OpenShift Container Platform 4.7

Migration Toolkit for Containers

Migrating to OpenShift Container Platform 4

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Legal Notice

Abstract

This document provides instructions for migrating your OpenShift Container Platform cluster from version 3 to version 4, and also for migrating from an earlier OpenShift Container Platform 4 release to the latest version.

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CHAPTER 1. MIGRATING FROM OPENSHIFT CONTAINER PLATFORM 3

1.1. ABOUT MIGRATING OPENSHIFT CONTAINER PLATFORM 3 TO 4

OpenShift Container Platform 4 includes new technologies and functionality that results in a cluster that is self-managing, flexible, and automated. The way that OpenShift Container Platform 4 clusters are deployed and managed drastically differs from OpenShift Container Platform 3.

To successfully transition from OpenShift Container Platform 3 to OpenShift Container Platform 4, it is important that you review the following information:

Planning your transition

Learn about the differences between OpenShift Container Platform versions 3 and 4. Prior to transitioning, be sure that you have reviewed and prepared for storage, networking, logging, security, and monitoring considerations.

Performing your migration

Learn about and use Migration Toolkit for Containers (MTC) to migrate your application workloads.

1.2. PLANNING YOUR MIGRATION

Before performing your migration to OpenShift Container Platform 4.7, it is important to take the time to properly plan for the transition. OpenShift Container Platform 4 introduces architectural changes and enhancements, so the procedures that you used to manage your OpenShift Container Platform 3 cluster might not apply for OpenShift Container Platform 4.

NOTE

This planning document assumes that you are transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.7.

This document provides high-level information on the most important differences between OpenShift Container Platform 3 and OpenShift Container Platform 4 and the most noteworthy migration considerations. For detailed information on configuring your OpenShift Container Platform 4 cluster, review the appropriate sections of the OpenShift Container Platform documentation. For detailed information on new features and other notable technical changes, review the OpenShift Container Platform 4.7 release notes.

It is not possible to upgrade your existing OpenShift Container Platform 3 cluster to OpenShift Container Platform 4. You must start with a new OpenShift Container Platform 4 installation. Tools are available to assist in migrating your control plane settings and application workloads.

1.2.1. Comparing OpenShift Container Platform 3 and OpenShift Container Platform 4

With OpenShift Container Platform 3, administrators individually deployed Red Hat Enterprise Linux (RHEL) hosts, and then installed OpenShift Container Platform on top of these hosts to form a cluster. Administrators were responsible for properly configuring these hosts and performing updates.

OpenShift Container Platform 4 represents a significant change in the way that OpenShift Container Platform clusters are deployed and managed. OpenShift Container Platform 4 includes new technologies and functionality, such as Operators, machine sets, and Red Hat Enterprise Linux CoreOS

(RHCOS), which are core to the operation of the cluster. This technology shift enables clusters to self-manage some functions previously performed by administrators. This also ensures platform stability and consistency, and simplifies installation and scaling.

For more information, see OpenShift Container Platform architecture .

1.2.1.1. Architecture differences

Immutable infrastructure
OpenShift Container Platform 4 uses Red Hat Enterprise Linux CoreOS (RHCOS), which is designed to run containerized applications, and provides efficient installation, Operator-based management, and simplified upgrades. RHCOS is an immutable container host, rather than a customizable operating system like RHEL. RHCOS enables OpenShift Container Platform 4 to manage and automate the deployment of the underlying container host. RHCOS is a part of OpenShift Container Platform, which means that everything runs inside a container and is deployed using OpenShift Container Platform.

In OpenShift Container Platform 4, control plane nodes must run RHCOS, ensuring that full-stack automation is maintained for the control plane. This makes rolling out updates and upgrades a much easier process than in OpenShift Container Platform 3.

For more information, see Red Hat Enterprise Linux CoreOS (RHCOS) .

Operators
Operators are a method of packaging, deploying, and managing a Kubernetes application. Operators ease the operational complexity of running another piece of software. They watch over your environment and use the current state to make decisions in real time. Advanced Operators are designed to upgrade and react to failures automatically.

For more information, see Understanding Operators.

1.2.1.2. Installation and update differences

Installation process
To install OpenShift Container Platform 3.11, you prepared your Red Hat Enterprise Linux (RHEL) hosts, set all of the configuration values your cluster needed, and then ran an Ansible playbook to install and set up your cluster.

In OpenShift Container Platform 4.7, you use the OpenShift installation program to create a minimum set of resources required for a cluster. Once the cluster is running, you use Operators to further configure your cluster and to install new services. After first boot, Red Hat Enterprise Linux CoreOS (RHCOS) systems are managed by the Machine Config Operator (MCO) that runs in the OpenShift Container Platform cluster.

For more information, see Installation process.

If you want to add Red Hat Enterprise Linux (RHEL) (RHEL) worker machines to your OpenShift Container Platform 4.7 cluster, you use an Ansible playbook to join the RHEL worker machines after the cluster is running. For more information, see Adding RHEL compute machines to an OpenShift Container Platform cluster.

Infrastructure options
In OpenShift Container Platform 3.11, you installed your cluster on infrastructure that you prepared and maintained. In addition to providing your own infrastructure, OpenShift Container Platform 4 offers an option to deploy a cluster on infrastructure that the OpenShift Container Platform installation program provisions and the cluster maintains.

For more information, see OpenShift Container Platform installation overview .

Upgrading your cluster
In OpenShift Container Platform 3.11, you upgraded your cluster by running Ansible playbooks. In OpenShift Container Platform 4.7, the cluster manages its own updates, including updates to Red Hat Enterprise Linux CoreOS (RHCOS) on cluster nodes. You can easily upgrade your cluster by using the web console or by using the **oc adm upgrade** command from the OpenShift CLI and the Operators will automatically upgrade themselves. If your OpenShift Container Platform 4.7 cluster has RHEL worker machines, then you will still need to run an Ansible playbook to upgrade those worker machines.

For more information, see Updating clusters.

1.2.2. Migration considerations

Review the changes and other considerations that might affect your transition from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.

1.2.2.1. Storage considerations

Review the following storage changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.7.

Local volume persistent storage
Local storage is only supported by using the Local Storage Operator in OpenShift Container Platform 4.7. It is not supported to use the local provisioner method from OpenShift Container Platform 3.11.

For more information, see Persistent storage using local volumes .

FlexVolume persistent storage
The FlexVolume plug-in location changed from OpenShift Container Platform 3.11. The new location in OpenShift Container Platform 4.7 is **/etc/kubernetes/kubelet-plugins/volume/exec**. Attachable FlexVolume plug-ins are no longer supported.

For more information, see Persistent storage using FlexVolume .

Container Storage Interface (CSI) persistent storage
Persistent storage using the Container Storage Interface (CSI) was Technology Preview in OpenShift Container Platform 3.11. CSI version 1.1.0 is fully supported in OpenShift Container Platform 4.7, but does not ship with any CSI drivers. You must install your own driver.

For more information, see Persistent storage using the Container Storage Interface (CSI) .

Red Hat OpenShift Container Storage
Red Hat OpenShift Container Storage 3, which is available for use with OpenShift Container Platform 3.11, uses Red Hat Gluster Storage as the backing storage.

Red Hat OpenShift Container Storage 4, which is available for use with OpenShift Container Platform 4, uses Red Hat Ceph Storage as the backing storage.

For more information, see Persistent storage using Red Hat OpenShift Container Storage and the interoperability matrix article.

Unsupported persistent storage options
Support for the following persistent storage options from OpenShift Container Platform 3.11 has changed in OpenShift Container Platform 4.7:

- GlusterFS is no longer supported.
- CephFS as a standalone product is no longer supported.
- Ceph RBD as a standalone product is no longer supported.

If you used one of these in OpenShift Container Platform 3.11, you must choose a different persistent storage option for full support in OpenShift Container Platform 4.7.

For more information, see Understanding persistent storage.

1.2.2.2. Networking considerations

Review the following networking changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.7.

Network isolation mode
The default network isolation mode for OpenShift Container Platform 3.11 was **ovs-subnet**, though users frequently switched to use **ovn-multitenant**. The default network isolation mode for OpenShift Container Platform 4.7 is controlled by a network policy.

If your OpenShift Container Platform 3.11 cluster used the **ovs-subnet** or **ovs-multitenant** mode, it is recommended to switch to a network policy for your OpenShift Container Platform 4.7 cluster. Network policies are supported upstream, are more flexible, and they provide the functionality that **ovs-multitenant** does. If you want to maintain the **ovs-multitenant** behavior while using a network policy in OpenShift Container Platform 4.7, follow the steps to configure multitenant isolation using network policy.

For more information, see About network policy.

Encrypting traffic between hosts
In OpenShift Container Platform 3.11, you could use IPsec to encrypt traffic between hosts. OpenShift Container Platform 4.7 does not support IPsec. It is recommended to use Red Hat OpenShift Service Mesh to enable mutual TLS between services.

For more information, see Understanding Red Hat OpenShift Service Mesh .

1.2.2.3. Logging considerations

Review the following logging changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.7.

Deploying OpenShift Logging
OpenShift Container Platform 4 provides a simple deployment mechanism for OpenShift Logging, by using a Cluster Logging custom resource.

For more information, see Installing OpenShift Logging.

Aggregated logging data
You cannot transition your aggregate logging data from OpenShift Container Platform 3.11 into your new OpenShift Container Platform 4 cluster.

For more information, see About OpenShift Logging.

Unsupported logging configurations
Some logging configurations that were available in OpenShift Container Platform 3.11 are no longer supported in OpenShift Container Platform 4.7.

For more information on the explicitly unsupported logging cases, see Maintenance and support.

1.2.2.4. Security considerations

Review the following security changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.7.

Unauthenticated access to discovery endpoints
In OpenShift Container Platform 3.11, an unauthenticated user could access the discovery endpoints (for example, **/api/*** and **/apis/***). For security reasons, unauthenticated access to the discovery endpoints is no longer allowed in OpenShift Container Platform 4.7. If you do need to allow unauthenticated access, you can configure the RBAC settings as necessary; however, be sure to consider the security implications as this can expose internal cluster components to the external network.

Identity providers
Configuration for identity providers has changed for OpenShift Container Platform 4, including the following notable changes:

- The request header identity provider in OpenShift Container Platform 4.7 requires mutual TLS, where in OpenShift Container Platform 3.11 it did not.
- The configuration of the OpenID Connect identity provider was simplified in OpenShift Container Platform 4.7. It now obtains data, which previously had to specified in OpenShift Container Platform 3.11, from the provider's **/.well-known/openid-configuration** endpoint.

For more information, see Understanding identity provider configuration .

OAuth token storage format
Newly created OAuth HTTP bearer tokens no longer match the names of their OAuth access token objects. The object names are now a hash of the bearer token and are no longer sensitive. This reduces the risk of leaking sensitive information.

1.2.2.5. Monitoring considerations

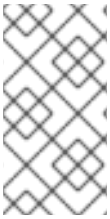
Review the following monitoring changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.7.

Alert for monitoring infrastructure availability
The default alert that triggers to ensure the availability of the monitoring structure was called **DeadMansSwitch** in OpenShift Container Platform 3.11. This was renamed to **Watchdog** in OpenShift Container Platform 4. If you had PagerDuty integration set up with this alert in OpenShift Container Platform 3.11, you must set up the PagerDuty integration for the **Watchdog** alert in OpenShift Container Platform 4.

For more information, see Applying custom Alertmanager configuration.

1.3. ABOUT THE MIGRATION TOOLKIT FOR CONTAINERS

You can migrate application workloads from OpenShift Container Platform 3.7, 3.9, 3.10, and 3.11 to OpenShift Container Platform 4.7 with the Migration Toolkit for Containers (MTC). MTC enables you to control the migration and to minimize application downtime.



NOTE

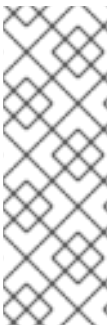
MTC is installed on the target cluster by default.

You can configure the Migration Toolkit for Containers Operator to install the MTC on an OpenShift Container Platform 3 cluster or on a remote cluster.

The MTC web console and API, based on Kubernetes custom resources, enable you to migrate stateful application workloads at the granularity of a namespace.

MTC supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

You can use migration hooks to run Ansible playbooks at certain points during the migration. The hooks are added when you create a migration plan.



NOTE

The service catalog is deprecated in OpenShift Container Platform 4. You can migrate workload resources provisioned with the service catalog from OpenShift Container Platform 3 to 4 but you cannot perform service catalog actions such as **provision**, **deprovision**, or **update** on these workloads after migration.

The MTC web console displays a message if the service catalog resources cannot be migrated.

IMPORTANT

Before you begin your migration, be sure to review the information on planning your migration.

1.3.1. Migration Toolkit for Containers workflow

You use the Migration Toolkit for Containers (MTC) to migrate Kubernetes resources, persistent volume data, and internal container images from an OpenShift Container Platform source cluster to an OpenShift Container Platform 4.7 target cluster by using the MTC web console or the Kubernetes API.

The (MTC) migrates the following resources:

- A namespace specified in a migration plan.
- Namespace-scoped resources: When the MTC migrates a namespace, it migrates all the objects and resources associated with that namespace, such as services or pods. Additionally, if a resource that exists in the namespace but not at the cluster level depends on a resource that exists at the cluster level, the MTC migrates both resources.
  For example, a security context constraint (SCC) is a resource that exists at the cluster level and a service account (SA) is a resource that exists at the namespace level. If an SA exists in a namespace that the MTC migrates, the MTC automatically locates any SCCs that are linked to the SA and also migrates those SCCs. Similarly, the MTC migrates persistent volume claims that are linked to the persistent volumes of the namespace.
- Custom resources (CRs) and custom resource definitions (CRDs): The MTC automatically migrates any CRs that exist at the namespace level as well as the CRDs that are linked to those CRs.

Migrating an application with the MTC web console involves the following steps:

1. Install the Migration Toolkit for Containers Operator on all clusters.
   You can install the Migration Toolkit for Containers Operator in a restricted environment with limited or no internet access. The source and target clusters must have network access to each other and to a mirror registry.

2. Configure the replication repository, an intermediate object storage that MTC uses to migrate data.
   The source and target clusters must have network access to the replication repository during migration. In a restricted environment, you can use an internally hosted S3 storage repository. If you are using a proxy server, you must configure it to allow network traffic between the replication repository and the clusters.

3. Add the source cluster to the MTC web console.

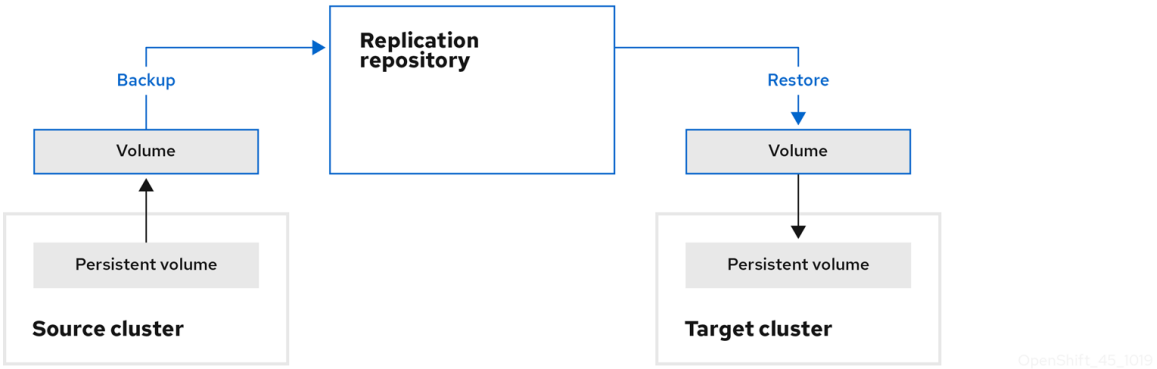
4. Add the replication repository to the MTC web console.

5. Create a migration plan, with one of the following data migration options:

   - **Copy**: MTC copies the data from the source cluster to the replication repository, and from the replication repository to the target cluster.

NOTE

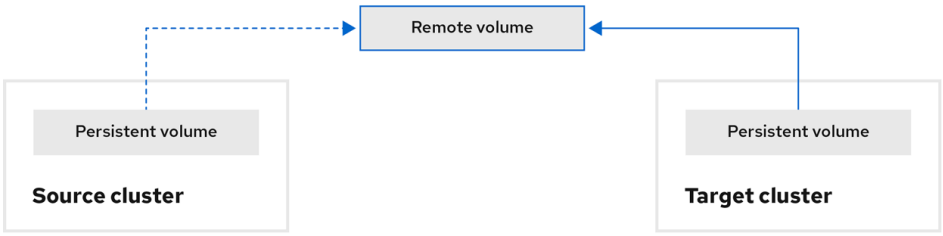
If you are using direct image migration or direct volume migration, the images or volumes are copied directly from the source cluster to the target cluster.



   - **Move**: MTC unmounts a remote volume, for example, NFS, from the source cluster, creates a PV resource on the target cluster pointing to the remote volume, and then mounts the remote volume on the target cluster. Applications running on the target cluster use the same remote volume that the source cluster was using. The remote volume must be accessible to the source and target clusters.

NOTE

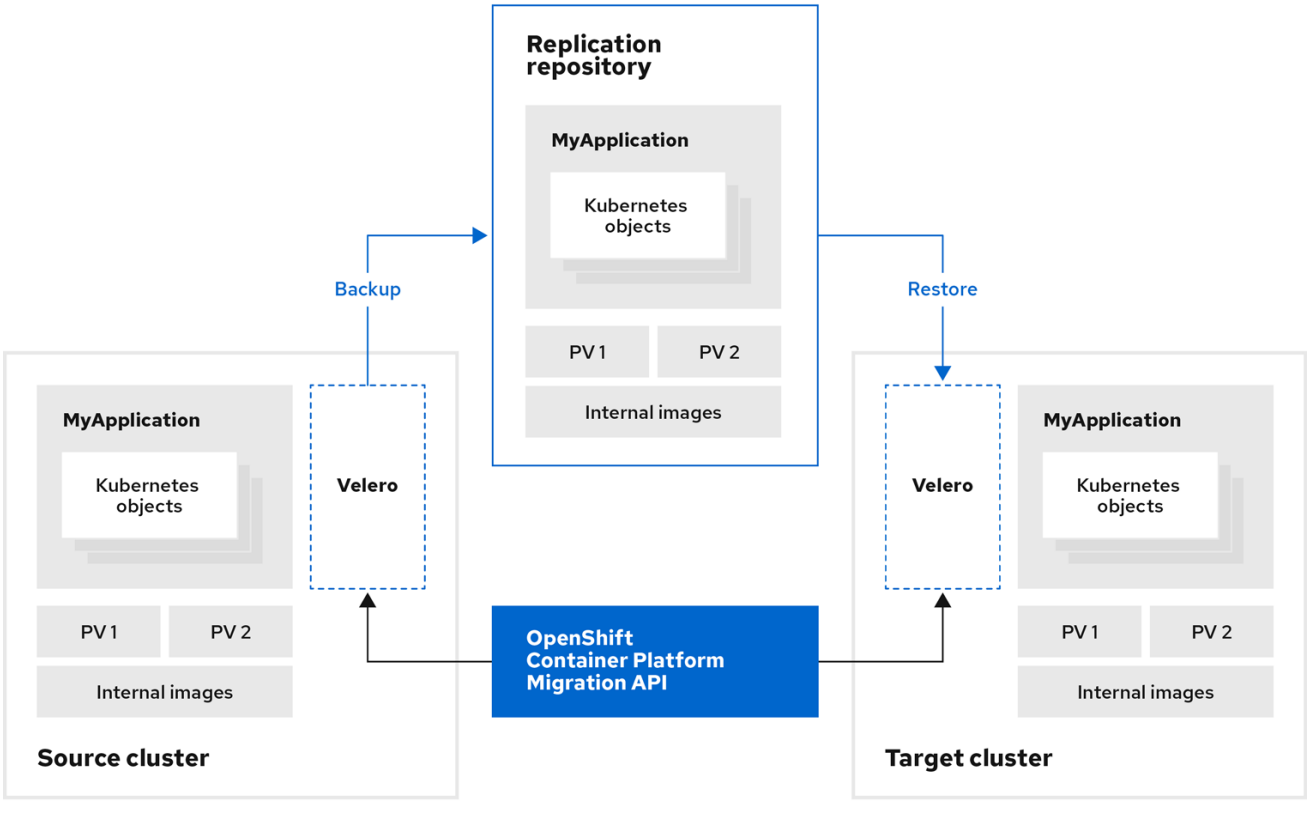
Although the replication repository does not appear in this diagram, it is required for migration.



6. Run the migration plan, with one of the following options:

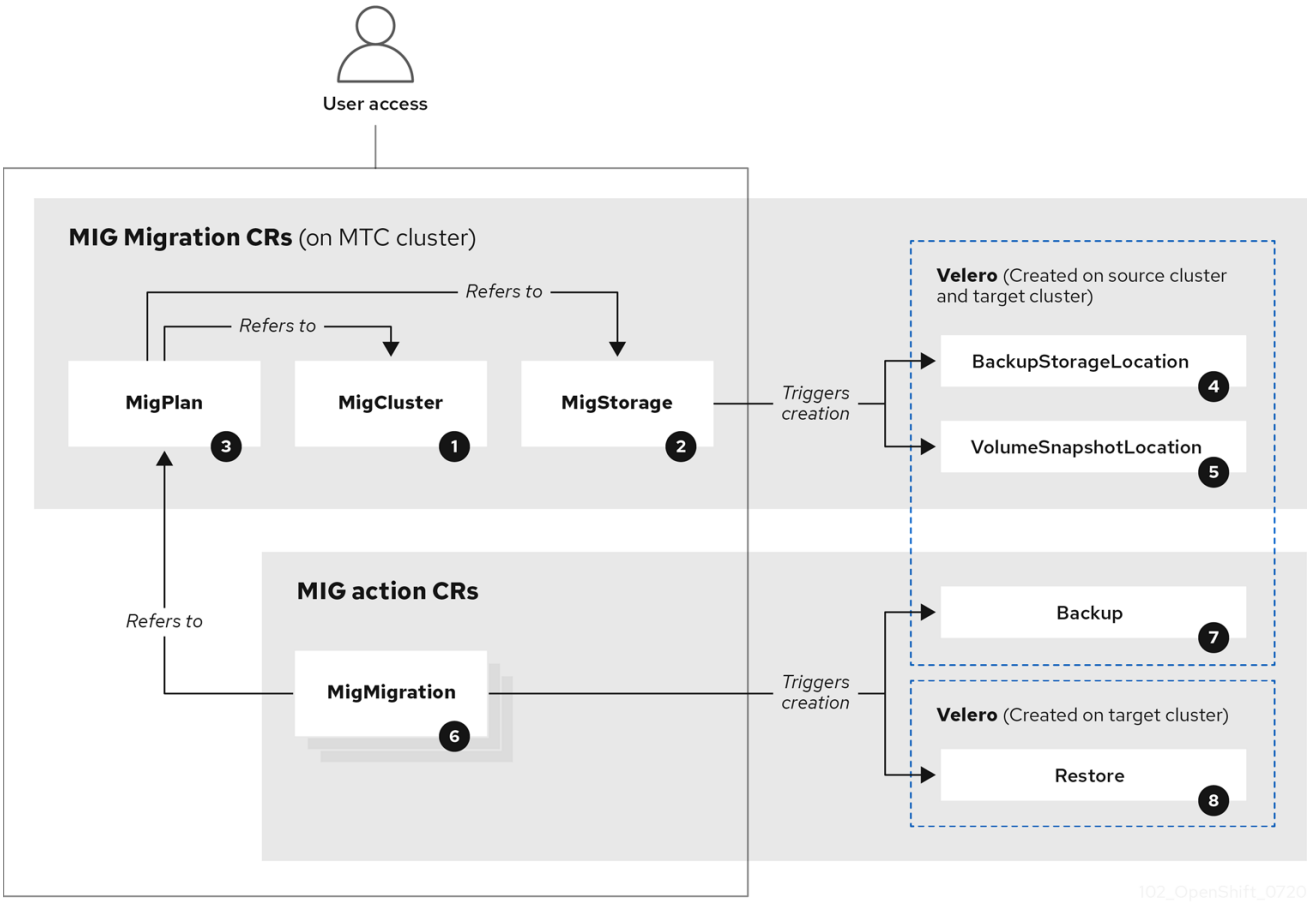
   - **Stage** (optional) copies data to the target cluster without stopping the application. Staging can be run multiple times so that most of the data is copied to the target before migration. This minimizes the duration of the migration and application downtime.

   - **Migrate** stops the application on the source cluster and recreates its resources on the target cluster. Optionally, you can migrate the workload without stopping the application.



1.3.2. Migration Toolkit for Containers custom resources

The Migration Toolkit for Containers (MTC) creates the following custom resources (CRs):

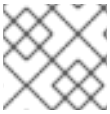


1 MigCluster (configuration, MTC cluster): Cluster definition

2 MigStorage (configuration, MTC cluster): Storage definition

3 MigPlan (configuration, MTC cluster): Migration plan

The **MigPlan** CR describes the source and target clusters, replication repository, and namespaces being migrated. It is associated with 0, 1, or many **MigMigration** CRs.



NOTE

Deleting a **MigPlan** CR deletes the associated **MigMigration** CRs.

4 BackupStorageLocation (configuration, MTC cluster): Location of **Velero** backup objects

5 VolumeSnapshotLocation (configuration, MTC cluster): Location of **Velero** volume snapshots

6 MigMigration (action, MTC cluster): Migration, created every time you stage or migrate data. Each **MigMigration** CR is associated with a **MigPlan** CR.

7 Backup (action, source cluster): When you run a migration plan, the **MigMigration** CR creates two **Velero** backup CRs on each source cluster:

- Backup CR #1 for Kubernetes objects

- Backup CR #2 for PV data

8 Restore (action, target cluster): When you run a migration plan, the **MigMigration** CR creates two **Velero** restore CRs on the target cluster:

- Restore CR #1 (using Backup CR #2) for PV data
- Restore CR #2 (using Backup CR #1) for Kubernetes objects

1.3.3. About data copy methods

The Migration Toolkit for Containers (MTC) supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

1.3.3.1. File system copy method

MTC copies data files from the source cluster to the replication repository, and from there to the target cluster.

Table 1.1. File system copy method summary

Benefits	Limitations
• Clusters can have different storage classes. • Supported for all S3 storage providers. • Optional data verification with checksum. • Supports direct volume migration, which significantly increases performance.	• Slower than the snapshot copy method. • Optional data verification significantly reduces performance.

1.3.3.2. Snapshot copy method

MTC copies a snapshot of the source cluster data to the replication repository of a cloud provider. The data is restored on the target cluster.

AWS, Google Cloud Provider, and Microsoft Azure support the snapshot copy method.

Table 1.2. Snapshot copy method summary

Benefits	Limitations

Benefits	Limitations
• Faster than the file system copy method.	• Cloud provider must support snapshots. • Clusters must be on the same cloud provider. • Clusters must be in the same location or region. • Clusters must have the same storage class. • Storage class must be compatible with snapshots. • Does not support direct volume migration.

1.3.3.3. Direct volume migration and direct image migration

You can use *direct image migration* and *direct volume migration* to migrate images and data directly from the source cluster to the target cluster.

Direct migration has significant performance benefits because it skips the intermediate steps of backing up files from the source cluster to the replication repository and restoring files from the replication repository to the target cluster.

Direct migration uses Rsync to transfer the files.

NOTE

Direct image migration and direct volume migration have additional prerequisites.

1.3.4. About migration hooks

You can use migration hooks to run custom code at certain points during a migration with the Migration Toolkit for Containers (MTC). You can add up to four migration hooks to a single migration plan, with each hook running at a different phase of the migration.

Migration hooks perform tasks such as customizing application quiescence, manually migrating unsupported data types, and updating applications after migration.

A migration hook runs on a source or a target cluster at one of the following migration steps:

- **PreBackup**: Before resources are backed up on the source cluster
- **PostBackup**: After resources are backed up on the source cluster
- **PreRestore**: Before resources are restored on the target cluster
- **PostRestore**: After resources are restored on the target cluster

You can create a hook by using an Ansible playbook or a custom hook container.

Ansible playbook

The Ansible playbook is mounted on a hook container as a config map. The hook container runs as a job, using the cluster, service account, and namespace specified in the **MigPlan** custom resource (CR). The job continues to run until it reaches the the default limit of 6 retries or a successful completion. This continues even if the initial pod is evicted or killed.

The default Ansible runtime image is **registry.redhat.io/rhmtc/openshift-migration-hook-runner-rhel7:1.4**. This image is based on the Ansible Runner image and includes **python-openshift** for Ansible Kubernetes resources and an updated **oc** binary.

Optional: You can use a custom Ansible runtime image containing additional Ansible modules or tools instead of the default image.

Custom hook container

You can create a custom hook container that includes Ansible playbooks or custom code.

1.4. INSTALLING AND UPGRADING THE MIGRATION TOOLKIT FOR CONTAINERS

You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4.7 target cluster and an OpenShift Container Platform 3 source cluster.

The **Migration Controller** pod runs on the target cluster by default. You can configure the **Migration Controller** pod to run on the source cluster or on a remote cluster.

1.4.1. Installing the Migration Toolkit for Containers in a connected environment

You can install the Migration Toolkit for Containers (MTC) in a connected environment.

IMPORTANT

You must install the same MTC version on all clusters.

1.4.1.1. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.7 target cluster

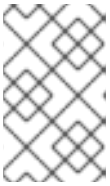
You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4.7 target cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.



NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
7. Click **Create**.
8. Click **Workloads → Pods** to verify that the MTC pods are running.

1.4.1.2. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 3 source cluster

You can install the Migration Toolkit for Containers (MTC) manually on an OpenShift Container Platform 3 source cluster.

IMPORTANT

You must install the same MTC version on the OpenShift Container Platform 3 and 4 clusters.

To ensure that you have the latest version on the OpenShift Container Platform 3 cluster, download the **operator.yml** and **controller-3.yml** files when you are ready to create and run the migration plan.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must have access to **registry.redhat.io**.
- You must have **podman** installed.
- The source cluster must be OpenShift Container Platform 3.7, 3.9, 3.10, or 3.11.
- The source cluster must be configured to pull images from **registry.redhat.io**.
  To pull images, you must create an image stream secret and copy it to each node in your cluster.

Procedure

1. Log in to **registry.redhat.io** with your Red Hat Customer Portal credentials:

```
$ sudo podman login registry.redhat.io
```

2. Download the **operator.yml** file:

```
$ sudo podman cp $(sudo podman create \
  registry.redhat.io/rhmtc/openshift-migration-rhel7-operator:v1.4):/operator.yml ./
```

3. Download the **controller-3.yml** file:

```
$ sudo podman cp $(sudo podman create \
  registry.redhat.io/rhmtc/openshift-migration-rhel7-operator:v1.4):/controller-3.yml ./
```

4. Log in to your OpenShift Container Platform 3 cluster.

5. Verify that the cluster can authenticate with **registry.redhat.io**:

```
$ oc run test --image registry.redhat.io/ubi8 --command sleep infinity
```

6. Create the Migration Toolkit for Containers Operator object:

```
$ oc create -f operator.yml
```

Example output

```
namespace/openshift-migration created
rolebinding.rbac.authorization.k8s.io/system:deployers created
serviceaccount/migration-operator created
customresourcedefinition.apiextensions.k8s.io/migrationcontrollers.migration.openshift.io
created
role.rbac.authorization.k8s.io/migration-operator created
rolebinding.rbac.authorization.k8s.io/migration-operator created
clusterrolebinding.rbac.authorization.k8s.io/migration-operator created
deployment.apps/migration-operator created
Error from server (AlreadyExists): error when creating "./operator.yml":
rolebindings.rbac.authorization.k8s.io "system:image-builders" already exists 1
Error from server (AlreadyExists): error when creating "./operator.yml":
rolebindings.rbac.authorization.k8s.io "system:image-pullers" already exists
```

1 You can ignore **Error from server (AlreadyExists)** messages. They are caused by the Migration Toolkit for Containers Operator creating resources for earlier versions of OpenShift Container Platform 3 that are provided in later releases.

7. Create the **MigrationController** object:

```
$ oc create -f controller-3.yml
```

8. Verify that the **Velero** and **Restic** pods are running:

```
$ oc get pods -n openshift-migration
```

1.4.2. Installing the Migration Toolkit for Containers in a restricted environment

You can install the Migration Toolkit for Containers (MTC) in a restricted environment.

IMPORTANT

You must install the same MTC version on all clusters.

You can build a custom Operator catalog image for OpenShift Container Platform 4, push it to a local mirror image registry, and configure Operator Lifecycle Manager (OLM) to install the Migration Toolkit for Containers Operator from the local registry.

1.4.2.1. Disabling the default OperatorHub 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.

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 → Global Configuration → OperatorHub** page, click the **Sources** tab, where you can create, delete, disable, and enable individual sources.

1.4.2.2. Pruning an index image

An index image, based on the Operator Bundle Format, is a containerized snapshot of an Operator catalog. You can 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.

When configuring Operator Lifecycle Manager (OLM) to use mirrored content on restricted network OpenShift Container Platform clusters, use this pruning method if you want to only mirror a subset of Operators from the default catalogs.

For the steps in this procedure, the target registry is an existing mirror registry that is accessible by your workstation with unrestricted network access. This example also shows pruning the index image for the default **redhat-operators** catalog, but the process is the same for any index image.

Prerequisites

- Workstation with unrestricted network access
- **podman** version 1.9.3+
- **grpcurl**
- **opm** version 1.12.3+
- Access to a registry that supports Docker v2-2

Procedure

1. Authenticate with **registry.redhat.io**:

```
$ podman login registry.redhat.io
```

2. Authenticate with your target registry:

```
$ podman login <target_registry>
```

3. 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:v4.7
```

   Example output

```
Trying to pull registry.redhat.io/redhat/redhat-operator-index:v4.7...
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.

4. 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:v4.7 \ 1
    -p advanced-cluster-management,jaeger-product,quay-operator \ 2
    [-i registry.redhat.io/openshift4/ose-operator-registry:v4.7] \ 3
    -t <target_registry>:<port>/<namespace>/redhat-operator-index:v4.7 4
```

1. Index to prune.
2. Comma-separated list of packages to keep.
3. Required only for IBM Power Systems and IBM Z images: Operator Registry base image with the tag that matches the target OpenShift Container Platform cluster major and minor version.
4. Custom tag for new index image being built.

5. Run the following command to push the new index image to your target registry:

```
$ podman push <target_registry>:<port>/<namespace>/redhat-operator-index:v4.7
```

where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

1.4.2.3. Mirroring an Operator catalog

You can mirror the Operator content of a Red Hat-provided catalog, or a custom catalog, into a container image registry using the **oc adm catalog mirror** command. The target registry must support Docker v2-2. For a cluster on a restricted network, this registry can be one that the cluster has network access to, such as a mirror registry created during a restricted network cluster installation.

The **oc adm catalog mirror** command also automatically mirrors the index image that is specified during the mirroring process, whether it be a Red Hat-provided index image or your own custom-built index image, to the target registry. You can then use the mirrored index image to create a catalog source that allows Operator Lifecycle Manager (OLM) to load the mirrored catalog onto your OpenShift Container Platform cluster.

Prerequisites

- Workstation with unrestricted network access.
- **podman** version 1.9.3 or later.
- Access to mirror registry that supports Docker v2-2.
- Decide which namespace on your mirror registry you will use to store the mirrored Operator content. For example, you might create an **olm-mirror** namespace.
- If your mirror registry does not have Internet access, connect removable media to your workstation with unrestricted network access.
- If you are working with private registries, set the **REG_CREDS** environment variable to the file path of your registry credentials for use in later steps. For example, for the **podman** CLI:

```
$ REG_CREDS=${XDG_RUNTIME_DIR}/containers/auth.json
```

Procedure

1. If you want to mirror a Red Hat-provided catalog, run the following command on your workstation with unrestricted network access to authenticate with **registry.redhat.io**:

```
$ podman login registry.redhat.io
```

2. The **oc adm catalog mirror** command extracts the contents of an index image to generate the manifests required for mirroring. The default behavior of the command generates manifests, then automatically mirrors all of the image content from the index image, as well as the index image itself, to your mirror registry. Alternatively, if your mirror registry is on a completely disconnected, or *airgapped*, host, you can first mirror the content to removable media, move the media to the disconnected environment, then mirror the content from the media to the registry.

- **Option A: If your mirror registry is on the same network** as your workstation with unrestricted network access, take the following actions on your workstation:

a. If your mirror registry requires authentication, run the following command to log in to the registry:

```
$ podman login <mirror_registry>
```

b. Run the following command to mirror the content:

```
$ oc adm catalog mirror \
    <index_image> \ 1
    <mirror_registry>:<port>/<namespace> \ 2
    [-a ${REG_CREDS}] \ 3
    [--insecure] \ 4
    [--index-filter-by-os='<platform>/<arch>'] \ 5
    [--manifests-only] 6
```

1. Specify the index image for the catalog you want to mirror. For example, this might be a pruned index image that you created previously, or one of the source index images for the default catalogs, such as **registry.redhat.io/redhat/redhat-operator-index:v4.7**.

2. Specify the target registry and namespace to mirror the Operator content to, where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

3. Optional: If required, specify the location of your registry credentials file.

4. Optional: If you do not want to configure trust for the target registry, add the **--insecure** flag.

5. Optional: Specify which platform and architecture of the index image to select when multiple variants are available. Images are passed as **'<platform>/<arch>[/<variant>]'**. This does not apply to images referenced by the index. Valid values are **linux/amd64**, **linux/ppc64le**, and **linux/s390x**.

6. Optional: Generate only the manifests required for mirroring, and do not actually mirror the image content to a registry. This option can be useful for reviewing what will be mirrored, and it allows you to make any changes to the mapping list if you require only a subset of packages. You can then use the **mapping.txt** file with the

oc image mirror command to mirror the modified list of images in a later step. This flag is intended for only advanced selective mirroring of content from the catalog; the **opm index prune** command, if you used it previously to prune the index image, is suitable for most catalog management use cases.

Example output

```
src image has index label for database path: /database/index.db
using database path mapping: /database/index.db:/tmp/153048078
wrote database to /tmp/153048078 1
...
wrote mirroring manifests to manifests-redhat-operator-index-1614211642 2
```

1. Directory for the temporary **index.db** database generated by the command.
2. Record the manifests directory name that is generated. This directory name is used in a later step.

- **Option B: If your mirror registry is on a disconnected host**, take the following actions.

  a. Run the following command on your workstation with unrestricted network access to mirror the content to local files:

```
$ oc adm catalog mirror \
    <index_image> \ 1
    file:///local/index \ 2
    [-a ${REG_CREDS}] \
    [--insecure]
```

1. Specify the index image for the catalog you want to mirror. For example, this might be a pruned index image that you created previously, or one of the source index images for the default catalogs, such as **registry.redhat.io/redhat/redhat-operator-index:v4.7**.
2. Mirrors content to local files in your current directory.

Example output

```
...
info: Mirroring completed in 5.93s (5.915MB/s)
wrote mirroring manifests to manifests-my-index-1614985528 1

To upload local images to a registry, run:

 oc adm catalog mirror file://local/index/myrepo/my-index:v1
REGISTRY/REPOSITORY 2
```

1. Record the manifests directory name that is generated. This directory name is used in a later step.
2. Record the expanded **file://** path that based on your provided index image. This path is used in a later step.

b. Copy the **v2/** directory that is generated in your current directory to removable media.

c. Physically remove the media and attach it to a host in the disconnected environment that has access to the mirror registry.

d. If your mirror registry requires authentication, run the following command on your host in the disconnected environment to log in to the registry:

```
$ podman login <mirror_registry>
```

e. Run the following command from the parent directory containing the **v2/** directory to upload the images from local files to the mirror registry:

```
$ oc adm catalog mirror \
    file://local/index/<repo>/<index_image>:<tag> \ 1
    <mirror_registry>:<port>/<namespace> \ 2
    [-a ${REG_CREDS}] \
    [--insecure]
```

1 Specify the **file://** path from the previous command output.

2 Specify the target registry and namespace to mirror the Operator content to, where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

3. After mirroring the content to your registry, inspect the manifests directory that is generated in your current directory.

NOTE

The manifests directory name is used in a later step.

If you mirrored content to a registry on the same network in the previous step, the directory name takes the following form:

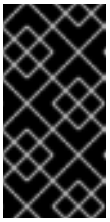
```
manifests-<index_image_name>-<random_number>
```

If you mirrored content to a registry on a disconnected host in the previous step, the directory name takes the following form:

```
manifests-index/<namespace>/<index_image_name>-<random_number>
```

The manifests directory contains the following files, some of which might require further modification:

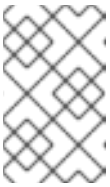
- The **catalogSource.yaml** file is a basic definition for a **CatalogSource** object that is pre-populated with your index image tag and other relevant metadata. This file can be used as is or modified to add the catalog source to your cluster.



IMPORTANT

If you mirrored the content to local files, you must modify your **catalogSource.yaml** file to remove any backslash (/) characters from the **metadata.name** field. Otherwise, when you attempt to create the object, it fails with an "invalid resource name" error.

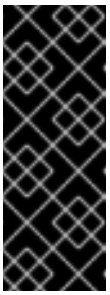
- The **imageContentSourcePolicy.yaml** file defines an **ImageContentSourcePolicy** object that can configure nodes to translate between the image references stored in Operator manifests and the mirrored registry.



NOTE

If your cluster uses an **ImageContentSourcePolicy** object to configure repository mirroring, you can use only global pull secrets for mirrored registries. You cannot add a pull secret to a project.

- The **mapping.txt** file contains all of the source images and where to map them in the target registry. This file is compatible with the **oc image mirror** command and can be used to further customize the mirroring configuration.



IMPORTANT

If you used the **--manifests-only** flag during the mirroring process and want to further trim the subset of packages to be mirrored, see the steps in the "Mirroring a Package Manifest Format catalog image" procedure about modifying your **mapping.txt** file and using the file with the **oc image mirror** command. After following those further actions, you can continue this procedure.

4. On a host with access to the disconnected cluster, create the **ImageContentSourcePolicy** object by running the following command to specify the **imageContentSourcePolicy.yaml** file in your manifests directory:

```
$ oc create -f <path/to/manifests/dir>/imageContentSourcePolicy.yaml
```

where **<path/to/manifests/dir>** is the path to the manifests directory for your mirrored content.

You can now create a **CatalogSource** object to reference your mirrored index image and Operator content.

1.4.2.4. Creating a catalog from an index image

You can create an Operator catalog from an index image and apply it to an OpenShift Container Platform cluster for use with Operator Lifecycle Manager (OLM).

Prerequisites

- An index image built and pushed to a registry.

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
spec:
  sourceType: grpc
  image: <registry>:<port>/<namespace>/redhat-operator-index:v4.7 <.>
  displayName: My Operator Catalog
  publisher: <publisher_name> <.>
  updateStrategy:
    registryPoll: <.>
      interval: 30m
```

<.> Specify your index image. <.> Specify your name or an organization name publishing the catalog. <.> 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.

1.4.2.5. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.7 target cluster in a restricted environment

You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4.7 target cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must create a custom Operator catalog and push it to a mirror registry.
- You must configure Operator Lifecycle Manager to install the Migration Toolkit for Containers Operator from the mirror registry.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.

NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
7. Click **Create**.
8. Click **Workloads → Pods** to verify that the MTC pods are running.

1.4.2.6. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 3 source cluster in a restricted environment

You can create a manifest file based on the Migration Toolkit for Containers (MTC) Operator image and edit the manifest to point to your local image registry. Then, you can use the local image to create the Migration Toolkit for Containers Operator on an OpenShift Container Platform 3 source cluster.

IMPORTANT

You must install the same MTC version on the OpenShift Container Platform 3 and 4 clusters.

To ensure that you have the latest version on the OpenShift Container Platform 3 cluster, download the **operator.yml** and **controller-3.yml** files when you are ready to create and run the migration plan.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must have access to **registry.redhat.io**.
- You must have **podman** installed.
- The source cluster must be OpenShift Container Platform 3.7, 3.9, 3.10, or 3.11.
- You must have a Linux workstation with unrestricted network access.
- You must have access to a mirror registry that supports Docker v2-2

Procedure

1. On the workstation with unrestricted network access, log in to **registry.redhat.io** with your Red Hat Customer Portal credentials:

```
$ sudo podman login registry.redhat.io
```

2. Download the **operator.yml** file:

```
$ sudo podman cp $(sudo podman create \
  registry.redhat.io/rhmtc/openshift-migration-rhel7-operator:v1.4):/operator.yml ./
```

3. Download the **controller-3.yml** file:

```
$ sudo podman cp $(sudo podman create \
  registry.redhat.io/rhmtc/openshift-migration-rhel7-operator:v1.4):/controller-3.yml ./
```

4. Obtain the Operator image value from the **mapping.txt** file that was created when you ran the **oc adm catalog mirror** on the OpenShift Container Platform 4 cluster:

```
$ grep openshift-migration-rhel7-operator ./mapping.txt | grep rhmtc
```

The output shows the mapping between the **registry.redhat.io** image and your mirror registry image.

