



# Migration Toolkit for Virtualization 2.0

## Installing and using the Migration Toolkit for Virtualization

Migrating from VMware to Red Hat OpenShift Virtualization



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Migrating from VMware to Red Hat OpenShift Virtualization

Red Hat Modernization and Migration Documentation Team  
migration-docs@redhat.com

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## Abstract

The Migration Toolkit for Virtualization (MTV) enables you to migrate virtual machines from VMware vSphere to OpenShift Virtualization running on OpenShift Container Platform.

## Table of Contents

<b>MAKING OPEN SOURCE MORE INCLUSIVE</b> .....	<b>3</b>
<b>CHAPTER 1. ABOUT THE MIGRATION TOOLKIT FOR VIRTUALIZATION</b> .....	<b>4</b>
1.1. MTV CUSTOM RESOURCES AND SERVICES	4
1.2. HIGH-LEVEL MIGRATION WORKFLOW	5
1.3. DETAILED MIGRATION WORKFLOW	6
1.4. STORAGE SUPPORT AND DEFAULT MODES	6
1.5. WARM MIGRATION	7
<b>CHAPTER 2. INSTALLING THE MIGRATION TOOLKIT FOR VIRTUALIZATION</b> .....	<b>9</b>
2.1. INSTALLING THE MTV OPERATOR	9
2.1.1. Installing the MTV Operator by using the OpenShift Container Platform web console	9
Obtaining the MTV web console URL	9
2.1.2. Installing the MTV Operator from the command line interface	10
Obtaining the MTV web console URL	11
2.2. CREATING AND USING A VDDK IMAGE	12
<b>CHAPTER 3. MIGRATING VIRTUAL MACHINES TO OPENSIFT VIRTUALIZATION</b> .....	<b>14</b>
3.1. MIGRATION ENVIRONMENT REQUIREMENTS	14
3.1.1. Increasing the NFC service memory of an ESXi host	15
3.2. MIGRATING VIRTUAL MACHINES BY USING THE MTV WEB CONSOLE	15
3.2.1. Adding providers	15
3.2.1.1. Adding a VMware source provider	15
Selecting a migration network for a VMware provider	16
3.2.1.2. Adding an OpenShift Virtualization provider	17
Selecting a migration network for an OpenShift Virtualization provider	17
3.2.2. Creating a network mapping	18
3.2.3. Creating a storage mapping	19
3.2.4. Creating a migration plan	19
3.2.5. Running a migration plan	21
3.2.6. Canceling a migration	21
3.3. MIGRATING VIRTUAL MACHINES FROM THE COMMAND LINE INTERFACE	22
3.3.1. Canceling a migration	27
<b>CHAPTER 4. UPGRADING THE MIGRATION TOOLKIT FOR VIRTUALIZATION</b> .....	<b>28</b>
<b>CHAPTER 5. UNINSTALLING THE MIGRATION TOOLKIT FOR VIRTUALIZATION</b> .....	<b>29</b>
5.1. UNINSTALLING MTV BY USING THE OPENSIFT CONTAINER PLATFORM WEB CONSOLE	29
5.2. UNINSTALLING MTV FROM THE COMMAND LINE INTERFACE	29
<b>CHAPTER 6. TROUBLESHOOTING</b> .....	<b>31</b>
6.1. ERROR MESSAGES	31
6.2. USING THE MUST-GATHER TOOL	31
6.3. KNOWN ISSUES	31



## MAKING OPEN SOURCE MORE INCLUSIVE

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

# CHAPTER 1. ABOUT THE MIGRATION TOOLKIT FOR VIRTUALIZATION

The Migration Toolkit for Virtualization (MTV) enables you to migrate virtual machines from VMware vSphere to OpenShift Virtualization, an add-on to OpenShift Container Platform 4.7. With OpenShift Virtualization, you can run and manage virtual machine workloads alongside container workloads.

## 1.1. MTV CUSTOM RESOURCES AND SERVICES

The Migration Toolkit for Virtualization (MTV) is provided as an OpenShift Container Platform Operator. It creates and manages the following custom resources (CRs) and services.

### MTV custom resources

- **Provider** CR stores attributes that enable MTV to connect to and interact with the source and target providers.
- **NetworkMapping** CR maps the networks of the source and target providers.
- **StorageMapping** CR maps the storage of the source and target providers.
- **Provisioner** CR stores the configuration of the storage provisioners, such as supported volume and access modes.
- **Plan** CR contains a list of VMs with the same migration parameters and associated network and storage mappings.
- **Migration** CR runs a migration plan.  
Only one **Migration** CR per migration plan can run at a given time. You can create multiple **Migration** CRs for a single **Plan** CR.

### MTV services

- **Provider Inventory** service:
  - Connects to the source and target providers.
  - Maintains a local inventory for mappings and plans.
  - Stores VM configurations.
  - Runs the **Validation** service if a VM configuration change is detected.
- **Validation** service checks the suitability of a VM for migration by applying rules.



### IMPORTANT

The Validation service is a Technology Preview feature only. Technology Preview features are not supported with Red Hat production service level agreements (SLAs) and might not be functionally complete. Red Hat does not recommend using them in production. These features provide early access to upcoming product features, enabling customers to test functionality and provide feedback during the development process.

