OpenShift Container Platform 4.6

Migrating from version 3 to 4

Migrating to OpenShift Container Platform 4
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Migrating to OpenShift Container Platform 4
Abstract

This document provides instructions for migrating your OpenShift Container Platform cluster from version 3 to version 4.
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CHAPTER 1. MIGRATION FROM OPENSSHIFT CONTAINER PLATFORM 3 TO 4 OVERVIEW

OpenShift Container Platform 4 clusters are different from OpenShift Container Platform 3 clusters. OpenShift Container Platform 4 clusters contain new technologies and functionality that result in a cluster that is self-managing, flexible, and automated. To learn more about migrating from OpenShift Container Platform 3 to 4 see About migrating from OpenShift Container Platform 3 to 4.

1.1. DIFFERENCES BETWEEN OPENSHEET CONTAINER PLATFORM 3 AND 4

Before migrating from OpenShift Container Platform 3 to 4, you can check differences between OpenShift Container Platform 3 and 4. Review the following information:

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

1.2. PLANNING NETWORK CONSIDERATIONS

Before migrating from OpenShift Container Platform 3 to 4, review the differences between OpenShift Container Platform 3 and 4 for information about the following areas:

- DNS considerations
  - Isolating the DNS domain of the target cluster from the clients.
  - Setting up the target cluster to accept the source DNS domain.

You can migrate stateful application workloads from OpenShift Container Platform 3 to 4 at the granularity of a namespace. To learn more about MTC see Understanding MTC.

NOTE

If you are migrating from OpenShift Container Platform 3, see About migrating from OpenShift Container Platform 3 to 4 and Installing the legacy Migration Toolkit for Containers Operator on OpenShift Container Platform 3.

1.3. INSTALLING MTC

Review the following tasks to install the MTC:

1. Install the Migration Toolkit for Containers Operator on target cluster by using Operator Lifecycle Manager (OLM).
2. Install the legacy Migration Toolkit for Containers Operator on the source cluster manually.
3. Configure object storage to use as a replication repository.

1.4. UPGRADING MTC
You upgrade the Migration Toolkit for Containers (MTC) on OpenShift Container Platform 4.6 by using OLM. You upgrade MTC on OpenShift Container Platform 3 by reinstalling the legacy Migration Toolkit for Containers Operator.

1.5. REVIEWING PREMIGRATION CHECKLISTS

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

1.6. MIGRATING APPLICATIONS

You can migrate your applications by using the MTC web console or the command line.

1.7. ADVANCED MIGRATION OPTIONS

You can automate your migrations and modify MTC custom resources to improve the performance of large-scale migrations by using the following options:

- Running a state migration
- Creating migration hooks
- Editing, excluding, and mapping migrated resources
- Configuring the migration controller for large migrations

1.8. TROUBLESHOOTING MIGRATIONS

You can perform the following troubleshooting tasks:

- Viewing migration plan resources by using the MTC web console
- Viewing the migration plan aggregated log file
- Using the migration log reader
- Accessing performance metrics
- Using the must-gather tool
- Using the Velero CLI to debug Backup and Restore CRs
- Using MTC custom resources for troubleshooting
- Checking common issues and concerns

1.9. ROLLING BACK A MIGRATION

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

1.10. UNINSTALLING MTC AND DELETING RESOURCES

You can uninstall the MTC and delete its resources to clean up the cluster.
CHAPTER 2. ABOUT MIGRATING FROM OPENSIFT 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 3. DIFFERENCES BETWEEN OPENSHIFT CONTAINER PLATFORM 3 AND 4

OpenShift Container Platform 4.6 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 4.6 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.

3.1. 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.

3.2. 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 4.6, 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 4.6 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 4.6, 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 4.6 cluster has RHEL worker machines, then you will still need to run an Ansible playbook to upgrade those worker machines.

For more information, see Upgrading clusters.

### 3.3. MIGRATION CONSIDERATIONS

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

#### 3.3.1. Storage considerations

Review the following storage changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.6.

**Local volume persistent storage**
Local storage is only supported by using the Local Storage Operator in OpenShift Container Platform 4.6. 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 4.6 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 4.6 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 4.6:

- 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 4.6.

For more information, see [Understanding persistent storage](#).

### 3.3.2. Networking considerations

Review the following networking changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.6.

**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 4.6 is controlled by a network policy.

If your OpenShift Container Platform 3.11 cluster used the `ovs-subnet` or `ovn-multitenant` mode, it is recommended to switch to a network policy for your OpenShift Container Platform 4.6 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 4.6, 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 4.6 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.

### 3.3.3. Logging considerations

Review the following logging changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.6.

**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 4.6.

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

### 3.3.4. Security considerations

Review the following security changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.6.

**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 4.6. 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 4.6 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 4.6. It now obtains data, which previously had to be 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.

### 3.3.5. Monitoring considerations
Review the following monitoring changes to consider when transitioning from OpenShift Container Platform 3.11 to OpenShift Container Platform 4.6.

**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 4. PLANNING CONSIDERATIONS

This section describes considerations and strategies for planning your migration from OpenShift Container Platform 3 to 4.

4.1. DNS CONSIDERATIONS

The DNS domain of the OpenShift Container Platform 4 target cluster is different from the domain of the OpenShift Container Platform 3 source cluster. By default, applications get FQDNs of the OpenShift Container Platform 4 cluster after migration.

To preserve the source DNS domain of migrated applications, select one of the two options described below.

4.1.1. Isolating the DNS domain of the target cluster from the clients

You can allow the clients’ requests sent to the DNS domain of the source cluster to reach the DNS domain of the target cluster without exposing the target cluster to the clients.

Procedure

1. Place an exterior network component, such as an application load balancer or a reverse proxy, between the clients and the OpenShift Container Platform 4 cluster.

2. Update the original application FQDN (app1.apps.ocp3.example.com) in the DNS server to return the IP address of the exterior network component.

3. Configure the network component to send requests received for the application in the source domain to the load balancer in the target OpenShift Container Platform 4 cluster domain.

4. Create a wildcard DNS record for the *.apps.ocp3.example.com domain that points to the IP address of the load balancer of the source cluster.

5. Create a specific DNS record for each application that points to the IP address of the exterior network component in front of the target cluster. A specific DNS record has higher priority than a wildcard record, so no conflict arises when the application FQDN is resolved.

NOTE

- The exterior network component must terminate all secure TLS connections. If the connections pass through to the OpenShift Container Platform 4 load balancer, the FQDN of the target application is exposed to the client and certificate errors occur.

- The applications must not return links referencing the target cluster domain to the clients. Otherwise, parts of the application might not load or work properly.

4.1.2. Setting up the target cluster to accept the source DNS domain

You can set up the target cluster to accept requests for migrated applications in the DNS domain of the source cluster.

Procedure

For both non-secure HTTP access and secure HTTPS access, perform the following steps:
1. Create a route in the application’s project for the hostname that applications used in the source cluster:

   ```
   $ oc expose svc app1-svc --hostname app1.apps.ocp3.example.com \
   -n app1-namespace
   ```

   With this new route in place, the server accepts any request for that FQDN and sends it to the corresponding application pods. In addition, when you migrate the application, another route is created in the target cluster domain (app1.apps.ocp4.example.com). Requests can reach the migrated application using both of these hostnames.

2. Create a specific DNS record for the FQDN in the route hostname parameter that points to the IP address of the default load balancer of the target cluster. Specific DNS records take priority over wildcard records.

   The FQDN of the application resolves to the load balancer of the target cluster. The default ingress controller router accept requests for that FQDN because a route for that hostname is exposed.

For secure HTTPS access, perform the following additional step:

1. Replace the x509 certificate of the default ingress controller created during the installation process with a custom certificate.

2. Configure this certificate to include the wildcard DNS domains for both the source and target clusters in the **subjectAltName** field.

   The new certificate is valid for securing connections made using either of the two DNS domains.

**Additional resources**

- See [Replacing the default ingress certificate](#) for more information.
CHAPTER 5. ABOUT THE MIGRATION TOOLKIT FOR CONTAINERS

The Migration Toolkit for Containers (MTC) enables you to migrate stateful application workloads from OpenShift Container Platform 3 to 4.6 at the granularity of a namespace.

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.

5.1. TERMINOLOGY

Table 5.1. MTC terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source cluster</td>
<td>Cluster from which the applications are migrated.</td>
</tr>
<tr>
<td>Destination cluster[1]</td>
<td>Cluster to which the applications are migrated.</td>
</tr>
<tr>
<td>Replication repository</td>
<td>Object storage used for copying images, volumes, and Kubernetes objects during indirect migration or for Kubernetes objects during direct volume migration or direct image migration. The replication repository must be accessible to all clusters.</td>
</tr>
<tr>
<td>Host cluster</td>
<td>Cluster on which the migration-controller pod and the web console are running. The host cluster is usually the destination cluster but this is not required. The host cluster does not require an exposed registry route for direct image migration.</td>
</tr>
</tbody>
</table>
A remote cluster is usually the source cluster but this is not required. A remote cluster requires a Secret custom resource that contains the migration-controller service account token. A remote cluster requires an exposed secure registry route for direct image migration.

Indirect migration
Images, volumes, and Kubernetes objects are copied from the source cluster to the replication repository and then from the replication repository to the destination cluster.

