to make before updating. Subscriptions with manual approvals for updates ensure that administrators have the opportunity to verify the permissions of the later version, take any necessary steps, and then update.

As an Operator author preparing an Operator for use alongside the updated CCO in OpenShift Container Platform 4.17 and later, you should instruct users and add code to handle the divergence from earlier CCO versions, in addition to handling GCP Workload Identity token authentication (if your Operator is not already enabled). The recommended method is to provide a **CredentialsRequest** object with the correctly filled GCP Workload Identity fields and let the CCO create the **Secret** object for you.



IMPORTANT

If you plan to support OpenShift Container Platform clusters earlier than version 4.17, consider providing users with instructions on how to manually create a secret with the GCP Workload Identity-enabling information by using the CCO utility (**ccoctl**). Earlier CCO versions are unaware of GCP Workload Identity mode on the cluster and cannot create secrets for you.

Your code should check for secrets that never appear and warn users to follow the fallback instructions you have provided.

To authenticate with Google Cloud using short-lived tokens via Google Cloud Platform Workload Identity, Operators must provide the following information:

AUDIENCE

Created in Google Cloud by the administrator when they set up GCP Workload Identity, the **AUDIENCE** value must be a preformatted URL in the following format:

```
//iam.googleapis.com/projects/<project_number>/locations/global/workloadIdentityPools/<pool_id>/pr
oviders/<provider_id>
```

SERVICE_ACCOUNT_EMAIL

The **SERVICE_ACCOUNT_EMAIL** value is a Google Cloud service account email that is impersonated during Operator operation, for example:

```
<service_account_name>@<project_id>.iam.gserviceaccount.com
```

The **Install Operator** page in the web console allows cluster administrators to provide this information at installation time. This information is then propagated to the **Subscription** object as environment variables on the Operator pod.

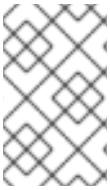
Additional resources

- OLM-managed Operator support for authentication with GCP Workload Identity
- Installing from OperatorHub using the web console
- Installing from OperatorHub using the CLI

5.1.4.1. Enabling Operators to support CCO-based workflows with GCP Workload Identity

As an Operator author designing your project to run on Operator Lifecycle Manager (OLM), you can enable your Operator to authenticate against Google Cloud Platform Workload Identity on OpenShift Container Platform clusters by customizing your project to support the Cloud Credential Operator (CCO).

With this method, the Operator is responsible for and requires RBAC permissions for creating the **CredentialsRequest** object and reading the resulting **Secret** object.



NOTE

By default, pods related to the Operator deployment mount a **serviceAccountToken** volume so that the service account token can be referenced in the resulting **Secret** object.

Prerequisities

- OpenShift Container Platform 4.17 or later
- Cluster in **GCP Workload Identity / Federated Identity** mode
- OLM-based Operator project

Procedure

1. Update your Operator project's **ClusterServiceVersion** (CSV) object:
   a. Ensure Operator deployment in the CSV has the following **volumeMounts** and **volumes** fields so that the Operator can assume the role with web identity:

Example 5.12. Example volumeMounts and volumes fields

```
# ...
    volumeMounts:

    - name: bound-sa-token
      mountPath: /var/run/secrets/openshift/serviceaccount
      readOnly: true
    volumes:
```

```
    # This service account token can be used to provide identity outside the cluster.
  - name: bound-sa-token
    projected:
      sources:
      - serviceAccountToken:
        path: token
        audience: openshift
```

b. Ensure your Operator has RBAC permission to create **CredentialsRequests** objects:

Example 5.13. Example clusterPermissions list

```
# ...
install:
  spec:
    clusterPermissions:
    - rules:
      - apiGroups:
        - "cloudcredential.openshift.io"
        resources:
        - credentialsrequests
        verbs:
        - create
        - delete
        - get
        - list
        - patch
        - update
        - watch
```

c. Add the following annotation to claim support for this method of CCO-based workflow with GCP Workload Identity:

```
# ...
metadata:
 annotations:
   features.operators.openshift.io/token-auth-gcp: "true"
```

2. Update your Operator project code:

a. Get the **audience** and the **serviceAccountEmail** values from the environment variables set on the pod by the subscription config:

```
// Get ENV var
  audience := os.Getenv("AUDIENCE")
  serviceAccountEmail := os.Getenv("SERVICE_ACCOUNT_EMAIL")
  gcpIdentityTokenFile := "/var/run/secrets/openshift/serviceaccount/token"
```

b. Ensure you have a **CredentialsRequest** object ready to be patched and applied.