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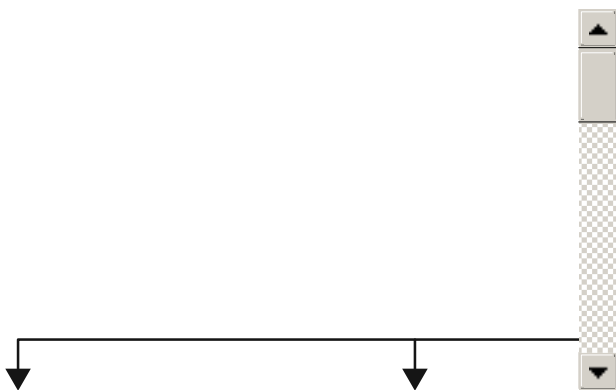
- **User Interface** service:
  - Enables you to create and configure MTV CRs.
  - Displays the status of the CRs and the progress of a migration.
- **Migration Controller** service orchestrates migrations.
 

When you create a migration plan, the Migration Controller service validates the plan and adds a status label. If the plan fails validation, the plan status is **Not ready** and the plan cannot be used to perform a migration. If the plan passes validation, the plan status is **Ready** and it can be used to perform a migration. After a successful migration, the Migration Controller changes the plan status to **Completed**.
- **Virtual Machine Import Controller, Kubevirt Controller, and Containerized Data Import (CDI) Controller** services handle most technical operations.

## 1.2. HIGH-LEVEL MIGRATION WORKFLOW

The high-level workflow shows the migration process from the point of view of the user.

Figure 1.1. High-level workflow



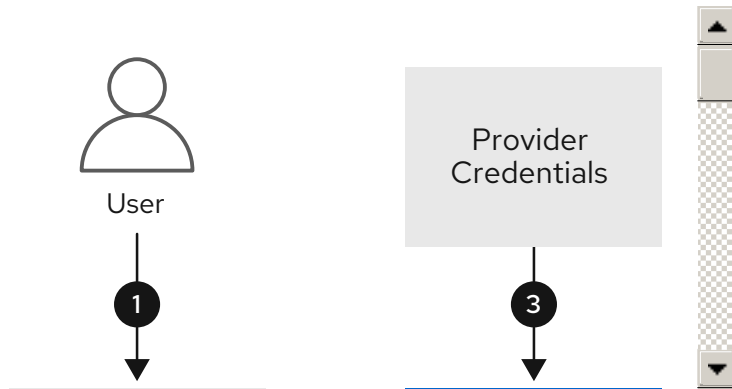
The workflow describes the following steps:

1. You create a source provider, a target provider, a network mapping, and a storage mapping.
2. You create a migration plan that includes the following resources:
  - Source provider
  - Target provider
  - Network mapping
  - Storage mapping
  - One or more VMs
3. You run a migration plan by creating a **Migration** CR that references the migration plan. If a migration is incomplete, you can run a migration plan multiple times until all VMs are migrated.
4. For each VM in the migration plan, the Migration Controller creates a **VirtualMachineImport** CR and monitors its status. When all VMs have been migrated, the Migration Controller sets the status of the migration plan to **Completed**. The power state of a source VM is maintained after migration.

### 1.3. DETAILED MIGRATION WORKFLOW

You can use the detailed migration workflow to troubleshoot a failed migration.

Figure 1.2. Detailed OpenShift Virtualization migration workflow



The workflow describes the following steps:

1. When you run a migration plan, the Migration Controller creates a **VirtualMachineImport** custom resource (CR) for each source VM.
2. The Virtual Machine Import Controller validates the **VirtualMachineImport** CR and generates a **VirtualMachine** CR.
3. The Virtual Machine Import Controller retrieves the VM configuration, including network, storage, and metadata, linked in the **VirtualMachineImport** CR.■■  
**For each VM disk:**
4. The Virtual Machine Import Controller creates a **DataVolume** CR as a wrapper for a Persistent Volume Claim (PVC) and annotations.■■
5. The Containerized Data Importer (CDI) Controller creates a PVC. The Persistent Volume (PV) is dynamically provisioned by the **StorageClass** provisioner.■■
6. The CDI Controller creates an **Importer** pod.
7. The **Importer** pod connects to the VM disk by using the VMware Virtual Disk Development Kit (VDDK) SDK and streams the VM disk to the PV.  
**After the VM disks are transferred:**
8. The Virtual Machine Import Controller creates a **Conversion** pod with the PVCs attached to it. The **Conversion** pod runs **virt-v2v**, which installs and configures device drivers on the PVCs of the target VM.
9. The Virtual Machine Import Controller creates a **VirtualMachineInstance** CR.
10. When the target VM is powered on, the KubeVirt Controller creates a VM pod. The VM pod runs **QEMU-KVM** with the PVCs attached as VM disks.

### 1.4. STORAGE SUPPORT AND DEFAULT MODES

The Migration Toolkit for Virtualization (MTV) supports [OpenShift Virtualization storage features](#).

**NOTE**

If the OpenShift Virtualization storage does not support [dynamic provisioning](#), MTV applies the default settings, **Filesystem** volume mode and **ReadWriteOnce** access mode. **Filesystem** volume mode is slower than **Block** volume mode. **ReadWriteOnce** access mode does not enable live virtual machine migration.

MTV uses the following default volume and access modes.

**Table 1.1. Default volume and access modes**

Provisioner	Volume mode	Access mode
kubernetes.io/aws-ebs	Block	ReadWriteOnce
kubernetes.io/azure-disk	Block	ReadWriteOnce
kubernetes.io/azure-file	Filesystem	ReadWriteMany
kubernetes.io/cinder	Block	ReadWriteOnce
kubernetes.io/gce-pd	Block	ReadWriteOnce
kubernetes.io/hostpath-provisioner	Filesystem	ReadWriteOnce
manila.csi.openstack.org	Filesystem	ReadWriteMany
openshift-storage.cephfs.csi.ceph.com	Filesystem	ReadWriteMany
openshift-storage.rbd.csi.ceph.com	Block	ReadWriteOnce
kubernetes.io/rbd	Block	ReadWriteOnce
kubernetes.io/vsphere-volume	Block	ReadWriteOnce

## 1.5. WARM MIGRATION

The default migration type for the Migration Toolkit for Virtualization (MTV) is cold migration. During cold migration, the virtual machines (VMs) are shut down while the data is copied.