Direct volume migration
Persistent volumes are copied directly from the source cluster to the destination cluster.

Direct image migration
Images are copied directly from the source cluster to the destination cluster.

Stage migration
Data is copied to the destination cluster without stopping the application. Running a stage migration multiple times reduces the duration of the cutover migration.

Cutover migration
The application is stopped on the source cluster and its resources are migrated to the destination cluster.

State migration
Application state is migrated by copying specific persistent volume claims and Kubernetes objects to the destination cluster.

Rollback migration
Rollback migration rolls back a completed migration.

1 Called the target cluster in the MTC web console.

5.2. MTC WORKFLOW

You can migrate Kubernetes resources, persistent volume data, and internal container images to OpenShift Container Platform 4.6 by using the Migration Toolkit for Containers (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

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<table>
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<th>Term</th>
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<td>Remote cluster</td>
<td>A remote cluster is usually the source cluster but this is not required. A remote cluster requires a Secret custom resource that contains the migration-controller service account token. A remote cluster requires an exposed secure registry route for direct image migration.</td>
</tr>
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<tr>
<td>Rollback migration</td>
<td>Rollback migration rolls back a completed migration.</td>
</tr>
</tbody>
</table>
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. 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** copies data to the target cluster without stopping the application. A stage migration can be run multiple times so that most of the data is copied to the target before migration. Running one or more stage migrations reduces the duration of the cutover migration.

- **Cutover** stops the application on the source cluster and moves the resources to the target cluster. Optional: You can clear the **Halt transactions on the source cluster during migration** checkbox.
5.3. ABOUT DATA COPY METHODS

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

5.3.1. File system copy method

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

The file system copy method uses Restic for indirect migration or Rsync for direct volume migration.

Table 5.2. File system copy method summary

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

5.3.2. Snapshot copy method

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

The snapshot copy method can be used with Amazon Web Services, Google Cloud Provider, and Microsoft Azure.

Table 5.3. Snapshot copy method summary

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Faster than the file system copy method.</td>
<td>• Cloud provider must support snapshots.</td>
</tr>
<tr>
<td></td>
<td>• Clusters must be on the same cloud provider.</td>
</tr>
<tr>
<td></td>
<td>• Clusters must be in the same location or region.</td>
</tr>
<tr>
<td></td>
<td>• Clusters must have the same storage class.</td>
</tr>
<tr>
<td></td>
<td>• Storage class must be compatible with snapshots.</td>
</tr>
<tr>
<td></td>
<td>• Does not support direct volume migration.</td>
</tr>
</tbody>
</table>
5.4. 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 6. INSTALLING THE MIGRATION TOOLKIT FOR
CONTAINERS

You can install the Migration Toolkit for Containers (MTC) on OpenShift Container Platform 3 and 4.

After you install the Migration Toolkit for Containers Operator on OpenShift Container Platform 4.6 by using the Operator Lifecycle Manager, you manually install the legacy Migration Toolkit for Containers Operator on OpenShift Container Platform 3.

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.

To uninstall MTC, see Uninstalling MTC and deleting resources.

6.1. COMPATIBILITY GUIDELINES

You must install the Migration Toolkit for Containers (MTC) Operator that is compatible with your OpenShift Container Platform version.

You cannot install MTC 1.6 on OpenShift Container Platform 4.5, or earlier versions, because the custom resource definition API versions are incompatible.

You can migrate workloads from a source cluster with MTC 1.5.3 to a target cluster with MTC 1.6 as long as the MigrationController custom resource and the MTC web console are running on the target cluster.

<table>
<thead>
<tr>
<th>OpenShift Container Platform version</th>
<th>MTC version</th>
<th>Migration Toolkit for Containers Operator</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5 and earlier</td>
<td>1.5.3</td>
<td>Legacy Migration Toolkit for Containers Operator, installed manually with the operator.yml file.</td>
</tr>
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<td>Latest 1.6.x z-stream release</td>
<td>Migration Toolkit for Containers Operator, installed with Operator Lifecycle Manager.</td>
</tr>
</tbody>
</table>

6.2. INSTALLING THE LEGACY MIGRATION TOOLKIT FOR
CONTAINERS OPERATOR ON OPENSIFHT CONTAINER PLATFORM 3

You can install the legacy Migration Toolkit for Containers Operator manually on OpenShift Container Platform 3.

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.

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

2. Download the operator.yml file:
   
   ```text
   $ sudo podman cp $(sudo podman create \ registry.redhat.io/rhmtc/openshift-migration-legacy-rhel8-operator:v1.5.3):/operator.yml ./
   ```

3. Download the controller.yml file:
   
   ```text
   $ sudo podman cp $(sudo podman create \ registry.redhat.io/rhmtc/openshift-migration-legacy-rhel8-operator:v1.5.3):/controller.yml ./
   ```

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

5. Verify that the cluster can authenticate with registry.redhat.io:
   
   ```text
   $ oc run test --image registry.redhat.io/ubi8 --command sleep infinity
   ```

6. Create the Migration Toolkit for Containers Operator object:
   
   ```text
   $ oc create -f operator.yml
   ```

   **Example output**

   ```text
   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
   Error from server (AlreadyExists): error when creating "/operator.yml": rolebindings.rbac.authorization.k8s.io "system:image-pullers" already exists
   ```

   🔄 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:
6.3. INSTALLING THE MIGRATION TOOLKIT FOR CONTAINERS OPERATOR ON OPENShift CONTAINER PLATFORM 4.6

You install the Migration Toolkit for Containers Operator on OpenShift Container Platform 4.6 by using the Operator Lifecycle Manager.

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

6.4. CONFIGURING PROXIES

For OpenShift Container Platform 4.1 and earlier versions, you must configure proxies in the MigrationController custom resource (CR) manifest after you install the Migration Toolkit for Containers Operator because these versions do not support a cluster-wide proxy object.

For OpenShift Container Platform 4.2 to 4.6, the Migration Toolkit for Containers (MTC) inherits the cluster-wide proxy settings. You can change the proxy parameters if you want to override the cluster-wide proxy settings.

You must configure the proxies to allow the SPDY protocol and to forward the Upgrade HTTP header to the API server. Otherwise, an Upgrade request required error is displayed. The MigrationController CR uses SPDY to run commands within remote pods. The Upgrade HTTP header is required in order to open awebsocket connection with the API server.

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

DVM 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. Get the **MigrationController** CR manifest:

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

2. Update the proxy parameters:

   ```yaml
   apiVersion: migration.openshift.io/v1alpha1
   kind: MigrationController
   metadata:
     name: <migration_controller>
     namespace: openshift-migration
   ...
   spec:
     stunnel_tcp_proxy: http://<username>:<password>@<ip>:<port> ①
     httpProxy: http://<username>:<password>@<ip>:<port> ②
     httpsProxy: http://<username>:<password>@<ip>:<port> ③
     noProxy: example.com ④
   ```

   ① Stunnel proxy URL for direct volume migration.
   ② Proxy URL for creating HTTP connections outside the cluster. The URL scheme must be `http`.
   ③ Proxy URL for creating HTTPS connections outside the cluster. If this is not specified, then `httpProxy` is used for both HTTP and HTTPS connections.
   ④ Comma-separated list of destination domain names, domains, IP addresses, or other network CIDRs to exclude proxying.

   Preface a domain with . to match subdomains only. For example, .y.com matches x.y.com, but not y.com. Use * to bypass proxy for all destinations. If you scale up workers that are not included in the network defined by the `networking.machineNetwork[].cidr` field from the installation configuration, you must add them to this list to prevent connection issues.

   This field is ignored if neither the `httpProxy` nor the `httpsProxy` field is set.

3. Save the manifest as **migration-controller.yaml**.

4. Apply the updated manifest:

   ```bash
   $ oc replace -f migration-controller.yaml -n openshift-migration
   ```
For more information, see Configuring the cluster-wide proxy.

6.5. 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.

The following storage providers are supported:

- Multicloud Object Gateway
- Amazon Web Services S3
- Google Cloud Platform
- Microsoft Azure Blob
- Generic S3 object storage, for example, Minio or Ceph S3

6.5.1. Prerequisites

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

6.5.2. Configuring the Multicloud Object Gateway

You can configure the Multicloud Object Gateway (MCG) as a replication repository for the Migration Toolkit for Containers (MTC). MCG is a component of OpenShift Container Storage.

Procedure

1. Deploy OpenShift Container Storage by using the appropriate OpenShift Container Storage deployment guide.

2. Obtain the S3 endpoint, `AWS_ACCESS_KEY_ID`, and `AWS_SECRET_ACCESS_KEY` by running the `describe` command on the NooBaa custom resource. These values are required in order to add MCG as a replication repository to the MTC web console.

