



OpenShift Container Platform 4.5

Installing on RHV

Installing OpenShift Container Platform RHV clusters

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Abstract

This document provides instructions for installing and uninstalling OpenShift Container Platform clusters on Red Hat Virtualization.

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CHAPTER 1. INSTALLING ON RHV

1.1. INSTALLING A CLUSTER QUICKLY ON RHV



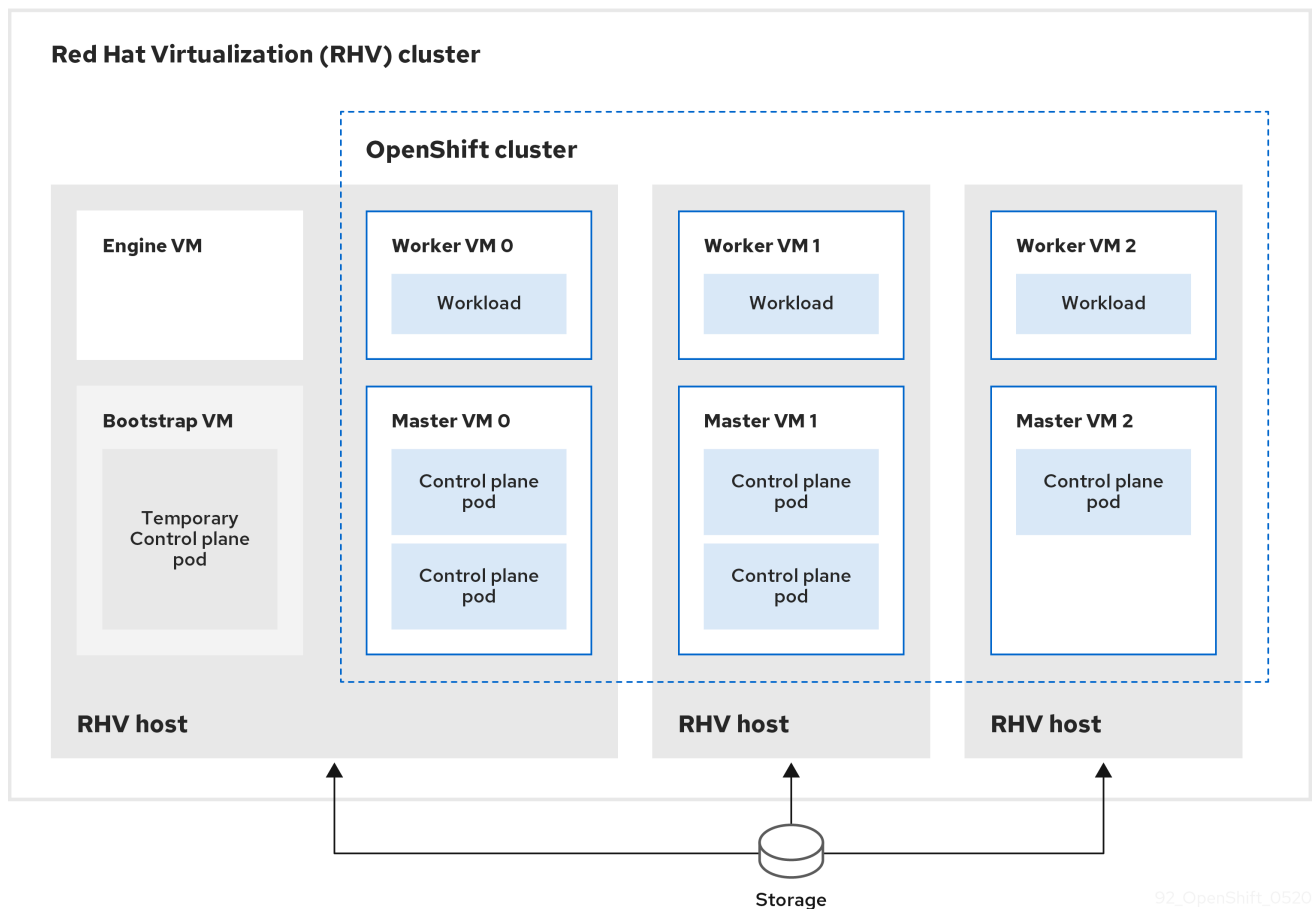
WARNING

Due to a known issue, this default installation procedure does not work with OpenShift Container Platform versions 4.4 and 4.5 on Red Hat Virtualization (RHV) 4.4.1. This defect is fixed in RHV 4.4.2.

Instead, follow the steps in [Installing a cluster on RHV with customizations](#).

During that procedure, customize `install-config.yaml` as described in [OpenShift IPI installation on RHV-4.x failed with "Error: timeout while waiting for state to become 'up' \(last state: 'down', timeout: 10m0s\)"](#).

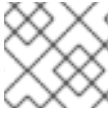
You can quickly install a default, non-customized, OpenShift Container Platform cluster on a Red Hat Virtualization (RHV) cluster, similar to the one shown in the following diagram.



The installation program uses installer-provisioned infrastructure to automate creating and deploying the cluster.

To install a default cluster, you prepare the environment, run the installation program and answer its prompts. Then, the installation program creates the OpenShift Container Platform cluster.

For an alternative to installing a default cluster, see [Installing a cluster with customizations](#).



NOTE

This installation program is available for Linux and macOS only.

1.1.1. Prerequisites

- Review details about the [OpenShift Container Platform installation and update](#) processes.
- If you use a firewall, [configure it to allow the sites](#) that your cluster requires access to.

1.1.2. Internet and Telemetry access for OpenShift Container Platform

In OpenShift Container Platform 4.5, you require access to the internet to install your cluster. The Telemetry service, which runs by default to provide metrics about cluster health and the success of updates, also requires internet access. If your cluster is connected to the internet, Telemetry runs automatically, and your cluster is registered to the [Red Hat OpenShift Cluster Manager \(OCM\)](#).

Once you confirm that your Red Hat OpenShift Cluster Manager inventory is correct, either maintained automatically by Telemetry or manually using OCM, [use subscription watch](#) to track your OpenShift Container Platform subscriptions at the account or multi-cluster level.

You must have internet access to:

- Access the [Red Hat OpenShift Cluster Manager](#) page to download the installation program and perform subscription management. If the cluster has internet access and you do not disable Telemetry, that service automatically entitles your cluster.
- Access [Quay.io](#) to obtain the packages that are required to install your cluster.
- Obtain the packages that are required to perform cluster updates.



IMPORTANT

If your cluster cannot have direct internet access, you can perform a restricted network installation on some types of infrastructure that you provision. During that process, you download the content that is required and use it to populate a mirror registry with the packages that you need to install a cluster and generate the installation program. With some installation types, the environment that you install your cluster in will not require internet access. Before you update the cluster, you update the content of the mirror registry.

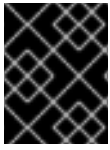
1.1.3. Requirements for the RHV environment

To install and run an OpenShift Container Platform cluster, the RHV environment must meet the following requirements. Not meeting these requirements can cause failures.

The following requirements for CPUs, memory, and storage are based on *default* values multiplied by the default number of virtual machines the installation program creates.

By default, the installation program creates seven machines during the installation process, which

includes one bootstrap machine. When the installation program finishes, it deletes the bootstrap machine and frees up its resources. If you perform a custom installation, you can increase the number of virtual machines the installation program creates.



IMPORTANT

If you increase the number of virtual machines or resources in the `install_config.yaml` file, you must also increase these requirements.

Requirements

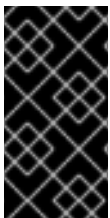
- The RHV version is 4.3.10 or later.
- The RHV environment has one data center whose state is **Up**.
- The RHV data center contains an RHV cluster.
- The RHV cluster has the following resources exclusively for the OpenShift Container Platform cluster:
 - Minimum 28 vCPUs, which is 4 vCPUs for each of the seven virtual machines created during installation.
 - 112 GiB RAM or more, including:
 - 16 GiB or more for the bootstrap machine, which provides the temporary control plane.
 - 16 GiB or more for each of the three control plane machines which provide the control plane.
 - 16 GiB or more for each of the three compute machines, which run the application workloads.
- The RHV storage domain must meet [these etcd backend performance requirements](#).
- In production environments, each virtual machine must have 120 GiB or more, so the storage domain must have 840 GiB or more for the OpenShift Container Platform cluster. In resource-constrained or non-production environments, each virtual machine must have 32 GiB or more, so the storage domain must have 230 GiB or more for the OpenShift Container Platform cluster.
- The RHV cluster must have access to an Internet connection to download images from the Red Hat Ecosystem Catalog during installation and updates, and for the Telemetry service to simplify the subscription and entitlement process.
- The RHV cluster has a virtual network with access to the REST API on the RHV Manager.

**NOTE**

- All together, the hosts must have the required memory and CPU resources **in addition to and aside from** what they use to operate or provide to non-OpenShift Container Platform operations.
- The release cycles of OpenShift Container Platform and RHV are different and versions tested might vary in the future depending on the release dates of both products.
- The bootstrap machine provides a temporary control plane while the installation program creates the OpenShift Container Platform cluster. After it creates the cluster, the installation program removes the bootstrap machine and releases its resources.

1.1.4. Verifying the requirements for the RHV environment

Verify that the RHV environment meets the requirements to install and run an OpenShift Container Platform cluster. Not meeting these requirements can cause failures.

**IMPORTANT**

These requirements are based on the default resources the installation program uses to create control plane and compute machines. These resources include vCPUs, memory, and storage. If you change these resources or increase the number of OpenShift Container Platform machines, adjust these requirements accordingly.