Warm migration copies most of the data during the precopy stage. Then the VMs are shut down and the remaining data is copied during the cutover stage.

### Precopy stage

The VMs are not shut down during the precopy stage.

The VM disks are copied incrementally using [changed block tracking \(CBT\)](#) snapshots. The snapshots are created at one-hour intervals by default. You can change the snapshot interval by patching the **vm-import-controller-config** config map.



### IMPORTANT

You must enable CBT on the source VMs and the VM disks.

A VM can support up to 28 CBT snapshots. If that limit is exceeded, a **warm import retry limit reached** error message is displayed. If the VM has preexisting CBT snapshots, it will reach this limit sooner.

The precopy stage runs until either the cutover stage starts or the maximum number of CBT snapshots is reached.

### Cutover stage

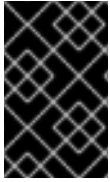
The VMs are shut down during the cutover stage and the remaining data is migrated. Data stored in RAM is not migrated.

You can start the cutover stage manually in the MTV console.

You can schedule a cutover time from the CLI by specifying the value of the **cutover** parameter in the **Migration** CR manifest.

## CHAPTER 2. INSTALLING THE MIGRATION TOOLKIT FOR VIRTUALIZATION

You can install the Migration Toolkit for Virtualization (MTV) by using the OpenShift Container Platform web console or the command line interface (CLI).



### IMPORTANT

After you have installed MTV, you must create a VMware Virtual Disk Development Kit (VDDK) image and add it to the **spec.vddkInitImage** field of the **HyperConverged** custom resource (CR).

## 2.1. INSTALLING THE MTV OPERATOR

You can install the MTV Operator by using the OpenShift Container Platform web console or the command line interface (CLI).

### 2.1.1. Installing the MTV Operator by using the OpenShift Container Platform web console

You can install the MTV Operator by using the OpenShift Container Platform web console.

#### Prerequisites

- OpenShift Container Platform 4.7 installed.
- OpenShift Virtualization Operator installed.
- You must be logged in as a user with **cluster-admin** permissions.

#### Procedure

1. In the OpenShift Container Platform web console, click **Operators** → **OperatorHub**.
2. Use the **Filter by keyword** field to search for **mtv-operator**.
3. Click the MTV Operator and then click **Install**.
4. On the **Install Operator** page, click **Install**.
5. Click **Operators** → **Installed Operators** to verify that the MTV Operator appears in the **openshift-mtv** project with the status **Succeeded**.
6. Click the MTV Operator.
7. Under **Provided APIs**, locate the **ForkliftController**, and click **Create Instance**.
8. Click **Create**.
9. Click **Workloads** → **Pods** to verify that the MTV pods are running.

#### Obtaining the MTV web console URL

You can obtain the MTV web console URL by using the OpenShift Container Platform web console.

## Prerequisites

- OpenShift Virtualization Operator installed.
- MTV Operator installed.
- You must be logged in as a user with **cluster-admin** privileges.

## Procedure

1. Log in to the OpenShift Container Platform web console.
2. Click **Networking** → **Routes**.
3. Select the **openshift-mtv** project in the **Project:** list.
4. Click the URL for the **forklift-ui** service to open the login page for the MTV web console.

### 2.1.2. Installing the MTV Operator from the command line interface

You can install the MTV Operator from the command line interface (CLI).

## Prerequisites

- OpenShift Container Platform 4.7 installed.
- OpenShift Virtualization Operator installed.
- You must be logged in as a user with **cluster-admin** permissions.

## Procedure

1. Create the openshift-mtv project:

```
$ cat << EOF | oc apply -f -
apiVersion: project.openshift.io/v1
kind: Project
metadata:
  name: openshift-mtv
EOF
```

2. Create an **OperatorGroup** CR called **migration**:

```
$ cat << EOF | oc apply -f -
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  name: migration
namespace: openshift-mtv
spec:
  targetNamespaces:
    - openshift-mtv
EOF
```

3. Create a **Subscription** CR for the Operator:

```
$ cat << EOF | oc apply -f -
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: mtv-operator
  namespace: openshift-mtv
spec:
  channel: release-v2.0.0
  installPlanApproval: Automatic
  name: mtv-operator
  source: redhat-operators
  sourceNamespace: openshift-marketplace
  startingCSV: "mtv-operator.v2.0.0"
EOF
```

4. Create a **ForkliftController** CR:

```
$ cat << EOF | oc apply -f -
apiVersion: forklift.konveyor.io/v1beta1
kind: ForkliftController
metadata:
  name: forklift-controller
  namespace: openshift-mtv
spec:
  olm_managed: true
EOF
```

5. Verify that the MTV pods are running:

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

### Example output

```
NAME                                READY STATUS RESTARTS AGE
forklift-controller-788bdb4c69-mw268 2/2 Running 0      2m
forklift-operator-6bf45b8d8-qps9v    1/1 Running 0      5m
forklift-ui-7cdf96d8f6-xnw5n        1/1 Running 0      2m
```

## Obtaining the MTV web console URL

You can obtain the MTV web console URL from the command line.

### Prerequisites

- OpenShift Virtualization Operator installed.
- MTV Operator installed.
- You must be logged in as a user with **cluster-admin** privileges.