Example output

```
registry.redhat.io/rhmtc/openshift-migration-rhel7-
operator@sha256:468a6126f73b1ee12085ca53a312d1f96ef5a2ca03442bcb63724af5e2614e8
a=<registry.apps.example.com>/rhmtc/openshift-migration-rhel7-operator
```

5. Update the **image** and **REGISTRY** values in the Operator configuration file:

```
containers:
  - name: ansible
    image: <registry.apps.example.com>/rhmtc/openshift-migration-rhel7-operator@sha256:
<468a6126f73b1ee12085ca53a312d1f96ef5a2ca03442bcb63724af5e2614e8a> 1
...
  - name: operator
    image: <registry.apps.example.com>/rhmtc/openshift-migration-rhel7-operator@sha256:
<468a6126f73b1ee12085ca53a312d1f96ef5a2ca03442bcb63724af5e2614e8a> 2
...
    env:
    - name: REGISTRY
      value: <registry.apps.example.com> 3
```

1. Specify your mirror registry and the **sha256** value of the Operator image in the **mapping.txt** file.
2. Specify your mirror registry and the **sha256** value of the Operator image in the **mapping.txt** file.
3. Specify your mirror registry.

6. Log in to your OpenShift Container Platform 3 cluster.
7. Create the Migration Toolkit for Containers Operator object:

```
$ oc create -f operator.yml
```

Example output

```
namespace/openshift-migration created
rolebinding.rbac.authorization.k8s.io/system:deployers created
serviceaccount/migration-operator created
customresourcedefinition.apiextensions.k8s.io/migrationcontrollers.migration.openshift.io
created
role.rbac.authorization.k8s.io/migration-operator created
rolebinding.rbac.authorization.k8s.io/migration-operator created
clusterrolebinding.rbac.authorization.k8s.io/migration-operator created
deployment.apps/migration-operator created
Error from server (AlreadyExists): error when creating "./operator.yml":
rolebindings.rbac.authorization.k8s.io "system:image-builders" already exists 1
Error from server (AlreadyExists): error when creating "./operator.yml":
rolebindings.rbac.authorization.k8s.io "system:image-pullers" already exists
```

1. You can ignore **Error from server (AlreadyExists)** messages. They are caused by the Migration Toolkit for Containers Operator creating resources for earlier versions of OpenShift Container Platform 3 that are provided in later releases.

8. Create the **MigrationController** object:

```
$ oc create -f controller-3.yml
```

9. Verify that the **Velero** and **Restic** pods are running:

```
$ oc get pods -n openshift-migration
```

1.4.3. Upgrading the Migration Toolkit for Containers

You can upgrade the Migration Toolkit for Containers (MTC) by using the OpenShift Container Platform web console.

IMPORTANT

You must ensure that the same MTC version is installed on all clusters.

If you are upgrading MTC version 1.3, you must perform an additional procedure to update the **MigPlan** custom resource (CR).

1.4.3.1. Upgrading the Migration Toolkit for Containers on an OpenShift Container Platform 4 cluster

You can upgrade the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4 cluster by using the OpenShift Container Platform web console.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges.

Procedure

1. In the OpenShift Container Platform console, navigate to **Operators → Installed Operators**. Operators that have a pending upgrade display an **Upgrade available** status.
2. Click **Migration Toolkit for Containers Operator**.
3. Click the **Subscription** tab. Any upgrades 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 upgrade and click **Approve**.
6. Navigate back to the **Operators → Installed Operators** page to monitor the progress of the upgrade. When complete, the status changes to **Succeeded** and **Up to date**.
7. Click **Workloads → Pods** to verify that the MTC pods are running.

1.4.3.2. Upgrading the Migration Toolkit for Containers on an OpenShift Container Platform 3 cluster

You can upgrade Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 3 cluster with **podman**.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges.

- You must have access to **registry.redhat.io**.
- You must have **podman** installed.

Procedure

1. Log in to **registry.redhat.io** with your Red Hat Customer Portal credentials:

```
$ sudo podman login registry.redhat.io
```

2. Download the latest **operator.yml** file:

```
$ sudo podman cp $(sudo podman create \
  registry.redhat.io/rhmtc/openshift-migration-rhel7-operator:v1.4):/operator.yml ./ 1
```

1 You can specify a z-stream release, if necessary.

3. Replace the Migration Toolkit for Containers Operator:

```
$ oc replace --force -f operator.yml
```

4. Apply the changes:
   - For MTC 1.1.2 and earlier versions, delete the **Restic** pods:

```
$ oc delete pod <restic_pod>
```

   - For MTC 1.2 and later versions:
     a. Scale the **migration-operator** deployment to **0** to stop the deployment:

```
$ oc scale -n openshift-migration --replicas=0 deployment/migration-operator
```

     b. Scale the **migration-operator** deployment to **1** to start the deployment and apply the changes:

```
$ oc scale -n openshift-migration --replicas=1 deployment/migration-operator
```

5. Verify that the **migration-operator** was upgraded:

```
$ oc -o yaml -n openshift-migration get deployment/migration-operator | grep image: | awk -F
":" '{ print $NF }'
```

6. Download the latest **controller-3.yml** file:

```
$ sudo podman cp $(sudo podman create \
  registry.redhat.io/rhmtc/openshift-migration-rhel7-operator:v1.4):/controller-3.yml ./
```

7. Create the **migration-controller** object:

```
$ oc create -f controller-3.yml
```

8. If your OpenShift Container Platform version is 3.10 or earlier, set the security context constraint of the **migration-controller** service account to **anyuid** to enable direct image migration and direct volume migration:

```
$ oc adm policy add-scc-to-user anyuid -z migration-controller -n openshift-migration
```

9. Verify that the MTC pods are running:

```
$ oc get pods -n openshift-migration
```

10. If you have previously added the OpenShift Container Platform 3 cluster to the MTC web console, you must update the service account token in the web console because the upgrade process deletes and restores the **openshift-migration** namespace:

    a. Obtain the service account token:

    ```
    $ oc sa get-token migration-controller -n openshift-migration
    ```

    b. In the MTC web console, click **Clusters**.

    c. Click the Options menu  next to the cluster and select **Edit**.

    d. Enter the new service account token in the **Service account token** field.

    e. Click **Update cluster** and then click **Close**.

1.4.3.3. Upgrading MTC 1.3 to 1.4

If you are upgrading Migration Toolkit for Containers (MTC) version 1.3.x to 1.4, you must update the **MigPlan** custom resource (CR) manifest on the cluster on which the **MigrationController** pod is running.

Because the **indirectImageMigration** and **indirectVolumeMigration** parameters do not exist in MTC 1.3, their default value in version 1.4 is **false**, which means that direct image migration and direct volume migration are enabled. Because the direct migration requirements are not fulfilled, the migration plan cannot reach a **Ready** state unless these parameter values are changed to **true**.

Prerequisites

- You must have MTC 1.3 installed.
- You must be logged in as a user with **cluster-admin** privileges.

Procedure

1. Log in to the cluster on which the **MigrationController** pod is running.
2. Get the **MigPlan** CR manifest:

```
$ oc get migplan <migplan> -o yaml -n openshift-migration
```

3. Update the following parameter values and save the file as **migplan.yaml**:

```
...
spec:
  indirectImageMigration: true
  indirectVolumeMigration: true
```

4. Replace the **MigPlan** CR manifest to apply the changes:

```
$ oc replace -f migplan.yaml -n openshift-migration
```

5. Get the updated **MigPlan** CR manifest to verify the changes:

```
$ oc get migplan <migplan> -o yaml -n openshift-migration
```

1.5. CONFIGURING OBJECT STORAGE FOR A REPLICATION REPOSITORY

You must configure an object storage to use as a replication repository. The Migration Toolkit for Containers (MTC) copies data from the source cluster to the replication repository, and then from the replication repository to the target cluster.

MTC supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

The following storage providers are supported:

- Multi-Cloud Object Gateway (MCG)
- Amazon Web Services (AWS) S3
- Google Cloud Provider (GCP)
- Microsoft Azure
- Generic S3 object storage, for example, Minio or Ceph S3

In a restricted environment, you can create an internally hosted replication repository.

Prerequisites

- All clusters must have uninterrupted network access to the replication repository.
- If you use a proxy server with an internally hosted replication repository, you must ensure that the proxy allows access to the replication repository.

1.5.1. Configuring a Multi-Cloud Object Gateway storage bucket as a replication repository

You can install the OpenShift Container Storage Operator and configure a Multi-Cloud Object Gateway (MCG) storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

1.5.1.1. Installing the OpenShift Container Storage Operator

You can install the OpenShift Container Storage Operator from OperatorHub.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use **Filter by keyword** (in this case, **OCS**) to find the **OpenShift Container Storage Operator**.
3. Select the **OpenShift Container Storage Operator** and click **Install**.
4. Select an **Update Channel**, **Installation Mode**, and **Approval Strategy**.
5. Click **Install**.
   On the **Installed Operators** page, the **OpenShift Container Storage Operator** appears in the **openshift-storage** project with the status **Succeeded**.

1.5.1.2. Creating the Multi-Cloud Object Gateway storage bucket

You can create the Multi-Cloud Object Gateway (MCG) storage bucket's custom resources (CRs).

Procedure

1. Log in to the OpenShift Container Platform cluster:

```
$ oc login -u <username>
```

2. Create the **NooBaa** CR configuration file, **noobaa.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: NooBaa
metadata:
  name: noobaa
  namespace: openshift-storage
spec:
 dbResources:
   requests:
     cpu: 0.5 (1)
     memory: 1Gi
 coreResources:
   requests:
     cpu: 0.5 (2)
     memory: 1Gi
```

(1) (2) For a very small cluster, you can change the **cpu** value to **0.1**.

3. Create the **NooBaa** object:

```
$ oc create -f noobaa.yml
```

4. Create the **BackingStore** CR configuration file, **bs.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: BackingStore
metadata:
  finalizers:
  - noobaa.io/finalizer
```

```
  labels:
    app: noobaa
  name: mcg-pv-pool-bs
  namespace: openshift-storage
spec:
  pvPool:
    numVolumes: 3 (1)
    resources:
      requests:
        storage: 50Gi (2)
    storageClass: gp2 (3)
  type: pv-pool
```

(1) Specify the number of volumes in the persistent volume pool.

(2) Specify the size of the volumes.

(3) Specify the storage class.

5. Create the **BackingStore** object:

```
$ oc create -f bs.yml
```

6. Create the **BucketClass** CR configuration file, **bc.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: BucketClass
metadata:
  labels:
    app: noobaa
  name: mcg-pv-pool-bc
  namespace: openshift-storage
spec:
  placementPolicy:
    tiers:
    - backingStores:
      - mcg-pv-pool-bs
      placement: Spread
```

7. Create the **BucketClass** object:

```
$ oc create -f bc.yml
```

8. Create the **ObjectBucketClaim** CR configuration file, **obc.yml**, with the following content:

```
apiVersion: objectbucket.io/v1alpha1
kind: ObjectBucketClaim
metadata:
  name: migstorage
  namespace: openshift-storage
spec:
  bucketName: migstorage (1)
```

```
storageClassName: openshift-storage.noobaa.io
additionalConfig:
  bucketclass: mcg-pv-pool-bc
```

1 Record the bucket name for adding the replication repository to the MTC web console.

9. Create the **ObjectBucketClaim** object:

```
$ oc create -f obc.yml
```

10. Watch the resource creation process to verify that the **ObjectBucketClaim** status is **Bound**:

```
$ watch -n 30 'oc get -n openshift-storage objectbucketclaim migstorage -o yaml'
```

This process can take five to ten minutes.

11. Obtain and record the following values, which are required when you add the replication repository to the MTC web console:

- S3 endpoint:

```
$ oc get route -n openshift-storage s3
```

- S3 provider access key:

```
$ oc get secret -n openshift-storage migstorage -o go-template='{{
.data.AWS_ACCESS_KEY_ID }}' | base64 --decode
```

- S3 provider secret access key:

```
$ oc get secret -n openshift-storage migstorage -o go-template='{{
.data.AWS_SECRET_ACCESS_KEY }}' | base64 --decode
```

1.5.2. Configuring an AWS S3 storage bucket as a replication repository

You can configure an AWS S3 storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- The AWS S3 storage bucket must be accessible to the source and target clusters.
- You must have the AWS CLI installed.
- If you are using the snapshot copy method:
  - You must have access to EC2 Elastic Block Storage (EBS).
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Create an AWS S3 bucket:

```
$ aws s3api create-bucket \
    --bucket <bucket_name> \ 1
    --region <bucket_region> 2
```

1. Specify your S3 bucket name.
2. Specify your S3 bucket region, for example, **us-east-1**.

2. Create the IAM user **velero**:

```
$ aws iam create-user --user-name velero
```

3. Create an EC2 EBS snapshot policy:

```
$ cat > velero-ec2-snapshot-policy.json <<EOF
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "ec2:DescribeVolumes",
                "ec2:DescribeSnapshots",
                "ec2:CreateTags",
                "ec2:CreateVolume",
                "ec2:CreateSnapshot",
                "ec2:DeleteSnapshot"
            ],
            "Resource": "*"
        }
    ]
}
EOF
```

4. Create an AWS S3 access policy for one or for all S3 buckets:

```
$ cat > velero-s3-policy.json <<EOF
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "s3:GetObject",
                "s3:DeleteObject",
                "s3:PutObject",
                "s3:AbortMultipartUpload",
                "s3:ListMultipartUploadParts"
            ],
            "Resource": [
```

```
            "arn:aws:s3:::<bucket_name>/*" (1)
        ]
    },
    {
        "Effect": "Allow",
        "Action": [
            "s3:ListBucket",
            "s3:GetBucketLocation",
            "s3:ListBucketMultipartUploads"
        ],
        "Resource": [
            "arn:aws:s3:::<bucket_name>" (2)
        ]
    }
  ]
}
EOF
```

(1) (2) To grant access to a single S3 bucket, specify the bucket name. To grant access to all AWS S3 buckets, specify * instead of a bucket name as in the following example:

Example output

```
"Resource": [
    "arn:aws:s3:::*"
```

5. Attach the EC2 EBS policy to **velero**:

```
$ aws iam put-user-policy \
  --user-name velero \
  --policy-name velero-ebs \
  --policy-document file://velero-ec2-snapshot-policy.json
```

6. Attach the AWS S3 policy to **velero**:

```
$ aws iam put-user-policy \
  --user-name velero \
  --policy-name velero-s3 \
  --policy-document file://velero-s3-policy.json
```

7. Create an access key for **velero**:

```
$ aws iam create-access-key --user-name velero
{
  "AccessKey": {
        "UserName": "velero",
        "Status": "Active",
        "CreateDate": "2017-07-31T22:24:41.576Z",
        "SecretAccessKey": <AWS_SECRET_ACCESS_KEY>, (1)
        "AccessKeyId": <AWS_ACCESS_KEY_ID> (2)
    }
}
```

1 2 Record the **AWS_SECRET_ACCESS_KEY** and the **AWS_ACCESS_KEY_ID** for adding the AWS repository to the MTC web console.

1.5.3. Configuring a Google Cloud Provider storage bucket as a replication repository

You can configure a Google Cloud Provider (GCP) storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- The GCP storage bucket must be accessible to the source and target clusters.
- You must have **gsutil** installed.
- If you are using the snapshot copy method:
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Log in to **gsutil**:

```
$ gsutil init
```

Example output

```
Welcome! This command will take you through the configuration of gcloud.

Your current configuration has been set to: [default]

To continue, you must login. Would you like to login (Y/n)?
```

2. Set the **BUCKET** variable:

```
$ BUCKET=<bucket_name> 1
```

1 Specify your bucket name.

3. Create a storage bucket:

```
$ gsutil mb gs://$BUCKET/
```

4. Set the **PROJECT_ID** variable to your active project:

```
$ PROJECT_ID=`gcloud config get-value project`
```

5. Create a **velero** IAM service account:

```
$ gcloud iam service-accounts create velero \
    --display-name "Velero Storage"
```

6. Create the **SERVICE_ACCOUNT_EMAIL** variable:

```
$ SERVICE_ACCOUNT_EMAIL=`gcloud iam service-accounts list \
  --filter="displayName:Velero Storage" \
  --format 'value(email)'`
```

7. Create the **ROLE_PERMISSIONS** variable:

```
$ ROLE_PERMISSIONS=(
    compute.disks.get
    compute.disks.create
    compute.disks.createSnapshot
    compute.snapshots.get
    compute.snapshots.create
    compute.snapshots.useReadOnly
    compute.snapshots.delete
    compute.zones.get
)
```

8. Create the **velero.server** custom role:

```
$ gcloud iam roles create velero.server \
    --project $PROJECT_ID \
    --title "Velero Server" \
    --permissions "$(IFS=","; echo "${ROLE_PERMISSIONS[*]}")"
```

9. Add IAM policy binding to the project:

```
$ gcloud projects add-iam-policy-binding $PROJECT_ID \
    --member serviceAccount:$SERVICE_ACCOUNT_EMAIL \
    --role projects/$PROJECT_ID/roles/velero.server
```

10. Update the IAM service account:

```
$ gsutil iam ch serviceAccount:$SERVICE_ACCOUNT_EMAIL:objectAdmin gs://${BUCKET}
```

11. Save the IAM service account keys to the **credentials-velero** file in the current directory:

```
$ gcloud iam service-accounts keys create credentials-velero \
  --iam-account $SERVICE_ACCOUNT_EMAIL
```

1.5.4. Configuring a Microsoft Azure Blob storage container as a replication repository

You can configure a Microsoft Azure Blob storage container as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- You must have an Azure storage account.
- You must have the Azure CLI installed.
- The Azure Blob storage container must be accessible to the source and target clusters.
- If you are using the snapshot copy method:
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Set the **AZURE_RESOURCE_GROUP** variable:

```
$ AZURE_RESOURCE_GROUP=Velero_Backups
```

2. Create an Azure resource group:

```
$ az group create -n $AZURE_RESOURCE_GROUP --location <CentralUS> 1
```

1 Specify your location.

3. Set the **AZURE_STORAGE_ACCOUNT_ID** variable:

```
$ AZURE_STORAGE_ACCOUNT_ID=velerobackups
```

4. Create an Azure storage account:

```
$ az storage account create \
  --name $AZURE_STORAGE_ACCOUNT_ID \
  --resource-group $AZURE_RESOURCE_GROUP \
  --sku Standard_GRS \
  --encryption-services blob \
  --https-only true \
  --kind BlobStorage \
  --access-tier Hot
```

5. Set the **BLOB_CONTAINER** variable:

```
$ BLOB_CONTAINER=velero
```

6. Create an Azure Blob storage container:

```
$ az storage container create \
  -n $BLOB_CONTAINER \
  --public-access off \
  --account-name $AZURE_STORAGE_ACCOUNT_ID
```

7. Create a service principal and credentials for **velero**:

```
$ AZURE_SUBSCRIPTION_ID=`az account list --query '[?isDefault].id' -o tsv` \
  AZURE_TENANT_ID=`az account list --query '[?isDefault].tenantId' -o tsv` \
  AZURE_CLIENT_SECRET=`az ad sp create-for-rbac --name "velero" --role "Contributor" --
query 'password' -o tsv` \
  AZURE_CLIENT_ID=`az ad sp list --display-name "velero" --query '[0].appId' -o tsv`
```

8. Save the service principal credentials in the **credentials-velero** file:

```
$ cat << EOF  > ./credentials-velero
AZURE_SUBSCRIPTION_ID=${AZURE_SUBSCRIPTION_ID}
AZURE_TENANT_ID=${AZURE_TENANT_ID}
AZURE_CLIENT_ID=${AZURE_CLIENT_ID}
AZURE_CLIENT_SECRET=${AZURE_CLIENT_SECRET}
AZURE_RESOURCE_GROUP=${AZURE_RESOURCE_GROUP}
AZURE_CLOUD_NAME=AzurePublicCloud
EOF
```

1.6. MIGRATING YOUR APPLICATIONS

You can migrate your applications by using the Migration Toolkit for Containers (MTC) web console or from the command line.

1.6.1. Prerequisites

The Migration Toolkit for Containers (MTC) has the following prerequisites:

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- The MTC version must be the same on all clusters.
- If your application uses internal images from the **openshift** namespace, you must ensure that the required versions of the images are present on the target cluster.
  You can manually update an image stream tag in order to use a deprecated OpenShift Container Platform 3 image on an OpenShift Container Platform 4.7 cluster.
- Clusters:
  - The source cluster must be upgraded to the latest MTC z-stream release.
  - The cluster on which the **migration-controller** pod is running must have unrestricted network access to the other clusters.
  - The clusters must have unrestricted network access to each other.
  - The clusters must have unrestricted network access to the replication repository.
  - The clusters must be able to communicate using OpenShift routes on port 443.
  - The clusters must have no critical conditions.
  - The clusters must be in a ready state.
- Volume migration:
  - The persistent volumes (PVs) must be valid.

- The PVs must be bound to persistent volume claims.
- If you copy the PVs by using the *move* method, the clusters must have unrestricted network access to the remote volume.
- If you copy the PVs by using the *snapshot* copy method, the following prerequisites apply:
  - The cloud provider must support snapshots.
  - The volumes must have the same cloud provider.
  - The volumes must be located in the same geographic region.
  - The volumes must have the same storage class.

- If you perform a direct volume migration in a proxy environment, you must configure an Stunnel TCP proxy.
- If you perform a direct image migration, you must expose the internal registry of the source cluster to external traffic.

1.6.1.1. Updating deprecated internal images with podman

If your application uses images from the **openshift** namespace, the required versions of the images must be present on the target cluster.

If the OpenShift Container Platform 3 image is deprecated in OpenShift Container Platform 4.7, you can manually update the image stream tag by using **podman**.

Prerequisites

- You must have **podman** installed.
- You must be logged in as a user with **cluster-admin** privileges.

Procedure

1. Expose the internal registries on the source and target clusters.
2. If you are using insecure registries, add your registry host values to the **[registries.insecure]** section of **/etc/container/registries.conf** to ensure that **podman** does not encounter a TLS verification error.
3. Log in to the source cluster registry:

```
$ podman login -u $(oc whoami) -p $(oc whoami -t) --tls-verify=false <source_cluster>
```

4. Log in to the target cluster registry:

```
$ podman login -u $(oc whoami) -p $(oc whoami -t) --tls-verify=false <target_cluster>
```

5. Pull the deprecated image:

```
$ podman pull <source_cluster>/openshift/<image>
```

6. Tag the image for the target cluster registry:

```
$ podman tag <source_cluster>/openshift/<image> <target_cluster>/openshift/<image>
```

7. Push the image to the target cluster 4 registry:

```
$ podman push <target_cluster>/openshift/<image>
```

8. Verify that the image has a valid image stream on the target cluster:

```
$ oc get imagestream -n openshift | grep <image>
```

Example output

```
<image>    <target_cluster>/openshift/<image>     <versions>
more...      6 seconds ago
```

1.6.1.2. Creating a CA certificate bundle file

If you use a self-signed certificate to secure a cluster or a replication repository for the Migration Toolkit for Containers (MTC), certificate verification might fail with the following error message: **Certificate signed by unknown authority**.

You can create a custom CA certificate bundle file and upload it in the MTC web console when you add a cluster or a replication repository.

Procedure

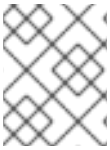
Download a CA certificate from a remote endpoint and save it as a CA bundle file:

```
$ echo -n | openssl s_client -connect <host_FQDN>:<port> \ 1
  | sed -ne '/-BEGIN CERTIFICATE-/,/-END CERTIFICATE-/p' > <ca_bundle.cert> 2
```

1. Specify the host FQDN and port of the endpoint, for example, **api.my-cluster.example.com:6443**.
2. Specify the name of the CA bundle file.

1.6.1.3. Configuring a proxy for direct volume migration

If you are performing direct volume migration from a source cluster behind a proxy, you must configure an Stunnel proxy in the **MigrationController** custom resource (CR). Stunnel creates a transparent tunnel between the source and target clusters for the TCP connection without changing the certificates.



NOTE

Direct volume migration supports only one proxy. The source cluster cannot access the route of the target cluster if the target cluster is also behind a proxy.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.

Procedure

1. Log in to the cluster on which the **MigrationController** pod runs.
2. Get the **MigrationController** CR manifest:

```
$ oc get migrationcontroller <migration_controller> -n openshift-migration
```

3. Add the **stunnel_tcp_proxy** parameter:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigrationController
metadata:
  name: migration-controller
  namespace: openshift-migration
...
spec:
  stunnel_tcp_proxy: <stunnel_proxy> 1
```

1 Specify the Stunnel proxy: **http://<user_name>:<password>@<ip_address>:<port>**.

4. Save the manifest as **migration-controller.yaml**.
5. Apply the updated manifest:

```
$ oc replace -f migration-controller.yaml -n openshift-migration
```

1.6.1.4. Writing an Ansible playbook for a migration hook

You can write an Ansible playbook to use as a migration hook. The hook is added to a migration plan by using the MTC web console or by specifying values for the **spec.hooks** parameters in the **MigPlan** custom resource (CR) manifest.

The Ansible playbook is mounted onto a hook container as a config map. The hook container runs as a job, using the cluster, service account, and namespace specified in the **MigPlan** CR. The hook container uses a specified service account token so that the tasks do not require authentication before they run in the cluster.

1.6.1.4.1. Ansible modules

You can use the Ansible **shell** module to run **oc** commands.

Example shell module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: get pod name
    shell: oc get po --all-namespaces
```

You can use **kubernetes.core** modules, such as **k8s_info**, to interact with Kubernetes resources.

Example k8s_facts module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: Get pod
    k8s_info:
      kind: pods
      api: v1
      namespace: openshift-migration
      name: "{{ lookup( 'env', 'HOSTNAME') }}"
    register: pods

  - name: Print pod name
    debug:
      msg: "{{ pods.resources[0].metadata.name }}"
```

You can use the **fail** module to produce a non-zero exit status in cases where a non-zero exit status would not normally be produced, ensuring that the success or failure of a hook is detected. Hooks run as jobs and the success or failure status of a hook is based on the exit status of the job container.

Example fail module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: Set a boolean
    set_fact:
      do_fail: true

  - name: "fail"
    fail:
      msg: "Cause a failure"
    when: do_fail
```

1.6.1.4.2. Environment variables

The **MigPlan** CR name and migration namespaces are passed as environment variables to the hook container. These variables are accessed by using the **lookup** plug-in.

Example environment variables

```
- hosts: localhost
  gather_facts: false
  tasks:
  - set_fact:
      namespaces: "{{ (lookup( 'env', 'migration_namespaces')).split(',') }}"

  - debug:
      msg: "{{ item }}"
    with_items: "{{ namespaces }}"

  - debug:
      msg: "{{ lookup( 'env', 'migplan_name') }}"
```

1.6.1.5. Additional resources

- About migration hooks
- MigHook custom resource
- MigPlan custom resource

1.6.2. Migrating your applications by using the MTC web console

You can configure clusters and a replication repository by using the MTC web console. Then, you can create and run a migration plan.

1.6.2.1. Launching the MTC web console

You can launch the Migration Toolkit for Containers (MTC) web console in a browser.

Prerequisites

- The MTC web console must have network access to the OpenShift Container Platform web console.
- The MTC web console must have network access to the OAuth authorization server.

Procedure

1. Log in to the OpenShift Container Platform cluster on which you have installed MTC.
2. Obtain the MTC web console URL by entering the following command:

```
$ oc get -n openshift-migration route/migration -o go-template='https://{{ .spec.host }}'
```

   The output resembles the following: **https://migration-openshift-migration.apps.cluster.openshift.com**.

3. Launch a browser and navigate to the MTC web console.

NOTE

If you try to access the MTC web console immediately after installing the Migration Toolkit for Containers Operator, the console might not load because the Operator is still configuring the cluster. Wait a few minutes and retry.

4. If you are using self-signed CA certificates, you will be prompted to accept the CA certificate of the source cluster API server. The web page guides you through the process of accepting the remaining certificates.
5. Log in with your OpenShift Container Platform **username** and **password**.

1.6.2.2. Adding a cluster to the MTC web console

You can add a cluster to the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- If you are using Azure snapshots to copy data:
  - You must specify the Azure resource group name for the cluster.
  - The clusters must be in the same Azure resource group.
  - The clusters must be in the same geographic location.

Procedure

1. Log in to the cluster.
2. Obtain the **migration-controller** service account token:

```
$ oc sa get-token migration-controller -n openshift-migration
```

Example output

```
eyJhbGciOiJSUzI1NiIsImtpZCI6IiJ9.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwi
a3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9uYW1lc3BhY2UiOiJtaWciLCJrdWJlcm5ldGV:
LmlvL3NlcnZpY2VhY2NvdW50L3NlY3JldC5uYW1lIjoibWlnLXRva2VuLWs4dDJyIiwia3ViZXJuZ
XRlcy5pby9zZXJ2aWNlYWNjb3VudC9zZXJ2aWNlLWFjY291bnQubmFtZSI6Im1pZyIsImt1YmV
ybmV0ZXMuaW8vc2VydmljZWFjY291bnQvc2VydmljZS1hY2NvdW50LnVpZCI6ImE1YjFiYWM
wLWMxYmYtMTFlOS05Y2NiLTAyOWRmODYwYjMwOCIsInN1YiI6InN5c3RlbTpzZXJ2aWNlY
WNjb3VudDptaWc6bWlnIn0.xqeeAINK7UXpdRqAtOj70qhBJPeMwmgLomV9iFxr5RoqUgKchZ
RG2J2rkqmPm6vr7K-
cm7ibD1IBpdQJCcVDuoHYsFgV4mp9vgOfn9osSDp2TGikwNz4Az95e81xnjVUmzh-
NjDsEpw71DH92iHV_xt2sTwtzftS49LpPW2LjrV0evtNBP_t_RfskdArt5VSv25eORI7zScqfe1CiM
kcVbf2UqACQjo3LbkpfN26HAioO2oH0ECPiRzT0Xyh-KwFutJLS9Xgghyw-
LD9kPKcE_xbbJ9Y4Rqajh7WdPYuB0Jd9DPVrslmzK-F6cgHHYoZEv0SvLQi-
PO0rpDrcjOEQQ
```

3. In the MTC web console, click **Clusters**.
4. Click **Add cluster**.
5. Fill in the following fields:
   - **Cluster name**: The cluster name can contain lower-case letters (**a-z**) and numbers (**0-9**). It must not contain spaces or international characters.
   - **URL**: Specify the API server URL, for example, **https://<www.example.com>:8443**.
   - **Service account token**: Paste the **migration-controller** service account token.
   - **Exposed route host to image registry**: If you are using direct image migration, specify the exposed route to the image registry of the source cluster, for example, **www.example.apps.cluster.com**.
     You can specify a port. The default port is **5000**.
   - **Azure cluster**: You must select this option if you use Azure snapshots to copy your data.
   - **Azure resource group**: This field is displayed if **Azure cluster** is selected. Specify the Azure resource group.
   - **Require SSL verification**: Optional. Select this option to verify SSL connections to the

- **Require SSL verification**: Optional: Select this option to verify SSL connections to the cluster.
- **CA bundle file**: This field is displayed if **Require SSL verification** is selected. If you created a custom CA certificate bundle file for self-signed certificates, click **Browse**, select the CA bundle file, and upload it.

6. Click **Add cluster**.
   The cluster appears in the **Clusters** list.

1.6.2.3. Adding a replication repository to the MTC web console

You can add an object storage bucket as a replication repository to the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- You must configure an object storage bucket for migrating the data.

Procedure

1. In the MTC web console, click **Replication repositories**.
2. Click **Add repository**.
3. Select a **Storage provider type** and fill in the following fields:
   - **AWS** for AWS S3, MCG, and generic S3 providers:
     - **Replication repository name**: Specify the replication repository name in the MTC web console.
     - **S3 bucket name**: Specify the name of the S3 bucket you created.
     - **S3 bucket region**: Specify the S3 bucket region. **Required** for AWS S3. **Optional** for other S3 providers.
     - **S3 endpoint**: Specify the URL of the S3 service, not the bucket, for example, **https://<s3-storage.apps.cluster.com>**. **Required** for a generic S3 provider. You must use the **https://** prefix.
     - **S3 provider access key**: Specify the **<AWS_SECRET_ACCESS_KEY>** for AWS or the S3 provider access key for MCG.
     - **S3 provider secret access key**: Specify the **<AWS_ACCESS_KEY_ID>** for AWS or the S3 provider secret access key for MCG.
     - **Require SSL verification**: Clear this check box if you are using a generic S3 provider.
     - If you use a custom CA bundle, click **Browse** and browse to the Base64-encoded CA bundle file.
   - **GCP**:
     - **Replication repository name**: Specify the replication repository name in the MTC web console.

- **GCP bucket name**: Specify the name of the GCP bucket.
- **GCP credential JSON blob**: Specify the string in the **credentials-velero** file.

- Azure:
  - **Replication repository name**: Specify the replication repository name in the MTC web console.
  - **Azure resource group**: Specify the resource group of the Azure Blob storage.
  - **Azure storage account name**: Specify the Azure Blob storage account name.
  - **Azure credentials - INI file contents** Specify the string in the **credentials-velero** file.

4. Click **Add repository** and wait for connection validation.
5. Click **Close**.
   The new repository appears in the **Replication repositories** list.

1.6.2.4. Creating a migration plan in the MTC web console

You can create a migration plan in the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must ensure that the same MTC version is installed on all clusters.
- You must add the clusters and the replication repository to the MTC web console.
- If you want to use the *move* data copy method to migrate a persistent volume (PV), the source and target clusters must have uninterrupted network access to the remote volume.
- If you want to use direct image migration, the **MigCluster** custom resource manifest of the source cluster must specify the exposed route of the internal image registry.

Procedure

1. In the MTC web console, click **Migration plans**.
2. Click **Add migration plan**.
3. Enter the **Plan name** and click **Next**.
   The migration plan name must not exceed 253 lower-case alphanumeric characters (**a-z, 0-9**) and must not contain spaces or underscores (_).
4. Select a **Source cluster**.
5. Select a **Target cluster**.
6. Select a **Replication repository**.
7. Select the projects to be migrated and click **Next**.
8. Select a **Source cluster**, a **Target cluster**, and a **Repository**, and click **Next**.

9. On the **Namespaces** page, select the projects to be migrated and click **Next**.

10. On the **Persistent volumes** page, click a **Migration type** for each PV:

    - The **Copy** option copies the data from the PV of a source cluster to the replication repository and then restores the data on a newly created PV, with similar characteristics, in the target cluster.

    - The **Move** option unmounts a remote volume, for example, NFS, from the source cluster, creates a PV resource on the target cluster pointing to the remote volume, and then mounts the remote volume on the target cluster. Applications running on the target cluster use the same remote volume that the source cluster was using.

11. Click **Next**.

12. On the **Copy options** page, select a **Copy method** for each PV:

    - **Snapshot copy** backs up and restores data using the cloud provider's snapshot functionality. It is significantly faster than **Filesystem copy**.

    - **Filesystem copy** backs up the files on the source cluster and restores them on the target cluster.
      The file system copy method is required for direct volume migration.

13. You can select **Verify copy** to verify data migrated with **Filesystem copy**. Data is verified by generating a checksum for each source file and checking the checksum after restoration. Data verification significantly reduces performance.

14. Select a **Target storage class**.
    If you selected **Filesystem copy**, you can change the target storage class.

15. Click **Next**.

16. On the **Migration options** page, the **Direct image migration** option is selected if you specified an exposed image registry route for the source cluster. The **Direct PV migration** option is selected if you are migrating data with **Filesystem copy**.
    The direct migration options copy images and files directly from the source cluster to the target cluster. This option is much faster than copying images and files from the source cluster to the replication repository and then from the replication repository to the target cluster.

17. Click **Next**.

18. Optional: On the **Hooks** page, click **Add Hook** to add a hook to the migration plan.
    A hook runs custom code. You can add up to four hooks to a single migration plan. Each hook runs during a different migration step.

    a. Enter the name of the hook to display in the web console.

    b. If the hook is an Ansible playbook, select **Ansible playbook** and click **Browse** to upload the playbook or paste the contents of the playbook in the field.

    c. Optional: Specify an Ansible runtime image if you are not using the default hook image.

    d. If the hook is not an Ansible playbook, select **Custom container image** and specify the image name and path.
       A custom container image can include Ansible playbooks.

e. Select **Source cluster** or **Target cluster**.

f. Enter the **Service account name** and the **Service account namespace**

g. Select the migration step for the hook:

- **preBackup**: Before the application workload is backed up on the source cluster
- **postBackup**: After the application workload is backed up on the source cluster
- **preRestore**: Before the application workload is restored on the target cluster
- **postRestore**: After the application workload is restored on the target cluster

h. Click **Add**.

19. Click **Finish**.
The migration plan is displayed in the **Migration plans** list.

1.6.2.5. Running a migration plan in the MTC web console

You can stage or migrate applications and data with the migration plan you created in the Migration Toolkit for Containers (MTC) web console.

NOTE

During migration, MTC sets the reclaim policy of migrated persistent volumes (PVs) to **Retain** on the target cluster.

The **Backup** custom resource contains a **PVOriginalReclaimPolicy** annotation that indicates the original reclaim policy. You can manually restore the reclaim policy of the migrated PVs.

Prerequisites

The MTC web console must contain the following:

- Source cluster in a **Ready** state
- Target cluster in a **Ready** state
- Replication repository
- Valid migration plan

Procedure

1. Log in to the source cluster.
2. Delete old images:

```
$ oc adm prune images
```

3. Log in to the MTC web console and click **Migration plans**.

4. Click the **Options** menu  next to a migration plan and select **Stage** to copy data from the source cluster to the target cluster without stopping the application.
   You can run **Stage** multiple times to reduce the actual migration time.

5. When you are ready to migrate the application workload, the **Options** menu  beside a migration plan and select **Migrate**.

6. Optional: In the **Migrate** window, you can select **Do not stop applications on the source cluster during migration**.

7. Click **Migrate**.

8. When the migration is complete, verify that the application migrated successfully in the OpenShift Container Platform web console:

   a. Click **Home → Projects**.

   b. Click the migrated project to view its status.

   c. In the **Routes** section, click **Location** to verify that the application is functioning, if applicable.

   d. Click **Workloads → Pods** to verify that the pods are running in the migrated namespace.

   e. Click **Storage → Persistent volumes** to verify that the migrated persistent volumes are correctly provisioned.

1.6.3. Migrating your applications from the command line

You can migrate your applications on the command line by using the MTC custom resources (CRs).

You can migrate applications from a local cluster to a remote cluster, from a remote cluster to a local cluster, and between remote clusters.

MTC terminology
The following terms are relevant for configuring clusters:

- **host** cluster:
  - The **migration-controller** pod runs on the **host** cluster.
  - A **host** cluster does not require an exposed secure registry route for direct image migration.
- Local cluster: The local cluster is often the same as the **host** cluster but this is not a requirement.
- Remote cluster:
  - A remote cluster must have an exposed secure registry route for direct image migration.
  - A remote cluster must have a **Secret** CR containing the **migration-controller** service account token.

The following terms are relevant for performing a migration:

- Source cluster: Cluster from which the applications are migrated.
- Destination cluster: Cluster to which the applications are migrated.

1.6.3.1. Migrating your applications with the Migration Toolkit for Containers API

You can migrate your applications on the command line with the Migration Toolkit for Containers (MTC) API.

You can migrate applications from a local cluster to a remote cluster, from a remote cluster to a local cluster, and between remote clusters.

This procedure describes how to perform indirect migration and direct migration:

- Indirect migration: Images, volumes, and Kubernetes objects are copied from the source cluster to the replication repository and then from the replication repository to the destination cluster.
- Direct migration: Images or volumes are copied directly from the source cluster to the destination cluster. Direct image migration and direct volume migration have significant performance benefits.

You create the following custom resources (CRs) to perform a migration:

- **MigCluster** CR: Defines a **host**, local, or remote cluster
  The **migration-controller** pod runs on the **host** cluster.
- **Secret** CR: Contains credentials for a remote cluster or storage
- **MigStorage** CR: Defines a replication repository
  Different storage providers require different parameters in the **MigStorage** CR manifest.
- **MigPlan** CR: Defines a migration plan
- **MigMigration** CR: Performs a migration defined in an associated **MigPlan**
  You can create multiple **MigMigration** CRs for a single **MigPlan** CR for the following purposes:
- To perform stage migrations, which copy most of the data without stopping the application, before running a migration. Stage migrations improve the performance of the migration.
- To cancel a migration in progress
- To roll back a completed migration

Prerequisites

- You must have **cluster-admin** privileges for all clusters.
- You must install the OpenShift Container Platform CLI (**oc**).
- You must install the Migration Toolkit for Containers Operator on all clusters.
- The *version* of the installed Migration Toolkit for Containers Operator must be the same on all clusters.
- You must configure an object storage as a replication repository.

- If you are using direct image migration, you must expose a secure registry route on all remote clusters.
- If you are using direct volume migration, the source cluster must not have an HTTP proxy configured.

Procedure

1. Create a **MigCluster** CR manifest for the **host** cluster called **host-cluster.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  name: host
  namespace: openshift-migration
spec:
  isHostCluster: true
```

2. Create a **MigCluster** CR for the **host** cluster:

```
$ oc create -f host-cluster.yaml -n openshift-migration
```

3. Create a **Secret** CR manifest for each remote cluster called **cluster-secret.yaml**:

```
apiVersion: v1
kind: Secret
metadata:
  name: <cluster_secret>
  namespace: openshift-config
type: Opaque
data:
  saToken: <sa_token> 1
```

1 Specify the base64-encoded **migration-controller** service account (SA) token of the remote cluster.

You can obtain the SA token by running the following command:

```
$ oc sa get-token migration-controller -n openshift-migration | base64 -w 0
```

4. Create a **Secret** CR for each remote cluster:

```
$ oc create -f cluster-secret.yaml
```

5. Create a **MigCluster** CR manifest for each remote cluster called **remote-cluster.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  name: <remote_cluster>
  namespace: openshift-migration
spec:
  exposedRegistryPath: <exposed_registry_route> 1
```

```
  insecure: false 2
  isHostCluster: false
  serviceAccountSecretRef:
    name: <remote_cluster_secret> 3
    namespace: openshift-config
  url: <remote_cluster_url> 4
```

1. Optional: Specify the exposed registry route, for example, **docker-registry-default.apps.example.com** if you are using direct image migration.
2. SSL verification is enabled if **false**. CA certificates are not required or checked if **true**.
3. Specify the **Secret** CR of the remote cluster.
4. Specify the URL of the remote cluster.

6. Create a **MigCluster** CR for each remote cluster:

```
$ oc create -f remote-cluster.yaml -n openshift-migration
```

7. Verify that all clusters are in a **Ready** state:

```
$ oc describe cluster <cluster_name>
```

8. Create a **Secret** CR manifest for the replication repository called **storage-secret.yaml**:

```
apiVersion: v1
kind: Secret
metadata:
  namespace: openshift-config
  name: <migstorage_creds>
type: Opaque
data:
  aws-access-key-id: <key_id_base64> 1
  aws-secret-access-key: <secret_key_base64> 2
```

1. Specify the key ID in base64 format.
2. Specify the secret key in base64 format.

AWS credentials are base64-encoded by default. If you are using another storage provider, you must encode your credentials by running the following command with each key:

```
$ echo -n "<key>" | base64 -w 0 1
```

1. Specify the key ID or the secret key. Both keys must be base64-encoded.

9. Create the **Secret** CR for the replication repository:

```
$ oc create -f storage-secret.yaml
```

10. Create a **MigStorage** CR manifest for the replication repository called **migstorage.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigStorage
metadata:
  name: <storage_name>
  namespace: openshift-migration
spec:
  backupStorageConfig:
    awsBucketName: <bucket_name> 1
    credsSecretRef:
      name: <storage_secret_ref> 2
      namespace: openshift-config
  backupStorageProvider: <storage_provider_name> 3
  volumeSnapshotConfig:
    credsSecretRef:
      name: <storage_secret_ref> 4
      namespace: openshift-config
  volumeSnapshotProvider: <storage_provider_name> 5
```

1. Specify the bucket name.
2. Specify the **Secrets** CR of the object storage. You must ensure that the credentials stored in the **Secrets** CR of the object storage are correct.
3. Specify the storage provider.
4. Optional: If you are copying data by using snapshots, specify the **Secrets** CR of the object storage. You must ensure that the credentials stored in the **Secrets** CR of the object storage are correct.
5. Optional: If you are copying data by using snapshots, specify the storage provider.