NOTE

Adding a **CredentialsRequest** object to the Operator bundle is not currently supported.

c. Add the GCP Workload Identity variables to the credentials request and apply it during Operator initialization:

Example 5.14. Example applying CredentialsRequest object during Operator initialization

```
// apply CredentialsRequest on install
  credReqTemplate.Spec.GCPProviderSpec.Audience = audience
  credReqTemplate.Spec.GCPProviderSpec.ServiceAccountEmail =
serviceAccountEmail
  credReqTemplate.CloudTokenPath = gcpIdentityTokenFile


  c := mgr.GetClient()
  if err := c.Create(context.TODO(), credReq); err != nil {
     if !errors.IsAlreadyExists(err) {
        setupLog.Error(err, "unable to create CredRequest")
        os.Exit(1)
     }
  }
```

d. Ensure your Operator can wait for a **Secret** object to show up from the CCO, as shown in the following example, which is called along with the other items you are reconciling in your Operator:

Example 5.15. Example wait for Secret object

```
// WaitForSecret is a function that takes a Kubernetes client, a namespace, and a v1
"k8s.io/api/core/v1" name as arguments
// It waits until the secret object with the given name exists in the given namespace
// It returns the secret object or an error if the timeout is exceeded
func WaitForSecret(client kubernetes.Interface, namespace, name string)
(*v1.Secret, error) {
  // set a timeout of 10 minutes
  timeout := time.After(10 * time.Minute) (1)

  // set a polling interval of 10 seconds
  ticker := time.NewTicker(10 * time.Second)

  // loop until the timeout or the secret is found
  for {
    select {
    case <-timeout:
      // timeout is exceeded, return an error
      return nil, fmt.Errorf("timed out waiting for secret %s in namespace %s", name,
namespace)
// add to this error with a pointer to instructions for following a manual path to a Secret
that will work
    case <-ticker.C:
      // polling interval is reached, try to get the secret
```

```
        secret, err := client.CoreV1().Secrets(namespace).Get(context.Background(),
name, metav1.GetOptions{})
        if err != nil {
          if errors.IsNotFound(err) {
            // secret does not exist yet, continue waiting
            continue
          } else {
            // some other error occurred, return it
            return nil, err
          }
        } else {
          // secret is found, return it
          return secret, nil
        }
      }
    }
  }
```

1 The **timeout** value is based on an estimate of how fast the CCO might detect an added **CredentialsRequest** object and generate a **Secret** object. You might consider lowering the time or creating custom feedback for cluster administrators that could be wondering why the Operator is not yet accessing the cloud resources.

e. Read the **service_account.json** field from the secret and use it to authenticate your Google Cloud client:

```
service_account_json := secret.StringData["service_account.json"]
```

CHAPTER 6. CLUSTER OPERATORS REFERENCE

This reference guide indexes the *cluster Operators* shipped by Red Hat that serve as the architectural foundation for OpenShift Container Platform. Cluster Operators are installed by default, unless otherwise noted, and are managed by the Cluster Version Operator (CVO). For more details on the control plane architecture, see Operators in OpenShift Container Platform .

Cluster administrators can view cluster Operators in the OpenShift Container Platform web console from the **Administration → Cluster Settings** page.

NOTE

Cluster Operators are not managed by Operator Lifecycle Manager (OLM) and OperatorHub. OLM and OperatorHub are part of the Operator Framework used in OpenShift Container Platform for installing and running optional add-on Operators.

Some of the following cluster Operators can be disabled prior to installation. For more information see cluster capabilities.

6.1. CLUSTER BAREMETAL OPERATOR

NOTE

The Cluster Baremetal Operator is an optional cluster capability that can be disabled by cluster administrators during installation. For more information about optional cluster capabilities, see "Cluster capabilities" in *Installing*.

The Cluster Baremetal Operator (CBO) deploys all the components necessary to take a bare-metal server to a fully functioning worker node ready to run OpenShift Container Platform compute nodes. The CBO ensures that the metal3 deployment, which consists of the Bare Metal Operator (BMO) and Ironic containers, runs on one of the control plane nodes within the OpenShift Container Platform cluster. The CBO also listens for OpenShift Container Platform updates to resources that it watches and takes appropriate action.

6.1.1. Project

cluster-baremetal-operator

Additional resources

- Bare-metal capability

6.2. CLOUD CREDENTIAL OPERATOR

The Cloud Credential Operator (CCO) manages cloud provider credentials as Kubernetes custom resource definitions (CRDs). The CCO syncs on **CredentialsRequest** custom resources (CRs) to allow OpenShift Container Platform components to request cloud provider credentials with the specific permissions that are required for the cluster to run.

By setting different values for the **credentialsMode** parameter in the **install-config.yaml** file, the CCO can be configured to operate in several different modes. If no mode is specified, or the **credentialsMode** parameter is set to an empty string (**""**), the CCO operates in its default mode.

6.2.1. Project

openshift-cloud-credential-operator

6.2.2. CRDs

- **credentialsrequests.cloudcredential.openshift.io**
  - Scope: Namespaced
  - CR: **CredentialsRequest**
  - Validation: Yes

6.2.3. Configuration objects

No configuration required.

6.2.4. Additional resources

- About the Cloud Credential Operator
- **CredentialsRequest** custom resource

6.3. CLUSTER AUTHENTICATION OPERATOR

The Cluster Authentication Operator installs and maintains the **Authentication** custom resource in a cluster and can be viewed with:

```
$ oc get clusteroperator authentication -o yaml
```

6.3.1. Project

cluster-authentication-operator

6.4. CLUSTER AUTOSCALER OPERATOR

The Cluster Autoscaler Operator manages deployments of the OpenShift Cluster Autoscaler using the **cluster-api** provider.