### Procedure

1. Obtain the MTV web console URL:

```
$ oc get route virt -n openshift-mtv \
-o custom-columns=:.spec.host
```

### Example output

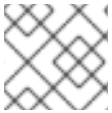
```
https://virt-openshift-mtv.apps.cluster.openshift.com.
```

2. Launch a browser and navigate to the MTV web console.

## 2.2. CREATING AND USING A VDDK IMAGE

The Migration Toolkit for Virtualization (MTV) uses the VMware Virtual Disk Development Kit (VDDK) SDK to transfer virtual disks from VMware vSphere.

You can download the VMware Virtual Disk Development Kit (VDDK), build a VDDK image, and push the VDDK image to your image registry. You then add the VDDK image to the **spec.vddkInitImage** field of the **HyperConverged** custom resource (CR).



### NOTE

Storing the VDDK image in a public registry might violate the VMware license terms.

### Prerequisites

- [OpenShift Container Platform image registry](#) or a secure [external registry](#).
- **podman** installed.
- If you are using an external registry, OpenShift Virtualization must be able to access it.

### Procedure

1. Create and navigate to a temporary directory:

```
$ mkdir /tmp/<dir_name> && cd /tmp/<dir_name>
```

2. In a browser, navigate to the [VMware VDDK download page](#).
3. Select the latest VDDK version and click **Download**.
4. Save the VDDK archive file in the temporary directory.
5. Extract the VDDK archive:

```
$ tar -xzf VMware-vix-disklib-<version>.x86_64.tar.gz
```

6. Create a **Dockerfile**:

```
$ cat > Dockerfile <<EOF
FROM registry.access.redhat.com/ubi8/ubi-minimal
COPY vmware-vix-disklib-distrib /vmware-vix-disklib-distrib
```



```
RUN mkdir -p /opt
ENTRYPOINT ["cp", "-r", "/vmware-vix-disklib-distrib", "/opt"]
EOF
```

7. Build the VDDK image:

```
$ podman build . -t <registry_route_or_server_path>/vddk:<tag>
```

8. Push the VDDK image to the registry:

```
$ podman push <registry_route_or_server_path>/vddk:<tag>
```

9. Ensure that the image is accessible to your OpenShift Virtualization environment.

10. Edit the **HyperConverged** CR in the **openshift-cnv** project:

```
$ oc edit hco -n openshift-cnv kubevirt-hyperconverged
```

11. Add the **vddkInitImage** parameter to the **spec** stanza:

```
apiVersion: hco.kubevirt.io/v1beta1
kind: HyperConverged
metadata:
  name: kubevirt-hyperconverged
  namespace: openshift-cnv
spec:
  vddkInitImage: <registry_route_or_server_path>/vddk:<tag>
```

## CHAPTER 3. MIGRATING VIRTUAL MACHINES TO OPENSIFT VIRTUALIZATION

You can migrate virtual machines (VMs) to OpenShift Virtualization by using the MTV web console or the command line interface (CLI).

You can run a cold or a warm migration. For details, see [Warm migration](#).

### 3.1. MIGRATION ENVIRONMENT REQUIREMENTS

Check your migration environment to ensure that the following requirements are met.

#### VMware environment requirements

- VMware vSphere must be version 6.5 or later.
- If you are migrating more than 10 VMs from an ESXi host in the same migration plan, you must increase the NFC service memory of the host.
- Virtual machines:
  - [VMware Tools](#) is installed.
  - ISO/CDROM disks are unmounted.
  - Each NIC must contain no more than one IPv4 and/or one IPv6 address.
  - VM name contains only lowercase letters (**a-z**), numbers (**0-9**), or hyphens (-), up to a maximum of 253 characters. The first and last characters must be alphanumeric. The name must not contain uppercase letters, spaces, periods (.), or special characters.
  - VM name does not duplicate the name of a VM in the OpenShift Virtualization environment.
  - Operating system is certified and supported [for use as a guest operating system with OpenShift Virtualization](#) and [for conversion to KVM with virt-v2v](#).

#### Network requirements

- IP addresses, VLANs, and other network configuration settings must not be changed before or after migration. The MAC addresses of the virtual machines are preserved during migration.
- Uninterrupted and reliable network connections between the clusters and the replication repository.
- Network ports enabled in the firewall rules.

**Table 3.1. Network ports required for migration**

Port	Protocol	Source	Destination	Purpose
443	TCP	OpenShift nodes	VMware vCenter	VMware provider inventory Disk transfer authentication

Port	Protocol	Source	Destination	Purpose
443	TCP	OpenShift nodes	VMware ESXi hosts	Disk transfer authentication
902	TCP	OpenShift nodes	VMware ESXi hosts	Disk transfer data copy

### 3.1.1. Increasing the NFC service memory of an ESXi host

If you are performing more than 10 concurrent migrations from a single ESXi host, you must increase the NFC service memory of the host to enable additional connections for migrations. Otherwise, the migration will fail because the NFC service memory is limited to 10 parallel connections.

#### Procedure

1. Log in to the ESXi host as root.
2. Change the value of **maxMemory** to **1000000000** in **/etc/vmware/hostd/config.xml**:

```

...
<nfcsvc>
  <path>libnfcsvc.so</path>
  <enabled>true</enabled>
  <maxMemory>1000000000</maxMemory>
  <maxStreamMemory>10485760</maxStreamMemory>
</nfcsvc>
...

```

3. Restart **hostd**:

```
# /etc/init.d/hostd restart
```

You do not need to reboot the host.

## 3.2. MIGRATING VIRTUAL MACHINES BY USING THE MTV WEB CONSOLE

You can migrate virtual machines to OpenShift Virtualization by using the MTV web console.