6.5.3. 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](https://aws.amazon.com/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:

   ```bash
   $ 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**:

   ```bash
   $ aws iam create-user --user-name velero
   
3. Create an EC2 EBS snapshot policy:

   ```bash
   $ 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:

   ```bash
   $ cat > velero-s3-policy.json <<EOF
   {
   ```
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:

```
"Resource": ["arn:aws:s3:::<bucket>/*")
```

```
"Resource": ["arn:aws:s3:::<bucket>"
```

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:
Record the `AWS_SECRET_ACCESS_KEY` and the `AWS_ACCESS_KEY_ID`. You use the credentials to add AWS as a replication repository.

### 6.5.4. 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`:

   ```bash
   $ 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:

   ```bash
   $ BUCKET=<bucket>  
   ```
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
```
You use the `credentials-velero` file to add GCP as a replication repository.

### 6.5.5. 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:
   
   ```bash
   $ AZURE_RESOURCE_GROUP=Velero_Backups
   ```

2. Create an Azure resource group:
   
   ```bash
   $ az group create -n $AZURE_RESOURCE_GROUP --location <CentralUS>
   ```
   
   Specify your location.

3. Set the `AZURE_STORAGE_ACCOUNT_ID` variable:
   
   ```bash
   $ AZURE_STORAGE_ACCOUNT_ID=velerobackups
   ```

4. Create an Azure storage account:
   
   ```bash
   $ 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:
Create an Azure Blob storage container:

```bash
$ BLOB_CONTAINER=velero

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

Create a service principal and credentials for velero:

```bash
$ 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`
```

Save the service principal credentials in the `credentials-velero` file:

```bash
$ 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
```

You use the `credentials-velero` file to add Azure as a replication repository.

### 6.5.6. Additional resources
- MTC workflow
- About data copy methods
- Adding a replication repository to the MTC web console

### 6.6. UNINSTALLING MTC AND DELETING RESOURCES

You can uninstall the Migration Toolkit for Containers (MTC) and delete its resources to clean up the cluster.

**NOTE**

Deleting the `velero` CRDs removes Velero from the cluster.

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

**Procedure**
1. Delete the MigrationController custom resource (CR) on all clusters:

   $ oc delete migrationcontroller <migration_controller>

2. Uninstall the Migration Toolkit for Containers Operator on OpenShift Container Platform 4 by using the Operator Lifecycle Manager.

3. Delete cluster-scoped resources on all clusters by running the following commands:
   
   - migration custom resource definitions (CRDs):
     
     $ oc delete $(oc get crds -o name | grep 'migration.openshift.io')
   
   - velero CRDs:
     
     $ oc delete $(oc get crds -o name | grep 'velero')
   
   - migration cluster roles:
     
     $ oc delete $(oc get clusterroles -o name | grep 'migration.openshift.io')
   
   - migration-operator cluster role:
     
     $ oc delete clusterrole migration-operator
   
   - velero cluster roles:
     
     $ oc delete $(oc get clusterroles -o name | grep 'velero')
   
   - migration cluster role bindings:
     
     $ oc delete $(oc get clusterrolebindings -o name | grep 'migration.openshift.io')
   
   - migration-operator cluster role bindings:
     
     $ oc delete clusterrolebindings migration-operator
   
   - velero cluster role bindings:
     
     $ oc delete $(oc get clusterrolebindings -o name | grep 'velero')
CHAPTER 7. 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 4 in a restricted network environment by performing the following procedures:

1. Create a mirrored Operator catalog.
   This process creates a `mapping.txt` file, which contains the mapping between the `registry.redhat.io` image and your mirror registry image. The `mapping.txt` file is required for installing the Operator on the source cluster.

2. Install the Migration Toolkit for Containers Operator on the OpenShift Container Platform 4.6 target cluster by using Operator Lifecycle Manager.
   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.

3. Install the legacy Migration Toolkit for Containers Operator on the OpenShift Container Platform 3 source cluster from the command line interface.

4. Configure object storage to use as a replication repository.

To uninstall MTC, see Uninstalling MTC and deleting resources.

7.1. COMPATIBILITY GUIDELINES

You must install the Migration Toolkit for Containers (MTC) Operator that is compatible with your OpenShift Container Platform version.

You cannot install MTC 1.6 on OpenShift Container Platform 4.5, or earlier versions, because the custom resource definition API versions are incompatible.

You can migrate workloads from a source cluster with MTC 1.5.3 to a target cluster with MTC 1.6 as long as the MigrationController custom resource and the MTC web console are running on the target cluster.

Table 7.1. OpenShift Container Platform and MTC compatibility

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<th>MTC version</th>
<th>Migration Toolkit for Containers Operator</th>
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<td>Legacy Migration Toolkit for Containers Operator, installed manually with the <code>operator.yml</code> file.</td>
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</tr>
</tbody>
</table>

7.2. INSTALLING THE MIGRATION TOOLKIT FOR CONTAINERS OPERATOR ON OPENSHIFT CONTAINER PLATFORM 4.6

You install the Migration Toolkit for Containers Operator on OpenShift Container Platform 4.6 by using the Operator Lifecycle Manager.
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. Click `Create`.
8. Click `Workloads → Pods` to verify that the MTC pods are running.

7.3. INSTALLING THE LEGACY MIGRATION TOOLKIT FOR CONTAINERS OPERATOR ON OPENSOURCE CONTAINER PLATFORM 3

You can install the legacy Migration Toolkit for Containers Operator manually on OpenShift Container Platform 3.

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.
- You must create an `image stream secret` and copy it to each node in the cluster.
- You must have a Linux workstation with network access in order to download files from `registry.redhat.io`.
- You must create a mirror image of the Operator catalog.
- You must install the Migration Toolkit for Containers Operator from the mirrored Operator catalog on OpenShift Container Platform 4.6.

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 \n   registry.redhat.io/rhmtc/openshift-migration-legacy-rhel8-operator:v1.5.3):/operator.yml ./
   ```

3. Download the `controller.yml` file:
   
   ```
   $ sudo podman cp $(sudo podman create \n   registry.redhat.io/rhmtc/openshift-migration-legacy-rhel8-operator:v1.5.3):/controller.yml ./
   ```

4. Obtain the Operator image mapping by running the following command:
   
   ```
   $ grep openshift-migration-legacy-rhel8-operator .:/mapping.txt | grep rhmtc
   ```

   The `mapping.txt` file was created when you mirrored the Operator catalog. The output shows the mapping between the `registry.redhat.io` image and your mirror registry image.

   **Example output**
   
   ```
   registry.redhat.io/rhmtc/openshift-migration-legacy-rhel8-operator@sha256:468a6126f73b1ee12085ca53a312d1f96ef5a2ca03442bcb63724af5e2614e8a
   ```