Procedure

1. Check the RHV version.
 - a. In the RHV Administration Portal, click the ? help icon in the upper-right corner and select **About**.
 - b. In the window that opens, confirm that the **RHV Software Version** is **4.3.10** or higher.
2. Inspect the data center, cluster, and storage.
 - a. In the RHV Administration Portal, click **Compute → Data Centers**.
 - b. Confirm the data center where you plan to install OpenShift Container Platform displays a green up arrow, meaning it is "Up".
 - c. Click the name of that data center.
 - d. In the data center details, on the **Storage** tab, confirm the storage domain where you plan to install OpenShift Container Platform is **Active**.
 - e. Record the **Domain Name** for use later on.
 - f. Confirm **Free Space** has at least 230 GiB.
 - g. Confirm that the storage domain meets [these etcd backend performance requirements](#), which can be [measured using the fio performance benchmarking tool](#).
 - h. In the data center details, click the **Clusters** tab.

- i. Find the RHV cluster where you plan to install OpenShift Container Platform. Record the cluster name for use later on.
3. Inspect the RHV host resources.
 - a. In the RHV Administration Portal, click **Compute > Clusters**.
 - b. Click the cluster where you plan to install OpenShift Container Platform.
 - c. In the cluster details, click the **Hosts** tab.
 - d. Inspect the hosts and confirm they have a combined total of at least 28 **Logical CPU Cores** available *exclusively* for the OpenShift Container Platform cluster.
 - e. Record the number of available **Logical CPU Cores** for use later on.
 - f. Confirm that these CPU cores are distributed so each of the seven virtual machines created during installation can have four cores.
 - g. Confirm that, all together, the hosts have 112 GiB of **Max free Memory for scheduling new VMs** distributed to meet the requirements for each of the following OpenShift Container Platform machines:
 - 16 GiB required for the bootstrap machine
 - 16 GiB required for each of the three control plane machines
 - 16 GiB for each of the three compute machines
 - h. Record the amount of **Max free Memory for scheduling new VMs** for use later on.
 4. Verify that the virtual network for installing OpenShift Container Platform has access to the RHV Manager's REST API. From a virtual machine on this network, use a curl command with the RHV Manager's REST API. Use the following format:

```
$ curl -k -u <username>@<profile>:<password> \ 1
https://<engine-fqdn>/ovirt-engine/api 2
```

1 For **<username>**, specify the user name of an RHV administrator. For **<profile>**, specify the login profile, which you can get by going to the RHV Administration Portal login page and reviewing the **Profile** dropdown list. For **<password>**, specify the admin password.

2 For **<engine-fqdn>**, specify the fully qualified domain name of the RHV environment.

For example:

```
$ curl -k -u rhvadmin@internal:pw123 \
https://rhv-env.virtlab.example.com/ovirt-engine/api
```

1.1.5. Preparing the network environment on RHV

Configure three static IP addresses for the OpenShift Container Platform cluster and create DNS entries using two of these addresses.

Procedure

1. Reserve three static IP addresses
 - a. On the network where you plan to install OpenShift Container Platform, identify three static IP addresses that are outside the DHCP lease pool.
 - b. Connect to a host on this network and verify that each of the IP addresses is not in use. For example, use `arp` to check that none of the IP addresses have entries:

```
$ arp 10.35.1.19
```

Example output

```
10.35.1.19 (10.35.1.19) -- no entry
```

- c. Reserve three static IP addresses following the standard practices for your network environment.
 - d. Record these IP addresses for future reference.
2. Create DNS entries for the OpenShift Container Platform REST API and apps domain names using this format:

```
api.<cluster-name>.<base-domain> <ip-address> 1
*.apps.<cluster-name>.<base-domain> <ip-address> 2
```

- 1 For **<cluster-name>**, **<base-domain>**, and **<ip-address>**, specify the cluster name, base domain, and static IP address of your OpenShift Container Platform API.
- 2 Specify the cluster name, base domain, and static IP address of your OpenShift Container Platform apps (ingress/load balancer).

For example:

```
api.my-cluster.virtlab.example.com 10.35.1.19
*.apps.my-cluster.virtlab.example.com 10.35.1.20
```



NOTE

The third static IP address does not require a DNS entry. The OpenShift Container Platform cluster uses that address for its internal DNS service.

1.1.6. Setting up the CA certificate for RHV

Download the CA certificate from the Red Hat Virtualization (RHV) Manager and set it up on the installation machine.

You can download the certificate from a webpage on the RHV Manager or by using a **curl** command.

Later, you provide the certificate to the installation program.

Procedure

1. Use either of these two methods to download the CA certificate:

- Go to the Manager's webpage, <https://<engine-fqdn>/ovirt-engine/>. Then, under **Downloads**, click the **CA Certificate** link.
- Run the following command:

```
$ curl -k 'https://<engine-fqdn>/ovirt-engine/services/pki-resource?resource=ca-certificate&format=X509-PEM-CA' -o /tmp/ca.pem 1
```

- 1** For **<engine-fqdn>**, specify the fully qualified domain name of the RHV Manager, such as **rhv-env.virtlab.example.com**.

2. Configure the CA file to grant rootless user access to the Manager. Set the CA file permissions to have an octal value of **0644** (symbolic value: **-rw-r--r--**):

```
$ sudo chmod 0644 /tmp/ca.pem
```

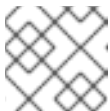
3. For Linux, copy the CA certificate to the directory for server certificates. Use **-p** to preserve the permissions:

```
$ sudo cp -p /tmp/ca.pem /etc/pki/ca-trust/source/anchors/ca.pem
```

4. Add the certificate to the certificate manager for your operating system:

- For macOS, double-click the certificate file and use the **Keychain Access** utility to add the file to the **System** keychain.
- For Linux, update the CA trust:

```
$ sudo update-ca-trust
```



NOTE

If you use your own certificate authority, make sure the system trusts it.

Additional Resources

To learn more, see [Authentication and Security](#) in the RHV documentation.

1.1.7. Generating an SSH private key and adding it to the agent

If you want to perform installation debugging or disaster recovery on your cluster, you must provide an SSH key to both your **ssh-agent** and to the installation program.



NOTE

In a production environment, you require disaster recovery and debugging.

You can use this key to SSH into the master nodes as the user **core**. When you deploy the cluster, the key is added to the **core** user's `~/.ssh/authorized_keys` list.

Procedure

1. If you do not have an SSH key that is configured for password-less authentication on your computer, create one. For example, on a computer that uses a Linux operating system, run the following command:

```
$ ssh-keygen -t rsa -b 4096 -N "" \
-f <path>/<file_name> 1
```

- 1 Specify the path and file name, such as `~/.ssh/id_rsa`, of the SSH key. Do not specify an existing SSH key, as it will be overwritten.

Running this command generates an SSH key that does not require a password in the location that you specified.

2. Start the **ssh-agent** process as a background task:

```
$ eval "$(ssh-agent -s)"
```

Example output

```
Agent pid 31874
```

3. Add your SSH private key to the **ssh-agent**:

```
$ ssh-add <path>/<file_name> 1
```

Example output

```
Identity added: /home/<you>/<path>/<file_name> (<computer_name>)
```

- 1 Specify the path and file name for your SSH private key, such as `~/.ssh/id_rsa`

Next steps

- When you install OpenShift Container Platform, provide the SSH public key to the installation program.

1.1.8. Obtaining the installation program

Before you install OpenShift Container Platform, download the installation file on a local computer.

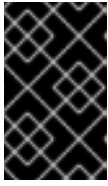
Prerequisites

- You must install the cluster from a computer that uses Linux or macOS.
- You need 500 MB of local disk space to download the installation program.

Procedure

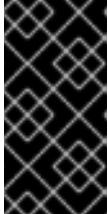
1. Access the [Infrastructure Provider](#) page on the Red Hat OpenShift Cluster Manager site. If you have a Red Hat account, log in with your credentials. If you do not, create an account.

- Navigate to the page for your installation type, download the installation program for your operating system, and place the file in the directory where you will store the installation configuration files.



IMPORTANT

The installation program creates several files on the computer that you use to install your cluster. You must keep both the installation program and the files that the installation program creates after you finish installing the cluster.



IMPORTANT

Deleting the files created by the installation program does not remove your cluster, even if the cluster failed during installation. You must complete the OpenShift Container Platform uninstallation procedures outlined for your specific cloud provider to remove your cluster entirely.

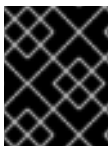
- Extract the installation program. For example, on a computer that uses a Linux operating system, run the following command:

```
$ tar xvf <installation_program>.tar.gz
```

- From the [Pull Secret](#) page on the Red Hat OpenShift Cluster Manager site, download your installation pull secret as a **.txt** file. This pull secret allows you to authenticate with the services that are provided by the included authorities, including Quay.io, which serves the container images for OpenShift Container Platform components.

1.1.9. Deploying the cluster

You can install OpenShift Container Platform on a compatible cloud platform.



IMPORTANT

You can run the **create cluster** command of the installation program only once, during initial installation.

Prerequisites

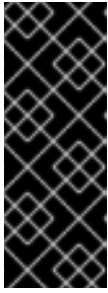
- Obtain the OpenShift Container Platform installation program and the pull secret for your cluster.

Procedure

- Run the installation program:

```
$ ./openshift-install create cluster --dir=<installation_directory> \ 1  
--log-level=info 2
```

- 1** For **<installation_directory>**, specify the directory name to store the files that the installation program creates.
- 2** To view different installation details, specify **warn**, **debug**, or **error** instead of **info**.