### 3.2.1. Adding providers

You can add VMware and OpenShift Virtualization providers by using the MTV web console.

#### 3.2.1.1. Adding a VMware source provider

You can add a VMware source provider by using the MTV web console.

#### Procedure

1. In the MTV web console, click **Providers**.
2. Click **Add provider**.
3. Select **VMware** from the **Type** list.
4. Fill in the following fields:
  - **Name:** Name to display in the list of providers
  - **Hostname or IP address:** vCenter host name or IP address
  - **Username:** vCenter admin user name, for example, **administrator@vsphere.local**
  - **Password:** vCenter admin password
  - **SHA-1 fingerprint:** vCenter SHA-1 fingerprint  
To obtain the vCenter SHA-1 fingerprint, enter the following command:

```
$ openssl s_client \
  -connect <vcenter.example.com>:443 </dev/null 2>/dev/null \ 1
  | openssl x509 -fingerprint -noout -in /dev/stdin \
  | cut -d '=' -f 2
```

- 1** Specify the vCenter host name.

5. Click **Add** to add and save the provider.  
The VMware provider appears in the list of providers.

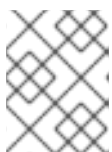
### Selecting a migration network for a VMware provider

You can select a migration network in the MTV web console for a VMware source provider to reduce risk to the VMware environment and to improve performance.

The default migration network is the management network. However, using the management network for migration can result in poor performance because the network might not have sufficient bandwidth. This situation can have a negative effect on the VMware platform because the disk transfer operation might saturate the network and impede communication between vCenter and the ESXi hosts.

### Prerequisites

- The migration network must have sufficient throughput, minimum speed of 10 Gbps, for disk transfer.
- The migration network must be accessible to the OpenShift Virtualization nodes through the default gateway.



#### NOTE

The source virtual disks are copied by a pod that is connected to the pod network of the target namespace.

- The migration network must have jumbo frames enabled.
- You must have administrator privileges for each ESXi host.

## Procedure

1. In the MTV web console, click **Providers**
2. Click **VMware**.
3. Click the host number in the **Hosts** column beside a VMware provider to view a list of hosts.
4. Select one or more hosts and click **Select migration network**.
5. Complete the following fields:
  - **Network:** Select the migration network.  
You can clear the migration network selection by selecting the default management network.
  - **ESXi host admin username:** Specify the ESXi host admin user name, for example, **root**.
  - **ESXi host admin password:** Specify the ESXi host password.
6. Click **Save**.
7. Verify that the status of each host is **Ready**.  
If a host status is not **Ready**, the host might be unreachable on the migration network or the credentials might be incorrect. You can modify the host configuration and save the changes.

### 3.2.1.2. Adding an OpenShift Virtualization provider

You can add an OpenShift Virtualization provider to the MTV web console in addition to the default OpenShift Virtualization provider, which is the provider where you installed MTV.

## Prerequisites

- You must have an OpenShift Virtualization [service account token](#) with **cluster-admin** privileges.

## Procedure

1. In the MTV web console, click **Providers**.
2. Click **Add provider**.
3. Select **OpenShift Virtualization** from the **Type** list.
4. Complete the following fields:
  - **Cluster name:** Specify the cluster name to display in the list of target providers.
  - **URL:** Specify the API endpoint of the cluster.
  - **Service account token:** Specify the **cluster-admin** service account token.
5. Click **Check connection** to verify the credentials.
6. Click **Add**.  
The provider appears in the list of providers.

### Selecting a migration network for an OpenShift Virtualization provider

You can select a default migration network for an OpenShift Virtualization provider in the MTV web console to improve performance. The default migration network is used to transfer disks to the namespaces in which it is configured.

If you do not select a migration network, the default migration network is the **pod** network, which might not be optimal for disk transfer.



#### NOTE

You can override the default migration network of the provider by selecting a different network when you create a migration plan.

#### Procedure

1. In the MTV web console, click **Providers**.
2. Click **OpenShift Virtualization**.
3. Select a provider and click **Select migration network**.
4. Select a network from the list of available networks and click **Select**.
5. Click the network number in the **Networks** column beside the provider to verify that the selected network is the default migration network.

### 3.2.2. Creating a network mapping

You can create one or more network mappings by using the MTV web console to map source networks to OpenShift Virtualization networks.



#### NOTE

You cannot map an opaque network, typically managed by NSX, to an OpenShift Virtualization network.

#### Prerequisites

- Source and target providers added to the web console.
- If you map more than one source and target network, you must create a [network attachment definition](#) for each additional target network.

#### Procedure

1. Click **Mappings → Network**.
2. Click **Create mapping**.
3. Complete the following fields:
  - **Name:** Enter a name to display in the network mappings list.
  - **Source provider:** Select a source provider.
  - **Target provider:** Select a target provider.

- **Source networks:** Select a source network.
  - **Target namespaces/networks:** Select a target network.
4. Optional: Click **Add** to create additional network mappings or to map multiple source networks to a single target network.
  5. If you create an additional network mapping, select the network attachment definition as the target network.
  6. Click **Create**.  
The network mapping is displayed on the **Network mappings** screen.

### 3.2.3. Creating a storage mapping

You can create a storage mapping by using the MTV web console to map source data stores to OpenShift Virtualization storage classes.

#### Prerequisites

- Source and target providers added to the web console.
- Local and shared persistent storage that support VM migration.

