OpenShift Container Platform 4.5

Migrating from OpenShift Container Platform 3 to 4

Migrating to OpenShift Container Platform 4

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Migrating to OpenShift Container Platform 4

Legal Notice

Abstract

This document provides instructions for migrating your OpenShift Container Platform cluster from version 3 to version 4.

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CHAPTER 1. ABOUT MIGRATING FROM OPENSHIFT CONTAINER PLATFORM 3 TO 4

OpenShift Container Platform 4 contains new technologies and functionality that result in a cluster that is self-managing, flexible, and automated. OpenShift Container Platform 4 clusters are deployed and managed very differently from OpenShift Container Platform 3.

The most effective way to migrate from OpenShift Container Platform 3 to 4 is by using a CI/CD pipeline to automate deployments in an application lifecycle management framework.

If you do not have a CI/CD pipeline or if you are migrating stateful applications, you can use the Migration Toolkit for Containers (MTC) to migrate your application workloads.

To successfully transition to OpenShift Container Platform 4, review the following information:

Differences between OpenShift Container Platform 3 and 4

- Architecture
- Installation and upgrade
- Storage, network, logging, security, and monitoring considerations

About the Migration Toolkit for Containers

- Workflow
- File system and snapshot copy methods for persistent volumes (PVs)
- Direct volume migration
- Direct image migration

Advanced migration options

- Automating your migration with migration hooks
- Using the MTC API
- Excluding resources from a migration plan
- Configuring the **MigrationController** custom resource for large-scale migrations
- Enabling automatic PV resizing for direct volume migration
- Enabling cached Kubernetes clients for improved performance

CHAPTER 2. DIFFERENCES BETWEEN OPENSHIFT CONTAINER PLATFORM 3 AND 4

OpenShift Container Platform 4.5 introduces architectural changes and enhancements. The procedures that you used to manage your OpenShift Container Platform 3 cluster might not apply to OpenShift Container Platform 4.

For information on configuring your OpenShift Container Platform 4 cluster, review the appropriate sections of the OpenShift Container Platform documentation. For information on new features and other notable technical changes, review the OpenShift Container Platform 4.5 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.

2.1. ARCHITECTURE

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.

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.

2.2. INSTALLATION AND UPGRADE

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 4.5, 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) worker machines to your OpenShift Container Platform 4.5 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 4.5, 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 4.5 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.

2.3. MIGRATION CONSIDERATIONS

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

2.3.1. Storage considerations

Review the following storage changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.5.

Local volume persistent storage

Local storage is only supported by using the Local Storage Operator in OpenShift Container Platform 4.5. 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 4.5 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. OpenShift Container Platform 4.5 fully supports CSI version 1.1.0 and ships with several CSI drivers. You can also 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 4.5:

- 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 4.5.

For more information, see Understanding persistent storage.

2.3.2. Networking considerations

Review the following networking changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.5.

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 4.5 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 4.5 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 4.5, 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 4.5 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 .

2.3.3. Logging considerations

Review the following logging changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.5.

Deploying cluster logging
OpenShift Container Platform 4 provides a simple deployment mechanism for cluster 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 4.5.

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

2.3.4. Security considerations

Review the following security changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.5.

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 4.5. 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 4.5 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 4.5. 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.

2.3.5. Monitoring considerations

Review the following monitoring changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.5.

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.

CHAPTER 3. ABOUT THE MIGRATION TOOLKIT FOR CONTAINERS

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

You can migrate from OpenShift Container Platform 3.7, 3.9, 3.10, or 3.11 to 4.5. MTC enables you to control the migration and to minimize application downtime.

IMPORTANT

Before you begin your migration, be sure to review the differences between OpenShift Container Platform 3 and 4.

The MTC console is installed on the target cluster by default. You can configure the Migration Toolkit for Containers Operator to install the console on an OpenShift Container Platform 3 source cluster or on a remote 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 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 console displays a message if the service catalog resources cannot be migrated.

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 to OpenShift Container Platform 4.5 by using the MTC web console or the Kubernetes API.

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.

  NOTE

  Cluster-scoped resources might have to be migrated manually, depending on the resource.

- Custom resources (CRs) and custom resource definitions (CRDs): MTC automatically migrates CRs and CRDs at the namespace level.

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 Multi-Cloud Object Gateway (MCG). 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.

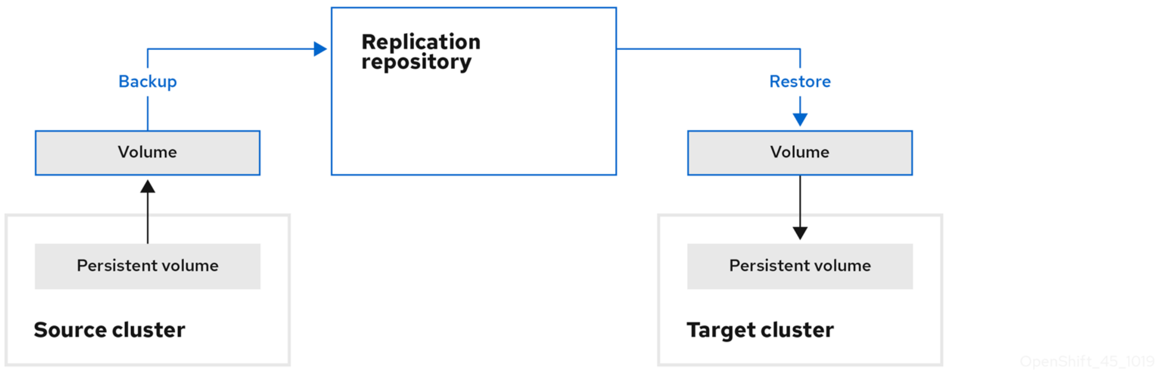
4. Add the replication repository to the MTC web console.

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

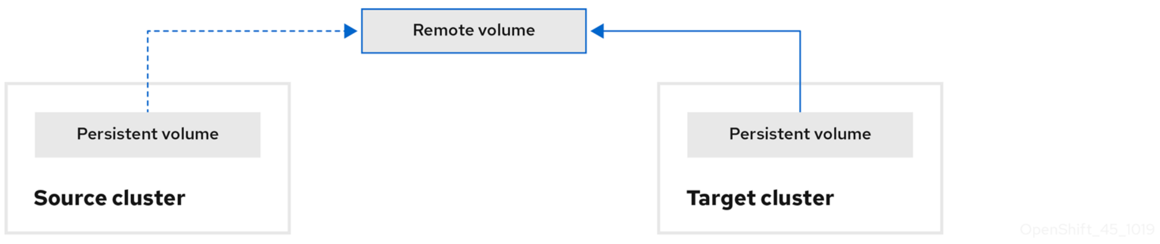
     If you are using direct image migration or direct volume migration, the images or volumes are copied directly from the source cluster to the target cluster.