IMPORTANT

Specify an empty directory. Some installation assets, like bootstrap X.509 certificates have short expiration intervals, so you must not reuse an installation directory. If you want to reuse individual files from another cluster installation, you can copy them into your directory. However, the file names for the installation assets might change between releases. Use caution when copying installation files from an earlier OpenShift Container Platform version.

Respond to the installation program prompts.

- a. Optional: For **SSH Public Key**, select a password-less public key, such as `~/.ssh/id_rsa.pub`. This key authenticates connections with the new OpenShift Container Platform cluster.



NOTE

For production OpenShift Container Platform clusters on which you want to perform installation debugging or disaster recovery, select an SSH key that your **ssh-agent** process uses.

- b. For **Platform**, select **ovirt**.
- c. For **Enter oVirt's API endpoint URL**, enter the URL of the RHV API using this format:

```
https://<engine-fqdn>/ovirt-engine/api 1
```

- 1** For **<engine-fqdn>**, specify the fully qualified domain name of the RHV environment.

For example:

```
https://rhv-env.virtlab.example.com/ovirt-engine/api
```

- d. For **Is the oVirt CA trusted locally?**, enter **Yes** since you have already set up a CA certificate. Otherwise, enter **No**.
- e. For **oVirt's CA bundle**, if you entered **Yes** for the preceding question, copy the certificate content from `/etc/pki/ca-trust/source/anchors/ca.pem` and paste it here. Then, press **Enter** twice. Otherwise, if you entered **No** for the preceding question, this question does not appear.
- f. For **oVirt engine username**, enter the user name and profile of the RHV administrator using this format:

```
<username>@<profile> 1
```

- 1** For **<username>**, specify the user name of an RHV administrator. For **<profile>**, specify the login profile, which you can get by going to the RHV Administration Portal login page and reviewing the **Profile** dropdown list. Together, the user name and profile should look similar to this example:

```
admin@internal
```


- g. For **oVirt engine password**, enter the RHV admin password.
- h. For **oVirt cluster**, select the cluster for installing OpenShift Container Platform.
- i. For **oVirt storage domain**, select the storage domain for installing OpenShift Container Platform.
- j. For **oVirt network**, select a virtual network that has access to the RHV Manager REST API.
- k. For **Internal API Virtual IP**, enter the static IP address you set aside for the cluster's REST API.
- l. For **Internal DNS Virtual IP**, enter the static IP address you set aside for the cluster's internal DNS service.
- m. For **Ingress virtual IP**, enter the static IP address you reserved for the wildcard apps domain.
- n. For **Base Domain**, enter the base domain of the OpenShift Container Platform cluster. If this cluster is exposed to the outside world, this must be a valid domain recognized by DNS infrastructure. For example, enter: **virtlab.example.com**
- o. For **Cluster Name**, enter the name of the cluster. For example, **my-cluster**. Use cluster name from the externally registered/resolvable DNS entries you created for the OpenShift Container Platform REST API and apps domain names. The installation program also gives this name to the cluster in the RHV environment.
- p. For **Pull Secret**, copy the pull secret from the **pull-secret.txt** file you downloaded earlier and paste it here. You can also get a copy of the same pull secret from the [Pull Secret](#) page on the Red Hat OpenShift Cluster Manager site.



NOTE

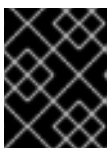
If the cloud provider account that you configured on your host does not have sufficient permissions to deploy the cluster, the installation process stops, and the missing permissions are displayed.

When the cluster deployment completes, directions for accessing your cluster, including a link to its web console and credentials for the **kubeadmin** user, display in your terminal.



IMPORTANT

The Ignition config files that the installation program generates contain certificates that expire after 24 hours. You must keep the cluster running for 24 hours in a non-degraded state to ensure that the first certificate rotation has finished.



IMPORTANT

You must not delete the installation program or the files that the installation program creates. Both are required to delete the cluster.



IMPORTANT

You have completed the steps required to install the cluster. The remaining steps show you how to verify the cluster and troubleshoot the installation.

CHAPTER 2. INSTALLING THE CLI BY DOWNLOADING THE BINARY

You can install the OpenShift CLI (**oc**) in order to interact with OpenShift Container Platform from a command-line interface. You can install **oc** on Linux, Windows, or macOS.



IMPORTANT

If you installed an earlier version of **oc**, you cannot use it to complete all of the commands in OpenShift Container Platform 4.5. Download and install the new version of **oc**.

2.1. INSTALLING THE CLI ON LINUX

You can install the OpenShift CLI (**oc**) binary on Linux by using the following procedure.

Procedure

1. Navigate to the [Infrastructure Provider](#) page on the Red Hat OpenShift Cluster Manager site.
2. Select your infrastructure provider, and, if applicable, your installation type.
3. In the **Command-line interface** section, select **Linux** from the drop-down menu and click **Download command-line tools**.
4. Unpack the archive:

```
$ tar xvzf <file>
```

5. Place the **oc** binary in a directory that is on your **PATH**.
To check your **PATH**, execute the following command:

```
$ echo $PATH
```

After you install the CLI, it is available using the **oc** command:

```
$ oc <command>
```

2.2. INSTALLING THE CLI ON WINDOWS

You can install the OpenShift CLI (**oc**) binary on Windows by using the following procedure.

Procedure

1. Navigate to the [Infrastructure Provider](#) page on the Red Hat OpenShift Cluster Manager site.
2. Select your infrastructure provider, and, if applicable, your installation type.
3. In the **Command-line interface** section, select **Windows** from the drop-down menu and click **Download command-line tools**.
4. Unzip the archive with a ZIP program.

5. Move the **oc** binary to a directory that is on your **PATH**.
To check your **PATH**, open the command prompt and execute the following command:

```
C:\> path
```

After you install the CLI, it is available using the **oc** command:

```
C:\> oc <command>
```

2.3. INSTALLING THE CLI ON MACOS

You can install the OpenShift CLI (**oc**) binary on macOS by using the following procedure.

Procedure

1. Navigate to the [Infrastructure Provider](#) page on the Red Hat OpenShift Cluster Manager site.
2. Select your infrastructure provider, and, if applicable, your installation type.
3. In the **Command-line interface** section, select **MacOS** from the drop-down menu and click **Download command-line tools**.
4. Unpack and unzip the archive.
5. Move the **oc** binary to a directory on your PATH.
To check your **PATH**, open a terminal and execute the following command:

```
$ echo $PATH
```

After you install the CLI, it is available using the **oc** command:

```
$ oc <command>
```

To learn more, see [Getting started with the CLI](#).

CHAPTER 3. LOGGING IN TO THE CLUSTER

You can log in to your cluster as a default system user by exporting the cluster **kubeconfig** file. The **kubeconfig** file contains information about the cluster that is used by the CLI to connect a client to the correct cluster and API server. The file is specific to a cluster and is created during OpenShift Container Platform installation.

Prerequisites

- Deploy an OpenShift Container Platform cluster.
- Install the **oc** CLI.

Procedure

1. Export the **kubeadmin** credentials:

```
$ export KUBECONFIG=<installation_directory>/auth/kubeconfig 1
```

- 1** For **<installation_directory>**, specify the path to the directory that you stored the installation files in.

2. Verify you can run **oc** commands successfully using the exported configuration:

```
$ oc whoami
```

Example output

```
system:admin
```

3.1. VERIFYING CLUSTER STATUS

You can verify your OpenShift Container Platform cluster's status during or after installation.

Procedure

1. In the cluster environment, export the administrator's kubeconfig file:

```
$ export KUBECONFIG=<installation_directory>/auth/kubeconfig 1
```

- 1** For **<installation_directory>**, specify the path to the directory that you stored the installation files in.

The **kubeconfig** file contains information about the cluster that is used by the CLI to connect a client to the correct cluster and API server.

2. View the control plane and compute machines created after a deployment:

```
$ oc get nodes
```

3. View your cluster's version:

```
$ oc get clusterversion
```

4. View your operators' status:

```
$ oc get clusteroperator
```

5. View all running Pods in the cluster:

```
$ oc get pods -A
```

Troubleshooting

If the installation fails, the installation program times out and displays an error message. To learn more, see [Troubleshooting installation issues](#).

3.2. ACCESSING THE OPENSIFT CONTAINER PLATFORM WEB CONSOLE ON RHV

After the OpenShift Container Platform cluster initializes, you can log into the OpenShift Container Platform web console.

Procedure

1. Optional: In the Red Hat Virtualization (RHV) Administration Portal, open **Compute → Cluster**.
2. Verify that the installation program creates the virtual machines.
3. Return to the command line where the installation program is running. When the installation program finishes, it displays the user name and temporary password for logging into the OpenShift Container Platform web console.
4. In a browser, open the URL of the OpenShift Container Platform web console. The URL uses this format:

```
console-openshift-console.apps.<clustername>.<basedomain> 1
```

- 1** For **<clustername>.<basedomain>**, specify the cluster name and base domain.

For example:

```
console-openshift-console.apps.my-cluster.virtlab.example.com
```

3.3. TROUBLESHOOTING COMMON ISSUES WITH INSTALLING ON RED HAT VIRTUALIZATION (RHV)

Here are some common issues you might encounter, along with proposed causes and solutions.

3.3.1. CPU load increases and nodes go into a Not Ready state

- **Symptom:** CPU load increases significantly and nodes start going into a Not Ready state.