11. Create the **MigStorage** CR:

```
$ oc create -f migstorage.yaml -n openshift-migration
```

12. Verify that the **MigStorage** CR is in a **Ready** state:

```
$ oc describe migstorage <migstorage_name>
```

13. Create a **MigPlan** CR manifest called **migplan.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigPlan
metadata:
  name: <migration_plan>
  namespace: openshift-migration
spec:
  destMigClusterRef:
    name: host
    namespace: openshift-migration
  indirectImageMigration: true 1
```

```
  indirectVolumeMigration: true (2)
  migStorageRef:
    name: <migstorage_ref> (3)
    namespace: openshift-migration
  namespaces:
    - <application_namespace> (4)
  srcMigClusterRef:
    name: <remote_cluster_ref> (5)
    namespace: openshift-migration
```

1. Direct image migration is enabled if **false**.
2. Direct volume migration is enabled if **false**.
3. Specify the name of the **MigStorage** CR instance.
4. Specify one or more namespaces to be migrated.
5. Specify the name of the source cluster **MigCluster** instance.

14. Create the **MigPlan** CR:

```
$ oc create -f migplan.yaml -n openshift-migration
```

15. View the **MigPlan** instance to verify that it is in a **Ready** state:

```
$ oc describe migplan <migplan_name> -n openshift-migration
```

16. Create a **MigMigration** CR manifest called **migmigration.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  name: <migmigration_name>
  namespace: openshift-migration
spec:
  migPlanRef:
    name: <migplan_name> (1)
    namespace: openshift-migration
  quiescePods: true (2)
  stage: false (3)
  rollback: false (4)
```

1. Specify the **MigPlan** CR name.
2. The pods on the source cluster are stopped before migration if **true**.
3. A stage migration, which copies most of the data without stopping the application, is performed if **true**.
4. A completed migration is rolled back if **true**.

17. Create the **MigMigration** CR to start the migration defined in the **MigPlan** CR:

```
$ oc create -f migmigration.yaml -n openshift-migration
```

18. Verify the progress of the migration by watching the **MigMigration** CR:

```
$ oc watch migmigration <migmigration_name> -n openshift-migration
```

The output resembles the following:

Example output

```
Name:         c8b034c0-6567-11eb-9a4f-0bc004db0fbc
Namespace:    openshift-migration
Labels:       migration.openshift.io/migplan-name=django
Annotations:  openshift.io/touch: e99f9083-6567-11eb-8420-0a580a81020c
API Version:  migration.openshift.io/v1alpha1
Kind:         MigMigration
...
Spec:
  Mig Plan Ref:
    Name:       my_application
    Namespace:  openshift-migration
  Stage:        false
Status:
  Conditions:
    Category:              Advisory
    Last Transition Time:  2021-02-02T15:04:09Z
    Message:               Step: 19/47
    Reason:                InitialBackupCreated
    Status:                True
    Type:                  Running
    Category:              Required
    Last Transition Time:  2021-02-02T15:03:19Z
    Message:               The migration is ready.
    Status:                True
    Type:                  Ready
    Category:              Required
    Durable:               true
    Last Transition Time:  2021-02-02T15:04:05Z
    Message:               The migration registries are healthy.
    Status:                True
    Type:                  RegistriesHealthy
  Itinerary:               Final
  Observed Digest:
7fae9d21f15979c71ddc7dd075cb97061895caac5b936d92fae967019ab616d5
  Phase:                   InitialBackupCreated
  Pipeline:
    Completed:  2021-02-02T15:04:07Z
    Message:    Completed
    Name:       Prepare
    Started:    2021-02-02T15:03:18Z
    Message:    Waiting for initial Velero backup to complete.
    Name:       Backup
    Phase:      InitialBackupCreated
    Progress:
      Backup openshift-migration/c8b034c0-6567-11eb-9a4f-0bc004db0fbc-wpc44: 0 out of
```

```
estimated total of 0 objects backed up (5s)
    Started:       2021-02-02T15:04:07Z
    Message:       Not started
    Name:          StageBackup
    Message:       Not started
    Name:          StageRestore
    Message:       Not started
    Name:          DirectImage
    Message:       Not started
    Name:          DirectVolume
    Message:       Not started
    Name:          Restore
    Message:       Not started
    Name:          Cleanup
  Start Timestamp:  2021-02-02T15:03:18Z
Events:
  Type    Reason   Age                From                    Message
  ----    ------   ----               ----                    -------
  Normal  Running  57s                migmigration_controller  Step: 2/47
  Normal  Running  57s                migmigration_controller  Step: 3/47
  Normal  Running  57s (x3 over 57s)   migmigration_controller  Step: 4/47
  Normal  Running  54s                migmigration_controller  Step: 5/47
  Normal  Running  54s                migmigration_controller  Step: 6/47
  Normal  Running  52s (x2 over 53s)   migmigration_controller  Step: 7/47
  Normal  Running  51s (x2 over 51s)   migmigration_controller  Step: 8/47
  Normal  Ready    50s (x12 over 57s)  migmigration_controller  The migration is ready.
  Normal  Running  50s                migmigration_controller  Step: 9/47
  Normal  Running  50s                migmigration_controller  Step: 10/47
```

1.6.3.2. MTC custom resource manifests

Migration Toolkit for Containers (MTC) uses the following custom resource (CR) manifests to create CRs for migrating applications.

1.6.3.2.1. DirectImageMigration

The **DirectImageMigration** CR copies images directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectImageMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: <directimagemigration_name>
spec:
  srcMigClusterRef:
    name: <source_cluster_ref> 1
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster_ref> 2
    namespace: openshift-migration
  namespaces:
  - <namespace> 3
```

1. Specify the **MigCluster** CR name of the source cluster.
2. Specify the **MigCluster** CR name of the destination cluster.
3. Specify one or more namespaces containing images to be migrated.

1.6.3.2.2. DirectImageStreamMigration

The **DirectImageStreamMigration** CR copies image stream references directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectImageStreamMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: directimagestreammigration_name
spec:
  srcMigClusterRef:
    name: <source_cluster_ref> 1
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster_ref> 2
    namespace: openshift-migration
  imageStreamRef:
    name: <image_stream_name> 3
    namespace: <source_image_stream_namespace> 4
  destNamespace: <destination_image_stream_namespace> 5
```

1. Specify the **MigCluster** CR name of the source cluster.
2. Specify the **MigCluster** CR name of the destination cluster.
3. Specify the image stream name.
4. Specify the image stream namespace on the source cluster.
5. Specify the image stream namespace on the destination cluster.

1.6.3.2.3. DirectVolumeMigration

The **DirectVolumeMigration** CR copies persistent volumes (PVs) directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectVolumeMigration
metadata:
  name: <directvolumemigration_name>
  namespace: openshift-migration
spec:
  createDestinationNamespaces: false 1
  deleteProgressReportingCRs: false 2
  destMigClusterRef:
```

```
    name: host 3
    namespace: openshift-migration
  persistentVolumeClaims:
  - name: <pvc_name> 4
    namespace: <pvc_namespace> 5
  srcMigClusterRef:
    name: <source_cluster_ref> 6
    namespace: openshift-migration
```

1. Namespaces are created for the PVs on the destination cluster if **true**.
2. The **DirectVolumeMigrationProgress** CRs are deleted after migration if **true**. The default value is **false** so that **DirectVolumeMigrationProgress** CRs are retained for troubleshooting.
3. Update the cluster name if the destination cluster is not the host cluster.
4. Specify one or more PVCs to be migrated with direct volume migration.
5. Specify the namespace of each PVC.
6. Specify the **MigCluster** CR name of the source cluster.

1.6.3.2.4. DirectVolumeMigrationProgress

The **DirectVolumeMigrationProgress** CR shows the progress of the **DirectVolumeMigration** CR.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectVolumeMigrationProgress
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: directvolumemigrationprogress_name
spec:
  clusterRef:
    name: source_cluster
    namespace: openshift-migration
  podRef:
    name: rsync_pod
    namespace: openshift-migration
```

1.6.3.2.5. MigAnalytic

The **MigAnalytic** CR collects the number of images, Kubernetes resources, and the PV capacity from an associated **MigPlan** CR.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigAnalytic
metadata:
  annotations:
    migplan: <migplan_name> 1
  name: miganalytic_name
  namespace: openshift-migration
  labels:
```

```
    migplan: <migplan_name> 2
spec:
  analyzeImageCount: true 3
  analyzeK8SResources: true 4
  analyzePVCapacity: true 5
  listImages: false 6
  listImagesLimit: 50 7
  migPlanRef:
    name: migplan_name 8
    namespace: openshift-migration
```

1. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.
2. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.
3. Optional: The number of images is returned if **true**.
4. Optional: Returns the number, kind, and API version of the Kubernetes resources if **true**.
5. Optional: Returns the PV capacity if **true**.
6. Returns a list of image names if **true**. Default is **false** so that the output is not excessively long.
7. Optional: Specify the maximum number of image names to return if **listImages** is **true**.
8. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.

1.6.3.2.6. MigCluster

The **MigCluster** CR defines a host, local, or remote cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: host 1
  namespace: openshift-migration
spec:
  isHostCluster: true 2
  azureResourceGroup: <azure_resource_group> 3
  caBundle: <ca_bundle_base64> 4
  insecure: false 5
  refresh: false 6
# The 'restartRestic' parameter is relevant for a source cluster.
# restartRestic: true 7
# The following parameters are relevant for a remote cluster.
# isHostCluster: false
# exposedRegistryPath: 8
# url: <destination_cluster_url> 9
# serviceAccountSecretRef:
#   name: <source_secret_ref> 10
#   namespace: openshift-config
```

-

1. Optional: Update the cluster name if the **migration-controller** pod is not running on this cluster.
2. The **migration-controller** pod runs on this cluster if **true**.
3. Optional: If the storage provider is Microsoft Azure, specify the resource group.
4. Optional: If you created a certificate bundle for self-signed CA certificates and if the **insecure** parameter value is **false**, specify the base64-encoded certificate bundle.
5. SSL verification is enabled if **false**.
6. The cluster is validated if **true**.
7. The **restic** pods are restarted on the source cluster after the **stage** pods are created if **true**.
8. Optional: If you are using direct image migration, specify the exposed registry path of a remote cluster.
9. Specify the URL of the remote cluster.
10. Specify the name of the **Secret** CR for the remote cluster.

1.6.3.2.7. MigHook

The **MigHook** CR defines an Ansible playbook or a custom image that runs tasks at a specified stage of the migration.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigHook
metadata:
  generateName: <hook_name_prefix> 1
  name: <hook_name> 2
  namespace: openshift-migration
spec:
  activeDeadlineSeconds: 3
  custom: false 4
  image: <hook_image> 5
  playbook: <ansible_playbook_base64> 6
  targetCluster: source 7
```

1. Optional: A unique hash is appended to the value for this parameter so that each migration hook has a unique name. You do not need to specify the value of the **name** parameter.
2. Specify the migration hook name, unless you specify the value of the **generateName** parameter.
3. Optional: Specify the maximum number of seconds that a hook can run. The default value is **1800**.
4. The hook is a custom image if **true**. The custom image can include Ansible or it can be written in a different programming language.
5. Specify the custom image, for example, **quay.io/konveyor/hook-runner:latest**. Required if **custom** is **true**.

6 Specify the entire base64-encoded Ansible playbook. Required if **custom** is **false**.

7 Specify **source** or **destination** as the cluster on which the hook will run.

1.6.3.2.8. MigMigration

The **MigMigration** CR runs an associated **MigPlan** CR.

You can create multiple **MigMigration** CRs associated with the same **MigPlan** CR for the following scenarios:

- You can run multiple *stage* or incremental migrations to copy data without stopping the pods on the source cluster. Running stage migrations improves the performance of the actual migration.
- You can cancel a migration in progress.
- You can roll back a migration.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migmigration_name
  namespace: openshift-migration
spec:
  canceled: false 1
  rollback: false 2
  stage: false 3
  quiescePods: true 4
  keepAnnotations: true 5
  verify: false 6
  migPlanRef:
    name: <migplan_ref> 7
    namespace: openshift-migration
```

1 A migration in progress is canceled if **true**.

2 A completed migration is rolled back if **true**.

3 Data is copied incrementally and the pods on the source cluster are not stopped if **true**.

4 The pods on the source cluster are scaled to **0** after the **Backup** stage of a migration if **true**.

5 The labels and annotations applied during the migration are retained if **true**.

6 The status of the migrated pods on the destination cluster are checked and the names of pods that are not in a **Running** state are returned if **true**.

7 **migPlanRef.name**: Specify the name of the associated **MigPlan** CR.

1.6.3.2.9. MigPlan

The **MigPlan** CR defines the parameters of a migration plan. It contains a group of virtual machines that are being migrated with the same parameters.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigPlan
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migplan_name
  namespace: openshift-migration
spec:
  closed: false (1)
  srcMigClusterRef:
    name: <source_migcluster_ref> (2)
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_migcluster_ref> (3)
    namespace: openshift-migration
  hooks: (4)
    - executionNamespace: <namespace> (5)
      phase: <migration_phase> (6)
      reference:
        name: <mighook_name> (7)
        namespace: <hook_namespace> (8)
      serviceAccount: <service_account> (9)
  indirectImageMigration: true (10)
  indirectVolumeMigration: false (11)
  migStorageRef:
    name: <migstorage_name> (12)
    namespace: openshift-migration
  namespaces:
  - <namespace> (13)
  refresh: false (14)
```

1. The migration has completed if **true**. You cannot create another **MigMigration** CR for this **MigPlan** CR.
2. Specify the name of the source cluster **MigCluster** CR.
3. Specify the name of the destination cluster **MigCluster** CR.
4. Optional: You can specify up to four migration hooks.
5. Optional: Specify the namespace in which the hook will run.
6. Optional: Specify the migration phase during which a hook runs. One hook can be assigned to one phase. The expected values are **PreBackup**, **PostBackup**, **PreRestore**, and **PostRestore**.
7. Optional: Specify the name of the **MigHook** CR.
8. Optional: Specify the namespace of **MigHook** CR.
9. Optional: Specify a service account with **cluster-admin** privileges.

10 Direct image migration is disabled if **true**. Images are copied from the source cluster to the replication repository and from the replication repository to the destination cluster.

11 Direct volume migration is disabled if **true**. PVs are copied from the source cluster to the replication repository and from the replication repository to the destination cluster.

12 Specify the name of **MigStorage** CR.

13 Specify one or more namespaces.

14 The **MigPlan** CR is validated if **true**.

1.6.3.2.10. MigStorage

The **MigStorage** CR describes the object storage for the replication repository. You can configure Amazon Web Services, Microsoft Azure, Google Cloud Storage, and generic S3-compatible cloud storage, for example, Minio or NooBaa.

Different providers require different parameters.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigStorage
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migstorage_name
  namespace: openshift-migration
spec:
  backupStorageProvider: <storage_provider> 1
  volumeSnapshotProvider: 2
  backupStorageConfig:
    awsBucketName: 3
    awsRegion: 4
    credsSecretRef:
      namespace: openshift-config
      name: <storage_secret> 5
    awsKmsKeyId: 6
    awsPublicUrl: 7
    awsSignatureVersion: 8
  volumeSnapshotConfig:
    awsRegion: 9
    credsSecretRef:
      namespace: openshift-config
      name: 10
  refresh: false 11
```

1 Specify the storage provider.

2 Optional: If you are using the snapshot copy method, specify the storage provider.

3 If you are using AWS, specify the bucket name.

4 If you are using AWS, specify the bucket region, for example, **us-east-1**.

5. Specify the name of the **Secret** CR that you created for the **MigStorage** CR.
6. Optional: If you are using the AWS Key Management Service, specify the unique identifier of the key.
7. Optional: If you granted public access to the AWS bucket, specify the bucket URL.
8. Optional: Specify the AWS signature version for authenticating requests to the bucket, for example, **4**.
9. Optional: If you are using the snapshot copy method, specify the geographical region of the clusters.
10. Optional: If you are using the snapshot copy method, specify the name of the **Secret** CR that you created for the **MigStorage** CR.
11. The cluster is validated if **true**.

1.6.4. Additional resources

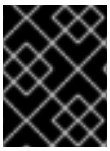
- Exposing a secure registry manually on an OpenShift Container Platform 4 cluster
- MTC file system copy method
- MTC snapshot copy method
- Viewing migration custom resources

1.6.5. Configuring a migration plan

You can increase the number of objects to be migrated or exclude resources from the migration.

1.6.5.1. Increasing limits for large migrations

You can increase the limits on migration objects and container resources for large migrations with the Migration Toolkit for Containers (MTC).



IMPORTANT

You must test these changes before you perform a migration in a production environment.

Procedure

1. Edit the **MigrationController** custom resource (CR) manifest:

```
$ oc edit migrationcontroller -n openshift-migration
```

2. Update the following parameters:

```
...
mig_controller_limits_cpu: "1" 1
mig_controller_limits_memory: "10Gi" 2
```

```
...
mig_controller_requests_cpu: "100m" 3
mig_controller_requests_memory: "350Mi" 4
...
mig_pv_limit: 100 5
mig_pod_limit: 100 6
mig_namespace_limit: 10 7
...
```

1. Specifies the number of CPUs available to the **MigrationController** CR.
2. Specifies the amount of memory available to the **MigrationController** CR.
3. Specifies the number of CPU units available for **MigrationController** CR requests. **100m** represents 0.1 CPU units (100 * 1e-3).
4. Specifies the amount of memory available for **MigrationController** CR requests.
5. Specifies the number of persistent volumes that can be migrated.
6. Specifies the number of pods that can be migrated.
7. Specifies the number of namespaces that can be migrated.

3. Create a migration plan that uses the updated parameters to verify the changes.
   If your migration plan exceeds the **MigrationController** CR limits, the MTC console displays a warning message when you save the migration plan.

1.6.5.2. Excluding resources from a migration plan

You can exclude resources, for example, image streams, persistent volumes (PVs), or subscriptions, from a Migration Toolkit for Containers (MTC) migration plan to reduce the resource load for migration or to migrate images or PVs with a different tool.

By default, the MTC excludes service catalog resources and Operator Lifecycle Manager (OLM) resources from migration. These resources are parts of the service catalog API group and the OLM API group, neither of which is supported for migration at this time.

Procedure

1. Edit the **MigrationController** custom resource manifest:

```
$ oc edit migrationcontroller <migration_controller> -n openshift-migration
```

2. Update the **spec** section by adding a parameter to exclude specific resources or by adding a resource to the **excluded_resources** parameter if it does not have its own exclusion parameter:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigrationController
metadata:
  name: migration-controller
  namespace: openshift-migration
spec:
  disable_image_migration: true 1
```

```
disable_pv_migration: true (2)
...
excluded_resources: (3)
- imagetags
- templateinstances
- clusterserviceversions
- packagemanifests
- subscriptions
- servicebrokers
- servicebindings
- serviceclasses
- serviceinstances
- serviceplans
- operatorgroups
- events
```

1. Add **disable_image_migration: true** to exclude image streams from the migration. Do not edit the **excluded_resources** parameter. **imagestreams** is added to **excluded_resources** when the **MigrationController** pod restarts.
2. Add **disable_pv_migration: true** to exclude PVs from the migration plan. Do not edit the **excluded_resources** parameter. **persistentvolumes** and **persistentvolumeclaims** are added to **excluded_resources** when the **MigrationController** pod restarts. Disabling PV migration also disables PV discovery when you create the migration plan.
3. You can add OpenShift Container Platform resources to the **excluded_resources** list. Do not delete the default excluded resources. These resources are problematic to migrate and must be excluded.

3. Wait two minutes for the **MigrationController** pod to restart so that the changes are applied.
4. Verify that the resource is excluded:

```
$ oc get deployment -n openshift-migration migration-controller -o yaml | grep
EXCLUDED_RESOURCES -A1
```

The output contains the excluded resources:

Example output

```
- name: EXCLUDED_RESOURCES
  value:

imagetags,templateinstances,clusterserviceversions,packagemanifests,subscriptions,servicebro
ers,servicebindings,serviceclasses,serviceinstances,serviceplans,imagestreams,persistentvolun
es,persistentvolumeclaims
```

1.7. TROUBLESHOOTING

You can view the Migration Toolkit for Containers (MTC) custom resources and download logs to troubleshoot a failed migration.

If the application was stopped during the failed migration, you must roll it back manually to prevent data corruption.

NOTE

Manual rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

1.7.1. Viewing MTC custom resources

You can view the following Migration Toolkit for Containers (MTC) custom resources (CRs) to troubleshoot a failed migration:

- **MigCluster**
- **MigStorage**
- **MigPlan**
- **BackupStorageLocation**
  The **BackupStorageLocation** CR contains a **migrationcontroller** label to identify the MTC instance that created the CR:

```
labels:
  migrationcontroller: ebe13bee-c803-47d0-a9e9-83f380328b93
```

- **VolumeSnapshotLocation**
  The **VolumeSnapshotLocation** CR contains a **migrationcontroller** label to identify the MTC instance that created the CR:

```
labels:
  migrationcontroller: ebe13bee-c803-47d0-a9e9-83f380328b93
```

- **MigMigration**
- **Backup**
  MTC changes the reclaim policy of migrated persistent volumes (PVs) to **Retain** on the target cluster. The **Backup** CR contains an **openshift.io/orig-reclaim-policy** annotation that indicates the original reclaim policy. You can manually restore the reclaim policy of the migrated PVs.
- **Restore**

Procedure

1. List the **MigMigration** CRs in the **openshift-migration** namespace:

```
$ oc get migmigration -n openshift-migration
```

Example output

```
NAME                                   AGE
88435fe0-c9f8-11e9-85e6-5d593ce65e10   6m42s
```

2. Inspect the **MigMigration** CR:

```
$ oc describe migmigration 88435fe0-c9f8-11e9-85e6-5d593ce65e10 -n openshift-migration
```

The output is similar to the following examples.

MigMigration example output

```
name:         88435fe0-c9f8-11e9-85e6-5d593ce65e10
namespace:    openshift-migration
labels:       <none>
annotations:  touch: 3b48b543-b53e-4e44-9d34-33563f0f8147
apiVersion:  migration.openshift.io/v1alpha1
kind:         MigMigration
metadata:
  creationTimestamp:  2019-08-29T01:01:29Z
  generation:         20
  resourceVersion:    88179
  selfLink:           /apis/migration.openshift.io/v1alpha1/namespaces/openshift-
migration/migmigrations/88435fe0-c9f8-11e9-85e6-5d593ce65e10
  uid:                8886de4c-c9f8-11e9-95ad-0205fe66cbb6
spec:
  migPlanRef:
    name:         socks-shop-mig-plan
    namespace:    openshift-migration
  quiescePods:  true
  stage:        false
status:
  conditions:
    category:              Advisory
    durable:               True
    lastTransitionTime:  2019-08-29T01:03:40Z
    message:               The migration has completed successfully.
    reason:                Completed
    status:                True
    type:                  Succeeded
  phase:                   Completed
  startTimestamp:          2019-08-29T01:01:29Z
events:                    <none>
```

Velero backup CR #2 example output that describes the PV data

```
apiVersion: velero.io/v1
kind: Backup
metadata:
  annotations:
    openshift.io/migrate-copy-phase: final
    openshift.io/migrate-quiesce-pods: "true"
    openshift.io/migration-registry: 172.30.105.179:5000
    openshift.io/migration-registry-dir: /socks-shop-mig-plan-registry-44dd3bd5-c9f8-11e9-95ad-
0205fe66cbb6
    openshift.io/orig-reclaim-policy: delete
  creationTimestamp: "2019-08-29T01:03:15Z"
  generateName: 88435fe0-c9f8-11e9-85e6-5d593ce65e10-
  generation: 1
  labels:
    app.kubernetes.io/part-of: migration
```

```
    migmigration: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
    migration-stage-backup: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
    velero.io/storage-location: myrepo-vpzq9
  name: 88435fe0-c9f8-11e9-85e6-5d593ce65e10-59gb7
  namespace: openshift-migration
  resourceVersion: "87313"
  selfLink: /apis/velero.io/v1/namespaces/openshift-migration/backups/88435fe0-c9f8-11e9-85e6-
5d593ce65e10-59gb7
  uid: c80dbbc0-c9f8-11e9-95ad-0205fe66cbb6
spec:
  excludedNamespaces: []
  excludedResources: []
  hooks:
    resources: []
  includeClusterResources: null
  includedNamespaces:
  - sock-shop
  includedResources:
  - persistentvolumes
  - persistentvolumeclaims
  - namespaces
  - imagestreams
  - imagestreamtags
  - secrets
  - configmaps
  - pods
  labelSelector:
    matchLabels:
      migration-included-stage-backup: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
  storageLocation: myrepo-vpzq9
  ttl: 720h0m0s
  volumeSnapshotLocations:
  - myrepo-wv6fx
status:
  completionTimestamp: "2019-08-29T01:02:36Z"
  errors: 0
  expiration: "2019-09-28T01:02:35Z"
  phase: Completed
  startTimestamp: "2019-08-29T01:02:35Z"
  validationErrors: null
  version: 1
  volumeSnapshotsAttempted: 0
  volumeSnapshotsCompleted: 0
  warnings: 0
```

Velero restore CR #2 example output that describes the Kubernetes resources

```
apiVersion: velero.io/v1
kind: Restore
metadata:
  annotations:
    openshift.io/migrate-copy-phase: final
    openshift.io/migrate-quiesce-pods: "true"
    openshift.io/migration-registry: 172.30.90.187:5000
    openshift.io/migration-registry-dir: /socks-shop-mig-plan-registry-36f54ca7-c925-11e9-825a-
```

```
06fa9fb68c88
  creationTimestamp: "2019-08-28T00:09:49Z"
  generateName: e13a1b60-c927-11e9-9555-d129df7f3b96-
  generation: 3
  labels:
    app.kubernetes.io/part-of: migration
    migmigration: e18252c9-c927-11e9-825a-06fa9fb68c88
    migration-final-restore: e18252c9-c927-11e9-825a-06fa9fb68c88
  name: e13a1b60-c927-11e9-9555-d129df7f3b96-gb8nx
  namespace: openshift-migration
  resourceVersion: "82329"
  selfLink: /apis/velero.io/v1/namespaces/openshift-migration/restores/e13a1b60-c927-11e9-9555-
d129df7f3b96-gb8nx
  uid: 26983ec0-c928-11e9-825a-06fa9fb68c88
spec:
  backupName: e13a1b60-c927-11e9-9555-d129df7f3b96-sz24f
  excludedNamespaces: null
  excludedResources:
  - nodes
  - events
  - events.events.k8s.io
  - backups.velero.io
  - restores.velero.io
  - resticrepositories.velero.io
  includedNamespaces: null
  includedResources: null
  namespaceMapping: null
  restorePVs: true
status:
  errors: 0
  failureReason: ""
  phase: Completed
  validationErrors: null
  warnings: 15
```

1.7.2. Using the migration log reader

You can use the migration log reader to display a single filtered view of all the migration logs.

Procedure

1. Get the **mig-log-reader** pod:

```
$ oc -n openshift-migration get pods | grep log
```

2. Enter the following command to display a single migration log:

```
$ oc -n openshift-migration logs -f <mig-log-reader-pod> -c color
```
(1)

(1) The **-c plain** option displays the log without colors.

1.7.3. Downloading migration logs

You can download the **Velero**, **Restic**, and **MigrationController** pod logs in the Migration Toolkit for Containers (MTC) web console to troubleshoot a failed migration.

Procedure

1. In the MTC console, click **Migration plans** to view the list of migration plans.
2. Click the **Options** menu  of a specific migration plan and select **Logs**.
3. Click **Download Logs** to download the logs of the **MigrationController**, **Velero**, and **Restic** pods for all clusters.
   You can download a single log by selecting the cluster, log source, and pod source, and then clicking **Download Selected**.

   You can access a pod log from the CLI by using the **oc logs** command:

   ```
   $ oc logs <pod-name> -f -n openshift-migration 1
   ```

   1 Specify the pod name.

1.7.4. Updating deprecated APIs

If your source cluster uses deprecated APIs, the following warning message is displayed when you create a migration plan in the Migration Toolkit for Containers (MTC) web console:

```
Some namespaces contain GVKs incompatible with destination cluster
```

You can click **See details** to view the namespace and the incompatible APIs. This warning message does not block the migration.

During migration with the Migration Toolkit for Containers (MTC), the deprecated APIs are saved in the **Velero** Backup #1 for Kubernetes objects. You can download the **Velero** Backup, extract the deprecated API **yaml** files, and update them with the **oc convert** command. Then you can create the updated APIs on the target cluster.

Procedure

1. Run the migration plan.
2. View the **MigPlan** custom resource (CR):

   ```
   $ oc describe migplan <migplan_name> -n openshift-migration 1
   ```

   1 Specify the name of the **MigPlan** CR.

   The output is similar to the following:

   ```
   metadata:
     ...
     uid: 79509e05-61d6-11e9-bc55-02ce4781844a 1
   ```

```
status:
  ...
  conditions:
  - category: Warn
    lastTransitionTime: 2020-04-30T17:16:23Z
    message: 'Some namespaces contain GVKs incompatible with destination cluster.
      See: `incompatibleNamespaces` for details'
    status: "True"
    type: GVKsIncompatible
  incompatibleNamespaces:
  - gvks: (2)
    - group: batch
      kind: cronjobs
      version: v2alpha1
    - group: batch
      kind: scheduledjobs
      version: v2alpha1
```

(1) Record the **MigPlan** CR UID.

(2) Record the deprecated APIs listed in the **gvks** section.

3. Get the **MigMigration** name associated with the **MigPlan** UID:

```
$ oc get migmigration -o json | jq -r '.items[] | select(.metadata.ownerReferences[].uid=="
<migplan_uid>") | .metadata.name' (1)
```

(1) Specify the **MigPlan** CR UID.

4. Get the **MigMigration** UID associated with the **MigMigration** name:

```
$ oc get migmigration <migmigration_name> -o jsonpath='{.metadata.uid}' (1)
```

(1) Specify the **MigMigration** name.

5. Get the **Velero** Backup name associated with the **MigMigration** UID:

```
$ oc get backup.velero.io --selector migration-initial-backup="<migmigration_uid>" -o
jsonpath={.items[*].metadata.name} (1)
```

(1) Specify the **MigMigration** UID.

6. Download the contents of the **Velero** Backup to your local machine by running the command for your storage provider:

   - AWS S3:

```
$ aws s3 cp s3://<bucket_name>/velero/backups/<backup_name> <backup_local_dir> --
recursive (1)
```

(1) Specify the bucket, backup name, and your local backup directory name.

- GCP:

```
$ gsutil cp gs://<bucket_name>/velero/backups/<backup_name> <backup_local_dir> --recursive 1
```

1 Specify the bucket, backup name, and your local backup directory name.

- Azure:

```
$ azcopy copy 'https://velerobackups.blob.core.windows.net/velero/backups/<backup_name>' '<backup_local_dir>' --recursive 1
```

1 Specify the backup name and your local backup directory name.

7. Extract the **Velero** Backup archive file:

```
$ tar -xfv <backup_local_dir>/<backup_name>.tar.gz -C <backup_local_dir>
```

8. Run **oc convert** in offline mode on each deprecated API:

```
$ oc convert -f <backup_local_dir>/resources/<gvk>.json
```

9. Create the converted API on the target cluster:

```
$ oc create -f <gvk>.json
```

1.7.5. Error messages and resolutions

This section describes common error messages you might encounter with the Migration Toolkit for Containers (MTC) and how to resolve their underlying causes.

1.7.5.1. CA certificate error in the MTC console

If a **CA certificate error** message is displayed the first time you try to access the MTC console, the likely cause is the use of self-signed CA certificates in one of the clusters.

To resolve this issue, navigate to the **oauth-authorization-server** URL displayed in the error message and accept the certificate. To resolve this issue permanently, add the certificate to the trust store of your web browser.

If an **Unauthorized** message is displayed after you have accepted the certificate, navigate to the MTC console and refresh the web page.

1.7.5.2. OAuth timeout error in the MTC console

If a **connection has timed out** message is displayed in the MTC console after you have accepted a self-signed certificate, the causes are likely to be the following:

- Interrupted network access to the OAuth server
- Interrupted network access to the OpenShift Container Platform console

- Proxy configuration that blocks access to the **oauth-authorization-server** URL. See MTC console inaccessible because of OAuth timeout error for details.

You can determine the cause of the timeout.

Procedure

1. Navigate to the MTC console and inspect the elements with the browser web inspector.
2. Check the **MigrationUI** pod log:

```
$ oc logs <MigrationUI_Pod> -n openshift-migration
```

1.7.5.3. PodVolumeBackups timeout error in Velero pod log

If a migration fails because Restic times out, the following error is displayed in the **Velero** pod log.

Example output

```
level=error msg="Error backing up item" backup=velero/monitoring error="timed out waiting for all
PodVolumeBackups to complete"
error.file="/go/src/github.com/heptio/velero/pkg/restic/backupper.go:165"
error.function="github.com/heptio/velero/pkg/restic.(*backupper).BackupPodVolumes" group=v1
```

The default value of **restic_timeout** is one hour. You can increase this parameter for large migrations, keeping in mind that a higher value may delay the return of error messages.

Procedure

1. In the OpenShift Container Platform web console, navigate to **Operators → Installed Operators**.
2. Click **Migration Toolkit for Containers Operator**.
3. In the **MigrationController** tab, click **migration-controller**.
4. In the **YAML** tab, update the following parameter value:

```
spec:
  restic_timeout: 1h (1)
```

(1) Valid units are **h** (hours), **m** (minutes), and **s** (seconds), for example, **3h30m15s**.

5. Click **Save**.

1.7.5.4. ResticVerifyErrors in the MigMigration custom resource

If data verification fails when migrating a persistent volume with the file system data copy method, the following error is displayed in the **MigMigration** CR.

Example output

```
status:
```

```
  conditions:
  - category: Warn
    durable: true
    lastTransitionTime: 2020-04-16T20:35:16Z
    message: There were verify errors found in 1 Restic volume restores. See restore `<registry-
example-migration-rvwcm>`
      for details 1
    status: "True"
    type: ResticVerifyErrors 2
```

1. The error message identifies the **Restore** CR name.
2. **ResticVerifyErrors** is a general error warning type that includes verification errors.

NOTE

A data verification error does not cause the migration process to fail.

You can check the **Restore** CR to identify the source of the data verification error.

Procedure

1. Log in to the target cluster.
2. View the **Restore** CR:

```
$ oc describe <registry-example-migration-rvwcm> -n openshift-migration
```

The output identifies the persistent volume with **PodVolumeRestore** errors.

Example output

```
status:
  phase: Completed
  podVolumeRestoreErrors:
  - kind: PodVolumeRestore
    name: <registry-example-migration-rvwcm-98t49>
    namespace: openshift-migration
  podVolumeRestoreResticErrors:
  - kind: PodVolumeRestore
    name: <registry-example-migration-rvwcm-98t49>
    namespace: openshift-migration
```

3. View the **PodVolumeRestore** CR:

```
$ oc describe <migration-example-rvwcm-98t49>
```

The output identifies the **Restic** pod that logged the errors.

Example output

```
completionTimestamp: 2020-05-01T20:49:12Z
```

```
errors: 1
resticErrors: 1
...
resticPod: <restic-nr2v5>
```

4. View the **Restic** pod log to locate the errors:

```
$ oc logs -f <restic-nr2v5>
```

1.7.6. Direct volume migration does not complete

If direct volume migration does not complete, the target cluster might not have the same **node-selector** annotations as the source cluster.

Migration Toolkit for Containers (MTC) migrates namespaces with all annotations to preserve security context constraints and scheduling requirements. During direct volume migration, MTC creates Rsync transfer pods on the target cluster in the namespaces that were migrated from the source cluster. If a target cluster namespace does not have the same annotations as the source cluster namespace, the Rsync transfer pods cannot be scheduled. The Rsync pods remain in a **Pending** state.

You can identify and fix this issue by performing the following procedure.

Procedure

1. Check the status of the **MigMigration** CR:

```
$ oc describe migmigration <pod_name> -n openshift-migration
```

The output includes the following status message:

Example output

```
...
Some or all transfer pods are not running for more than 10 mins on destination cluster
...
```

2. On the source cluster, obtain the details of a migrated namespace:

```
$ oc get namespace <namespace> -o yaml 1
```

1 Specify the migrated namespace.

3. On the target cluster, edit the migrated namespace:

```
$ oc edit namespace <namespace>
```

4. Add missing **openshift.io/node-selector** annotations to the migrated namespace as in the following example:

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

```
  annotations:
    openshift.io/node-selector: "region=east"
...
```

5. Run the migration plan again.

1.7.7. Using the Velero CLI to debug Backup and Restore CRs

You can debug the **Backup** and **Restore** custom resources (CRs) and partial migration failures with the Velero command line interface (CLI). The Velero CLI runs in the **velero** pod.

1.7.7.1. Velero command syntax

Velero CLI commands use the following syntax:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero <resource> <command> <resource_id>
```

You can specify **velero-<pod> -n openshift-migration** in place of **$(oc get pods -n openshift-migration -o name | grep velero)**.

1.7.7.2. Help command

The Velero **help** command lists all the Velero CLI commands:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero --help
```

1.7.7.3. Describe command

The Velero **describe** command provides a summary of warnings and errors associated with a Velero resource:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero  <resource> describe <resource_id>
```

Example

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero backup describe 0e44ae00-5dc3-11eb-9ca8-df7e5254778b-2d8ql
```

1.7.7.4. Logs command

The Velero **logs** command provides the logs associated with a Velero resource:

```
velero <resource> logs <resource_id>
```

Example

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero restore logs ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
```

1.7.7.5. Debugging a partial migration failure

You can debug a partial migration failure warning message by using the Velero CLI to examine the **Restore** custom resource (CR) logs.

A partial failure occurs when Velero encounters an issue that does not cause a migration to fail. For example, if a custom resource definition (CRD) is missing or if there is a discrepancy between CRD versions on the source and target clusters, the migration completes but the CR is not created on the target cluster.

Velero logs the issue as a partial failure and then processes the rest of the objects in the **Backup** CR.

Procedure

1. Check the status of a **MigMigration** CR:

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

Example output

```
status:
  conditions:
  - category: Warn
    durable: true
    lastTransitionTime: "2021-01-26T20:48:40Z"
    message: 'Final Restore openshift-migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-
x4lbf: partially failed on destination cluster'
    status: "True"
    type: VeleroFinalRestorePartiallyFailed
  - category: Advisory
    durable: true
    lastTransitionTime: "2021-01-26T20:48:42Z"
    message: The migration has completed with warnings, please look at `Warn` conditions.
    reason: Completed
    status: "True"
    type: SucceededWithWarnings
```

2. Check the status of the **Restore** CR by using the Velero **describe** command:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -n openshift-migration -
- ./velero restore describe <restore>
```

Example output

```
Phase:  PartiallyFailed (run 'velero restore logs ccc7c2d0-6017-11eb-afab-85d0007f5a19-
x4lbf' for more information)

Errors:
  Velero:     <none>
  Cluster:    <none>
  Namespaces:
    migration-example:  error restoring example.com/migration-example/migration-example:
the server could not find the requested resource
```

3. Check the **Restore** CR logs by using the Velero **logs** command:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -n openshift-migration -- ./velero restore logs <restore>
```

Example output

```
time="2021-01-26T20:48:37Z" level=info msg="Attempting to restore migration-example: migration-example" logSource="pkg/restore/restore.go:1107" restore=openshift-migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
time="2021-01-26T20:48:37Z" level=info msg="error restoring migration-example: the server could not find the requested resource" logSource="pkg/restore/restore.go:1170" restore=openshift-migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
```

The **Restore** CR log error message, **the server could not find the requested resource**, indicates the cause of the partially failed migration.

1.7.8. Using must-gather to collect data

You must run the **must-gather** tool if you open a customer support case on the Red Hat Customer Portal for the Migration Toolkit for Containers (MTC).

The **openshift-migration-must-gather-rhel8** image for MTC collects migration-specific logs and data that are not collected by the default **must-gather** image.

Procedure

1. Navigate to the directory where you want to store the **must-gather** data.
2. Run the **must-gather** command:

```
$ oc adm must-gather --image=registry.redhat.io/rhmtc/openshift-migration-must-gather-rhel8:v1.4
```

3. Remove authentication keys and other sensitive information.
4. Create an archive file containing the contents of the **must-gather** data directory:

```
$ tar cvaf must-gather.tar.gz must-gather.local.<uid>/
```

5. Upload the compressed file as an attachment to your customer support case.

1.7.9. Rolling back a migration

You can roll back a migration by using the MTC web console or the CLI.

1.7.9.1. Rolling back a migration in the MTC web console

You can roll back a migration by using the Migration Toolkit for Containers (MTC) web console.

If your application was stopped during a failed migration, you must roll back the migration to prevent data corruption in the persistent volume.

Rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

Procedure

1. In the MTC web console, click **Migration plans**.
2. Click the Options menu  beside a migration plan and select **Rollback**.
3. Click **Rollback** and wait for rollback to complete.
   In the migration plan details, **Rollback succeeded** is displayed.
4. Verify that rollback was successful in the OpenShift Container Platform web console of the source cluster:
   a. Click **Home → Projects**.
   b. Click the migrated project to view its status.
   c. In the **Routes** section, click **Location** to verify that the application is functioning, if applicable.
   d. Click **Workloads → Pods** to verify that the pods are running in the migrated namespace.
   e. Click **Storage → Persistent volumes** to verify that the migrated persistent volume is correctly provisioned.

1.7.9.1.1. Rolling back a migration from the CLI

You can roll back a migration by creating a **MigMigration** custom resource (CR) from the CLI.

If your application was stopped during a failed migration, you must roll back the migration to prevent data corruption in the persistent volume.

Rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

Procedure

1. Create a **MigMigration** CR based on the following example:

```
$ cat << EOF | oc apply -f -
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migration-rollback
  namespace: openshift-migration
spec:
...
  rollback: true
...
  migPlanRef:
```

```
    name: <migplan_name> 1
    namespace: openshift-migration
EOF
```

1 Specify the name of the associated **MigPlan** CR.

2. In the MTC web console, verify that the migrated project resources have been removed from the target cluster.

3. Verify that the migrated project resources are present in the source cluster and that the application is running.

1.7.10. Known issues

This release has the following known issues:

- During migration, the Migration Toolkit for Containers (MTC) preserves the following namespace annotations:
  - **openshift.io/sa.scc.mcs**
  - **openshift.io/sa.scc.supplemental-groups**
  - **openshift.io/sa.scc.uid-range**
    These annotations preserve the UID range, ensuring that the containers retain their file system permissions on the target cluster. There is a risk that the migrated UIDs could duplicate UIDs within an existing or future namespace on the target cluster. (BZ#1748440)
- If an AWS bucket is added to the MTC web console and then deleted, its status remains **True** because the **MigStorage** CR is not updated. (BZ#1738564)
- Most cluster-scoped resources are not yet handled by MTC. If your applications require cluster-scoped resources, you might have to create them manually on the target cluster.
- If a migration fails, the migration plan does not retain custom PV settings for quiesced pods. You must manually roll back the migration, delete the migration plan, and create a new migration plan with your PV settings. (BZ#1784899)
- If a large migration fails because Restic times out, you can increase the **restic_timeout** parameter value (default: **1h**) in the **MigrationController** CR.
- If you select the data verification option for PVs that are migrated with the file system copy method, performance is significantly slower.

1.7.11. Additional resources

- MTC workflow
- MTC custom resources

CHAPTER 2. MIGRATING FROM OPENSHIFT CONTAINER PLATFORM 4.1

2.1. ABOUT THE MIGRATION TOOLKIT FOR CONTAINERS

You can migrate application workloads from OpenShift Container Platform 4.1 to 4.7 with the Migration Toolkit for Containers (MTC). MTC enables you to control the migration and to minimize application downtime.

NOTE

You can migrate between OpenShift Container Platform clusters of the same version, for example, from 4.1 to 4.1, as long as the source and target clusters are configured correctly.

MTC is installed on the target cluster by default. You can configure the Migration Toolkit for Containers Operator to install the MTC on a remote cluster.

The MTC web console and API, based on Kubernetes custom resources, enable you to migrate stateful and stateless application workloads at the granularity of a namespace.

MTC supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

You can use migration hooks to run Ansible playbooks at certain points during the migration. The hooks are added when you create a migration plan.

2.1.1. Migration Toolkit for Containers workflow

You use the Migration Toolkit for Containers (MTC) to migrate Kubernetes resources, persistent volume data, and internal container images from an OpenShift Container Platform source cluster to an OpenShift Container Platform 4.7 target cluster by using the MTC web console or the Kubernetes API.