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-legacy-rhel8-operator@sha256:<468a6126f73b1ee12085ca53a312d1f96ef5a2ca03442bcb63724af5e2614e8a>
     ...
   - name: operator
     image: <registry.apps.example.com>/rhmtc/openshift-migration-legacy-rhel8-operator@sha256:<468a6126f73b1ee12085ca53a312d1f96ef5a2ca03442bcb63724af5e2614e8a>
     ...
     env:
     - name: REGISTRY
       value: <registry.apps.example.com>
   ```

   **Specify your mirror registry and the sha256 value of the Operator image.**

   **Specify your mirror registry.**


7. Create the Migration Toolkit for Containers Operator object:
   
   ```
   $ oc create -f operator.yml
   ```

   **Example output**
namespaces/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
Error from server (AlreadyExists): error when creating "./operator.yml":
rolebindings.rbac.authorization.k8s.io "system:image-pullers" already exists

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.yml

9. Verify that the MTC pods are running:

    $ oc get pods -n openshift-migration

7.4. CONFIGURING PROXIES

For OpenShift Container Platform 4.1 and earlier versions, you must configure proxies in the MigrationController custom resource (CR) manifest after you install the Migration Toolkit for Containers Operator because these versions do not support a cluster-wide proxy object.

For OpenShift Container Platform 4.2 to 4.6, the Migration Toolkit for Containers (MTC) inherits the cluster-wide proxy settings. You can change the proxy parameters if you want to override the cluster-wide proxy settings.

You must configure the proxies to allow the SPDY protocol and to forward the Upgrade HTTP header to the API server. Otherwise, an Upgrade request required error is displayed. The MigrationController CR uses SPDY to run commands within remote pods. The Upgrade HTTP header is required in order to open a websocket connection with the API server.

Direct volume migration

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

DVM 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. Get the **MigrationController** CR manifest:

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

2. Update the proxy parameters:

   ```
   apiVersion: migration.openshift.io/v1alpha1
   kind: MigrationController
   metadata:
     name: <migration_controller>
     namespace: openshift-migration
   ...
   spec:
     stunnel_tcp_proxy: http://<username>:<password>@<ip>:<port>
     httpProxy: http://<username>:<password>@<ip>:<port>
     httpsProxy: http://<username>:<password>@<ip>:<port>
     noProxy: example.com
   ```

   - **1** Stunnel proxy URL for direct volume migration.
   - **2** Proxy URL for creating HTTP connections outside the cluster. The URL scheme must be `http`.
   - **3** Proxy URL for creating HTTPS connections outside the cluster. If this is not specified, then `httpProxy` is used for both HTTP and HTTPS connections.
   - **4** Comma-separated list of destination domain names, domains, IP addresses, or other network CIDRs to exclude proxying.

   Preface a domain with . to match subdomains only. For example, `.y.com` matches `x.y.com`, but not `y.com`. Use * to bypass proxy for all destinations. If you scale up workers that are not included in the network defined by the `networking.machineNetwork[].cidr` field from the installation configuration, you must add them to this list to prevent connection issues.

   This field is ignored if neither the `httpProxy` nor the `httpsProxy` field is set.

3. Save the manifest as `migration-controller.yaml`.

4. Apply the updated manifest:

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

For more information, see [Configuring the cluster-wide proxy](#).

### 7.5. Configuring a Replication Repository

The Multicloud Object Gateway 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.
7.5.1. Prerequisites

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

7.5.2. Configuring the Multicloud Object Gateway

You can configure the Multicloud Object Gateway (MCG) as a replication repository for the Migration Toolkit for Containers (MTC). MCG is a component of OpenShift Container Storage.

Procedure

1. Deploy OpenShift Container Storage by using the appropriate OpenShift Container Storage deployment guide.

2. Obtain the S3 endpoint, AWS_ACCESS_KEY_ID, and AWS_SECRET_ACCESS_KEY by running the describe command on the NooBaa custom resource. These values are required in order to add MCG as a replication repository to the MTC web console.

7.5.3. Additional resources

- Disconnected environment in the Red Hat OpenShift Container Storage documentation.
- MTC workflow
- About data copy methods
- Adding a replication repository to the MTC web console

7.6. UNINSTALLING MTC AND DELETING RESOURCES

You can uninstall the Migration Toolkit for Containers (MTC) and delete its resources to clean up the cluster.

NOTE

Deleting the velero CRDs removes Velero from the cluster.

Prerequisites

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

Procedure

1. Delete the MigrationController custom resource (CR) on all clusters:

   $ oc delete migrationcontroller <migration_controller>

2. Uninstall the Migration Toolkit for Containers Operator on OpenShift Container Platform 4 by using the Operator Lifecycle Manager.
3. Delete cluster-scoped resources on all clusters by running the following commands:

- **migration** custom resource definitions (CRDs):
  
  ```bash
  $ oc delete $(oc get crds -o name | grep 'migration.openshift.io')
  ```

- **velero** CRDs:
  
  ```bash
  $ oc delete $(oc get crds -o name | grep 'velero')
  ```

- **migration** cluster roles:
  
  ```bash
  $ oc delete $(oc get clusterroles -o name | grep 'migration.openshift.io')
  ```

- **migration-operator** cluster role:
  
  ```bash
  $ oc delete clusterrole migration-operator
  ```

- **velero** cluster roles:
  
  ```bash
  $ oc delete $(oc get clusterroles -o name | grep 'velero')
  ```

- **migration** cluster role bindings:
  
  ```bash
  $ oc delete $(oc get clusterrolebindings -o name | grep 'migration.openshift.io')
  ```

- **migration-operator** cluster role bindings:
  
  ```bash
  $ oc delete clusterrolebindings migration-operator
  ```

- **velero** cluster role bindings:
  
  ```bash
  $ oc delete $(oc get clusterrolebindings -o name | grep 'velero')
  ```
CHAPTER 8. UPGRADING THE MIGRATION TOOLKIT FOR CONTAINERS

You can upgrade the Migration Toolkit for Containers (MTC) on OpenShift Container Platform 4.6 by using Operator Lifecycle Manager.

You can upgrade MTC on OpenShift Container Platform 3 by reinstalling the legacy Migration Toolkit for Containers Operator.

IMPORTANT

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

8.1. UPGRADING THE MIGRATION TOOLKIT FOR CONTAINERS ON OPENSHIFT CONTAINER PLATFORM 4.6

You can upgrade the Migration Toolkit for Containers (MTC) on OpenShift Container Platform 4.6 by using the Operator Lifecycle Manager.

Prerequisites

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

Procedure

1. In the OpenShift Container Platform console, navigate to Operators → Installed Operators. Operators that have a pending upgrade display an Upgrade available status.

2. Click Migration Toolkit for Containers Operator.

3. Click the Subscription tab. Any upgrades requiring approval are displayed next to Upgrade Status. For example, it might display 1 requires approval.

4. Click 1 requires approval, then click Preview Install Plan.

5. Review the resources that are listed as available for upgrade and click Approve.

6. Navigate back to the Operators → Installed Operators page to monitor the progress of the upgrade. When complete, the status changes to Succeeded and Up to date.

7. Click Migration Toolkit for Containers Operator.

8. Under Provided APIs, locate the Migration Controller tile, and click Create Instance.

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

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

You can upgrade Migration Toolkit for Containers (MTC) on OpenShift Container Platform 3 by manually installing the legacy Migration Toolkit for Containers Operator.
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:
   ```bash
   $ sudo podman login registry.redhat.io
   
   $ sudo podman cp $(sudo podman create registry.redhat.io/rhmtc/openshift-migration-legacy-rhel8-operator:v1.5.3):/operator.yml ./
   
   $ oc replace --force -f operator.yml
   
   $ oc scale -n openshift-migration --replicas=0 deployment/migration-operator
   
   $ oc scale -n openshift-migration --replicas=1 deployment/migration-operator
   
   $ oc -o yaml -n openshift-migration get deployment/migration-operator | grep image: | awk -F":" '{ print $NF }'
   ```

2. Download the `operator.yml` file:
   ```bash
   $ sudo podman cp $(sudo podman create registry.redhat.io/rhmtc/openshift-migration-legacy-rhel8-operator:v1.5.3):/controller.yml ./
   
   $ oc create -f controller.yml
   ```

3. Replace the Migration Toolkit for Containers Operator:
   ```bash
   $ oc sa get-token migration-controller -n openshift-migration
   ```

4. Scale the `migration-operator` deployment to 0 to stop the deployment:
   ```bash
   $ oc scale -n openshift-migration --replicas=0 deployment/migration-operator
   ```

5. Scale the `migration-operator` deployment to 1 to start the deployment and apply the changes:
   ```bash
   $ oc scale -n openshift-migration --replicas=1 deployment/migration-operator
   ```

6. Verify that the `migration-operator` was upgraded:
   ```bash
   $ oc -o yaml -n openshift-migration get deployment/migration-operator | grep image: | awk -F"":" '{ print $NF }'
   ```

7. Download the `controller.yml` file:
   ```bash
   $ sudo podman cp $(sudo podman create registry.redhat.io/rhmtc/openshift-migration-legacy-rhel8-operator:v1.5.3):/controller.yml ./
   ```

8. Create the `migration-controller` object:
   ```bash
   $ oc create -f controller.yml
   ```

9. 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:
   ```bash
   a. Obtain the service account token:
      ```bash
      $ 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**.

10. Verify that the MTC pods are running:

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

## 8.3. UPGRADING MTC 1.3 TO 1.6

If you are upgrading Migration Toolkit for Containers (MTC) version 1.3.x to 1.6, 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 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 9. PREMIGRATION CHECKLISTS

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

9.1. RESOURCES

☐ If your application uses an internal service network or an external route for communicating with services, the relevant route exists.

☐ If your application uses cluster-level resources, you have re-created them on the target cluster.

☐ You have excluded persistent volumes (PVs), image streams, and other resources that you do not want to migrate.

☐ PV data has been backed up in case an application displays unexpected behavior after migration and corrupts the data.

9.2. SOURCE CLUSTER

☐ The cluster meets the minimum hardware requirements.

☐ You have installed the correct legacy Migration Toolkit for Containers Operator version:
  - [operator-3.7.yml](#) on OpenShift Container Platform version 3.7.
  - [operator.yml](#) on OpenShift Container Platform versions 3.9 to 4.5.

☐ The MTC version is the same on all clusters.

☐ All nodes have an active OpenShift Container Platform subscription.

☐ You have performed all the run-once tasks.

☐ You have performed all the environment health checks.

☐ You have checked for 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 removed old builds, deployments, and images from each namespace to be migrated by pruning.

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:

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

The identity provider is working.

### 9.3. TARGET CLUSTER

You have installed Migration Toolkit for Containers Operator version 1.5.1.

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 4.6, 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.

DNS records for your application exist on the target cluster.
Set the value of the `annotation.openshift.io/host.generated` parameter to `true` for each OpenShift Container Platform route to update its host name for the target cluster. Otherwise, the migrated routes retain the source cluster host name.

Certificates that your application uses exist on the target cluster.

You have configured appropriate firewall rules on the target cluster.

You have correctly configured load balancing on the target cluster.

If you migrate objects to an existing namespace on the target cluster that has the same name as the namespace being migrated from the source, the target namespace contains no objects of the same name and type as the objects being migrated.

**NOTE**

Do not create namespaces for your application on the target cluster before migration because this might cause quotas to change.

### 9.4. PERFORMANCE

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 10. MIGRATING YOUR APPLICATIONS

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

You can use stage migration and cutover migration to migrate an application between clusters:

- Stage migration copies data from the source cluster to the target cluster without stopping the application. You can run a stage migration multiple times to reduce the duration of the cutover migration.
- Cutover migration stops the transactions on the source cluster and moves the resources to the target cluster.

You can use state migration to migrate an application's state:

- State migration copies selected persistent volume claims (PVCs) and Kubernetes resources.
- You can use state migration to migrate a namespace within the same cluster.

10.1. 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

10.2. **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.