- **Cause:** The storage domain latency might be too high, especially for master nodes.
- **Solution:**
Make the nodes Ready again by restarting the kubelet service. Enter:

```
$ systemctl restart kubelet
```

Inspect the OpenShift Container Platform metrics service, which automatically gathers and reports on some valuable data such as the etcd disk sync duration. If the cluster is operational, use this data to help determine whether storage latency or throughput is the root issue. If so, consider using a storage resource that has lower latency and higher throughput.

To get raw metrics, enter the following command as kubeadmin or user with cluster-admin privileges:

```
$ oc get --insecure-skip-tls-verify --server=https://localhost:<port> --raw=/metrics`
```

To learn more, see [Exploring Application Endpoints for the purposes of Debugging with OpenShift 4.x](#)

3.3.2. Trouble connecting the OpenShift Container Platform cluster API

- **Symptom:** The installation program completes but the OpenShift Container Platform cluster API is not available. The bootstrap virtual machine remains up after the bootstrap process is complete. When you enter the following command, the response will time out.

```
$ oc login -u kubeadmin -p *** <apiurl>
```

- **Cause:** The bootstrap VM was not deleted by the installation program and has not released the cluster's API IP address.
- **Solution:** Use the **wait-for** subcommand to be notified when the bootstrap process is complete:

```
$ ./openshift-install wait-for bootstrap-complete
```

When the bootstrap process is complete, delete the bootstrap virtual machine:

```
$ ./openshift-install destroy bootstrap
```

3.4. POST-INSTALLATION TASKS

After the OpenShift Container Platform cluster initializes, you can perform the following tasks.

- Optional: After deployment, add or replace SSH keys using the Machine Config Operator (MCO) in OpenShift Container Platform.
- Optional: Remove the **kubeadmin** user. Instead, use the authentication provider to create a user with cluster-admin privileges.

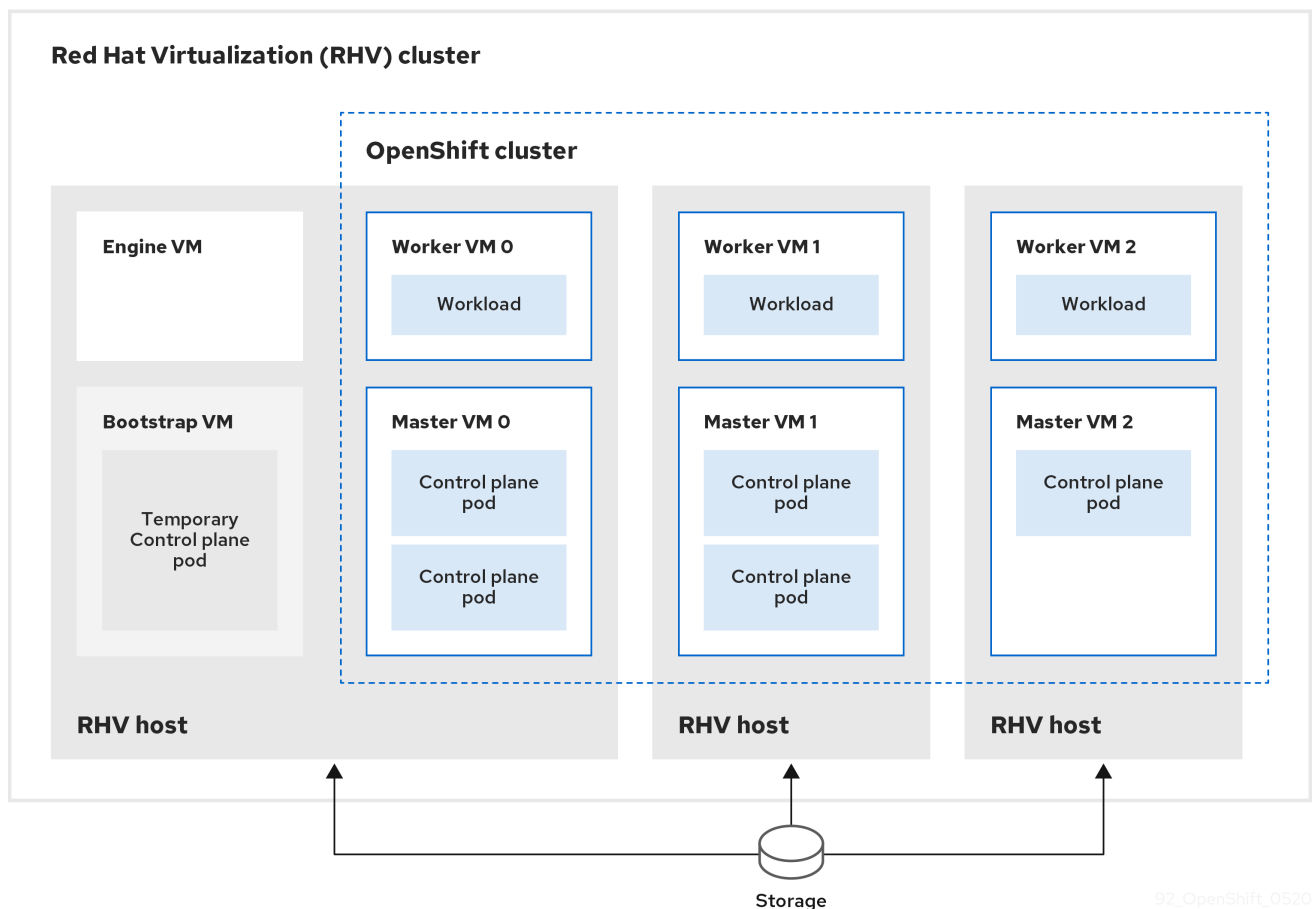
3.5. INSTALLING A CLUSTER ON RHV WITH CUSTOMIZATIONS



WARNING

Due to a known issue with installing OpenShift Container Platform versions 4.4 and 4.5 on Red Hat Virtualization (RHV) 4.4.1, you must customize **install-config.yaml** as described in [OpenShift IPI installation on RHV-4.x failed with "Error: timeout while waiting for state to become 'up' \(last state: 'down', timeout: 10m0s\)"](#). This defect is fixed in RHV 4.4.2.

You can customize and install an OpenShift Container Platform cluster on Red Hat Virtualization (RHV), similar to the one shown in the following diagram.



The installation program uses installer-provisioned infrastructure to automate creating and deploying the cluster.

To install a customized cluster, you prepare the environment and perform the following steps:

1. Create an installation configuration file, the **install-config.yaml** file, by running the installation program and answering its prompts.
2. Inspect and modify parameters in the **install-config.yaml** file.
3. Make a working copy of the **install-config.yaml** file.
4. Run the installation program with a copy of the **install-config.yaml** file.

Then, the installation program creates the OpenShift Container Platform cluster.

For an alternative to installing a customized cluster, see [Installing a default cluster](#).



NOTE

This installation program is available for Linux and macOS only.

3.5.1. Prerequisites

- Review details about the [OpenShift Container Platform installation and update](#) processes.
- If you use a firewall, [configure it to allow the sites](#) that your cluster requires access to.

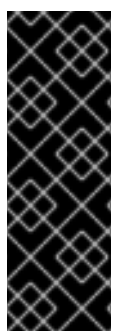
3.5.2. Internet and Telemetry access for OpenShift Container Platform

In OpenShift Container Platform 4.5, you require access to the internet to install your cluster. The Telemetry service, which runs by default to provide metrics about cluster health and the success of updates, also requires internet access. If your cluster is connected to the internet, Telemetry runs automatically, and your cluster is registered to the [Red Hat OpenShift Cluster Manager \(OCM\)](#).

Once you confirm that your Red Hat OpenShift Cluster Manager inventory is correct, either maintained automatically by Telemetry or manually using OCM, [use subscription watch](#) to track your OpenShift Container Platform subscriptions at the account or multi-cluster level.

You must have internet access to:

- Access the [Red Hat OpenShift Cluster Manager](#) page to download the installation program and perform subscription management. If the cluster has internet access and you do not disable Telemetry, that service automatically entitles your cluster.
- Access [Quay.io](#) to obtain the packages that are required to install your cluster.
- Obtain the packages that are required to perform cluster updates.



IMPORTANT

If your cluster cannot have direct internet access, you can perform a restricted network installation on some types of infrastructure that you provision. During that process, you download the content that is required and use it to populate a mirror registry with the packages that you need to install a cluster and generate the installation program. With some installation types, the environment that you install your cluster in will not require internet access. Before you update the cluster, you update the content of the mirror registry.

3.5.3. Requirements for the RHV environment

To install and run an OpenShift Container Platform cluster, the RHV environment must meet the following requirements. Not meeting these requirements can cause failures.

The following requirements for CPUs, memory, and storage are based on *default* values multiplied by the default number of virtual machines the installation program creates.

By default, the installation program creates seven machines during the installation process, which includes one bootstrap machine. When the installation program finishes, it deletes the bootstrap

machine and frees up its resources. If you perform a custom installation, you can increase the number of virtual machines the installation program creates.



IMPORTANT

If you increase the number of virtual machines or resources in the `install_config.yaml` file, you must also increase these requirements.

Requirements

- The RHV version is 4.3.10 or later.
- The RHV environment has one data center whose state is **Up**.
- The RHV data center contains an RHV cluster.
- The RHV cluster has the following resources exclusively for the OpenShift Container Platform cluster:
 - Minimum 28 vCPUs, which is 4 vCPUs for each of the seven virtual machines created during installation.
 - 112 GiB RAM or more, including:
 - 16 GiB or more for the bootstrap machine, which provides the temporary control plane.
 - 16 GiB or more for each of the three control plane machines which provide the control plane.
 - 16 GiB or more for each of the three compute machines, which run the application workloads.
- The RHV storage domain must meet [these etcd backend performance requirements](#).
- In production environments, each virtual machine must have 120 GiB or more, so the storage domain must have 840 GiB or more for the OpenShift Container Platform cluster. In resource-constrained or non-production environments, each virtual machine must have 32 GiB or more, so the storage domain must have 230 GiB or more for the OpenShift Container Platform cluster.
- The RHV cluster must have access to an Internet connection to download images from the Red Hat Ecosystem Catalog during installation and updates, and for the Telemetry service to simplify the subscription and entitlement process.
- The RHV cluster has a virtual network with access to the REST API on the RHV Manager.