The (MTC) migrates the following resources:

- A namespace specified in a migration plan.
- Namespace-scoped resources: When the MTC migrates a namespace, it migrates all the objects and resources associated with that namespace, such as services or pods. Additionally, if a resource that exists in the namespace but not at the cluster level depends on a resource that exists at the cluster level, the MTC migrates both resources.
  For example, a security context constraint (SCC) is a resource that exists at the cluster level and a service account (SA) is a resource that exists at the namespace level. If an SA exists in a namespace that the MTC migrates, the MTC automatically locates any SCCs that are linked to the SA and also migrates those SCCs. Similarly, the MTC migrates persistent volume claims that are linked to the persistent volumes of the namespace.
- Custom resources (CRs) and custom resource definitions (CRDs): The MTC automatically migrates any CRs that exist at the namespace level as well as the CRDs that are linked to those CRs.

Migrating an application with the MTC web console involves the following steps:

1. Install the Migration Toolkit for Containers Operator on all clusters.
   You can install the Migration Toolkit for Containers Operator in a restricted environment with limited or no internet access. The source and target clusters must have network access to each other and to a mirror registry.

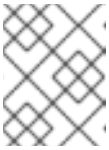
2. Configure the replication repository, an intermediate object storage that MTC uses to migrate data.
   The source and target clusters must have network access to the replication repository during migration. In a restricted environment, you can use an internally hosted S3 storage repository. If you are using a proxy server, you must configure it to allow network traffic between the replication repository and the clusters.

3. Add the source cluster to the MTC web console.

4. Add the replication repository to the MTC web console.

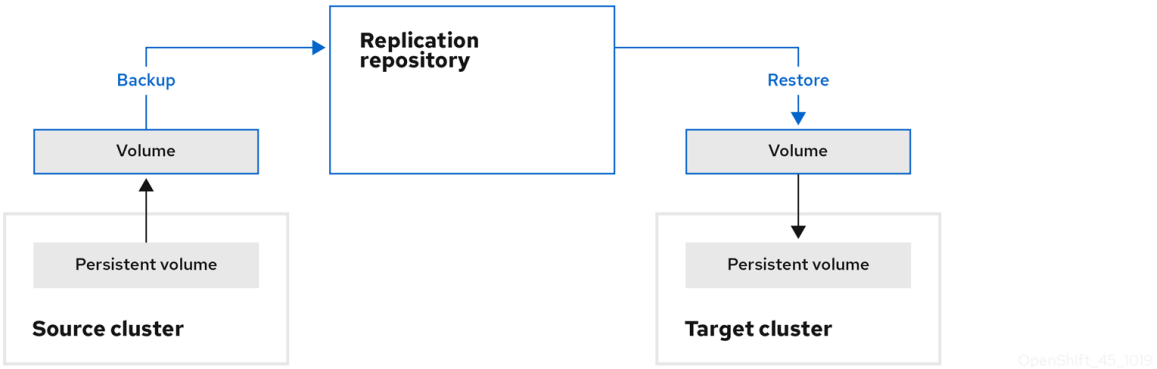
5. Create a migration plan, with one of the following data migration options:

   - **Copy**: MTC copies the data from the source cluster to the replication repository, and from the replication repository to the target cluster.

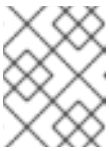


NOTE

If you are using direct image migration or direct volume migration, the images or volumes are copied directly from the source cluster to the target cluster.

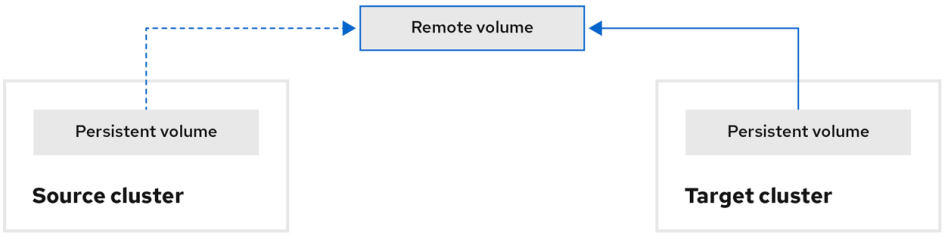


   - **Move**: MTC unmounts a remote volume, for example, NFS, from the source cluster, creates a PV resource on the target cluster pointing to the remote volume, and then mounts the remote volume on the target cluster. Applications running on the target cluster use the same remote volume that the source cluster was using. The remote volume must be accessible to the source and target clusters.



NOTE

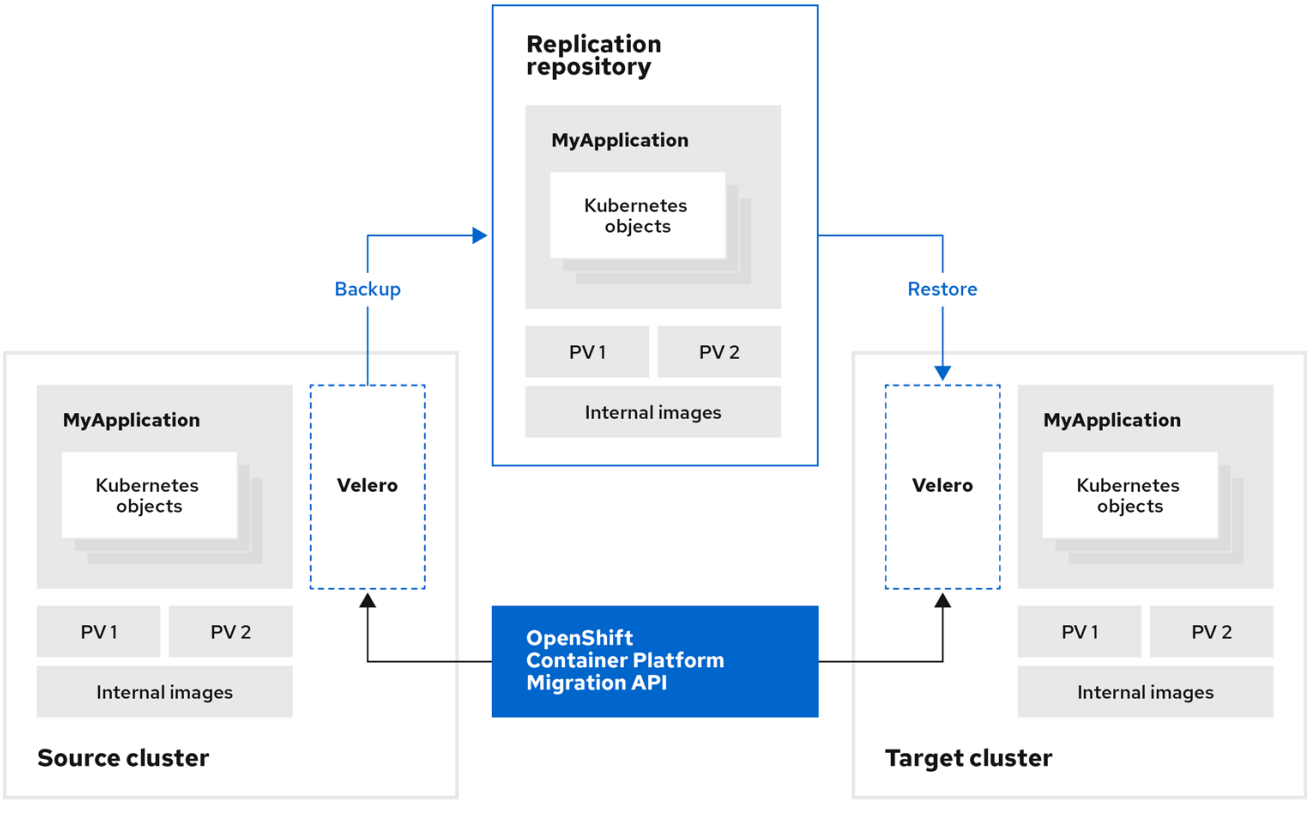
Although the replication repository does not appear in this diagram, it is required for migration.



6. Run the migration plan, with one of the following options:

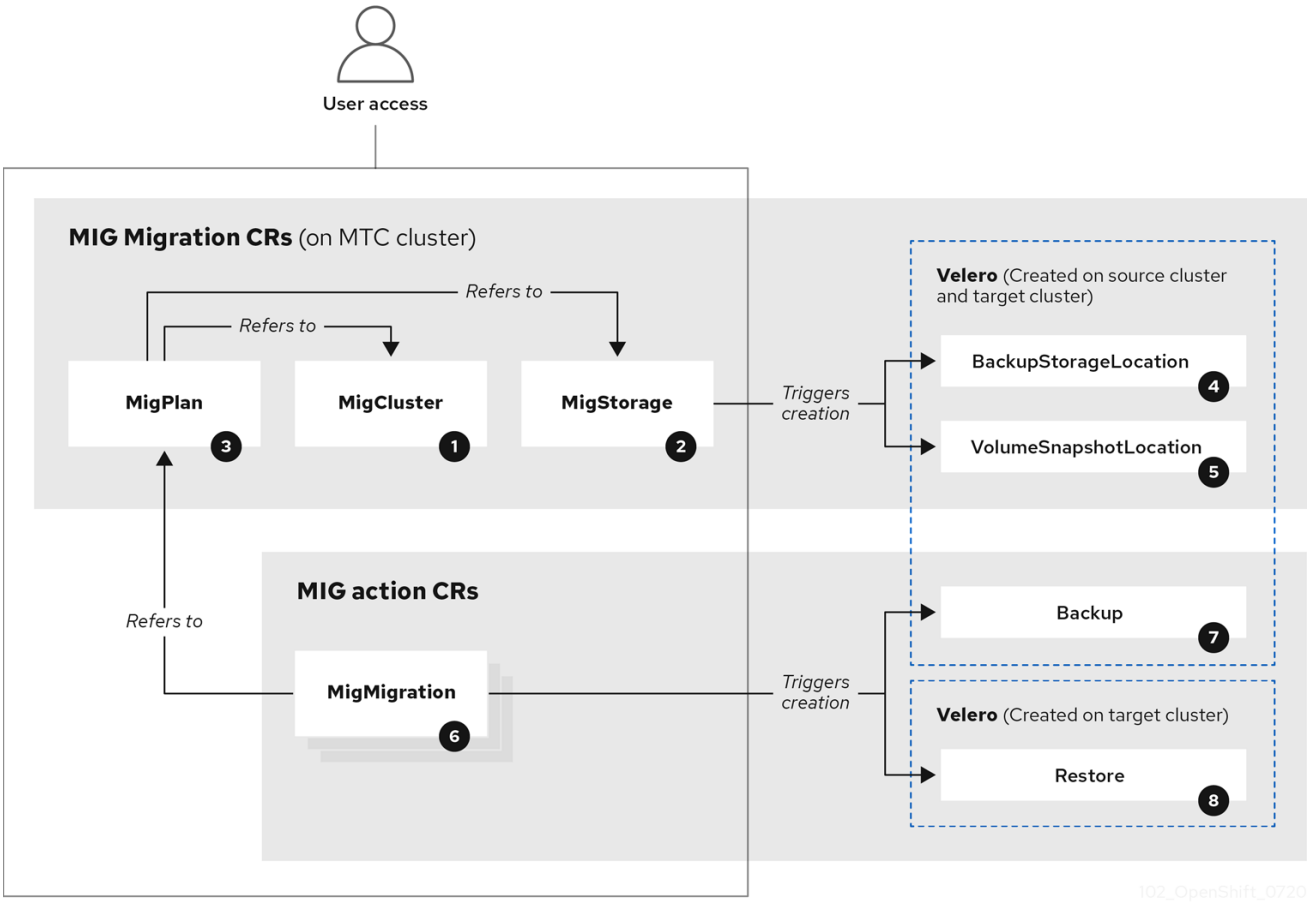
   - **Stage** (optional) copies data to the target cluster without stopping the application. Staging can be run multiple times so that most of the data is copied to the target before migration. This minimizes the duration of the migration and application downtime.

   - **Migrate** stops the application on the source cluster and recreates its resources on the target cluster. Optionally, you can migrate the workload without stopping the application.



2.1.2. Migration Toolkit for Containers custom resources

The Migration Toolkit for Containers (MTC) creates the following custom resources (CRs):

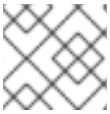


1 MigCluster (configuration, MTC cluster): Cluster definition

2 MigStorage (configuration, MTC cluster): Storage definition

3 MigPlan (configuration, MTC cluster): Migration plan

The **MigPlan** CR describes the source and target clusters, replication repository, and namespaces being migrated. It is associated with 0, 1, or many **MigMigration** CRs.



NOTE

Deleting a **MigPlan** CR deletes the associated **MigMigration** CRs.

4 BackupStorageLocation (configuration, MTC cluster): Location of **Velero** backup objects

5 VolumeSnapshotLocation (configuration, MTC cluster): Location of **Velero** volume snapshots

6 MigMigration (action, MTC cluster): Migration, created every time you stage or migrate data. Each **MigMigration** CR is associated with a **MigPlan** CR.

7 Backup (action, source cluster): When you run a migration plan, the **MigMigration** CR creates two **Velero** backup CRs on each source cluster:

- Backup CR #1 for Kubernetes objects

- Backup CR #2 for PV data

8 Restore (action, target cluster): When you run a migration plan, the **MigMigration** CR creates two **Velero** restore CRs on the target cluster:

- Restore CR #1 (using Backup CR #2) for PV data
- Restore CR #2 (using Backup CR #1) for Kubernetes objects

2.1.3. About data copy methods

The Migration Toolkit for Containers (MTC) supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

2.1.3.1. File system copy method

MTC copies data files from the source cluster to the replication repository, and from there to the target cluster.

Table 2.1. File system copy method summary

Benefits	Limitations
• Clusters can have different storage classes. • Supported for all S3 storage providers. • Optional data verification with checksum. • Supports direct volume migration, which significantly increases performance.	• Slower than the snapshot copy method. • Optional data verification significantly reduces performance.

2.1.3.2. Snapshot copy method

MTC copies a snapshot of the source cluster data to the replication repository of a cloud provider. The data is restored on the target cluster.

AWS, Google Cloud Provider, and Microsoft Azure support the snapshot copy method.

Table 2.2. Snapshot copy method summary

Benefits	Limitations

Benefits	Limitations
• Faster than the file system copy method.	• Cloud provider must support snapshots. • Clusters must be on the same cloud provider. • Clusters must be in the same location or region. • Clusters must have the same storage class. • Storage class must be compatible with snapshots. • Does not support direct volume migration.

2.1.3.3. Direct volume migration and direct image migration

You can use *direct image migration* and *direct volume migration* to migrate images and data directly from the source cluster to the target cluster.

Direct migration has significant performance benefits because it skips the intermediate steps of backing up files from the source cluster to the replication repository and restoring files from the replication repository to the target cluster.

Direct migration uses Rsync to transfer the files.

NOTE

Direct image migration and direct volume migration have additional prerequisites.

2.1.4. About migration hooks

You can use migration hooks to run custom code at certain points during a migration with the Migration Toolkit for Containers (MTC). You can add up to four migration hooks to a single migration plan, with each hook running at a different phase of the migration.

Migration hooks perform tasks such as customizing application quiescence, manually migrating unsupported data types, and updating applications after migration.

A migration hook runs on a source or a target cluster at one of the following migration steps:

- **PreBackup**: Before resources are backed up on the source cluster
- **PostBackup**: After resources are backed up on the source cluster
- **PreRestore**: Before resources are restored on the target cluster
- **PostRestore**: After resources are restored on the target cluster

You can create a hook by using an Ansible playbook or a custom hook container.

Ansible playbook

The Ansible playbook is mounted on a hook container as a config map. The hook container runs as a job, using the cluster, service account, and namespace specified in the **MigPlan** custom resource (CR). The job continues to run until it reaches the the default limit of 6 retries or a successful completion. This continues even if the initial pod is evicted or killed.

The default Ansible runtime image is **registry.redhat.io/rhmtc/openshift-migration-hook-runner-rhel7:1.4**. This image is based on the Ansible Runner image and includes **python-openshift** for Ansible Kubernetes resources and an updated **oc** binary.

Optional: You can use a custom Ansible runtime image containing additional Ansible modules or tools instead of the default image.

Custom hook container

You can create a custom hook container that includes Ansible playbooks or custom code.

2.2. INSTALLING AND UPGRADING THE MIGRATION TOOLKIT FOR CONTAINERS

You can install the Migration Toolkit for Containers on an OpenShift Container Platform 4.7 target cluster and on a 4.1 source cluster.

MTC is installed on the target cluster by default. You can install the MTC on an OpenShift Container Platform 3 cluster or on a remote cluster.

2.2.1. Installing the Migration Toolkit for Containers in a connected environment

You can install the Migration Toolkit for Containers (MTC) in a connected environment.

IMPORTANT

You must install the same MTC version on all clusters.

2.2.1.1. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.7 target cluster

You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4.7 target cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.

NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
7. Click **Create**.
8. Click **Workloads → Pods** to verify that the MTC pods are running.

2.2.1.2. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.1 source cluster

You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4 source cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.

Procedure

1. In the OpenShift Container Platform web console, click **Catalog → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.

NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
7. Update the following parameters in the **migration-controller** custom resource manifest:

```
spec:
...
  migration_controller: false
```

```
  migration_ui: false
...
  deprecated_cors_configuration: true (1)
```

(1) Add the **deprecated_cors_configuration** parameter and its value.

8. Click **Create**.
9. Click **Workloads → Pods** to verify that the MTC pods are running.

2.2.2. Installing the Migration Toolkit for Containers in a restricted environment

You can install the Migration Toolkit for Containers (MTC) in a restricted environment.

IMPORTANT

You must install the same MTC version on all clusters.

You can build a custom Operator catalog image for OpenShift Container Platform 4, push it to a local mirror image registry, and configure Operator Lifecycle Manager (OLM) to install the Migration Toolkit for Containers Operator from the local registry.

2.2.2.1. Disabling the default OperatorHub 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.

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 → Global Configuration → OperatorHub** page, click the **Sources** tab, where you can create, delete, disable, and enable individual sources.

2.2.2.2. Pruning an index image

An index image, based on the Operator Bundle Format, is a containerized snapshot of an Operator catalog. You can 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.

When configuring Operator Lifecycle Manager (OLM) to use mirrored content on restricted network OpenShift Container Platform clusters, use this pruning method if you want to only mirror a subset of Operators from the default catalogs.

For the steps in this procedure, the target registry is an existing mirror registry that is accessible by your workstation with unrestricted network access. This example also shows pruning the index image for the default **redhat-operators** catalog, but the process is the same for any index image.

Prerequisites

- Workstation with unrestricted network access
- **podman** version 1.9.3+
- **grpcurl**
- **opm** version 1.12.3+
- Access to a registry that supports Docker v2-2

Procedure

1. Authenticate with **registry.redhat.io**:

```
$ podman login registry.redhat.io
```

2. Authenticate with your target registry:

```
$ podman login <target_registry>
```

3. 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:v4.7
```

Example output

```
Trying to pull registry.redhat.io/redhat/redhat-operator-index:v4.7...
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.

4. 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:v4.7 \ 1
   -p advanced-cluster-management,jaeger-product,quay-operator \ 2
   [-i registry.redhat.io/openshift4/ose-operator-registry:v4.7] \ 3
   -t <target_registry>:<port>/<namespace>/redhat-operator-index:v4.7 4
```

1. Index to prune.
2. Comma-separated list of packages to keep.
3. Required only for IBM Power Systems and IBM Z images: Operator Registry base image with the tag that matches the target OpenShift Container Platform cluster major and minor version.
4. Custom tag for new index image being built.

5. Run the following command to push the new index image to your target registry:

```
$ podman push <target_registry>:<port>/<namespace>/redhat-operator-index:v4.7
```

where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

2.2.2.3. Mirroring an Operator catalog

You can mirror the Operator content of a Red Hat-provided catalog, or a custom catalog, into a container image registry using the **oc adm catalog mirror** command. The target registry must support Docker v2-2. For a cluster on a restricted network, this registry can be one that the cluster has network access to, such as a mirror registry created during a restricted network cluster installation.

The **oc adm catalog mirror** command also automatically mirrors the index image that is specified during the mirroring process, whether it be a Red Hat-provided index image or your own custom-built index image, to the target registry. You can then use the mirrored index image to create a catalog source that allows Operator Lifecycle Manager (OLM) to load the mirrored catalog onto your OpenShift Container Platform cluster.

Prerequisites

- Workstation with unrestricted network access.
- **podman** version 1.9.3 or later.
- Access to mirror registry that supports Docker v2-2.
- Decide which namespace on your mirror registry you will use to store the mirrored Operator content. For example, you might create an **olm-mirror** namespace.
- If your mirror registry does not have Internet access, connect removable media to your workstation with unrestricted network access.
- If you are working with private registries, set the **REG_CREDS** environment variable to the file path of your registry credentials for use in later steps. For example, for the **podman** CLI:

```
$ REG_CREDS=${XDG_RUNTIME_DIR}/containers/auth.json
```

Procedure

1. If you want to mirror a Red Hat-provided catalog, run the following command on your workstation with unrestricted network access to authenticate with **registry.redhat.io**:

```
$ podman login registry.redhat.io
```

2. The **oc adm catalog mirror** command extracts the contents of an index image to generate the manifests required for mirroring. The default behavior of the command generates manifests, then automatically mirrors all of the image content from the index image, as well as the index image itself, to your mirror registry. Alternatively, if your mirror registry is on a completely disconnected, or *airgapped*, host, you can first mirror the content to removable media, move the media to the disconnected environment, then mirror the content from the media to the registry.

   - **Option A: If your mirror registry is on the same network** as your workstation with unrestricted network access, take the following actions on your workstation:

     a. If your mirror registry requires authentication, run the following command to log in to the registry:

```
$ podman login <mirror_registry>
```

     b. Run the following command to mirror the content:

```
$ oc adm catalog mirror \
    <index_image> \ 1
    <mirror_registry>:<port>/<namespace> \ 2
    [-a ${REG_CREDS}] \ 3
    [--insecure] \ 4
    [--index-filter-by-os='<platform>/<arch>'] \ 5
    [--manifests-only] 6
```

     1 Specify the index image for the catalog you want to mirror. For example, this might be a pruned index image that you created previously, or one of the source index images for the default catalogs, such as **registry.redhat.io/redhat/redhat-operator-index:v4.7**.

2. Specify the target registry and namespace to mirror the Operator content to, where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

3. Optional: If required, specify the location of your registry credentials file.

4. Optional: If you do not want to configure trust for the target registry, add the **--insecure** flag.

5. Optional: Specify which platform and architecture of the index image to select when multiple variants are available. Images are passed as **'<platform>/<arch>[/<variant>]'**. This does not apply to images referenced by the index. Valid values are **linux/amd64**, **linux/ppc64le**, and **linux/s390x**.

6. Optional: Generate only the manifests required for mirroring, and do not actually mirror the image content to a registry. This option can be useful for reviewing what will be mirrored, and it allows you to make any changes to the mapping list if you require only a subset of packages. You can then use the **mapping.txt** file with the **oc image mirror** command to mirror the modified list of images in a later step. This flag is intended for only advanced selective mirroring of content from the catalog; the **opm index prune** command, if you used it previously to prune the index image, is suitable for most catalog management use cases.

Example output

```
src image has index label for database path: /database/index.db
using database path mapping: /database/index.db:/tmp/153048078
wrote database to /tmp/153048078 1
...
wrote mirroring manifests to manifests-redhat-operator-index-1614211642 2
```

1. Directory for the temporary **index.db** database generated by the command.

2. Record the manifests directory name that is generated. This directory name is used in a later step.

- **Option B: If your mirror registry is on a disconnected host**, take the following actions.

  a. Run the following command on your workstation with unrestricted network access to mirror the content to local files:

```
$ oc adm catalog mirror \
    <index_image> \ 1
    file:///local/index \ 2
    [-a ${REG_CREDS}] \
    [--insecure]
```

1. Specify the index image for the catalog you want to mirror. For example, this might be a pruned index image that you created previously, or one of the source index images for the default catalogs, such as **registry.redhat.io/redhat/redhat-operator-index:v4.7**.

2. Mirrors content to local files in your current directory.

Example output

```
...
info: Mirroring completed in 5.93s (5.915MB/s)
wrote mirroring manifests to manifests-my-index-1614985528 (1)

To upload local images to a registry, run:

 oc adm catalog mirror file://local/index/myrepo/my-index:v1
REGISTRY/REPOSITORY (2)
```

(1) Record the manifests directory name that is generated. This directory name is used in a later step.

(2) Record the expanded **file://** path that based on your provided index image. This path is used in a later step.

b. Copy the **v2/** directory that is generated in your current directory to removable media.

c. Physically remove the media and attach it to a host in the disconnected environment that has access to the mirror registry.

d. If your mirror registry requires authentication, run the following command on your host in the disconnected environment to log in to the registry:

```
$ podman login <mirror_registry>
```

e. Run the following command from the parent directory containing the **v2/** directory to upload the images from local files to the mirror registry:

```
$ oc adm catalog mirror \
    file://local/index/<repo>/<index_image>:<tag> \(1)
    <mirror_registry>:<port>/<namespace> \(2)
    [-a ${REG_CREDS}] \
    [--insecure]
```

(1) Specify the **file://** path from the previous command output.

(2) Specify the target registry and namespace to mirror the Operator content to, where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

3. After mirroring the content to your registry, inspect the manifests directory that is generated in your current directory.

NOTE

The manifests directory name is used in a later step.

If you mirrored content to a registry on the same network in the previous step, the directory name takes the following form:

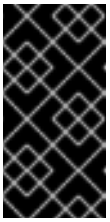
```
manifests-<index_image_name>-<random_number>
```

If you mirrored content to a registry on a disconnected host in the previous step, the directory name takes the following form:

```
manifests-index/<namespace>/<index_image_name>-<random_number>
```

The manifests directory contains the following files, some of which might require further modification:

- The **catalogSource.yaml** file is a basic definition for a **CatalogSource** object that is pre-populated with your index image tag and other relevant metadata. This file can be used as is or modified to add the catalog source to your cluster.



IMPORTANT

If you mirrored the content to local files, you must modify your **catalogSource.yaml** file to remove any backslash (/) characters from the **metadata.name** field. Otherwise, when you attempt to create the object, it fails with an "invalid resource name" error.

- The **imageContentSourcePolicy.yaml** file defines an **ImageContentSourcePolicy** object that can configure nodes to translate between the image references stored in Operator manifests and the mirrored registry.

NOTE

If your cluster uses an **ImageContentSourcePolicy** object to configure repository mirroring, you can use only global pull secrets for mirrored registries. You cannot add a pull secret to a project.

- The **mapping.txt** file contains all of the source images and where to map them in the target registry. This file is compatible with the **oc image mirror** command and can be used to further customize the mirroring configuration.

IMPORTANT

If you used the **--manifests-only** flag during the mirroring process and want to further trim the subset of packages to be mirrored, see the steps in the "Mirroring a Package Manifest Format catalog image" procedure about modifying your **mapping.txt** file and using the file with the **oc image mirror** command. After following those further actions, you can continue this procedure.

4. On a host with access to the disconnected cluster, create the **ImageContentSourcePolicy** object by running the following command to specify the **imageContentSourcePolicy.yaml** file in your manifests directory:

```
$ oc create -f <path/to/manifests/dir>/imageContentSourcePolicy.yaml
```

where **<path/to/manifests/dir>** is the path to the manifests directory for your mirrored content.

You can now create a **CatalogSource** object to reference your mirrored index image and Operator content.

2.2.2.4. Creating a catalog from an index image

You can create an Operator catalog from an index image and apply it to an OpenShift Container Platform cluster for use with Operator Lifecycle Manager (OLM).

Prerequisites

- An index image built and pushed to a registry.

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
spec:
  sourceType: grpc
  image: <registry>:<port>/<namespace>/redhat-operator-index:v4.7 <.>
  displayName: My Operator Catalog
  publisher: <publisher_name> <.>
  updateStrategy:
    registryPoll: <.>
      interval: 30m
```

   <.> Specify your index image. <.> Specify your name or an organization name publishing the catalog. <.> 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.

2.2.2.5. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.7 target cluster in a restricted environment

You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4.7 target cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must create a custom Operator catalog and push it to a mirror registry.
- You must configure Operator Lifecycle Manager to install the Migration Toolkit for Containers Operator from the mirror registry.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.

NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.

7. Click **Create**.
8. Click **Workloads → Pods** to verify that the MTC pods are running.

2.2.2.6. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.1 source cluster in a restricted environment

You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4 source cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must create a custom Operator catalog and push it to a mirror registry.
- You must configure Operator Lifecycle Manager to install the Migration Toolkit for Containers Operator from the mirror registry.

Procedure

1. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
2. Select the **Migration Toolkit for Containers Operator** and click **Install**.

NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

3. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
4. Click **Migration Toolkit for Containers Operator**.
5. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
6. Click **Create**.
7. Click **Workloads → Pods** to verify that the MTC pods are running.

2.2.3. Upgrading the Migration Toolkit for Containers

You can upgrade the Migration Toolkit for Containers (MTC) by using the OpenShift Container Platform web console.

IMPORTANT

You must ensure that the same MTC version is installed on all clusters.

If you are upgrading MTC version 1.3, you must perform an additional procedure to update the **MigPlan** custom resource (CR).

2.2.3.1. Upgrading the Migration Toolkit for Containers on an OpenShift Container Platform 4 cluster

You can upgrade the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4 cluster by using the OpenShift Container Platform web console.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges.

Procedure

1. In the OpenShift Container Platform console, navigate to **Operators → Installed Operators**. Operators that have a pending upgrade display an **Upgrade available** status.
2. Click **Migration Toolkit for Containers Operator**.
3. Click the **Subscription** tab. Any upgrades 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 upgrade and click **Approve**.
6. Navigate back to the **Operators → Installed Operators** page to monitor the progress of the upgrade. When complete, the status changes to **Succeeded** and **Up to date**.
7. Click **Migration Toolkit for Containers Operator**.
8. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
9. If you are upgrading MTC on a *source* cluster, update the following parameters in the **MigrationController** custom resource (CR) manifest:

```
spec:
...
  migration_controller: false
  migration_ui: false
...
  deprecated_cors_configuration: true
```

   You do not need to update the **MigrationController** CR manifest on the target cluster.
10. Click **Create**.
11. Click **Workloads → Pods** to verify that the MTC pods are running.

2.2.3.2. Upgrading MTC 1.3 to 1.4

If you are upgrading Migration Toolkit for Containers (MTC) version 1.3.x to 1.4, you must update the **MigPlan** custom resource (CR) manifest on the cluster on which the **MigrationController** pod is running.

Because the **indirectImageMigration** and **indirectVolumeMigration** parameters do not exist in MTC 1.3, their default value in version 1.4 is **false**, which means that direct image migration and direct volume migration are enabled. Because the direct migration requirements are not fulfilled, the migration plan

cannot reach a **Ready** state unless these parameter values are changed to **true**.

Prerequisites

- You must have MTC 1.3 installed.
- You must be logged in as a user with **cluster-admin** privileges.

Procedure

1. Log in to the cluster on which the **MigrationController** pod is running.
2. Get the **MigPlan** CR manifest:

```
$ oc get migplan <migplan> -o yaml -n openshift-migration
```

3. Update the following parameter values and save the file as **migplan.yaml**:

```
...
spec:
  indirectImageMigration: true
  indirectVolumeMigration: true
```

4. Replace the **MigPlan** CR manifest to apply the changes:

```
$ oc replace -f migplan.yaml -n openshift-migration
```

5. Get the updated **MigPlan** CR manifest to verify the changes:

```
$ oc get migplan <migplan> -o yaml -n openshift-migration
```

2.3. CONFIGURING OBJECT STORAGE FOR A REPLICATION REPOSITORY

You must configure an object storage to use as a replication repository. The Migration Toolkit for Containers (MTC) copies data from the source cluster to the replication repository, and then from the replication repository to the target cluster.

MTC supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

The following storage providers are supported:

- Multi-Cloud Object Gateway (MCG)
- Amazon Web Services (AWS) S3
- Google Cloud Provider (GCP)
- Microsoft Azure
- Generic S3 object storage, for example, Minio or Ceph S3

In a restricted environment, you can create an internally hosted replication repository.

Prerequisites

- All clusters must have uninterrupted network access to the replication repository.
- If you use a proxy server with an internally hosted replication repository, you must ensure that the proxy allows access to the replication repository.

2.3.1. Configuring a Multi-Cloud Object Gateway storage bucket as a replication repository

You can install the OpenShift Container Storage Operator and configure a Multi-Cloud Object Gateway (MCG) storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

2.3.1.1. Installing the OpenShift Container Storage Operator

You can install the OpenShift Container Storage Operator from OperatorHub.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use **Filter by keyword** (in this case, **OCS**) to find the **OpenShift Container Storage Operator**.
3. Select the **OpenShift Container Storage Operator** and click **Install**.
4. Select an **Update Channel**, **Installation Mode**, and **Approval Strategy**.
5. Click **Install**.
   On the **Installed Operators** page, the **OpenShift Container Storage Operator** appears in the **openshift-storage** project with the status **Succeeded**.

2.3.1.2. Creating the Multi-Cloud Object Gateway storage bucket

You can create the Multi-Cloud Object Gateway (MCG) storage bucket's custom resources (CRs).

Procedure

1. Log in to the OpenShift Container Platform cluster:

```
$ oc login -u <username>
```

2. Create the **NooBaa** CR configuration file, **noobaa.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: NooBaa
metadata:
  name: noobaa
  namespace: openshift-storage
spec:
 dbResources:
   requests:
     cpu: 0.5 (1)
```

```
    memory: 1Gi
  coreResources:
    requests:
      cpu: 0.5 (2)
      memory: 1Gi
```

(1) (2) For a very small cluster, you can change the **cpu** value to **0.1**.

3. Create the **NooBaa** object:

```
$ oc create -f noobaa.yml
```

4. Create the **BackingStore** CR configuration file, **bs.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: BackingStore
metadata:
  finalizers:
  - noobaa.io/finalizer
  labels:
    app: noobaa
  name: mcg-pv-pool-bs
  namespace: openshift-storage
spec:
  pvPool:
    numVolumes: 3 (1)
    resources:
      requests:
        storage: 50Gi (2)
    storageClass: gp2 (3)
  type: pv-pool
```

(1) Specify the number of volumes in the persistent volume pool.

(2) Specify the size of the volumes.

(3) Specify the storage class.

5. Create the **BackingStore** object:

```
$ oc create -f bs.yml
```

6. Create the **BucketClass** CR configuration file, **bc.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: BucketClass
metadata:
  labels:
    app: noobaa
  name: mcg-pv-pool-bc
  namespace: openshift-storage
spec:
  placementPolicy:
```

```
    tiers:
    - backingStores:
      - mcg-pv-pool-bs
      placement: Spread
```

7. Create the **BucketClass** object:

```
$ oc create -f bc.yml
```

8. Create the **ObjectBucketClaim** CR configuration file, **obc.yml**, with the following content:

```
apiVersion: objectbucket.io/v1alpha1
kind: ObjectBucketClaim
metadata:
  name: migstorage
  namespace: openshift-storage
spec:
  bucketName: migstorage 1
  storageClassName: openshift-storage.noobaa.io
  additionalConfig:
    bucketclass: mcg-pv-pool-bc
```

1 Record the bucket name for adding the replication repository to the MTC web console.

9. Create the **ObjectBucketClaim** object:

```
$ oc create -f obc.yml
```

10. Watch the resource creation process to verify that the **ObjectBucketClaim** status is **Bound**:

```
$ watch -n 30 'oc get -n openshift-storage objectbucketclaim migstorage -o yaml'
```

This process can take five to ten minutes.

11. Obtain and record the following values, which are required when you add the replication repository to the MTC web console:

- S3 endpoint:

```
$ oc get route -n openshift-storage s3
```

- S3 provider access key:

```
$ oc get secret -n openshift-storage migstorage -o go-template='{{
.data.AWS_ACCESS_KEY_ID }}' | base64 --decode
```

- S3 provider secret access key:

```
$ oc get secret -n openshift-storage migstorage -o go-template='{{
.data.AWS_SECRET_ACCESS_KEY }}' | base64 --decode
```

2.3.2. Configuring an AWS S3 storage bucket as a replication repository

You can configure an AWS S3 storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- The AWS S3 storage bucket must be accessible to the source and target clusters.
- You must have the AWS CLI installed.
- If you are using the snapshot copy method:
  - You must have access to EC2 Elastic Block Storage (EBS).
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Create an AWS S3 bucket:

```
$ aws s3api create-bucket \
    --bucket <bucket_name> \ 1
    --region <bucket_region> 2
```

1 Specify your S3 bucket name.

2 Specify your S3 bucket region, for example, **us-east-1**.

2. Create the IAM user **velero**:

```
$ aws iam create-user --user-name velero
```

3. Create an EC2 EBS snapshot policy:

```
$ cat > velero-ec2-snapshot-policy.json <<EOF
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "ec2:DescribeVolumes",
                "ec2:DescribeSnapshots",
                "ec2:CreateTags",
                "ec2:CreateVolume",
                "ec2:CreateSnapshot",
                "ec2:DeleteSnapshot"
            ],
            "Resource": "*"
        }
```

```
    ]
}
EOF
```

4. Create an AWS S3 access policy for one or for all S3 buckets:

```
$ cat > velero-s3-policy.json <<EOF
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "s3:GetObject",
                "s3:DeleteObject",
                "s3:PutObject",
                "s3:AbortMultipartUpload",
                "s3:ListMultipartUploadParts"
            ],
            "Resource": [
                "arn:aws:s3:::<bucket_name>/*" (1)
            ]
        },
        {
            "Effect": "Allow",
            "Action": [
                "s3:ListBucket",
                "s3:GetBucketLocation",
                "s3:ListBucketMultipartUploads"
            ],
            "Resource": [
                "arn:aws:s3:::<bucket_name>" (2)
            ]
        }
    ]
}
EOF
```

(1) (2) To grant access to a single S3 bucket, specify the bucket name. To grant access to all AWS S3 buckets, specify * instead of a bucket name as in the following example:

Example output

```
"Resource": [
    "arn:aws:s3:::*"
```

5. Attach the EC2 EBS policy to **velero**:

```
$ aws iam put-user-policy \
  --user-name velero \
  --policy-name velero-ebs \
  --policy-document file://velero-ec2-snapshot-policy.json
```

6. Attach the AWS S3 policy to **velero**:

```
$ aws iam put-user-policy \
  --user-name velero \
  --policy-name velero-s3 \
  --policy-document file://velero-s3-policy.json
```

7. Create an access key for **velero**:

```
$ aws iam create-access-key --user-name velero
{
  "AccessKey": {
        "UserName": "velero",
        "Status": "Active",
        "CreateDate": "2017-07-31T22:24:41.576Z",
        "SecretAccessKey": <AWS_SECRET_ACCESS_KEY>, 1
        "AccessKeyId": <AWS_ACCESS_KEY_ID> 2
    }
}
```

1 2 Record the **AWS_SECRET_ACCESS_KEY** and the **AWS_ACCESS_KEY_ID** for adding the AWS repository to the MTC web console.

2.3.3. Configuring a Google Cloud Provider storage bucket as a replication repository

You can configure a Google Cloud Provider (GCP) storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- The GCP storage bucket must be accessible to the source and target clusters.
- You must have **gsutil** installed.
- If you are using the snapshot copy method:
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Log in to **gsutil**:

```
$ gsutil init
```

Example output

```
Welcome! This command will take you through the configuration of gcloud.
```

```
Your current configuration has been set to: [default]

To continue, you must login. Would you like to login (Y/n)?
```

2. Set the **BUCKET** variable:

```
$ BUCKET=<bucket_name> 1
```

1 Specify your bucket name.

3. Create a storage bucket:

```
$ gsutil mb gs://$BUCKET/
```

4. Set the **PROJECT_ID** variable to your active project:

```
$ PROJECT_ID=`gcloud config get-value project`
```

5. Create a **velero** IAM service account:

```
$ gcloud iam service-accounts create velero \
    --display-name "Velero Storage"
```

6. Create the **SERVICE_ACCOUNT_EMAIL** variable:

```
$ SERVICE_ACCOUNT_EMAIL=`gcloud iam service-accounts list \
  --filter="displayName:Velero Storage" \
  --format 'value(email)'`
```

7. Create the **ROLE_PERMISSIONS** variable:

```
$ ROLE_PERMISSIONS=(
    compute.disks.get
    compute.disks.create
    compute.disks.createSnapshot
    compute.snapshots.get
    compute.snapshots.create
    compute.snapshots.useReadOnly
    compute.snapshots.delete
    compute.zones.get
)
```

8. Create the **velero.server** custom role:

```
$ gcloud iam roles create velero.server \
    --project $PROJECT_ID \
    --title "Velero Server" \
    --permissions "$(IFS=","; echo "${ROLE_PERMISSIONS[*]}")"
```

9. Add IAM policy binding to the project:

```
$ gcloud projects add-iam-policy-binding $PROJECT_ID \
    --member serviceAccount:$SERVICE_ACCOUNT_EMAIL \
    --role projects/$PROJECT_ID/roles/velero.server
```

10. Update the IAM service account:

```
$ gsutil iam ch serviceAccount:$SERVICE_ACCOUNT_EMAIL:objectAdmin gs://${BUCKET}
```

11. Save the IAM service account keys to the **credentials-velero** file in the current directory:

```
$ gcloud iam service-accounts keys create credentials-velero \
  --iam-account $SERVICE_ACCOUNT_EMAIL
```

2.3.4. Configuring a Microsoft Azure Blob storage container as a replication repository

You can configure a Microsoft Azure Blob storage container as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- You must have an Azure storage account.
- You must have the Azure CLI installed.
- The Azure Blob storage container must be accessible to the source and target clusters.
- If you are using the snapshot copy method:
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Set the **AZURE_RESOURCE_GROUP** variable:

```
$ AZURE_RESOURCE_GROUP=Velero_Backups
```

2. Create an Azure resource group:

```
$ az group create -n $AZURE_RESOURCE_GROUP --location <CentralUS> 1
```

1 Specify your location.

3. Set the **AZURE_STORAGE_ACCOUNT_ID** variable:

```
$ AZURE_STORAGE_ACCOUNT_ID=velerobackups
```

4. Create an Azure storage account:

```
$ az storage account create \
  --name $AZURE_STORAGE_ACCOUNT_ID \
  --resource-group $AZURE_RESOURCE_GROUP \
  --sku Standard_GRS \
  --encryption-services blob \
  --https-only true \
  --kind BlobStorage \
  --access-tier Hot
```

5. Set the **BLOB_CONTAINER** variable:

```
$ BLOB_CONTAINER=velero
```

6. Create an Azure Blob storage container:

```
$ az storage container create \
  -n $BLOB_CONTAINER \
  --public-access off \
  --account-name $AZURE_STORAGE_ACCOUNT_ID
```

7. Create a service principal and credentials for **velero**:

```
$ AZURE_SUBSCRIPTION_ID=`az account list --query '[?isDefault].id' -o tsv` \
  AZURE_TENANT_ID=`az account list --query '[?isDefault].tenantId' -o tsv` \
  AZURE_CLIENT_SECRET=`az ad sp create-for-rbac --name "velero" --role "Contributor" --
query 'password' -o tsv` \
  AZURE_CLIENT_ID=`az ad sp list --display-name "velero" --query '[0].appId' -o tsv`
```

8. Save the service principal credentials in the **credentials-velero** file:

```
$ cat << EOF  > ./credentials-velero
AZURE_SUBSCRIPTION_ID=${AZURE_SUBSCRIPTION_ID}
AZURE_TENANT_ID=${AZURE_TENANT_ID}
AZURE_CLIENT_ID=${AZURE_CLIENT_ID}
AZURE_CLIENT_SECRET=${AZURE_CLIENT_SECRET}
AZURE_RESOURCE_GROUP=${AZURE_RESOURCE_GROUP}
AZURE_CLOUD_NAME=AzurePublicCloud
EOF
```

2.4. MIGRATING YOUR APPLICATIONS

You can migrate your applications by using the Migration Toolkit for Containers (MTC) web console or on the command line.

2.4.1. Prerequisites

The Migration Toolkit for Containers (MTC) has the following prerequisites:

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- The MTC version must be the same on all clusters.
- Clusters:

- The source cluster must be upgraded to the latest MTC z-stream release.
- The cluster on which the **migration-controller** pod is running must have unrestricted network access to the other clusters.
- The clusters must have unrestricted network access to each other.
- The clusters must have unrestricted network access to the replication repository.
- The clusters must be able to communicate using OpenShift routes on port 443.
- The clusters must have no critical conditions.
- The clusters must be in a ready state.

- Volume migration:
  - The persistent volumes (PVs) must be valid.
  - The PVs must be bound to persistent volume claims.
  - If you copy the PVs by using the *move* method, the clusters must have unrestricted network access to the remote volume.
  - If you copy the PVs by using the *snapshot* copy method, the following prerequisites apply:
    - The cloud provider must support snapshots.
    - The volumes must have the same cloud provider.
    - The volumes must be located in the same geographic region.
    - The volumes must have the same storage class.
- If you perform a direct volume migration in a proxy environment, you must configure an Stunnel TCP proxy.
- If you perform a direct image migration, you must expose the internal registry of the source cluster to external traffic.

2.4.1.1. Creating a CA certificate bundle file

If you use a self-signed certificate to secure a cluster or a replication repository for the Migration Toolkit for Containers (MTC), certificate verification might fail with the following error message: **Certificate signed by unknown authority**.

You can create a custom CA certificate bundle file and upload it in the MTC web console when you add a cluster or a replication repository.

Procedure

Download a CA certificate from a remote endpoint and save it as a CA bundle file:

```
$ echo -n | openssl s_client -connect <host_FQDN>:<port> \ 1
  | sed -ne '/-BEGIN CERTIFICATE-/,/-END CERTIFICATE-/p' > <ca_bundle.cert> 2
```

1 Specify the host FQDN and port of the endpoint, for example, **api.my-cluster.example.com:6443**.

2 Specify the name of the CA bundle file.

2.4.1.2. Configuring a proxy for direct volume migration

If you are performing direct volume migration from a source cluster behind a proxy, you must configure an Stunnel proxy in the **MigrationController** custom resource (CR). Stunnel creates a transparent tunnel between the source and target clusters for the TCP connection without changing the certificates.

NOTE

Direct volume migration supports only one proxy. The source cluster cannot access the route of the target cluster if the target cluster is also behind a proxy.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.

Procedure

1. Log in to the cluster on which the **MigrationController** pod runs.
2. Get the **MigrationController** CR manifest:

```
$ oc get migrationcontroller <migration_controller> -n openshift-migration
```

3. Add the **stunnel_tcp_proxy** parameter:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigrationController
metadata:
  name: migration-controller
  namespace: openshift-migration
...
spec:
  stunnel_tcp_proxy: <stunnel_proxy> 1
```

1 Specify the Stunnel proxy: **http://<user_name>:<password>@<ip_address>:<port>**.

4. Save the manifest as **migration-controller.yaml**.
5. Apply the updated manifest:

```
$ oc replace -f migration-controller.yaml -n openshift-migration
```

2.4.1.3. Writing an Ansible playbook for a migration hook

You can write an Ansible playbook to use as a migration hook. The hook is added to a migration plan by using the MTC web console or by specifying values for the **spec.hooks** parameters in the **MigPlan** custom resource (CR) manifest.