6.4.1. Project

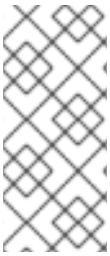
cluster-autoscaler-operator

6.4.2. CRDs

- **ClusterAutoscaler**: This is a singleton resource, which controls the configuration autoscaler instance for the cluster. The Operator only responds to the **ClusterAutoscaler** resource named **default** in the managed namespace, the value of the **WATCH_NAMESPACE** environment variable.

- **MachineAutoscaler**: This resource targets a node group and manages the annotations to enable and configure autoscaling for that group, the **min** and **max** size. Currently only **MachineSet** objects can be targeted.

6.5. CLOUD CONTROLLER MANAGER OPERATOR



NOTE

The status of this Operator is General Availability for Amazon Web Services (AWS), Google Cloud, IBM Cloud®, global Microsoft Azure, Microsoft Azure Stack Hub, Nutanix, Red Hat OpenStack Platform (RHOSP), and VMware vSphere.

The Operator is available as a Technology Preview for IBM Power® Virtual Server.

The Cloud Controller Manager Operator manages and updates the cloud controller managers deployed on top of OpenShift Container Platform. The Operator is based on the Kubebuilder framework and **controller-runtime** libraries. You can install the Cloud Controller Manager Operator by using the Cluster Version Operator (CVO).

The Cloud Controller Manager Operator includes the following components:

- Operator
- Cloud configuration observer

By default, the Operator exposes Prometheus metrics through the **metrics** service.

6.5.1. Project

cluster-cloud-controller-manager-operator

6.6. CLUSTER CAPI OPERATOR

The Cluster CAPI Operator maintains the lifecycle of Cluster API resources. This Operator is responsible for all administrative tasks related to deploying the Cluster API project within an OpenShift Container Platform cluster.

NOTE

This Operator is available as a Technology Preview for Amazon Web Services (AWS), Google Cloud, Microsoft Azure, Red Hat OpenStack Platform (RHOSP), and VMware vSphere clusters.

6.6.1. Project

cluster-capi-operator

6.6.2. CRDs

- **awsmachines.infrastructure.cluster.x-k8s.io**
  - Scope: Namespaced

    - CR: **awsmachine**
- **gcpmachines.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **gcpmachine**
- **azuremachines.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **azuremachine**
- **openstackmachines.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **openstackmachine**
- **vspheremachines.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **vspheremachine**
- **metal3machines.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **metal3machine**
- **awsmachinetemplates.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **awsmachinetemplate**
- **gcpmachinetemplates.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **gcpmachinetemplate**
- **azuremachinetemplates.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **azuremachinetemplate**
- **openstackmachinetemplates.infrastructure.cluster.x-k8s.io**
    - Scope: Namespaced
    - CR: **openstackmachinetemplate**
- **vspheremachinetemplates.infrastructure.cluster.x-k8s.io**

- Scope: Namespaced
- CR: **vspheremachinetemplate**

- **metal3machinetemplates.infrastructure.cluster.x-k8s.io**
  - Scope: Namespaced
  - CR: **metal3machinetemplate**

6.7. CLUSTER CONFIG OPERATOR

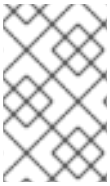
The Cluster Config Operator performs the following tasks related to **config.openshift.io**:

- Creates CRDs.
- Renders the initial custom resources.
- Handles migrations.

6.7.1. Project

cluster-config-operator

6.8. CLUSTER CSI SNAPSHOT CONTROLLER OPERATOR



NOTE

The Cluster CSI Snapshot Controller Operator is an optional cluster capability that can be disabled by cluster administrators during installation. For more information about optional cluster capabilities, see "Cluster capabilities" in *Installing*.

The Cluster CSI Snapshot Controller Operator installs and maintains the CSI Snapshot Controller. The CSI Snapshot Controller is responsible for watching the **VolumeSnapshot** CRD objects and manages the creation and deletion lifecycle of volume snapshots.

6.8.1. Project

cluster-csi-snapshot-controller-operator

Additional resources

- CSI snapshot controller capability

6.9. CLUSTER IMAGE REGISTRY OPERATOR

The Cluster Image Registry Operator manages a singleton instance of the OpenShift image registry. It manages all configuration of the registry, including creating storage.

On initial start up, the Operator creates a default **image-registry** resource instance based on the configuration detected in the cluster. This indicates what cloud storage type to use based on the cloud provider.

If insufficient information is available to define a complete **image-registry** resource, then an incomplete resource is defined and the Operator updates the resource status with information about what is missing.

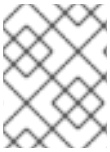
The Cluster Image Registry Operator runs in the **openshift-image-registry** namespace and it also manages the registry instance in that location. All configuration and workload resources for the registry reside in that namespace.

6.9.1. Project

cluster-image-registry-operator

6.10. CLUSTER MACHINE APPROVER OPERATOR

The Cluster Machine Approver Operator automatically approves the CSRs requested for a new worker node after cluster installation.



NOTE

For the control plane node, the **approve-csr** service on the bootstrap node automatically approves all CSRs during the cluster bootstrapping phase.

6.10.1. Project

cluster-machine-approver-operator

6.11. CLUSTER MONITORING OPERATOR

The Cluster Monitoring Operator (CMO) manages and updates the Prometheus-based cluster monitoring stack deployed on top of OpenShift Container Platform.