   - **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

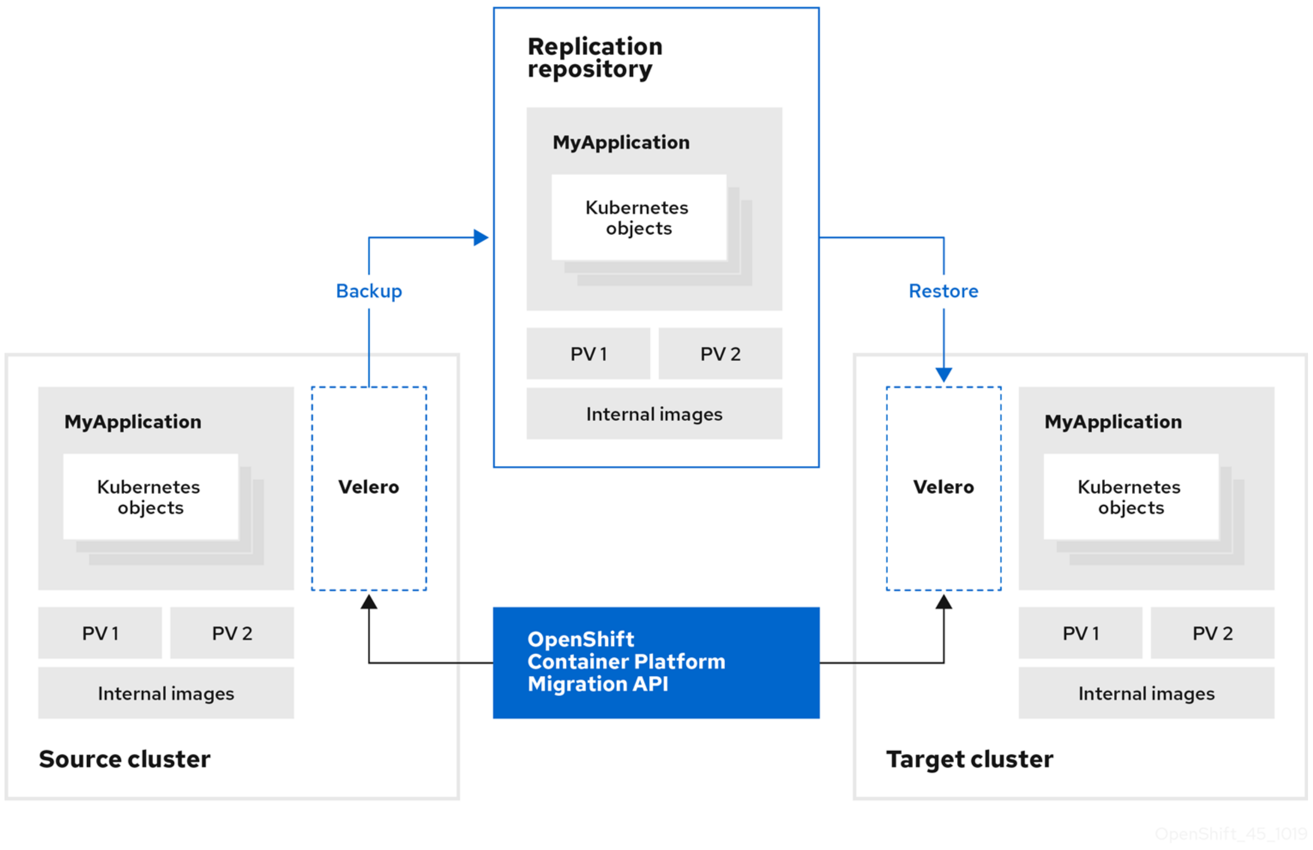
     Although the replication repository does not appear in this diagram, it is required for migration.



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 the 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.



3.2. 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.

3.2.1. 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	• Slower than the snapshot copy method • Optional data verification significantly reduces performance

3.2.2. 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
• 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.

3.3. DIRECT VOLUME MIGRATION AND DIRECT IMAGE MIGRATION

You can use direct image migration (DIM) and direct volume migration (DVM) to migrate images and data directly from the source cluster to the target cluster.

If you run DVM with nodes that are in different availability zones, the migration might fail because the migrated pods cannot access the persistent volume claim.

DIM and DVM have significant performance benefits because 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 are skipped. The data is transferred with Rsync.

DIM and DVM have additional prerequisites.

CHAPTER 4. INSTALLING THE MIGRATION TOOLKIT FOR CONTAINERS

You can install the Migration Toolkit for Containers (MTC) on OpenShift Container Platform 3 and on OpenShift Container Platform 4.5 clusters.

IMPORTANT

You must install the same MTC version on all clusters.

By default, the MTC web console and the **Migration Controller** pod run on the target cluster. You can configure the **Migration Controller** custom resource manifest to run the MTC web console and the **Migration Controller** pod on a source cluster or on a remote cluster.

After you have installed MTC, you must configure an object storage to use as a replication repository.

4.1. INSTALLING THE MIGRATION TOOLKIT FOR CONTAINERS OPERATOR ON OPENSHIFT CONTAINER PLATFORM 4

You can install the MTC Operator on OpenShift Container Platform 4 by using the OpenShift Container Platform web console.

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. If you do not want to run the MTC web console and the **Migration Controller** pod on the cluster, update the following parameters in the **migration-controller** custom resource manifest:

```
spec:
```

```
...
  migration_controller: false
  migration_ui: false
...
  deprecated_cors_configuration: true (1)
```

(1) This parameter is required only for OpenShift Container Platform 4.1.

8. Click **Create**.

9. Click **Workloads** → **Pods** to verify that the MTC pods are running.

4.2. INSTALLING THE MIGRATION TOOLKIT FOR CONTAINERS OPERATOR ON OPENSHIFT CONTAINER PLATFORM 3

You can install the Migration Toolkit for Containers Operator manually on OpenShift Container Platform 3.7, 3.9, 3.10, or 3.11.

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 cluster on which you are installing MTC must be OpenShift Container Platform 3.7, 3.9, 3.10, or 3.11.
- You must create an image stream secret and copy it to each node in the 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 MTC pods are running:

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

4.3. CONFIGURING 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.

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.

The following storage providers are supported:

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

Additional resources

- MTC workflow
- About data copy methods
- Adding a replication repository to the MTC web console

4.3.1. Configuring Multi-Cloud Object Gateway

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).

4.3.1.1. 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**.

4.3.1.2. 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
```

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 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_backing_store>
  namespace: openshift-storage
spec:
  pvPool:
    numVolumes: 3 1
    resources:
      requests:
        storage: <volume_size> 2
    storageClass: <storage_class> 3
  type: pv-pool
```

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

2 Specify the size of the volumes, for example, **50Gi**.

3 Specify the storage class, for example, **gp2**.

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_bucket_class>
  namespace: openshift-storage
spec:
  placementPolicy:
    tiers:
    - backingStores:
      - <mcg_backing_store>
      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: <bucket>
  namespace: openshift-storage
spec:
  bucketName: <bucket> 1
  storageClassName: <storage_class>
  additionalConfig:
    bucketclass: <mcg_bucket_class>
```

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
```

4.3.2. Configuring Amazon Web Services S3

You can configure an Amazon Web Services (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> \ (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>/*" (1)
            ]
        },
        {
            "Effect": "Allow",
            "Action": [
                "s3:ListBucket",
                "s3:GetBucketLocation",
                "s3:ListBucketMultipartUploads"
            ],
            "Resource": [
                "arn:aws:s3:::<bucket>" (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.

4.3.3. Configuring Google Cloud Platform

You can configure a Google Cloud Platform (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> (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
```

4.3.4. Configuring Microsoft Azure Blob

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
```

CHAPTER 5. INSTALLING THE MIGRATION TOOLKIT FOR CONTAINERS IN A RESTRICTED NETWORK ENVIRONMENT

You can install the Migration Toolkit for Containers (MTC) on OpenShift Container Platform 3 and on OpenShift Container Platform 4.5 in a restricted network environment.