#### Procedure

1. Click **Mappings → Storage**.
2. Click **Create mapping**.
3. Complete the following fields:
  - **Name:** Enter a name to display in the storage mappings list.
  - **Source provider:** Select a source provider.
  - **Target provider:** Select a target provider.
  - **Source datastores:** Select a source data store.
  - **Target storage classes:** Select a target storage class.
4. Optional: Click **Add** to create additional storage mappings or to map multiple data stores to a single storage class.
5. Click **Create**.  
The mapping is displayed on the **Storage mappings** screen.

### 3.2.4. Creating a migration plan

You can create a migration plan by using the MTV web console.

A migration plan allows you to group virtual machines to be migrated together or with the same migration parameters, for example, a percentage of the members of a cluster or a complete application.

#### Prerequisites

- You must add the VDDK image to the **spec.vddkInitImage** field of the **HyperConverged** custom resource (CR).
- You must add a source provider to the web console.
- If the target provider is not the OpenShift Virtualization cluster on which you installed MTV, you must add a target provider.
- If you are running a warm migration, you must enable [changed block tracking \(CBT\)](#) on the VMs and on the VM disks.
- If you are performing more than 10 concurrent migrations from a single ESXi host, you must increase the NFC service memory of the host.

## Procedure

1. In the web console, click **Migration plans** and then click **Create migration plan**.
2. Complete the following fields:
  - **Plan name:** Enter a migration plan name to display in the migration plan list.
  - **Plan description:** Optional. Brief description of the migration plan.
  - **Source provider:** Select a source provider.
  - **Target provider:** Select a target provider.
  - **Target namespace:** You can type to search for an existing target namespace or create a new namespace.
  - You can change the migration transfer network for this plan by clicking **Select a different network**, selecting a network from the list, and clicking **Select**.  
If you defined a migration transfer network for the OpenShift Virtualization provider and if the network is in the target namespace, that network is the default network for all migration plans. Otherwise, the **pod** network is used.
3. Click **Next**.
4. Click **By clusters and hosts** or **By folders**, select clusters, hosts, or folders to *filter* the list of VMs, and then click **Next**.
5. Select the VMs to migrate and then click **Next**.
6. Select an existing network mapping or create a new network mapping.  
To create a new network mapping:
  - Select a target network for each source network.
  - Optional. Select **Save mapping to use again** and enter a network mapping name.
7. Click **Next**.
8. Select an existing storage mapping or create a new storage mapping.  
To create a new storage mapping:
  - Select a target storage class for each source data store.



- Optional. Select **Save mapping to use again** and enter a storage mapping name.
9. Click **Next**.
  10. Select **Cold migration** or **Warm migration** and click **Next**.
    - Cold migration: The source VMs are stopped while the data is copied.
    - Warm migration: The source VMs run while the data is copied incrementally. Later, you will run the cutover, which stops the VMs and copies the remaining VM data and metadata.
  11. Review your migration plan and click **Finish**.  
The migration plan is saved in the migration plan list.

### 3.2.5. Running a migration plan

You can run a migration plan and view its progress in the MTV web console.

#### Prerequisites

- Valid migration plan.

#### Procedure

1. Click **Migration plans**.  
The **Migration plans** list displays the source and target providers, the number of VMs being migrated, and the status of the plan.
2. Click **Start** beside a migration plan to start the migration.  
If the migration type is **Warm**, the precopy stage starts.
3. Click **Cutover** beside a warm migration plan to complete the migration.
4. Expand a migration plan to view the migration details.  
The migration details screen displays the migration start and end time, the amount of data copied, and a progress pipeline for each VM being migrated.
5. Expand a VM to view the migration steps, elapsed time of each step, and the state.

### 3.2.6. Canceling a migration

You can cancel the migration of some or all virtual machines (VMs) while a migration plan is in progress by using the MTV web console.

#### Procedure

1. Click **Migration Plans**.
2. Click the name of a running migration plan to view the migration details.
3. Select one or more VMs and click **Cancel**.
4. Click **Yes, cancel** to confirm the cancellation.  
In the **Migration details by VM** list, the status of the canceled VMs is **Canceled**. The unmigrated and the migrated virtual machines are not affected.

You can restart a canceled migration by clicking **Restart** beside the migration plan on the **Migration plans** page.

### 3.3. MIGRATING VIRTUAL MACHINES FROM THE COMMAND LINE INTERFACE

You can migrate virtual machines (VMs) from the command line (CLI) by creating the following custom resources (CRs):

- **Secret** contains the VMware provider credentials.
- **Provider** contains the VMware provider details.
- **Host** contains the VMware host details.
- **NetworkMap** maps the source and destination networks.
- **StorageMap** maps the source and destination storage.
- **Plan** contains a list of VMs to migrate and specifies whether the migration is cold or warm. The **Plan** references the providers and maps.
- **Migration** runs the **Plan**. If the migration is warm, it specifies the cutover time. You can associate multiple **Migration** CRs with a single **Plan** CR. If a migration does not complete, you can create a new **Migration** CR, without changing the **Plan** CR, to migrate the remaining VMs.

The term *destination* in the API is the same as *target* in the web console.



#### IMPORTANT

You must specify a name for cluster-scoped CRs.

You must specify both a name and a namespace for namespace-scoped CRs.

#### Prerequisites

- You must be logged in as a user with **cluster-admin** privileges.
- The [OpenShift CLI](#) must be installed.
- If you are mapping more than one source and destination network, you must create a [network attachment definition](#) for each additional destination network.
- You must add the VDDK image to the **spec.vddkInitImage** field of the **HyperConverged** custom resource (CR).
- If you are performing a warm migration, you must enable [changed block tracking \(CBT\)](#) on the VMs and on the VM disks.
- If you are performing more than 10 concurrent migrations from a single ESXi host, you must increase the NFC service memory of the host.