The Ansible playbook is mounted onto a hook container as a config map. The hook container runs as a

job, using the cluster, service account, and namespace specified in the **MigPlan** CR. The hook container uses a specified service account token so that the tasks do not require authentication before they run in the cluster.

2.4.1.3.1. Ansible modules

You can use the Ansible **shell** module to run **oc** commands.

Example shell module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: get pod name
    shell: oc get po --all-namespaces
```

You can use **kubernetes.core** modules, such as **k8s_info**, to interact with Kubernetes resources.

Example k8s_facts module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: Get pod
    k8s_info:
      kind: pods
      api: v1
      namespace: openshift-migration
      name: "{{ lookup( 'env', 'HOSTNAME') }}"
    register: pods

  - name: Print pod name
    debug:
      msg: "{{ pods.resources[0].metadata.name }}"
```

You can use the **fail** module to produce a non-zero exit status in cases where a non-zero exit status would not normally be produced, ensuring that the success or failure of a hook is detected. Hooks run as jobs and the success or failure status of a hook is based on the exit status of the job container.

Example fail module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: Set a boolean
    set_fact:
      do_fail: true

  - name: "fail"
    fail:
      msg: "Cause a failure"
    when: do_fail
```

2.4.1.3.2. Environment variables

The **MigPlan** CR name and migration namespaces are passed as environment variables to the hook container. These variables are accessed by using the **lookup** plug-in.

Example environment variables

```
- hosts: localhost
  gather_facts: false
  tasks:
  - set_fact:
      namespaces: "{{ (lookup( 'env', 'migration_namespaces')).split(',') }}"

  - debug:
      msg: "{{ item }}"
    with_items: "{{ namespaces }}"

  - debug:
      msg: "{{ lookup( 'env', 'migplan_name') }}"
```

2.4.1.4. Additional resources

- About migration hooks
- MigHook custom resource
- MigPlan custom resource

2.4.2. Migrating your applications using the MTC web console

You can configure clusters and a replication repository by using the MTC web console. Then, you can create and run a migration plan.

2.4.2.1. Launching the MTC web console

You can launch the Migration Toolkit for Containers (MTC) web console in a browser.

Prerequisites

- The MTC web console must have network access to the OpenShift Container Platform web console.
- The MTC web console must have network access to the OAuth authorization server.

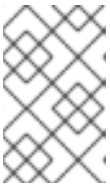
Procedure

1. Log in to the OpenShift Container Platform cluster on which you have installed MTC.
2. Obtain the MTC web console URL by entering the following command:

   ```
   $ oc get -n openshift-migration route/migration -o go-template='https://{{ .spec.host }}'
   ```

   The output resembles the following: **https://migration-openshift-migration.apps.cluster.openshift.com**.

3. Launch a browser and navigate to the MTC web console.



NOTE

If you try to access the MTC web console immediately after installing the Migration Toolkit for Containers Operator, the console might not load because the Operator is still configuring the cluster. Wait a few minutes and retry.

4. If you are using self-signed CA certificates, you will be prompted to accept the CA certificate of the source cluster API server. The web page guides you through the process of accepting the remaining certificates.

5. Log in with your OpenShift Container Platform **username** and **password**.

2.4.2.2. Adding a cluster to the MTC web console

You can add a cluster to the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- If you are using Azure snapshots to copy data:
  - You must specify the Azure resource group name for the cluster.
  - The clusters must be in the same Azure resource group.
  - The clusters must be in the same geographic location.

Procedure

1. Log in to the cluster.

2. Obtain the **migration-controller** service account token:

```
$ oc sa get-token migration-controller -n openshift-migration
```

Example output

```
eyJhbGciOiJSUzI1NiIsImtpZCI6IiJ9.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwi
a3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9uYW1lc3BhY2UiOiJtaWciLCJrdWJlcm5ldGV:
LmlvL3NlcnZpY2VhY2NvdW50L3NlY3JldC5uYW1lIjoibWlnLXRva2VuLWs4dDJyIiwia3ViZXJuZ
XRlcy5pby9zZXJ2aWNlYWNjb3VudC9zZXJ2aWNlLWFjY291bnQubmFtZSI6Im1pZyIsImt1YmV
ybmV0ZXMuaW8vc2VydmljZWFjY291bnQvc2VydmljZS1hY2NvdW50LnVpZCI6ImE1YjFiYWM
wLWMxYmYtMTFlOS05Y2NiLTAyOWRmODYwYjMwOCIsInN1YiI6InN5c3RlbTpzZXJ2aWNlY
WNjb3VudDptaWc6bWlnIn0.xqeeAINK7UXpdRqAtOj70qhBJPeMwmgLomV9iFxr5RoqUgKchZ
RG2J2rkqmPm6vr7K-
cm7ibD1IBpdQJCcVDuoHYsFgV4mp9vgOfn9osSDp2TGikwNz4Az95e81xnjVUmzh-
NjDsEpw71DH92iHV_xt2sTwtzftS49LpPW2LjrV0evtNBP_t_RfskdArt5VSv25eORI7zScqfe1CiM
kcVbf2UqACQjo3LbkpfN26HAioO2oH0ECPiRzT0Xyh-KwFutJLS9Xgghyw-
LD9kPKcE_xbbJ9Y4Rqajh7WdPYuB0Jd9DPVrslmzK-F6cgHHYoZEv0SvLQi-
PO0rpDrcjOEQQ
```

3. In the MTC web console, click **Clusters**.

4. Click **Add cluster**.
5. Fill in the following fields:
   - **Cluster name**: The cluster name can contain lower-case letters (**a-z**) and numbers (**0-9**). It must not contain spaces or international characters.
   - **URL**: Specify the API server URL, for example, **https://<www.example.com>:8443**.
   - **Service account token**: Paste the **migration-controller** service account token.
   - **Exposed route host to image registry**: If you are using direct image migration, specify the exposed route to the image registry of the source cluster, for example, **www.example.apps.cluster.com**.
     You can specify a port. The default port is **5000**.
   - **Azure cluster**: You must select this option if you use Azure snapshots to copy your data.
   - **Azure resource group**: This field is displayed if **Azure cluster** is selected. Specify the Azure resource group.
   - **Require SSL verification**: Optional: Select this option to verify SSL connections to the cluster.
   - **CA bundle file**: This field is displayed if **Require SSL verification** is selected. If you created a custom CA certificate bundle file for self-signed certificates, click **Browse**, select the CA bundle file, and upload it.
6. Click **Add cluster**.
   The cluster appears in the **Clusters** list.

2.4.2.3. Adding a replication repository to the MTC web console

You can add an object storage bucket as a replication repository to the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- You must configure an object storage bucket for migrating the data.

Procedure

1. In the MTC web console, click **Replication repositories**.
2. Click **Add repository**.
3. Select a **Storage provider type** and fill in the following fields:
   - **AWS** for AWS S3, MCG, and generic S3 providers:
     - **Replication repository name**: Specify the replication repository name in the MTC web console.
     - **S3 bucket name**: Specify the name of the S3 bucket you created.
     - **S3 bucket region**: Specify the S3 bucket region. **Required** for AWS S3. **Optional** for other S3 providers.

- **S3 endpoint**: Specify the URL of the S3 service, not the bucket, for example, **https://<s3-storage.apps.cluster.com>**. **Required** for a generic S3 provider. You must use the **https://** prefix.
- **S3 provider access key**: Specify the **<AWS_SECRET_ACCESS_KEY>** for AWS or the S3 provider access key for MCG.
- **S3 provider secret access key**: Specify the **<AWS_ACCESS_KEY_ID>** for AWS or the S3 provider secret access key for MCG.
- **Require SSL verification**: Clear this check box if you are using a generic S3 provider.
- If you use a custom CA bundle, click **Browse** and browse to the Base64-encoded CA bundle file.

- GCP:
  - **Replication repository name**: Specify the replication repository name in the MTC web console.
  - **GCP bucket name**: Specify the name of the GCP bucket.
  - **GCP credential JSON blob**: Specify the string in the **credentials-velero** file.
- Azure:
  - **Replication repository name**: Specify the replication repository name in the MTC web console.
  - **Azure resource group**: Specify the resource group of the Azure Blob storage.
  - **Azure storage account name**: Specify the Azure Blob storage account name.
  - **Azure credentials - INI file contents** Specify the string in the **credentials-velero** file.

4. Click **Add repository** and wait for connection validation.
5. Click **Close**.
   The new repository appears in the **Replication repositories** list.

2.4.2.4. Creating a migration plan in the MTC web console

You can create a migration plan in the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must ensure that the same MTC version is installed on all clusters.
- You must add the clusters and the replication repository to the MTC web console.
- If you want to use the *move* data copy method to migrate a persistent volume (PV), the source and target clusters must have uninterrupted network access to the remote volume.
- If you want to use direct image migration, the **MigCluster** custom resource manifest of the source cluster must specify the exposed route of the internal image registry.

Procedure

1. In the MTC web console, click **Migration plans**.
2. Click **Add migration plan**.
3. Enter the **Plan name** and click **Next**.
   The migration plan name must not exceed 253 lower-case alphanumeric characters (**a-z, 0-9**) and must not contain spaces or underscores (_).
4. Select a **Source cluster**.
5. Select a **Target cluster**.
6. Select a **Replication repository**.
7. Select the projects to be migrated and click **Next**.
8. Select a **Source cluster**, a **Target cluster**, and a **Repository**, and click **Next**.
9. On the **Namespaces** page, select the projects to be migrated and click **Next**.
10. On the **Persistent volumes** page, click a **Migration type** for each PV:
    - The **Copy** option copies the data from the PV of a source cluster to the replication repository and then restores the data on a newly created PV, with similar characteristics, in the target cluster.
    - The **Move** option unmounts a remote volume, for example, NFS, from the source cluster, creates a PV resource on the target cluster pointing to the remote volume, and then mounts the remote volume on the target cluster. Applications running on the target cluster use the same remote volume that the source cluster was using.
11. Click **Next**.
12. On the **Copy options** page, select a **Copy method** for each PV:
    - **Snapshot copy** backs up and restores data using the cloud provider's snapshot functionality. It is significantly faster than **Filesystem copy**.
    - **Filesystem copy** backs up the files on the source cluster and restores them on the target cluster.
      The file system copy method is required for direct volume migration.
13. You can select **Verify copy** to verify data migrated with **Filesystem copy**. Data is verified by generating a checksum for each source file and checking the checksum after restoration. Data verification significantly reduces performance.
14. Select a **Target storage class**.
    If you selected **Filesystem copy**, you can change the target storage class.
15. Click **Next**.
16. On the **Migration options** page, the **Direct image migration** option is selected if you specified an exposed image registry route for the source cluster. The **Direct PV migration** option is selected if you are migrating data with **Filesystem copy**.

    The direct migration options copy images and files directly from the source cluster to the target

The direct migration options copy images and files directly from the source cluster to the target cluster. This option is much faster than copying images and files from the source cluster to the replication repository and then from the replication repository to the target cluster.

17. Click **Next**.

18. Optional: On the **Hooks** page, click **Add Hook** to add a hook to the migration plan.
A hook runs custom code. You can add up to four hooks to a single migration plan. Each hook runs during a different migration step.

    a. Enter the name of the hook to display in the web console.

    b. If the hook is an Ansible playbook, select **Ansible playbook** and click **Browse** to upload the playbook or paste the contents of the playbook in the field.

    c. Optional: Specify an Ansible runtime image if you are not using the default hook image.

    d. If the hook is not an Ansible playbook, select **Custom container image** and specify the image name and path.
    A custom container image can include Ansible playbooks.

    e. Select **Source cluster** or **Target cluster**.

    f. Enter the **Service account name** and the **Service account namespace**

    g. Select the migration step for the hook:

    - **preBackup**: Before the application workload is backed up on the source cluster
    - **postBackup**: After the application workload is backed up on the source cluster
    - **preRestore**: Before the application workload is restored on the target cluster
    - **postRestore**: After the application workload is restored on the target cluster

    h. Click **Add**.

19. Click **Finish**.
The migration plan is displayed in the **Migration plans** list.

2.4.2.5. Running a migration plan in the MTC web console

You can stage or migrate applications and data with the migration plan you created in the Migration Toolkit for Containers (MTC) web console.

NOTE

During migration, MTC sets the reclaim policy of migrated persistent volumes (PVs) to **Retain** on the target cluster.

The **Backup** custom resource contains a **PVOriginalReclaimPolicy** annotation that indicates the original reclaim policy. You can manually restore the reclaim policy of the migrated PVs.

Prerequisites

The MTC web console must contain the following:

- Source cluster in a **Ready** state
- Target cluster in a **Ready** state
- Replication repository
- Valid migration plan

Procedure

1. Log in to the source cluster.
2. Delete old images:

```
$ oc adm prune images
```

3. Log in to the MTC web console and click **Migration plans**.
4. Click the **Options** menu  next to a migration plan and select **Stage** to copy data from the source cluster to the target cluster without stopping the application.
   You can run **Stage** multiple times to reduce the actual migration time.
5. When you are ready to migrate the application workload, the **Options** menu  beside a migration plan and select **Migrate**.
6. Optional: In the **Migrate** window, you can select **Do not stop applications on the source cluster during migration**.
7. Click **Migrate**.
8. When the migration is complete, verify that the application migrated successfully in the OpenShift Container Platform web console:
   a. Click **Home → Projects**.
   b. Click the migrated project to view its status.
   c. In the **Routes** section, click **Location** to verify that the application is functioning, if applicable.
   d. Click **Workloads → Pods** to verify that the pods are running in the migrated namespace.
   e. Click **Storage → Persistent volumes** to verify that the migrated persistent volumes are correctly provisioned.

2.4.3. Migrating your applications from the command line

You can migrate your applications on the command line by using the MTC custom resources (CRs).

You can migrate applications from a local cluster to a remote cluster, from a remote cluster to a local cluster, and between remote clusters.

MTC terminology

The following terms are relevant for configuring clusters:

- **host** cluster:
  - The **migration-controller** pod runs on the **host** cluster.
  - A **host** cluster does not require an exposed secure registry route for direct image migration.
- Local cluster: The local cluster is often the same as the **host** cluster but this is not a requirement.
- Remote cluster:
  - A remote cluster must have an exposed secure registry route for direct image migration.
  - A remote cluster must have a **Secret** CR containing the **migration-controller** service account token.

The following terms are relevant for performing a migration:

- Source cluster: Cluster from which the applications are migrated.
- Destination cluster: Cluster to which the applications are migrated.

2.4.3.1. Migrating your applications with the Migration Toolkit for Containers API

You can migrate your applications on the command line with the Migration Toolkit for Containers (MTC) API.

You can migrate applications from a local cluster to a remote cluster, from a remote cluster to a local cluster, and between remote clusters.

This procedure describes how to perform indirect migration and direct migration:

- Indirect migration: Images, volumes, and Kubernetes objects are copied from the source cluster to the replication repository and then from the replication repository to the destination cluster.
- Direct migration: Images or volumes are copied directly from the source cluster to the destination cluster. Direct image migration and direct volume migration have significant performance benefits.

You create the following custom resources (CRs) to perform a migration:

- **MigCluster** CR: Defines a **host**, local, or remote cluster
  The **migration-controller** pod runs on the **host** cluster.
- **Secret** CR: Contains credentials for a remote cluster or storage
- **MigStorage** CR: Defines a replication repository
  Different storage providers require different parameters in the **MigStorage** CR manifest.
- **MigPlan** CR: Defines a migration plan
- **MigMigration** CR: Performs a migration defined in an associated **MigPlan**
  You can create multiple **MigMigration** CRs for a single **MigPlan** CR for the following purposes:

- To perform stage migrations, which copy most of the data without stopping the application, before running a migration. Stage migrations improve the performance of the migration.
- To cancel a migration in progress
- To roll back a completed migration

Prerequisites

- You must have **cluster-admin** privileges for all clusters.
- You must install the OpenShift Container Platform CLI (**oc**).
- You must install the Migration Toolkit for Containers Operator on all clusters.
- The *version* of the installed Migration Toolkit for Containers Operator must be the same on all clusters.
- You must configure an object storage as a replication repository.
- If you are using direct image migration, you must expose a secure registry route on all remote clusters.
- If you are using direct volume migration, the source cluster must not have an HTTP proxy configured.

Procedure

1. Create a **MigCluster** CR manifest for the **host** cluster called **host-cluster.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  name: host
  namespace: openshift-migration
spec:
  isHostCluster: true
```

2. Create a **MigCluster** CR for the **host** cluster:

```
$ oc create -f host-cluster.yaml -n openshift-migration
```

3. Create a **Secret** CR manifest for each remote cluster called **cluster-secret.yaml**:

```
apiVersion: v1
kind: Secret
metadata:
  name: <cluster_secret>
  namespace: openshift-config
type: Opaque
data:
  saToken: <sa_token> (1)
```

(1) Specify the base64-encoded **migration-controller** service account (SA) token of the remote cluster.

You can obtain the SA token by running the following command:

```
$ oc sa get-token migration-controller -n openshift-migration | base64 -w 0
```

4. Create a **Secret** CR for each remote cluster:

```
$ oc create -f cluster-secret.yaml
```

5. Create a **MigCluster** CR manifest for each remote cluster called **remote-cluster.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  name: <remote_cluster>
  namespace: openshift-migration
spec:
  exposedRegistryPath: <exposed_registry_route> 1
  insecure: false 2
  isHostCluster: false
  serviceAccountSecretRef:
    name: <remote_cluster_secret> 3
    namespace: openshift-config
  url: <remote_cluster_url> 4
```

1. Optional: Specify the exposed registry route, for example, **docker-registry-default.apps.example.com** if you are using direct image migration.
2. SSL verification is enabled if **false**. CA certificates are not required or checked if **true**.
3. Specify the **Secret** CR of the remote cluster.
4. Specify the URL of the remote cluster.

6. Create a **MigCluster** CR for each remote cluster:

```
$ oc create -f remote-cluster.yaml -n openshift-migration
```

7. Verify that all clusters are in a **Ready** state:

```
$ oc describe cluster <cluster_name>
```

8. Create a **Secret** CR manifest for the replication repository called **storage-secret.yaml**:

```
apiVersion: v1
kind: Secret
metadata:
  namespace: openshift-config
  name: <migstorage_creds>
type: Opaque
data:
  aws-access-key-id: <key_id_base64> 1
  aws-secret-access-key: <secret_key_base64> 2
```

1. Specify the key ID in base64 format.
2. Specify the secret key in base64 format.

AWS credentials are base64-encoded by default. If you are using another storage provider, you must encode your credentials by running the following command with each key:

```
$ echo -n "<key>" | base64 -w 0 1
```

1. Specify the key ID or the secret key. Both keys must be base64-encoded.

9. Create the **Secret** CR for the replication repository:

```
$ oc create -f storage-secret.yaml
```

10. Create a **MigStorage** CR manifest for the replication repository called **migstorage.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigStorage
metadata:
  name: <storage_name>
  namespace: openshift-migration
spec:
  backupStorageConfig:
    awsBucketName: <bucket_name> 1
    credsSecretRef:
      name: <storage_secret_ref> 2
      namespace: openshift-config
  backupStorageProvider: <storage_provider_name> 3
  volumeSnapshotConfig:
    credsSecretRef:
      name: <storage_secret_ref> 4
      namespace: openshift-config
  volumeSnapshotProvider: <storage_provider_name> 5
```

1. Specify the bucket name.
2. Specify the **Secrets** CR of the object storage. You must ensure that the credentials stored in the **Secrets** CR of the object storage are correct.
3. Specify the storage provider.
4. Optional: If you are copying data by using snapshots, specify the **Secrets** CR of the object storage. You must ensure that the credentials stored in the **Secrets** CR of the object storage are correct.
5. Optional: If you are copying data by using snapshots, specify the storage provider.

11. Create the **MigStorage** CR:

```
$ oc create -f migstorage.yaml -n openshift-migration
```

12. Verify that the **MigStorage** CR is in a **Ready** state:

```
$ oc describe migstorage <migstorage_name>
```

13. Create a **MigPlan** CR manifest called **migplan.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigPlan
metadata:
  name: <migration_plan>
  namespace: openshift-migration
spec:
  destMigClusterRef:
    name: host
    namespace: openshift-migration
  indirectImageMigration: true (1)
  indirectVolumeMigration: true (2)
  migStorageRef:
    name: <migstorage_ref> (3)
    namespace: openshift-migration
  namespaces:
    - <application_namespace> (4)
  srcMigClusterRef:
    name: <remote_cluster_ref> (5)
    namespace: openshift-migration
```

(1) Direct image migration is enabled if **false**.

(2) Direct volume migration is enabled if **false**.

(3) Specify the name of the **MigStorage** CR instance.

(4) Specify one or more namespaces to be migrated.

(5) Specify the name of the source cluster **MigCluster** instance.

14. Create the **MigPlan** CR:

```
$ oc create -f migplan.yaml -n openshift-migration
```

15. View the **MigPlan** instance to verify that it is in a **Ready** state:

```
$ oc describe migplan <migplan_name> -n openshift-migration
```

16. Create a **MigMigration** CR manifest called **migmigration.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  name: <migmigration_name>
  namespace: openshift-migration
spec:
  migPlanRef:
```

```
  name: <migplan_name> 1
  namespace: openshift-migration
quiescePods: true 2
stage: false 3
rollback: false 4
```

1. Specify the **MigPlan** CR name.
2. The pods on the source cluster are stopped before migration if **true**.
3. A stage migration, which copies most of the data without stopping the application, is performed if **true**.
4. A completed migration is rolled back if **true**.

17. Create the **MigMigration** CR to start the migration defined in the **MigPlan** CR:

```
$ oc create -f migmigration.yaml -n openshift-migration
```

18. Verify the progress of the migration by watching the **MigMigration** CR:

```
$ oc watch migmigration <migmigration_name> -n openshift-migration
```

The output resembles the following:

Example output

```
Name:         c8b034c0-6567-11eb-9a4f-0bc004db0fbc
Namespace:    openshift-migration
Labels:       migration.openshift.io/migplan-name=django
Annotations:  openshift.io/touch: e99f9083-6567-11eb-8420-0a580a81020c
API Version:  migration.openshift.io/v1alpha1
Kind:         MigMigration
...
Spec:
  Mig Plan Ref:
    Name:       my_application
    Namespace:  openshift-migration
  Stage:        false
Status:
  Conditions:
    Category:              Advisory
    Last Transition Time:  2021-02-02T15:04:09Z
    Message:               Step: 19/47
    Reason:                InitialBackupCreated
    Status:                True
    Type:                  Running
    Category:              Required
    Last Transition Time:  2021-02-02T15:03:19Z
    Message:               The migration is ready.
    Status:                True
    Type:                  Ready
    Category:              Required
    Durable:               true
```

```
    Last Transition Time:  2021-02-02T15:04:05Z
    Message:               The migration registries are healthy.
    Status:                True
    Type:                  RegistriesHealthy
  Itinerary:               Final
  Observed Digest:
7fae9d21f15979c71ddc7dd075cb97061895caac5b936d92fae967019ab616d5
  Phase:                   InitialBackupCreated
  Pipeline:
    Completed:  2021-02-02T15:04:07Z
    Message:    Completed
    Name:       Prepare
    Started:    2021-02-02T15:03:18Z
    Message:    Waiting for initial Velero backup to complete.
    Name:       Backup
    Phase:      InitialBackupCreated
    Progress:
      Backup openshift-migration/c8b034c0-6567-11eb-9a4f-0bc004db0fbc-wpc44: 0 out of
estimated total of 0 objects backed up (5s)
    Started:        2021-02-02T15:04:07Z
    Message:        Not started
    Name:           StageBackup
    Message:        Not started
    Name:           StageRestore
    Message:        Not started
    Name:           DirectImage
    Message:        Not started
    Name:           DirectVolume
    Message:        Not started
    Name:           Restore
    Message:        Not started
    Name:           Cleanup
  Start Timestamp:  2021-02-02T15:03:18Z
Events:
  Type    Reason   Age                From                    Message
  ----    ------   ----               ----                    -------
  Normal  Running  57s                migmigration_controller  Step: 2/47
  Normal  Running  57s                migmigration_controller  Step: 3/47
  Normal  Running  57s (x3 over 57s)   migmigration_controller  Step: 4/47
  Normal  Running  54s                migmigration_controller  Step: 5/47
  Normal  Running  54s                migmigration_controller  Step: 6/47
  Normal  Running  52s (x2 over 53s)   migmigration_controller  Step: 7/47
  Normal  Running  51s (x2 over 51s)   migmigration_controller  Step: 8/47
  Normal  Ready    50s (x12 over 57s)  migmigration_controller  The migration is ready.
  Normal  Running  50s                migmigration_controller  Step: 9/47
  Normal  Running  50s                migmigration_controller  Step: 10/47
```

2.4.3.2. MTC custom resource manifests

Migration Toolkit for Containers (MTC) uses the following custom resource (CR) manifests to create CRs for migrating applications.

2.4.3.2.1. DirectImageMigration

The **DirectImageMigration** CR copies images directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectImageMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: <directimagemigration_name>
spec:
  srcMigClusterRef:
    name: <source_cluster_ref> 1
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster_ref> 2
    namespace: openshift-migration
  namespaces:
  - <namespace> 3
```

1. Specify the **MigCluster** CR name of the source cluster.
2. Specify the **MigCluster** CR name of the destination cluster.
3. Specify one or more namespaces containing images to be migrated.

2.4.3.2.2. DirectImageStreamMigration

The **DirectImageStreamMigration** CR copies image stream references directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectImageStreamMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: directimagestreammigration_name
spec:
  srcMigClusterRef:
    name: <source_cluster_ref> 1
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster_ref> 2
    namespace: openshift-migration
  imageStreamRef:
    name: <image_stream_name> 3
    namespace: <source_image_stream_namespace> 4
  destNamespace: <destination_image_stream_namespace> 5
```

1. Specify the **MigCluster** CR name of the source cluster.
2. Specify the **MigCluster** CR name of the destination cluster.
3. Specify the image stream name.
4. Specify the image stream namespace on the source cluster.

5 Specify the image stream namespace on the destination cluster.

2.4.3.2.3. DirectVolumeMigration

The **DirectVolumeMigration** CR copies persistent volumes (PVs) directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectVolumeMigration
metadata:
  name: <directvolumemigration_name>
  namespace: openshift-migration
spec:
  createDestinationNamespaces: false 1
  deleteProgressReportingCRs: false 2
  destMigClusterRef:
    name: host 3
    namespace: openshift-migration
  persistentVolumeClaims:
  - name: <pvc_name> 4
    namespace: <pvc_namespace> 5
  srcMigClusterRef:
    name: <source_cluster_ref> 6
    namespace: openshift-migration
```

1 Namespaces are created for the PVs on the destination cluster if **true**.

2 The **DirectVolumeMigrationProgress** CRs are deleted after migration if **true**. The default value is **false** so that **DirectVolumeMigrationProgress** CRs are retained for troubleshooting.

3 Update the cluster name if the destination cluster is not the host cluster.

4 Specify one or more PVCs to be migrated with direct volume migration.

5 Specify the namespace of each PVC.

6 Specify the **MigCluster** CR name of the source cluster.

2.4.3.2.4. DirectVolumeMigrationProgress

The **DirectVolumeMigrationProgress** CR shows the progress of the **DirectVolumeMigration** CR.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectVolumeMigrationProgress
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: directvolumemigrationprogress_name
spec:
  clusterRef:
    name: source_cluster
    namespace: openshift-migration
```

```
  podRef:
    name: rsync_pod
    namespace: openshift-migration
```

2.4.3.2.5. MigAnalytic

The **MigAnalytic** CR collects the number of images, Kubernetes resources, and the PV capacity from an associated **MigPlan** CR.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigAnalytic
metadata:
  annotations:
    migplan: <migplan_name> 1
  name: miganalytic_name
  namespace: openshift-migration
  labels:
    migplan: <migplan_name> 2
spec:
  analyzeImageCount: true 3
  analyzeK8SResources: true 4
  analyzePVCapacity: true 5
  listImages: false 6
  listImagesLimit: 50 7
  migPlanRef:
    name: migplan_name 8
    namespace: openshift-migration
```

1. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.
2. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.
3. Optional: The number of images is returned if **true**.
4. Optional: Returns the number, kind, and API version of the Kubernetes resources if **true**.
5. Optional: Returns the PV capacity if **true**.
6. Returns a list of image names if **true**. Default is **false** so that the output is not excessively long.
7. Optional: Specify the maximum number of image names to return if **listImages** is **true**.
8. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.

2.4.3.2.6. MigCluster

The **MigCluster** CR defines a host, local, or remote cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
```

```
  name: host (1)
  namespace: openshift-migration
spec:
  isHostCluster: true (2)
  azureResourceGroup: <azure_resource_group> (3)
  caBundle: <ca_bundle_base64> (4)
  insecure: false (5)
  refresh: false (6)
# The 'restartRestic' parameter is relevant for a source cluster.
# restartRestic: true (7)
# The following parameters are relevant for a remote cluster.
# isHostCluster: false
# exposedRegistryPath: (8)
# url: <destination_cluster_url> (9)
# serviceAccountSecretRef:
#   name: <source_secret_ref> (10)
#   namespace: openshift-config
```

(1) Optional: Update the cluster name if the **migration-controller** pod is not running on this cluster.

(2) The **migration-controller** pod runs on this cluster if **true**.

(3) Optional: If the storage provider is Microsoft Azure, specify the resource group.

(4) Optional: If you created a certificate bundle for self-signed CA certificates and if the **insecure** parameter value is **false**, specify the base64-encoded certificate bundle.

(5) SSL verification is enabled if **false**.

(6) The cluster is validated if **true**.

(7) The **restic** pods are restarted on the source cluster after the **stage** pods are created if **true**.

(8) Optional: If you are using direct image migration, specify the exposed registry path of a remote cluster.

(9) Specify the URL of the remote cluster.

(10) Specify the name of the **Secret** CR for the remote cluster.

2.4.3.2.7. MigHook

The **MigHook** CR defines an Ansible playbook or a custom image that runs tasks at a specified stage of the migration.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigHook
metadata:
  generateName: <hook_name_prefix> (1)
  name: <hook_name> (2)
  namespace: openshift-migration
spec:
  activeDeadlineSeconds: (3)
```

```
  custom: false 4
  image: <hook_image> 5
  playbook: <ansible_playbook_base64> 6
  targetCluster: source 7
```

1. Optional: A unique hash is appended to the value for this parameter so that each migration hook has a unique name. You do not need to specify the value of the **name** parameter.
2. Specify the migration hook name, unless you specify the value of the **generateName** parameter.
3. Optional: Specify the maximum number of seconds that a hook can run. The default value is **1800**.
4. The hook is a custom image if **true**. The custom image can include Ansible or it can be written in a different programming language.
5. Specify the custom image, for example, **quay.io/konveyor/hook-runner:latest**. Required if **custom** is **true**.
6. Specify the entire base64-encoded Ansible playbook. Required if **custom** is **false**.
7. Specify **source** or **destination** as the cluster on which the hook will run.

2.4.3.2.8. MigMigration

The **MigMigration** CR runs an associated **MigPlan** CR.

You can create multiple **MigMigration** CRs associated with the same **MigPlan** CR for the following scenarios:

- You can run multiple *stage* or incremental migrations to copy data without stopping the pods on the source cluster. Running stage migrations improves the performance of the actual migration.
- You can cancel a migration in progress.
- You can roll back a migration.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migmigration_name
  namespace: openshift-migration
spec:
  canceled: false 1
  rollback: false 2
  stage: false 3
  quiescePods: true 4
  keepAnnotations: true 5
  verify: false 6
  migPlanRef:
    name: <migplan_ref> 7
    namespace: openshift-migration
```

1. A migration in progress is canceled if **true**.
2. A completed migration is rolled back if **true**.
3. Data is copied incrementally and the pods on the source cluster are not stopped if **true**.
4. The pods on the source cluster are scaled to **0** after the **Backup** stage of a migration if **true**.
5. The labels and annotations applied during the migration are retained if **true**.
6. The status of the migrated pods on the destination cluster are checked and the names of pods that are not in a **Running** state are returned if **true**.
7. **migPlanRef.name**: Specify the name of the associated **MigPlan** CR.

2.4.3.2.9. MigPlan

The **MigPlan** CR defines the parameters of a migration plan. It contains a group of virtual machines that are being migrated with the same parameters.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigPlan
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migplan_name
  namespace: openshift-migration
spec:
  closed: false 1
  srcMigClusterRef:
    name: <source_migcluster_ref> 2
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_migcluster_ref> 3
    namespace: openshift-migration
  hooks: 4
    - executionNamespace: <namespace> 5
      phase: <migration_phase> 6
      reference:
        name: <mighook_name> 7
        namespace: <hook_namespace> 8
      serviceAccount: <service_account> 9
  indirectImageMigration: true 10
  indirectVolumeMigration: false 11
  migStorageRef:
    name: <migstorage_name> 12
    namespace: openshift-migration
  namespaces:
  - <namespace> 13
  refresh: false 14
```

1. The migration has completed if **true**. You cannot create another **MigMigration** CR for this **MigPlan** CR.

2 Specify the name of the source cluster **MigCluster** CR.

3 Specify the name of the destination cluster **MigCluster** CR.

4 Optional: You can specify up to four migration hooks.

5 Optional: Specify the namespace in which the hook will run.

6 Optional: Specify the migration phase during which a hook runs. One hook can be assigned to one phase. The expected values are **PreBackup**, **PostBackup**, **PreRestore**, and **PostRestore**.

7 Optional: Specify the name of the **MigHook** CR.

8 Optional: Specify the namespace of **MigHook** CR.

9 Optional: Specify a service account with **cluster-admin** privileges.

10 Direct image migration is disabled if **true**. Images are copied from the source cluster to the replication repository and from the replication repository to the destination cluster.

11 Direct volume migration is disabled if **true**. PVs are copied from the source cluster to the replication repository and from the replication repository to the destination cluster.

12 Specify the name of **MigStorage** CR.

13 Specify one or more namespaces.

14 The **MigPlan** CR is validated if **true**.

2.4.3.2.10. MigStorage

The **MigStorage** CR describes the object storage for the replication repository. You can configure Amazon Web Services, Microsoft Azure, Google Cloud Storage, and generic S3-compatible cloud storage, for example, Minio or NooBaa.

Different providers require different parameters.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigStorage
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migstorage_name
  namespace: openshift-migration
spec:
  backupStorageProvider: <storage_provider> 1
  volumeSnapshotProvider: 2
  backupStorageConfig:
    awsBucketName: 3
    awsRegion: 4
    credsSecretRef:
      namespace: openshift-config
      name: <storage_secret> 5
    awsKmsKeyId: 6
    awsPublicUrl: 7
```

```
    awsSignatureVersion: 8
  volumeSnapshotConfig:
    awsRegion: 9
    credsSecretRef:
      namespace: openshift-config
      name: 10
  refresh: false 11
```

1. Specify the storage provider.
2. Optional: If you are using the snapshot copy method, specify the storage provider.
3. If you are using AWS, specify the bucket name.
4. If you are using AWS, specify the bucket region, for example, **us-east-1**.
5. Specify the name of the **Secret** CR that you created for the **MigStorage** CR.
6. Optional: If you are using the AWS Key Management Service, specify the unique identifier of the key.
7. Optional: If you granted public access to the AWS bucket, specify the bucket URL.
8. Optional: Specify the AWS signature version for authenticating requests to the bucket, for example, **4**.
9. Optional: If you are using the snapshot copy method, specify the geographical region of the clusters.
10. Optional: If you are using the snapshot copy method, specify the name of the **Secret** CR that you created for the **MigStorage** CR.
11. The cluster is validated if **true**.

2.4.4. Additional resources

- Exposing a secure registry manually on an OpenShift Container Platform 4 cluster
- MTC file system copy method
- MTC snapshot copy method
- Viewing migration custom resources

2.4.5. Configuring a migration plan

You can increase the number of objects to be migrated or exclude resources from the migration.

2.4.5.1. Increasing limits for large migrations

You can increase the limits on migration objects and container resources for large migrations with the Migration Toolkit for Containers (MTC).

IMPORTANT

You must test these changes before you perform a migration in a production environment.

Procedure

1. Edit the **MigrationController** custom resource (CR) manifest:

```
$ oc edit migrationcontroller -n openshift-migration
```

2. Update the following parameters:

```
...
mig_controller_limits_cpu: "1" 1
mig_controller_limits_memory: "10Gi" 2
...
mig_controller_requests_cpu: "100m" 3
mig_controller_requests_memory: "350Mi" 4
...
mig_pv_limit: 100 5
mig_pod_limit: 100 6
mig_namespace_limit: 10 7
...
```

1. Specifies the number of CPUs available to the **MigrationController** CR.
2. Specifies the amount of memory available to the **MigrationController** CR.
3. Specifies the number of CPU units available for **MigrationController** CR requests. **100m** represents 0.1 CPU units (100 * 1e-3).
4. Specifies the amount of memory available for **MigrationController** CR requests.
5. Specifies the number of persistent volumes that can be migrated.
6. Specifies the number of pods that can be migrated.
7. Specifies the number of namespaces that can be migrated.

3. Create a migration plan that uses the updated parameters to verify the changes.
If your migration plan exceeds the **MigrationController** CR limits, the MTC console displays a warning message when you save the migration plan.

2.4.5.2. Excluding resources from a migration plan

You can exclude resources, for example, image streams, persistent volumes (PVs), or subscriptions, from a Migration Toolkit for Containers (MTC) migration plan to reduce the resource load for migration or to migrate images or PVs with a different tool.

By default, the MTC excludes service catalog resources and Operator Lifecycle Manager (OLM) resources from migration. These resources are parts of the service catalog API group and the OLM API group, neither of which is supported for migration at this time.