IMPORTANT

You must install the same MTC version on all clusters.

By default, the MTC web console and the **Migration Controller** pod run on the target cluster.

You can configure the **Migration Controller** custom resource manifest to run the MTC web console and the **Migration Controller** pod on a source cluster or on a remote cluster.

After you have installed MTC, you must configure an object storage to use as a replication repository.

5.1. INSTALLING THE MIGRATION TOOLKIT FOR CONTAINERS OPERATOR ON OPENSHIFT CONTAINER PLATFORM 4

You can install the MTC Operator on OpenShift Container Platform 4 by using the OpenShift Container Platform web console.

Prerequisites

- You must be logged in as a user with **cluster-admin** privileges on all clusters.
- You must create an Operator catalog from a mirror image in a local 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**.
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. If you do not want to run the MTC web console and the **Migration Controller** pod on the cluster, update the following parameters in the **migration-controller** custom resource manifest:

```
spec:
...
  migration_controller: false
  migration_ui: false
...
  deprecated_cors_configuration: true (1)
```

(1) This parameter is required only for OpenShift Container Platform 4.1.

8. Click **Create**.

9. Click **Workloads** → **Pods** to verify that the MTC pods are running.

5.2. INSTALLING THE MIGRATION TOOLKIT FOR CONTAINERS OPERATOR ON OPENSHIFT CONTAINER PLATFORM 3

You can install the Migration Toolkit for Containers Operator manually on OpenShift Container Platform 3.7, 3.9, 3.10, or 3.11.

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 cluster on which you are installing MTC must be OpenShift Container Platform 3.7, 3.9, 3.10, or 3.11.
- You must have a Linux workstation with network access in order to download files from **registry.redhat.io**.
- You must first install the MTC Operator on an OpenShift Container Platform 4 cluster from a local registry.

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. Obtain the Operator image mapping by running the following command 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** values for the **ansible** and **operator** containers and the **REGISTRY** value in the **operator.yml** 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 2 Specify your mirror registry and the **sha256** value of the Operator image.

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 MTC pods are running:

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

5.3. CONFIGURING 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. Multi-Cloud Object Gateway (MCG) is the only supported option for a restricted network environment.

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.

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.

Additional resources

- MTC workflow
- About data copy methods
- Adding a replication repository to the MTC web console

5.3.1. Configuring Multi-Cloud Object Gateway

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).

5.3.1.1. Installing the OpenShift Container Storage Operator

You can install the OpenShift Container Storage Operator from OperatorHub.

See Disconnected environment in *Red Hat OpenShift Container Storage: Planning your deployment* for more information.

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**.

5.3.1.2. 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
```

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 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_backing_store>
  namespace: openshift-storage
spec:
  pvPool:
    numVolumes: 3 (1)
    resources:
      requests:
        storage: <volume_size> (2)
    storageClass: <storage_class> (3)
  type: pv-pool
```

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

(2) Specify the size of the volumes, for example, **50Gi**.

(3) Specify the storage class, for example, **gp2**.

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_bucket_class>
  namespace: openshift-storage
spec:
  placementPolicy:
    tiers:
    - backingStores:
      - <mcg_backing_store>
      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: <bucket>
  namespace: openshift-storage
spec:
  bucketName: <bucket> (1)
  storageClassName: <storage_class>
  additionalConfig:
    bucketclass: <mcg_bucket_class>
```

(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
      ```

CHAPTER 6. 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 you upgrade to the same MTC version on all clusters.

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

6.1. UPGRADING THE MIGRATION TOOLKIT FOR CONTAINERS ON OPENSHIFT CONTAINER PLATFORM 4

You can upgrade the Migration Toolkit for Containers (MTC) on OpenShift Container Platform 4 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.

6.2. UPGRADING THE MIGRATION TOOLKIT FOR CONTAINERS ON OPENSHIFT CONTAINER PLATFORM 3

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

6.3. 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
```

CHAPTER 7. PREMIGRATION CHECKLISTS

Before you migrate your application workloads with the Migration Toolkit for Containers (MTC), review the following checklists.

7.1. SOURCE CLUSTER CHECKLIST

❑ The cluster meets the minimum hardware requirements.

❑ The OpenShift Container Platform version is 3.7, 3.9, 3.10, or 3.11.

❑ The MTC version is the same on all clusters.

❑ All nodes have an active OpenShift Container Platform subscription.

❑ All the run-once tasks have been performed.

❑ All the environment health checks have been performed.

❑ You have checked for persistent volumes (PVs) with abnormal configurations stuck in a **Terminating** state by running the following command:

```
$ oc get pv
```

❑ You have checked for pods whose status is other than **Running** or **Completed** by running the following command:

```
$ oc get pods --all-namespaces | egrep -v 'Running | Completed'
```

❑ You have checked for pods with a high restart count by running the following command:

```
$ oc get pods --all-namespaces --field-selector=status.phase=Running \
  -o json | jq '.items[]|select(any( .status.containerStatuses[]; \
  .restartCount > 3))|.metadata.name'
```

Even if the pods are in a **Running** state, a high restart count might indicate underlying problems.

❑ You have deleted old images by running the following command:

```
$ oc adm prune images
```

❑ The internal registry uses a supported storage type.

❑ Direct image migration only: The internal registry is exposed to external traffic.

❑ You can read and write images to the registry.

❑ The etcd cluster is healthy.

❑ The average API server response time on the source cluster is less than 50 ms.

❑ The cluster certificates are valid for the duration of the migration process.

❑ You have checked for pending certificate-signing requests by running the following command:

```
$ oc get csr -A | grep pending -i
```

❑ The identity provider is working.

7.2. TARGET CLUSTER CHECKLIST

❑ The MTC version is the same on all clusters.

❑ All MTC prerequisites are met.

❑ The cluster meets the minimum hardware requirements for the specific platform and installation method, for example, on bare metal.

❑ The cluster has storage classes defined for the storage types used by the source cluster, for example, block volume, file system, or object storage.

NOTE

NFS does not require a defined storage class.

❑ The cluster has the correct network configuration and permissions to access external services, for example, databases, source code repositories, container image registries, and CI/CD tools.

❑ External applications and services that use services provided by the cluster have the correct network configuration and permissions to access the cluster.

❑ Internal container image dependencies are met.
If an application uses an internal image in the **openshift** namespace that is not supported by OpenShift Container Platform 4.5, you can manually update the OpenShift Container Platform 3 image stream tag with **podman**.

❑ The target cluster and the replication repository have sufficient storage space.

❑ The identity provider is working.

7.3. PERFORMANCE CHECKLIST

❑ The migration network has a minimum throughput of 10 Gbps.

❑ The clusters have sufficient resources for migration.

NOTE

Clusters require additional memory, CPUs, and storage in order to run a migration on top of normal workloads. Actual resource requirements depend on the number of Kubernetes resources being migrated in a single migration plan. You must test migrations in a non-production environment in order to estimate the resource requirements.

❑ The memory and CPU usage of the nodes are healthy.

❑ The etcd disk performance of the clusters has been checked with **fio**.

CHAPTER 8. MIGRATING YOUR APPLICATIONS

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

8.1. MIGRATION PREREQUISITES

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

Direct image migration

- You must ensure that the secure internal registry of the source cluster is exposed.
- You must create a route to the exposed registry.