#### Procedure

1. Obtain the vCenter SHA-1 fingerprint:

```
$ openssl s_client \
  -connect <www.example.com>:443 \ 1
  < /dev/null 2>/dev/null \
  | openssl x509 -fingerprint -noout -in /dev/stdin \
  | cut -d '=' -f 2
```

- 1 Specify the vCenter name.

### Example output

```
01:23:45:67:89:AB:CD:EF:01:23:45:67:89:AB:CD:EF:01:23:45:67
```

2. Create a **Secret** CR manifest for the VMware provider:

```
$ cat << EOF | oc apply -f -
apiVersion: v1
kind: Secret
metadata:
  name: <vmware_secret>
  namespace: openshift-mtv
type: Opaque
stringData:
  user: <vcenter_user> 1
  password: <vcenter_password> 2
  thumbprint: <vcenter_fingerprint> 3
EOF
```

- 1 Specify the vCenter administrator account, for example, **administrator@vsphere.local**.
- 2 Specify the vCenter password.
- 3 Specify the vCenter SHA-1 fingerprint.

3. Create a **Provider** CR manifest for the VMware provider:

```
$ cat << EOF | oc apply -f -
apiVersion: forklift.konveyor.io/v1beta1
kind: Provider
metadata:
  name: <vmware_provider>
  namespace: openshift-mtv
spec:
  type: vsphere
  url: <api_end_point> 1
  secret:
    name: <vmware_secret> 2
    namespace: openshift-mtv
EOF
```

- 1 Specify the vSphere API end point, for example, **https://<vcenter.host.com>/sdk**.

- 2 Specify the name of the VMware **Secret** CR.

4. Create a **Host** CR manifest for the VMware host:

```
$ cat << EOF | oc apply -f -
apiVersion: forklift.konveyor.io/v1beta1
kind: Host
metadata:
  name: <vmware_host>
  namespace: openshift-mtv
spec:
  provider:
    namespace: openshift-mtv
    name: <source_provider> 1
  id: <source_host_mor> 2
  ipAddress: <source_network_ip> 3
EOF
```

- 1 Specify the name of the VMware **Provider** CR.
- 2 Specify the *managed object reference* of the VMware host.
- 3 Specify the IP address of the VMware migration network.

5. Create a **NetworkMap** CR manifest to map the source and destination networks:

```
$ cat << EOF | oc apply -f -
apiVersion: forklift.konveyor.io/v1beta1
kind: NetworkMap
metadata:
  name: <network_map>
  namespace: openshift-mtv
spec:
  map:
    - destination:
        type: pod 1
      source:
        id: <source_network_mor> 2
    - destination:
        type: multus
        name: <network_attachment_definition> 3
        namespace: <network_attachment_definition_namespace> 4
      source:
        id: <source_network_mor>
  provider:
    source:
      name: <vmware_provider>
      namespace: openshift-mtv
    destination:
      name: <destination_cluster>
      namespace: openshift-mtv
EOF
```

- 1 Allowed values are **pod** and **multus**.
- 2 Specify the managed object reference of the VMware network.
- 3 Specify the network attachment definition for each additional destination network.
- 4 Specify the namespace of the network attachment definition.

6. Create a **StorageMap** CR manifest:

```
$ cat << EOF | oc apply -f -
apiVersion: forklift.konveyor.io/v1beta1
kind: StorageMap
metadata:
  name: <storage_map>
  namespace: openshift-mtv
spec:
  map:
    - destination:
        storageClass: <storage_class>
        source:
          id: <source_datastore_mor> 1
  provider:
    source:
      name: <vmware_provider>
      namespace: openshift-mtv
    destination:
      name: <destination_cluster>
      namespace: openshift-mtv
EOF
```

- 1 Specify the managed object reference of the VMware data storage.

7. Create a **Plan** CR manifest for the migration:

```
$ cat << EOF | oc apply -f -
apiVersion: forklift.konveyor.io/v1beta1
kind: Plan
metadata:
  name: <plan> 1
  namespace: openshift-mtv
spec:
  provider:
    source:
      name: <vmware_provider>
      namespace: openshift-mtv
    destination:
      name: <destination_cluster>
      namespace: openshift-mtv
  warm: true 2
  map:
    network: 3
      name: <network_map> 4
```

```

namespace: openshift-mtv
storage:
  name: <storage_map> 5
  namespace: openshift-mtv
targetNamespace: openshift-mtv
vms: 6
  - id: <source_vm_mor> 7
  - name: <source_vm>
EOF

```

- 1 Specify the name of the **Plan** CR.
  - 2 Specify whether the migration is warm or cold. If you specify a warm migration without specifying a value for the **cutover** parameter in the **Migration** CR manifest, only the precopy stage will run.
  - 3 You can create multiple network mappings for source and destination networks.
  - 4 Specify the name of the **NetworkMap** CR.
  - 5 Specify the name of the **StorageMap** CR.
  - 6 You can use either the **id** or the **name** parameter to specify the source VMs.
  - 7 Specify the managed object reference of the VMware VM.
8. Optional: To change the time interval between the CBT snapshots for warm migration, patch the **vm-import-controller-config** config map:

```

$ oc patch configmap/vm-import-controller-config \
-n openshift-cnv -p '{"data": \
{"warmImport.intervalMinutes": "<interval>"}' 1

```

- 1 Specify the time interval in minutes. The default value is **60**.
9. Create a **Migration** CR manifest to run the **Plan** CR:

```

$ cat << EOF | oc apply -f -
apiVersion: forklift.konveyor.io/v1beta1
kind: Migration
metadata:
  name: <migration> 1
  namespace: openshift-mtv
spec:
  plan:
    name: <plan> 2
    namespace: openshift-mtv
  cutover: <cutover_time> 3
EOF

```

- 1 Specify the name of the **Migration** CR.
- 2 Specify the name of the **Plan** CR that you are running. The **Migration** CR creates a **VirtualMachineImport** CR for each VM that is migrated.