10.2.1. **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:

   ```bash
   $ 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.

10.2.2. 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:

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

Example output

```text
eyJhbGciOiJSUzI1NiIsImtpZCI6IiJ9.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpZy10cnVlcy5saXR5cy5saW5rLXVzZXJ2aWNlc3Npb24iLCJzdWIiOiJ0b29tbzIiLCJlbmR0aWN0cyI6W197
```

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.

### 10.2.3. 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 checkbox 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.

### 10.2.4. 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

- MTC file system copy method
- MTC snapshot copy method

10.2.5. Running a migration plan in the MTC web console

You can 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 one of the following options under **Migration**:

   - **Stage** copies data from the source cluster to the target cluster without stopping the application.
   - **Cutover** stops the transactions on the source cluster and moves the resources to the target cluster.
     Optional: In the **Cutover migration** dialog, you can clear the **Halt transactions on the source cluster during migration** checkbox.
   - **State** copies selected persistent volume claims (PVCs) and Kubernetes resources that constitute an application’s state. You can use state migration to migrate a namespace within the same cluster.

     **IMPORTANT**

     Do not use state migration to migrate a namespace between clusters. Use stage or cutover migration instead.

     - Select one or more PVCs in the **State migration** dialog and click **Migrate**.

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

   a. Click **Home → Projects**.
   b. Click the migrated project to view its status.
c. In the **Routes** section, click **Location** to verify that the application is functioning, if applicable.

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

e. Click **Storage → Persistent volumes** to verify that the migrated persistent volumes are correctly provisioned.
CHAPTER 11. ADVANCED MIGRATION OPTIONS

You can automate your migrations and modify the MigPlan and MigrationController custom resources in order to perform large-scale migrations and to improve performance.

11.1. TERMINOLOGY

Table 11.1. MTC terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source cluster</td>
<td>Cluster from which the applications are migrated.</td>
</tr>
<tr>
<td>Destination cluster[1]</td>
<td>Cluster to which the applications are migrated.</td>
</tr>
<tr>
<td>Replication repository</td>
<td>Object storage used for copying images, volumes, and Kubernetes objects during indirect migration or for Kubernetes objects during direct volume migration or direct image migration. The replication repository must be accessible to all clusters.</td>
</tr>
<tr>
<td>Host cluster</td>
<td>Cluster on which the migration-controller pod and the web console are running. The host cluster is usually the destination cluster but this is not required. The host cluster does not require an exposed registry route for direct image migration.</td>
</tr>
<tr>
<td>Remote cluster</td>
<td>A remote cluster is usually the source cluster but this is not required. A remote cluster requires a Secret custom resource that contains the migration-controller service account token. A remote cluster requires an exposed secure registry route for direct image migration.</td>
</tr>
<tr>
<td>Indirect migration</td>
<td>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.</td>
</tr>
<tr>
<td>Direct volume migration</td>
<td>Persistent volumes are copied directly from the source cluster to the destination cluster.</td>
</tr>
<tr>
<td>Direct image migration</td>
<td>Images are copied directly from the source cluster to the destination cluster.</td>
</tr>
<tr>
<td>Stage migration</td>
<td>Data is copied to the destination cluster without stopping the application. Running a stage migration multiple times reduces the duration of the cutover migration.</td>
</tr>
<tr>
<td>Cutover migration</td>
<td>The application is stopped on the source cluster and its resources are migrated to the destination cluster.</td>
</tr>
</tbody>
</table>
State migration
Application state is migrated by copying specific persistent volume claims and Kubernetes objects to the destination cluster.

Rollback migration
Rollback migration rolls back a completed migration.

1 Called the target cluster in the MTC web console.

11.2. MIGRATING APPLICATIONS BY USING THE COMMAND LINE

You can migrate applications with the MTC API by using the command line interface (CLI) in order to automate the migration.

11.2.1. 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.

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 4.6 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.

### 11.2.2. 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:
  ```bash
  $ oc create route passthrough --service=docker-registry -n default
  
  $ oc create route passthrough --service=image-registry -n openshift-image-registry
  ```

### 11.2.3. Configuring proxies

For OpenShift Container Platform 4.1 and earlier versions, you must configure proxies in the

```bash
$ oc create route passthrough --service=docker-registry -n default
$ oc create route passthrough --service=image-registry -n openshift-image-registry
```
For OpenShift Container Platform 4.1 and earlier versions, you must configure proxies in the MigrationController custom resource (CR) manifest after you install the Migration Toolkit for Containers Operator because these versions do not support a cluster-wide proxy object.

For OpenShift Container Platform 4.2 to 4.6, the Migration Toolkit for Containers (MTC) inherits the cluster-wide proxy settings. You can change the proxy parameters if you want to override the cluster-wide proxy settings.

You must configure the proxies to allow the SPDY protocol and to forward the Upgrade HTTP header to the API server. Otherwise, an Upgrade request required error is displayed. The MigrationController CR uses SPDY to run commands within remote pods. The Upgrade HTTP header is required in order to open a websocket connection with the API server.

Direct volume migration

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

DVM 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. Get the MigrationController CR manifest:

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

2. Update the proxy parameters:

   ```yaml
   apiVersion: migration.openshift.io/v1alpha1
   kind: MigrationController
   metadata:
     name: <migration_controller>
     namespace: openshift-migration
   ...
   spec:
     stunnel_tcp_proxy: http://<username>:<password>@<ip>:<port> ①
     httpProxy: http://<username>:<password>@<ip>:<port> ②
     httpsProxy: http://<username>:<password>@<ip>:<port> ③
     noProxy: example.com ④
   ```

   ① Stunnel proxy URL for direct volume migration.
   ② Proxy URL for creating HTTP connections outside the cluster. The URL scheme must be http.
   ③ Proxy URL for creating HTTPS connections outside the cluster. If this is not specified, then httpProxy is used for both HTTP and HTTPS connections.
   ④ Comma-separated list of destination domain names, domains, IP addresses, or other
Preface a domain with . to match subdomains only. For example, .y.com matches x.y.com, but not y.com. Use * to bypass proxy for all destinations. If you scale up workers that are not included in the network defined by the networking.machineNetwork[].cidr field from the installation configuration, you must add them to this list to prevent connection issues.

This field is ignored if neither the httpProxy nor the httpsProxy field is set.

3. Save the manifest as migration-controller.yaml.

4. Apply the updated manifest:

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

11.2.4. Migrating an application by using the MTC API

You can migrate an application from the command line by using 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>  
   EOF

   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 -

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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 object 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>
     aws-secret-access-key: <secret_key_base64>
   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
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
EOF
```

---

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CHAPTER 11. ADVANCED MIGRATION OPTIONS

indirectImageMigration: true
indirectVolumeMigration: true
migStorageRef:
  name: <migstorage>
  namespace: openshift-migration
namespaces:
  - <application_namespace>
srcMigClusterRef:
  name: <remote_cluster>
  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 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>
     namespace: openshift-migration
     quiescePods: true
     stage: false
     rollback: false
   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.
II. Verify the migration by watching the MigMigration CR progress:

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

The output resembles the following:

**Example output**

```markdown
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
```
11.2.5. State migration

You can perform repeatable, state-only migrations by using Migration Toolkit for Containers (MTC) to migrate persistent volume claims (PVCs) that constitute an application’s state. You migrate specified PVCs by excluding other PVCs from the migration plan. Persistent volume (PV) data is copied to the target cluster. The PV references are not moved. The application pods continue to run on the source cluster. You can map the PVCs to ensure that the source and target PVCs are synchronized.

You can perform a one-time migration of Kubernetes objects that constitute an application’s state. If you have a CI/CD pipeline, you can migrate stateless components by deploying them on the target cluster. Then you can migrate stateful components by using MTC.

You can perform a state migration between clusters or within the same cluster.

**IMPORTANT**

State migration migrates only the components that constitute an application’s state. If you want to migrate an entire namespace, use stage or cutover migration.

**Additional resources**

- See Excluding PVCs from migration to select PVCs for state migration.
- See Mapping PVCs to migrate source PV data to provisioned PVCs on the destination cluster.
- See Migrating Kubernetes objects to migrate the Kubernetes objects that constitute an application’s state.
11.3. 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-rhel7:1.6`. 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.

11.3.1. 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.

11.3.1.1. Ansible modules

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

**Example shell module**

```yaml
- 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**

```yaml
- 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**

```yaml
- 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
```

### 11.3.1.2. 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**

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

- debug:
  msg: "{{ item }}"
  with_items: "{{ namespaces }}"
```
11.4. MIGRATION PLAN OPTIONS

You can exclude, edit, and map components in the MigPlan custom resource (CR).

11.4.1. Excluding resources

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
     disable_pv_migration: true
     ... 
     excluded_resources:
       - imagetags
       - templateinstances
       - clusterserviceversions
       - packagemanifests
       - subscriptions
       - servicebrokers
       - servicebindings
       - serviceclasses
       - serviceinstances
       - serviceplans
       - operatorgroups
       - events
       - events.events.k8s.io
   ```

   **Add disable_image_migration: true to exclude image streams from the migration. Do not edit the excluded_resources parameter. imagetstreams is added to excluded_resources when the MigrationController pod restarts.**
Add `disable_pv_migration: true` to exclude PVs from the migration plan. Do not edit the `excluded_resources` parameter. `persistentvolumes` and `persistentvolumeclaims` are

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:

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

   The output contains the excluded resources:

   **Example output**

   ```yaml
   - name: EXCLUDED_RESOURCES
     value:
       imagetags,templateinstances,clusterserviceversions,packagemanifests,subscriptions,servicebrokers,servicebindings,serviceclasses,serviceinstances,serviceplans,imagestreams,persistentvolumes,persistentvolumeclaims
   ```