Direct volume migration

- If your clusters use proxies, you must configure an Stunnel TCP proxy.

Clusters

- The source cluster must be upgraded to the latest MTC z-stream release.
- The MTC version must be the same on all clusters.

Network

- The clusters have unrestricted network access to each other and to the replication repository.
- If you copy the persistent volumes with **move**, the clusters must have unrestricted network access to the remote volumes.
- You must enable the following ports on an OpenShift Container Platform 4 cluster:
  - **6443** (API server)
  - **443** (routes)
  - **53** (DNS)
- You must enable port **443** on the replication repository if you are using TLS.

Persistent volumes (PVs)

- The PVs must be valid.
- The PVs must be bound to persistent volume claims.
- If you use snapshots to copy the PVs, the following additional prerequisites apply:
  - The cloud provider must support snapshots.
  - The PVs must have the same cloud provider.
  - The PVs must be located in the same geographic region.

- The PVs must have the same storage class.

Additional resources for migration prerequisites

- Manually exposing a secure registry for OpenShift Container Platform 3
- Updating deprecated internal images

8.1.1. Configuring an Stunnel 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>:<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
```

8.2. 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.

8.2.1. 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**.

8.2.2. 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_RfskdArt5VSv25eORl7zScqfe1CiM
   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.

8.2.3. Adding a replication repository to the MTC web console

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

MTC supports the following storage providers:

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

Prerequisites

- You must configure the object storage as a replication repository.

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 S3 providers, including AWS and MCG:
     - **Replication repository name**: Specify the replication repository name in the MTC web console.
     - **S3 bucket name**: Specify the name of the S3 bucket.
     - **S3 bucket region**: Specify the S3 bucket region. **Required** for AWS S3. **Optional** for some S3 providers. Check the product documentation of your S3 provider for expected values.
     - **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 and other S3 providers.
     - **S3 provider secret access key**: Specify the **<AWS_ACCESS_KEY_ID>** for AWS or the S3 provider secret access key for MCG and other S3 providers.
     - **Require SSL verification**: Clear this check box if you are using a generic S3 provider.
     - If you created a custom CA certificate bundle for self-signed certificates, click **Browse** and browse to the Base64-encoded 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.

8.2.4. 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**.
   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**, a **Target cluster**, and a **Repository**, and click **Next**.
5. On the **Namespaces** page, select the projects to be migrated and click **Next**.

6. 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.
7. Click **Next**.
8. 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.
9. 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.
10. Select a **Target storage class**.
    If you selected **Filesystem copy**, you can change the target storage class.
11. Click **Next**.
12. 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.
13. Click **Next**.
14. 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**.

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

Additional resources for persistent volume copy methods

- MTC file system copy method
- MTC snapshot copy method

8.2.5. 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 MTC web console and click **Migration plans**.
2. 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.

3. When you are ready to migrate the application workload, the **Options** menu ⋮ beside a migration plan and select **Migrate**.
4. Optional: In the **Migrate** window, you can select **Do not stop applications on the source cluster during migration**.
5. Click **Migrate**.
6. 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 volume is correctly provisioned.

CHAPTER 9. ADVANCED MIGRATION OPTIONS

This section describes advanced options for automating your migration and for modifying the migration plan.

Additional resources

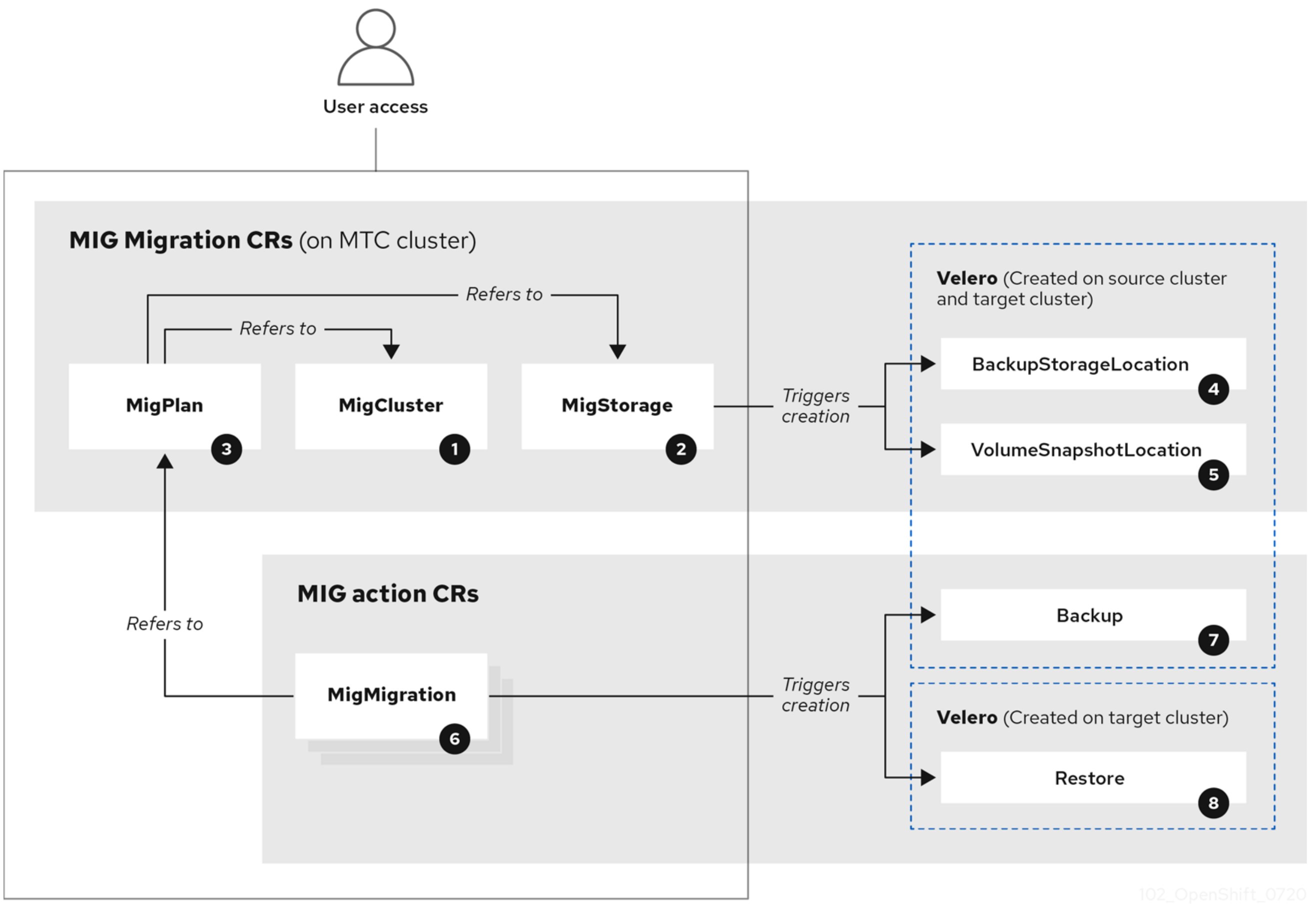
- MTC workflow

9.1. MTC CUSTOM RESOURCES

This section describes the custom resources (CRs) that are used by the Migration Toolkit for Containers (MTC).

9.1.1. About MTC 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

9.1.2. MTC custom resource manifests

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

9.1.2.1. 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: <direct_image_migration>
spec:
  srcMigClusterRef:
    name: <source_cluster>
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster>
    namespace: openshift-migration
  namespaces: 1
    - <source_namespace_1>
    - <source_namespace_2>:<destination_namespace_3> 2
```

1 One or more namespaces containing images to be migrated. By default, the destination namespace has the same name as the source namespace.