- 3 Optional: Specify a cutover time according to the ISO 8601 format with the UTC time offset, for example, **2021-04-04T01:23:45.678+09:00**.

10. View the **VirtualMachineImport** pods to monitor the progress of the migration:

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

### 3.3.1. Canceling a migration

You can cancel an entire migration or individual virtual machines (VMs) while a migration is in progress from the command line interface (CLI).

#### Canceling an entire migration

- Delete the **Migration** CR:

```
$ oc delete migration <migration_name> -n openshift-mtv 1
```

#### Canceling the migration of individual VMs

1. Add the individual VMs to the **Migration** CR manifest:

```
$ cat << EOF | oc apply -f -
apiVersion: forklift.konveyor.io/v1beta1
kind: Migration
metadata:
  name: <migration_name>
  namespace: openshift-mtv
...
spec:
  cancel:
    - id: vm-102 1
    - id: vm-203
    - name: rhel8-vm
EOF
```

- 1 1 The **id** is the *managed object reference* of the source VM.

2. View the **VirtualMachineImport** pods to monitor the progress of the remaining VMs:

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

## CHAPTER 4. UPGRADING THE MIGRATION TOOLKIT FOR VIRTUALIZATION

You can upgrade the MTV Operator by using the OpenShift Container Platform web console to install the new version.



### NOTE

You must upgrade to the next release without skipping a release, for example, from 2.0 to 2.1 or from 2.1 to 2.2.

See [Upgrading installed Operators](#) in the OpenShift Container Platform documentation.



## CHAPTER 5. UNINSTALLING THE MIGRATION TOOLKIT FOR VIRTUALIZATION

You can uninstall the Migration Toolkit for Virtualization (MTV) by using the OpenShift Container Platform web console or the command line interface (CLI).



### 5.1. UNINSTALLING MTV BY USING THE OPENSIFT CONTAINER PLATFORM WEB CONSOLE

You can uninstall Migration Toolkit for Virtualization (MTV) by using the OpenShift Container Platform web console to delete the **openshift-mtv** project and custom resource definitions (CRDs).

#### Prerequisites

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

#### Procedure

- Click **Home** → **Projects**.
- Enter **rhmtv** in the **Search** field to locate the openshift-mtv project.
- On the right side of the project, select **Delete Project** from the Options menu .
- In the **Delete Project** pane, enter the project name and click **Delete**.
- Click **Administration** → **CustomResourceDefinitions**.
- Enter **forklift** in the **Search** field to locate the CRDs in the **forklift.konveyor.io** group.
- On the right side of each CRD, select **Delete CustomResourceDefinition** from the Options menu .

### 5.2. UNINSTALLING MTV FROM THE COMMAND LINE INTERFACE

You can uninstall Migration Toolkit for Virtualization (MTV) from the command line interface (CLI) by deleting the **openshift-mtv** project and the **forklift.konveyor.io** custom resource definitions (CRDs).

#### Prerequisites

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

#### Procedure

- Delete the project:

```
$ oc delete project openshift-mtv
```

- Delete the CRDs:

```
$ oc get crd -o name | grep 'forklift' | xargs oc delete
```

3. Delete the OAuthClient:

```
┆ $ oc delete oauthclient/forklift-ui
```

## CHAPTER 6. TROUBLESHOOTING

This section describes ways to troubleshoot migration issues and error messages.

### 6.1. ERROR MESSAGES

This section describes error messages and how to resolve them.

#### warm import retry limit reached

The **warm import retry limit reached** error message is displayed during a warm migration if the virtual machine (VM) has reached the maximum number (28) of changed block tracking (CBT) snapshots during the precopy stage. You must delete some of the CBT snapshots from the VM and restart the migration plan.

### 6.2. USING THE MUST-GATHER TOOL

You can collect logs and information about MTV custom resources (CRs) by using the **must-gather** tool. You must attach a **must-gather** data file to all customer cases.

#### Prerequisites

- You must be logged in to the OpenShift Virtualization cluster as a user with the **cluster-admin** role.
- You must have the [OpenShift Container Platform CLI \(oc\)](#) installed.

#### Collecting logs and CR information

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

```
$ oc adm must-gather --image=registry.redhat.io/migration-toolkit-virtualization/mtv-must-gather-rhel8:2.0.0
```

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](#).

### 6.3. KNOWN ISSUES

This section describes known issues and mitigations.

#### Network map displays a Destination network not found error

If the network map remains in a **NotReady** state and the **NetworkMap** CR manifest displays a **Destination network not found** error, the cause is a missing network attachment definition. You must create a [network attachment definition](#) for each additional destination network before you create the network map. ([BZ#1971259](#))

#### Warm migration gets stuck during third precopy

Warm migration uses changed block tracking snapshots to copy data during the precopy stage. The snapshots are created at one-hour intervals by default. When a snapshot is created, its contents are copied to the destination cluster. However, when the third snapshot is created, the first snapshot is

deleted and the block tracking is lost. ([BZ#1969894](#))

You can do one of the following to mitigate this issue:

- Start the cutover stage no more than one hour after the precopy stage begins so that only one internal snapshot is created.
- Increase the snapshot interval in the **vm-import-controller-config** config map to **720** minutes:

```
$ oc patch configmap/vm-import-controller-config \  
-n openshift-cnv -p '{"data": \  
{"warmImport.intervalMinutes": "720"}'}'
```