Project
openshift-monitoring

CRDs

- **alertmanagers.monitoring.coreos.com**
  - Scope: Namespaced
  - CR: **alertmanager**
  - Validation: Yes
- **prometheuses.monitoring.coreos.com**
  - Scope: Namespaced
  - CR: **prometheus**
  - Validation: Yes
- **prometheusrules.monitoring.coreos.com**
  - Scope: Namespaced

- CR: **prometheusrule**
- Validation: Yes

- **servicemonitors.monitoring.coreos.com**
  - Scope: Namespaced
  - CR: **servicemonitor**
  - Validation: Yes

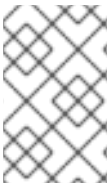
Configuration objects

```
$ oc -n openshift-monitoring edit cm cluster-monitoring-config
```

6.12. CLUSTER NETWORK OPERATOR

The Cluster Network Operator installs and upgrades the networking components on an OpenShift Container Platform cluster.

6.13. CLUSTER SAMPLES OPERATOR



NOTE

The Cluster Samples Operator is an optional cluster capability that can be disabled by cluster administrators during installation. For more information about optional cluster capabilities, see "Cluster capabilities" in *Installing*.

The Cluster Samples Operator manages the sample image streams and templates stored in the **openshift** namespace.

On initial start up, the Operator creates the default samples configuration resource to initiate the creation of the image streams and templates. The configuration object is a cluster scoped object with the key **cluster** and type **configs.samples**.

The image streams are the Red Hat Enterprise Linux CoreOS (RHCOS)-based OpenShift Container Platform image streams pointing to images on **registry.redhat.io**. Similarly, the templates are those categorized as OpenShift Container Platform templates.

The Cluster Samples Operator deployment is contained within the **openshift-cluster-samples-operator** namespace. On start up, the install pull secret is used by the image stream import logic in the OpenShift image registry and API server to authenticate with **registry.redhat.io**. An administrator can create any additional secrets in the **openshift** namespace if they change the registry used for the sample image streams. If created, those secrets contain the content of a **config.json** for **docker** needed to facilitate image import.

The image for the Cluster Samples Operator contains image stream and template definitions for the associated OpenShift Container Platform release. After the Cluster Samples Operator creates a sample, it adds an annotation that denotes the OpenShift Container Platform version that it is compatible with. The Operator uses this annotation to ensure that each sample matches the compatible release version. Samples outside of its inventory are ignored, as are skipped samples.

Modifications to any samples that are managed by the Operator are allowed as long as the version annotation is not modified or deleted. However, on an upgrade, as the version annotation will change, those modifications can get replaced as the sample will be updated with the newer version. The Jenkins images are part of the image payload from the installation and are tagged into the image streams directly.

The samples resource includes a finalizer, which cleans up the following upon its deletion:

- Operator-managed image streams
- Operator-managed templates
- Operator-generated configuration resources
- Cluster status resources

Upon deletion of the samples resource, the Cluster Samples Operator recreates the resource using the default configuration.

6.13.1. Project

cluster-samples-operator

Additional resources

- OpenShift samples capability

6.14. CLUSTER STORAGE OPERATOR

NOTE

The Cluster Storage Operator is an optional cluster capability that can be disabled by cluster administrators during installation. For more information about optional cluster capabilities, see "Cluster capabilities" in *Installing*.

The Cluster Storage Operator sets OpenShift Container Platform cluster-wide storage defaults. It ensures a default **storageclass** exists for OpenShift Container Platform clusters. It also installs Container Storage Interface (CSI) drivers which enable your cluster to use various storage backends.

6.14.1. Project

cluster-storage-operator

6.14.2. Configuration

No configuration is required.

6.14.3. Notes

- The storage class that the Operator creates can be made non-default by editing its annotation, but this storage class cannot be deleted as long as the Operator runs.

Additional resources

- Storage capability

6.15. CLUSTER VERSION OPERATOR

Cluster Operators manage specific areas of cluster functionality. The Cluster Version Operator (CVO) manages the lifecycle of cluster Operators, many of which are installed in OpenShift Container Platform by default.

The CVO also checks with the OpenShift Update Service to see the valid updates and update paths based on current component versions and information in the graph by collecting the status of both the cluster version and its cluster Operators. This status includes the condition type, which informs you of the health and current state of the OpenShift Container Platform cluster.

For more information regarding cluster version condition types, see "Understanding cluster version condition types".

6.15.1. Project

cluster-version-operator

Additional resources

- Understanding cluster version condition types

6.16. CONSOLE OPERATOR

NOTE

The Console Operator is an optional cluster capability that can be disabled by cluster administrators during installation. If you disable the Console Operator at installation, your cluster is still supported and upgradable. For more information about optional cluster capabilities, see "Cluster capabilities" in *Installing*.

The Console Operator installs and maintains the OpenShift Container Platform web console on a cluster. The Console Operator is installed by default and automatically maintains a console.

6.16.1. Project

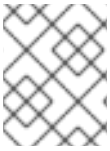
console-operator

Additional resources

- Web console capability

6.17. CONTROL PLANE MACHINE SET OPERATOR

The Control Plane Machine Set Operator automates the management of control plane machine resources within an OpenShift Container Platform cluster.