**11.4.2. Mapping namespaces**

If you map namespaces in the `MigPlan` custom resource (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**

```yaml
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**

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

**Correct namespace reference**

```yaml
spec:
  namespaces:
    - namespace_1
```
11.4.3. Excluding persistent volume claims

You select persistent volume claims (PVCs) for state migration by excluding the PVCs that you do not want to migrate. You exclude PVCs by setting the `spec.persistentVolumes.pvc.selection.action` parameter of the MigPlan custom resource (CR) after the persistent volumes (PVs) have been discovered.

Prerequisites

- MigPlan CR is in a Ready state.

Procedure

- Add the `spec.persistentVolumes.pvc.selection.action` parameter to the MigPlan CR and set it to skip:

```
apiVersion: migration.openshift.io/v1alpha1
custom:
kind: MigPlan
metadata: name: <migplan>
namespace: openshift-migration
spec:
  ...persistentVolumes:
  - capacity: 10Gi
    name: <pv_name>
    pvc:
      ...selection:
        action: skip
```

11.4.4. Mapping persistent volume claims

You can migrate persistent volume (PV) data from the source cluster to persistent volume claims (PVCs) that are already provisioned in the destination cluster in the MigPlan CR by mapping the PVCs. This mapping ensures that the destination PVCs of migrated applications are synchronized with the source PVCs.

You map PVCs by updating the `spec.persistentVolumes.pvc.name` parameter in the MigPlan custom resource (CR) after the PVs have been discovered.

Prerequisites

- MigPlan CR is in a Ready state.

Procedure

- Update the `spec.persistentVolumes.pvc.name` parameter in the MigPlan CR:

```
apiVersion: migration.openshift.io/v1alpha1
custom:
kind: MigPlan
metadata: name: <migplan>
namespace: openshift-migration
```
1. Specify the PVC on the source cluster and the PVC on the destination cluster. If the destination PVC does not exist, it will be created. You can use this mapping to change the PVC name during migration.

11.4.5. Editing persistent volume attributes

After you create a MigPlan custom resource (CR), the MigrationController CR discovers the persistent volumes (PVs). The spec.persistentVolumes block and the status.destStorageClasses block are added to the MigPlan CR.

You can edit the values in the spec.persistentVolumes.selection block. If you change values outside the spec.persistentVolumes.selection block, the values are overwritten when the MigPlan CR is reconciled by the MigrationController CR.

**NOTE**

The default value for the spec.persistentVolumes.selection.storageClass parameter is determined by the following logic:

1. If the source cluster PV is Gluster or NFS, the default is either cephfs, for accessMode: ReadWriteMany, or cephrbd, for accessMode: ReadWriteOnce.
2. If the PV is neither Gluster nor NFS or if cephfs or cephrbd are not available, the default is a storage class for the same provisioner.
3. If a storage class for the same provisioner is not available, the default is the default storage class of the destination cluster.

You can change the storageClass value to the value of any name parameter in the status.destStorageClasses block of the MigPlan CR.

If the storageClass value is empty, the PV will have no storage class after migration. This option is appropriate if, for example, you want to move the PV to an NFS volume on the destination cluster.

**Prerequisites**

- MigPlan CR is in a Ready state.

**Procedure**

- Edit the spec.persistentVolumes.selection values in the MigPlan CR:

```
apiVersion: migration.openshift.io/v1alpha1
class: MigPlan
metadata:
```
name: <migplan>
namespace: openshift-migration
spec:
persistentVolumes:
- capacity: 10Gi
  name: pvc-095a6559-b27f-11eb-b27f-021bddcaf6e4
  proposedCapacity: 10Gi
pvc:
  accessModes:
  - ReadWriteMany
  hasReference: true
  name: mysql
  namespace: mysql-persistent
  selection:
    action: <copy> 1
    copyMethod: <filesystem> 2
    verify: true 3
    storageClass: <gp2> 4
    accessMode: <ReadWriteMany> 5
  storageClass: cephfs

1. Allowed values are move, copy, and skip. If only one action is supported, the default value is the supported action. If multiple actions are supported, the default value is copy.

2. Allowed values are snapshot and filesystem. Default value is filesystem.

3. The verify parameter is displayed if you select the verification option for file system copy in the MTC web console. You can set it to false.

4. You can change the default value to the value of any name parameter in the status.destStorageClasses block of the MigPlan CR. If no value is specified, the PV will have no storage class after migration.

5. Allowed values are ReadWriteOnce and ReadWriteMany. If this value is not specified, the default is the access mode of the source cluster PVC. You can only edit the access mode in the MigPlan CR. You cannot edit it by using the MTC web console.

**Additional resources**

- For details about the move and copy actions, see MTC workflow.
- For details about the skip action, see Excluding PVCs from migration.
- For details about the file system and snapshot copy methods, see About data copy methods.

### 11.4.6. Migrating Kubernetes objects

You can perform a one-time migration of Kubernetes objects that constitute an application’s state.

**NOTE**

After migration, the closed parameter of the MigPlan CR is set to true. You cannot create another MigMigration CR for this MigPlan CR.
You add Kubernetes objects to the MigPlan CR by using one of the following options:

- Adding the Kubernetes objects to the includedResources section.
- Using the labelSelector parameter to reference labeled Kubernetes objects.
- Adding Kubernetes objects to the includedResources section and then filtering them with the labelSelector parameter, for example, Secret and ConfigMap resources with the label app: frontend.

Procedure

- Update the MigPlan CR:

  ```yaml
  apiVersion: migration.openshift.io/v1alpha1
  kind: MigPlan
  metadata:
    name: <migplan>
    namespace: openshift-migration
  spec:
    includedResources:
    - kind: <kind>  
      group: ""
    - kind: <kind>  
      group: ""
    ...  
    labelSelector:
      matchLabels:
        <label>  
  ```

  1. Specify the Kubernetes object, for example, Secret or ConfigMap.
  2. Specify the label of the resources to migrate, for example, app: frontend.

11.5. MIGRATION CONTROLLER OPTIONS

You can edit migration plan limits, enable persistent volume resizing, or enable cached Kubernetes clients in the MigrationController custom resource (CR) for large migrations and improved performance.

11.5.1. Increasing limits for large migrations

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

IMPORTANT

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

Procedure

1. Edit the MigrationController custom resource (CR) manifest:
2. Update the following parameters:

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

### 11.5.2. Enabling persistent volume resizing for direct volume migration

You can enable persistent volume (PV) resizing for direct volume migration to avoid running out of disk space on the destination cluster.

When the disk usage of a PV reaches a configured level, the MigrationController custom resource (CR) compares the requested storage capacity of a persistent volume claim (PVC) to its actual provisioned capacity. Then, it calculates the space required on the destination cluster.

A `pv_resizing_threshold` parameter determines when PV resizing is used. The default threshold is 3%. This means that PV resizing occurs when the disk usage of a PV is more than 97%. You can increase this threshold so that PV resizing occurs at a lower disk usage level.

PVC capacity is calculated according to the following criteria:

- If the requested storage capacity (`spec.resources.requests.storage`) of the PVC is not equal to its actual provisioned capacity (`status.capacity.storage`), the greater value is used.
If a PV is provisioned through a PVC and then subsequently changed so that its PV and PVC capacities no longer match, the greater value is used.

**Prerequisites**

- The PVCs must be attached to one or more running pods so that the MigrationController CR can execute commands.

**Procedure**

1. Log in to the host cluster.

2. Enable PV resizing by patching the MigrationController CR:

   ```bash
   $ oc patch migrationcontroller migration-controller -p '{"spec": {"enable_dvm_pv_resizing":true}}' --type='merge' -n openshift-migration
   ``
   
   Set the value to `false` to disable PV resizing.

3. Optional: Update the `pv_resizing_threshold` parameter to increase the threshold:

   ```bash
   $ oc patch migrationcontroller migration-controller -p '{"spec":{"pv_resizing_threshold":41}}' --type='merge' -n openshift-migration
   ``
   
   The default value is `3`.

When the threshold is exceeded, the following status message is displayed in the MigPlan CR status:

```
status:
  conditions:
  ...
  - category: Warn
durable: true
    lastTransitionTime: "2021-06-17T08:57:01Z"
    message: "Capacity of the following volumes will be automatically adjusted to avoid disk capacity issues in the target cluster: [pvc-b800eb7b-cf3b-11eb-a3f7-0eae3e0555f3]"
    reason: Done
    status: "False"
    type: PvCapacityAdjustmentRequired
```

**NOTE**

For AWS gp2 storage, this message does not appear unless the `pv_resizing_threshold` is 42% or greater because of the way gp2 calculates volume usage and size. ([BZ#1973148](BZ#1973148))

**11.5.3. Enabling cached Kubernetes clients**

You can enable cached Kubernetes clients in the `MigrationController` custom resource (CR) for improved performance during migration. The greatest performance benefit is displayed when migrating between clusters in different regions or with significant network latency.

**NOTE**

Delegated tasks, for example, Rsync backup for direct volume migration or Velero backup and restore, however, do not show improved performance with cached clients.

Cached clients require extra memory because the `MigrationController` CR caches all API resources that are required for interacting with `MigCluster` CRs. Requests that are normally sent to the API server are directed to the cache instead. The cache watches the API server for updates.

You can increase the memory limits and requests of the `MigrationController` CR if OOMKilled errors occur after you enable cached clients.

**Procedure**

1. Enable cached clients by running the following command:

   ```bash
   $ oc -n openshift-migration patch migrationcontroller migration-controller --type=json --patch 
   '[[ "op": "replace", "path": "/spec/mig_controller_enable_cache", "value": true]]'
   ```

2. Optional: Increase the `MigrationController` CR memory limits by running the following command:

   ```bash
   $ oc -n openshift-migration patch migrationcontroller migration-controller --type=json --patch 
   '[[ "op": "replace", "path": "/spec/mig_controller_limits_memory", "value": <10Gi>]]'
   ```

3. Optional: Increase the `MigrationController` CR memory requests by running the following command:

   ```bash
   $ oc -n openshift-migration patch migrationcontroller migration-controller --type=json --patch 
   '[[ "op": "replace", "path": "/spec/mig_controller_requests_memory", "value": <350Mi>]]'
   ```
CHAPTER 12. TROUBLESHOOTING

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

For known issues, see the MTC release notes.

12.1. MTC WORKFLOW

You can migrate Kubernetes resources, persistent volume data, and internal container images to OpenShift Container Platform 4.6 by using the Migration Toolkit for Containers (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. 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** copies data to the target cluster without stopping the application.
  A stage migration can be run multiple times so that most of the data is copied to the target before migration. Running one or more stage migrations reduces the duration of the cutover migration.

- **Cutover** stops the application on the source cluster and moves the resources to the target cluster.
  Optional: You can clear the **Halt transactions on the source cluster during migration** checkbox.
About MTC custom resources
The Migration Toolkit for Containers (MTC) creates the following custom resources (CRs):

MIG Migration CRs (on MTC cluster)
- MigPlan
- MigCluster
- MigStorage

MIG action CRs
- MigMigration

Velero (Created on source cluster and target cluster)
- BackupStorageLocation
- VolumeSnapshotLocation

Velero (Created on target cluster)
- Backup
- Restore
MigCluster (configuration, MTC cluster): Cluster definition

MigStorage (configuration, MTC cluster): Storage definition

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.

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

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

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

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

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

12.2. MTC CUSTOM RESOURCE MANIFESTS

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

12.2.1. DirectImageMigration

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

```yaml
apiVersion: migration.openshift.io/v1alpha1
kind: DirectImageMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
name: <direct_image_migration>
spec:
```
One or more namespaces containing images to be migrated. By default, the destination namespace has the same name as the source namespace.

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

12.2.2. DirectImageStreamMigration

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

```yaml
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
  namespaces:
    - <source_namespace_1>
    - <source_namespace_2>:<destination_namespace_3>
```

12.2.3. DirectVolumeMigration

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

```yaml
apiVersion: migration.openshift.io/v1alpha1
kind: DirectVolumeMigration
metadata:
  name: <direct_volume_migration>
  namespace: openshift-migration
spec:
  createDestinationNamespaces: false  
deleteProgressReportingCRs: false 
  destMigClusterRef:
    name: <host_cluster>  
```
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.

### 12.2.4. DirectVolumeMigrationProgress

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

```yaml
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
```

### 12.2.5. 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.

```yaml
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. Optional: 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.

12.2.6. 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>
  namespace: openshift-migration
spec:
  isHostCluster: true
  # The 'azureResourceGroup' parameter is relevant only for Microsoft Azure.
  azureResourceGroup: <azure_resource_group>
  caBundle: <ca_bundle_base64>
  insecure: false
  refresh: false
  # The 'restartRestic' parameter is relevant for a source cluster.
  restartRestic: true
  # The following parameters are relevant for a remote cluster.
  exposedRegistryPath: <registry_route>
  url: <destination_cluster_url>
  serviceAccountSecretRef:
    name: <source_secret>
    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.
Remote cluster and direct image migration only: Specify the exposed secure registry path.

Remote cluster only: Specify the URL.

Remote cluster only: Specify the name of the Secret CR.

12.2.7. 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>  
  name: <mighook>  
  namespace: openshift-migration
spec:
  activeDeadlineSeconds: 1800  
  custom: false  
  image: <hook_image>  
  playbook: <ansible_playbook_base64>  
  targetCluster: source
```

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.

12.2.8. 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.
Set to `true` to cancel a migration in progress.

Set to `true` to roll back a completed migration.

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

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

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

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.

### 12.2.9. 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.

```yaml
apiVersion: migration.openshift.io/v1alpha1
kind: MigMigration
metadata:
  labels:
    controller-tools.k8s.io: "1.0"
  name: <migmigration>
  namespace: openshift-migration
spec:
  canceled: false
  rollback: false
  stage: false
  quiescePods: true
  keepAnnotations: true
  verify: false
  migPlanRef:
    name: <migplan>
    namespace: openshift-migration
```
The migration has completed if true. You cannot create another MigMigration CR for this MigPlan CR.

Optional: You can specify up to four migration hooks. Each hook must run during a different migration phase.

Optional: Specify the namespace in which the hook will run.

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.

Optional: Specify the name of the MigHook CR.

Optional: Specify the namespace of MigHook CR.

Optional: Specify a service account with cluster-admin privileges.

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.

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.

Specify one or more source namespaces. If you specify only the source namespace, the destination namespace is the same.

Specify the destination namespace if it is different from the source namespace.

The MigPlan CR is validated if true.
12.2.10. 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>  
  volumeSnapshotProvider: <snapshot_storage_provider> 
  backupStorageConfig:
    awsBucketName: <bucket>  
    awsRegion: <region> 
    credsSecretRef:
      namespace: openshift-config
      name: <storage_secret> 
    awsKmsKeyId: <key_id> 
    awsPublicUrl: <public_url> 
    awsSignatureVersion: <signature_version> 
  volumeSnapshotConfig:
    awsRegion: <region> 
    credsSecretRef:
      namespace: openshift-config
      name: <storage_secret> 
  refresh: false
```

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.

12.3. LOGS AND DEBUGGING TOOLS

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

12.3.1. 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.
3. Click a migration to view the Migration details.
4. Expand Migration resources to view the migration resources and their status in a tree view.

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.

12.3.2. 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.
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.

12.3.3. 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 The -c plain option displays the log without colors.

12.3.4. Accessing performance metrics

The MigrationController custom resource (CR) records metrics and pulls them into on-cluster monitoring storage. You can query the metrics by using Prometheus Query Language (PromQL) to diagnose migration performance issues. All metrics are reset when the Migration Controller pod restarts.

You can access the performance metrics and run queries by using the OpenShift Container Platform web console.

Procedure

1. In the OpenShift Container Platform web console, click Monitoring → Metrics.
2. Enter a PromQL query, select a time window to display, and click Run Queries. If your web browser does not display all the results, use the Prometheus console.
12.3.4.1. Provided metrics

The MigrationController custom resource (CR) provides metrics for the MigMigration CR count and for its API requests.

12.3.4.1.1. cam_app_workload_migrations

This metric is a count of MigMigration CRs over time. It is useful for viewing alongside the mtc_client_request_count and mtc_client_request_elapsed metrics to collate API request information with migration status changes. This metric is included in Telemetry.

Table 12.1. cam_app_workload_migrations metric

<table>
<thead>
<tr>
<th>Queryable label name</th>
<th>Sample label values</th>
<th>Label description</th>
</tr>
</thead>
<tbody>
<tr>
<td>status</td>
<td>running, idle, failed,</td>
<td>Status of the MigMigration CR</td>
</tr>
<tr>
<td></td>
<td>completed</td>
<td></td>
</tr>
<tr>
<td>type</td>
<td>stage, final</td>
<td>Type of the MigMigration CR</td>
</tr>
</tbody>
</table>

12.3.4.1.2. mtc_client_request_count

This metric is a cumulative count of Kubernetes API requests that MigrationController issued. It is not included in Telemetry.

Table 12.2. mtc_client_request_count metric

<table>
<thead>
<tr>
<th>Queryable label name</th>
<th>Sample label values</th>
<th>Label description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cluster</td>
<td><a href="https://migcluster-url:443">https://migcluster-url:443</a></td>
<td>Cluster that the request was issued against</td>
</tr>
<tr>
<td>component</td>
<td>MigPlan, MigCluster</td>
<td>Sub-controller API that issued request</td>
</tr>
<tr>
<td>function</td>
<td>(*ReconcileMigPlan).Reconcile</td>
<td>Function that the request was issued from</td>
</tr>
<tr>
<td>kind</td>
<td>SecretList, Deployment</td>
<td>Kubernetes kind the request was issued for</td>
</tr>
</tbody>
</table>

12.3.4.1.3. mtc_client_request_elapsed

This metric is a cumulative latency, in milliseconds, of Kubernetes API requests that MigrationController issued. It is not included in Telemetry.