2 Source namespace mapped to a destination namespace with a different name.

9.1.2.2. 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: <direct_image_stream_migration>
spec:
  srcMigClusterRef:
    name: <source_cluster>
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster>
    namespace: openshift-migration
  imageStreamRef:
    name: <image_stream>
    namespace: <source_image_stream_namespace>
  destNamespace: <destination_image_stream_namespace>
```

9.1.2.3. 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: <direct_volume_migration>
  namespace: openshift-migration
spec:
  createDestinationNamespaces: false 1
  deleteProgressReportingCRs: false 2
  destMigClusterRef:
    name: <host_cluster> 3
    namespace: openshift-migration
  persistentVolumeClaims:
  - name: <pvc> 4
    namespace: <pvc_namespace>
  srcMigClusterRef:
    name: <source_cluster>
    namespace: openshift-migration
```

1 Set to **true** to create namespaces for the PVs on the destination cluster.

2 Set to **true** to delete **DirectVolumeMigrationProgress** CRs after migration. The default 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.

9.1.2.4. 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: <direct_volume_migration_progress>
spec:
  clusterRef:
    name: <source_cluster>
    namespace: openshift-migration
  podRef:
    name: <rsync_pod>
    namespace: openshift-migration
```

9.1.2.5. MigAnalytic

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

You can configure the data that it collects.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigAnalytic
metadata:
  annotations:
    migplan: <migplan>
  name: <miganalytic>
  namespace: openshift-migration
  labels:
    migplan: <migplan>
spec:
  analyzeImageCount: true <.>
  analyzeK8SResources: true <.>
  analyzePVCapacity: true <.>
  listImages: false <.>
  listImagesLimit: 50 <.>
  migPlanRef:
    name: <migplan>
    namespace: openshift-migration
```

<.> Optional: Returns the number of images. <.> Optional: Returns the number, kind, and API version of the Kubernetes resources. <.> Optional: Returns the PV capacity. <.> Returns a list of image names. The default is **false** so that the output is not excessively long. <.> Optional: Specify the maximum number of

image names to return if **listImages** is **true**.

9.1.2.6. 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_cluster> 1
  namespace: openshift-migration
spec:
  isHostCluster: true 2
# The 'azureResourceGroup' parameter is relevant only for Microsoft Azure.
  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.
  exposedRegistryPath: <registry_route> 8
  url: <destination_cluster_url> 9
  serviceAccountSecretRef:
    name: <source_secret> 10
    namespace: openshift-config
```

1. 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. Microsoft Azure only: 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. Set to **true** to disable SSL verification.
6. Set to **true** to validate the cluster.
7. Set to **true** to restart the **Restic** pods on the source cluster after the **Stage** pods are created.
8. Remote cluster and direct image migration only: Specify the exposed secure registry path.
9. Remote cluster only: Specify the URL.
10. Remote cluster only: Specify the name of the **Secret** CR.

9.1.2.7. MigHook

The **MigHook** CR defines a migration hook that runs custom code at a specified stage of the migration. You can create up to four migration hooks. Each hook runs during a different phase of the migration.

You can configure the hook name, runtime duration, a custom image, and the cluster where the hook will run.

The migration phases and namespaces of the hooks are configured in the **MigPlan** CR.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigHook
metadata:
  generateName: <hook_name_prefix> 1
  name: <mighook> 2
  namespace: openshift-migration
spec:
  activeDeadlineSeconds: 1800 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 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. Base64-encoded Ansible playbook. Required if **custom** is **false**.

7. Specify the cluster on which the hook will run. Valid values are **source** or **destination**.

9.1.2.8. MigMigration

The **MigMigration** CR runs a **MigPlan** CR.

You can configure a **Migmigration** CR to run a stage or incremental migration, to cancel a migration in progress, or to roll back a completed migration.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: <migmigration>
  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>
      namespace: openshift-migration
```

1 Set to **true** to cancel a migration in progress.

2 Set to **true** to roll back a completed migration.

3 Set to **true** to run a stage migration. Data is copied incrementally and the pods on the source cluster are not stopped.

4 Set to **true** to stop the application during migration. The pods on the source cluster are scaled to **0** after the **Backup** stage.

5 Set to **true** to retain the labels and annotations applied during the migration.

6 Set to **true** to check the status of the migrated pods on the destination cluster are checked and to return the names of pods that are not in a **Running** state.

9.1.2.9. MigPlan

The **MigPlan** CR defines the parameters of a migration plan.

You can configure destination namespaces, hook phases, and direct or indirect migration.

NOTE

By default, a destination namespace has the same name as the source namespace. If you configure a different destination namespace, you must ensure that the namespaces are not duplicated on the source or the destination clusters because the UID and GID ranges are copied during migration.

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigPlan
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: <migplan>
  namespace: openshift-migration
spec:
  closed: false 1
  srcMigClusterRef:
    name: <source_cluster>
    namespace: openshift-migration
  destMigClusterRef:
    name: <destination_cluster>
    namespace: openshift-migration
  hooks: 2
```

```
    - executionNamespace: <namespace> (3)
      phase: <migration_phase> (4)
      reference:
        name: <hook> (5)
        namespace: <hook_namespace> (6)
      serviceAccount: <service_account> (7)
  indirectImageMigration: true (8)
  indirectVolumeMigration: false (9)
  migStorageRef:
    name: <migstorage>
    namespace: openshift-migration
  namespaces:
    - <source_namespace_1> (10)
    - <source_namespace_2>
    - <source_namespace_3>:<destination_namespace_4> (11)
  refresh: false (12)
```

1. The migration has completed if **true**. You cannot create another **MigMigration** CR for this **MigPlan** CR.
2. Optional: You can specify up to four migration hooks. Each hook must run during a different migration phase.
3. Optional: Specify the namespace in which the hook will run.
4. Optional: Specify the migration phase during which a hook runs. One hook can be assigned to one phase. Valid values are **PreBackup**, **PostBackup**, **PreRestore**, and **PostRestore**.
5. Optional: Specify the name of the **MigHook** CR.
6. Optional: Specify the namespace of **MigHook** CR.
7. Optional: Specify a service account with **cluster-admin** privileges.
8. 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.
9. 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.
10. Specify one or more source namespaces. If you specify only the source namespace, the destination namespace is the same.
11. Specify the destination namespace if it is different from the source namespace.
12. The **MigPlan** CR is validated if **true**.

9.1.2.10. MigStorage

The **MigStorage** CR describes the object storage for the replication repository.

Amazon Web Services (AWS), Microsoft Azure, Google Cloud Storage, Multi-Cloud Object Gateway, and generic S3-compatible cloud storage are supported.

AWS and the snapshot copy method have additional parameters.

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

1. Specify the storage provider.
2. Snapshot copy method only: Specify the storage provider.
3. AWS only: Specify the bucket name.
4. AWS only: Specify the bucket region, for example, **us-east-1**.
5. Specify the name of the **Secret** CR that you created for the storage.
6. AWS only: If you are using the AWS Key Management Service, specify the unique identifier of the key.
7. AWS only: If you granted public access to the AWS bucket, specify the bucket URL.
8. AWS only: Specify the AWS signature version for authenticating requests to the bucket, for example, **4**.
9. Snapshot copy method only: Specify the geographical region of the clusters.
10. Snapshot copy method only: Specify the name of the **Secret** CR that you created for the storage.
11. Set to **true** to validate the cluster.

9.2. MIGRATING YOUR APPLICATIONS WITH THE MTC API

This section describes how to migrate your applications with the MTC API from the command line interface (CLI).

9.2.1. About migrating applications

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

9.2.1.1. Terminology

Source cluster

- Cluster from which the applications are migrated.

Destination cluster

- Cluster to which the applications are migrated.

Replication repository

- Object storage.
- Requires network access to all clusters.

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 volume migration

- Volumes are copied directly from the source cluster to the destination cluster.
- Significantly faster than indirect migration.

Direct image migration

- Images are copied directly from the source cluster to the destination cluster.
- Significantly faster than indirect migration.

Host cluster

- Cluster on which the **migration-controller** pod and the web console run.
- Usually the same as the destination cluster and the local cluster but this is not a requirement.
- Does not require an exposed secure registry route for direct image migration.

Remote cluster

- Usually the same as the source cluster but this is not a requirement.
- Requires an exposed secure registry route for direct image migration.
- Requires a **Secret** CR containing the **migration-controller** service account token.

9.2.1.2. Mapping destination namespaces in the MigPlan custom resource (CR)

If you map destination namespaces in the **MigPlan** CR, you must ensure that the namespaces are not duplicated on the source or the destination clusters because the UID and GID ranges of the namespaces are copied during migration.

Two source namespaces mapped to the same destination namespace