NOTE

This Operator is available for Amazon Web Services (AWS), Google Cloud, Microsoft Azure, Nutanix, and VMware vSphere.

6.17.1. Project

cluster-control-plane-machine-set-operator

6.17.2. CRDs

- **controlplanemachineset.machine.openshift.io**
  - Scope: Namespaced
  - CR: **ControlPlaneMachineSet**
  - Validation: Yes

6.17.3. Additional resources

- About control plane machine sets
- **ControlPlaneMachineSet** custom resource

6.18. DNS OPERATOR

The DNS Operator deploys and manages CoreDNS to provide a name resolution service to pods that enables DNS-based Kubernetes Service discovery in OpenShift Container Platform.

The Operator creates a working default deployment based on the cluster's configuration.

- The default cluster domain is **cluster.local**.
- Configuration of the CoreDNS Corefile or Kubernetes plugin is not yet supported.

The DNS Operator manages CoreDNS as a Kubernetes daemon set exposed as a service with a static IP. CoreDNS runs on all nodes in the cluster.

6.18.1. Project

cluster-dns-operator

6.19. ETCD CLUSTER OPERATOR

The etcd cluster Operator automates etcd cluster scaling, enables etcd monitoring and metrics, and simplifies disaster recovery procedures.

6.19.1. Project

cluster-etcd-operator

6.19.2. CRDs

- **etcds.operator.openshift.io**
  - Scope: Cluster
  - CR: **etcd**
  - Validation: Yes

6.19.3. Configuration objects

```
$ oc edit etcd cluster
```

6.20. INGRESS OPERATOR

The Ingress Operator configures and manages the OpenShift Container Platform router.

6.20.1. Project

openshift-ingress-operator

6.20.2. CRDs

- **clusteringresses.ingress.openshift.io**
  - Scope: Namespaced
  - CR: **clusteringresses**
  - Validation: No

6.20.3. Configuration objects

- Cluster config
  - Type Name: **clusteringresses.ingress.openshift.io**
  - Instance Name: **default**
  - View Command:

```
$ oc get clusteringresses.ingress.openshift.io -n openshift-ingress-operator default -o yaml
```

6.20.4. Notes

The Ingress Operator sets up the router in the **openshift-ingress** project and creates the deployment for the router:

```
$ oc get deployment -n openshift-ingress
```

The Ingress Operator uses the **clusterNetwork[].cidr** from the **network/cluster** status to determine what mode (IPv4, IPv6, or dual stack) the managed Ingress Controller (router) should operate in. For example, if **clusterNetwork** contains only a v6 **cidr**, then the Ingress Controller operates in IPv6-only

mode.

In the following example, Ingress Controllers managed by the Ingress Operator will run in IPv4-only mode because only one cluster network exists and the network is an IPv4 **cidr**:

```
$ oc get network/cluster -o jsonpath='{.status.clusterNetwork[*]}'
```

Example output

```
map[cidr:10.128.0.0/14 hostPrefix:23]
```

6.21. INSIGHTS OPERATOR

NOTE

The Insights Operator is an optional cluster capability that can be disabled by cluster administrators during installation. For more information about optional cluster capabilities, see "Cluster capabilities" in *Installing*.

The Insights Operator gathers OpenShift Container Platform configuration data and sends it to Red Hat. The data is used to produce proactive insights recommendations about potential issues that a cluster might be exposed to. These insights are communicated to cluster administrators through the Insights advisor service on console.redhat.com.

6.21.1. Project

insights-operator

6.21.2. Configuration

No configuration is required.

6.21.3. Notes

Insights Operator complements OpenShift Container Platform Telemetry.

Additional resources

- Insights capability
- About remote health monitoring

6.22. KUBERNETES API SERVER OPERATOR

The Kubernetes API Server Operator manages and updates the Kubernetes API server deployed on top of OpenShift Container Platform. The Operator is based on the OpenShift Container Platform **library-go** framework and it is installed using the Cluster Version Operator (CVO).

6.22.1. Project

openshift-kube-apiserver-operator

6.22.2. CRDs

- **kubeapiservers.operator.openshift.io**
  - Scope: Cluster
  - CR: **kubeapiserver**
  - Validation: Yes

6.22.3. Configuration objects

```
$ oc edit kubeapiserver
```

6.23. KUBERNETES CONTROLLER MANAGER OPERATOR

The Kubernetes Controller Manager Operator manages and updates the Kubernetes Controller Manager deployed on top of OpenShift Container Platform. The Operator is based on OpenShift Container Platform **library-go** framework and it is installed via the Cluster Version Operator (CVO).

It contains the following components:

- Operator
- Bootstrap manifest renderer
- Installer based on static pods
- Configuration observer

By default, the Operator exposes Prometheus metrics through the **metrics** service.

6.23.1. Project

cluster-kube-controller-manager-operator

6.24. KUBERNETES SCHEDULER OPERATOR

The Kubernetes Scheduler Operator manages and updates the Kubernetes Scheduler deployed on top of OpenShift Container Platform. The Operator is based on the OpenShift Container Platform **library-go** framework and it is installed with the Cluster Version Operator (CVO).

The Kubernetes Scheduler Operator contains the following components:

- Operator
- Bootstrap manifest renderer
- Installer based on static pods
- Configuration observer

By default, the Operator exposes Prometheus metrics through the metrics service.