Table 12.3. mtc_client_request_elapsed metric

<table>
<thead>
<tr>
<th>Queryable label name</th>
<th>Sample label values</th>
<th>Label description</th>
</tr>
</thead>
</table>

OpenShift Container Platform 4.6 Migrating from version 3 to 4
<table>
<thead>
<tr>
<th>Queryable label name</th>
<th>Sample label values</th>
<th>Label description</th>
</tr>
</thead>
<tbody>
<tr>
<td>cluster</td>
<td><a href="https://cluster-url.com:443">https://cluster-url.com:443</a></td>
<td>Cluster that the request was issued against</td>
</tr>
<tr>
<td>component</td>
<td>migplan, migcluster</td>
<td>Sub-controller API that issued request</td>
</tr>
<tr>
<td>function</td>
<td>(*ReconcileMigPlan).Reconcile</td>
<td>Function that the request was issued from</td>
</tr>
<tr>
<td>kind</td>
<td>SecretList, Deployment</td>
<td>Kubernetes resource that the request was issued for</td>
</tr>
</tbody>
</table>

12.3.4.1.4. Useful queries

The table lists some helpful queries that can be used for monitoring performance.

<table>
<thead>
<tr>
<th>Query</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>mtc_client_request_count</td>
<td>Number of API requests issued, sorted by request type</td>
</tr>
<tr>
<td>sum(mtc_client_request_count)</td>
<td>Total number of API requests issued</td>
</tr>
<tr>
<td>mtc_client_request_elapsed</td>
<td>API request latency, sorted by request type</td>
</tr>
<tr>
<td>sum(mtc_client_request_elapsed)</td>
<td>Total latency of API requests</td>
</tr>
<tr>
<td>sum(mtc_client_request_elapsed) / sum(mtc_client_request_count)</td>
<td>Average latency of API requests</td>
</tr>
<tr>
<td>mtc_client_request_elapsed / mtc_client_request_count</td>
<td>Average latency of API requests, sorted by request type</td>
</tr>
<tr>
<td>cam_app_workload_migrations{status=&quot;running&quot;} * 100</td>
<td>Count of running migrations, multiplied by 100 for easier viewing alongside request counts</td>
</tr>
</tbody>
</table>

12.3.5. 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 for one of the following data collection options:
   - To collect data for the past hour:
     
     ```sh
     $ oc adm must-gather --image=registry.redhat.io/rhmtc/openshift-migration-must-gather-rhel8:v1.6
     
     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](https://access.redhat.com/).
   - To collect data for the past 24 hours:
     
     ```sh
     $ oc adm must-gather --image=registry.redhat.io/rhmtc/openshift-migration-must-gather-rhel8:v1.6 \
     -- /usr/bin/gather_metrics_dump
     
     This operation can take a long time. The data is saved as `must-gather/metrics/prom_data.tar.gz`.

Viewing metrics data with the Prometheus console

You can view the metrics data with the Prometheus console.

Procedure

1. Decompress the `prom_data.tar.gz` file:

   ```sh
   $ tar -xvzf must-gather/metrics/prom_data.tar.gz
   
   2. Create a local Prometheus instance:

   ```sh
   $ make prometheus-run
   
   The command outputs the Prometheus URL.

Output

- Started Prometheus on http://localhost:9090

3. Launch a web browser and navigate to the URL to view the data by using the Prometheus web console.

4. After you have viewed the data, delete the Prometheus instance and data:
12.3.6. Debugging Velero resources with the Velero CLI tool

You can debug **Backup** and **Restore** custom resources (CRs) and retrieve logs with the Velero CLI tool.

The Velero CLI tool provides more detailed information than the OpenShift CLI tool.

**Syntax**

Use the `oc exec` command to run a Velero CLI command:

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

**Example**

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

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

**Example**

```
$ oc exec velero--<pod> -n openshift-migration -- ./velero backup describe 0e44ae00-5dc3-11eb-9ca8-df7e5254778b-2d8ql
```

**Help option**

Use the `velero --help` option to list all Velero CLI commands:

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

**Describe command**

Use the `velero describe` command to retrieve a summary of warnings and errors associated with a **Backup** or **Restore** CR:

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

**Example**

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

**Logs command**

Use the `velero logs` command to retrieve the logs of a **Backup** or **Restore** CR:

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

**Example**

```
$ oc exec $(oc get pods -n openshift-migration -o name | grep velero) \
   -- ./velero <backupRestore_cr> logs <cr_name>
```
12.3.7. 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>```
3. Check the **Restore CR logs** by using the Velero *logs* command:

```bash
$ 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-x4lb

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-x4lb
```

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

### 12.3.8. Using MTC custom resources for troubleshooting

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

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

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

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

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

- **MigMigration**
- **Backup**

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

Procedure

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

   $ oc get migmigration -n openshift-migration

   **Example output**

<table>
<thead>
<tr>
<th>NAME</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>88435fe0-c9f8-11e9-85e6-5d593ce65e10</td>
<td>6m42s</td>
</tr>
</tbody>
</table>

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**
12.4. COMMON ISSUES AND CONCERNS

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

12.4.1. Updating deprecated internal images

```yaml
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-06fa9f68c88
  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-06fa9f68c88
    migration-final-restore: e18252c9-c927-11e9-825a-06fa9f68c88
  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-06fa9f68c88
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
```

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

volumeSnapshotsAttempted: 0
volumeSnapshotsCompleted: 0
warnings: 0
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 4.6, 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> \
   <registry_url>:<port>/openshift/<image> 1
   ```

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

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

   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**

<table>
<thead>
<tr>
<th>NAME</th>
<th>IMAGE REPOSITORY</th>
<th>TAGS</th>
<th>UPDATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>my_image</td>
<td>image-registry.openshift-image-registry.svc:5000/openshift/my_image</td>
<td>latest</td>
<td>32 seconds ago</td>
</tr>
</tbody>
</table>

12.4.2. 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. 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
Run the migration plan again.

12.4.3. 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.

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

If the MTC console displays a CA certificate error message the first time you try to access it, the likely cause is that a cluster uses self-signed CA certificates.

Navigate to the oauth-authorization-server URL in the error message and accept the certificate. To resolve this issue permanently, install the certificate authority so that it is trusted.

If the browser displays an Unauthorized message after you have accepted the CA certificate, navigate to the MTC console and then refresh the web page.

12.4.3.2. OAuth timeout error in the MTC console

If the MTC console displays a connection has timed out message after you have accepted a self-signed certificate, the cause is likely to be one of the following:

- Interrupted network access to the OAuth server
- Interrupted network access to the OpenShift Container Platform console
- Proxy configuration blocking access to the OAuth server. See MTC console inaccessible because of OAuth timeout error for details.

To determine the cause:

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

12.4.3.3. 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:
Specify the host FQDN and port of the endpoint, for example, `api.my-cluster.example.com:6443`.

Specify the name of the CA bundle file.

### 12.4.3.4. Backup storage location errors in the Velero pod log

If a [Velero Backup](https://velero.io) 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:

- Error checking repository for stale locks
- Error getting backup storage location: `backupstoragelocation.velero.io "my-bsl"` not found

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

### 12.4.3.5. Pod volume backup timeout error in the Velero pod log

If a migration fails because Restic times out, the Velero pod log displays the following error:

```
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:
   ```yaml
   spec:
     restic_timeout: 1h
   ```
   Valid units are **h** (hours), **m** (minutes), and **s** (seconds), for example, `3h30m15s`.
5. Click **Save**.

### 12.4.3.6. 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 **MigMigration** CR displays the following error:

```
$ 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.
MigMigration CR status

```yaml
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
status: "True"
type: ResticVerifyErrors
```

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 troubleshoot the data verification error.

**Procedure**

1. Log in to the target cluster.

2. View the `Restore` CR:

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

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

**Example output**

```yaml
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:

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

   The output identifies the `Restic` pod that logged the errors.
PodVolumeRestore CR with Restic pod error

```
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>
```

12.4.3.7. 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 Restic pod log displays the following error:

**Restic permission error**

```
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:

   ```json
   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.

12.4.4. 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:

```yaml
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)*

## 12.5. ROLLING BACK A MIGRATION

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

You can also roll back a migration manually.

### 12.5.1. 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

The following resources remain in the migrated namespaces for debugging after a failed direct volume migration (DVM):

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

These resources do not affect rollback. You can delete them 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 under Migration.

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.

12.5.2. 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

The following resources remain in the migrated namespaces for debugging after a failed direct volume migration (DVM):

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

These resources do not affect rollback. You can delete them 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>  # Specify the name of the associated MigPlan CR.
     namespace: openshift-migration
   EOF
   ```

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.

12.5.3. Rolling back a migration manually
You can roll back a failed migration manually by deleting the stage pods and unquiescing the application.

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

**NOTE**

The following resources remain in the migrated namespaces after a failed direct volume migration (DVM):

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

These resources do not affect rollback. You can delete them manually.

**Procedure**

1. Delete the stage pods on all clusters:

   ```
   $ oc delete $(oc get pods -l migration.openshift.io/is-stage-pod -n <namespace>)
   ```

   Namespaces specified in the MigPlan CR.

2. Unquiesce the application on the source cluster by scaling the replicas to their premigration number:

   ```
   $ oc scale deployment <deployment> --replicas=<premigration_replicas>
   ```

   The `migration.openshift.io/preQuiesceReplicas` annotation in the Deployment CR displays the premigration number of replicas:

   ```
   apiVersion: extensions/v1beta1
   kind: Deployment
   metadata:
     annotations:
       deployment.kubernetes.io/revision: "1"
       migration.openshift.io/preQuiesceReplicas: "1"
   ```

3. Verify that the application pods are running on the source cluster:

   ```
   $ oc get pod -n <namespace>
   ```

**Additional resources**

- Deleting Operators from a cluster using the web console