```
spec:
  namespaces:
    - namespace_2
    - namespace_1:namespace_2
```

If you want the source namespace to be mapped to a namespace of the same name, you do not need to create a mapping. By default, a source namespace and a target namespace have the same name.

Incorrect namespace mapping

```
spec:
  namespaces:
    - namespace_1:namespace_1
```

Correct namespace reference

```
spec:
  namespaces:
    - namespace_1
```

9.2.1.3. Stage migration, migration cancellation, and migration rollback

You can create and associate multiple **MigMigration** custom resources (CRs) with the same **MigPlan** CR for the following use cases:

- To perform a stage migration, which copies all available data without stopping the application pods. Running a stage migration reduces the cutover time.
- To cancel a migration in progress.
- To roll back a completed migration.

9.2.1.4. Creating a registry route for direct image migration

For direct image migration, you must create a route to the exposed internal registry on all remote clusters.

Prerequisites

- The internal registry must be exposed to external traffic on all remote clusters.
  The OpenShift Container Platform 4 registry is exposed by default.

  The OpenShift Container Platform 3 registry must be exposed manually.

Procedure

- To create a route to an OpenShift Container Platform 3 registry, run the following command:

```
$ oc create route passthrough --service=docker-registry --port=5000 -n default
```

- To create a route to an OpenShift Container Platform 4 registry, run the following command:

```
$ oc create route passthrough --service=image-registry --port=5000 -n openshift-image-
registry
```

9.2.2. Migration prerequisites

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

Direct image migration

- You must ensure that the secure internal registry of the source cluster is exposed.
- You must create a route to the exposed registry.

Direct volume migration

- If your clusters use proxies, you must configure an Stunnel TCP proxy.

Internal images

- 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 4.5 cluster.

Clusters

- The source cluster must be upgraded to the latest MTC z-stream release.
- The MTC version must be the same on all clusters.

Network

- The clusters have unrestricted network access to each other and to the replication repository.
- If you copy the persistent volumes with **move**, the clusters must have unrestricted network access to the remote volumes.
- You must enable the following ports on an OpenShift Container Platform 3 cluster:
  - **8443** (API server)
  - **443** (routes)
  - **53** (DNS)
- You must enable the following ports on an OpenShift Container Platform 4 cluster:
  - **6443** (API server)

    - **443** (routes)
    - **53** (DNS)

- You must enable port **443** on the replication repository if you are using TLS.

Persistent volumes (PVs)

- The PVs must be valid.
- The PVs must be bound to persistent volume claims.
- If you use snapshots to copy the PVs, the following additional prerequisites apply:
    - The cloud provider must support snapshots.
    - The PVs must have the same cloud provider.
    - The PVs must be located in the same geographic region.
    - The PVs must have the same storage class.

9.2.2.1. Configuring an Stunnel 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>:<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
```

9.2.3. Migrating your applications from the command line

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

Procedure

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

```
$ cat << EOF | oc apply -f -
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  name: <host_cluster>
  namespace: openshift-migration
spec:
  isHostCluster: true
EOF
```

2. Create a **Secret** CR manifest for each remote cluster:

```
$ cat << EOF | oc apply -f -
apiVersion: v1
kind: Secret
metadata:
  name: <cluster_secret>
  namespace: openshift-config
type: Opaque
data:
  saToken: <sa_token> 1
EOF
```

1 Specify the base64-encoded **migration-controller** service account (SA) token of the remote cluster. You can obtain the token by running the following command:

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

3. Create a **MigCluster** CR manifest for each remote cluster:

```
$ cat << EOF | oc apply -f -
```

```
apiVersion: migration.openshift.io/v1alpha1
kind: MigCluster
metadata:
  name: <remote_cluster> <.>
  namespace: openshift-migration
spec:
  exposedRegistryPath: <exposed_registry_route> <.>
  insecure: false <.>
  isHostCluster: false
  serviceAccountSecretRef:
    name: <remote_cluster_secret> <.>
    namespace: openshift-config
  url: <remote_cluster_url> <.>
EOF
```

<.> Specify the **Cluster** CR of the remote cluster. <.> Optional: For direct image migration, specify the exposed registry route. <.> SSL verification is enabled if **false**. CA certificates are not required or checked if **true**. <.> Specify the **Secret** CR of the remote cluster. <.> Specify the URL of the remote cluster.

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

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

5. Create a **Secret** CR manifest for the replication repository:

```
$ cat << EOF | oc apply -f -
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
EOF
```

1 Specify the key ID in base64 format.

2 Specify the secret key in base64 format.

AWS credentials are base64-encoded by default. For other storage providers, 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.

6. Create a **MigStorage** CR manifest for the replication repository:

```
$ cat << EOF | oc apply -f -
apiVersion: migration.openshift.io/v1alpha1
```

```
kind: MigStorage
metadata:
  name: <migstorage>
  namespace: openshift-migration
spec:
  backupStorageConfig:
    awsBucketName: <bucket> 1
    credsSecretRef:
      name: <storage_secret> 2
      namespace: openshift-config
  backupStorageProvider: <storage_provider> 3
  volumeSnapshotConfig:
    credsSecretRef:
      name: <storage_secret> 4
      namespace: openshift-config
  volumeSnapshotProvider: <storage_provider> 5
EOF
```

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.

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

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

8. Create a **MigPlan** CR manifest:

```
$ cat << EOF | oc apply -f -
apiVersion: migration.openshift.io/v1alpha1
kind: MigPlan
metadata:
  name: <migplan>
  namespace: openshift-migration
spec:
  destMigClusterRef:
    name: <host_cluster>
    namespace: openshift-migration
  indirectImageMigration: true 1
  indirectVolumeMigration: true 2
  migStorageRef:
    name: <migstorage> 3
    namespace: openshift-migration
  namespaces:
    - <application_namespace> 4
  srcMigClusterRef:
    name: <remote_cluster> (5)
    namespace: openshift-migration
EOF
```

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 source namespaces. By default, the destination namespace has the same name.
5. Specify a destination namespace if it is different from the source namespace.