NOTE

- All together, the hosts must have the required memory and CPU resources **in addition to and aside from** what they use to operate or provide to non-OpenShift Container Platform operations.
- The release cycles of OpenShift Container Platform and RHV are different and versions tested might vary in the future depending on the release dates of both products.
- The bootstrap machine provides a temporary control plane while the installation program creates the OpenShift Container Platform cluster. After it creates the cluster, the installation program removes the bootstrap machine and releases its resources.

3.5.4. Verifying the requirements for the RHV environment

Verify that the RHV environment meets the requirements to install and run an OpenShift Container Platform cluster. Not meeting these requirements can cause failures.



IMPORTANT

These requirements are based on the default resources the installation program uses to create control plane and compute machines. These resources include vCPUs, memory, and storage. If you change these resources or increase the number of OpenShift Container Platform machines, adjust these requirements accordingly.

Procedure

1. Check the RHV version.
 - a. In the RHV Administration Portal, click the ? help icon in the upper-right corner and select **About**.
 - b. In the window that opens, confirm that the **RHV Software Version** is **4.3.10** or higher.
2. Inspect the data center, cluster, and storage.
 - a. In the RHV Administration Portal, click **Compute → Data Centers**.
 - b. Confirm the data center where you plan to install OpenShift Container Platform displays a green up arrow, meaning it is "Up".
 - c. Click the name of that data center.
 - d. In the data center details, on the **Storage** tab, confirm the storage domain where you plan to install OpenShift Container Platform is **Active**.
 - e. Record the **Domain Name** for use later on.
 - f. Confirm **Free Space** has at least 230 GiB.
 - g. Confirm that the storage domain meets [these etcd backend performance requirements](#), which can be [measured using the fio performance benchmarking tool](#).
 - h. In the data center details, click the **Clusters** tab.

- i. Find the RHV cluster where you plan to install OpenShift Container Platform. Record the cluster name for use later on.
3. Inspect the RHV host resources.
 - a. In the RHV Administration Portal, click **Compute > Clusters**.
 - b. Click the cluster where you plan to install OpenShift Container Platform.
 - c. In the cluster details, click the **Hosts** tab.
 - d. Inspect the hosts and confirm they have a combined total of at least 28 **Logical CPU Cores** available *exclusively* for the OpenShift Container Platform cluster.
 - e. Record the number of available **Logical CPU Cores** for use later on.
 - f. Confirm that these CPU cores are distributed so each of the seven virtual machines created during installation can have four cores.
 - g. Confirm that, all together, the hosts have 112 GiB of **Max free Memory for scheduling new VMs** distributed to meet the requirements for each of the following OpenShift Container Platform machines:
 - 16 GiB required for the bootstrap machine
 - 16 GiB required for each of the three control plane machines
 - 16 GiB for each of the three compute machines
 - h. Record the amount of **Max free Memory for scheduling new VMs** for use later on.
 4. Verify that the virtual network for installing OpenShift Container Platform has access to the RHV Manager's REST API. From a virtual machine on this network, use a curl command with the RHV Manager's REST API. Use the following format:

```
$ curl -k -u <username>@<profile>:<password> \ 1
https://<engine-fqdn>/ovirt-engine/api 2
```

1 For **<username>**, specify the user name of an RHV administrator. For **<profile>**, specify the login profile, which you can get by going to the RHV Administration Portal login page and reviewing the **Profile** dropdown list. For **<password>**, specify the admin password.

2 For **<engine-fqdn>**, specify the fully qualified domain name of the RHV environment.

For example:

```
$ curl -k -u rhvadmin@internal:pw123 \
https://rhv-env.virtlab.example.com/ovirt-engine/api
```

3.5.5. Preparing the network environment on RHV

Configure three static IP addresses for the OpenShift Container Platform cluster and create DNS entries using two of these addresses.

Procedure

1. Reserve three static IP addresses
 - a. On the network where you plan to install OpenShift Container Platform, identify three static IP addresses that are outside the DHCP lease pool.
 - b. Connect to a host on this network and verify that each of the IP addresses is not in use. For example, use `arp` to check that none of the IP addresses have entries:

```
$ arp 10.35.1.19
```

Example output

```
10.35.1.19 (10.35.1.19) -- no entry
```

- c. Reserve three static IP addresses following the standard practices for your network environment.
 - d. Record these IP addresses for future reference.
2. Create DNS entries for the OpenShift Container Platform REST API and apps domain names using this format:

```
api.<cluster-name>.<base-domain> <ip-address> 1
*.apps.<cluster-name>.<base-domain> <ip-address> 2
```

- 1 For **<cluster-name>**, **<base-domain>**, and **<ip-address>**, specify the cluster name, base domain, and static IP address of your OpenShift Container Platform API.
- 2 Specify the cluster name, base domain, and static IP address of your OpenShift Container Platform apps (ingress/load balancer).

For example:

```
api.my-cluster.virtlab.example.com 10.35.1.19
*.apps.my-cluster.virtlab.example.com 10.35.1.20
```



NOTE

The third static IP address does not require a DNS entry. The OpenShift Container Platform cluster uses that address for its internal DNS service.

3.5.6. Setting up the CA certificate for RHV

Download the CA certificate from the Red Hat Virtualization (RHV) Manager and set it up on the installation machine.

You can download the certificate from a webpage on the RHV Manager or by using a **curl** command.

Later, you provide the certificate to the installation program.

Procedure

1. Use either of these two methods to download the CA certificate:

- Go to the Manager's webpage, <https://<engine-fqdn>/ovirt-engine/>. Then, under **Downloads**, click the **CA Certificate** link.
- Run the following command:

```
$ curl -k 'https://<engine-fqdn>/ovirt-engine/services/pki-resource?resource=ca-certificate&format=X509-PEM-CA' -o /tmp/ca.pem 1
```

- 1 For **<engine-fqdn>**, specify the fully qualified domain name of the RHV Manager, such as **rhv-env.virtlab.example.com**.

2. Configure the CA file to grant rootless user access to the Manager. Set the CA file permissions to have an octal value of **0644** (symbolic value: **-rw-r--r--**):

```
$ sudo chmod 0644 /tmp/ca.pem
```

3. For Linux, copy the CA certificate to the directory for server certificates. Use **-p** to preserve the permissions:

```
$ sudo cp -p /tmp/ca.pem /etc/pki/ca-trust/source/anchors/ca.pem
```

4. Add the certificate to the certificate manager for your operating system:

- For macOS, double-click the certificate file and use the **Keychain Access** utility to add the file to the **System** keychain.
- For Linux, update the CA trust:

```
$ sudo update-ca-trust
```



NOTE

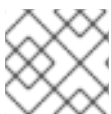
If you use your own certificate authority, make sure the system trusts it.

Additional Resources

To learn more, see [Authentication and Security](#) in the RHV documentation.

3.5.7. Generating an SSH private key and adding it to the agent

If you want to perform installation debugging or disaster recovery on your cluster, you must provide an SSH key to both your **ssh-agent** and to the installation program.



NOTE

In a production environment, you require disaster recovery and debugging.

You can use this key to SSH into the master nodes as the user **core**. When you deploy the cluster, the key is added to the **core** user's `~/.ssh/authorized_keys` list.

Procedure

1. If you do not have an SSH key that is configured for password-less authentication on your computer, create one. For example, on a computer that uses a Linux operating system, run the following command:

```
$ ssh-keygen -t rsa -b 4096 -N "" \
-f <path>/<file_name> 1
```

- 1 Specify the path and file name, such as `~/.ssh/id_rsa`, of the SSH key. Do not specify an existing SSH key, as it will be overwritten.

Running this command generates an SSH key that does not require a password in the location that you specified.

2. Start the **ssh-agent** process as a background task:

```
$ eval "$(ssh-agent -s)"
```

Example output

```
Agent pid 31874
```

3. Add your SSH private key to the **ssh-agent**:

```
$ ssh-add <path>/<file_name> 1
```

Example output

```
Identity added: /home/<you>/<path>/<file_name> (<computer_name>)
```

- 1 Specify the path and file name for your SSH private key, such as `~/.ssh/id_rsa`

Next steps

- When you install OpenShift Container Platform, provide the SSH public key to the installation program.

3.5.8. Obtaining the installation program

Before you install OpenShift Container Platform, download the installation file on a local computer.

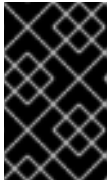
Prerequisites

- You must install the cluster from a computer that uses Linux or macOS.
- You need 500 MB of local disk space to download the installation program.

Procedure

1. Access the [Infrastructure Provider](#) page on the Red Hat OpenShift Cluster Manager site. If you have a Red Hat account, log in with your credentials. If you do not, create an account.

2. Navigate to the page for your installation type, download the installation program for your operating system, and place the file in the directory where you will store the installation configuration files.



IMPORTANT

The installation program creates several files on the computer that you use to install your cluster. You must keep both the installation program and the files that the installation program creates after you finish installing the cluster.