Procedure

1. Edit the **MigrationController** custom resource manifest:

```
$ oc edit migrationcontroller <migration_controller> -n openshift-migration
```

2. Update the **spec** section by adding a parameter to exclude specific resources or by adding a resource to the **excluded_resources** parameter if it does not have its own exclusion parameter:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigrationController
metadata:
  name: migration-controller
  namespace: openshift-migration
spec:
  disable_image_migration: true (1)
  disable_pv_migration: true (2)
  ...
  excluded_resources: (3)
  - imagetags
  - templateinstances
  - clusterserviceversions
  - packagemanifests
  - subscriptions
  - servicebrokers
  - servicebindings
  - serviceclasses
  - serviceinstances
  - serviceplans
  - operatorgroups
  - events
```

(1) Add **disable_image_migration: true** to exclude image streams from the migration. Do not edit the **excluded_resources** parameter. **imagestreams** is added to **excluded_resources** when the **MigrationController** pod restarts.

(2) Add **disable_pv_migration: true** to exclude PVs from the migration plan. Do not edit the **excluded_resources** parameter. **persistentvolumes** and **persistentvolumeclaims** are added to **excluded_resources** when the **MigrationController** pod restarts. Disabling PV migration also disables PV discovery when you create the migration plan.

(3) You can add OpenShift Container Platform resources to the **excluded_resources** list. Do not delete the default excluded resources. These resources are problematic to migrate and must be excluded.

3. Wait two minutes for the **MigrationController** pod to restart so that the changes are applied.

4. Verify that the resource is excluded:

```
$ oc get deployment -n openshift-migration migration-controller -o yaml | grep
EXCLUDED_RESOURCES -A1
```

The output contains the excluded resources:

Example output

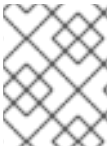
```
- name: EXCLUDED_RESOURCES
  value:

imagetags,templateinstances,clusterserviceversions,packagemanifests,subscriptions,servicebro
ers,servicebindings,serviceclasses,serviceinstances,serviceplans,imagestreams,persistentvolun
es,persistentvolumeclaims
```

2.5. TROUBLESHOOTING

You can view the Migration Toolkit for Containers (MTC) custom resources and download logs to troubleshoot a failed migration.

If the application was stopped during the failed migration, you must roll back the migration to prevent data corruption.



NOTE

Manual rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

2.5.1. Viewing MTC custom resources

You can view the following Migration Toolkit for Containers (MTC) custom resources (CRs) to troubleshoot a failed migration:

- **MigCluster**
- **MigStorage**
- **MigPlan**
- **BackupStorageLocation**
  The **BackupStorageLocation** CR contains a **migrationcontroller** label to identify the MTC instance that created the CR:

  ```
  labels:
    migrationcontroller: ebe13bee-c803-47d0-a9e9-83f380328b93
  ```

- **VolumeSnapshotLocation**
  The **VolumeSnapshotLocation** CR contains a **migrationcontroller** label to identify the MTC instance that created the CR:

  ```
  labels:
    migrationcontroller: ebe13bee-c803-47d0-a9e9-83f380328b93
  ```

- **MigMigration**
- **Backup**
  MTC changes the reclaim policy of migrated persistent volumes (PVs) to **Retain** on the target cluster. The **Backup** CR contains an **openshift.io/orig-reclaim-policy** annotation that indicates the original reclaim policy. You can manually restore the reclaim policy of the migrated

PVs.

- **Restore**

Procedure

1. List the **MigMigration** CRs in the **openshift-migration** namespace:

```
$ oc get migmigration -n openshift-migration
```

Example output

```
NAME                                   AGE
88435fe0-c9f8-11e9-85e6-5d593ce65e10   6m42s
```

2. Inspect the **MigMigration** CR:

```
$ oc describe migmigration 88435fe0-c9f8-11e9-85e6-5d593ce65e10 -n openshift-migration
```

The output is similar to the following examples.

MigMigration example output

```
name:         88435fe0-c9f8-11e9-85e6-5d593ce65e10
namespace:    openshift-migration
labels:       <none>
annotations:  touch: 3b48b543-b53e-4e44-9d34-33563f0f8147
apiVersion:  migration.openshift.io/v1alpha1
kind:         MigMigration
metadata:
  creationTimestamp:  2019-08-29T01:01:29Z
  generation:         20
  resourceVersion:    88179
  selfLink:           /apis/migration.openshift.io/v1alpha1/namespaces/openshift-
migration/migmigrations/88435fe0-c9f8-11e9-85e6-5d593ce65e10
  uid:                8886de4c-c9f8-11e9-95ad-0205fe66cbb6
spec:
  migPlanRef:
    name:         socks-shop-mig-plan
    namespace:    openshift-migration
  quiescePods:  true
  stage:        false
status:
  conditions:
    category:              Advisory
    durable:               True
    lastTransitionTime:  2019-08-29T01:03:40Z
    message:               The migration has completed successfully.
    reason:                Completed
    status:                True
    type:                  Succeeded
  phase:                   Completed
  startTimestamp:          2019-08-29T01:01:29Z
events:                    <none>
```

Velero backup CR #2 example output that describes the PV data

```
apiVersion: velero.io/v1
kind: Backup
metadata:
  annotations:
    openshift.io/migrate-copy-phase: final
    openshift.io/migrate-quiesce-pods: "true"
    openshift.io/migration-registry: 172.30.105.179:5000
    openshift.io/migration-registry-dir: /socks-shop-mig-plan-registry-44dd3bd5-c9f8-11e9-95ad-
0205fe66cbb6
    openshift.io/orig-reclaim-policy: delete
  creationTimestamp: "2019-08-29T01:03:15Z"
  generateName: 88435fe0-c9f8-11e9-85e6-5d593ce65e10-
  generation: 1
  labels:
    app.kubernetes.io/part-of: migration
    migmigration: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
    migration-stage-backup: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
    velero.io/storage-location: myrepo-vpzq9
  name: 88435fe0-c9f8-11e9-85e6-5d593ce65e10-59gb7
  namespace: openshift-migration
  resourceVersion: "87313"
  selfLink: /apis/velero.io/v1/namespaces/openshift-migration/backups/88435fe0-c9f8-11e9-85e6-
5d593ce65e10-59gb7
  uid: c80dbbc0-c9f8-11e9-95ad-0205fe66cbb6
spec:
  excludedNamespaces: []
  excludedResources: []
  hooks:
    resources: []
  includeClusterResources: null
  includedNamespaces:
  - sock-shop
  includedResources:
  - persistentvolumes
  - persistentvolumeclaims
  - namespaces
  - imagestreams
  - imagestreamtags
  - secrets
  - configmaps
  - pods
  labelSelector:
    matchLabels:
      migration-included-stage-backup: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
  storageLocation: myrepo-vpzq9
  ttl: 720h0m0s
  volumeSnapshotLocations:
  - myrepo-wv6fx
status:
  completionTimestamp: "2019-08-29T01:02:36Z"
  errors: 0
  expiration: "2019-09-28T01:02:35Z"
  phase: Completed
  startTimestamp: "2019-08-29T01:02:35Z"
```

```
  validationErrors: null
  version: 1
  volumeSnapshotsAttempted: 0
  volumeSnapshotsCompleted: 0
  warnings: 0
```

Velero restore CR #2 example output that describes the Kubernetes resources

```
apiVersion: velero.io/v1
kind: Restore
metadata:
  annotations:
    openshift.io/migrate-copy-phase: final
    openshift.io/migrate-quiesce-pods: "true"
    openshift.io/migration-registry: 172.30.90.187:5000
    openshift.io/migration-registry-dir: /socks-shop-mig-plan-registry-36f54ca7-c925-11e9-825a-
06fa9fb68c88
  creationTimestamp: "2019-08-28T00:09:49Z"
  generateName: e13a1b60-c927-11e9-9555-d129df7f3b96-
  generation: 3
  labels:
    app.kubernetes.io/part-of: migration
    migmigration: e18252c9-c927-11e9-825a-06fa9fb68c88
    migration-final-restore: e18252c9-c927-11e9-825a-06fa9fb68c88
  name: e13a1b60-c927-11e9-9555-d129df7f3b96-gb8nx
  namespace: openshift-migration
  resourceVersion: "82329"
  selfLink: /apis/velero.io/v1/namespaces/openshift-migration/restores/e13a1b60-c927-11e9-9555-
d129df7f3b96-gb8nx
  uid: 26983ec0-c928-11e9-825a-06fa9fb68c88
spec:
  backupName: e13a1b60-c927-11e9-9555-d129df7f3b96-sz24f
  excludedNamespaces: null
  excludedResources:
  - nodes
  - events
  - events.events.k8s.io
  - backups.velero.io
  - restores.velero.io
  - resticrepositories.velero.io
  includedNamespaces: null
  includedResources: null
  namespaceMapping: null
  restorePVs: true
status:
  errors: 0
  failureReason: ""
  phase: Completed
  validationErrors: null
  warnings: 15
```

2.5.2. Using the migration log reader

You can use the migration log reader to display a single filtered view of all the migration logs.

Procedure

1. Get the **mig-log-reader** pod:

```
$ oc -n openshift-migration get pods | grep log
```

2. Enter the following command to display a single migration log:

```
$ oc -n openshift-migration logs -f <mig-log-reader-pod> -c color 1
```

1 The **-c plain** option displays the log without colors.

2.5.3. Downloading migration logs

You can download the **Velero**, **Restic**, and **MigrationController** pod logs in the Migration Toolkit for Containers (MTC) web console to troubleshoot a failed migration.

Procedure

1. In the MTC console, click **Migration plans** to view the list of migration plans.
2. Click the **Options** menu  of a specific migration plan and select **Logs**.
3. Click **Download Logs** to download the logs of the **MigrationController**, **Velero**, and **Restic** pods for all clusters.
   You can download a single log by selecting the cluster, log source, and pod source, and then clicking **Download Selected**.

   You can access a pod log from the CLI by using the **oc logs** command:

```
$ oc logs <pod-name> -f -n openshift-migration 1
```

1 Specify the pod name.

2.5.4. Updating deprecated APIs

If your source cluster uses deprecated APIs, the following warning message is displayed when you create a migration plan in the Migration Toolkit for Containers (MTC) web console:

```
Some namespaces contain GVKs incompatible with destination cluster
```

You can click **See details** to view the namespace and the incompatible APIs. This warning message does not block the migration.

During migration with the Migration Toolkit for Containers (MTC), the deprecated APIs are saved in the **Velero** Backup #1 for Kubernetes objects. You can download the **Velero** Backup, extract the deprecated API **yaml** files, and update them with the **oc convert** command. Then you can create the updated APIs on the target cluster.

Procedure

1. Run the migration plan.

2. View the **MigPlan** custom resource (CR):

```
$ oc describe migplan <migplan_name> -n openshift-migration 1
```

1 Specify the name of the **MigPlan** CR.

The output is similar to the following:

```
metadata:
  ...
  uid: 79509e05-61d6-11e9-bc55-02ce4781844a 1
status:
  ...
  conditions:
  - category: Warn
    lastTransitionTime: 2020-04-30T17:16:23Z
    message: 'Some namespaces contain GVKs incompatible with destination cluster.
      See: `incompatibleNamespaces` for details'
    status: "True"
    type: GVKsIncompatible
  incompatibleNamespaces:
  - gvks: 2
    - group: batch
      kind: cronjobs
      version: v2alpha1
    - group: batch
      kind: scheduledjobs
      version: v2alpha1
```

1 Record the **MigPlan** CR UID.

2 Record the deprecated APIs listed in the **gvks** section.

3. Get the **MigMigration** name associated with the **MigPlan** UID:

```
$ oc get migmigration -o json | jq -r '.items[] | select(.metadata.ownerReferences[].uid=="
<migplan_uid>") | .metadata.name' 1
```

1 Specify the **MigPlan** CR UID.

4. Get the **MigMigration** UID associated with the **MigMigration** name:

```
$ oc get migmigration <migmigration_name> -o jsonpath='{.metadata.uid}' 1
```

1 Specify the **MigMigration** name.

5. Get the **Velero** Backup name associated with the **MigMigration** UID:

```
$ oc get backup.velero.io --selector migration-initial-backup="<migmigration_uid>" -o
jsonpath={.items[*].metadata.name} 1
```

1 Specify the **MigMigration** UID.

6. Download the contents of the **Velero** Backup to your local machine by running the command for your storage provider:
   - AWS S3:

```
$ aws s3 cp s3://<bucket_name>/velero/backups/<backup_name> <backup_local_dir> --
recursive 1
```

1 Specify the bucket, backup name, and your local backup directory name.

   - GCP:

```
$ gsutil cp gs://<bucket_name>/velero/backups/<backup_name> <backup_local_dir> --
recursive 1
```

1 Specify the bucket, backup name, and your local backup directory name.

   - Azure:

```
$ azcopy copy
'https://velerobackups.blob.core.windows.net/velero/backups/<backup_name>'
'<backup_local_dir>' --recursive 1
```

1 Specify the backup name and your local backup directory name.

7. Extract the **Velero** Backup archive file:

```
$ tar -xfv <backup_local_dir>/<backup_name>.tar.gz -C <backup_local_dir>
```

8. Run **oc convert** in offline mode on each deprecated API:

```
$ oc convert -f <backup_local_dir>/resources/<gvk>.json
```

9. Create the converted API on the target cluster:

```
$ oc create -f <gvk>.json
```

2.5.5. Error messages and resolutions

This section describes common error messages you might encounter with the Migration Toolkit for Containers (MTC) and how to resolve their underlying causes.

2.5.5.1. CA certificate error in the MTC console

If a **CA certificate error** message is displayed the first time you try to access the MTC console, the likely cause is the use of self-signed CA certificates in one of the clusters.

To resolve this issue, navigate to the **oauth-authorization-server** URL displayed in the error message and accept the certificate. To resolve this issue permanently, add the certificate to the trust store of your web browser.

If an **Unauthorized** message is displayed after you have accepted the certificate, navigate to the MTC console and refresh the web page.

2.5.5.2. OAuth timeout error in the MTC console

If a **connection has timed out** message is displayed in the MTC console after you have accepted a self-signed certificate, the causes are likely to be the following:

- Interrupted network access to the OAuth server
- Interrupted network access to the OpenShift Container Platform console
- Proxy configuration that blocks access to the **oauth-authorization-server** URL. See MTC console inaccessible because of OAuth timeout error for details.

You can determine the cause of the timeout.

Procedure

1. Navigate to the MTC console and inspect the elements with the browser web inspector.
2. Check the **MigrationUI** pod log:

```
$ oc logs <MigrationUI_Pod> -n openshift-migration
```

2.5.5.3. PodVolumeBackups timeout error in Velero pod log

If a migration fails because Restic times out, the following error is displayed in the **Velero** pod log.

Example output

```
level=error msg="Error backing up item" backup=velero/monitoring error="timed out waiting for all
PodVolumeBackups to complete"
error.file="/go/src/github.com/heptio/velero/pkg/restic/backupper.go:165"
error.function="github.com/heptio/velero/pkg/restic.(*backupper).BackupPodVolumes" group=v1
```

The default value of **restic_timeout** is one hour. You can increase this parameter for large migrations, keeping in mind that a higher value may delay the return of error messages.

Procedure

1. In the OpenShift Container Platform web console, navigate to **Operators → Installed Operators**.
2. Click **Migration Toolkit for Containers Operator**.
3. In the **MigrationController** tab, click **migration-controller**.

4. In the **YAML** tab, update the following parameter value:

```
spec:
  restic_timeout: 1h (1)
```

(1) Valid units are **h** (hours), **m** (minutes), and **s** (seconds), for example, **3h30m15s**.

5. Click **Save**.

2.5.5.4. ResticVerifyErrors in the MigMigration custom resource

If data verification fails when migrating a persistent volume with the file system data copy method, the following error is displayed in the **MigMigration** CR.

Example output

```
status:
  conditions:
  - category: Warn
    durable: true
    lastTransitionTime: 2020-04-16T20:35:16Z
    message: There were verify errors found in 1 Restic volume restores. See restore `<registry-example-migration-rvwcm>`
      for details (1)
    status: "True"
    type: ResticVerifyErrors (2)
```

(1) The error message identifies the **Restore** CR name.

(2) **ResticVerifyErrors** is a general error warning type that includes verification errors.

NOTE

A data verification error does not cause the migration process to fail.

You can check the **Restore** CR to identify the source of the data verification error.

Procedure

1. Log in to the target cluster.
2. View the **Restore** CR:

```
$ oc describe <registry-example-migration-rvwcm> -n openshift-migration
```

The output identifies the persistent volume with **PodVolumeRestore** errors.

Example output

```
status:
  phase: Completed
```

```
  podVolumeRestoreErrors:
  - kind: PodVolumeRestore
    name: <registry-example-migration-rvwcm-98t49>
    namespace: openshift-migration
  podVolumeRestoreResticErrors:
  - kind: PodVolumeRestore
    name: <registry-example-migration-rvwcm-98t49>
    namespace: openshift-migration
```

3. View the **PodVolumeRestore** CR:

```
$ oc describe <migration-example-rvwcm-98t49>
```

The output identifies the **Restic** pod that logged the errors.

Example output

```
  completionTimestamp: 2020-05-01T20:49:12Z
  errors: 1
  resticErrors: 1
  ...
  resticPod: <restic-nr2v5>
```

4. View the **Restic** pod log to locate the errors:

```
$ oc logs -f <restic-nr2v5>
```

2.5.6. Direct volume migration does not complete

If direct volume migration does not complete, the target cluster might not have the same **node-selector** annotations as the source cluster.

Migration Toolkit for Containers (MTC) migrates namespaces with all annotations to preserve security context constraints and scheduling requirements. During direct volume migration, MTC creates Rsync transfer pods on the target cluster in the namespaces that were migrated from the source cluster. If a target cluster namespace does not have the same annotations as the source cluster namespace, the Rsync transfer pods cannot be scheduled. The Rsync pods remain in a **Pending** state.

You can identify and fix this issue by performing the following procedure.

Procedure

1. Check the status of the **MigMigration** CR:

```
$ oc describe migmigration <pod_name> -n openshift-migration
```

The output includes the following status message:

Example output

```
...
Some or all transfer pods are not running for more than 10 mins on destination cluster
...
```

2. On the source cluster, obtain the details of a migrated namespace:

```
$ oc get namespace <namespace> -o yaml 1
```

1 Specify the migrated namespace.

3. On the target cluster, edit the migrated namespace:

```
$ oc edit namespace <namespace>
```

4. Add missing **openshift.io/node-selector** annotations to the migrated namespace as in the following example:

```
apiVersion: v1
kind: Namespace
metadata:
  annotations:
    openshift.io/node-selector: "region=east"
...
```

5. Run the migration plan again.

2.5.7. Using the Velero CLI to debug Backup and Restore CRs

You can debug the **Backup** and **Restore** custom resources (CRs) and partial migration failures with the Velero command line interface (CLI). The Velero CLI runs in the **velero** pod.

2.5.7.1. Velero command syntax

Velero CLI commands use the following syntax:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero <resource>
<command> <resource_id>
```

You can specify **velero-<pod> -n openshift-migration** in place of **$(oc get pods -n openshift-migration -o name | grep velero)**.

2.5.7.2. Help command

The Velero **help** command lists all the Velero CLI commands:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero --help
```

2.5.7.3. Describe command

The Velero **describe** command provides a summary of warnings and errors associated with a Velero resource:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero  <resource>
describe <resource_id>
```

Example

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero backup describe
0e44ae00-5dc3-11eb-9ca8-df7e5254778b-2d8ql
```

2.5.7.4. Logs command

The Velero **logs** command provides the logs associated with a Velero resource:

```
velero <resource> logs <resource_id>
```

Example

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero restore logs
ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
```

2.5.7.5. Debugging a partial migration failure

You can debug a partial migration failure warning message by using the Velero CLI to examine the **Restore** custom resource (CR) logs.

A partial failure occurs when Velero encounters an issue that does not cause a migration to fail. For example, if a custom resource definition (CRD) is missing or if there is a discrepancy between CRD versions on the source and target clusters, the migration completes but the CR is not created on the target cluster.

Velero logs the issue as a partial failure and then processes the rest of the objects in the **Backup** CR.

Procedure

1. Check the status of a **MigMigration** CR:

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

Example output

```
status:
  conditions:
  - category: Warn
    durable: true
    lastTransitionTime: "2021-01-26T20:48:40Z"
    message: 'Final Restore openshift-migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-
x4lbf: partially failed on destination cluster'
    status: "True"
    type: VeleroFinalRestorePartiallyFailed
  - category: Advisory
    durable: true
    lastTransitionTime: "2021-01-26T20:48:42Z"
    message: The migration has completed with warnings, please look at `Warn` conditions.
    reason: Completed
    status: "True"
    type: SucceededWithWarnings
```

2. Check the status of the **Restore** CR by using the Velero **describe** command:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -n openshift-migration -
- ./velero restore describe <restore>
```

Example output

```
Phase:  PartiallyFailed (run 'velero restore logs ccc7c2d0-6017-11eb-afab-85d0007f5a19-
x4lbf' for more information)

Errors:
  Velero:     <none>
  Cluster:    <none>
  Namespaces:
    migration-example:  error restoring example.com/migration-example/migration-example:
the server could not find the requested resource
```

3. Check the **Restore** CR logs by using the Velero **logs** command:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -n openshift-migration -
- ./velero restore logs <restore>
```

Example output

```
time="2021-01-26T20:48:37Z" level=info msg="Attempting to restore migration-example:
migration-example" logSource="pkg/restore/restore.go:1107" restore=openshift-
migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
time="2021-01-26T20:48:37Z" level=info msg="error restoring migration-example: the server
could not find the requested resource" logSource="pkg/restore/restore.go:1170"
restore=openshift-migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
```

The **Restore** CR log error message, **the server could not find the requested resource**, indicates the cause of the partially failed migration.

2.5.8. Using must-gather to collect data

You must run the **must-gather** tool if you open a customer support case on the Red Hat Customer Portal for the Migration Toolkit for Containers (MTC).

The **openshift-migration-must-gather-rhel8** image for MTC collects migration-specific logs and data that are not collected by the default **must-gather** image.

Procedure

1. Navigate to the directory where you want to store the **must-gather** data.
2. Run the **must-gather** command:

```
$ oc adm must-gather --image=registry.redhat.io/rhmtc/openshift-migration-must-gather-
rhel8:v1.4
```

3. Remove authentication keys and other sensitive information.

4. Create an archive file containing the contents of the **must-gather** data directory:

```
$ tar cvaf must-gather.tar.gz must-gather.local.<uid>/
```

5. Upload the compressed file as an attachment to your customer support case.

2.5.9. Rolling back a migration

You can roll back a migration by using the MTC web console or the CLI.

2.5.9.1. Rolling back a migration in the MTC web console

You can roll back a migration by using the Migration Toolkit for Containers (MTC) web console.

If your application was stopped during a failed migration, you must roll back the migration to prevent data corruption in the persistent volume.

Rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

Procedure

1. In the MTC web console, click **Migration plans**.
2. Click the Options menu  beside a migration plan and select **Rollback**.
3. Click **Rollback** and wait for rollback to complete.
   In the migration plan details, **Rollback succeeded** is displayed.
4. Verify that rollback was successful in the OpenShift Container Platform web console of the source cluster:
   a. Click **Home → Projects**.
   b. Click the migrated project to view its status.
   c. In the **Routes** section, click **Location** to verify that the application is functioning, if applicable.
   d. Click **Workloads → Pods** to verify that the pods are running in the migrated namespace.
   e. Click **Storage → Persistent volumes** to verify that the migrated persistent volume is correctly provisioned.

2.5.9.1.1. Rolling back a migration from the CLI

You can roll back a migration by creating a **MigMigration** custom resource (CR) from the CLI.

If your application was stopped during a failed migration, you must roll back the migration to prevent data corruption in the persistent volume.

Rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

Procedure

1. Create a **MigMigration** CR based on the following example:

```
$ cat << EOF | oc apply -f -
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migration-rollback
  namespace: openshift-migration
spec:
...
  rollback: true
...
  migPlanRef:
    name: <migplan_name> 1
    namespace: openshift-migration
EOF
```

1 Specify the name of the associated **MigPlan** CR.

2. In the MTC web console, verify that the migrated project resources have been removed from the target cluster.

3. Verify that the migrated project resources are present in the source cluster and that the application is running.

2.5.10. Known issues

This release has the following known issues:

- During migration, the Migration Toolkit for Containers (MTC) preserves the following namespace annotations:
  - **openshift.io/sa.scc.mcs**
  - **openshift.io/sa.scc.supplemental-groups**
  - **openshift.io/sa.scc.uid-range**
    These annotations preserve the UID range, ensuring that the containers retain their file system permissions on the target cluster. There is a risk that the migrated UIDs could duplicate UIDs within an existing or future namespace on the target cluster. (BZ#1748440)
- If an AWS bucket is added to the MTC web console and then deleted, its status remains **True** because the **MigStorage** CR is not updated. (BZ#1738564)
- Most cluster-scoped resources are not yet handled by MTC. If your applications require cluster-scoped resources, you might have to create them manually on the target cluster.
- If a migration fails, the migration plan does not retain custom PV settings for quiesced pods. You must manually roll back the migration, delete the migration plan, and create a new migration plan with your PV settings. (BZ#1784899)

- If a large migration fails because Restic times out, you can increase the **restic_timeout** parameter value (default: **1h**) in the **MigrationController** CR.
- If you select the data verification option for PVs that are migrated with the file system copy method, performance is significantly slower.

2.5.11. Additional resources

- MTC workflow
- MTC custom resources

CHAPTER 3. MIGRATING FROM OPENSHIFT CONTAINER PLATFORM 4.2 AND LATER

3.1. ABOUT THE MIGRATION TOOLKIT FOR CONTAINERS

You can migrate application workloads from OpenShift Container Platform 4.2 to 4.7 with the Migration Toolkit for Containers (MTC). MTC enables you to control the migration and to minimize application downtime.

NOTE

You can migrate between OpenShift Container Platform clusters of the same version, for example, from 4.2 to 4.2 or from 4.3 to 4.3, as long as the source and target clusters are configured correctly.

MTC is installed on the target cluster by default. You can configure the Migration Toolkit for Containers Operator to install the MTC on a remote cluster.

The MTC web console and API, based on Kubernetes custom resources, enable you to migrate stateful and stateless application workloads at the granularity of a namespace.

MTC supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

You can use migration hooks to run Ansible playbooks at certain points during the migration. The hooks are added when you create a migration plan.

3.1.1. Migration Toolkit for Containers workflow

You use the Migration Toolkit for Containers (MTC) to migrate Kubernetes resources, persistent volume data, and internal container images from an OpenShift Container Platform source cluster to an OpenShift Container Platform 4.7 target cluster by using the MTC web console or the Kubernetes API.

The (MTC) migrates the following resources:

- A namespace specified in a migration plan.
- Namespace-scoped resources: When the MTC migrates a namespace, it migrates all the objects and resources associated with that namespace, such as services or pods. Additionally, if a resource that exists in the namespace but not at the cluster level depends on a resource that exists at the cluster level, the MTC migrates both resources.
  For example, a security context constraint (SCC) is a resource that exists at the cluster level and a service account (SA) is a resource that exists at the namespace level. If an SA exists in a namespace that the MTC migrates, the MTC automatically locates any SCCs that are linked to the SA and also migrates those SCCs. Similarly, the MTC migrates persistent volume claims that are linked to the persistent volumes of the namespace.
- Custom resources (CRs) and custom resource definitions (CRDs): The MTC automatically migrates any CRs that exist at the namespace level as well as the CRDs that are linked to those CRs.

Migrating an application with the MTC web console involves the following steps:

1. Install the Migration Toolkit for Containers Operator on all clusters.
   You can install the Migration Toolkit for Containers Operator in a restricted environment with limited or no internet access. The source and target clusters must have network access to each other and to a mirror registry.

2. Configure the replication repository, an intermediate object storage that MTC uses to migrate data.
   The source and target clusters must have network access to the replication repository during migration. In a restricted environment, you can use an internally hosted S3 storage repository. If you are using a proxy server, you must configure it to allow network traffic between the replication repository and the clusters.

3. Add the source cluster to the MTC web console.

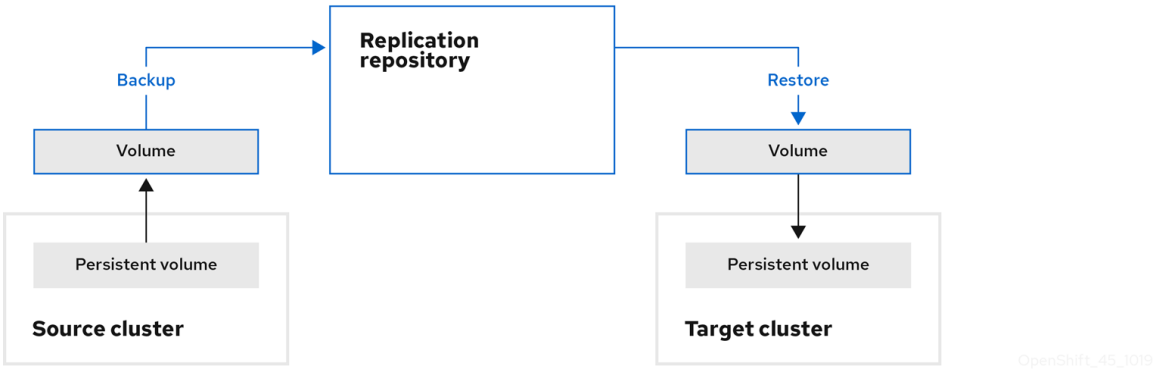
4. Add the replication repository to the MTC web console.

5. Create a migration plan, with one of the following data migration options:

   - **Copy**: MTC copies the data from the source cluster to the replication repository, and from the replication repository to the target cluster.

NOTE

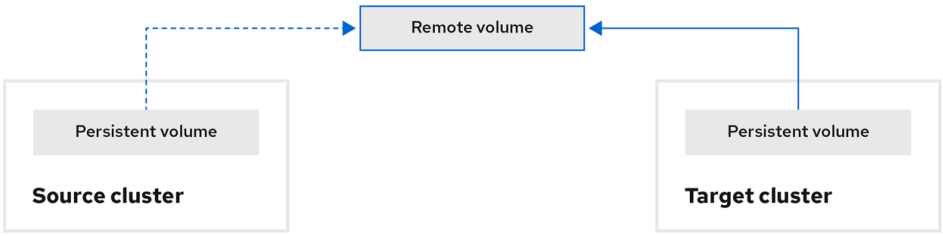
If you are using direct image migration or direct volume migration, the images or volumes are copied directly from the source cluster to the target cluster.



   - **Move**: MTC unmounts a remote volume, for example, NFS, from the source cluster, creates a PV resource on the target cluster pointing to the remote volume, and then mounts the remote volume on the target cluster. Applications running on the target cluster use the same remote volume that the source cluster was using. The remote volume must be accessible to the source and target clusters.

NOTE

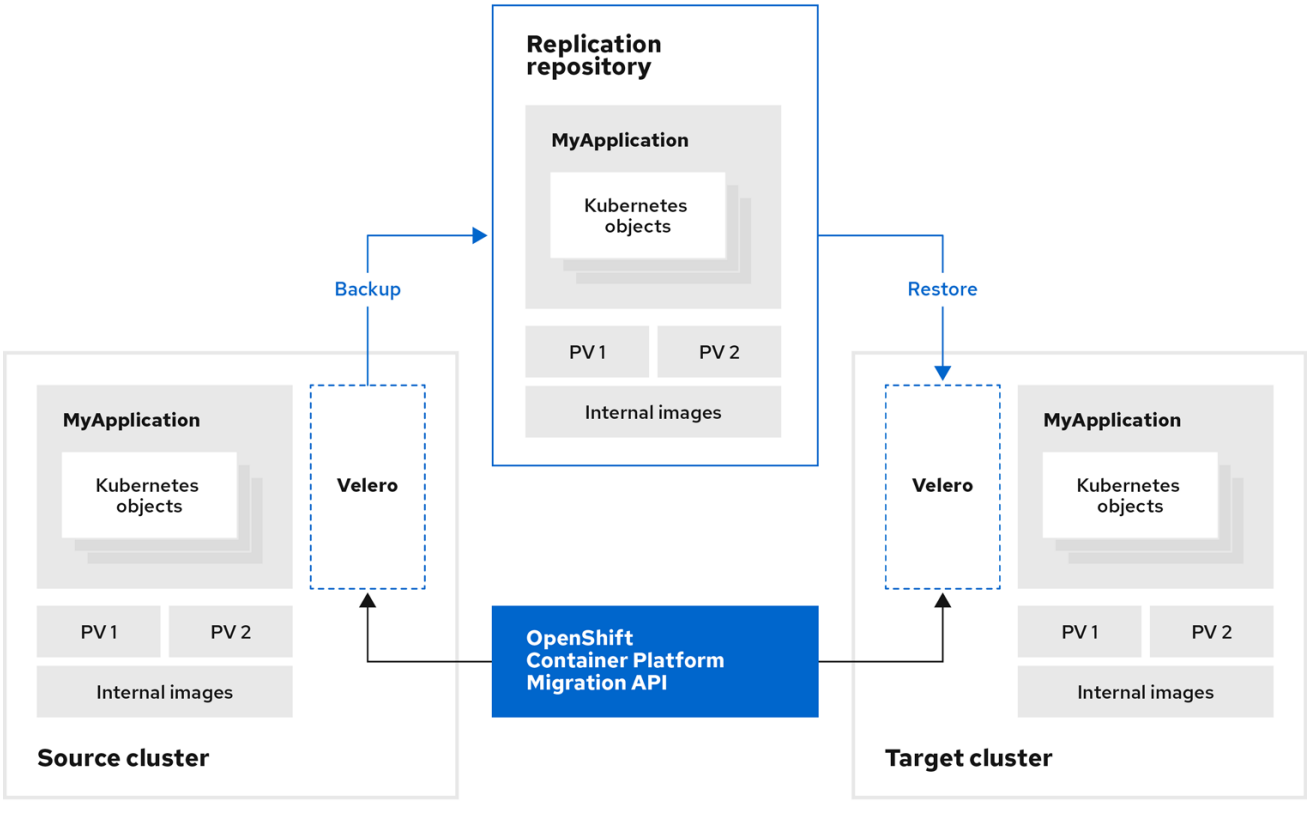
Although the replication repository does not appear in this diagram, it is required for migration.



6. Run the migration plan, with one of the following options:

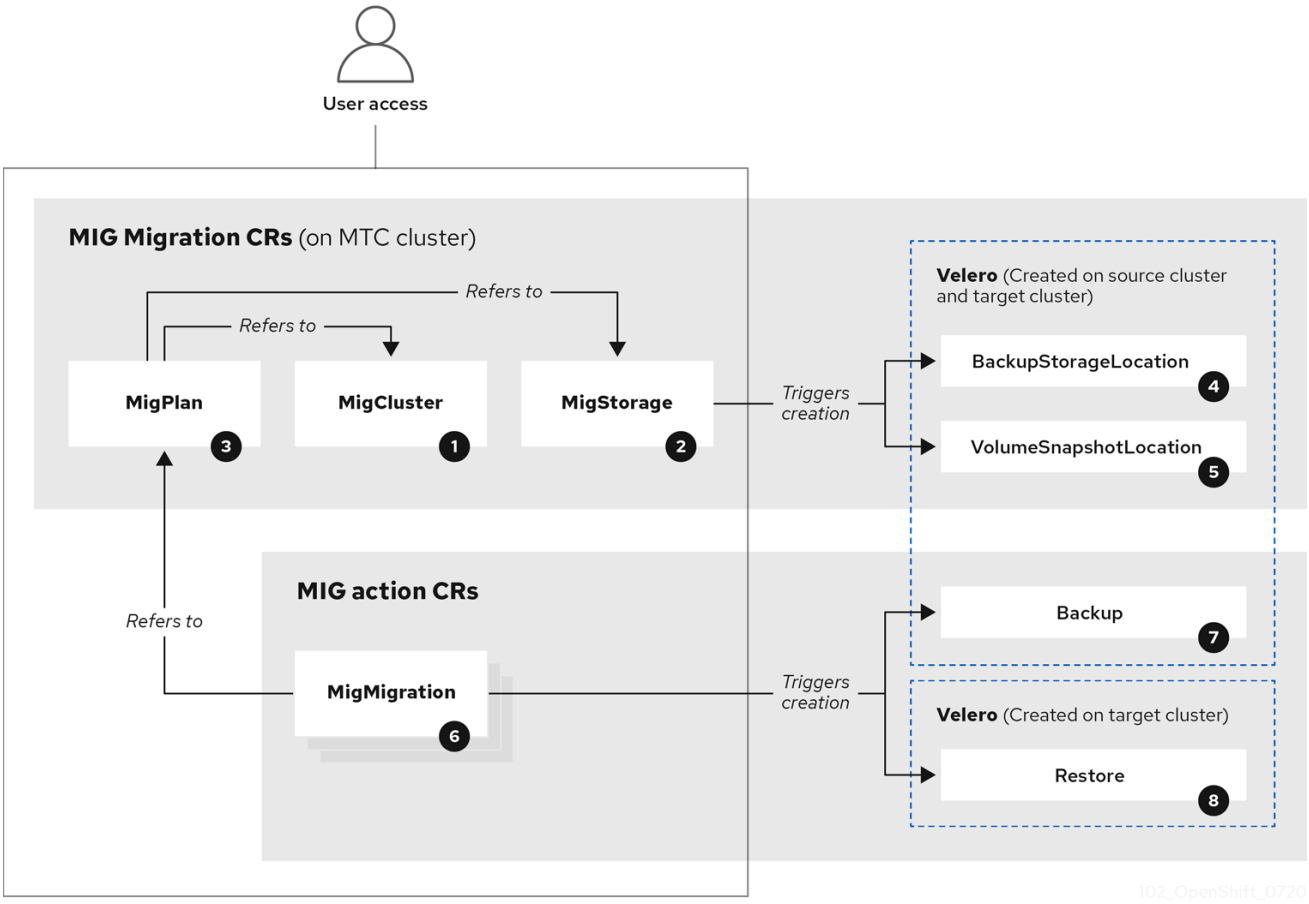
   - **Stage** (optional) copies data to the target cluster without stopping the application. Staging can be run multiple times so that most of the data is copied to the target before migration. This minimizes the duration of the migration and application downtime.

   - **Migrate** stops the application on the source cluster and recreates its resources on the target cluster. Optionally, you can migrate the workload without stopping the application.



3.1.2. Migration Toolkit for Containers custom resources

The Migration Toolkit for Containers (MTC) creates the following custom resources (CRs):



1 MigCluster (configuration, MTC cluster): Cluster definition

2 MigStorage (configuration, MTC cluster): Storage definition

3 MigPlan (configuration, MTC cluster): Migration plan

The **MigPlan** CR describes the source and target clusters, replication repository, and namespaces being migrated. It is associated with 0, 1, or many **MigMigration** CRs.

NOTE

Deleting a **MigPlan** CR deletes the associated **MigMigration** CRs.

4 BackupStorageLocation (configuration, MTC cluster): Location of **Velero** backup objects

5 VolumeSnapshotLocation (configuration, MTC cluster): Location of **Velero** volume snapshots

6 MigMigration (action, MTC cluster): Migration, created every time you stage or migrate data. Each **MigMigration** CR is associated with a **MigPlan** CR.

7 Backup (action, source cluster): When you run a migration plan, the **MigMigration** CR creates two **Velero** backup CRs on each source cluster:

- Backup CR #1 for Kubernetes objects

- Backup CR #2 for PV data

8 Restore (action, target cluster): When you run a migration plan, the **MigMigration** CR creates two **Velero** restore CRs on the target cluster:

- Restore CR #1 (using Backup CR #2) for PV data
- Restore CR #2 (using Backup CR #1) for Kubernetes objects

3.1.3. About data copy methods

The Migration Toolkit for Containers (MTC) supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

3.1.3.1. File system copy method

MTC copies data files from the source cluster to the replication repository, and from there to the target cluster.

Table 3.1. File system copy method summary

Benefits	Limitations
• Clusters can have different storage classes. • Supported for all S3 storage providers. • Optional data verification with checksum. • Supports direct volume migration, which significantly increases performance.	• Slower than the snapshot copy method. • Optional data verification significantly reduces performance.

3.1.3.2. Snapshot copy method

MTC copies a snapshot of the source cluster data to the replication repository of a cloud provider. The data is restored on the target cluster.

AWS, Google Cloud Provider, and Microsoft Azure support the snapshot copy method.

Table 3.2. Snapshot copy method summary

Benefits	Limitations

Benefits	Limitations
• Faster than the file system copy method.	• Cloud provider must support snapshots. • Clusters must be on the same cloud provider. • Clusters must be in the same location or region. • Clusters must have the same storage class. • Storage class must be compatible with snapshots. • Does not support direct volume migration.

3.1.3.3. Direct volume migration and direct image migration

You can use *direct image migration* and *direct volume migration* to migrate images and data directly from the source cluster to the target cluster.

Direct migration has significant performance benefits because it skips the intermediate steps of backing up files from the source cluster to the replication repository and restoring files from the replication repository to the target cluster.

Direct migration uses Rsync to transfer the files.

NOTE

Direct image migration and direct volume migration have additional prerequisites.

3.1.4. About migration hooks

You can use migration hooks to run custom code at certain points during a migration with the Migration Toolkit for Containers (MTC). You can add up to four migration hooks to a single migration plan, with each hook running at a different phase of the migration.

Migration hooks perform tasks such as customizing application quiescence, manually migrating unsupported data types, and updating applications after migration.

A migration hook runs on a source or a target cluster at one of the following migration steps:

- **PreBackup**: Before resources are backed up on the source cluster
- **PostBackup**: After resources are backed up on the source cluster
- **PreRestore**: Before resources are restored on the target cluster
- **PostRestore**: After resources are restored on the target cluster

You can create a hook by using an Ansible playbook or a custom hook container.

Ansible playbook

The Ansible playbook is mounted on a hook container as a config map. The hook container runs as a job, using the cluster, service account, and namespace specified in the **MigPlan** custom resource (CR). The job continues to run until it reaches the the default limit of 6 retries or a successful completion. This continues even if the initial pod is evicted or killed.

The default Ansible runtime image is **registry.redhat.io/rhmtc/openshift-migration-hook-runner-rhel7:1.4**. This image is based on the Ansible Runner image and includes **python-openshift** for Ansible Kubernetes resources and an updated **oc** binary.

Optional: You can use a custom Ansible runtime image containing additional Ansible modules or tools instead of the default image.

Custom hook container

You can create a custom hook container that includes Ansible playbooks or custom code.

3.2. INSTALLING AND UPGRADING THE MIGRATION TOOLKIT FOR CONTAINERS

You can install the Migration Toolkit for Containers Operator on your OpenShift Container Platform 4.7 target cluster and 4.2 source cluster.

MTC is installed on the target cluster by default. You can install MTC on an OpenShift Container Platform 3 cluster or on a remote cluster.

IMPORTANT

You must install the same MTC version on all clusters.

3.2.1. Installing the Migration Toolkit for Containers in a connected environment

You can install the Migration Toolkit for Containers (MTC) in a connected environment.

3.2.1.1. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.7 target cluster

You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4.7 target cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.

NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
7. Click **Create**.
8. Click **Workloads → Pods** to verify that the MTC pods are running.

3.2.1.2. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.2 source cluster

You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4 source cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.

NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
7. Update the following parameters in in the **migration-controller** custom resource manifest:

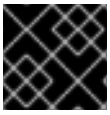
```
spec:
...
  migration_controller: false
```

```
migration_ui: false
```

8. Click **Create**.
9. Click **Workloads → Pods** to verify that the MTC pods are running.

3.2.2. Installing the Migration Toolkit for Containers in a restricted environment

You can install the Migration Toolkit for Containers (MTC) in a restricted environment.



IMPORTANT

You must install the same MTC version on all clusters.

You can build a custom Operator catalog image for OpenShift Container Platform 4, push it to a local mirror image registry, and configure Operator Lifecycle Manager (OLM) to install the Migration Toolkit for Containers Operator from the local registry.

3.2.2.1. Disabling the default OperatorHub 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.

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 → Global Configuration → OperatorHub** page, click the **Sources** tab, where you can create, delete, disable, and enable individual sources.

3.2.2.2. Pruning an index image

An index image, based on the Operator Bundle Format, is a containerized snapshot of an Operator catalog. You can 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.

When configuring Operator Lifecycle Manager (OLM) to use mirrored content on restricted network OpenShift Container Platform clusters, use this pruning method if you want to only mirror a subset of Operators from the default catalogs.

For the steps in this procedure, the target registry is an existing mirror registry that is accessible by your workstation with unrestricted network access. This example also shows pruning the index image for the default **redhat-operators** catalog, but the process is the same for any index image.

Prerequisites

- Workstation with unrestricted network access
- **podman** version 1.9.3+
- **grpcurl**
- **opm** version 1.12.3+
- Access to a registry that supports Docker v2-2

Procedure

1. Authenticate with **registry.redhat.io**:

```
$ podman login registry.redhat.io
```

2. Authenticate with your target registry:

```
$ podman login <target_registry>
```

3. 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:v4.7
```

Example output

```
Trying to pull registry.redhat.io/redhat/redhat-operator-index:v4.7...
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.