   Specify the name of the source cluster **MigCluster** instance.

9. Verify that the **MigPlan** instance is in a **Ready** state:

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

10. Create a **MigMigration** CR manifest to start the migration defined in the **MigPlan** instance:

```
$ cat << EOF | oc apply -f -
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  name: <migmigration>
  namespace: openshift-migration
spec:
  migPlanRef:
    name: <migplan> (1)
    namespace: openshift-migration
  quiescePods: true (2)
  stage: false (3)
  rollback: false (4)
EOF
```

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**.

11. Verify the migration by watching the **MigMigration** CR progress:

```
$ oc watch migmigration <migmigration> -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:       migplan
    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
```

9.3. MIGRATION HOOKS

You can use migration hooks to run custom code at certain points during a migration.

9.3.1. About migration hooks

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 creating an Ansible playbook that runs with the default Ansible image or with 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. The job continues to run until it reaches 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.

Custom hook container

You can use a custom hook container instead of the default Ansible image.

9.3.2. 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.

9.3.2.1. 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
```

9.3.2.2. 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') }}"
```

9.4. 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.

9.5. 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 in order 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
```

CHAPTER 10. TROUBLESHOOTING

This section describes resources for troubleshooting the Migration Toolkit for Containers (MTC).

10.1. LOGS AND DEBUGGING TOOLS

This section describes logs and debugging tools that you can use for troubleshooting.

10.1.1. Viewing migration plan resources

You can view migration plan resources to monitor a running migration or to troubleshoot a failed migration by using the MTC web console and the command line interface (CLI).

Procedure

1. In the MTC web console, click **Migration Plans**.
2. Click the **Migrations** number next to a migration plan to view the **Migrations** page.
   The **Migrations** page displays the migration types associated with the migration plan, for example, **Stage**, **Migration**, or **Rollback**.
3. Click the **Type** link to view the **Migration details** page.
4. Expand **Migration resources** to view the migration resources and their status.

   NOTE

   To troubleshoot a failed migration, start with a high-level resource that has failed and then work down the resource tree towards the lower-level resources.

5. Click the Options menu ⋮ next to a resource and select one of the following options:
   - **Copy oc describe command** copies the command to your clipboard.
     - Log in to the relevant cluster and then run the command.
       The conditions and events of the resource are displayed in YAML format.
   - **Copy oc logs command** copies the command to your clipboard.
     - Log in to the relevant cluster and then run the command.
       If the resource supports log filtering, a filtered log is displayed.
   - **View JSON** displays the resource data in JSON format in a web browser.
     The data is the same as the output for the **oc get <resource>** command.

10.1.2. Viewing a migration plan log

You can view an aggregated log for a migration plan. You use the MTC web console to copy a command to your clipboard and then run the command from the command line interface (CLI).

The command displays the filtered logs of the following pods:

- **Migration Controller**

- **Velero**
- **Restic**
- **Rsync**
- **Stunnel**
- **Registry**

Procedure

1. In the MTC web console, click **Migration Plans**.
2. Click the **Migrations** number next to a migration plan to view the **Migrations** page.
   The **Migrations** page displays the migration types associated with the migration plan, for example, **Stage** or **Cutover** for warm migration.
3. Click **View logs**.
4. Click the Copy icon to copy the **oc logs** command to your clipboard.
5. Log in to the relevant cluster and enter the command on the CLI.
   The aggregated log for the migration plan is displayed.

10.1.3. 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.

10.1.4. Using the must-gather tool

You can collect logs, metrics, and information about MTC custom resources by using the **must-gather** tool.

The **must-gather** data must be attached to all customer cases.

You can collect data for a one-hour or a 24-hour period and view the data with the Prometheus console.

Prerequisites

- You must be logged in to the OpenShift Container Platform cluster as a user with the **cluster-admin** role.

- You must have the OpenShift CLI installed.

Procedure

1. Navigate to the directory where you want to store the **must-gather** data.
2. Run the **oc adm must-gather** command:
   - To gather data for the past hour:

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

     The data is saved as **/must-gather/must-gather.tar.gz**. You can upload this file to a support case on the Red Hat Customer Portal .
   - To gather data for the past 24 hours:

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

     This operation can take a long time. The data is saved as **/must-gather/metrics/prom_data.tar.gz**. You can view this file with the Prometheus console.

To view data with the Prometheus console

1. Create a local Prometheus instance:

   ```
   $ make prometheus-run
   ```

   The command outputs the Prometheus URL:

   Output

   ```
   Started Prometheus on http://localhost:9090
   ```
2. Launch a web browser and navigate to the URL to view the data by using the Prometheus web console.
3. After you have viewed the data, delete the Prometheus instance and data:

   ```
   $ make prometheus-cleanup
   ```

10.1.5. 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.

10.1.5.1. 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)**.

10.1.5.2. 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
```

10.1.5.3. 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
```

10.1.5.4. 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
```

10.1.6. 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>
```

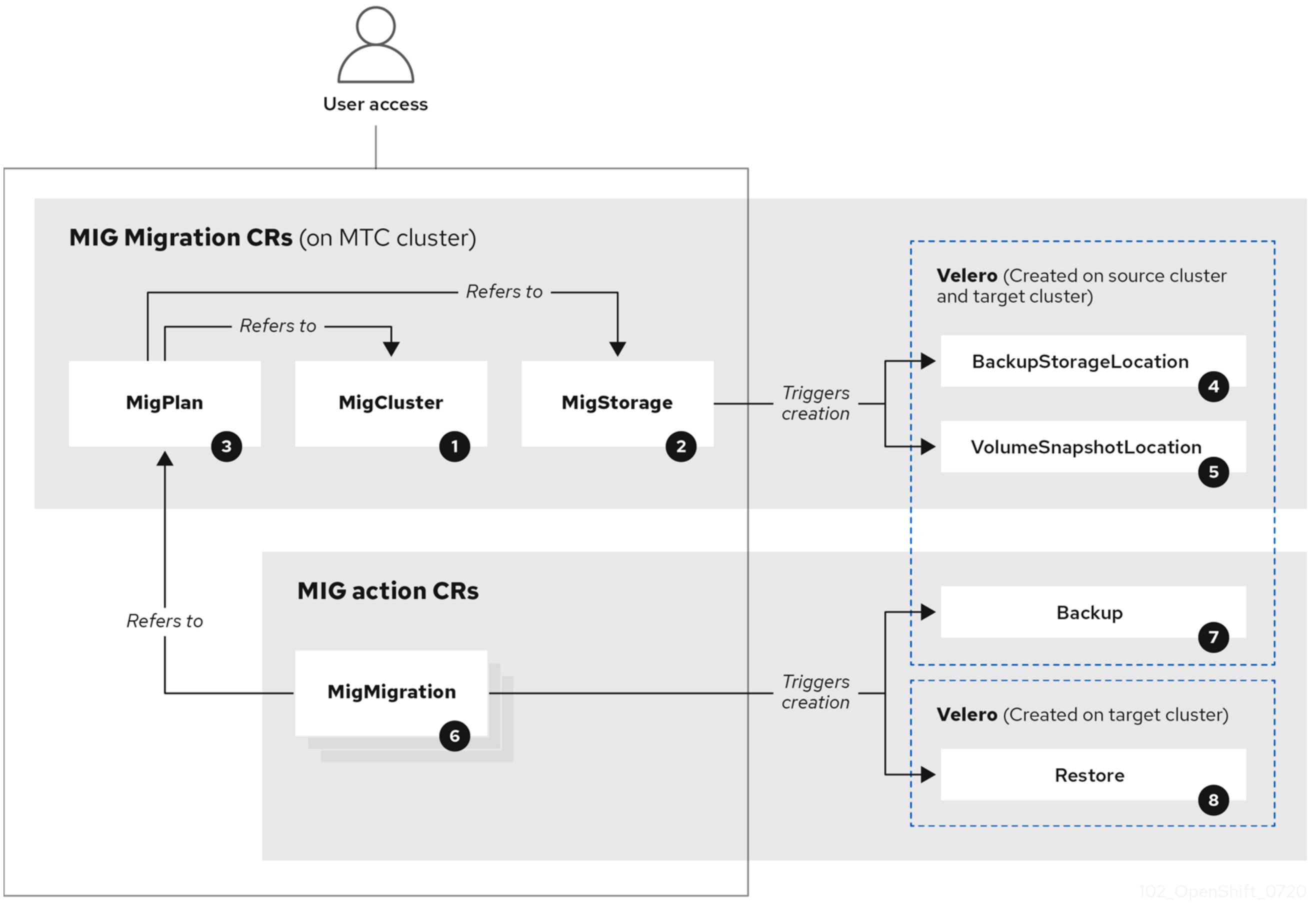
Example output