6.24.1. Project

cluster-kube-scheduler-operator

6.24.2. Configuration

The configuration for the Kubernetes Scheduler is the result of merging:

- a default configuration.
- an observed configuration from the spec **schedulers.config.openshift.io**.

All of these are sparse configurations, invalidated JSON snippets which are merged to form a valid configuration at the end.

6.25. KUBERNETES STORAGE VERSION MIGRATOR OPERATOR

The Kubernetes Storage Version Migrator Operator detects changes of the default storage version, creates migration requests for resource types when the storage version changes, and processes migration requests.

6.25.1. Project

cluster-kube-storage-version-migrator-operator

6.26. MACHINE API OPERATOR

The Machine API Operator manages the lifecycle of specific purpose custom resource definitions (CRD), controllers, and RBAC objects that extend the Kubernetes API. This declares the desired state of machines in a cluster.

6.26.1. Project

machine-api-operator

6.26.2. CRDs

- **MachineSet**
- **Machine**
- **MachineHealthCheck**

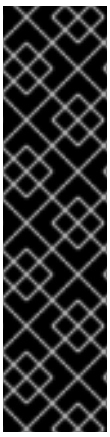
6.27. MACHINE CONFIG OPERATOR

The Machine Config Operator manages and applies configuration and updates of the base operating system and container runtime, including everything between the kernel and kubelet.

There are four components:

- **machine-config-server**: Provides Ignition configuration to new machines joining the cluster.

- **machine-config-controller**: Coordinates the upgrade of machines to the desired configurations defined by a **MachineConfig** object. Options are provided to control the upgrade for sets of machines individually.
- **machine-config-daemon**: Applies new machine configuration during update. Validates and verifies the state of the machine to the requested machine configuration.
- **machine-config**: Provides a complete source of machine configuration at installation, first start up, and updates for a machine.



IMPORTANT

Currently, there is no supported way to block or restrict the machine config server endpoint. The machine config server must be exposed to the network so that newly-provisioned machines, which have no existing configuration or state, are able to fetch their configuration. In this model, the root of trust is the certificate signing requests (CSR) endpoint, which is where the kubelet sends its certificate signing request for approval to join the cluster. Because of this, machine configs should not be used to distribute sensitive information, such as secrets and certificates.

To ensure that the machine config server endpoints, ports 22623 and 22624, are secured in bare metal scenarios, customers must configure proper network policies.

6.27.1. Project

openshift-machine-config-operator

6.28. MARKETPLACE OPERATOR

NOTE

The Marketplace Operator is an optional cluster capability that can be disabled by cluster administrators if it is not needed. For more information about optional cluster capabilities, see "Cluster capabilities" in *Installing*.

The Marketplace Operator simplifies the process for bringing off-cluster Operators to your cluster by using a set of default Operator Lifecycle Manager (OLM) catalogs on the cluster. When the Marketplace Operator is installed, it creates the **openshift-marketplace** namespace. OLM ensures catalog sources installed in the **openshift-marketplace** namespace are available for all namespaces on the cluster.

6.28.1. Project

operator-marketplace

Additional resources

- Marketplace capability

6.29. NODE TUNING OPERATOR

The Node Tuning Operator helps you manage node-level tuning by orchestrating the TuneD daemon and achieves low latency performance by using the Performance Profile controller. The majority of high-

performance applications require some level of kernel tuning. The Node Tuning Operator provides a unified management interface to users of node-level sysctls and more flexibility to add custom tuning specified by user needs.

The Operator manages the containerized TuneD daemon for OpenShift Container Platform as a Kubernetes daemon set. It ensures the custom tuning specification is passed to all containerized TuneD daemons running in the cluster in the format that the daemons understand. The daemons run on all nodes in the cluster, one per node.

Node-level settings applied by the containerized TuneD daemon are rolled back on an event that triggers a profile change or when the containerized TuneD daemon is terminated gracefully by receiving and handling a termination signal.

The Node Tuning Operator uses the Performance Profile controller to implement automatic tuning to achieve low latency performance for OpenShift Container Platform applications.

The cluster administrator configures a performance profile to define node-level settings such as the following:

- Updating the kernel to kernel-rt.
- Choosing CPUs for housekeeping.
- Choosing CPUs for running workloads.

The Node Tuning Operator is part of a standard OpenShift Container Platform installation in version 4.1 and later.

NOTE

In earlier versions of OpenShift Container Platform, the Performance Addon Operator was used to implement automatic tuning to achieve low latency performance for OpenShift applications. In OpenShift Container Platform 4.11 and later, this functionality is part of the Node Tuning Operator.

6.29.1. Project

cluster-node-tuning-operator

6.29.2. Additional resources

- About low latency

6.30. OPENSHIFT API SERVER OPERATOR

The OpenShift API Server Operator installs and maintains the **openshift-apiserver** on a cluster.