4. 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:v4.7 \ 1
   -p advanced-cluster-management,jaeger-product,quay-operator \ 2
   [-i registry.redhat.io/openshift4/ose-operator-registry:v4.7] \ 3
   -t <target_registry>:<port>/<namespace>/redhat-operator-index:v4.7 4
```

1. Index to prune.
2. Comma-separated list of packages to keep.
3. Required only for IBM Power Systems and IBM Z images: Operator Registry base image with the tag that matches the target OpenShift Container Platform cluster major and minor version.
4. Custom tag for new index image being built.

5. Run the following command to push the new index image to your target registry:

```
$ podman push <target_registry>:<port>/<namespace>/redhat-operator-index:v4.7
```

where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

3.2.2.3. Mirroring an Operator catalog

You can mirror the Operator content of a Red Hat-provided catalog, or a custom catalog, into a container image registry using the **oc adm catalog mirror** command. The target registry must support Docker v2-2. For a cluster on a restricted network, this registry can be one that the cluster has network access to, such as a mirror registry created during a restricted network cluster installation.

The **oc adm catalog mirror** command also automatically mirrors the index image that is specified during the mirroring process, whether it be a Red Hat-provided index image or your own custom-built index image, to the target registry. You can then use the mirrored index image to create a catalog source that allows Operator Lifecycle Manager (OLM) to load the mirrored catalog onto your OpenShift Container Platform cluster.

Prerequisites

- Workstation with unrestricted network access.
- **podman** version 1.9.3 or later.
- Access to mirror registry that supports Docker v2-2.

- Decide which namespace on your mirror registry you will use to store the mirrored Operator content. For example, you might create an **olm-mirror** namespace.
- If your mirror registry does not have Internet access, connect removable media to your workstation with unrestricted network access.
- If you are working with private registries, set the **REG_CREDS** environment variable to the file path of your registry credentials for use in later steps. For example, for the **podman** CLI:

```
$ REG_CREDS=${XDG_RUNTIME_DIR}/containers/auth.json
```

Procedure

1. If you want to mirror a Red Hat-provided catalog, run the following command on your workstation with unrestricted network access to authenticate with **registry.redhat.io**:

```
$ podman login registry.redhat.io
```

2. The **oc adm catalog mirror** command extracts the contents of an index image to generate the manifests required for mirroring. The default behavior of the command generates manifests, then automatically mirrors all of the image content from the index image, as well as the index image itself, to your mirror registry. Alternatively, if your mirror registry is on a completely disconnected, or *airgapped*, host, you can first mirror the content to removable media, move the media to the disconnected environment, then mirror the content from the media to the registry.

   - **Option A: If your mirror registry is on the same network** as your workstation with unrestricted network access, take the following actions on your workstation:

     a. If your mirror registry requires authentication, run the following command to log in to the registry:

```
$ podman login <mirror_registry>
```

     b. Run the following command to mirror the content:

```
$ oc adm catalog mirror \
    <index_image> \ 1
    <mirror_registry>:<port>/<namespace> \ 2
    [-a ${REG_CREDS}] \ 3
    [--insecure] \ 4
    [--index-filter-by-os='<platform>/<arch>'] \ 5
    [--manifests-only] 6
```

     1 Specify the index image for the catalog you want to mirror. For example, this might be a pruned index image that you created previously, or one of the source index images for the default catalogs, such as **registry.redhat.io/redhat/redhat-operator-index:v4.7**.

     2 Specify the target registry and namespace to mirror the Operator content to, where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

     3 Optional: If required, specify the location of your registry credentials file.

4. Optional: If you do not want to configure trust for the target registry, add the **--insecure** flag.

5. Optional: Specify which platform and architecture of the index image to select when multiple variants are available. Images are passed as **'<platform>/<arch>[/<variant>]'**. This does not apply to images referenced by the index. Valid values are **linux/amd64**, **linux/ppc64le**, and **linux/s390x**.

6. Optional: Generate only the manifests required for mirroring, and do not actually mirror the image content to a registry. This option can be useful for reviewing what will be mirrored, and it allows you to make any changes to the mapping list if you require only a subset of packages. You can then use the **mapping.txt** file with the **oc image mirror** command to mirror the modified list of images in a later step. This flag is intended for only advanced selective mirroring of content from the catalog; the **opm index prune** command, if you used it previously to prune the index image, is suitable for most catalog management use cases.

Example output

```
src image has index label for database path: /database/index.db
using database path mapping: /database/index.db:/tmp/153048078
wrote database to /tmp/153048078 1
...
wrote mirroring manifests to manifests-redhat-operator-index-1614211642 2
```

1. Directory for the temporary **index.db** database generated by the command.

2. Record the manifests directory name that is generated. This directory name is used in a later step.

- **Option B: If your mirror registry is on a disconnected host**, take the following actions.

  a. Run the following command on your workstation with unrestricted network access to mirror the content to local files:

```
$ oc adm catalog mirror \
    <index_image> \ 1
    file:///local/index \ 2
    [-a ${REG_CREDS}] \
    [--insecure]
```

1. Specify the index image for the catalog you want to mirror. For example, this might be a pruned index image that you created previously, or one of the source index images for the default catalogs, such as **registry.redhat.io/redhat/redhat-operator-index:v4.7**.

2. Mirrors content to local files in your current directory.

Example output

```
...
info: Mirroring completed in 5.93s (5.915MB/s)
```

```
wrote mirroring manifests to manifests-my-index-1614985528 (1)

To upload local images to a registry, run:

 oc adm catalog mirror file://local/index/myrepo/my-index:v1
REGISTRY/REPOSITORY (2)
```

(1) Record the manifests directory name that is generated. This directory name is used in a later step.

(2) Record the expanded **file://** path that based on your provided index image. This path is used in a later step.

b. Copy the **v2/** directory that is generated in your current directory to removable media.

c. Physically remove the media and attach it to a host in the disconnected environment that has access to the mirror registry.

d. If your mirror registry requires authentication, run the following command on your host in the disconnected environment to log in to the registry:

```
$ podman login <mirror_registry>
```

e. Run the following command from the parent directory containing the **v2/** directory to upload the images from local files to the mirror registry:

```
$ oc adm catalog mirror \
    file://local/index/<repo>/<index_image>:<tag> \ (1)
    <mirror_registry>:<port>/<namespace> \ (2)
    [-a ${REG_CREDS}] \
    [--insecure]
```

(1) Specify the **file://** path from the previous command output.

(2) Specify the target registry and namespace to mirror the Operator content to, where **<namespace>** is any existing namespace on the registry. For example, you might create an **olm-mirror** namespace to push all mirrored content to.

3. After mirroring the content to your registry, inspect the manifests directory that is generated in your current directory.

NOTE

The manifests directory name is used in a later step.

If you mirrored content to a registry on the same network in the previous step, the directory name takes the following form:

```
manifests-<index_image_name>-<random_number>
```

If you mirrored content to a registry on a disconnected host in the previous step, the directory name takes the following form:

```
manifests-index/<namespace>/<index_image_name>-<random_number>
```

The manifests directory contains the following files, some of which might require further modification:

- The **catalogSource.yaml** file is a basic definition for a **CatalogSource** object that is pre-populated with your index image tag and other relevant metadata. This file can be used as is or modified to add the catalog source to your cluster.

IMPORTANT

If you mirrored the content to local files, you must modify your **catalogSource.yaml** file to remove any backslash (/) characters from the **metadata.name** field. Otherwise, when you attempt to create the object, it fails with an "invalid resource name" error.

- The **imageContentSourcePolicy.yaml** file defines an **ImageContentSourcePolicy** object that can configure nodes to translate between the image references stored in Operator manifests and the mirrored registry.

NOTE

If your cluster uses an **ImageContentSourcePolicy** object to configure repository mirroring, you can use only global pull secrets for mirrored registries. You cannot add a pull secret to a project.

- The **mapping.txt** file contains all of the source images and where to map them in the target registry. This file is compatible with the **oc image mirror** command and can be used to further customize the mirroring configuration.

IMPORTANT

If you used the **--manifests-only** flag during the mirroring process and want to further trim the subset of packages to be mirrored, see the steps in the "Mirroring a Package Manifest Format catalog image" procedure about modifying your **mapping.txt** file and using the file with the **oc image mirror** command. After following those further actions, you can continue this procedure.

4. On a host with access to the disconnected cluster, create the **ImageContentSourcePolicy** object by running the following command to specify the **imageContentSourcePolicy.yaml** file in your manifests directory:

```
$ oc create -f <path/to/manifests/dir>/imageContentSourcePolicy.yaml
```

where **<path/to/manifests/dir>** is the path to the manifests directory for your mirrored content.

You can now create a **CatalogSource** object to reference your mirrored index image and Operator content.

3.2.2.4. Creating a catalog from an index image

You can create an Operator catalog from an index image and apply it to an OpenShift Container Platform cluster for use with Operator Lifecycle Manager (OLM).

Prerequisites

- An index image built and pushed to a registry.

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
   spec:
     sourceType: grpc
     image: <registry>:<port>/<namespace>/redhat-operator-index:v4.7 <.>
     displayName: My Operator Catalog
     publisher: <publisher_name> <.>
     updateStrategy:
       registryPoll: <.>
         interval: 30m
   ```

   <.> Specify your index image. <.> Specify your name or an organization name publishing the catalog. <.> 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.

3.2.2.5. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.7 target cluster in a restricted environment

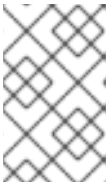
You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4.7 target cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must create a custom Operator catalog and push it to a mirror registry.
- You must configure Operator Lifecycle Manager to install the Migration Toolkit for Containers Operator from the mirror registry.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.



NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
7. Click **Create**.
8. Click **Workloads → Pods** to verify that the MTC pods are running.

3.2.2.6. Installing the Migration Toolkit for Containers on an OpenShift Container Platform 4.2 source cluster in a restricted environment

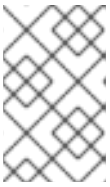
You can install the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4 source cluster.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must create a custom Operator catalog and push it to a mirror registry.
- You must configure Operator Lifecycle Manager to install the Migration Toolkit for Containers Operator from the mirror registry.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use the **Filter by keyword** field to find the **Migration Toolkit for Containers Operator**.
3. Select the **Migration Toolkit for Containers Operator** and click **Install**.



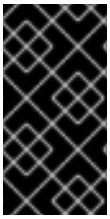
NOTE

Do not change the subscription approval option to **Automatic**. The Migration Toolkit for Containers version must be the same on the source and the target clusters.

4. Click **Install**.
   On the **Installed Operators** page, the **Migration Toolkit for Containers Operator** appears in the **openshift-migration** project with the status **Succeeded**.
5. Click **Migration Toolkit for Containers Operator**.
6. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
7. Click **Create**.
8. Click **Workloads → Pods** to verify that the MTC pods are running.

3.2.3. Upgrading the Migration Toolkit for Containers

You can upgrade the Migration Toolkit for Containers (MTC) by using the OpenShift Container Platform web console.



IMPORTANT

You must ensure that the same MTC version is installed on all clusters.

If you are upgrading MTC version 1.3, you must perform an additional procedure to update the **MigPlan** custom resource (CR).

3.2.3.1. Upgrading the Migration Toolkit for Containers on an OpenShift Container Platform 4 cluster

You can upgrade the Migration Toolkit for Containers (MTC) on an OpenShift Container Platform 4 cluster by using the OpenShift Container Platform web console.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges.

Procedure

1. In the OpenShift Container Platform console, navigate to **Operators → Installed Operators**. Operators that have a pending upgrade display an **Upgrade available** status.
2. Click **Migration Toolkit for Containers Operator**.
3. Click the **Subscription** tab. Any upgrades 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 upgrade and click **Approve**.
6. Navigate back to the **Operators → Installed Operators** page to monitor the progress of the upgrade. When complete, the status changes to **Succeeded** and **Up to date**.
7. Click **Migration Toolkit for Containers Operator**.
8. Under **Provided APIs**, locate the **Migration Controller** tile, and click **Create Instance**.
9. If you are upgrading MTC on a *source* cluster, update the following parameters in the **MigrationController** custom resource (CR) manifest:

```
spec:
...
  migration_controller: false
  migration_ui: false
```

   You do not need to update the **MigrationController** CR manifest on the target cluster.
10. Click **Create**.
11. Click **Workloads → Pods** to verify that the MTC pods are running.

3.2.3.2. Upgrading MTC 1.3 to 1.4

If you are upgrading Migration Toolkit for Containers (MTC) version 1.3.x to 1.4, you must update the **MigPlan** custom resource (CR) manifest on the cluster on which the **MigrationController** pod is running.

Because the **indirectImageMigration** and **indirectVolumeMigration** parameters do not exist in MTC 1.3, their default value in version 1.4 is **false**, which means that direct image migration and direct volume migration are enabled. Because the direct migration requirements are not fulfilled, the migration plan cannot reach a **Ready** state unless these parameter values are changed to **true**.

Prerequisites

- You must have MTC 1.3 installed.
- You must be logged in as a user with **cluster-admin** privileges.

Procedure

1. Log in to the cluster on which the **MigrationController** pod is running.
2. Get the **MigPlan** CR manifest:

```
$ oc get migplan <migplan> -o yaml -n openshift-migration
```

3. Update the following parameter values and save the file as **migplan.yaml**:

```
...
spec:
  indirectImageMigration: true
  indirectVolumeMigration: true
```

4. Replace the **MigPlan** CR manifest to apply the changes:

```
$ oc replace -f migplan.yaml -n openshift-migration
```

5. Get the updated **MigPlan** CR manifest to verify the changes:

```
$ oc get migplan <migplan> -o yaml -n openshift-migration
```

3.3. CONFIGURING OBJECT STORAGE FOR A REPLICATION REPOSITORY

You must configure an object storage to use as a replication repository. The Migration Toolkit for Containers (MTC) copies data from the source cluster to the replication repository, and then from the replication repository to the target cluster.

MTC supports the file system and snapshot data copy methods for migrating data from the source cluster to the target cluster. You can select a method that is suited for your environment and is supported by your storage provider.

The following storage providers are supported:

- Multi-Cloud Object Gateway (MCG)
- Amazon Web Services (AWS) S3
- Google Cloud Provider (GCP)
- Microsoft Azure
- Generic S3 object storage, for example, Minio or Ceph S3

In a restricted environment, you can create an internally hosted replication repository.

Prerequisites

- All clusters must have uninterrupted network access to the replication repository.
- If you use a proxy server with an internally hosted replication repository, you must ensure that the proxy allows access to the replication repository.

3.3.1. Configuring a Multi-Cloud Object Gateway storage bucket as a replication repository

You can install the OpenShift Container Storage Operator and configure a Multi-Cloud Object Gateway (MCG) storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

3.3.1.1. Installing the OpenShift Container Storage Operator

You can install the OpenShift Container Storage Operator from OperatorHub.

Procedure

1. In the OpenShift Container Platform web console, click **Operators → OperatorHub**.
2. Use **Filter by keyword** (in this case, **OCS**) to find the **OpenShift Container Storage Operator**.
3. Select the **OpenShift Container Storage Operator** and click **Install**.
4. Select an **Update Channel**, **Installation Mode**, and **Approval Strategy**.
5. Click **Install**.
   On the **Installed Operators** page, the **OpenShift Container Storage Operator** appears in the **openshift-storage** project with the status **Succeeded**.

3.3.1.2. Creating the Multi-Cloud Object Gateway storage bucket

You can create the Multi-Cloud Object Gateway (MCG) storage bucket's custom resources (CRs).

Procedure

1. Log in to the OpenShift Container Platform cluster:

```
$ oc login -u <username>
```

2. Create the **NooBaa** CR configuration file, **noobaa.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: NooBaa
metadata:
  name: noobaa
  namespace: openshift-storage
spec:
 dbResources:
   requests:
     cpu: 0.5 (1)
     memory: 1Gi
 coreResources:
```

```
    requests:
      cpu: 0.5 (2)
      memory: 1Gi
```

(1) (2) For a very small cluster, you can change the **cpu** value to **0.1**.

3. Create the **NooBaa** object:

```
$ oc create -f noobaa.yml
```

4. Create the **BackingStore** CR configuration file, **bs.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: BackingStore
metadata:
  finalizers:
  - noobaa.io/finalizer
  labels:
    app: noobaa
  name: mcg-pv-pool-bs
  namespace: openshift-storage
spec:
  pvPool:
    numVolumes: 3 (1)
    resources:
      requests:
        storage: 50Gi (2)
    storageClass: gp2 (3)
  type: pv-pool
```

(1) Specify the number of volumes in the persistent volume pool.

(2) Specify the size of the volumes.

(3) Specify the storage class.

5. Create the **BackingStore** object:

```
$ oc create -f bs.yml
```

6. Create the **BucketClass** CR configuration file, **bc.yml**, with the following content:

```
apiVersion: noobaa.io/v1alpha1
kind: BucketClass
metadata:
  labels:
    app: noobaa
  name: mcg-pv-pool-bc
  namespace: openshift-storage
spec:
  placementPolicy:
    tiers:
```

```
    - backingStores:
      - mcg-pv-pool-bs
      placement: Spread
```

7. Create the **BucketClass** object:

```
$ oc create -f bc.yml
```

8. Create the **ObjectBucketClaim** CR configuration file, **obc.yml**, with the following content:

```
apiVersion: objectbucket.io/v1alpha1
kind: ObjectBucketClaim
metadata:
  name: migstorage
  namespace: openshift-storage
spec:
  bucketName: migstorage 1
  storageClassName: openshift-storage.noobaa.io
  additionalConfig:
    bucketclass: mcg-pv-pool-bc
```

1 Record the bucket name for adding the replication repository to the MTC web console.

9. Create the **ObjectBucketClaim** object:

```
$ oc create -f obc.yml
```

10. Watch the resource creation process to verify that the **ObjectBucketClaim** status is **Bound**:

```
$ watch -n 30 'oc get -n openshift-storage objectbucketclaim migstorage -o yaml'
```

This process can take five to ten minutes.

11. Obtain and record the following values, which are required when you add the replication repository to the MTC web console:

- S3 endpoint:

```
$ oc get route -n openshift-storage s3
```

- S3 provider access key:

```
$ oc get secret -n openshift-storage migstorage -o go-template='{{
.data.AWS_ACCESS_KEY_ID }}' | base64 --decode
```

- S3 provider secret access key:

```
$ oc get secret -n openshift-storage migstorage -o go-template='{{
.data.AWS_SECRET_ACCESS_KEY }}' | base64 --decode
```

3.3.2. Configuring an AWS S3 storage bucket as a replication repository

You can configure an AWS S3 storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- The AWS S3 storage bucket must be accessible to the source and target clusters.
- You must have the AWS CLI installed.
- If you are using the snapshot copy method:
  - You must have access to EC2 Elastic Block Storage (EBS).
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Create an AWS S3 bucket:

```
$ aws s3api create-bucket \
    --bucket <bucket_name> \ 1
    --region <bucket_region> 2
```

1. Specify your S3 bucket name.
2. Specify your S3 bucket region, for example, **us-east-1**.

2. Create the IAM user **velero**:

```
$ aws iam create-user --user-name velero
```

3. Create an EC2 EBS snapshot policy:

```
$ cat > velero-ec2-snapshot-policy.json <<EOF
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "ec2:DescribeVolumes",
                "ec2:DescribeSnapshots",
                "ec2:CreateTags",
                "ec2:CreateVolume",
                "ec2:CreateSnapshot",
                "ec2:DeleteSnapshot"
            ],
            "Resource": "*"
        }
```

```
    ]
}
EOF
```

4. Create an AWS S3 access policy for one or for all S3 buckets:

```
$ cat > velero-s3-policy.json <<EOF
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "s3:GetObject",
                "s3:DeleteObject",
                "s3:PutObject",
                "s3:AbortMultipartUpload",
                "s3:ListMultipartUploadParts"
            ],
            "Resource": [
                "arn:aws:s3:::<bucket_name>/*" (1)
            ]
        },
        {
            "Effect": "Allow",
            "Action": [
                "s3:ListBucket",
                "s3:GetBucketLocation",
                "s3:ListBucketMultipartUploads"
            ],
            "Resource": [
                "arn:aws:s3:::<bucket_name>" (2)
            ]
        }
    ]
}
EOF
```

(1) (2) To grant access to a single S3 bucket, specify the bucket name. To grant access to all AWS S3 buckets, specify * instead of a bucket name as in the following example:

Example output

```
"Resource": [
    "arn:aws:s3:::*"
```

5. Attach the EC2 EBS policy to **velero**:

```
$ aws iam put-user-policy \
  --user-name velero \
  --policy-name velero-ebs \
  --policy-document file://velero-ec2-snapshot-policy.json
```

6. Attach the AWS S3 policy to **velero**:

```
$ aws iam put-user-policy \
  --user-name velero \
  --policy-name velero-s3 \
  --policy-document file://velero-s3-policy.json
```

7. Create an access key for **velero**:

```
$ aws iam create-access-key --user-name velero
{
  "AccessKey": {
        "UserName": "velero",
        "Status": "Active",
        "CreateDate": "2017-07-31T22:24:41.576Z",
        "SecretAccessKey": <AWS_SECRET_ACCESS_KEY>, 1
        "AccessKeyId": <AWS_ACCESS_KEY_ID> 2
    }
}
```

1 2 Record the **AWS_SECRET_ACCESS_KEY** and the **AWS_ACCESS_KEY_ID** for adding the AWS repository to the MTC web console.

3.3.3. Configuring a Google Cloud Provider storage bucket as a replication repository

You can configure a Google Cloud Provider (GCP) storage bucket as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- The GCP storage bucket must be accessible to the source and target clusters.
- You must have **gsutil** installed.
- If you are using the snapshot copy method:
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Log in to **gsutil**:

```
$ gsutil init
```

Example output

```
Welcome! This command will take you through the configuration of gcloud.
```

```
Your current configuration has been set to: [default]

To continue, you must login. Would you like to login (Y/n)?
```

2. Set the **BUCKET** variable:

```
$ BUCKET=<bucket_name> 1
```

1 Specify your bucket name.

3. Create a storage bucket:

```
$ gsutil mb gs://$BUCKET/
```

4. Set the **PROJECT_ID** variable to your active project:

```
$ PROJECT_ID=`gcloud config get-value project`
```

5. Create a **velero** IAM service account:

```
$ gcloud iam service-accounts create velero \
    --display-name "Velero Storage"
```

6. Create the **SERVICE_ACCOUNT_EMAIL** variable:

```
$ SERVICE_ACCOUNT_EMAIL=`gcloud iam service-accounts list \
  --filter="displayName:Velero Storage" \
  --format 'value(email)'`
```

7. Create the **ROLE_PERMISSIONS** variable:

```
$ ROLE_PERMISSIONS=(
    compute.disks.get
    compute.disks.create
    compute.disks.createSnapshot
    compute.snapshots.get
    compute.snapshots.create
    compute.snapshots.useReadOnly
    compute.snapshots.delete
    compute.zones.get
)
```

8. Create the **velero.server** custom role:

```
$ gcloud iam roles create velero.server \
    --project $PROJECT_ID \
    --title "Velero Server" \
    --permissions "$(IFS=","; echo "${ROLE_PERMISSIONS[*]}")"
```

9. Add IAM policy binding to the project:

```
$ gcloud projects add-iam-policy-binding $PROJECT_ID \
    --member serviceAccount:$SERVICE_ACCOUNT_EMAIL \
    --role projects/$PROJECT_ID/roles/velero.server
```

10. Update the IAM service account:

```
$ gsutil iam ch serviceAccount:$SERVICE_ACCOUNT_EMAIL:objectAdmin gs://${BUCKET}
```

11. Save the IAM service account keys to the **credentials-velero** file in the current directory:

```
$ gcloud iam service-accounts keys create credentials-velero \
  --iam-account $SERVICE_ACCOUNT_EMAIL
```

3.3.4. Configuring a Microsoft Azure Blob storage container as a replication repository

You can configure a Microsoft Azure Blob storage container as a replication repository for the Migration Toolkit for Containers (MTC).

Prerequisites

- You must have an Azure storage account.
- You must have the Azure CLI installed.
- The Azure Blob storage container must be accessible to the source and target clusters.
- If you are using the snapshot copy method:
  - The source and target clusters must be in the same region.
  - The source and target clusters must have the same storage class.
  - The storage class must be compatible with snapshots.

Procedure

1. Set the **AZURE_RESOURCE_GROUP** variable:

```
$ AZURE_RESOURCE_GROUP=Velero_Backups
```

2. Create an Azure resource group:

```
$ az group create -n $AZURE_RESOURCE_GROUP --location <CentralUS> 1
```

1 Specify your location.

3. Set the **AZURE_STORAGE_ACCOUNT_ID** variable:

```
$ AZURE_STORAGE_ACCOUNT_ID=velerobackups
```

4. Create an Azure storage account:

```
$ az storage account create \
  --name $AZURE_STORAGE_ACCOUNT_ID \
  --resource-group $AZURE_RESOURCE_GROUP \
  --sku Standard_GRS \
  --encryption-services blob \
  --https-only true \
  --kind BlobStorage \
  --access-tier Hot
```

5. Set the **BLOB_CONTAINER** variable:

```
$ BLOB_CONTAINER=velero
```

6. Create an Azure Blob storage container:

```
$ az storage container create \
  -n $BLOB_CONTAINER \
  --public-access off \
  --account-name $AZURE_STORAGE_ACCOUNT_ID
```

7. Create a service principal and credentials for **velero**:

```
$ AZURE_SUBSCRIPTION_ID=`az account list --query '[?isDefault].id' -o tsv` \
  AZURE_TENANT_ID=`az account list --query '[?isDefault].tenantId' -o tsv` \
  AZURE_CLIENT_SECRET=`az ad sp create-for-rbac --name "velero" --role "Contributor" --
query 'password' -o tsv` \
  AZURE_CLIENT_ID=`az ad sp list --display-name "velero" --query '[0].appId' -o tsv`
```

8. Save the service principal credentials in the **credentials-velero** file:

```
$ cat << EOF  > ./credentials-velero
AZURE_SUBSCRIPTION_ID=${AZURE_SUBSCRIPTION_ID}
AZURE_TENANT_ID=${AZURE_TENANT_ID}
AZURE_CLIENT_ID=${AZURE_CLIENT_ID}
AZURE_CLIENT_SECRET=${AZURE_CLIENT_SECRET}
AZURE_RESOURCE_GROUP=${AZURE_RESOURCE_GROUP}
AZURE_CLOUD_NAME=AzurePublicCloud
EOF
```

3.4. MIGRATING YOUR APPLICATIONS

You can migrate your applications by using the Migration Toolkit for Containers (MTC) web console or on the command line.

3.4.1. Prerequisites

The Migration Toolkit for Containers (MTC) has the following prerequisites:

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- The MTC version must be the same on all clusters.
- Clusters:

- The source cluster must be upgraded to the latest MTC z-stream release.
- The cluster on which the **migration-controller** pod is running must have unrestricted network access to the other clusters.
- The clusters must have unrestricted network access to each other.
- The clusters must have unrestricted network access to the replication repository.
- The clusters must be able to communicate using OpenShift routes on port 443.
- The clusters must have no critical conditions.
- The clusters must be in a ready state.

- Volume migration:
  - The persistent volumes (PVs) must be valid.
  - The PVs must be bound to persistent volume claims.
  - If you copy the PVs by using the *move* method, the clusters must have unrestricted network access to the remote volume.
  - If you copy the PVs by using the *snapshot* copy method, the following prerequisites apply:
    - The cloud provider must support snapshots.
    - The volumes must have the same cloud provider.
    - The volumes must be located in the same geographic region.
    - The volumes must have the same storage class.

- If you perform a direct volume migration in a proxy environment, you must configure an Stunnel TCP proxy.
- If you perform a direct image migration, you must expose the internal registry of the source cluster to external traffic.

3.4.1.1. Creating a CA certificate bundle file

If you use a self-signed certificate to secure a cluster or a replication repository for the Migration Toolkit for Containers (MTC), certificate verification might fail with the following error message: **Certificate signed by unknown authority**.

You can create a custom CA certificate bundle file and upload it in the MTC web console when you add a cluster or a replication repository.

Procedure

Download a CA certificate from a remote endpoint and save it as a CA bundle file:

```
$ echo -n | openssl s_client -connect <host_FQDN>:<port> \ 1
  | sed -ne '/-BEGIN CERTIFICATE-/,/-END CERTIFICATE-/p' > <ca_bundle.cert> 2
```

1 Specify the host FQDN and port of the endpoint, for example, **api.my-cluster.example.com:6443**.

2 Specify the name of the CA bundle file.

3.4.1.2. Configuring a proxy for direct volume migration

If you are performing direct volume migration from a source cluster behind a proxy, you must configure an Stunnel proxy in the **MigrationController** custom resource (CR). Stunnel creates a transparent tunnel between the source and target clusters for the TCP connection without changing the certificates.

NOTE

Direct volume migration supports only one proxy. The source cluster cannot access the route of the target cluster if the target cluster is also behind a proxy.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.

Procedure

1. Log in to the cluster on which the **MigrationController** pod runs.
2. Get the **MigrationController** CR manifest:

```
$ oc get migrationcontroller <migration_controller> -n openshift-migration
```

3. Add the **stunnel_tcp_proxy** parameter:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigrationController
metadata:
  name: migration-controller
  namespace: openshift-migration
...
spec:
  stunnel_tcp_proxy: <stunnel_proxy> 1
```

1 Specify the Stunnel proxy: **http://<user_name>:<password>@<ip_address>:<port>**.

4. Save the manifest as **migration-controller.yaml**.
5. Apply the updated manifest:

```
$ oc replace -f migration-controller.yaml -n openshift-migration
```

3.4.1.3. Writing an Ansible playbook for a migration hook

You can write an Ansible playbook to use as a migration hook. The hook is added to a migration plan by using the MTC web console or by specifying values for the **spec.hooks** parameters in the **MigPlan** custom resource (CR) manifest.

The Ansible playbook is mounted onto a hook container as a config map. The hook container runs as a

job, using the cluster, service account, and namespace specified in the **MigPlan** CR. The hook container uses a specified service account token so that the tasks do not require authentication before they run in the cluster.

3.4.1.3.1. Ansible modules

You can use the Ansible **shell** module to run **oc** commands.

Example shell module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: get pod name
    shell: oc get po --all-namespaces
```

You can use **kubernetes.core** modules, such as **k8s_info**, to interact with Kubernetes resources.

Example k8s_facts module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: Get pod
    k8s_info:
      kind: pods
      api: v1
      namespace: openshift-migration
      name: "{{ lookup( 'env', 'HOSTNAME') }}"
    register: pods

  - name: Print pod name
    debug:
      msg: "{{ pods.resources[0].metadata.name }}"
```

You can use the **fail** module to produce a non-zero exit status in cases where a non-zero exit status would not normally be produced, ensuring that the success or failure of a hook is detected. Hooks run as jobs and the success or failure status of a hook is based on the exit status of the job container.

Example fail module

```
- hosts: localhost
  gather_facts: false
  tasks:
  - name: Set a boolean
    set_fact:
      do_fail: true

  - name: "fail"
    fail:
      msg: "Cause a failure"
    when: do_fail
```

3.4.1.3.2. Environment variables

The **MigPlan** CR name and migration namespaces are passed as environment variables to the hook container. These variables are accessed by using the **lookup** plug-in.

Example environment variables

```
- hosts: localhost
  gather_facts: false
  tasks:
  - set_fact:
      namespaces: "{{ (lookup( 'env', 'migration_namespaces')).split(',') }}"

  - debug:
      msg: "{{ item }}"
    with_items: "{{ namespaces }}"

  - debug:
      msg: "{{ lookup( 'env', 'migplan_name') }}"
```

3.4.1.4. Additional resources

- About migration hooks
- MigHook custom resource
- MigPlan custom resource

3.4.2. Migrating your applications by using the MTC web console

You can configure clusters and a replication repository by using the MTC web console. Then, you can create and run a migration plan.

3.4.2.1. Launching the MTC web console

You can launch the Migration Toolkit for Containers (MTC) web console in a browser.

Prerequisites

- The MTC web console must have network access to the OpenShift Container Platform web console.
- The MTC web console must have network access to the OAuth authorization server.

Procedure

1. Log in to the OpenShift Container Platform cluster on which you have installed MTC.
2. Obtain the MTC web console URL by entering the following command:

   ```
   $ oc get -n openshift-migration route/migration -o go-template='https://{{ .spec.host }}'
   ```

   The output resembles the following: **https://migration-openshift-migration.apps.cluster.openshift.com**.

3. Launch a browser and navigate to the MTC web console.

NOTE

If you try to access the MTC web console immediately after installing the Migration Toolkit for Containers Operator, the console might not load because the Operator is still configuring the cluster. Wait a few minutes and retry.

4. If you are using self-signed CA certificates, you will be prompted to accept the CA certificate of the source cluster API server. The web page guides you through the process of accepting the remaining certificates.

5. Log in with your OpenShift Container Platform **username** and **password**.

3.4.2.2. Adding a cluster to the MTC web console

You can add a cluster to the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- If you are using Azure snapshots to copy data:
  - You must specify the Azure resource group name for the cluster.
  - The clusters must be in the same Azure resource group.
  - The clusters must be in the same geographic location.

Procedure

1. Log in to the cluster.

2. Obtain the **migration-controller** service account token:

```
$ oc sa get-token migration-controller -n openshift-migration
```

Example output

```
eyJhbGciOiJSUzI1NiIsImtpZCI6IiJ9.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwi
a3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9uYW1lc3BhY2UiOiJtaWciLCJrdWJlcm5ldGV:
LmlvL3NlcnZpY2VhY2NvdW50L3NlY3JldC5uYW1lIjoibWlnLXRva2VuLWs4dDJyIiwia3ViZXJuZ
XRlcy5pby9zZXJ2aWNlYWNjb3VudC9zZXJ2aWNlLWFjY291bnQubmFtZSI6Im1pZyIsImt1YmV
ybmV0ZXMuaW8vc2VydmljZWFjY291bnQvc2VydmljZS1hY2NvdW50LnVpZCI6ImE1YjFiYWM
wLWMxYmYtMTFlOS05Y2NiLTAyOWRmODYwYjMwOCIsInN1YiI6InN5c3RlbTpzZXJ2aWNlY
WNjb3VudDptaWc6bWlnIn0.xqeeAINK7UXpdRqAtOj70qhBJPeMwmgLomV9iFxr5RoqUgKchZ
RG2J2rkqmPm6vr7K-
cm7ibD1IBpdQJCcVDuoHYsFgV4mp9vgOfn9osSDp2TGikwNz4Az95e81xnjVUmzh-
NjDsEpw71DH92iHV_xt2sTwtzftS49LpPW2LjrV0evtNBP_t_RfskdArt5VSv25eORI7zScqfe1CiM
kcVbf2UqACQjo3LbkpfN26HAioO2oH0ECPiRzT0Xyh-KwFutJLS9Xgghyw-
LD9kPKcE_xbbJ9Y4Rqajh7WdPYuB0Jd9DPVrslmzK-F6cgHHYoZEv0SvLQi-
PO0rpDrcjOEQQ
```

3. In the MTC web console, click **Clusters**.

4. Click **Add cluster**.
5. Fill in the following fields:
   - **Cluster name**: The cluster name can contain lower-case letters (**a-z**) and numbers (**0-9**). It must not contain spaces or international characters.
   - **URL**: Specify the API server URL, for example, **https://<www.example.com>:8443**.
   - **Service account token**: Paste the **migration-controller** service account token.
   - **Exposed route host to image registry**: If you are using direct image migration, specify the exposed route to the image registry of the source cluster, for example, **www.example.apps.cluster.com**.
     You can specify a port. The default port is **5000**.
   - **Azure cluster**: You must select this option if you use Azure snapshots to copy your data.
   - **Azure resource group**: This field is displayed if **Azure cluster** is selected. Specify the Azure resource group.
   - **Require SSL verification**: Optional: Select this option to verify SSL connections to the cluster.
   - **CA bundle file**: This field is displayed if **Require SSL verification** is selected. If you created a custom CA certificate bundle file for self-signed certificates, click **Browse**, select the CA bundle file, and upload it.
6. Click **Add cluster**.
   The cluster appears in the **Clusters** list.

3.4.2.3. Adding a replication repository to the MTC web console

You can add an object storage bucket as a replication repository to the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- You must configure an object storage bucket for migrating the data.

Procedure

1. In the MTC web console, click **Replication repositories**.
2. Click **Add repository**.
3. Select a **Storage provider type** and fill in the following fields:
   - **AWS** for AWS S3, MCG, and generic S3 providers:
     - **Replication repository name**: Specify the replication repository name in the MTC web console.
     - **S3 bucket name**: Specify the name of the S3 bucket you created.
     - **S3 bucket region**: Specify the S3 bucket region. **Required** for AWS S3. **Optional** for other S3 providers.

- **S3 endpoint**: Specify the URL of the S3 service, not the bucket, for example, **https://<s3-storage.apps.cluster.com>**. **Required** for a generic S3 provider. You must use the **https://** prefix.
- **S3 provider access key**: Specify the **<AWS_SECRET_ACCESS_KEY>** for AWS or the S3 provider access key for MCG.
- **S3 provider secret access key**: Specify the **<AWS_ACCESS_KEY_ID>** for AWS or the S3 provider secret access key for MCG.
- **Require SSL verification**: Clear this check box if you are using a generic S3 provider.
- If you use a custom CA bundle, click **Browse** and browse to the Base64-encoded CA bundle file.

- GCP:
  - **Replication repository name**: Specify the replication repository name in the MTC web console.
  - **GCP bucket name**: Specify the name of the GCP bucket.
  - **GCP credential JSON blob**: Specify the string in the **credentials-velero** file.
- Azure:
  - **Replication repository name**: Specify the replication repository name in the MTC web console.
  - **Azure resource group**: Specify the resource group of the Azure Blob storage.
  - **Azure storage account name**: Specify the Azure Blob storage account name.
  - **Azure credentials - INI file contents** Specify the string in the **credentials-velero** file.

4. Click **Add repository** and wait for connection validation.
5. Click **Close**.
   The new repository appears in the **Replication repositories** list.

3.4.2.4. Creating a migration plan in the MTC web console

You can create a migration plan in the Migration Toolkit for Containers (MTC) web console.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must ensure that the same MTC version is installed on all clusters.
- You must add the clusters and the replication repository to the MTC web console.
- If you want to use the *move* data copy method to migrate a persistent volume (PV), the source and target clusters must have uninterrupted network access to the remote volume.
- If you want to use direct image migration, the **MigCluster** custom resource manifest of the source cluster must specify the exposed route of the internal image registry.

Procedure

1. In the MTC web console, click **Migration plans**.
2. Click **Add migration plan**.
3. Enter the **Plan name** and click **Next**.
   The migration plan name must not exceed 253 lower-case alphanumeric characters (**a-z, 0-9**) and must not contain spaces or underscores (_).
4. Select a **Source cluster**.
5. Select a **Target cluster**.
6. Select a **Replication repository**.
7. Select the projects to be migrated and click **Next**.
8. Select a **Source cluster**, a **Target cluster**, and a **Repository**, and click **Next**.
9. On the **Namespaces** page, select the projects to be migrated and click **Next**.
10. On the **Persistent volumes** page, click a **Migration type** for each PV:
    - The **Copy** option copies the data from the PV of a source cluster to the replication repository and then restores the data on a newly created PV, with similar characteristics, in the target cluster.
    - The **Move** option unmounts a remote volume, for example, NFS, from the source cluster, creates a PV resource on the target cluster pointing to the remote volume, and then mounts the remote volume on the target cluster. Applications running on the target cluster use the same remote volume that the source cluster was using.
11. Click **Next**.
12. On the **Copy options** page, select a **Copy method** for each PV:
    - **Snapshot copy** backs up and restores data using the cloud provider's snapshot functionality. It is significantly faster than **Filesystem copy**.
    - **Filesystem copy** backs up the files on the source cluster and restores them on the target cluster.
      The file system copy method is required for direct volume migration.
13. You can select **Verify copy** to verify data migrated with **Filesystem copy**. Data is verified by generating a checksum for each source file and checking the checksum after restoration. Data verification significantly reduces performance.
14. Select a **Target storage class**.
    If you selected **Filesystem copy**, you can change the target storage class.
15. Click **Next**.
16. On the **Migration options** page, the **Direct image migration** option is selected if you specified an exposed image registry route for the source cluster. The **Direct PV migration** option is selected if you are migrating data with **Filesystem copy**.

    The direct migration options copy images and files directly from the source cluster to the target

The direct migration options copy images and files directly from the source cluster to the target cluster. This option is much faster than copying images and files from the source cluster to the replication repository and then from the replication repository to the target cluster.

17. Click **Next**.

18. Optional: On the **Hooks** page, click **Add Hook** to add a hook to the migration plan.
A hook runs custom code. You can add up to four hooks to a single migration plan. Each hook runs during a different migration step.

    a. Enter the name of the hook to display in the web console.

    b. If the hook is an Ansible playbook, select **Ansible playbook** and click **Browse** to upload the playbook or paste the contents of the playbook in the field.

    c. Optional: Specify an Ansible runtime image if you are not using the default hook image.

    d. If the hook is not an Ansible playbook, select **Custom container image** and specify the image name and path.
    A custom container image can include Ansible playbooks.

    e. Select **Source cluster** or **Target cluster**.

    f. Enter the **Service account name** and the **Service account namespace**

    g. Select the migration step for the hook:

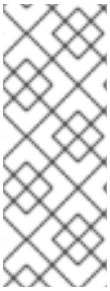
    - **preBackup**: Before the application workload is backed up on the source cluster
    - **postBackup**: After the application workload is backed up on the source cluster
    - **preRestore**: Before the application workload is restored on the target cluster
    - **postRestore**: After the application workload is restored on the target cluster

    h. Click **Add**.

19. Click **Finish**.
The migration plan is displayed in the **Migration plans** list.

3.4.2.5. Running a migration plan in the MTC web console

You can stage or migrate applications and data with the migration plan you created in the Migration Toolkit for Containers (MTC) web console.



NOTE

During migration, MTC sets the reclaim policy of migrated persistent volumes (PVs) to **Retain** on the target cluster.

The **Backup** custom resource contains a **PVOriginalReclaimPolicy** annotation that indicates the original reclaim policy. You can manually restore the reclaim policy of the migrated PVs.

Prerequisites

The MTC web console must contain the following:

- Source cluster in a **Ready** state
- Target cluster in a **Ready** state
- Replication repository
- Valid migration plan

Procedure

1. Log in to the source cluster.
2. Delete old images:

```
$ oc adm prune images
```

3. Log in to the MTC web console and click **Migration plans**.
4. Click the **Options** menu  next to a migration plan and select **Stage** to copy data from the source cluster to the target cluster without stopping the application.
   You can run **Stage** multiple times to reduce the actual migration time.
5. When you are ready to migrate the application workload, the **Options** menu  beside a migration plan and select **Migrate**.
6. Optional: In the **Migrate** window, you can select **Do not stop applications on the source cluster during migration**.
7. Click **Migrate**.
8. When the migration is complete, verify that the application migrated successfully in the OpenShift Container Platform web console:
   a. Click **Home → Projects**.
   b. Click the migrated project to view its status.
   c. In the **Routes** section, click **Location** to verify that the application is functioning, if applicable.
   d. Click **Workloads → Pods** to verify that the pods are running in the migrated namespace.
   e. Click **Storage → Persistent volumes** to verify that the migrated persistent volumes are correctly provisioned.

3.4.3. Migrating your applications from the command line

You can migrate your applications on the command line by using the MTC custom resources (CRs).

You can migrate applications from a local cluster to a remote cluster, from a remote cluster to a local cluster, and between remote clusters.

MTC terminology

The following terms are relevant for configuring clusters:

- **host** cluster:
  - The **migration-controller** pod runs on the **host** cluster.
  - A **host** cluster does not require an exposed secure registry route for direct image migration.
- Local cluster: The local cluster is often the same as the **host** cluster but this is not a requirement.
- Remote cluster:
  - A remote cluster must have an exposed secure registry route for direct image migration.
  - A remote cluster must have a **Secret** CR containing the **migration-controller** service account token.

The following terms are relevant for performing a migration:

- Source cluster: Cluster from which the applications are migrated.
- Destination cluster: Cluster to which the applications are migrated.

3.4.3.1. Migrating your applications with the Migration Toolkit for Containers API

You can migrate your applications on the command line with the Migration Toolkit for Containers (MTC) API.

You can migrate applications from a local cluster to a remote cluster, from a remote cluster to a local cluster, and between remote clusters.

This procedure describes how to perform indirect migration and direct migration:

- Indirect migration: Images, volumes, and Kubernetes objects are copied from the source cluster to the replication repository and then from the replication repository to the destination cluster.
- Direct migration: Images or volumes are copied directly from the source cluster to the destination cluster. Direct image migration and direct volume migration have significant performance benefits.

You create the following custom resources (CRs) to perform a migration:

- **MigCluster** CR: Defines a **host**, local, or remote cluster
  The **migration-controller** pod runs on the **host** cluster.
- **Secret** CR: Contains credentials for a remote cluster or storage
- **MigStorage** CR: Defines a replication repository
  Different storage providers require different parameters in the **MigStorage** CR manifest.
- **MigPlan** CR: Defines a migration plan
- **MigMigration** CR: Performs a migration defined in an associated **MigPlan**
  You can create multiple **MigMigration** CRs for a single **MigPlan** CR for the following purposes:

- To perform stage migrations, which copy most of the data without stopping the application, before running a migration. Stage migrations improve the performance of the migration.
- To cancel a migration in progress
- To roll back a completed migration

Prerequisites

- You must have **cluster-admin** privileges for all clusters.
- You must install the OpenShift Container Platform CLI (**oc**).
- You must install the Migration Toolkit for Containers Operator on all clusters.
- The *version* of the installed Migration Toolkit for Containers Operator must be the same on all clusters.
- You must configure an object storage as a replication repository.
- If you are using direct image migration, you must expose a secure registry route on all remote clusters.
- If you are using direct volume migration, the source cluster must not have an HTTP proxy configured.

Procedure

1. Create a **MigCluster** CR manifest for the **host** cluster called **host-cluster.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  name: host
  namespace: openshift-migration
spec:
  isHostCluster: true
```

2. Create a **MigCluster** CR for the **host** cluster:

```
$ oc create -f host-cluster.yaml -n openshift-migration
```

3. Create a **Secret** CR manifest for each remote cluster called **cluster-secret.yaml**:

```
apiVersion: v1
kind: Secret
metadata:
  name: <cluster_secret>
  namespace: openshift-config
type: Opaque
data:
  saToken: <sa_token> 1
```

1 Specify the base64-encoded **migration-controller** service account (SA) token of the remote cluster.

You can obtain the SA token by running the following command:

```
$ oc sa get-token migration-controller -n openshift-migration | base64 -w 0
```

4. Create a **Secret** CR for each remote cluster:

```
$ oc create -f cluster-secret.yaml
```

5. Create a **MigCluster** CR manifest for each remote cluster called **remote-cluster.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  name: <remote_cluster>
  namespace: openshift-migration
spec:
  exposedRegistryPath: <exposed_registry_route> 1
  insecure: false 2
  isHostCluster: false
  serviceAccountSecretRef:
    name: <remote_cluster_secret> 3
    namespace: openshift-config
  url: <remote_cluster_url> 4
```

1. Optional: Specify the exposed registry route, for example, **docker-registry-default.apps.example.com** if you are using direct image migration.
2. SSL verification is enabled if **false**. CA certificates are not required or checked if **true**.
3. Specify the **Secret** CR of the remote cluster.
4. Specify the URL of the remote cluster.

6. Create a **MigCluster** CR for each remote cluster:

```
$ oc create -f remote-cluster.yaml -n openshift-migration
```

7. Verify that all clusters are in a **Ready** state:

```
$ oc describe cluster <cluster_name>
```

8. Create a **Secret** CR manifest for the replication repository called **storage-secret.yaml**:

```
apiVersion: v1
kind: Secret
metadata:
  namespace: openshift-config
  name: <migstorage_creds>
type: Opaque
data:
  aws-access-key-id: <key_id_base64> 1
  aws-secret-access-key: <secret_key_base64> 2
```

1. Specify the key ID in base64 format.
2. Specify the secret key in base64 format.

AWS credentials are base64-encoded by default. If you are using another storage provider, you must encode your credentials by running the following command with each key:

```
$ echo -n "<key>" | base64 -w 0 (1)
```

1. Specify the key ID or the secret key. Both keys must be base64-encoded.

9. Create the **Secret** CR for the replication repository:

```
$ oc create -f storage-secret.yaml
```

10. Create a **MigStorage** CR manifest for the replication repository called **migstorage.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigStorage
metadata:
  name: <storage_name>
  namespace: openshift-migration
spec:
  backupStorageConfig:
    awsBucketName: <bucket_name> (1)
    credsSecretRef:
      name: <storage_secret_ref> (2)
      namespace: openshift-config
  backupStorageProvider: <storage_provider_name> (3)
  volumeSnapshotConfig:
    credsSecretRef:
      name: <storage_secret_ref> (4)
      namespace: openshift-config
  volumeSnapshotProvider: <storage_provider_name> (5)
```

1. Specify the bucket name.
2. Specify the **Secrets** CR of the object storage. You must ensure that the credentials stored in the **Secrets** CR of the object storage are correct.
3. Specify the storage provider.
4. Optional: If you are copying data by using snapshots, specify the **Secrets** CR of the object storage. You must ensure that the credentials stored in the **Secrets** CR of the object storage are correct.
5. Optional: If you are copying data by using snapshots, specify the storage provider.