IMPORTANT

Deleting the files created by the installation program does not remove your cluster, even if the cluster failed during installation. You must complete the OpenShift Container Platform uninstallation procedures outlined for your specific cloud provider to remove your cluster entirely.

3. Extract the installation program. For example, on a computer that uses a Linux operating system, run the following command:

```
$ tar xvf <installation_program>.tar.gz
```

4. From the [Pull Secret](#) page on the Red Hat OpenShift Cluster Manager site, download your installation pull secret as a **.txt** file. This pull secret allows you to authenticate with the services that are provided by the included authorities, including Quay.io, which serves the container images for OpenShift Container Platform components.

3.5.9. Creating the installation configuration file

You can customize the OpenShift Container Platform cluster you install on Red Hat Virtualization (RHV).



WARNING

Due to a known issue with installing OpenShift Container Platform versions 4.4 and 4.5 on Red Hat Virtualization (RHV) 4.4.1, you must customize **install-config.yaml** as described in [Openshift IPI installation on RHV-4.x failed with "Error: timeout while waiting for state to become 'up' \(last state: 'down', timeout: 10m0s\)"](#). This defect is fixed in RHV 4.4.2.

Prerequisites

- Download the OpenShift Container Platform installation program and the pull secret for your cluster.

Procedure

1. Create the **install-config.yaml** file.

- a. Run the following command:

```
$. /openshift-install create install-config --dir=<installation_directory> 1
```

- 1 For **<installation_directory>**, specify the directory name to store the files that the installation program creates.



IMPORTANT

Specify an empty directory. Some installation assets, like bootstrap X.509 certificates have short expiration intervals, so you must not reuse an installation directory. If you want to reuse individual files from another cluster installation, you can copy them into your directory. However, the file names for the installation assets might change between releases. Use caution when copying installation files from an earlier OpenShift Container Platform version.

- b. Respond to the installation program prompts.

- i. For **SSH Public Key**, select a password-less public key, such as `~/.ssh/id_rsa.pub`. This key authenticates connections with the new OpenShift Container Platform cluster.



NOTE

For production OpenShift Container Platform clusters on which you want to perform installation debugging or disaster recovery, select an SSH key that your **ssh-agent** process uses.

- ii. For **Platform**, select **ovirt**.
- iii. For **Enter oVirt's API endpoint URL**, enter the URL of the RHV API using this format:

```
https://<engine-fqdn>/ovirt-engine/api 1
```

- 1 For **<engine-fqdn>**, specify the fully qualified domain name of the RHV environment.

For example:

```
https://rhv-env.virtlab.example.com/ovirt-engine/api
```

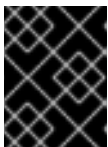
- iv. For **Is the oVirt CA trusted locally?**, enter **Yes** since you have already set up a CA certificate. Otherwise, enter **No**.
- v. For **oVirt's CA bundle**, if you entered **Yes** for the preceding question, copy the certificate content from `/etc/pki/ca-trust/source/anchors/ca.pem` and paste it here. Then, press **Enter** twice. Otherwise, if you entered **No** for the preceding question, this question does not appear.
- vi. For **oVirt engine username**, enter the user name and profile of the RHV administrator using this format:

`<username>@<profile>` **1**

- 1** For **<username>**, specify the user name of an RHV administrator. For **<profile>**, specify the login profile, which you can get by going to the RHV Administration Portal login page and reviewing the **Profile** dropdown list. Together, the user name and profile should look similar to this example:

`admin@internal`

- vii. For **oVirt engine password**, enter the RHV admin password.
 - viii. For **oVirt cluster**, select the cluster for installing OpenShift Container Platform.
 - ix. For **oVirt storage domain**, select the storage domain for installing OpenShift Container Platform.
 - x. For **oVirt network**, select a virtual network that has access to the RHV Manager REST API.
 - xi. For **Internal API Virtual IP**, enter the static IP address you set aside for the cluster's REST API.
 - xii. For **Internal DNS Virtual IP**, enter the static IP address you set aside for the cluster's internal DNS service.
 - xiii. For **Ingress virtual IP**, enter the static IP address you reserved for the wildcard apps domain.
 - xiv. For **Base Domain**, enter the base domain of the OpenShift Container Platform cluster. If this cluster is exposed to the outside world, this must be a valid domain recognized by DNS infrastructure. For example, enter: **virtlab.example.com**
 - xv. For **Cluster Name**, enter the name of the cluster. For example, **my-cluster**. Use cluster name from the externally registered/resolvable DNS entries you created for the OpenShift Container Platform REST API and apps domain names. The installation program also gives this name to the cluster in the RHV environment.
 - xvi. For **Pull Secret**, copy the pull secret from the **pull-secret.txt** file you downloaded earlier and paste it here. You can also get a copy of the same pull secret from the [Pull Secret](#) page on the Red Hat OpenShift Cluster Manager site.
2. Modify the **install-config.yaml** file. You can find more information about the available parameters in the **Installation configuration parameters** section.
 3. Back up the **install-config.yaml** file so that you can use it to install multiple clusters.



IMPORTANT

The **install-config.yaml** file is consumed during the installation process. If you want to reuse the file, you must back it up now.

3.5.9.1. Example install-config.yaml files for Red Hat Virtualization (RHV)

You can customize the OpenShift Container Platform cluster the installation program creates by changing the parameters and parameter values in the **install-config.yaml** file.

The following example is specific to installing OpenShift Container Platform on RHV.

This file is located in the **<installation_directory>** you specified when you ran the following command.

```
$ ./openshift-install create install-config --dir=<installation_directory>
```



NOTE

- These example files are provided for reference only. You must obtain your **install-config.yaml** file by using the installation program.
- Changing the **install-config.yaml** file can increase the resources your cluster requires. Verify that your RHV environment has those additional resources. Otherwise, the installation or cluster will fail.

Example: This is the default **install-config.yaml** file

```
apiVersion: v1
baseDomain: example.com
compute:
- architecture: amd64
  hyperthreading: Enabled
  name: worker
  platform: {}
  replicas: 3
controlPlane:
  architecture: amd64
  hyperthreading: Enabled
  name: master
  platform: {}
  replicas: 3
metadata:
  creationTimestamp: null
  name: my-cluster
networking:
  clusterNetwork:
  - cidr: 10.128.0.0/14
    hostPrefix: 23
  machineNetwork:
  - cidr: 10.0.0.0/16
  networkType: OpenShiftSDN
  serviceNetwork:
  - 172.30.0.0/16
platform:
  ovirt:
    api_vip: 10.46.8.230
    ingress_vip: 192.168.1.5
    ovirt_cluster_id: 68833f9f-e89c-4891-b768-e2ba0815b76b
    ovirt_storage_domain_id: ed7b0f4e-0e96-492a-8fff-279213ee1468
    ovirt_network_name: ovirtmgmt
    vnicProfileID: 3fa86930-0be5-4052-b667-b79f0a729692
```

```
publish: External
pullSecret: '{"auths": ...}'
sshKey: ssh-ed12345 AAAA...
```

Example: A minimal install-config.yaml file

```
apiVersion: v1
baseDomain: example.com
metadata:
  name: test-cluster
platform:
  ovirt:
    api_vip: 10.46.8.230
    ingress_vip: 10.46.8.232
    ovirt_cluster_id: 68833f9f-e89c-4891-b768-e2ba0815b76b
    ovirt_storage_domain_id: ed7b0f4e-0e96-492a-8fff-279213ee1468
    ovirt_network_name: ovirtmgmt
    vnicProfileID: 3fa86930-0be5-4052-b667-b79f0a729692
pullSecret: '{"auths": ...}'
sshKey: ssh-ed12345 AAAA...
```

Example: Custom machine pools in an install-config.yaml file

```
apiVersion: v1
baseDomain: example.com
controlPlane:
  name: master
platform:
  ovirt:
    cpu:
      cores: 4
      sockets: 2
    memoryMB: 65536
    osDisk:
      sizeGB: 100
    vmType: high_performance
  replicas: 3
compute:
- name: worker
  platform:
    ovirt:
      cpu:
        cores: 4
        sockets: 4
      memoryMB: 65536
      osDisk:
        sizeGB: 200
      vmType: high_performance
    replicas: 5
metadata:
  name: test-cluster
platform:
  ovirt:
    api_vip: 10.46.8.230
    ingress_vip: 10.46.8.232
```

```
ovirt_cluster_id: 68833f9f-e89c-4891-b768-e2ba0815b76b
ovirt_storage_domain_id: ed7b0f4e-0e96-492a-8fff-279213ee1468
ovirt_network_name: ovirtmgmt
vnicProfileID: 3fa86930-0be5-4052-b667-b79f0a729692
pullSecret: '{"auths": ...}'
sshKey: ssh-ed25519 AAAA...
```

3.5.9.2. Installation configuration parameters

Before you deploy an OpenShift Container Platform cluster, you provide parameter values to describe your account on the cloud platform that hosts your cluster and optionally customize your cluster's platform. When you create the **install-config.yaml** installation configuration file, you provide values for the required parameters through the command line. If you customize your cluster, you can modify the **install-config.yaml** file to provide more details about the platform.



NOTE

After installation, you cannot modify these parameters in the **install-config.yaml** file.


Table 3.1. Required parameters


Parameter	Description	Values
apiVersion	The API version for the install-config.yaml content. The current version is v1 . The installer may also support older API versions.	String
baseDomain	The base domain of your cloud provider. The base domain is used to create routes to your OpenShift Container Platform cluster components. The full DNS name for your cluster is a combination of the baseDomain and metadata.name parameter values that uses the <metadata.name>. <baseDomain> format.	A fully-qualified domain or subdomain name, such as example.com .
metadata	Kubernetes resource ObjectMeta, from which only the name parameter is consumed.	Object
metadata.name	The name of the cluster. DNS records for the cluster are all subdomains of {{.metadata.name}} . {{.baseDomain}} .	String of lowercase letters, hyphens (-), and periods (.), such as dev .