6.30.1. Project

openshift-apiserver-operator

6.30.2. CRDs

- **openshiftapiservers.operator.openshift.io**

- Scope: Cluster
- CR: **openshiftapiserver**
- Validation: Yes

6.31. OPENSHIFT CONTROLLER MANAGER OPERATOR

The OpenShift Controller Manager Operator installs and maintains the **OpenShiftControllerManager** custom resource in a cluster and can be viewed with:

```
$ oc get clusteroperator openshift-controller-manager -o yaml
```

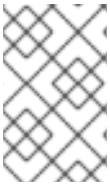
The custom resource definition (CRD) **openshiftcontrollermanagers.operator.openshift.io** can be viewed in a cluster with:

```
$ oc get crd openshiftcontrollermanagers.operator.openshift.io -o yaml
```

6.31.1. Project

cluster-openshift-controller-manager-operator

6.32. OPERATOR LIFECYCLE MANAGER (OLM) CLASSIC OPERATORS

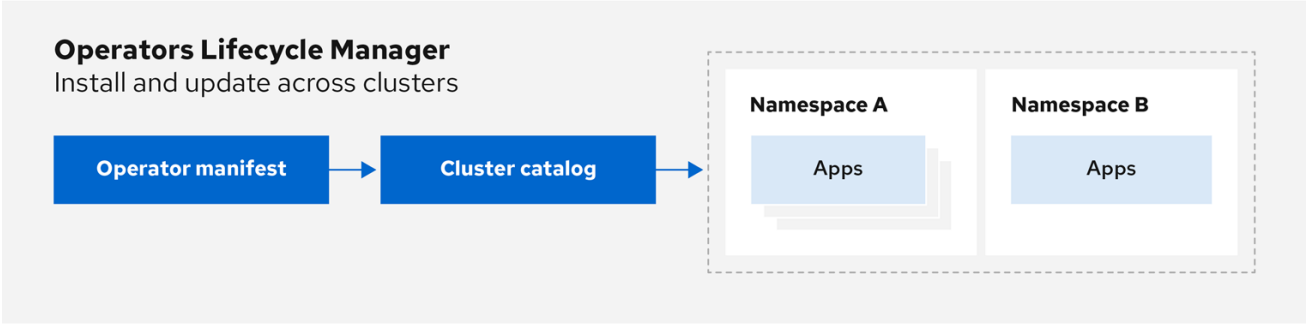


NOTE

The following sections pertain to Operator Lifecycle Manager (OLM) Classic that has been included with OpenShift Container Platform 4 since its initial release. For OLM v1, see Operator Lifecycle Manager (OLM) v1 Operators.

Operator Lifecycle Manager (OLM) Classic helps users install, update, and manage the lifecycle of Kubernetes native applications (Operators) and their associated services running across their OpenShift Container Platform clusters. It is part of the Operator Framework, an open source toolkit designed to manage Operators in an effective, automated, and scalable way.

Figure 6.1. OLM (Classic) workflow



OpenShift_43_1019

OLM runs by default in OpenShift Container Platform 4.19, which aids cluster administrators in installing, upgrading, and granting access to Operators running on their cluster. The OpenShift Container Platform web console provides management screens for cluster administrators to install Operators, as

well as grant specific projects access to use the catalog of Operators available on the cluster.

For developers, a self-service experience allows provisioning and configuring instances of databases, monitoring, and big data services without having to be subject matter experts, because the Operator has that knowledge baked into it.

6.32.1. OLM Operator

The OLM Operator is responsible for deploying applications defined by CSV resources after the required resources specified in the CSV are present in the cluster.

The OLM Operator is not concerned with the creation of the required resources; you can choose to manually create these resources using the CLI or using the Catalog Operator. This separation of concern allows users incremental buy-in in terms of how much of the OLM framework they choose to leverage for their application.

The OLM Operator uses the following workflow:

1. Watch for cluster service versions (CSVs) in a namespace and check that requirements are met.
2. If requirements are met, run the install strategy for the CSV.

NOTE

A CSV must be an active member of an Operator group for the install strategy to run.

6.32.2. Catalog Operator

The Catalog Operator is responsible for resolving and installing cluster service versions (CSVs) and the required resources they specify. It is also responsible for watching catalog sources for updates to packages in channels and upgrading them, automatically if desired, to the latest available versions.

To track a package in a channel, you can create a **Subscription** object configuring the desired package, channel, and the **CatalogSource** object you want to use for pulling updates. When updates are found, an appropriate **InstallPlan** object is written into the namespace on behalf of the user.

The Catalog Operator uses the following workflow:

1. Connect to each catalog source in the cluster.
2. Watch for unresolved install plans created by a user, and if found:
    a. Find the CSV matching the name requested and add the CSV as a resolved resource.
    b. For each managed or required CRD, add the CRD as a resolved resource.
    c. For each required CRD, find the CSV that manages it.
3. Watch for resolved install plans and create all of the discovered resources for it, if approved by a user or automatically.
4. Watch for catalog sources and subscriptions and create install plans based on them.

6.32.3. Catalog Registry

The Catalog Registry stores CSVs and CRDs for creation in a cluster and stores metadata about packages and channels.

A *package manifest* is an entry in the Catalog Registry that associates a package identity with sets of CSVs. Within a package, channels point to a particular CSV. Because CSVs explicitly reference the CSV that they replace, a package manifest provides the Catalog Operator with all of the information that is required to update a CSV to the latest version in a channel, stepping through each intermediate version.