11. Create the **MigStorage** CR:

```
$ oc create -f migstorage.yaml -n openshift-migration
```

12. Verify that the **MigStorage** CR is in a **Ready** state:

```
$ oc describe migstorage <migstorage_name>
```

13. Create a **MigPlan** CR manifest called **migplan.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigPlan
metadata:
  name: <migration_plan>
  namespace: openshift-migration
spec:
  destMigClusterRef:
    name: host
    namespace: openshift-migration
  indirectImageMigration: true (1)
  indirectVolumeMigration: true (2)
  migStorageRef:
    name: <migstorage_ref> (3)
    namespace: openshift-migration
  namespaces:
    - <application_namespace> (4)
  srcMigClusterRef:
    name: <remote_cluster_ref> (5)
    namespace: openshift-migration
```

(1) Direct image migration is enabled if **false**.

(2) Direct volume migration is enabled if **false**.

(3) Specify the name of the **MigStorage** CR instance.

(4) Specify one or more namespaces to be migrated.

(5) Specify the name of the source cluster **MigCluster** instance.

14. Create the **MigPlan** CR:

```
$ oc create -f migplan.yaml -n openshift-migration
```

15. View the **MigPlan** instance to verify that it is in a **Ready** state:

```
$ oc describe migplan <migplan_name> -n openshift-migration
```

16. Create a **MigMigration** CR manifest called **migmigration.yaml**:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  name: <migmigration_name>
  namespace: openshift-migration
spec:
  migPlanRef:
```

```
  name: <migplan_name> 1
  namespace: openshift-migration
quiescePods: true 2
stage: false 3
rollback: false 4
```

1. Specify the **MigPlan** CR name.
2. The pods on the source cluster are stopped before migration if **true**.
3. A stage migration, which copies most of the data without stopping the application, is performed if **true**.
4. A completed migration is rolled back if **true**.

17. Create the **MigMigration** CR to start the migration defined in the **MigPlan** CR:

```
$ oc create -f migmigration.yaml -n openshift-migration
```

18. Verify the progress of the migration by watching the **MigMigration** CR:

```
$ oc watch migmigration <migmigration_name> -n openshift-migration
```

The output resembles the following:

Example output

```
Name:         c8b034c0-6567-11eb-9a4f-0bc004db0fbc
Namespace:    openshift-migration
Labels:       migration.openshift.io/migplan-name=django
Annotations:  openshift.io/touch: e99f9083-6567-11eb-8420-0a580a81020c
API Version:  migration.openshift.io/v1alpha1
Kind:         MigMigration
...
Spec:
  Mig Plan Ref:
    Name:       my_application
    Namespace:  openshift-migration
  Stage:        false
Status:
  Conditions:
    Category:              Advisory
    Last Transition Time:  2021-02-02T15:04:09Z
    Message:               Step: 19/47
    Reason:                InitialBackupCreated
    Status:                True
    Type:                  Running
    Category:              Required
    Last Transition Time:  2021-02-02T15:03:19Z
    Message:               The migration is ready.
    Status:                True
    Type:                  Ready
    Category:              Required
    Durable:               true
```

```
    Last Transition Time:  2021-02-02T15:04:05Z
    Message:               The migration registries are healthy.
    Status:                True
    Type:                  RegistriesHealthy
  Itinerary:               Final
  Observed Digest:
7fae9d21f15979c71ddc7dd075cb97061895caac5b936d92fae967019ab616d5
  Phase:                   InitialBackupCreated
  Pipeline:
    Completed:  2021-02-02T15:04:07Z
    Message:    Completed
    Name:       Prepare
    Started:    2021-02-02T15:03:18Z
    Message:    Waiting for initial Velero backup to complete.
    Name:       Backup
    Phase:      InitialBackupCreated
    Progress:
      Backup openshift-migration/c8b034c0-6567-11eb-9a4f-0bc004db0fbc-wpc44: 0 out of
estimated total of 0 objects backed up (5s)
    Started:        2021-02-02T15:04:07Z
    Message:        Not started
    Name:           StageBackup
    Message:        Not started
    Name:           StageRestore
    Message:        Not started
    Name:           DirectImage
    Message:        Not started
    Name:           DirectVolume
    Message:        Not started
    Name:           Restore
    Message:        Not started
    Name:           Cleanup
  Start Timestamp:  2021-02-02T15:03:18Z
Events:
  Type    Reason   Age                From                    Message
  ----    ------   ----               ----                    -------
  Normal  Running  57s                migmigration_controller  Step: 2/47
  Normal  Running  57s                migmigration_controller  Step: 3/47
  Normal  Running  57s (x3 over 57s)   migmigration_controller  Step: 4/47
  Normal  Running  54s                migmigration_controller  Step: 5/47
  Normal  Running  54s                migmigration_controller  Step: 6/47
  Normal  Running  52s (x2 over 53s)   migmigration_controller  Step: 7/47
  Normal  Running  51s (x2 over 51s)   migmigration_controller  Step: 8/47
  Normal  Ready    50s (x12 over 57s)  migmigration_controller  The migration is ready.
  Normal  Running  50s                migmigration_controller  Step: 9/47
  Normal  Running  50s                migmigration_controller  Step: 10/47
```

3.4.3.2. MTC custom resource manifests

Migration Toolkit for Containers (MTC) uses the following custom resource (CR) manifests to create CRs for migrating applications.

3.4.3.2.1. DirectImageMigration

The **DirectImageMigration** CR copies images directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectImageMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: <directimagemigration_name>
spec:
  srcMigClusterRef:
    name: <source_cluster_ref> 1
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster_ref> 2
    namespace: openshift-migration
  namespaces:
  - <namespace> 3
```

1. Specify the **MigCluster** CR name of the source cluster.
2. Specify the **MigCluster** CR name of the destination cluster.
3. Specify one or more namespaces containing images to be migrated.

3.4.3.2.2. DirectImageStreamMigration

The **DirectImageStreamMigration** CR copies image stream references directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectImageStreamMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: directimagestreammigration_name
spec:
  srcMigClusterRef:
    name: <source_cluster_ref> 1
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster_ref> 2
    namespace: openshift-migration
  imageStreamRef:
    name: <image_stream_name> 3
    namespace: <source_image_stream_namespace> 4
  destNamespace: <destination_image_stream_namespace> 5
```

1. Specify the **MigCluster** CR name of the source cluster.
2. Specify the **MigCluster** CR name of the destination cluster.
3. Specify the image stream name.
4. Specify the image stream namespace on the source cluster.

5 Specify the image stream namespace on the destination cluster.

3.4.3.2.3. DirectVolumeMigration

The **DirectVolumeMigration** CR copies persistent volumes (PVs) directly from the source cluster to the destination cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectVolumeMigration
metadata:
  name: <directvolumemigration_name>
  namespace: openshift-migration
spec:
  createDestinationNamespaces: false 1
  deleteProgressReportingCRs: false 2
  destMigClusterRef:
    name: host 3
    namespace: openshift-migration
  persistentVolumeClaims:
  - name: <pvc_name> 4
    namespace: <pvc_namespace> 5
  srcMigClusterRef:
    name: <source_cluster_ref> 6
    namespace: openshift-migration
```

1 Namespaces are created for the PVs on the destination cluster if **true**.

2 The **DirectVolumeMigrationProgress** CRs are deleted after migration if **true**. The default value is **false** so that **DirectVolumeMigrationProgress** CRs are retained for troubleshooting.

3 Update the cluster name if the destination cluster is not the host cluster.

4 Specify one or more PVCs to be migrated with direct volume migration.

5 Specify the namespace of each PVC.

6 Specify the **MigCluster** CR name of the source cluster.

3.4.3.2.4. DirectVolumeMigrationProgress

The **DirectVolumeMigrationProgress** CR shows the progress of the **DirectVolumeMigration** CR.

```
apiVersion: migration.openshift.io/v1alpha1
kind: DirectVolumeMigrationProgress
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: directvolumemigrationprogress_name
spec:
  clusterRef:
    name: source_cluster
    namespace: openshift-migration
```

```
  podRef:
    name: rsync_pod
    namespace: openshift-migration
```

3.4.3.2.5. MigAnalytic

The **MigAnalytic** CR collects the number of images, Kubernetes resources, and the PV capacity from an associated **MigPlan** CR.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigAnalytic
metadata:
  annotations:
    migplan: <migplan_name> 1
  name: miganalytic_name
  namespace: openshift-migration
  labels:
    migplan: <migplan_name> 2
spec:
  analyzeImageCount: true 3
  analyzeK8SResources: true 4
  analyzePVCapacity: true 5
  listImages: false 6
  listImagesLimit: 50 7
  migPlanRef:
    name: migplan_name 8
    namespace: openshift-migration
```

1. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.
2. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.
3. Optional: The number of images is returned if **true**.
4. Optional: Returns the number, kind, and API version of the Kubernetes resources if **true**.
5. Optional: Returns the PV capacity if **true**.
6. Returns a list of image names if **true**. Default is **false** so that the output is not excessively long.
7. Optional: Specify the maximum number of image names to return if **listImages** is **true**.
8. Specify the **MigPlan** CR name associated with the **MigAnalytic** CR.

3.4.3.2.6. MigCluster

The **MigCluster** CR defines a host, local, or remote cluster.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
```

```
  name: host 1
  namespace: openshift-migration
spec:
  isHostCluster: true 2
  azureResourceGroup: <azure_resource_group> 3
  caBundle: <ca_bundle_base64> 4
  insecure: false 5
  refresh: false 6
# The 'restartRestic' parameter is relevant for a source cluster.
# restartRestic: true 7
# The following parameters are relevant for a remote cluster.
# isHostCluster: false
# exposedRegistryPath: 8
# url: <destination_cluster_url> 9
# serviceAccountSecretRef:
#   name: <source_secret_ref> 10
#   namespace: openshift-config
```

1. Optional: Update the cluster name if the **migration-controller** pod is not running on this cluster.
2. The **migration-controller** pod runs on this cluster if **true**.
3. Optional: If the storage provider is Microsoft Azure, specify the resource group.
4. Optional: If you created a certificate bundle for self-signed CA certificates and if the **insecure** parameter value is **false**, specify the base64-encoded certificate bundle.
5. SSL verification is enabled if **false**.
6. The cluster is validated if **true**.
7. The **restic** pods are restarted on the source cluster after the **stage** pods are created if **true**.
8. Optional: If you are using direct image migration, specify the exposed registry path of a remote cluster.
9. Specify the URL of the remote cluster.
10. Specify the name of the **Secret** CR for the remote cluster.

3.4.3.2.7. MigHook

The **MigHook** CR defines an Ansible playbook or a custom image that runs tasks at a specified stage of the migration.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigHook
metadata:
  generateName: <hook_name_prefix> 1
  name: <hook_name> 2
  namespace: openshift-migration
spec:
  activeDeadlineSeconds: 3
```

```
  custom: false 4
  image: <hook_image> 5
  playbook: <ansible_playbook_base64> 6
  targetCluster: source 7
```

1. Optional: A unique hash is appended to the value for this parameter so that each migration hook has a unique name. You do not need to specify the value of the **name** parameter.
2. Specify the migration hook name, unless you specify the value of the **generateName** parameter.
3. Optional: Specify the maximum number of seconds that a hook can run. The default value is **1800**.
4. The hook is a custom image if **true**. The custom image can include Ansible or it can be written in a different programming language.
5. Specify the custom image, for example, **quay.io/konveyor/hook-runner:latest**. Required if **custom** is **true**.
6. Specify the entire base64-encoded Ansible playbook. Required if **custom** is **false**.
7. Specify **source** or **destination** as the cluster on which the hook will run.

3.4.3.2.8. MigMigration

The **MigMigration** CR runs an associated **MigPlan** CR.

You can create multiple **MigMigration** CRs associated with the same **MigPlan** CR for the following scenarios:

- You can run multiple *stage* or incremental migrations to copy data without stopping the pods on the source cluster. Running stage migrations improves the performance of the actual migration.
- You can cancel a migration in progress.
- You can roll back a migration.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migmigration_name
  namespace: openshift-migration
spec:
  canceled: false 1
  rollback: false 2
  stage: false 3
  quiescePods: true 4
  keepAnnotations: true 5
  verify: false 6
  migPlanRef:
    name: <migplan_ref> 7
    namespace: openshift-migration
```

1. A migration in progress is canceled if **true**.
2. A completed migration is rolled back if **true**.
3. Data is copied incrementally and the pods on the source cluster are not stopped if **true**.
4. The pods on the source cluster are scaled to **0** after the **Backup** stage of a migration if **true**.
5. The labels and annotations applied during the migration are retained if **true**.
6. The status of the migrated pods on the destination cluster are checked and the names of pods that are not in a **Running** state are returned if **true**.
7. **migPlanRef.name**: Specify the name of the associated **MigPlan** CR.

3.4.3.2.9. MigPlan

The **MigPlan** CR defines the parameters of a migration plan. It contains a group of virtual machines that are being migrated with the same parameters.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigPlan
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migplan_name
  namespace: openshift-migration
spec:
  closed: false 1
  srcMigClusterRef:
    name: <source_migcluster_ref> 2
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_migcluster_ref> 3
    namespace: openshift-migration
  hooks: 4
    - executionNamespace: <namespace> 5
      phase: <migration_phase> 6
      reference:
        name: <mighook_name> 7
        namespace: <hook_namespace> 8
      serviceAccount: <service_account> 9
  indirectImageMigration: true 10
  indirectVolumeMigration: false 11
  migStorageRef:
    name: <migstorage_name> 12
    namespace: openshift-migration
  namespaces:
  - <namespace> 13
  refresh: false 14
```

1. The migration has completed if **true**. You cannot create another **MigMigration** CR for this **MigPlan** CR.

2. Specify the name of the source cluster **MigCluster** CR.
3. Specify the name of the destination cluster **MigCluster** CR.
4. Optional: You can specify up to four migration hooks.
5. Optional: Specify the namespace in which the hook will run.
6. Optional: Specify the migration phase during which a hook runs. One hook can be assigned to one phase. The expected values are **PreBackup**, **PostBackup**, **PreRestore**, and **PostRestore**.
7. Optional: Specify the name of the **MigHook** CR.
8. Optional: Specify the namespace of **MigHook** CR.
9. Optional: Specify a service account with **cluster-admin** privileges.
10. Direct image migration is disabled if **true**. Images are copied from the source cluster to the replication repository and from the replication repository to the destination cluster.
11. Direct volume migration is disabled if **true**. PVs are copied from the source cluster to the replication repository and from the replication repository to the destination cluster.
12. Specify the name of **MigStorage** CR.
13. Specify one or more namespaces.
14. The **MigPlan** CR is validated if **true**.

3.4.3.2.10. MigStorage

The **MigStorage** CR describes the object storage for the replication repository. You can configure Amazon Web Services, Microsoft Azure, Google Cloud Storage, and generic S3-compatible cloud storage, for example, Minio or NooBaa.

Different providers require different parameters.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigStorage
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migstorage_name
  namespace: openshift-migration
spec:
  backupStorageProvider: <storage_provider> 1
  volumeSnapshotProvider: 2
  backupStorageConfig:
    awsBucketName: 3
    awsRegion: 4
    credsSecretRef:
      namespace: openshift-config
      name: <storage_secret> 5
    awsKmsKeyId: 6
    awsPublicUrl: 7
```

```
    awsSignatureVersion: 8
  volumeSnapshotConfig:
    awsRegion: 9
    credsSecretRef:
      namespace: openshift-config
      name: 10
  refresh: false 11
```

1. Specify the storage provider.
2. Optional: If you are using the snapshot copy method, specify the storage provider.
3. If you are using AWS, specify the bucket name.
4. If you are using AWS, specify the bucket region, for example, **us-east-1**.
5. Specify the name of the **Secret** CR that you created for the **MigStorage** CR.
6. Optional: If you are using the AWS Key Management Service, specify the unique identifier of the key.
7. Optional: If you granted public access to the AWS bucket, specify the bucket URL.
8. Optional: Specify the AWS signature version for authenticating requests to the bucket, for example, **4**.
9. Optional: If you are using the snapshot copy method, specify the geographical region of the clusters.
10. Optional: If you are using the snapshot copy method, specify the name of the **Secret** CR that you created for the **MigStorage** CR.
11. The cluster is validated if **true**.

3.4.3.3. Additional resources

- About migration hooks
- MigHook custom resource
- MigPlan custom resource

3.4.4. Configuring a migration plan

You can increase the number of objects to be migrated or exclude resources from the migration.

3.4.4.1. Increasing limits for large migrations

You can increase the limits on migration objects and container resources for large migrations with the Migration Toolkit for Containers (MTC).

IMPORTANT

You must test these changes before you perform a migration in a production environment.

Procedure

1. Edit the **MigrationController** custom resource (CR) manifest:

```
$ oc edit migrationcontroller -n openshift-migration
```

2. Update the following parameters:

```
...
mig_controller_limits_cpu: "1" 1
mig_controller_limits_memory: "10Gi" 2
...
mig_controller_requests_cpu: "100m" 3
mig_controller_requests_memory: "350Mi" 4
...
mig_pv_limit: 100 5
mig_pod_limit: 100 6
mig_namespace_limit: 10 7
...
```

1. Specifies the number of CPUs available to the **MigrationController** CR.
2. Specifies the amount of memory available to the **MigrationController** CR.
3. Specifies the number of CPU units available for **MigrationController** CR requests. **100m** represents 0.1 CPU units (100 * 1e-3).
4. Specifies the amount of memory available for **MigrationController** CR requests.
5. Specifies the number of persistent volumes that can be migrated.
6. Specifies the number of pods that can be migrated.
7. Specifies the number of namespaces that can be migrated.

3. Create a migration plan that uses the updated parameters to verify the changes.
If your migration plan exceeds the **MigrationController** CR limits, the MTC console displays a warning message when you save the migration plan.

3.4.4.2. Excluding resources from a migration plan

You can exclude resources, for example, image streams, persistent volumes (PVs), or subscriptions, from a Migration Toolkit for Containers (MTC) migration plan to reduce the resource load for migration or to migrate images or PVs with a different tool.

By default, the MTC excludes service catalog resources and Operator Lifecycle Manager (OLM) resources from migration. These resources are parts of the service catalog API group and the OLM API group, neither of which is supported for migration at this time.

Procedure

1. Edit the **MigrationController** custom resource manifest:

```
$ oc edit migrationcontroller <migration_controller> -n openshift-migration
```

2. Update the **spec** section by adding a parameter to exclude specific resources or by adding a resource to the **excluded_resources** parameter if it does not have its own exclusion parameter:

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigrationController
metadata:
  name: migration-controller
  namespace: openshift-migration
spec:
  disable_image_migration: true (1)
  disable_pv_migration: true (2)
  ...
  excluded_resources: (3)
  - imagetags
  - templateinstances
  - clusterserviceversions
  - packagemanifests
  - subscriptions
  - servicebrokers
  - servicebindings
  - serviceclasses
  - serviceinstances
  - serviceplans
  - operatorgroups
  - events
```

(1) Add **disable_image_migration: true** to exclude image streams from the migration. Do not edit the **excluded_resources** parameter. **imagestreams** is added to **excluded_resources** when the **MigrationController** pod restarts.

(2) Add **disable_pv_migration: true** to exclude PVs from the migration plan. Do not edit the **excluded_resources** parameter. **persistentvolumes** and **persistentvolumeclaims** are added to **excluded_resources** when the **MigrationController** pod restarts. Disabling PV migration also disables PV discovery when you create the migration plan.

(3) You can add OpenShift Container Platform resources to the **excluded_resources** list. Do not delete the default excluded resources. These resources are problematic to migrate and must be excluded.

3. Wait two minutes for the **MigrationController** pod to restart so that the changes are applied.

4. Verify that the resource is excluded:

```
$ oc get deployment -n openshift-migration migration-controller -o yaml | grep
EXCLUDED_RESOURCES -A1
```

The output contains the excluded resources:

Example output

```
- name: EXCLUDED_RESOURCES
  value:

imagetags,templateinstances,clusterserviceversions,packagemanifests,subscriptions,servicebro
ers,servicebindings,serviceclasses,serviceinstances,serviceplans,imagestreams,persistentvolun
es,persistentvolumeclaims
```

3.5. TROUBLESHOOTING

You can view the Migration Toolkit for Containers (MTC) custom resources and download logs to troubleshoot a failed migration.

If the application was stopped during the failed migration, you must roll it back manually to prevent data corruption.

NOTE

Manual rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

3.5.1. Viewing MTC custom resources

You can view the following Migration Toolkit for Containers (MTC) custom resources (CRs) to troubleshoot a failed migration:

- **MigCluster**
- **MigStorage**
- **MigPlan**
- **BackupStorageLocation**
  The **BackupStorageLocation** CR contains a **migrationcontroller** label to identify the MTC instance that created the CR:

  ```
  labels:
    migrationcontroller: ebe13bee-c803-47d0-a9e9-83f380328b93
  ```

- **VolumeSnapshotLocation**
  The **VolumeSnapshotLocation** CR contains a **migrationcontroller** label to identify the MTC instance that created the CR:

  ```
  labels:
    migrationcontroller: ebe13bee-c803-47d0-a9e9-83f380328b93
  ```

- **MigMigration**
- **Backup**
  MTC changes the reclaim policy of migrated persistent volumes (PVs) to **Retain** on the target cluster. The **Backup** CR contains an **openshift.io/orig-reclaim-policy** annotation that indicates the original reclaim policy. You can manually restore the reclaim policy of the migrated

PVs.

- **Restore**

Procedure

1. List the **MigMigration** CRs in the **openshift-migration** namespace:

```
$ oc get migmigration -n openshift-migration
```

Example output

```
NAME                                   AGE
88435fe0-c9f8-11e9-85e6-5d593ce65e10   6m42s
```

2. Inspect the **MigMigration** CR:

```
$ oc describe migmigration 88435fe0-c9f8-11e9-85e6-5d593ce65e10 -n openshift-migration
```

The output is similar to the following examples.

MigMigration example output

```
name:         88435fe0-c9f8-11e9-85e6-5d593ce65e10
namespace:    openshift-migration
labels:       <none>
annotations:  touch: 3b48b543-b53e-4e44-9d34-33563f0f8147
apiVersion:  migration.openshift.io/v1alpha1
kind:         MigMigration
metadata:
  creationTimestamp:  2019-08-29T01:01:29Z
  generation:         20
  resourceVersion:    88179
  selfLink:           /apis/migration.openshift.io/v1alpha1/namespaces/openshift-
migration/migmigrations/88435fe0-c9f8-11e9-85e6-5d593ce65e10
  uid:                8886de4c-c9f8-11e9-95ad-0205fe66cbb6
spec:
  migPlanRef:
    name:         socks-shop-mig-plan
    namespace:    openshift-migration
  quiescePods:  true
  stage:        false
status:
  conditions:
    category:              Advisory
    durable:               True
    lastTransitionTime:  2019-08-29T01:03:40Z
    message:               The migration has completed successfully.
    reason:                Completed
    status:                True
    type:                  Succeeded
  phase:                   Completed
  startTimestamp:          2019-08-29T01:01:29Z
events:                    <none>
```

Velero backup CR #2 example output that describes the PV data

```
apiVersion: velero.io/v1
kind: Backup
metadata:
  annotations:
    openshift.io/migrate-copy-phase: final
    openshift.io/migrate-quiesce-pods: "true"
    openshift.io/migration-registry: 172.30.105.179:5000
    openshift.io/migration-registry-dir: /socks-shop-mig-plan-registry-44dd3bd5-c9f8-11e9-95ad-
0205fe66cbb6
    openshift.io/orig-reclaim-policy: delete
  creationTimestamp: "2019-08-29T01:03:15Z"
  generateName: 88435fe0-c9f8-11e9-85e6-5d593ce65e10-
  generation: 1
  labels:
    app.kubernetes.io/part-of: migration
    migmigration: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
    migration-stage-backup: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
    velero.io/storage-location: myrepo-vpzq9
  name: 88435fe0-c9f8-11e9-85e6-5d593ce65e10-59gb7
  namespace: openshift-migration
  resourceVersion: "87313"
  selfLink: /apis/velero.io/v1/namespaces/openshift-migration/backups/88435fe0-c9f8-11e9-85e6-
5d593ce65e10-59gb7
  uid: c80dbbc0-c9f8-11e9-95ad-0205fe66cbb6
spec:
  excludedNamespaces: []
  excludedResources: []
  hooks:
    resources: []
  includeClusterResources: null
  includedNamespaces:
  - sock-shop
  includedResources:
  - persistentvolumes
  - persistentvolumeclaims
  - namespaces
  - imagestreams
  - imagestreamtags
  - secrets
  - configmaps
  - pods
  labelSelector:
    matchLabels:
      migration-included-stage-backup: 8886de4c-c9f8-11e9-95ad-0205fe66cbb6
  storageLocation: myrepo-vpzq9
  ttl: 720h0m0s
  volumeSnapshotLocations:
  - myrepo-wv6fx
status:
  completionTimestamp: "2019-08-29T01:02:36Z"
  errors: 0
  expiration: "2019-09-28T01:02:35Z"
  phase: Completed
  startTimestamp: "2019-08-29T01:02:35Z"
```

```
  validationErrors: null
  version: 1
  volumeSnapshotsAttempted: 0
  volumeSnapshotsCompleted: 0
  warnings: 0
```

Velero restore CR #2 example output that describes the Kubernetes resources

```
apiVersion: velero.io/v1
kind: Restore
metadata:
  annotations:
    openshift.io/migrate-copy-phase: final
    openshift.io/migrate-quiesce-pods: "true"
    openshift.io/migration-registry: 172.30.90.187:5000
    openshift.io/migration-registry-dir: /socks-shop-mig-plan-registry-36f54ca7-c925-11e9-825a-
06fa9fb68c88
  creationTimestamp: "2019-08-28T00:09:49Z"
  generateName: e13a1b60-c927-11e9-9555-d129df7f3b96-
  generation: 3
  labels:
    app.kubernetes.io/part-of: migration
    migmigration: e18252c9-c927-11e9-825a-06fa9fb68c88
    migration-final-restore: e18252c9-c927-11e9-825a-06fa9fb68c88
  name: e13a1b60-c927-11e9-9555-d129df7f3b96-gb8nx
  namespace: openshift-migration
  resourceVersion: "82329"
  selfLink: /apis/velero.io/v1/namespaces/openshift-migration/restores/e13a1b60-c927-11e9-9555-
d129df7f3b96-gb8nx
  uid: 26983ec0-c928-11e9-825a-06fa9fb68c88
spec:
  backupName: e13a1b60-c927-11e9-9555-d129df7f3b96-sz24f
  excludedNamespaces: null
  excludedResources:
  - nodes
  - events
  - events.events.k8s.io
  - backups.velero.io
  - restores.velero.io
  - resticrepositories.velero.io
  includedNamespaces: null
  includedResources: null
  namespaceMapping: null
  restorePVs: true
status:
  errors: 0
  failureReason: ""
  phase: Completed
  validationErrors: null
  warnings: 15
```

3.5.2. Using the migration log reader

You can use the migration log reader to display a single filtered view of all the migration logs.

Procedure

1. Get the **mig-log-reader** pod:

```
$ oc -n openshift-migration get pods | grep log
```

2. Enter the following command to display a single migration log:

```
$ oc -n openshift-migration logs -f <mig-log-reader-pod> -c color 1
```

1 The **-c plain** option displays the log without colors.

3.5.3. Downloading migration logs

You can download the **Velero**, **Restic**, and **MigrationController** pod logs in the Migration Toolkit for Containers (MTC) web console to troubleshoot a failed migration.

Procedure

1. In the MTC console, click **Migration plans** to view the list of migration plans.
2. Click the **Options** menu  of a specific migration plan and select **Logs**.
3. Click **Download Logs** to download the logs of the **MigrationController**, **Velero**, and **Restic** pods for all clusters.
   You can download a single log by selecting the cluster, log source, and pod source, and then clicking **Download Selected**.

   You can access a pod log from the CLI by using the **oc logs** command:

```
$ oc logs <pod-name> -f -n openshift-migration 1
```

1 Specify the pod name.

3.5.4. Updating deprecated APIs

If your source cluster uses deprecated APIs, the following warning message is displayed when you create a migration plan in the Migration Toolkit for Containers (MTC) web console:

```
Some namespaces contain GVKs incompatible with destination cluster
```

You can click **See details** to view the namespace and the incompatible APIs. This warning message does not block the migration.

During migration with the Migration Toolkit for Containers (MTC), the deprecated APIs are saved in the **Velero** Backup #1 for Kubernetes objects. You can download the **Velero** Backup, extract the deprecated API **yaml** files, and update them with the **oc convert** command. Then you can create the updated APIs on the target cluster.

Procedure

1. Run the migration plan.
2. View the **MigPlan** custom resource (CR):

```
$ oc describe migplan <migplan_name> -n openshift-migration 1
```

1 Specify the name of the **MigPlan** CR.

The output is similar to the following:

```
metadata:
  ...
  uid: 79509e05-61d6-11e9-bc55-02ce4781844a 1
status:
  ...
  conditions:
  - category: Warn
    lastTransitionTime: 2020-04-30T17:16:23Z
    message: 'Some namespaces contain GVKs incompatible with destination cluster.
      See: `incompatibleNamespaces` for details'
    status: "True"
    type: GVKsIncompatible
  incompatibleNamespaces:
  - gvks: 2
    - group: batch
      kind: cronjobs
      version: v2alpha1
    - group: batch
      kind: scheduledjobs
      version: v2alpha1
```

1 Record the **MigPlan** CR UID.

2 Record the deprecated APIs listed in the **gvks** section.

3. Get the **MigMigration** name associated with the **MigPlan** UID:

```
$ oc get migmigration -o json | jq -r '.items[] | select(.metadata.ownerReferences[].uid=="
<migplan_uid>") | .metadata.name' 1
```

1 Specify the **MigPlan** CR UID.

4. Get the **MigMigration** UID associated with the **MigMigration** name:

```
$ oc get migmigration <migmigration_name> -o jsonpath='{.metadata.uid}' 1
```

1 Specify the **MigMigration** name.

5. Get the **Velero** Backup name associated with the **MigMigration** UID:

```
$ oc get backup.velero.io --selector migration-initial-backup="<migmigration_uid>" -o
jsonpath={.items[*].metadata.name} 1
```

1 Specify the **MigMigration** UID.

6. Download the contents of the **Velero** Backup to your local machine by running the command for your storage provider:
   - AWS S3:

```
$ aws s3 cp s3://<bucket_name>/velero/backups/<backup_name> <backup_local_dir> --
recursive 1
```

1 Specify the bucket, backup name, and your local backup directory name.

   - GCP:

```
$ gsutil cp gs://<bucket_name>/velero/backups/<backup_name> <backup_local_dir> --
recursive 1
```

1 Specify the bucket, backup name, and your local backup directory name.

   - Azure:

```
$ azcopy copy
'https://velerobackups.blob.core.windows.net/velero/backups/<backup_name>'
'<backup_local_dir>' --recursive 1
```

1 Specify the backup name and your local backup directory name.

7. Extract the **Velero** Backup archive file:

```
$ tar -xfv <backup_local_dir>/<backup_name>.tar.gz -C <backup_local_dir>
```

8. Run **oc convert** in offline mode on each deprecated API:

```
$ oc convert -f <backup_local_dir>/resources/<gvk>.json
```

9. Create the converted API on the target cluster:

```
$ oc create -f <gvk>.json
```

3.5.5. Error messages and resolutions

This section describes common error messages you might encounter with the Migration Toolkit for Containers (MTC) and how to resolve their underlying causes.

3.5.5.1. CA certificate error in the MTC console

If a **CA certificate error** message is displayed the first time you try to access the MTC console, the likely cause is the use of self-signed CA certificates in one of the clusters.

To resolve this issue, navigate to the **oauth-authorization-server** URL displayed in the error message and accept the certificate. To resolve this issue permanently, add the certificate to the trust store of your web browser.

If an **Unauthorized** message is displayed after you have accepted the certificate, navigate to the MTC console and refresh the web page.

3.5.5.2. OAuth timeout error in the MTC console

If a **connection has timed out** message is displayed in the MTC console after you have accepted a self-signed certificate, the causes are likely to be the following:

- Interrupted network access to the OAuth server
- Interrupted network access to the OpenShift Container Platform console
- Proxy configuration that blocks access to the **oauth-authorization-server** URL. See MTC console inaccessible because of OAuth timeout error for details.

You can determine the cause of the timeout.

Procedure

1. Navigate to the MTC console and inspect the elements with the browser web inspector.
2. Check the **MigrationUI** pod log:

```
$ oc logs <MigrationUI_Pod> -n openshift-migration
```

3.5.5.3. PodVolumeBackups timeout error in Velero pod log

If a migration fails because Restic times out, the following error is displayed in the **Velero** pod log.

Example output

```
level=error msg="Error backing up item" backup=velero/monitoring error="timed out waiting for all
PodVolumeBackups to complete"
error.file="/go/src/github.com/heptio/velero/pkg/restic/backupper.go:165"
error.function="github.com/heptio/velero/pkg/restic.(*backupper).BackupPodVolumes" group=v1
```

The default value of **restic_timeout** is one hour. You can increase this parameter for large migrations, keeping in mind that a higher value may delay the return of error messages.

Procedure

1. In the OpenShift Container Platform web console, navigate to **Operators → Installed Operators**.
2. Click **Migration Toolkit for Containers Operator**.
3. In the **MigrationController** tab, click **migration-controller**.

4. In the **YAML** tab, update the following parameter value:

```
spec:
  restic_timeout: 1h (1)
```

(1) Valid units are **h** (hours), **m** (minutes), and **s** (seconds), for example, **3h30m15s**.

5. Click **Save**.

3.5.5.4. ResticVerifyErrors in the MigMigration custom resource

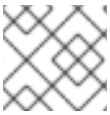
If data verification fails when migrating a persistent volume with the file system data copy method, the following error is displayed in the **MigMigration** CR.

Example output

```
status:
  conditions:
  - category: Warn
    durable: true
    lastTransitionTime: 2020-04-16T20:35:16Z
    message: There were verify errors found in 1 Restic volume restores. See restore `<registry-example-migration-rvwcm>`
      for details (1)
    status: "True"
    type: ResticVerifyErrors (2)
```

(1) The error message identifies the **Restore** CR name.

(2) **ResticVerifyErrors** is a general error warning type that includes verification errors.



NOTE

A data verification error does not cause the migration process to fail.

You can check the **Restore** CR to identify the source of the data verification error.

Procedure

1. Log in to the target cluster.
2. View the **Restore** CR:

```
$ oc describe <registry-example-migration-rvwcm> -n openshift-migration
```

The output identifies the persistent volume with **PodVolumeRestore** errors.

Example output

```
status:
  phase: Completed
```

```
    podVolumeRestoreErrors:
    - kind: PodVolumeRestore
      name: <registry-example-migration-rvwcm-98t49>
      namespace: openshift-migration
    podVolumeRestoreResticErrors:
    - kind: PodVolumeRestore
      name: <registry-example-migration-rvwcm-98t49>
      namespace: openshift-migration
```

3. View the **PodVolumeRestore** CR:

```
$ oc describe <migration-example-rvwcm-98t49>
```

The output identifies the **Restic** pod that logged the errors.

Example output

```
    completionTimestamp: 2020-05-01T20:49:12Z
    errors: 1
    resticErrors: 1
    ...
    resticPod: <restic-nr2v5>
```

4. View the **Restic** pod log to locate the errors:

```
$ oc logs -f <restic-nr2v5>
```

3.5.6. Direct volume migration does not complete

If direct volume migration does not complete, the target cluster might not have the same **node-selector** annotations as the source cluster.

Migration Toolkit for Containers (MTC) migrates namespaces with all annotations to preserve security context constraints and scheduling requirements. During direct volume migration, MTC creates Rsync transfer pods on the target cluster in the namespaces that were migrated from the source cluster. If a target cluster namespace does not have the same annotations as the source cluster namespace, the Rsync transfer pods cannot be scheduled. The Rsync pods remain in a **Pending** state.

You can identify and fix this issue by performing the following procedure.

Procedure

1. Check the status of the **MigMigration** CR:

```
$ oc describe migmigration <pod_name> -n openshift-migration
```

The output includes the following status message:

Example output

```
...
Some or all transfer pods are not running for more than 10 mins on destination cluster
...
```

2. On the source cluster, obtain the details of a migrated namespace:

```
$ oc get namespace <namespace> -o yaml 1
```

1 Specify the migrated namespace.

3. On the target cluster, edit the migrated namespace:

```
$ oc edit namespace <namespace>
```

4. Add missing **openshift.io/node-selector** annotations to the migrated namespace as in the following example:

```
apiVersion: v1
kind: Namespace
metadata:
  annotations:
    openshift.io/node-selector: "region=east"
...
```

5. Run the migration plan again.

3.5.7. Using the Velero CLI to debug Backup and Restore CRs

You can debug the **Backup** and **Restore** custom resources (CRs) and partial migration failures with the Velero command line interface (CLI). The Velero CLI runs in the **velero** pod.

3.5.7.1. Velero command syntax

Velero CLI commands use the following syntax:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero <resource>
<command> <resource_id>
```

You can specify **velero-<pod> -n openshift-migration** in place of **$(oc get pods -n openshift-migration -o name | grep velero)**.

3.5.7.2. Help command

The Velero **help** command lists all the Velero CLI commands:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero --help
```

3.5.7.3. Describe command

The Velero **describe** command provides a summary of warnings and errors associated with a Velero resource:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero  <resource>
describe <resource_id>
```

Example

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero backup describe
0e44ae00-5dc3-11eb-9ca8-df7e5254778b-2d8ql
```

3.5.7.4. Logs command

The Velero **logs** command provides the logs associated with a Velero resource:

```
velero <resource> logs <resource_id>
```

Example

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -- ./velero restore logs
ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
```

3.5.7.5. Debugging a partial migration failure

You can debug a partial migration failure warning message by using the Velero CLI to examine the **Restore** custom resource (CR) logs.

A partial failure occurs when Velero encounters an issue that does not cause a migration to fail. For example, if a custom resource definition (CRD) is missing or if there is a discrepancy between CRD versions on the source and target clusters, the migration completes but the CR is not created on the target cluster.

Velero logs the issue as a partial failure and then processes the rest of the objects in the **Backup** CR.

Procedure

1. Check the status of a **MigMigration** CR:

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

Example output

```
status:
  conditions:
  - category: Warn
    durable: true
    lastTransitionTime: "2021-01-26T20:48:40Z"
    message: 'Final Restore openshift-migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-
x4lbf: partially failed on destination cluster'
    status: "True"
    type: VeleroFinalRestorePartiallyFailed
  - category: Advisory
    durable: true
    lastTransitionTime: "2021-01-26T20:48:42Z"
    message: The migration has completed with warnings, please look at `Warn` conditions.
    reason: Completed
    status: "True"
    type: SucceededWithWarnings
```

2. Check the status of the **Restore** CR by using the Velero **describe** command:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -n openshift-migration -
- ./velero restore describe <restore>
```

Example output

```
Phase:  PartiallyFailed (run 'velero restore logs ccc7c2d0-6017-11eb-afab-85d0007f5a19-
x4lbf' for more information)

Errors:
  Velero:     <none>
  Cluster:    <none>
  Namespaces:
    migration-example:  error restoring example.com/migration-example/migration-example:
the server could not find the requested resource
```

3. Check the **Restore** CR logs by using the Velero **logs** command:

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) -n openshift-migration -
- ./velero restore logs <restore>
```

Example output

```
time="2021-01-26T20:48:37Z" level=info msg="Attempting to restore migration-example:
migration-example" logSource="pkg/restore/restore.go:1107" restore=openshift-
migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
time="2021-01-26T20:48:37Z" level=info msg="error restoring migration-example: the server
could not find the requested resource" logSource="pkg/restore/restore.go:1170"
restore=openshift-migration/ccc7c2d0-6017-11eb-afab-85d0007f5a19-x4lbf
```

The **Restore** CR log error message, **the server could not find the requested resource**, indicates the cause of the partially failed migration.

3.5.8. Using must-gather to collect data

You must run the **must-gather** tool if you open a customer support case on the Red Hat Customer Portal for the Migration Toolkit for Containers (MTC).

The **openshift-migration-must-gather-rhel8** image for MTC collects migration-specific logs and data that are not collected by the default **must-gather** image.

Procedure

1. Navigate to the directory where you want to store the **must-gather** data.
2. Run the **must-gather** command:

```
$ oc adm must-gather --image=registry.redhat.io/rhmtc/openshift-migration-must-gather-
rhel8:v1.4
```

3. Remove authentication keys and other sensitive information.

4. Create an archive file containing the contents of the **must-gather** data directory:

```
$ tar cvaf must-gather.tar.gz must-gather.local.<uid>/
```

5. Upload the compressed file as an attachment to your customer support case.

3.5.9. Rolling back a migration

You can roll back a migration by using the MTC web console or the CLI.

3.5.9.1. Rolling back a migration in the MTC web console

You can roll back a migration by using the Migration Toolkit for Containers (MTC) web console.

If your application was stopped during a failed migration, you must roll back the migration to prevent data corruption in the persistent volume.

Rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

Procedure

1. In the MTC web console, click **Migration plans**.
2. Click the Options menu  beside a migration plan and select **Rollback**.
3. Click **Rollback** and wait for rollback to complete.
   In the migration plan details, **Rollback succeeded** is displayed.
4. Verify that rollback was successful in the OpenShift Container Platform web console of the source cluster:
   a. Click **Home → Projects**.
   b. Click the migrated project to view its status.
   c. In the **Routes** section, click **Location** to verify that the application is functioning, if applicable.
   d. Click **Workloads → Pods** to verify that the pods are running in the migrated namespace.
   e. Click **Storage → Persistent volumes** to verify that the migrated persistent volume is correctly provisioned.

3.5.9.1.1. Rolling back a migration from the CLI

You can roll back a migration by creating a **MigMigration** custom resource (CR) from the CLI.

If your application was stopped during a failed migration, you must roll back the migration to prevent data corruption in the persistent volume.

Rollback is not required if the application was not stopped during migration because the original application is still running on the source cluster.

Procedure

1. Create a **MigMigration** CR based on the following example:

```
$ cat << EOF | oc apply -f -
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: migration-rollback
  namespace: openshift-migration
spec:
...
  rollback: true
...
  migPlanRef:
    name: <migplan_name> 1
    namespace: openshift-migration
EOF
```

1 Specify the name of the associated **MigPlan** CR.

2. In the MTC web console, verify that the migrated project resources have been removed from the target cluster.

3. Verify that the migrated project resources are present in the source cluster and that the application is running.

3.5.10. Known issues

This release has the following known issues:

- During migration, the Migration Toolkit for Containers (MTC) preserves the following namespace annotations:
  - **openshift.io/sa.scc.mcs**
  - **openshift.io/sa.scc.supplemental-groups**
  - **openshift.io/sa.scc.uid-range**
    These annotations preserve the UID range, ensuring that the containers retain their file system permissions on the target cluster. There is a risk that the migrated UIDs could duplicate UIDs within an existing or future namespace on the target cluster. (BZ#1748440)
- If an AWS bucket is added to the MTC web console and then deleted, its status remains **True** because the **MigStorage** CR is not updated. (BZ#1738564)
- Most cluster-scoped resources are not yet handled by MTC. If your applications require cluster-scoped resources, you might have to create them manually on the target cluster.
- If a migration fails, the migration plan does not retain custom PV settings for quiesced pods. You must manually roll back the migration, delete the migration plan, and create a new migration plan with your PV settings. (BZ#1784899)

- If a large migration fails because Restic times out, you can increase the **restic_timeout** parameter value (default: **1h**) in the **MigrationController** CR.
- If you select the data verification option for PVs that are migrated with the file system copy method, performance is significantly slower.

3.5.11. Additional resources

- MTC workflow
- MTC custom resources