Parameter	Description	Values
platform	The configuration for the specific platform upon which to perform the installation: aws, baremetal, azure, openstack, ovirt, vsphere . For additional information about platform.<platform> parameters, consult the following table for your specific platform.	Object
pullSecret	Get this pull secret from https://cloud.redhat.com/openshift/install/pull-secret to authenticate downloading container images for OpenShift Container Platform components from services such as Quay.io.	<pre>{ "auths":{ "cloud.openshift.com":{ "auth":"b3Blb=", "email":"you@example.com" }, "quay.io":{ "auth":"b3Blb=", "email":"you@example.com" } } }</pre>

Table 3.2. Optional parameters

Parameter	Description	Values
additionalTrustBundle	A PEM-encoded X.509 certificate bundle that is added to the nodes' trusted certificate store. This trust bundle may also be used when a proxy has been configured.	String
compute	The configuration for the machines that comprise the compute nodes.	Array of machine-pool objects. For details, see the following "Machine-pool" table.

Parameter	Description	Values
compute.architecture	Determines the instruction set architecture of the machines in the pool. Currently, heterogeneous clusters are not supported, so all pools must specify the same architecture. Valid values are amd64 (the default).	String
compute.hyperthreading	Whether to enable or disable simultaneous multithreading, or hyperthreading , on compute machines. By default, simultaneous multithreading is enabled to increase the performance of your machines' cores.  IMPORTANT If you disable simultaneous multithreading, ensure that your capacity planning accounts for the dramatically decreased machine performance.	Enabled or Disabled
compute.name	Required if you use compute . The name of the machine pool.	worker
compute.platform	Required if you use compute . Use this parameter to specify the cloud provider to host the worker machines. This parameter value must match the controlPlane.platform parameter value.	aws, azure, gcp, openstack, ovirt, vsphere , or {}
compute.replicas	The number of compute machines, which are also known as worker machines, to provision.	A positive integer greater than or equal to 2 . The default value is 3 .
controlPlane	The configuration for the machines that comprise the control plane.	Array of machine-pool objects. For details, see the following "Machine-pool" table.
controlPlane.architecture	Determines the instruction set architecture of the machines in the pool. Currently, heterogeneous clusters are not supported, so all pools must specify the same architecture. Valid values are amd64 (the default).	String

Parameter	Description	Values
controlPlane.hypertreading	<p>Whether to enable or disable simultaneous multithreading, or hyperthreading, on control plane machines. By default, simultaneous multithreading is enabled to increase the performance of your machines' cores.</p> <div style="display: flex; align-items: center;">  <div> <p>IMPORTANT</p> <p>If you disable simultaneous multithreading, ensure that your capacity planning accounts for the dramatically decreased machine performance.</p> </div> </div>	Enabled or Disabled
controlPlane.name	Required if you use controlPlane . The name of the machine pool.	master
controlPlane.platform	Required if you use controlPlane . Use this parameter to specify the cloud provider that hosts the control plane machines. This parameter value must match the compute.platform parameter value.	aws, azure, gcp, openstack, ovirt, vsphere , or {}
controlPlane.replicas	The number of control plane machines to provision.	A positive integer greater than or equal to 3 . The default value is 3 .
fips	Enable or disable FIPS mode. The default is false (disabled). If FIPS mode is enabled, the Red Hat Enterprise Linux CoreOS (RHCOS) machines that OpenShift Container Platform runs on bypass the default Kubernetes cryptography suite and use the cryptography modules that are provided with RHCOS instead.	false or true
imageContentSources	Sources and repositories for the release-image content.	Array of objects. Includes a source and, optionally, mirrors , as described in the following rows of this table.

Parameter	Description	Values
imageContentSources.source	Required if you use imageContentSources . Specify the repository that users refer to, for example, in image pull specifications.	String
imageContentSources.mirrors	Specify one or more repositories that may also contain the same images.	Array of strings
networking	The configuration for the Pod network provider in the cluster.	Object
networking.clusterNetwork	The IP address pools for Pods. The default is 10.128.0.0/14 with a host prefix of /23 .	Array of objects
networking.clusterNetwork.cidr	Required if you use networking.clusterNetwork . The IP block address pool.	IP network. IP networks are represented as strings using Classless Inter-Domain Routing (CIDR) notation with a traditional IP address or network number, followed by the "/" (slash) character, followed by a decimal value between 0 and 32 that describes the number of significant bits. For example, 10.0.0.0/16 represents IP addresses 10.0.0.0 through 10.0.255.255 .
networking.clusterNetwork.hostPrefix	Required if you use networking.clusterNetwork . The prefix size to allocate to each node from the CIDR. For example, 24 would allocate $2^8=256$ addresses to each node.	Integer
networking.machineNetwork	The IP address pools for machines.	Array of objects
networking.machineNetwork.cidr	Required if you use networking.machineNetwork . The IP block address pool. The default is 10.0.0.0/16 for all platforms other than libvirt. For libvirt, the default is 192.168.126.0/24 .	IP network. IP networks are represented as strings using Classless Inter-Domain Routing (CIDR) notation with a traditional IP address or network number, followed by the "/" (slash) character, followed by a decimal value between 0 and 32 that describes the number of significant bits. For example, 10.0.0.0/16 represents IP addresses 10.0.0.0 through 10.0.255.255 .


Parameter	Description	Values
networking.network Type	The type of network to install. The default is OpenShiftSDN .	String
networking.serviceNetwork	The IP address pools for services. The default is 172.30.0.0/16.	Array of IP networks. IP networks are represented as strings using Classless Inter-Domain Routing (CIDR) notation with a traditional IP address or network number, followed by the "/" (slash) character, followed by a decimal value between 0 and 32 that describes the number of significant bits. For example, 10.0.0.0/16 represents IP addresses 10.0.0.0 through 10.0.255.255 .
publish	How to publish or expose the user-facing endpoints of your cluster, such as the Kubernetes API, OpenShift routes.	Internal or External . To deploy a private cluster, which cannot be accessed from the internet, set publish to Internal . The default value is External .
sshKey	<p>The SSH key or keys to authenticate access your cluster machines.</p>  <p>NOTE</p> <p>For production OpenShift Container Platform clusters on which you want to perform installation debugging or disaster recovery, specify an SSH key that your ssh-agent process uses.</p>	<p>One or more keys. For example:</p> <pre>sshKey: key1... key2... key3...</pre>

Table 3.3. Additional Red Hat Virtualization (RHV) parameters for clusters

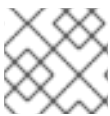
Parameter	Description	Values
platform.ovirt.ovirt_cluster_id	Required. The Cluster where the VMs will be created.	String. For example: 68833f9f-e89c-4891-b768-e2ba0815b76b
platform.ovirt.ovirt_storage_domain_id	Required. The Storage Domain ID where the VM disks will be created.	String. For example: ed7b0f4e-0e96-492a-8fff-279213ee1468

Parameter	Description	Values
platform.ovirt.ovirt_network_name	Required. The network name where the VM nics will be created.	String. For example: ocpcluster
platform.ovirt.vnicProfileID	Required. The vNIC profile ID of the VM network interfaces. This can be inferred if the cluster network has a single profile.	String. For example: 3fa86930-0be5-4052-b667-b79f0a729692
platform.ovirt.api_vip	Required. An IP address on the machineNetwork that will be assigned to the API virtual IP (VIP). You can access the OpenShift API at this endpoint.	String. Example: 10.46.8.230
platform.ovirt.ingress_vip	Required. An IP address on the machineNetwork that will be assigned to the Ingress virtual IP (VIP).	String. Example: 10.46.8.232

Table 3.4. Additional RHV parameters for machine pools

Parameter	Description	Values
<machine-pool>.platform.ovirt.cpu	Optional. Defines the CPU of the VM.	Object
<machine-pool>.platform.ovirt.cpu.cores	Required if you use <machine-pool>.platform.ovirt.cpu . The number of cores. Total virtual CPUs (vCPUs) is cores * sockets.	Integer
<machine-pool>.platform.ovirt.cpu.sockets	Required if you use <machine-pool>.platform.ovirt.cpu . The number of sockets per core. Total virtual CPUs (vCPUs) is cores * sockets.	Integer
<machine-pool>.platform.ovirt.memoryMB	Optional. Memory of the VM in MiB.	Integer

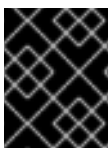
Parameter	Description	Values
<machine-pool>.platform.ovirt.instanceTypeID	Optional. An instance type UUID, such as 00000009-0009-0009-0009-0000000000f1 , which you can get from the <a href="https://<engine-fqdn>/ovirt-engine/api/instancetype">https://<engine-fqdn>/ovirt-engine/api/instancetype endpoint.	String of UUID
<machine-pool>.platform.ovirt.osDisk	Optional. Defines the first and bootable disk of the VM.	String
<machine-pool>.platform.ovirt.osDisk.sizeGB	Required if you use <machine-pool>.platform.ovirt.osDisk . Size of the disk in GiB.	Number
<machine-pool>.platform.ovirt.vmType	Optional. The VM workload type, such as high-performance, server , or desktop .	String

**NOTE**

You can replace **<machine-pool>** with **controlPlane** or **compute**.

3.5.10. Deploying the cluster

You can install OpenShift Container Platform on a compatible cloud platform.