```
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.

10.1.7. Using MTC custom resources for troubleshooting

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



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

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
  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
```

Additional resources for debugging tools

- MTC workflow
- MTC custom resources

10.2. COMMON ISSUES AND CONCERNS

This section describes common issues and concerns that can cause issues during migration.

10.2.1. Updating deprecated internal images

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

If an OpenShift Container Platform 3 image is deprecated in OpenShift Container Platform 4.5, 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.
- 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.
- The internal registries must be exposed on the source and target clusters.

Procedure

1. Ensure that the internal registries are exposed on the OpenShift Container Platform 3 and 4 clusters.
   The internal registry is exposed by default on OpenShift Container Platform 4.
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 OpenShift Container Platform 3 registry:

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

4. Log in to the OpenShift Container Platform 4 registry:

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

5. Pull the OpenShift Container Platform 3 image:

```
$ podman pull <registry_url>:<port>/openshift/<image>
```

6. Tag the OpenShift Container Platform 3 image for the OpenShift Container Platform 4 registry:

```
$ podman tag <registry_url>:<port>/openshift/<image> \ 1
  <registry_url>:<port>/openshift/<image> 2
```

1 Specify the registry URL and port for the OpenShift Container Platform 3 cluster.

2 Specify the registry URL and port for the OpenShift Container Platform 4 cluster.

7. Push the image to the OpenShift Container Platform 4 registry:

```
$ podman push <registry_url>:<port>/openshift/<image> 1
```

1 Specify the OpenShift Container Platform 4 cluster.

8. Verify that the image has a valid image stream:

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

Example output

```
NAME      IMAGE REPOSITORY                                                TAGS    UPDATED
my_image  image-registry.openshift-image-registry.svc:5000/openshift/my_image  latest  32
seconds ago
```

10.2.2. 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 in order 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> -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 the 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.

10.2.3. 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.

10.2.3.1. CA certificate error displayed when accessing the MTC console for the first time

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.

10.2.3.2. 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.

- Inspect the MTC console web page with a browser web inspector.
- Check the **Migration UI** pod log for errors.

10.2.3.3. Certificate signed by unknown authority error

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.

10.2.3.4. Backup storage location errors in the Velero pod log

If a **Velero Backup** custom resource contains a reference to a backup storage location (BSL) that does not exist, the **Velero** pod log might display the following error messages:

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

You can ignore these error messages. A missing BSL cannot cause a migration to fail.

10.2.3.5. Pod volume backup timeout error in the Velero pod log

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

```
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**.

10.2.3.6. Restic verification errors 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>
```

10.2.3.7. Restic permission error when migrating from NFS storage with root_squash enabled

If you are migrating data from NFS storage and **root_squash** is enabled, **Restic** maps to **nfsnobody** and does not have permission to perform the migration. The following error is displayed in the **Restic** pod log.

Example output

```
backup=openshift-migration/<backup_id> controller=pod-volume-backup error="fork/exec
/usr/bin/restic: permission denied" error.file="/go/src/github.com/vmware-
tanzu/velero/pkg/controller/pod_volume_backup_controller.go:280"
error.function="github.com/vmware-tanzu/velero/pkg/controller.
(*podVolumeBackupController).processBackup"
logSource="pkg/controller/pod_volume_backup_controller.go:280" name=<backup_id>
namespace=openshift-migration
```

You can resolve this issue by creating a supplemental group for Restic and adding the group ID to the **MigrationController** CR manifest.

Procedure

1. Create a supplemental group for Restic on the NFS storage.
2. Set the **setgid** bit on the NFS directories so that group ownership is inherited.
3. Add the **restic_supplemental_groups** parameter to the **MigrationController** CR manifest on the source and target clusters:

```
spec:
  restic_supplemental_groups: <group_id> (1)
```

(1) Specify the supplemental group ID.

4. Wait for the **Restic** pods to restart so that the changes are applied.

10.2.4. 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)
- 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** custom resource (CR) manifest.
- If you select the data verification option for PVs that are migrated with the file system copy method, performance is significantly slower.
- If you are migrating data from NFS storage and **root_squash** is enabled, **Restic** maps to **nfsnobody**. The migration fails and a permission error is displayed in the **Restic** pod log. (BZ#1873641)
  You can resolve this issue by adding supplemental groups for **Restic** to the **MigrationController** CR manifest:

```
spec:
...
  restic_supplemental_groups:
  - 5555
  - 6666
```

- If you perform direct volume migration with nodes that are in different availability zones, the migration might fail because the migrated pods cannot access the PVC. (BZ#1947487)

10.3. ROLLING BACK A MIGRATION

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

10.3.1. Rolling back a migration by using the MTC web console

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

NOTE

If you roll back a failed direct volume migration, the following resources are preserved in the namespaces specified in the migration plan to help you debug the failed migration:

- Config maps (source and target clusters)
- **Secret** CRs (source and target clusters)
- **Rsync** CRs (source cluster)
- **Service** CRs (target cluster)
- **Route** CRs (target cluster)

These resources must be deleted manually.

If you later run the same migration plan successfully, the resources from the failed migration are deleted automatically.

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.

10.3.2. Rolling back a migration from the command line interface

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

NOTE

If you roll back a failed direct volume migration, the following resources are preserved in the namespaces specified in the **MigPlan** custom resource (CR) to help you debug the failed migration:

- Config maps (source and destination clusters)
- **Secret** CRs (source and destination clusters)
- **Rsync** CRs (source cluster)
- **Service** CRs (destination cluster)
- **Route** CRs (destination cluster)

These resources must be deleted manually.

If you later run the same migration plan successfully, the resources from the failed migration are deleted automatically.

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: <migmigration>
  namespace: openshift-migration
spec:
...
  rollback: true
```

```
...
 migPlanRef:
   name: <migplan> (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.