6.32.4. CRDs

The OLM and Catalog Operators are responsible for managing the custom resource definitions (CRDs) that are the basis for the OLM framework:

Table 6.1. CRDs managed by OLM and Catalog Operators

Resource	Short name	Owner	Description
ClusterServiceVersion (CSV)	**csv**	OLM	Application metadata: name, version, icon, required resources, installation, and so on.
InstallPlan	**ip**	Catalog	Calculated list of resources to be created to automatically install or upgrade a CSV.
CatalogSource	**catsrc**	Catalog	A repository of CSVs, CRDs, and packages that define an application.
Subscription	**sub**	Catalog	Used to keep CSVs up to date by tracking a channel in a package.
OperatorGroup	**og**	OLM	Configures all Operators deployed in the same namespace as the **OperatorGroup** object to watch for their custom resource (CR) in a list of namespaces or cluster-wide.

Each of these Operators is also responsible for creating the following resources:

Table 6.2. Resources created by OLM and Catalog Operators

Resource	Owner
Deployments	OLM
ServiceAccounts	
(Cluster)Roles	
(Cluster)RoleBindings	

Resource	Owner
CustomResourceDefinitions (CRDs)	Catalog
ClusterServiceVersions	

6.32.5. Cluster Operators

In OpenShift Container Platform, OLM functionality is provided across a set of cluster Operators:

operator-lifecycle-manager

Provides the OLM Operator. Also informs cluster administrators if there are any installed Operators blocking cluster upgrade, based on their **olm.maxOpenShiftVersion** properties. For more information, see "Controlling Operator compatibility with OpenShift Container Platform versions".

operator-lifecycle-manager-catalog

Provides the Catalog Operator.

operator-lifecycle-manager-packageserver

Represents an API extension server responsible for collecting metadata from all catalogs on the cluster and serves the user-facing **PackageManifest** API.

6.32.6. Additional resources

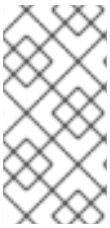
- Understanding Operator Lifecycle Manager (OLM)

6.33. OPERATOR LIFECYCLE MANAGER (OLM) V1 OPERATOR

Starting in OpenShift Container Platform 4.18, OLM v1 is enabled by default alongside OLM (Classic). This next-generation iteration provides an updated framework that evolves many of OLM (Classic) concepts that enable cluster administrators to extend capabilities for their users.

OLM v1 manages the lifecycle of the new **ClusterExtension** object, which includes Operators via the **registry+v1** bundle format, and controls installation, upgrade, and role-based access control (RBAC) of extensions within a cluster.

In OpenShift Container Platform, OLM v1 is provided by the **olm** cluster Operator.



NOTE

The **olm** cluster Operator informs cluster administrators if there are any installed extensions blocking cluster upgrade, based on their **olm.maxOpenShiftVersion** properties. For more information, see "Compatibility with OpenShift Container Platform versions".

6.33.1. Components

Operator Lifecycle Manager (OLM) v1 comprises the following component projects:

Operator Controller

The central component of OLM v1 that extends Kubernetes with an API through which users can install and manage the lifecycle of Operators and extensions. It consumes information from catalogd.

Catalogd

A Kubernetes extension that unpacks file-based catalog (FBC) content packaged and shipped in container images for consumption by on-cluster clients. As a component of the OLM v1 microservices architecture, catalogd hosts metadata for Kubernetes extensions packaged by the authors of the extensions, and as a result helps users discover installable content.

6.33.2. CRDs

- **clusterextension.olm.operatorframework.io**
  - Scope: Cluster
  - CR: **ClusterExtension**
- **clustercatalog.olm.operatorframework.io**
  - Scope: Cluster
  - CR: **ClusterCatalog**

6.33.3. Project

- operator-framework/operator-controller
- operator-framework/catalogd

6.33.4. Additional resources

- Extensions overview
- Compatibility with OpenShift Container Platform versions

6.34. OPENSHIFT SERVICE CA OPERATOR

The OpenShift Service CA Operator mints and manages serving certificates for Kubernetes services.

6.34.1. Project

openshift-service-ca-operator

6.35. VSPHERE PROBLEM DETECTOR OPERATOR

The vSphere Problem Detector Operator checks clusters that are deployed on vSphere for common installation and misconfiguration issues that are related to storage.

NOTE

The vSphere Problem Detector Operator is only started by the Cluster Storage Operator when the Cluster Storage Operator detects that the cluster is deployed on vSphere.

6.35.1. Configuration

No configuration is required.

6.35.2. Notes

- The Operator supports OpenShift Container Platform installations on vSphere.
- The Operator uses the **vsphere-cloud-credentials** to communicate with vSphere.
- The Operator performs checks that are related to storage.

Additional resources

- Using the vSphere Problem Detector Operator

CHAPTER 7. OLM V1

7.1. ABOUT OPERATOR LIFECYCLE MANAGER V1

Operator Lifecycle Manager (OLM) has been included with OpenShift Container Platform 4 since its initial release. OpenShift Container Platform 4.18 includes components for a next-generation iteration of OLM as a Generally Available (GA) feature, known during this phase as *OLM v1*. This updated framework evolves many of the concepts that have been part of previous versions of OLM and adds new capabilities.

Starting in OpenShift Container Platform 4.17, documentation for OLM v1 has been moved to the following new guide:

- Extensions (OLM v1)