**IMPORTANT**

You can run the **create cluster** command of the installation program only once, during initial installation.

Prerequisites

- Obtain the OpenShift Container Platform installation program and the pull secret for your cluster.

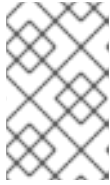
Procedure

1. Run the installation program:

```
$ ./openshift-install create cluster --dir=<installation_directory> \ 1
--log-level=info 2
```

- 1** For **<installation_directory>**, specify the location of your customized **./install-config.yaml** file.

- 2 To view different installation details, specify **warn**, **debug**, or **error** instead of **info**.



NOTE

If the cloud provider account that you configured on your host does not have sufficient permissions to deploy the cluster, the installation process stops, and the missing permissions are displayed.

When the cluster deployment completes, directions for accessing your cluster, including a link to its web console and credentials for the **kubeadmin** user, display in your terminal.



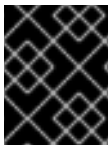
IMPORTANT

The Ignition config files that the installation program generates contain certificates that expire after 24 hours. You must keep the cluster running for 24 hours in a non-degraded state to ensure that the first certificate rotation has finished.



IMPORTANT

You must not delete the installation program or the files that the installation program creates. Both are required to delete the cluster.

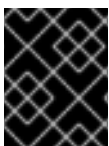


IMPORTANT

You have completed the steps required to install the cluster. The remaining steps show you how to verify the cluster and troubleshoot the installation.

3.5.11. Installing the CLI by downloading the binary

You can install the OpenShift CLI (**oc**) in order to interact with OpenShift Container Platform from a command-line interface. You can install **oc** on Linux, Windows, or macOS.



IMPORTANT

If you installed an earlier version of **oc**, you cannot use it to complete all of the commands in OpenShift Container Platform 4.5. Download and install the new version of **oc**.

3.5.11.1. Installing the CLI on Linux

You can install the OpenShift CLI (**oc**) binary on Linux by using the following procedure.

Procedure

1. Navigate to the [Infrastructure Provider](#) page on the Red Hat OpenShift Cluster Manager site.
2. Select your infrastructure provider, and, if applicable, your installation type.
3. In the **Command-line interface** section, select **Linux** from the drop-down menu and click **Download command-line tools**.
4. Unpack the archive:

-

```
$ tar xvzf <file>
```

5. Place the **oc** binary in a directory that is on your **PATH**.
To check your **PATH**, execute the following command:

```
$ echo $PATH
```

After you install the CLI, it is available using the **oc** command:

```
$ oc <command>
```

3.5.11.2. Installing the CLI on Windows

You can install the OpenShift CLI (**oc**) binary on Windows by using the following procedure.

Procedure

1. Navigate to the [Infrastructure Provider](#) page on the Red Hat OpenShift Cluster Manager site.
2. Select your infrastructure provider, and, if applicable, your installation type.
3. In the **Command-line interface** section, select **Windows** from the drop-down menu and click **Download command-line tools**.
4. Unzip the archive with a ZIP program.
5. Move the **oc** binary to a directory that is on your **PATH**.
To check your **PATH**, open the command prompt and execute the following command:

```
C:\> path
```

After you install the CLI, it is available using the **oc** command:

```
C:\> oc <command>
```

3.5.11.3. Installing the CLI on macOS

You can install the OpenShift CLI (**oc**) binary on macOS by using the following procedure.

Procedure

1. Navigate to the [Infrastructure Provider](#) page on the Red Hat OpenShift Cluster Manager site.
2. Select your infrastructure provider, and, if applicable, your installation type.
3. In the **Command-line interface** section, select **MacOS** from the drop-down menu and click **Download command-line tools**.
4. Unpack and unzip the archive.
5. Move the **oc** binary to a directory on your **PATH**.
To check your **PATH**, open a terminal and execute the following command:

-

```
$ echo $PATH
```

After you install the CLI, it is available using the **oc** command:

```
$ oc <command>
```

3.5.12. Logging in to the cluster

You can log in to your cluster as a default system user by exporting the cluster **kubeconfig** file. The **kubeconfig** file contains information about the cluster that is used by the CLI to connect a client to the correct cluster and API server. The file is specific to a cluster and is created during OpenShift Container Platform installation.

Prerequisites

- Deploy an OpenShift Container Platform cluster.
- Install the **oc** CLI.

Procedure

1. Export the **kubeadmin** credentials:

```
$ export KUBECONFIG=<installation_directory>/auth/kubeconfig 1
```

- 1** For **<installation_directory>**, specify the path to the directory that you stored the installation files in.

2. Verify you can run **oc** commands successfully using the exported configuration:

```
$ oc whoami
```

Example output

```
system:admin
```

To learn more, see [Getting started with the CLI](#).

3.5.13. Verifying cluster status

You can verify your OpenShift Container Platform cluster's status during or after installation.

Procedure

1. In the cluster environment, export the administrator's kubeconfig file:

```
$ export KUBECONFIG=<installation_directory>/auth/kubeconfig 1
```

- 1** For **<installation_directory>**, specify the path to the directory that you stored the installation files in.

The **kubeconfig** file contains information about the cluster that is used by the CLI to connect a client to the correct cluster and API server.

2. View the control plane and compute machines created after a deployment:

```
$ oc get nodes
```

3. View your cluster's version:

```
$ oc get clusterversion
```

4. View your operators' status:

```
$ oc get clusteroperator
```

5. View all running Pods in the cluster:

```
$ oc get pods -A
```

Troubleshooting

If the installation fails, the installation program times out and displays an error message. To learn more, see [Troubleshooting installation issues](#).

3.5.14. Accessing the OpenShift Container Platform web console on RHV

After the OpenShift Container Platform cluster initializes, you can log into the OpenShift Container Platform web console.

Procedure

1. Optional: In the Red Hat Virtualization (RHV) Administration Portal, open **Compute** → **Cluster**.
2. Verify that the installation program creates the virtual machines.
3. Return to the command line where the installation program is running. When the installation program finishes, it displays the user name and temporary password for logging into the OpenShift Container Platform web console.
4. In a browser, open the URL of the OpenShift Container Platform web console. The URL uses this format:

```
console-openshift-console.apps.<clustername>.<basedomain> 1
```

1 For **<clustername>.<basedomain>**, specify the cluster name and base domain.

For example:

```
console-openshift-console.apps.my-cluster.virtlab.example.com
```

3.5.15. Troubleshooting common issues with installing on Red Hat Virtualization (RHV)

Here are some common issues you might encounter, along with proposed causes and solutions.

3.5.15.1. CPU load increases and nodes go into a Not Ready state

- **Symptom:** CPU load increases significantly and nodes start going into a Not Ready state.
- **Cause:** The storage domain latency might be too high, especially for master nodes.
- **Solution:**
Make the nodes Ready again by restarting the kubelet service. Enter:

```
$ systemctl restart kubelet
```

Inspect the OpenShift Container Platform metrics service, which automatically gathers and reports on some valuable data such as the etcd disk sync duration. If the cluster is operational, use this data to help determine whether storage latency or throughput is the root issue. If so, consider using a storage resource that has lower latency and higher throughput.

To get raw metrics, enter the following command as kubeadmin or user with cluster-admin privileges:

```
$ oc get --insecure-skip-tls-verify --server=https://localhost:<port> --raw=/metrics`
```

To learn more, see [Exploring Application Endpoints for the purposes of Debugging with OpenShift 4.x](#)

3.5.15.2. Trouble connecting the OpenShift Container Platform cluster API

- **Symptom:** The installation program completes but the OpenShift Container Platform cluster API is not available. The bootstrap virtual machine remains up after the bootstrap process is complete. When you enter the following command, the response will time out.

```
$ oc login -u kubeadmin -p *** <apiurl>
```

- **Cause:** The bootstrap VM was not deleted by the installation program and has not released the cluster's API IP address.
- **Solution:** Use the **wait-for** subcommand to be notified when the bootstrap process is complete:

```
$ ./openshift-install wait-for bootstrap-complete
```

When the bootstrap process is complete, delete the bootstrap virtual machine:

```
$ ./openshift-install destroy bootstrap
```

3.5.16. Post-installation tasks

After the OpenShift Container Platform cluster initializes, you can perform the following tasks.

- **Optional:** After deployment, add or replace SSH keys using the Machine Config Operator (MCO) in OpenShift Container Platform.

- Optional: Remove the **kubeadmin** user. Instead, use the authentication provider to create a user with cluster-admin privileges.

3.5.17. Next steps

- [Customize your cluster.](#)
- If necessary, you can [opt out of remote health reporting](#) .

3.6. UNINSTALLING A CLUSTER ON RHV

You can remove an OpenShift Container Platform cluster from Red Hat Virtualization (RHV).

3.6.1. Removing a cluster that uses installer-provisioned infrastructure

You can remove a cluster that uses installer-provisioned infrastructure from your cloud.

Prerequisites

- Have a copy of the installation program that you used to deploy the cluster.
- Have the files that the installation program generated when you created your cluster.

Procedure

1. From the computer that you used to install the cluster, run the following command:

```
$ ./openshift-install destroy cluster \  
--dir=<installation_directory> --log-level=info 1 2
```

- 1** For **<installation_directory>**, specify the path to the directory that you stored the installation files in.
- 2** To view different details, specify **warn**, **debug**, or **error** instead of **info**.



NOTE

You must specify the directory that contains the cluster definition files for your cluster. The installation program requires the **metadata.json** file in this directory to delete the cluster.

2. Optional: Delete the **<installation_directory>** directory and the OpenShift Container Platform installation program.